No.296

THE BEST MAG FOR MAKERS, MODEL AND HOBBY ENGINEERS

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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: Andrew Tompkins

ADVERTISING
Business Development Manager: Angela Price
Email: angela.price@mytimemedia.com

MARKETING & SUBSCRIPTIONS
Subscriptions Executive: Beth Ashby-Njiiri
Email: beth.ashby@mytimemedia.com

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

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On the Editor's Bench

Welcome Back

When I wrote my last editorial, it was still uncertain whether or not we would be able to resume overseas subscriptions. I'm please to say that as of that last issue its seems that all overseas distribution is up and running again. We did our best to contact people and let them know what was happening, but I know a few people 'slipped through the net' as I have been in contact with them.

I'd like to thank all overseas readers for their patience and forbearance as we have been through a very difficult time for the magazine, as indeed has every one of us. I'd also like to thank Beth and Roberta at MyTimeMedia who have done sterling work in keeping readers informed and handing their subscription queries.

A 'Lockdown Project'

Like most readers I have done a fair few 'lockdown' projects. Most of these have had an astronomical focus and range from making a simple refractor telescope using bits and pieces at hand to making an Arduino controlled 'equatorial platform' so I can track stars and planets with my big Dobsonian reflector. All this has been a little more challenging than usual with much of my workshop stashed away, limiting how much metalworking I could do. I also fancied something a little different from the usual, so I bought a (ridiculously) cheap bass guitar kit by Harley Benton. Essentially this requires no more than shaping the headstock and finishing that and the body with suitable paint or lacquer, screwing it all together and setting it up. I decided to go with 'daphne blue' as one of my favourite vintage colours, in nitrocellulose. Although it's not perfect, after some attention with 1500 grit wet and dry and lots of T-cut it came up to a nice shine. Strung with Fender flatwound strings it honestly plays and sounds like a guitar ten times the price. If you are a musician looking for a quick but rewarding project, you could do worse than making such a kit.

Stevenson Trophy

The 'virtual' competition in the name of John Stevenson will have closed by the time you get this issue. We have received some really good entries and I am expecting to feature them in the next issue, together with a link to the voting pages. Thanks to everyone who has entered.

Stay safe and well,


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Coming up...

in our next issue

Coming up in our October issue, number 297 another great read

Regulars

ON THE COVER

Our cover shows Rev. Ian Strickland's outstandingly well made 5" rotary table. Ian made his own castings for this very usable piece of equipment.

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THIS MONTH'S BONUS CONTENT

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Any questions? If you have any questions about our recent Lathework for Beginners or Milling for Beginners series, or you would like to suggest ideas or topics for future instalments, head over to **www.model-engineer.co.uk** where there are Forum Topics specially to support these series.

Our Web forum continues to be exceptionally busy, and we have welcomed many more new members.

The forum is a 'safe space' for anyone with an interest in model and hobby engineering to come and join one of the busiest and friendliest model engineering forums on the web at **www.model-engineer.co.uk**? As well as plenty of engineering and hobby related discussion, we are happy for forum members to use it to share advice and support. If you feel isolated by the lockdown do join us and be assured of a warm welcome.

Testing Models
Thoughts on testing the power output of model steam engines and turbines.

Quorn using E32 collets
It's an obvious upgrade to a classic design for a tool and cutter grinder. Do you have any thoughts or experience to share?

Guard rails and stanchions.....how do you make yours?
Do you have any tips on making railings and the like for your models?

CLASSIFIEDS EXTRA SUBSCRIBE ARCHIVE SUPPLIERS

A Perfect Bench Drill?

Ray Griffin sets out the case in favour of his Cincinatti bench drill

I should be stronger but could not resist temptation; a friend was clearing out his garage and asked if I would like a bench drill hidden in the shadows. He said that it was a good make but missing the motor and motor pulley. It fitted into the boot of the car and was soon on my drive, **photo 1**. Included with the drill was a Morse taper drill set, comprising 5 to 14mm inclusive in 0.5 increments with No1 tapers, 14.5 to 20mm in 0.5 increments, and 21, 22 and 23mm in 1mm increments all Morse No2, also 24 and 25mm with No 3 Morse.

Although it looked grubby, the machine appeared solidly built with no damage. The makers plate indicated that it was a Cincinnati Milacron type MT. Internet searches suggest that the motor was probably a 0.55kW dual voltage by Leroy-Somer. A plate listing speeds indicated eight choices from 330- 6000 rpm: though this was useless information, as the motor and its pulley were missing. Before spending money or time on the machine it seemed sensible to decide whether it would be useful to me, and whether I had room for it in my workshop. I don't know how other people put together their collections of tools. Possibly, some start with a plan and work to that end. I seem to have assembled a set of machines on an eclectic basis. Things have come along over the years that seemed good at the time, were a bargain, or I was attracted to them because they were a joy to the eye. My workshop measures 3.5 by 5.5 metres and feels crowded as it is, so a review of drilling facilities seemed sensible. Did I really need another machine to drill holes? For some years, the mainstay has been a Boxford bench drill, **photo 2**. This is a well-made, capable machine, with spindle speeds of 620, 1100, 1840 and 3240. The chuck accepts drills from 1⁄32" to ½". There is a very useful working distance of 340mm between the drill chuck and base. A downside of this machine is the number 1 Morse taper in the spindle. I can only

Drill, gifted from a friend

Boxford bench drill

Aciera high speed drill

use a drill chuck fitted with a No. 1 Morse arbor, or drills with No.1 shanks, in the Boxford. I recall published comments suggesting that the No. 1 arbor lacks rigidity with large drills. I also have an Aciera sensitive drilling machine, **photo 3**. It is superbly engineered, heavy and solidly built; with a drill chuck that accommodates drills from 0mm to 4mm. There are two speed ranges offering 10,000, 6,500, 4,800, 3,800, 2,000 and 1,100 rpm, driven by a large three phase motor. Down feed is actuated by the pressure of one finger on a lever on the side of the machine. A superb device for drilling very small holes. To be honest, I have never had a job that required this level of sensitivity. So, it has always occupied space on the bench "for a job in the future". Then there are the two milling machines, which of course can be used for drilling holes. The first is an EMCO FB2 with its No. 2 Morse taper in the spindle. A fabulous little machine that is accurate and versatile. Drills can be held in an ER 25 collet chuck or a conventional drill chuck mounted on a No. 2 Morse taper arbour. I have reservations about using this machine for large drills; I somehow feel that large drills would be out of place on this small precision mill. My other mill is a Major HSU1. This is a heavy, versatile and accurate machine; built by Haighton in Burnley, UK in the 1950s. Equipped with a 2hp three phase motor, it is great for horizontal and vertical milling operations, but has limited use for drilling. The short distance between the quill and the table only allows small drills to be used. With an ER32 collet chuck, and a 6mm drill, there is only

Poor working distance on Haighton mill using ER32 collets

15mm to the top of the vice, **photo 4**. The distance to the table is 75mm. I have a 200DA collet chuck which gives a bit more head room, **photo 5**, however there is still only 25mm between the tip of a 6mm drill and the top of the vice or 85mm to the surface of the table. As can be seen from **photo 6**, conventional chucks mounted on the Int 30 arbours used on this mill are unworkable. Large diameter drills of normal length are too long. It is possible to turn the vertical milling head through 90° giving greater distance between the quill and work bolted to the table but returning the head to a truly vertical milling position is time consuming. It is also possible to use my Myford Super 7 Connoisseur for drilling operations, but it lacks the flexibility of a dedicated drilling machine. Following my review, I convinced myself that there was a place for the Cincinnati.

I cleaned the machine, removed old wires and set it up on a bench. The first thing to do was to test the spindle and bearings. The pad to mount the motor is substantial. **photo 7**, and includes a rack and pinion to adjust tension of the belt. I had an old single-phase motor, rated at ⅓ HP and operating at 1425 rpm and decided to use this for a test under power. Holes in the foot mount did not match the bolting holes the mount provided, so I took a piece of

Slight improvement using DA200 collets

¼" thick aluminium plate and drilled holes to match the mounting plate and the motor. The motor was soon bolted in place with a 3½" pulley attached to the spindle. The original stepped pulley remained on the spindle of the drill and was pressed into service, as I could not see how to remove it. I had a choice of four diameters 7¾", 7¼, 6⅜" and 5⅝" measured on the outer diameter of the

A section V belt pulley. I could not find an appropriate V belt in my collection so purchased a length of link belting. I had used this in the past on my milling machine, but for that chose the more expensive fibre-based product, which proved very satisfactory. For testing the drill, I used a cheaper plastic-based belt. It was satisfactory for that purpose but must be replaced with a V belt when the final length is decided. The plastic belt did not slip under load but was very noisy. I decided to use the 6⅜" pulley coupled with the motor pulley. The motor was switched on; the drive shaft rotated smoothly, and the down feed mechanism functioned perfectly. It was time to think about a new motor. As the original motor pulley was missing, I decided to use a single pulley and a variable speed motor. My lathe has a three-phase motor connected to single phase supply through an inverter. This has been a joy to use and provides a good range of speeds with no apparent (to me) reduction in power at the lowest speed setting. Where to purchase the motor and inverter? I have seen queries on the Model Engineer website from people that have obtained motors and controls from eBay style sources. Questions seem based on complexities of matching motors, inverters and controls supplied with unintelligible

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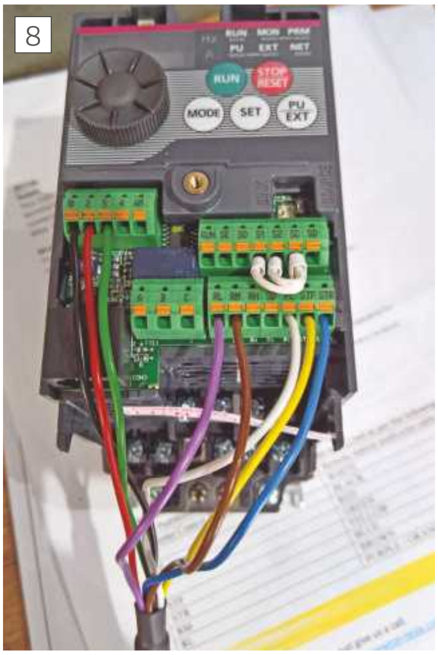
Hopeless using drill chuck

7

Motor mount on Cincinnati drill

instructions. It seemed to me more straightforward to buy a package of all components and competent instructions, from a clearly identifiable source. Perhaps this is a more expensive way of doing it, but I would get something that worked with guarantees of quality. I chose one of the suppliers that advertise regularly in magazines for model engineers. I made the phone call and received clear advice on the size of motor and accessories. This was available as a package which I paid for and it duly arrived in a substantial box. I wired the pieces together as test set up on the bench, to check that I had the wires in correct positions, **photo 8**. The motor turned silently at all setting of the speed controller. So, on to fitting to the drill. This was straightforward, I took a piece of aluminium plate ¼" thick and cut it to a size that would bolt to the motor plate on the drill and accept the foot mounting of the motor. Positions for mounting holes were found so that the spindle of the motor projected sufficiently into the shielded space for pulleys and the belt. This was almost the hardest part of the job as the motor is heavy and needed to be held in position. I did it by supporting the motor on blocks of wood. Once the position was established, the positions for holes were marked. I needed to drill and tap the holes with 6mm threads to hold the motor as there was insufficient



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Test of connections on inverter

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Three phase motor fitted to drill

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Good curls of steel swarf using large drill

11

Testing 1mm drill

12

Using the Boxford to drill my 1" Minnie boiler

space between the aluminium plate and plate on the drill to use nuts and spanners. **Photograph 9** shows the motor in place. Everything was bolted up and the 3½" pulley with its steel key fitted in place, in line with the 6⅜" pulley. The inverter and hand control were placed in convenient positions. The length of link belting was adjusted, giving mid travel on the belt tensioning arrangement. The motor was switched on and proved satisfactory at highest and lowest settings of the speed controller. Using an old Record mechanical revolution counter, speeds were recorded as follows, lowest power 75rpm, 50% power 408rpm and full power 910rpm. It is hard to be precise on correct speeds to use for drilling. I compiled a chart, **Table 1**, from four sources, and some variation in recommendation is clear. I decided to use the speeds available on my modified Cincinnati and see what happened; drilling into a piece of mild steel ½" thick, using drills from 1mm diameter at 910rpm to 23mm diameter at 75rpm. These speeds were well below recommendations in the chart. Drills cut into the metal easily; with larger drills producing long spirals of swarf, **photo 10**. I drill a small pilot hole before using larger sizes. The 1mm drill,

Table 1 *Comparison of recommended speeds for drilling metal*

Source	Metal	Drill diameter 1/8"	Drill diameter 5/16"	Drill diameter 1/2"	Drill diameter 7/8"
		rpm	rpm	rpm	rpm
A	Aluminium	9170	3660	2287	1307
B	Aluminium	as fast as possible	2950	1850	1050
C	Aluminium	as fast as possible	2950(8.5mm)	1850(12.5mm)	1050(22mm)
D	Aluminium	3000	2500	1500	1000
A	Brass	9170	3660	2287	1307
B	Brass	4500	1800	1140	650
C	Brass	3400(4mm)	1800(8.5mm)	1140(12.5mm)	650(22mm)
D	Brass	3000	1200	750	400
A	Steel	3056	1222	764	436
B	Steel	3100	1220	760	430
C	Steel	1700(4mm)	1220(8.5mm)	760(12.5mm)	430(22mm)
D	Steel	3000	1000	600	350

NOTES
A= Machinery's Handbook 15th Edition 1955
B= The Model Engineer's Handbook, Tubal Cain, 3rd Edition, 1996
C= Drills, taps and dies, Tubal Cain, Workshop Practice Series No 12, 2002
D= Wood Magazines drill press speed chart, Model Engineer's Workshop Forum Dec 2018
Perhaps not surprising that recommended speeds in B and C are mostly the same, as they are from the same author
In my workshop, as fast as possible = 10,000rpm

photo 11, went through smoothly and appeared to look good. However, I was deceived by appearances. The drill was removed from the chuck and tapped through the hole to check the path. To my horror, the exit hole deviated 0.6mm from the entry. A check of the larger drills showed that entries and exits were in line. What was happening with the 1mm drill? My conclusion was that at 910rpm, the top speed of the Cincinnati was too slow, and drill was not cutting fast enough for the down feed pressure, which forced the drill to deviate. I tested this using the same drill and steel block in the Aciera high speed drill at 10,000rpm. There is little chance of exerting too much pressure with this machine. Light pressure from one finger is applied on a short lever. There is not a rack coupled to a long lever on the down feed. The drill passed through the test block smoothly. A final test using the entry and exit holes demonstrated that there was no deviation from the proper track. My conclusion was that the Cincinnati drilled holes accurately down to $\frac{1}{16}$”; smaller than that, higher speeds are required. I think that the Cincinnati will be satisfactory using drills below $\frac{1}{16}$” on thinner metal, as the drill has little opportunity to wander.

The Cincinnati has now taken over as my mainstay for drilling. There is a quiet hum from the motor, even when running at full speed. Since changing the cheap plastic link belt for a standard rubber belt, the machine is smooth and quiet at all speeds. Was it worth the effort and cost? Well, for the cost of the motor, inverter and control box, I could probably have purchased a new machine. But few would compete with the rigidity and effortless capacity of the Cincinnati. The answer is a most definite yes. I can now, readily, drill holes up to 23mm diameter. Will I offload the Aciera and Boxford? Well, I’ve already shown that the Aciera will be required for using very small drills. Whilst this article was in preparation, the Boxford made its presence felt. I needed to drill some holes in the boiler of my 1” Minnie traction engine model, to attach the cylinder block. The drilling process needed a fine level of control to ensure that the drill did not pass through the outer layer of the boiler and damage the boiler tubes beneath. Also, the Minnie boiler is a large clumsy structure to accommodate, as can be seen from the photograph, **photo 12**. Then another job arose; requiring a large gap between the drill and base. Some time ago, I fitted a DRO system to my Myford Connoisseur Super 7 Lathe. The magnetic strip for the cross-slide travel was mounted on aluminium section bolted in place using the Tee slots on the right-hand edge of the cross slide. At the Midlands Model Engineering Exhibition in 2018 I saw an improved version of this, which required a slot to be cut in the underside of the cross slide and a bracket fixed to the rear of the cross slide. The Boxford accommodated it easily as seen in **photo 13**. The title of this article poses a question and the answer for me is that none of my drilling machines makes any of the others redundant. I wish a single replacement could be found for the three of them. ∎

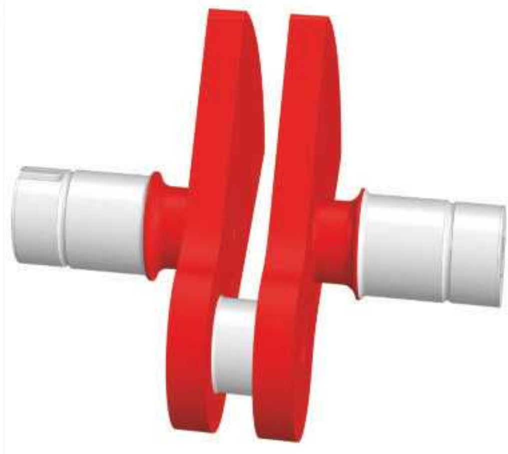
The Boxford used to drill the Myford cross slide

NEXT ISSUE

MODEL ENGINEER

- **Crank Axle**
  Graham Langer explains how the A1 Steam Locomotive Trust approached the design of the crank axle for the new-build P2 locomotive Prince of Wales.

- **Grasshopper**
  Stewart Hart builds a model of a ‘grasshopper’ engine, used originally for hauling minerals up an incline at an alkaline works.



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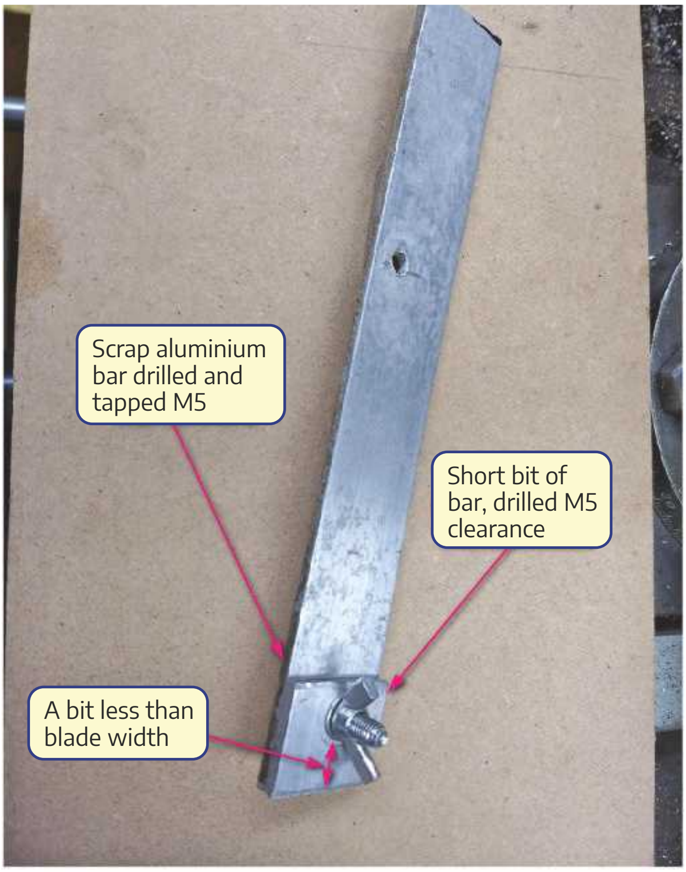
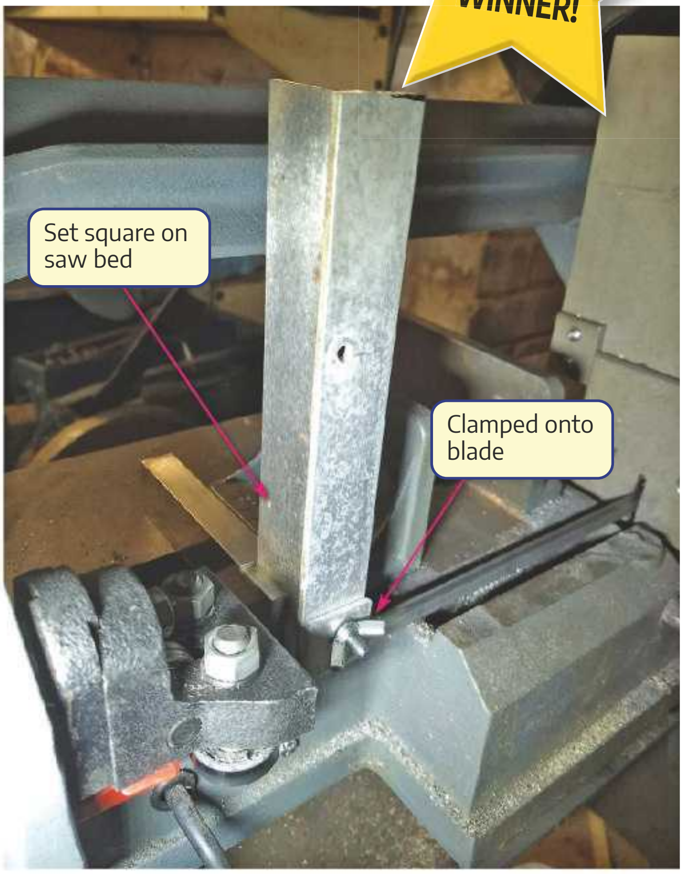
Readers' Tips

Bandsaw Blade Setting Aid

TIP OF THE MONTH WINNER!





This month our lucky winner of £30 in Chester gift vouchers is Gary Wooding who had to deal with setting up a misbehaving bandsaw.

I've got a very standard 6x4 horizontal bandsaw and have had lots of problems with it shedding it's bi-metal blade.

I've spent a long time with a set-square trying to align the blade vertically, and thought I'd managed it when 100mm deep cuts in 10mm thick metal were fine and beautifully square, But when I had to cut an 80x80mm chunk, the blade came off after a depth of 30mm. The blade 'looked' fine and unworn, but after putting it back to continue the cut, it was obvious that the bottom of the cut was not in line with the top, but I'd already checked the blade with a set-square!

I made up the little gizmo shown in the photo. It's just a bit of scrap aluminium bar, approximately 1/8"x1"x7", with another 1" bit of the same bar bolted to one end with an M5 screw and wing-nut. The long bar is threaded so that the screw is captive. The position of the screw allows the gizmo to clamp the blade without touching the teeth.

When clamping the gizmo to the blade at the extremities of the cutting space, it's very easy to check alignment accurately with the set-square. One end was accurate, but the other was out by about 1 or 2 degrees - too small to see with the set-square alone against the blade. After re-adjusting the blade, I was able to cut the big lump without shedding the blade.

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. You can make multiple entries, but we reserve the right not to award repeat prizes to the same person in order to encourage new entrants. All prizes are at the discretion of the Editor.

Scribe a line

YOUR CHANCE TO TALK TO US!

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

Drill Gauge

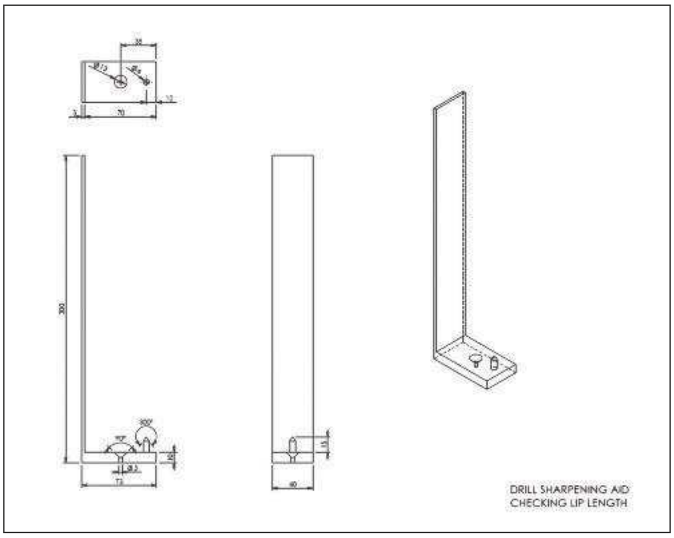
Dear Neil, I enjoyed Howard Lewis' article "A Simple Drill Grinding Aid" issue 293. A great little project for a newcomer and one that will certainly provide the basics to coming to grips with drill sharpening that so many find a challenge.

I have attached a photo of another simple aid I discovered many years ago. By using Howard's tool to ensure similar angles this aid ensures both cutting lips are the same. The jig can be fabricated from whatever scrap is available and requires a base approx. 70mm x 40mm with a sharp pointed spigot ideally 60 degrees or more, located approx. 15mm from one end on the centre line. On the other end of the base a perpendicular flat section is firmly attached and should be approx. 300mm high x 40mm wide.

Checking for equal lip lengths is made by holding the drill upright and placing the centre hole in the back of the drill onto the spigot and leaning the drill over towards the vertical flat section rotating it so that the corner edge of the lip is able to scratch a line on the vertical flat, by rotating the drill 180 deg. the other corner can scratch a line. If the lips are equal the two scratch lines will show as one, if not then the higher mark lip will require a touch up to get it right. Black marker pen is ideal to apply to the vertical flat section in order to highlight the scratch.

This aid is all very well for larger drills that have a centre hole in the back, however, by drilling a 90deg countersunk hole in the base aft of the spigot, normal jobber drills etc. can be checked by putting the back end into the countersink, the diameter of the countersink at the top surface will need to be large enough to check a 12mm drill at least.

Rex Goadby, North Queensland. Australia



From the Archives

Dear Neil, It was probably a necessity for you but I think the inclusion of articles from the archives is a great idea, there's plenty of good stuff back there. It reminded me of a now sadly defunct publication over here: "Electronics Australia"; they ran a service allowing you to purchase reprints of previous articles. I'm sure many of your readers would enjoy a similar service. The same would apply to Model Engineer and its readers - possibly more so given that its history goes back to the 19th century.

Stay safe in these troubled times,

Joe Harland, Melbourne Australia

Wide Guides

Dear Neil, a friend of mine here in New Zealand receives the " Model Engineers Workshop " and passes them onto me to read.

I noticed in last November's issue (287) a article on converting Myford 7 ins lathes to wide guiding of the saddle .As my super 7 is a narrow guide this greatly interests me as my lathe had a bit of slack that I could no adjust out.

I went ahead and converted mine to wide guide using a piece of 1/16 x 1/2 gauge plate 71/2 ins long and securing it onto the rear strip of the saddle, Had to machine 0.047 of the saddle and secured the gauge plate with two 3/16 dowels slightly under the plate face surface. This was only completed 4 days ago and then same day I received issue 288.

Lo and behold, another article (In Scribe a line) on the same subject. As this modification really takes care of any slackness with the bed to saddle fitment and makes a very usable lathe and a breeze to use. I can not see why Myford used the short narrow guide in the first place.

Ally Stephens, New Zealand.

Arduino Tacho

Dear Neil, My Axminster C2/300 lathe is not fitted with a speed readout nor does it have a facility to fit one. Because of this I was very interested in the article in issue 294 about an Arduino based tacho. The unit appears very simple in that most of it is made up from two main modules (the Arduino itself and the display) plus three other components and a power supply. Duncan said in his article that he would post the code on the ME forum, I have found Duncan's post, but this is where I start to run into problems. I have no worries about assembling electronic circuits, but I have no idea how to get the code from the post on the ME forum and into the Arduino.

The post on the ME forum also throws up some other problems:

1 Duncan said in the post that he calibrated his unit against another tacho but makes no mention about calibration in the MEW article.

2 From other posts on the forum it appears that the UGN3040 sensor has been discontinued. Duncan said that OH3144 or 49E could be substituted but does this require any changes to the value of the components, the connections or the code?

3 Duncan said that his tacho was not fitted to the final output shaft but to another shaft with a ratio of 8:7. What changes would need to be made for the tacho to be fitted on the main shaft of my lathe?

I am of a similar opinion to Davina Elaine Hocking in MEW 295 in that more information is required to enable the average reader to make a working tacho. How about a follow up article to tie up the loose ends? I would still be interested in making one if I can sort out these few minor problems.

Tom Cooksley, by email.

I'm glad to say Duncan has kindly provided more details on the forum at www.model-engineer.co.uk, including a download link for the Arduino file which can be opened and sent to an Arduino) using the Arduino IDE – free software available from www.arduino.cc.

Myford T-Slot inserts (on the cheap)

Dear Neil, I was having a squint on Ebay and could not help noticing many sellers advertising inserts for lathe cross slide Tee slots. I immediately thought of your latest (and recent) articles ref. 3D printing...ahh money maker! However, are we losing the plot?

My dear old Dad used to leave the slots empty (as do I) unless he wanted to commence numerous lathe tasks involving resetting the cross slide with other tooling/ accessories during manufacture.

The drill was clean all Tee slots with a small brush then roll up some sheets kitchen/toilet roll, give it a squirt of cheap oil and pack into the tee slot... easy peasy.

When the job required a refit on the cross slide, just lift out the packing, remove the swarfy sheet from the roll and upon completion when resetting the slide back to normal config. Just replace the rest of the kitchen roll if required. Much cheapness! And quickness and time saving, yes I know it is a hobby but..human nature.

I must add that during my 'squint' I realised that old Myford kit is becoming very expensive and that perhaps I should start selling surplus accessories.

It has taken me years to get around to even thinking about releasing surplus kit and when I do...Oh! It just goes to show how fragile the basis of society can become in so short a period of time.

Your latest 3D experiment I hate to admit started to get my attention. I have been involved in Nuclear Science and Engineering all my past career and I have until now shied away from having to embrace new technology in retirement...yes lazy! But you never should switch off the button. Only problem, I am no longer the project manager... guess who is?

Steve Middleyard, in Hyberborea

Thread Sizing Chart

Dear Neil, I have prepared the attached table to consolidate references when trying to identify small screws. As you know you have to look at various tables to check the various types and not all are in the handy tables in the charts in the workshop. I tend to keep my reference books indoors, so this table streamlines the process. With the outside diameter and TPI you can quickly check along the table. The Tapping Drill size is that for 70% engagement which I find excellent for grip and ease of tapping. If you think there is some merit, please feel to publish in scribe a line.

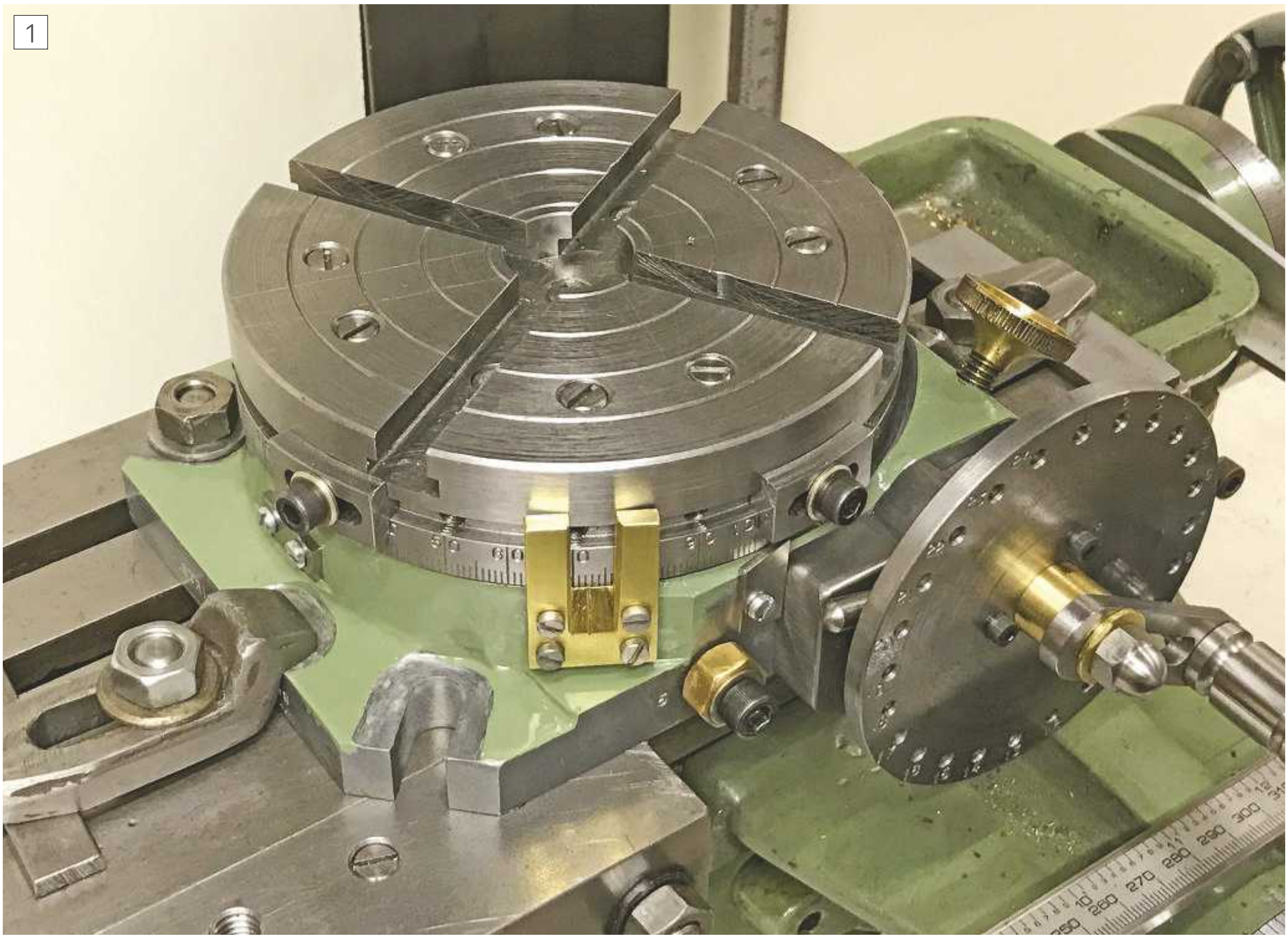
Stuart McPherson

Size		Metric Coarse		Metric Fine			BSF			BSW
		mm/TPI/Tap D								
1		1/101.60/0.79		1/127/0.83		3/16	0.1875/32/4.05		1/16	0.0625/60/1.21
2		2.0/63.5/1.66		2/101.6/1,79		7/32	0.2188/28/4.74		3/32	0.0938/48/1.91
3		3/50/80/2.57		3/72.57/2.7		1/4	0.2500/26/5.47		1/8	0.1250/40/2.61
4		4.0/36.29/3,40		4.0/50.80/3.57		5/16	0.3125/22/6.90		5/32	0.1562/32/3.26
5		5.0/31.75/4.31		5.0/50.80/4.57		3/8	0.3750/20/8.39		3/16	0.1875/24/3.81
6		6.0/25.4/5.14		6.0/33.87/5.36		7/16	0.4375/18/9.85		7/32	0.2188/24/4.61
7		7.0/25.40/6.14		7.0/33.87/6.36		1/2	0.500/16/11.28		1/4	0.2500/20/5.21
8		8.0/20.32/6.93		8.0/33.87/7.36		9/16	0.5625/16/12.86		5/16	0.3125/18/6.67
		UNC		UNF			BA 10>0			Model Engineer
1		0.0730/64/1.51	0	0.600/80/1.25		10	1.7/72.57/1,41		1/8	0.1250/40/2.61
2		0.0860/56/1.79	1	0.0730/72/1.55		9	1.90/65.13/1.57		3/32	0.1562/40/3.4
3		0.0990/48/2.06	2	0.0860/64/1.84		8	2.20/59.07/1,84		3/16	0.1875/40/4.19
4		0.1120/40/2.30	3	0.990/56/2.13		7	2.50/52.92/2.10		7/32	0.2188/40/4.99
5		0.1250/40/2,63	4	0,1120/48/2.39		6	2.80/47.92/2.35		1/4	0.2500/40/5.78
6		0.1380/32/2.82	5	0.1250/44/2.68		5	3.20/43.05/2.70		5/16	0.3125/40/7.37
8		0.1640/32/3.48	6	0.1380/40/2.96		4	3.60/38.48/3.05		3/8	0.3750/40/8.96
10		0.1900/24/3.92	8	0.1640/36/3.56		3	4.10/34.79/3.49		1/4	0.2500/32/5.64
			#	0.1900/32/4,14		2	4.7/31.36/4.02		9/32	0.2813/32/6.43
						1	5.3/28.22/4.54		5/16	0.3125/32/7.23
						0	6.0/25.40/5.16		3/8	0.3750/32/8.81

Scribe a Line continues on page 53

A 5" Diameter Rotary Table

Ian Strickland details the making of a fine piece of workshop tooling based on an original design by G.G. Tardrew.

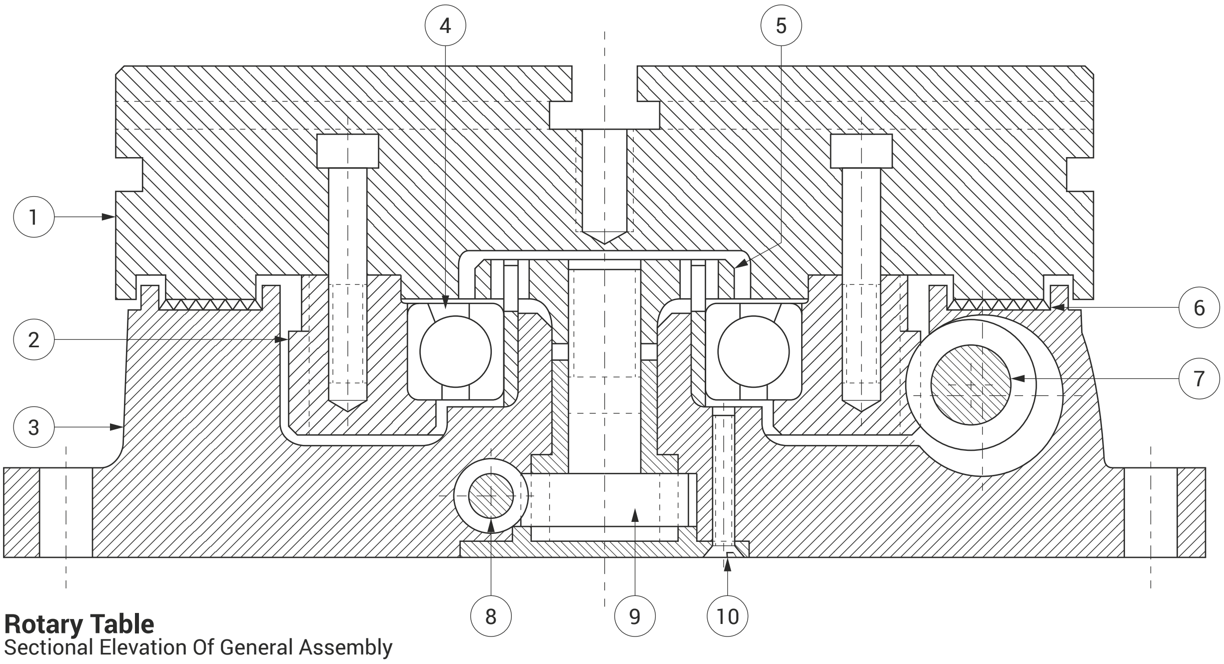


Finished and painted.

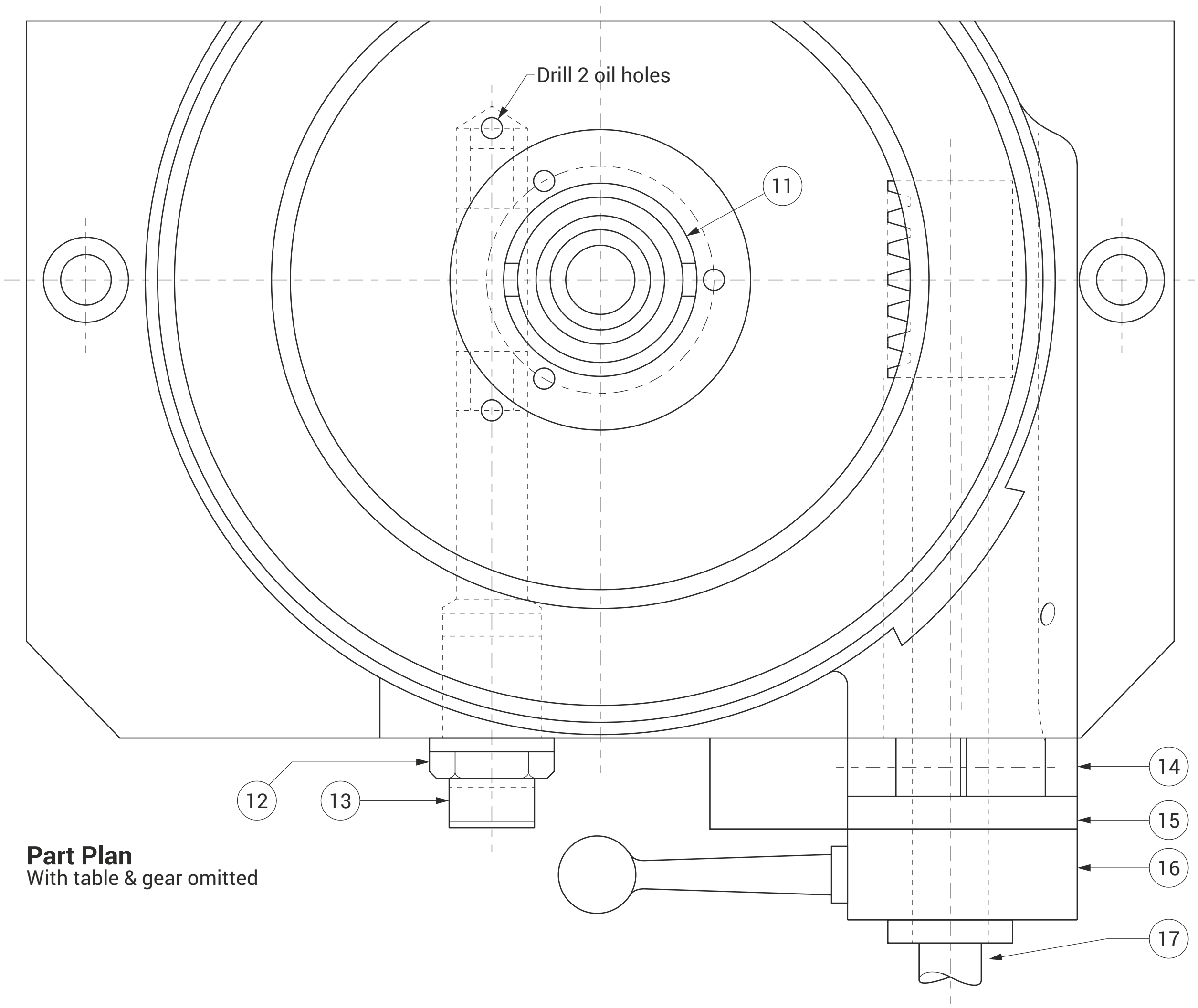
For some time I fancied having a rotary table for my small milling machine, **photo 1**. Having looked at what is available commercially, 6" was too large for my mill, and 4" was too small. Also, the commercially available rotary tables were rather tall for my mill which has limited "daylight" between the quill and the table. I remembered seeing an M.E., article way back in February 1984, about making a 6" rotary table, **ref. 1**. It was by G.G. Tardrew of South Africa and incorporated a damping control, a friction arrangement using Tufnol to provide the friction material. Built in was a clamping device operated by a small worm driving a worm gear which pulled the table down onto the friction material by pulling down on the inner race of the ball race, the outer race being fixed to the underside of the table via the worm gear. One can either lock it down solidly so the table cannot be moved by its own worm and wheel, or have enough friction to allow the table to be rotated but with enough friction to stop the table moving under the action of the cutter. The various internal moving parts run in oil, so the table can only be operated in the horizontal mode otherwise oil will slowly leak out from under the periphery of the table. In the original design 'O' rings were incorporated in a couple of places to keep the oil within, of which more later. I have found that with close fitting of the moving parts (parts 7, 8, & 16), I have had no oil leakage problems.

I set about scaling his design down to 5" diameter. Five sixths of the original size is 83.3333%, so I used 83±%. The final diameter was a little under 5.25".

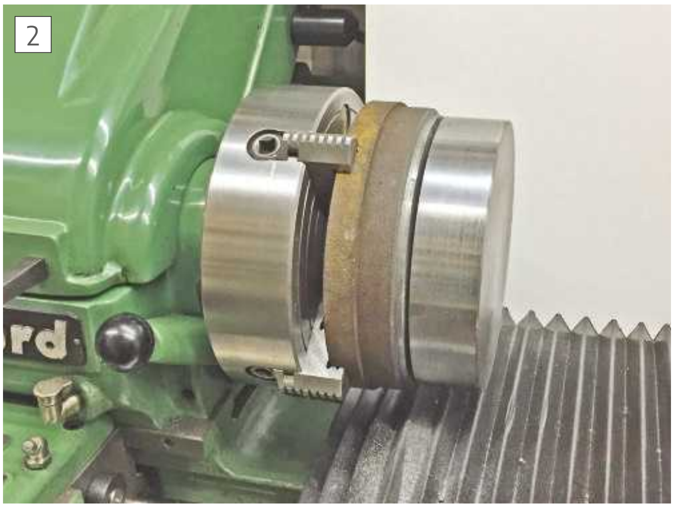
Fig.1

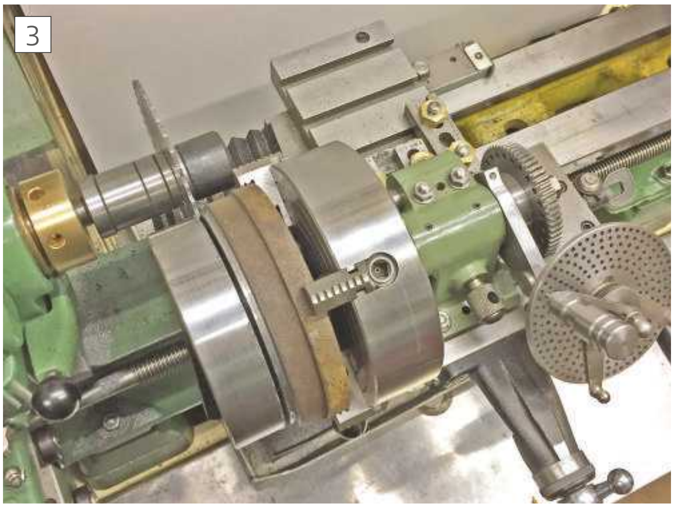


Rotary Table
Sectional Elevation Of General Assembly

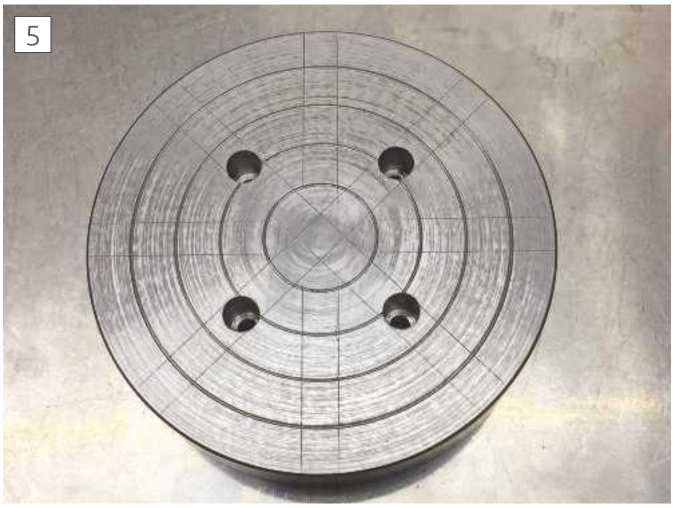


Part Plan
With table & gear omitted


2
Part 1, embryonic table top.


3
Second stage of parting off.


4
Final stage with a hacksaw.

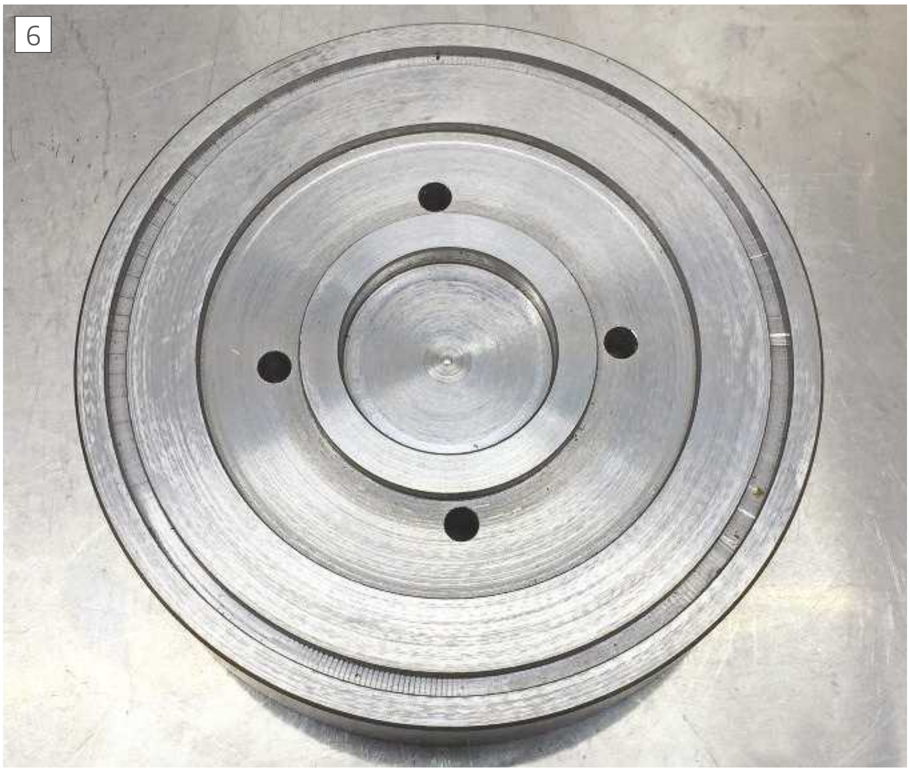

5
Top marked out for 'T' slots.

The finished height is a whisker under 2.5".

Figure 1 is Mr Tardrew's, but with my alteration to show T slots for clamping. It shows a sectional elevation and part plan. **Figure 3** shows my dimensions for the Table (Part 1) and the Base (Part 3).

Mr Tardrew's design has the rotary table as a four jaw chuck, whereas my version has four T slots to match those of my Myford lathe. I toyed with the idea of putting extra T slots in between the four already there, but instead decided to drill and tap eight blind holes 30° apart about an inch in from the edge of the table for additional clamping points. My workshop is standardised on 3/8" BSW threads for all the clamping bolts etc., but any convenient thread would do, to suit your workshop. Also the table is graduated 0 - 360°, and has moveable stops so one can limit the movement to virtually any number of degrees. A feature lacking in the original article.

In use the handle to rotate the table


6
Underside of top.

Milling the 'T' slots.

Finished 'T' slots.

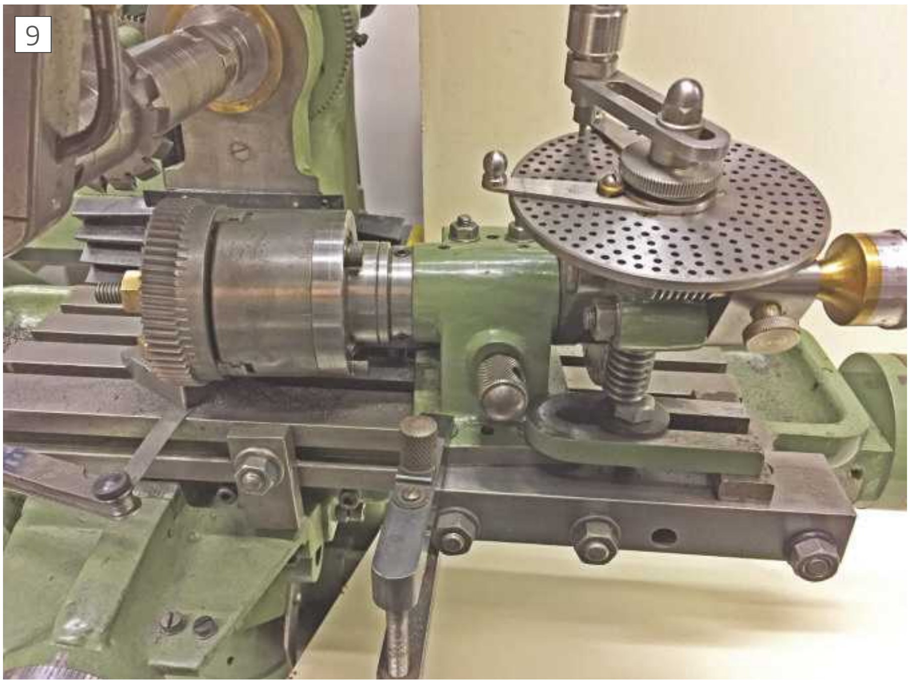
when turned clockwise turns the table clockwise also and vice versa. A handy feature.

Part 1, Table

Photograph 2 shows the embryonic table top ready to be parted from the lump of steel (cast iron could be used) which had been sitting under the bench for years. Being just over 5" in diameter, the parting tool would only go in about 1.25". **Photograph 3** shows the second stage of parting off using a 5" slitting saw running against the embryo table top. The lathe was run while the table top was rotated slowly by the dividing head. This reduced the diameter left to be hacksawed by hand, **photo 4**. The final stage was to hacksaw the final cut. I hasten to add that the lathe ways were protected by a piece of wood. It took me a day or two to do the hacksawing.

Photograph 5 shows the upper surface marked out for the T slots, which match those of my lathe and milling machine. The other scribed lines are for making the top into a four jaw independent chuck by borrowing the jaws and operating screws from my conventional 4" four jaw chuck. This was a feature of Mr Tardrew's rotary table which avoided the use of a chuck clamped to the rotary table, which would have used up a chunk my milling machine's limited clearance under the quill. I may yet fit out the top with the chuck jaws from my 4" independent chuck. Mr Tardrew said that he rarely used the chuck jaws; rather he clamped the workpiece using T bolts.

Photograph 6, The lower surface finished. The four holes are for the M6 x 30mm Allen screws to fix the worm gear (Item 2) to the underside of the table. The tops of the Allen screws are recessed in the bottom of the T slots so they don't



Setting the helix angle of 5.5247°

interfere with the T bolts or T nuts. The rough finish in the narrow outer groove doesn't matter as it is not a bearing surface; rather it's a slot to keep swarf out of the inner part of the rotary table.

In **photo 7** is the setup for milling out the T slots. Notice the stops (two clamps) bolted backwards to the milling table extension to aid relocating the rotary table top for milling the other slots. In **photo 8** we see the finished T slots. In use I have found that eight blind tapped holes at 30° spacing provide added clamping options depending of the size of whatever is being worked on.

Part 2, Worm gear / ball bearing housing

The cast iron worm wheel is 3.105" diameter and 0.900" thick. It has 60 teeth of 20 D.P., 20° P.A. on a P.C.D of 2.900". The helix angle of the worm is 5.5247°.

The bore in the centre is 52mm diameter for the ball bearing (Part 4).

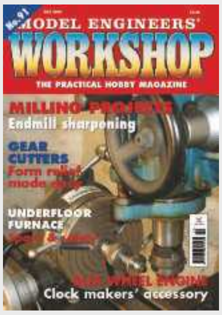
Photograph 9 shows the setup to set the dividing head for the correct helix angle for the gear teeth using a square clamped to the milling table and a 5" sine bar. The packing for 5.5247° is 0.481", using slip gauges. The formula for the packing is to enter 5.5247 into your iPhone scientific calculator, or other scientific calculator, then press the "Sin" button, then press the multiply button, then press the "5" button, as my sine bar is 5" long. Make sure your calculator is set to degrees and not radians. The answer to the nearest thousandth of an inch is 0.481".

●To be continued

From the Archives:

Improving a Mini Lathe

This article first appeared in MEW Issue 91 back in July 2002. Alastair Sinclair gave an update in 2015.



Alastair Sinclair's Update

I can't believe that I wrote this little piece as long ago as 2003. That feeling may be due to the seeming accelerated speed of my own ageing making it now seem like yesterday. Looking at the article today in the light of more recent experience, and in the knowledge that the popularity of the little mini lathes has soared beyond all expectations, it is interesting that they can clearly be seen to have met a real need within the hobby which continues to this day. After the publication of the article I was completely taken aback by the amount of correspondence I received from all over the world offering observations and asking for further information. Looking at what I said at the time in the piece, I today feel no need to alter any of the statements, suggestions or recommendations that were made. I still use this lathe today and continue to add additional features which improve its scope and versatility.

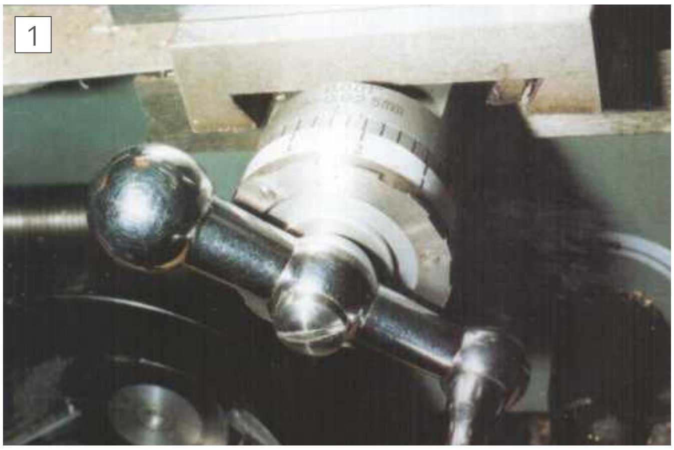
My first lathe purchased in 1986 was a Hobbymat MD65, then a relatively recent offering in the small machine tool market. This suited my requirements at the time since the available workshop space solely comprised of a bedroom cupboard into which a bench was squeezed supporting the said lathe and a ½ inch drilling machine. I also subsequently added a milling attachment to the lathe and this set up served me quite well for a number of years. The MD65 was a well-made and sturdy machine and was capable of producing good quality work. However it was quite noisy and its 65 mm centre height I found rather limiting at times. A replacement was therefore sought which offered a greater capacity along with more conventional design which could fit the available space and be somewhat quieter in use within a domestic environment. The eventual answer to this was the Conquest mini lathe as popularly marketed by Chester UK.

What's in a name?

Chester's Conquest lathe is of far Eastern manufacture and it or very similar models are marketed in many countries under various names. It is a 90 mm centre height machine with fully variable speed range from 100 to 2900 rpm via the combination of electronic control of the motor and a two speed gearbox. The bed is a raised single vee design giving 300 mm between centres and the mandrel is of generous proportions with a 20 mm diameter bore machined for 3 MT tooling. There is a conventionally arranged gear train with the usual adjustable banjo and gear set for fine feed or screwcutting via the leadscrew and the split nut at the saddle apron. Motor reverse is available electronically and there is also a tumbler reverse provided for controlling the direction of rotation of the leadscrew. The tailstock barrel is machined for 2MT tooling and is graduated along one side, while the casting has the facility for set-over to enable long tapers to be machined.

The cross slide and top slide are entirely conventional in design, with fully graduated dials supporting an indexable four way tool post. Overall weight is approximately 40 kg.

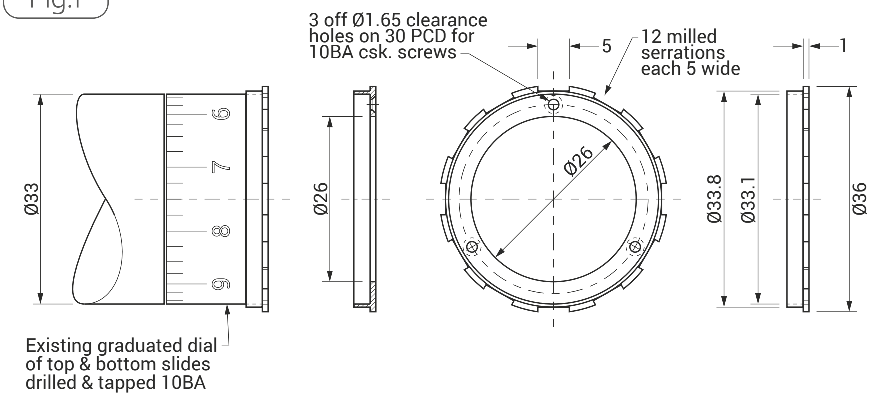
Irrespective of the name on the side of the machine, the above specifications appear to be the same in its various guises, the only difference being the colour and the changes necessary between metric and imperial versions. This principally applies to the leadscrew, the number and size of associated change gears supplied and the thread dial indicator. Oddly the cross slide and top slide feed screws seem to be the same for both versions although I am prepared to be corrected on that.



Improved graduations and grip-ring for the cross-slide dial.

The alternative toolpost fixture.

Fig.1



Finger Grips
Mat'l: Stainless steel or mild steel, 2 off

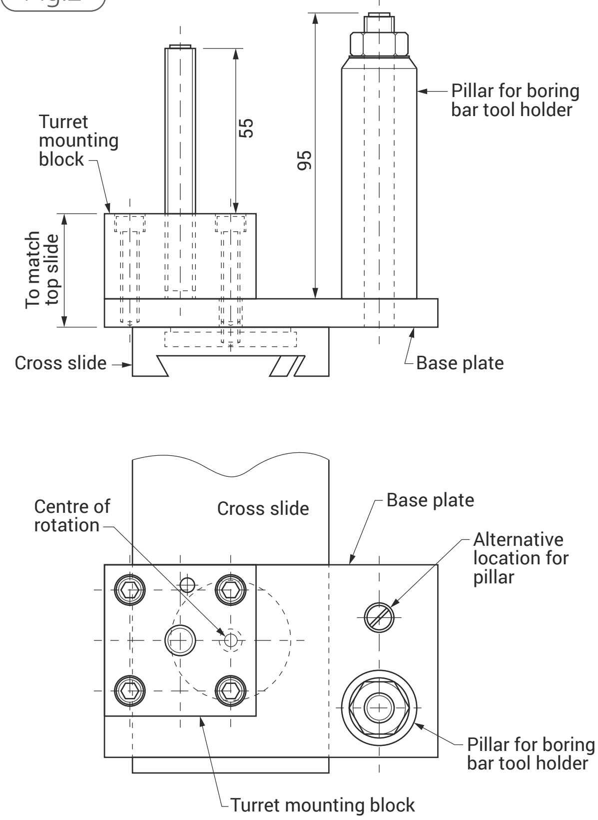
So what needs improving?

Originally offered at over £800 when first introduced, this is a well specified machine for the current (as of 2002) sub-£400 asking price and you may well wonder what needs to be improved. Well of course no machine is perfect and you might reasonably expect such a budget priced lathe to be lacking in finish, accuracy etc. Indeed there is some truth in this as my lathe as delivered exhibited a substantial lack of squareness between the cross slide and the between-centre axis which, after eventually convincing Chester UK that this was genuine and not operator error, was quite promptly corrected by them using their in-house machining facilities. I understand that this problem was confined to that particular batch of machines and that these were therefore all corrected in a similar manner. Other clear signs of manufacture to a price were noted but by and large these were generally cosmetic in nature, and do not seem to affect the operational accuracy of the lathe which is, in all normal respects, quite satisfactory.

All of the initial small improvements which I am sure most owners carry out were undertaken shortly after delivery and included the making of flush head screws for the cross and top slide handles, a saddle chip tray, a saddle lock and a tailstock clamp lever. Less commonly carried out I'm sure but very necessary in my opinion is the lowering of the four way toolpost to allow this to use normal sized tools of 10 mm to 12 mm square. While the turret is designed to accept these sizes of tool, it is in my opinion set too high relative to the centre line of the mandrel to properly use these and requires about 2.5 mm of material to be milled off the top surface of the top slide. This is most easily accomplished using a fly cutter but a decent sized end mill will be equally suitable in achieving this end.

One unaccountable feature of the metric version of this lathe is the number of graduations on the feed dials of the cross slide and top slide. There are 40 small graduations of which every 10th is enlarged and numbered, no doubt intended to suit the imperial version where every division is equal to 0.001". This is not at all appropriate for the metric version and I have therefore retained but re-numbered these graduations using a computer printed plastic film over a white taped background for ease of reading. The 40 graduations are split into ten groups of four and numbered 0 to 0.9, each large division being 0.1 mm and each small division 0.025 mm. This arrangement is shown in **photo 1** along with new 'grip-rings' for the dials which make these much easier to adjust and use. The advantage of using a computer printed film is that this can be made to a precise length to suit the diameter of the dial using a CAD program. A detail of the grip-rings is given in **figure 1** made in stainless steel although there is no reason why they cannot be made of mild steel if so desired.

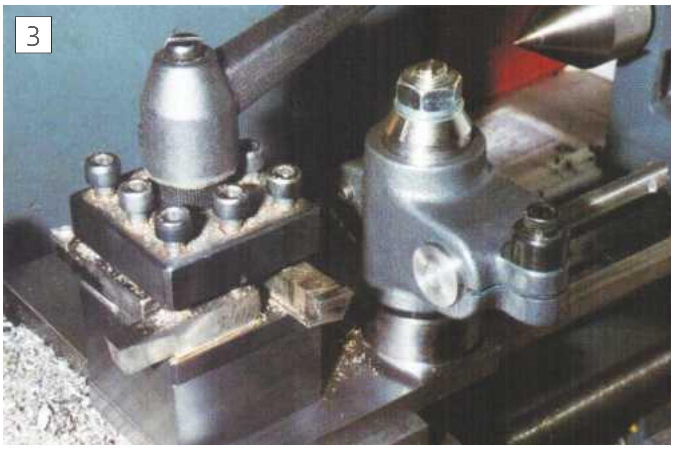
Fig.2



Assembled Toolpost

Top slide - who needs it?

While the Conquest performs satisfactorily as supplied, it has to be borne in mind that it is a very light lathe and is consequently not capable of really deep roughing cuts or heavy handed parting-off operations. Tooling has to be kept very sharp in order to get the best out of the machine, and providing this is done, perfectly satisfactory work can be carried out with good finish and accuracy. As a matter of good practice all slide gib adjustments should be kept fairly tight in order to avoid undue flexing of the tool and the resulting chatter which can spoil the finish of the work. In all amateur size lathes the top slide particularly is guilty of a certain degree of flexibility which affects the rigidity of the tool tip and this of course is all the more serious in any lightly constructed lathe such as the Conquest. So who needs the top slide then? Well I do actually but not all the time and if given a little thought it is quite clear that this is really only required occasionally for machining short tapers or setting over the single point tool during screwcutting. True, it is often also used for parallel turning short lengths or applying facing cuts, but in all



Four-way toolpost and boring bar holder fitted to fixture.

A selection of boring bars and the high-speed drilling spindle.

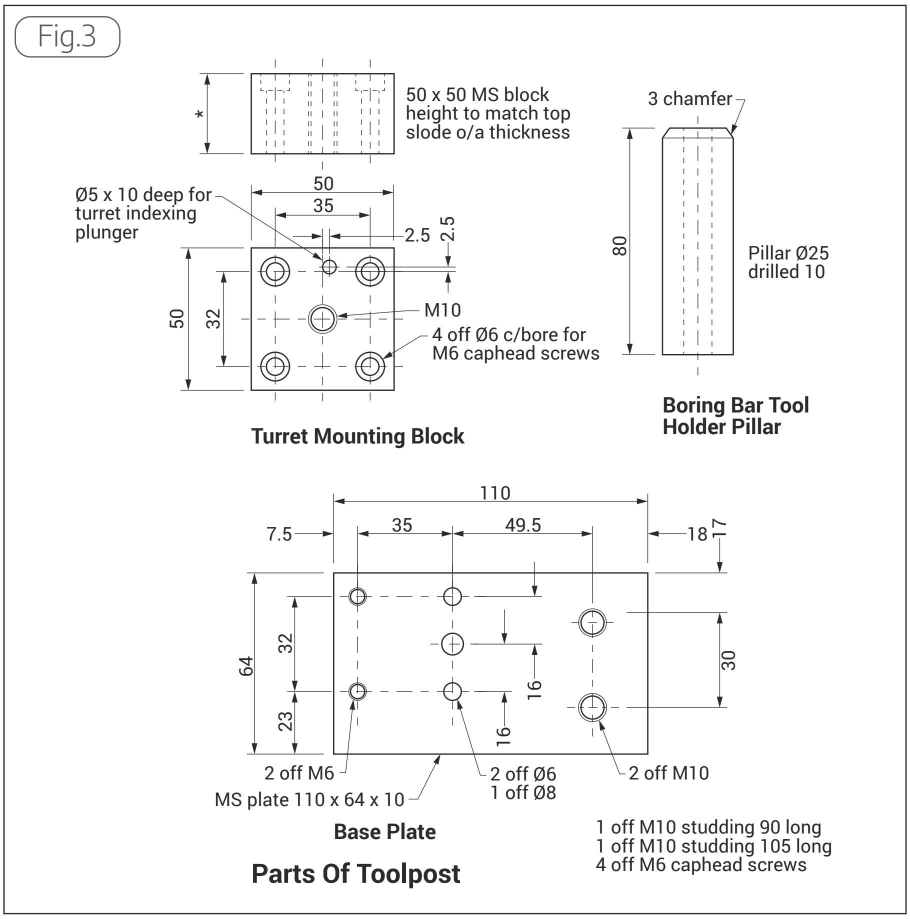
honesty, the majority of the time, it is doing very little other than that of a tool holder on top of the cross slide.

I am by no means the first to consider this matter as an article in a recent (ref. 1) MEW pointed out. This reports that Tubal Cain designed a toolpost which for the reasons discussed was mounted directly off the top of the cross slide. The same article describes a similar toolpost for the Myford which reportedly has `made an enormous difference to both the lathe's cutting capability and to its accuracy'. As a result of these thoughts, I set out to design a more rigid tool post fixture to entirely replace the top slide and obtain by this means greater stiffness which would allow deeper roughing cuts to be taken and improve general finish. It also seemed possible at the same time to improve the versatility of such an arrangement by incorporating a permanently fitted additional tool holder for boring tools which could if necessary also accept a light drilling spindle or grinding head. As yet a further bonus, a directly mounted tool post could, it was clear, obtain the same effect and advantage as a rear toolpost using parting tools mounted upside down while the mandrel runs in reverse. This is possible with the Conquest since the chuck is bolted directly to the mounting flange on the mandrel and cannot therefore come adrift during reverse running.

The versatile tool post

The design of the basic tool post fixture is really very simple with a base plate holed to match the fixing screws for the top slide and a square block of steel the same size as the four way tool post, fitted together such that the turret is in the same relative position to the cross slide as it is when fitted on the top slide. The main features of this are shown in **photo 2** and **figure 2**. It is of course essential that the height of the substitute fitting is precisely the same as that of the top slide assembly in order that the turret is interchangeable between each of these without having to adjust the packing height of the tool bits. On mine that is 38 mm but remember that I have reduced the tool height by 2.5 mm and this has therefore to be measured in each individual case to maintain the essential interchangeability necessary. The same indexing plunger is used on the replacement so that the turret can index round as normal.

For other owners of the Conquest who wish to make a similar fixture, **Figure 3** gives the necessary details and it will be clear that many of the dimensions can be varied t0 suit materials at hand. The thickness of the base plate at 10 mm can, for example, be increased if desired, the only consequence of which is a corresponding reduction in the height of the attached square block for mounting the turret. The overall size of the plate can also be varied but that shown is the minimum required to comfortably allow both the four way toolpost and the boring bar toolpost to operate independently without undue interference between them. Each of these main components requires to be machined on all faces to ensure that mating surfaces are square and flat. The clamping screws through the assembly



to connect this to the cross slide require to be spaced 32 mm apart to suit that of the circular plug in the slide thereby allowing the full 360° rotation of the fixture in the same way as the top slide that it replaces. The 25 mm dia. pillar for the boring bar tool holder is a straight turning job with a central 10 mm dia. hole, and needs no special comment regarding its manufacture.

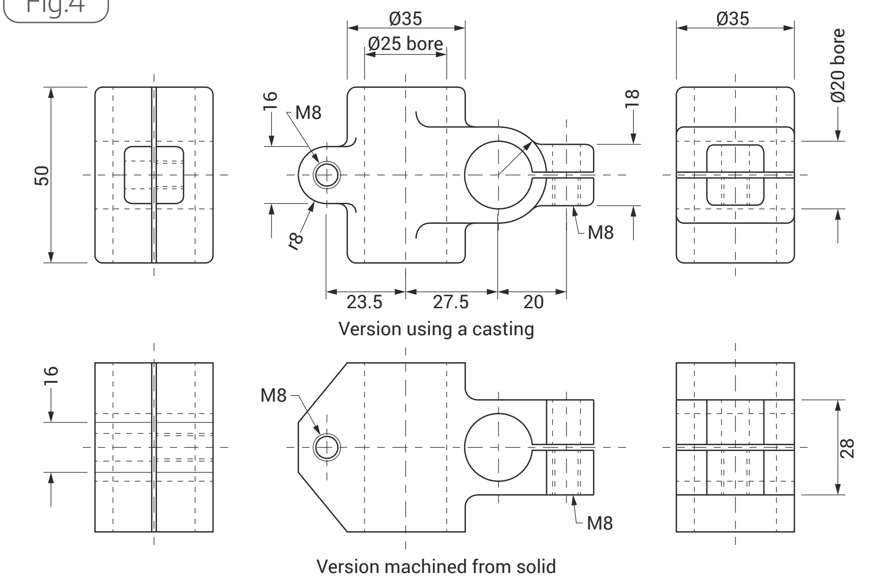
The four way tool turret supplied with the machine is quite satisfactory with regard to its design and for me, the question of quick change tooling is solved by having three of these each with a range of tool bits permanently fitted. The cost of each turret is only £7 or so (2002 price) from Machine Mart and there is therefore hardly any need to consider going to the trouble of making them. The boring bar tool holder has been made using a casting but a similar holder can easily be fashioned from a suitable block of mild steel. **Photograph 3** shows this and the four way turret mounted on the tool post fixture while **Figure 4** provides a detail of the boring bar tool holder both as a casting and as the alternative machined from solid version. The 20 mm diameter horizontal hole through this is the tool mounting point and allows all diameters of round boring bars up to that maximum size to be used, the smaller sizes being fitted using a 20 mm diameter collar with a central hole of the appropriate size and the necessary socket grub screws. A selection of such tooling is shown in **photo 4** with boring bar sizes between 8 mm and 20 mm diameter.

No free lunch

There is tremendous advantage in a tool post fixture of this design which imparts substantially greater stiffness and rigidity to the cutting edge of turret mounted tools rotated through 180° to present the fitted boring bar to the workpiece. This is shown in **photo 5**. Returning to normal turning work is simply the reverse of this and takes no more than twenty seconds or so to carry out each time. An engineers square can be used to set the fixture at right angles to the cross slide but this is not at all critical.

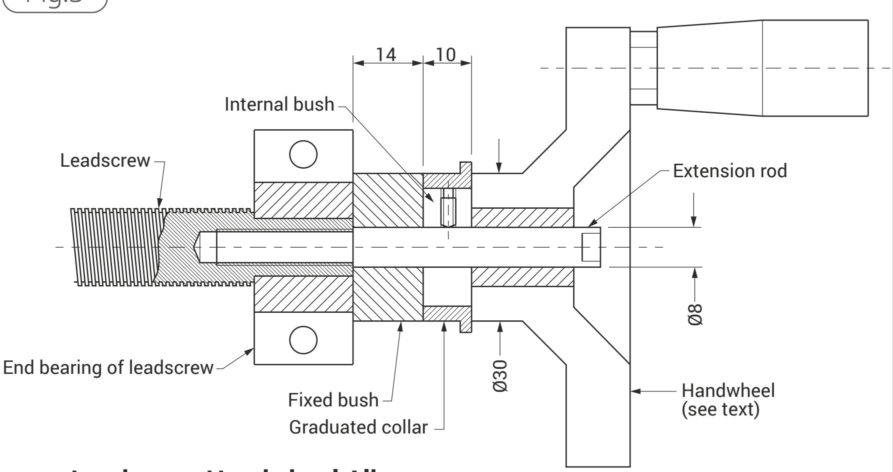
So far, so good. It is at this point I should however repeat the old adage that there is no such thing as a free lunch and many readers who have followed my simple logic to this point will be keen to point out that removal of the top slide also means that the important matter of the taking of fine facing cuts to a precise depth becomes no longer possible. Quite true and with this problem comes the obvious solution which, you have probably also anticipated, is the need for a leadscrew handwheel with graduated dial. Right. This is a simple solution to the problem which is also quite desirable in other ways (of which more later) that allows accurate advancing of the facing tool along the lathe axis. In this case, the leadscrew is 1.5 mm pitch and one complete tum of the handwheel will therefore advance the tool by this amount. However, things are never quite as easy as they seem at first sight as anyone will find out if after placing the tumbler reverse into neutral they grasp the while also providing the convenience of a permanently fitted boring bar tool holder. This allows boring operations to be quickly set up while avoiding removal and later resetting of the normal turning tools in the turret. Indeed, mounting boring tools in a turret is generally more awkward, usually disturbs and requires the removal of at least two of the turning tools and less easily permits length adjustment to minimise overhang of the tool tip. For boring operations therefore, this design is a worthwhile improvement both in greater stiffness at the tool point and in general ease of adjustment and use. To quickly change from the normal turning set up to that for boring, it only requires the two clamping screws beneath the turret to be slackened and the entire tool post fixture leadscrew and attempt to turn this. Although the mandrel is not then in gear the reverse velocity ratio of the gear train which is set up usually for fine feed, is such as to create considerable resistance to rotation of the leadscrew and effectively make this too stiff and laborious to conveniently use. What clearly is also

Fig.4



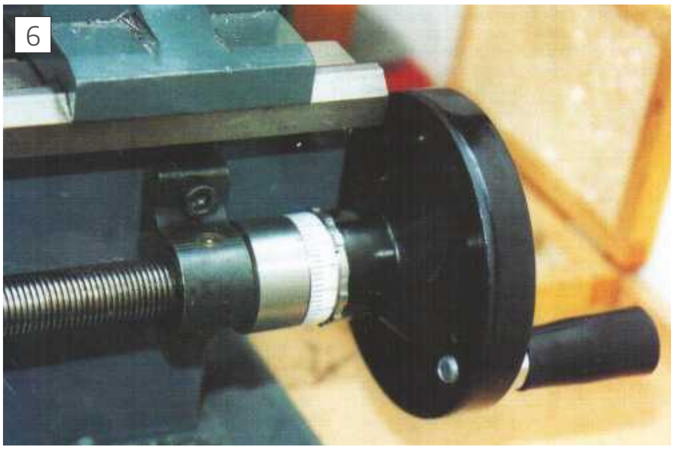
Boring Bar Tool Holder

Fig.5



Leadscrew Handwheel Alignment

Showing the fixture rotated 180 degrees to present the boring bar.



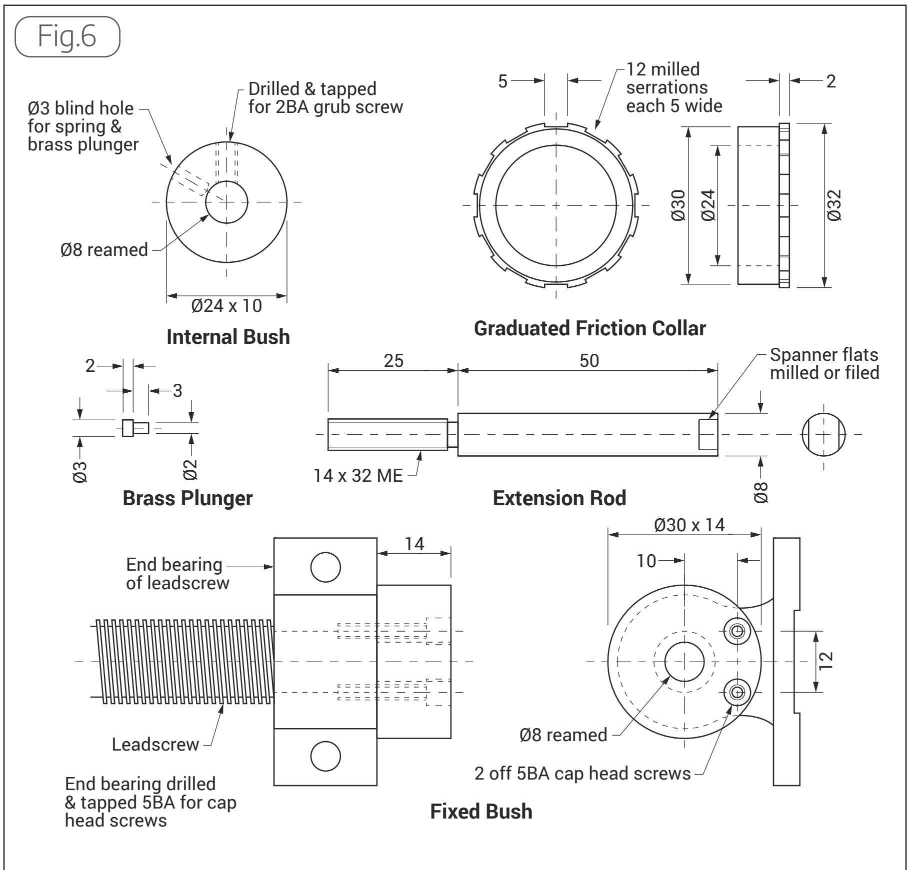
The matching handwheel might be mistaken for original equipment.

needed therefore is a clutch of some kind which effectively disengages the leadscrew from the rest of the gear train when the handwheel is in use.

So, as is often the way, one thing leads to another. The removal of the top slide which will allow the fitting of a superior tool post fixture is not by itself a solution and requires in addition the installation of a leadscrew handwheel and the design and fitting of a suitable leadscrew 'clutch'. I have to admit that as the germ of the idea for the new tool post arrangement had initially formed in my mind, the need for the handwheel had been easily anticipated but that for disengagement of the leadscrew had unfortunately not until much later in the process.

A leadscrew handwheel

Just about any suitable handwheel fabrication or proprietary casting could be used for this but it is in my view better to use the same style of wheel as that used for the saddle rack handwheel and tailstock. This gives the appearance of it being part of the original lathe design (see **photo 6**) and is in any case easily obtainable from one of the suppliers. I can't remember how much this cost but it is usually worth checking the price of any such spares with all of the suppliers, as this in my experience seems to vary quite substantially. It is the one normally provided for the saddle rack that is required which has an 8mm dia. bore and a fitted grub screw. The assembled arrangement is detailed in **Figure 5** and it should be noted that it firstly involves the removal of the leadscrew to enable a drilled and tapped hole to be made in the end of this. No difficulty should be experienced with this removal if the gear cluster and banjo is first taken away at the headstock end followed by disconnection of the bearing at the remote end then unscrewing the cap screws from the headstock end bearing. Withdrawal of the entire



Leadscrew Handwheel Components

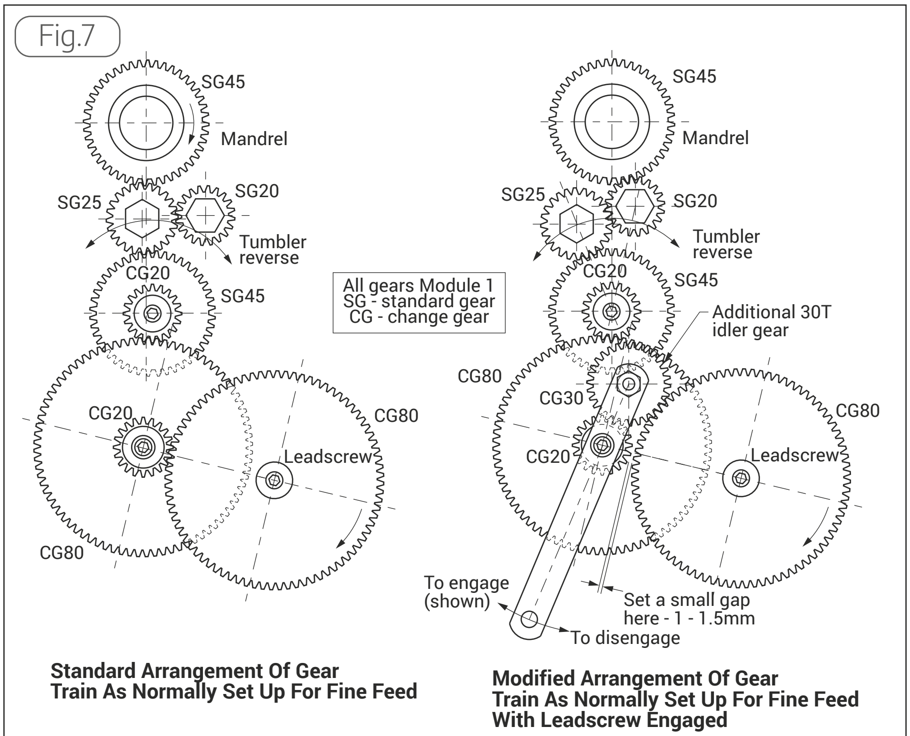
leadscrew may then be toward either end of the lathe depending on the extent of clearance available.

The leadscrew is 16mm dia. and will therefore easily pass through the hollow mandrel allowing the end that is to be drilled to be gripped in the chuck leaving the remainder to project at the rear. It is important to use a piece of aluminium sheet or tinplate around the end of the leadscrew to prevent the chuck jaws from damaging the square thread. Centre and drill a tapping size hole for ¼ x 32 ME thread as shown and cut this using a tailstock mounted tap. Simply gripping the tap in the tailstock chuck is unlikely to be satisfactory as the turning force required will easily overcome the gripping power of this. A better strategy is to use a hand tap wrench keeping the centred end of the tap firmly lodged in the fixed centre of the tailstock. The 8 mm diameter extension rod to the leadscrew which screws into this is a straight turning job with a die cut ¼ x 32 thread one end and milled spanner flats at the other. This has to be quite fully tightened into the end of the leadscrew applying Loctite to the thread to ensure its security during use of the handwheel. Note that the greatest turning force on the handwheel is when advancing the tool towards the headstock which needs a counter-clockwise direction of rotation. It would no doubt have been better therefore to have used a left hand thread and dispensed with the use of Loctite. I did not however possess the necessary left hand threading tap and die and I have to say that the method of attachment described has proved in use to be very secure.

The other three main parts of the handwheel assembly are the fixed bush, the graduated dial and the handwheel itself. These parts are shown fully detailed and dimensioned in **Figure 6**.The fixed bush is a plain 30 mm diameter turned disc with a central drilled and reamed hole 8 mm diameter to give a good fit on the extension rod. This is connected to the end bearing casting using two recessed 5 BA cap head screws. The reference graduation mark is on the periphery of this, cut with a fine blade saw. The graduated collar is 3mm thick and 10 mm wide with a 1mm high serrated finger grip. The serrations are made by using a simple dividing fixture and milling 12 gaps through it with a 5 mm end mill. The collar requires to be a good running fit over the internal bush which is locked to the extension rod with a 2 BA socket grub screw. The bush is drilled for a spring and brass friction plunger 3 mm dia. as shown in Figure 5. No alteration to the handwheel is necessary as already mentioned since this is supplied with an 8 mm bore and a socket grub screw already fitted. The graduations on the collar are for reasons of clarity again produced using computer printed plastic film over a white background tape. Fifteen main divisions this time of 0.1 mm each with four small divisions of 0.025 mm.

Declutching the leadscrew

As earlier discussed, the use of the handwheel to advance the saddle along the bed requires that the leadscrew be disengaged from the gear train. Ideally this should be in the form of a straightforward dog clutch which enables the leadscrew to be isolated from the gear train no matter whether this is set up for fine feed or screwcutting. However, the only suitable position for this kind of clutch mechanism is directly in front of the headstock where, in the case of the Conquest, all of the electronic speed control circuitry is located. This is enclosed in a box completely covering the front face of the headstock entirely surrounding the leadscrew. Inspection internally showed all of this space



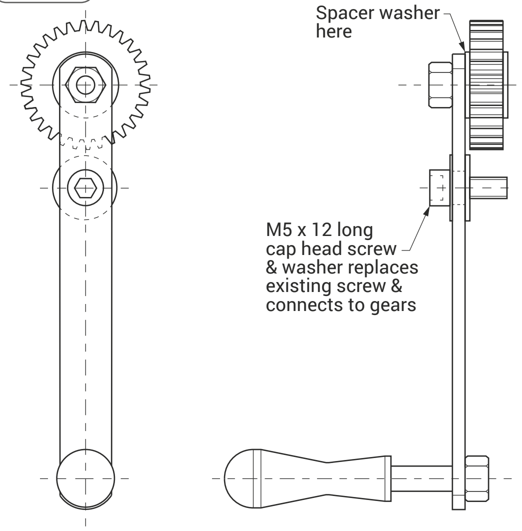
Conquest Gear Train

The swing arm arrangement to disengage the leadscrew.

to be fully utilised leaving no room whatsoever for a clutch. So this was not the answer I was looking for and some other approach was needed which would produce the same affect. A search of various texts and ME articles was undertaken to see if anyone else had done anything similar. I have always been a great believer in trying to avoid reinventing the wheel if I can possibly help it). Surprise, surprise... an early article in an old ME (ref. 2) describes a means of disengagement of a Myford leadscrew using an idler gear on a swing arm interposed between the leadscrew gear and the one immediately preceding it in the train. This is an elegantly simple solution and easy to introduce but while such an idler gear has no effect on the final gear ratio, it has the obvious effect of reversing the direction of rotation of the leadscrew. Fortunately this is not really a problem with the Conquest as the tumbler reverse can be used to correct the rotational direction and it is then only a matter of getting used in future to using the tumbler reverse the opposite way round from normal. The arrangement of this is illustrated in **Figure 7** where the standard setup for fine feed (a) is shown alongside the modified set-up (b) incorporating the swing arm and the additional 30 tooth idler gear. For this to work it is obviously necessary that a small gap is created between the final 20 tooth gear and the 80 tooth leadscrew gear. This gap is not critical but I suggest that 1 to 1.5 mm is about right. The arrangement described is illustrated in **photo 7**.

So there you have it. Not a clutch at all but a disengagement gear which in practice works extremely well and is particularly easy to make and install. Its one disadvantage over the clutch is that it will only properly work with one arrangement of gears, that for normal fine feed. This however is not really a disadvantage at all since there is no need in screwcutting to use the handwheel and it is in any event rarely desirable to disengage the gears and risk the loss

Fig.8



Engagement Lever Assembly

of the pickup of the thread being cut. Its primary purpose, which is to allow disengagement of the fine feed gear train and enable longitudinal control of the saddle using the handwheel, is achieved simply by moving the lever towards the front. This will be clear from examination of figure 7(b); moving the lever forward disengages the 30 tooth idler from the 80 tooth leadscrew gear thereby freeing the leadscrew for handwheel control. The assembled lever and gear arrangement is shown in **figure 8**.

Disengagement Gear

The bits and pieces required for this could not be simpler and these are detailed in **figure 9** and shown in **photo 8**. The control lever is merely a 12 to 12.5 mm wide flat 3mm thick cut to length and drilled 7.5 mm diameter at the pivot point with two M6 tapped holes either end. A turned mild steel collar to fit the 7.5 mm diameter hole is 16 mm overall diameter with the part which fits the hole being a little more in length than the thickness of the control lever; 2.1 mm is about right. This, together with a M5 x 12 cap head screw and washer enables the lever to be fitted to the gear train as shown in **Figure 7(D)** and freely pivot at this point. The 30 tooth gear is of course one of the change gears supplied and this requires to be push fitted with a bronze bush 12 mm diameter having a drilled and reamed 6 mm diameter hole through the centre. The bearing pin for this is turned from 16 mm diameter steel bar to 6mm diameter over most of its length leaving a 1 mm thick head at the full diameter. An M6 thread is cut at the end of this and the gear mounted at the end of lever introducing another washer and adjusting the bearing pin to allow free rotation without any binding. To maintain this the locknut is then tightened.

The control knob fitted to the end of the lever is turned from aluminium to the sizes shown or as desired from personal preference. This can equally be a black plastic knob of one kind or another but should not be unduly large or heavy. The reason for this is that in operation the idler gear remains in engagement with the leadscrew gear by virtue of the turning and tooth meshing forces which tend to impart a clockwise moment to the lever assembly. This has the considerable advantage that no locking mechanism is required to hold the lever in the engaged position during use of the fine feed and requires only a light touch to then disengage. Use of a heavy knob would reduce the turning moment effect and taken to extremes could risk unintentional disengagement.

When there is no engagement of the leadscrew the lever simply hangs freely on its pivot point. A slot therefore has to be cut in the rear cover to allow the engagement knob to project through and this can be cut to suit the swing movement of the lever using a fretsaw. **Photograph 9** shows the result which I think is neat and looks the part. The really

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The small slot in the end casing and the swing arm operating lever.

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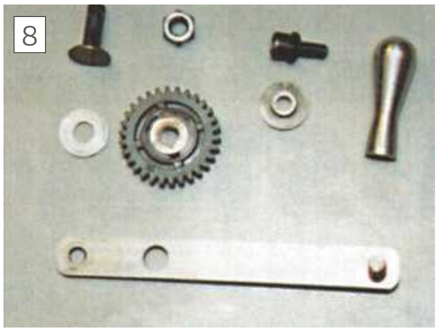


Components of the swing arm assembly.

nice thing about the disengagement arrangement described is that it does not require any modification to the existing gear train to install and can be taken off very easily when a screwcutting set of gears is required. An existing change gear is used in this design and therefore does not require to be purchased specially, although one can easily be obtained from one of the suppliers if so desired.

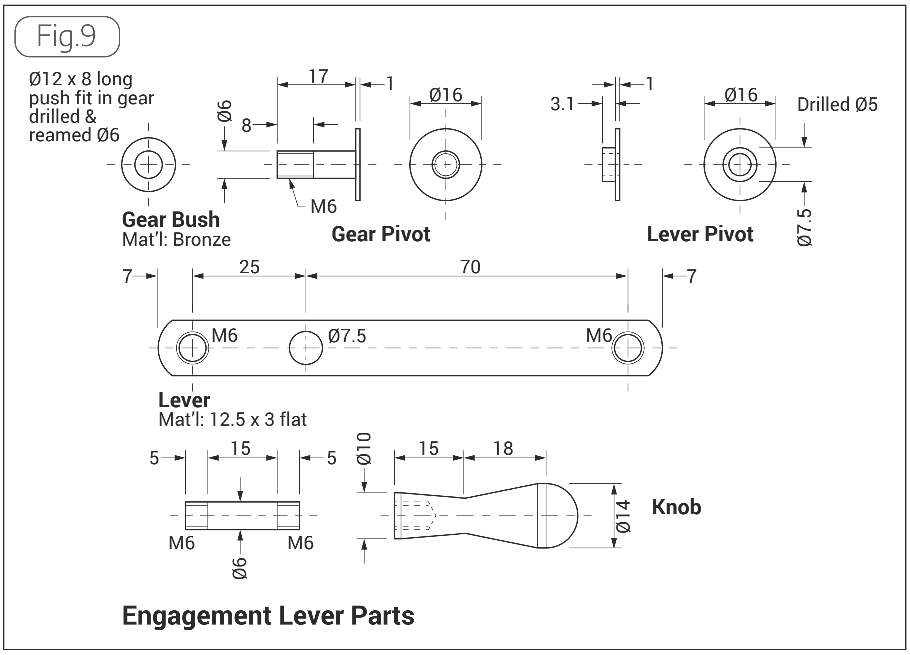
In use

I have got quite used to the new toolpost arrangement with associated leadscrew control and gear train disengagement. I have to say that I could not now do without it. The resulting ease with which the turning and boring tools are presented to the workpiece and the convenience of the leadscrew handwheel for both parallel turning, facing and boring cannot in my view be bettered in a small lathe like the Conquest. The relatively short length of the machine means that the use of the handwheel is not at all awkward and while the direction of rotation of this for advance of the tool along the bed is opposite to the natural direction, one soon gets used to it. The selection of tool bits instantly available from three turrets is certainly enough for all my usual needs although I generally leave one space clear for a special tool to be fitted when required for a one-off situation. The design of the boring tool holder which allows quick and accurate tool height adjustment and/or overhang adjustment is a pleasure to use. The deployment of a boring tool is as previously pointed out so rapid given that it can be ready for use immediately upon rotation of the tool post fixture through 180°. Combined turning, facing and boring operations are therefore easily undertaken and the flow of one operation to the next is particularly smooth and natural. There are consequently no annoying and time wasting delays in setting-up tooling during the progress of producing a workpiece which involves multiple and diverse machine operations. No loss of function has been created either and the original top slide can still be easily installed in place of the new arrangement whenever a taper is required or a screw thread needs to be cut.

Unexpected bonus

The original aim of the top slide replacement was as previously noted primarily to improve tool point rigidity and allow deeper roughing cuts to be taken and improve general finish. The former aim has been quite clearly achieved as has the lathe but the additional control available for achieving a better finish straight from the tool was an unexpected bonus. Previously, using a carbide tipped or HSS tool with fine feed engaged resulted in an extremely fine 'screw thread' type of finish unless the tool was made to effectively cut and rub the surface at the same time. Use of a round nose finishing tool sometimes helped but not always and the achievement of the desirable standard of finish became at times a little unpredictable. The increased rigidity of the tool using the new fixture of course has improved the finish but final cuts using fine feed still exhibit the 'screw thread' type of finish, albeit to a better standard. However by taking a final cut of say 0.05mm at about twice the normal turning speed and using the leadscrew handwheel to advance the tool along the work does obtain a good standard of finish even using a HSS knife tool. It of course requires the handwheel to be manually turned quite slowly for the final pass but this is no serious problem and any unevenness of handwheel rotation is not noticeable on the finished surface due to the high mandrel speed.

While on this subject it is perhaps worth mentioning that another way of improving surface finish is to turn the leadscrew and hence advance the tool under independent power. This need not be elaborate and indeed use can be made of the humble electric screwdriver hand held with a socket bit applied to the retaining screw of one gear within the gear train. Which gear to apply this to depends on the speed of the particular screwdriver used but in my case, a Black & Decker screwdriver works well on the 20 tooth gear immediately below the tumbler reverse. Obviously the tumbler reverse itself requires to be in neutral and the leadscrew engaged for this to work. The hole required for this through the end casing can be seen in **photo 9**. If a separate permanently fixed small electric motor is used this can be located behind the headstock with a round belt drive



to a pulley on an extension projecting through the end case from the gear in question. In that arrangement, the belt would only be quickly fitted immediately prior to taking the finishing cut and removed again afterwards.

Parting thoughts

With its somewhat generously proportioned mandrel, parting-off problems are not overly serious on the Conquest. Using a sharp tool, I found parting off mild steel and even stainless steel all from the normal top slide position to be reasonably free of trauma. There were occasional dig-ins however and when this happened it often ruined the work piece completely. With the new toolpost fixture came the promise of obtaining completely trouble free parting-off not only because of the more rigid mounting of the tool, but by reverse running of the mandrel while using the parting tool upside down. This obtains all the advantages that are credited to a rear toolpost which are both geometric and mechanical. Tests of this approach have indeed proved the case and I now have a parting tool mounted upside down in one of the turrets giving excellent cut-off even if handled quite roughly. The one small difficulty is in getting the tool tip to centre height in the standard turret and I now have a 50 mm square plate 3 mm thick which is interposed between the underside of the turret and the tool post block to raise the tool to the correct height. It is of course important to remember to put this in before attempting to part off. Only lathes like the Conquest where the chuck is directly bolted to the mandrel can use this

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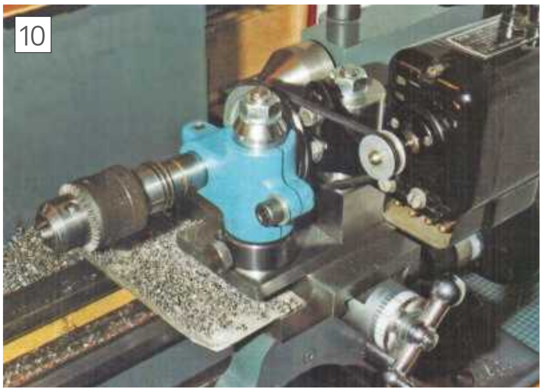

A high-speed drilling spindle mounted in the boring bar holder.

approach as otherwise the chuck could unscrew with disastrous results.

Future development

The boring tool holder would appear to be ideal for mounting a high speed drilling spindle or grinding head. In either case a small electric motor would require to be fitted to the square block which nominally supports the turret with a round belt drive to the spindle. An experimental set-up for this is currently being developed to initially determine if this is worth having and, in the case of the grinding head, to see if the lathe and mounting is rigid enough to achieve a good enough quality of finish (**photo 10**). ■

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Brazed Carbide Tools

Stub Mandrel says don't give up on the set of tools which frustrated you when you were starting out

A typical set of inexpensive brazed carbide tools.

A frequent issue raised on the forum (**www.model-engineer.co.uk**) is the experience of people, often beginners, who have purchased a set of brazed carbide turning tools and have had no luck with them at all.

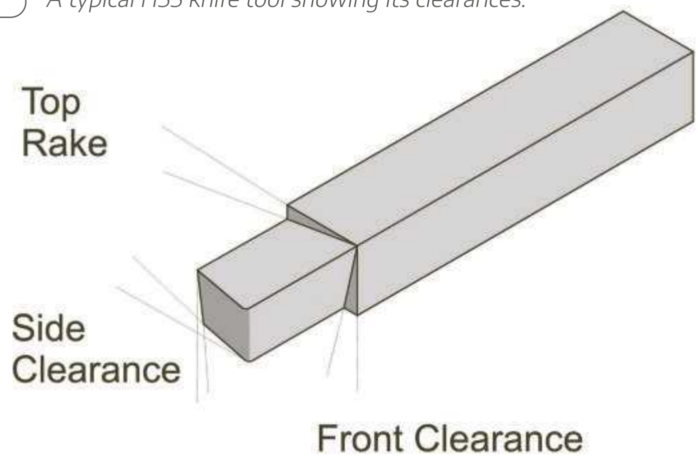
These tools consist of a shank, usually in a medium-carbon steel (or even mild steel) with a cutting tip of tungsten carbide brazed into a step on the end. They often come in sets of different types of tool usually in bright colours, **photo 1**.

In practice, these are rarely a good choice of tooling for a beginner, for a number of reasons. Even the very best carbide tools (e.g. quality indexed carbide tooling) are less forgiving of less than ideal cutting conditions than high-speed steel tools; the brazed carbide ones are usually even more fussy. It can take a while to find the speeds, feeds and depths of cut that best suit any tool as there are so many variables – rigidity, material, lubrication and even the technique of the operator.

The other, and possibly the biggest problem, is that many of these tools, especially the cheaper sets, are provided as unfinished blanks that require finish grinding. Such tooling typically lacks the clearances required to achieve free cutting. If your look at **fig. 1**, that shows a typical HSS tool, you can see that there needs to be clearance (also called relief) at the front and side of the tool to stop it rubbing rather than cutting (note that the 'front' depends on which edge is fed into the to the work). The top rake, combined with the front clearance, is what provides the sharp edge that does the work of cutting.

Many carbide tools, like the parting tool in **photo 2**, are supplied with a simple unfinished block of carbide brazed on, angled to provide the top rake. **Figure 2** shows a simplified profile of the parting tool as supplied. You can see how the carbide block has square edges creating a font face that actually angles the edge of the tool away from the work. It should be no surprise that using a tool like this gives at best a poor finish and at worse just refuses to cut at all. This condition is common to many tools and a 'give away' is often that the front edge of the carbide still has a layer of paint on it.

Fig.1 *A typical HSS knife tool showing its clearances.*



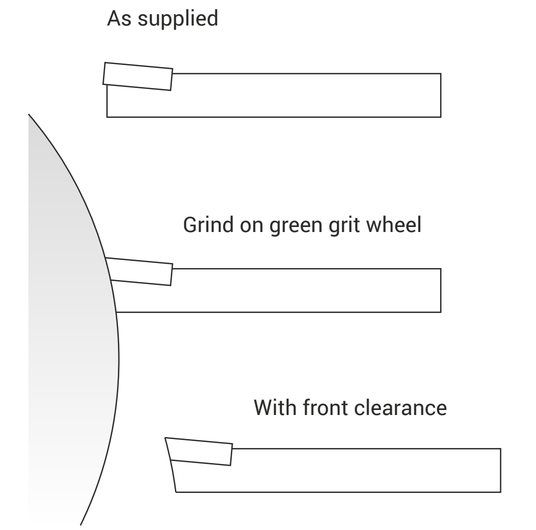
For best results you need to add front clearance, and possibly side clearance, by carefully grinding away this protruding material. As fig. 2 shows this can be done easily enough using a green grit wheel formulated for use on carbide – ordinary wheels for sharpening steels will not work well. Ideally, you can polish the edges by hand with a diamond slip but take care not to round over the cutting edge. You may also find that it helps to put a small radius on the corner of the tool as this makes it less likely to chip and can give a better finish.

That said, I have had a set for many years and the one task they excel at is removing the tough 'skin' on iron castings or even bullying your way through very hard 'chill spots'. If you do a reasonable amount of work with difficult materials it is worth having a set of these handy.

All of the tools in photo 1 have been sharpened in this way, you can see that I have also had to mark their shanks to show where to use packing to get them to centre height.

You may wonder why I have these tools as well as a plentiful choice of HSS and indexable carbide tools? The answer is that brazed carbide tools are (mostly) as tough as old boots. They are the ideal choice for getting under the 'skin' of tough iron castings, especially

Fig.2 *The steps in preparing an unground carbide tool.*



A carbide parting tool, the front face has been ground for clearance.

if they are less than even so the tool has to start with an interrupted cut. If you find yourself having to cope with bright silver 'chill spots' in a casting they are often the only tools that will do the job, even if the finish may be less than perfect.

There is great variation in quality between different sets of brazed carbide tooling. The DIN-marked ones supplied by companies such as Arc Euro Trade are mid-range tools with machined shanks and much superior to my old set with relatively crude forged shanks, for example. It's also possible to spend an arm and a leg and get precision ground brazed carbide tools – these are used in industry for heavy precision jobs where indexed tooling just isn't tough enough.

If you have a brightly coloured set of brazed carbide tools, languishing on your top shelf since the day you first tried them out and gave up in disgust, it may be time to fetch them down and take a close look at the cutting edges. It may be that an hour at the bench grinder will be enough to give you a set of tools to help you out when the going gets tough! ■

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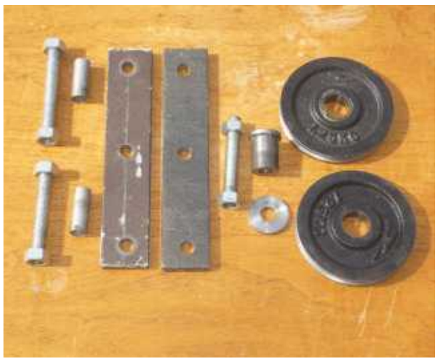
A simpler approach to indexing from **John Hinkley**.



Martin Berry makes a pulley block

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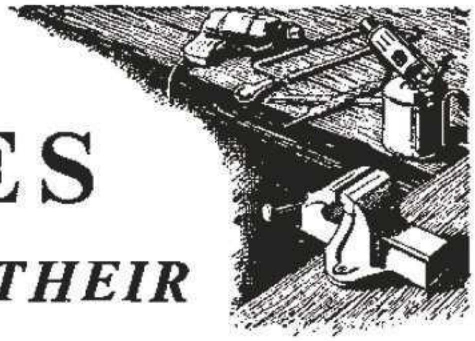
From the Archives:

The principles and practice of thread cutting are dealt with by GEOMETER in this article on



BEGINNER'S WORKSHOP

DIES

AND THEIR USES

FOR PRODUCING EXTERNAL threads on screws, bolts, pipes, etc., dies are employed, which are the counterparts of taps used for cutting threads in holes.

Dies, therefore, run in the same rates of threads and sizes as taps, with the difference that one die is usually sufficient for one diameter and rate of thread, whereas two and sometimes three taps are required. This is because the die is normally adjustable and can be contracted to produce threads in stages.

The engineers' most common die for general use is the split die, also known as the circular or button die. The outside diameter is a standard dimension, 3/16 in. or 1 in., and in larger sizes 1-5/16 m. A range of such dies of one size can be used in one die holder.

Three screws for adjustment

The split die is adjustable in its holder by means of three screws, the centre one with a coned end to fit in the slit, and the two side ones flat-ended or round to support the die either side of the slit, or to close it when necessary.

Certain types of split dies incorporate an adjusting screw in the side or in the slit, and this must be regulated instead of the centre screw in the die holder to obtain the required size.

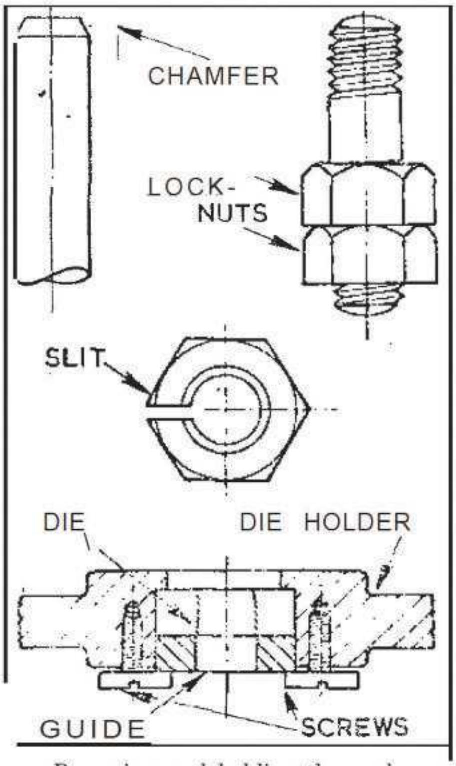
Die nuts resemble split dies, but are non-adjustable, and intended for use by turning with a spanner. While they will actually cut threads from a start in case of need, they are more often used for cleaning or sizing existing threads.

Another type of die, used in a stock, is the split rectangular pattern, which is in two portions sliding in V-guides in the stock. An adjusting screw in the stock admits of putting on cuts for the dies. This type of die can be placed round the work some distance from the end, as the two halves can be opened to clear. It will also cut threads somewhat oversize and undersize, to a greater degree than a split die. Dies of this type for different rates of thread can be used in the one stock.

Examination of a die reveals that the thread one side is bell-mouthed, or that there is a throat, while the other side ends squarely or flat. It is important that the die is placed on the work for a start so that the throat side advances first, gradually cutting the thread, and the rear portion of the die finishing it.

Danger of breaking

If the square or flat-sided portion of the die is run on the work, there will be difficulty in starting the cut, a considerable danger of breaking the die or chipping the threads, and a likelihood of tearing the thread on the work. The throat portion does not, of course, leave a full thread, and a nut run on will not go right to the end. The die can, therefore, be reversed on the work to bring the taper threads to full depth, though this needs, to be done carefully to avoid breaking the die or damaging the thread.



Preparing and holding the work

A split die is placed in the die holder with the flat side against the internal shoulder, the throat side outwards, thus permitting the face of the die to run up to any shoulder on the work, and enabling pressure to be put on the die to start its cut. Later, if necessary, it can be reversed in the holder to finish the thread.

The centre screw should engage the slit, and with the side screw free, the centre screw should be advanced to open the die slightly. Side screws should then be advanced to support the die. Failure to do this may result in breakage, as a die is hard and relatively weak against internal pressure. This setting will normally produce an oversize thread; then to bring it to size, the centre screw should be slackened slightly, and the side screws advanced to close the die.

Applying pressure

The end of the work should be chamfered for the throat of the die to start easily on the tapered portion. The die is placed on the work, end pressure applied, and the die slowly turned by means of the holder. Once a start has been made, it will advance itself, but should be eased back about every 1-1/2 to two turns to clear chips and free the thread; failure to do this may result in a broken die.

When starting a die, care should be exercised that it is square, and in the first few turns, it should be sighted from the side, and trued as required. Certain die holders are provided with a guide in front of the die to maintain it square on the work.

Work which is already threaded can be held without damage by using two nuts locked together, or one which is slit to grip in the vice. Lubrication may be as for tapping: that is, oil for steel, paraffin for alumimum and duralumin, while brass is threaded without lubricant. ❑

Desktop Gear Hobbing

Toby Kinsey has designed this fascinating piece of gearmaking equipment - Part 4

I also had to make sure the stepper motor had enough torque to drive the cutter. Stepper motor control is an open loop control system. You are sending pulses to move the motor and assume the motor is doing what you command. If the motor is overloaded and starts missing steps you have no way of knowing.

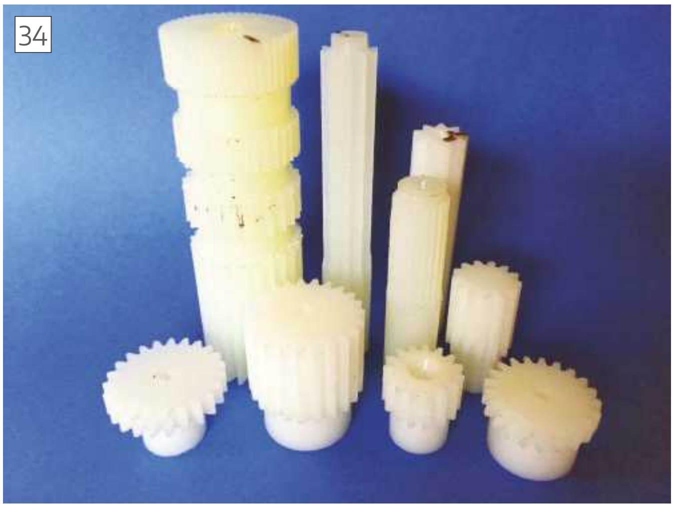
MEGS was duly placed back on top of the bench, literally dusted off and a stepper motor was fitted in place of the old motor. This merely required drilling some new holes in the motor mount to fit the spacing of the stepper motor. Also needed was a square of 2mm thick ABS sheet to fit over the register on the flange of the motor, **photo 33**. This allowed the motor to be more squarely mated to the motor mount. Using the spare Stepper motor driver already fitted in the electronics cabinet, another XLR cable was made up. The program was rewritten and after a small amount of fine tuning a gear blank was setup in the machine and with fingers crossed MEGS was set running. Slowly and surely a gear was hobbed! I cut a few gears in different modules to test everything was functioning, **photo 34**.

ABS spacer on top of stepper motor.

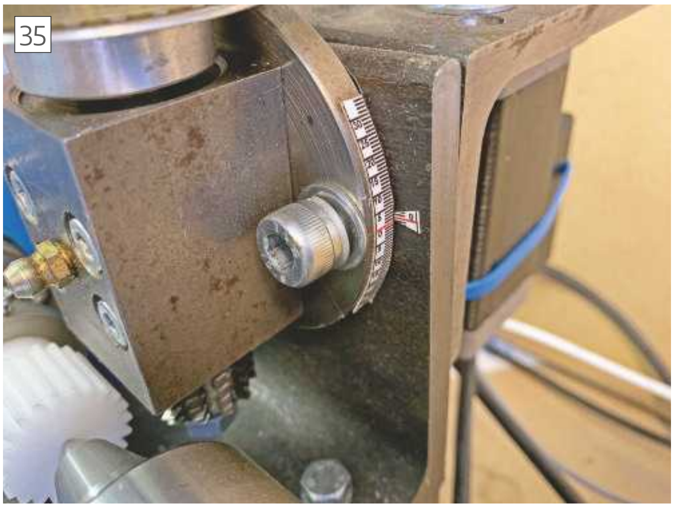
Setting the Helix Angle and More Changes

As mentioned before, you need to adjust the spindle to match the helix angle of the particular hob cutter. The angle is normally inscribed onto the cutter itself. The angle depends on the module of the cutter. The Module 1 cutter I have has a 2 degree 25 minute angle, and the 0.5 Module cutter has a 1 degree 14 minute helix angle. So that I could set the spindle to the angle I needed I made a degrees scale for the back plate.

These are normally scribed into the metal, but I thought it would be easier to print one using my computer. It would also easier to read and when you are scribing into the metal you only get one chance to get it right! I measured the circumference of the back plate and on a computer drawing package took that dimension and divided it into 360 to get degree marks then printed it off on an inkjet printer. Then I applied some clear sticky tape over the printing to protect it and placed some double-sided tape on the reverse. The section I needed was cut out and placed around the edge of the back plate, **photo 35**. After checking the spindle was perpendicular to the lathe, I printed off a line and using the same process as the scale placed it on the mounting plate opposite zero on the scale.



Selection of gears cut by MEGS.

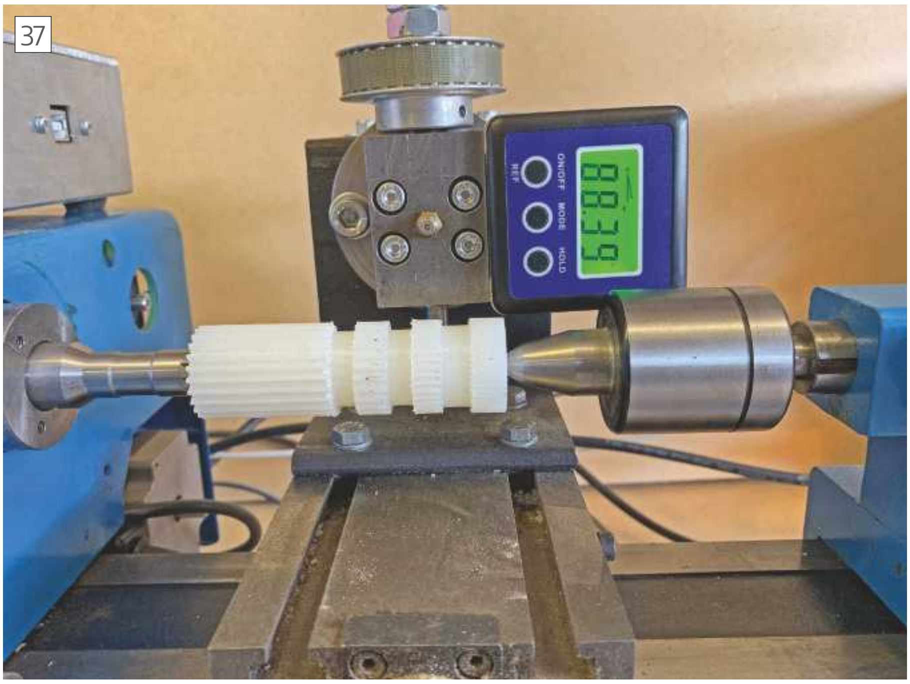


Helix angle scale.

This worked well until another change was needed. Some of the later hob cutters I had bought where different in the way they were setout. Some had a plain boss section above the cutting edges, some below, as shown in part 1, photo 3. The upshot of these differences was I couldn't mount the newer cutters to match the centerline of the gear blanks. This led to poor cutting of gears. I needed to be able to raise the whole spindle assembly. The easiest way to do it was to change the holes in the mounting plate. The central hole where the spigot from the back plate fitted was simply elongated. The curved slots where the clamping bolts passed through were enlarged to allow the spindle assembly to be rotated from the vertical the same amount whether it was in the raised position or the original position. This now allowed me to vary the height of the spindle to suit the cutter I was using. It also had the benefit of making it easier to change the cutters as I had more space between the end of the spindle and the crosslide.


36

Setting inclinometer to zero.


37

Setting cutter to helix angle.

What was not so handy, was the helix angle scale was now useless. Once the spindle was in the raised position the scale no longer coincided with the fixed mark. I was quite glad now I hadn't spent a lot of time scribing in the scale. The solution I found was to buy an electronic inclinometer online **photo 36**. These can be had for less then £10 and are supposedly accurate to a tenth of a degree. To set up I place the inclinometer on the bed of the lathe and zero it. Then using its built-in magnet, stick it to the side of the bearing block and adjust the spindle assembly until it reads the desired amount, **photo 37**.

Refinements

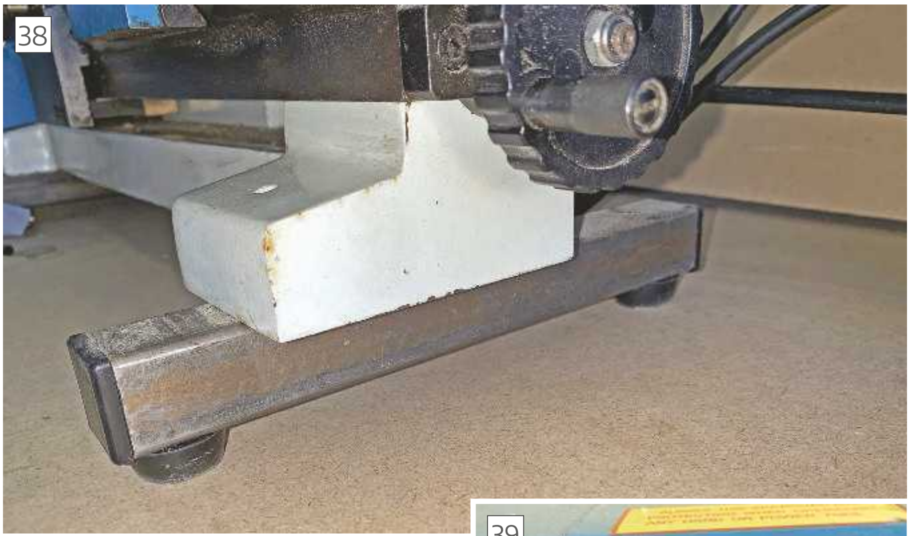
I had initially bolted some castors, utilizing some conveniently positioned and tapped original holes, to the underside of the lathe. This helped me push MEGS under a workbench on the many occasions that I tucked it away to ponder on my next steps. The problem was the weight of the motors would tip it on its back if I weren't careful. Some short lengths of 25 x 25mm box steel section were bolted on in place of the castors. These had 4 rubber feet bolted to each end. This made for an altogether more stable situation. To finish off four rubber plugs, designed for plugging off box section steel, purchased off the net were pushed into the ends, **photo 38**.

Various labels were made up using the same method I used for the helix scale and placed on the exterior of the electrical cabinet, so I knew what socket or fuse was what. Some bigger labels where made up and this time covered in clear sticky back plastic, Blue Peter style, and stuck onto 2mm ABS sheet. The one covering most of the front of the cabinet is actually covering the large hole I cut to place in the original motor controls. On the headstock of the lathe, a label showing the helix angles of the different cutters and how much to wind in the cross feed to cut different gears, filled the gap created by the removal of the same lathe motor controls, **photo 39**. The labels for the Arduino box were also made in this way.

Auto Feed

A side affect of a stepper motor driving the hob spindle was a slower cut, and the lead screw had to be turned quite slowly when cutting a gear. I was finding this a bit dull so I wondered if I could automate this. On this type of lathe the carriage is permanently attached to the lead screw and there is a clutch to disengage it from the gear chain in the headstock, **photo 40**. If I put a pulley on the end of the lead screw where you ›

38



Support feet.

normally placed a gear I could drive it with another stepper motor. Using the clutch, I could select either manual or auto feed. So back to the Internet and another stepper motor driver and stepper motor was bought. When they arrived, the driver was squeezed into by now a rather crowded cabinet. With another socket added and a new XLR cable made up and two buttons and a variable resistor fitted to the Arduino box. The variable resistor enables you to control the speed of the auto feed.

The other stepper motor was added above the headstock stepper motor with the same timing belt and pulley setup as the headstock drive. With an addition to the software I was now able to use auto feed by engaging the lead screw dog clutch and pressing a button. Is was very satisfying to set it all going, sit back and just watch as a gear appeared.

It did occur to me I might get too blasé and with my attention wandering it could lead to a disaster with a

39

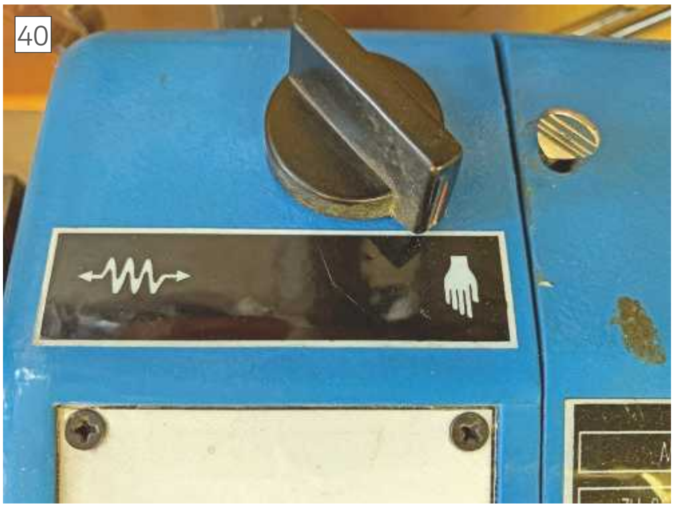
Printed information panel in place of original motor electronics panel.

meeting of a whirring cutter and headstock. So accordingly I made up an adjustable limit switch, **photo 41**, **fig. 8**. The stop is an aluminum tube free to slide through 2 sections of angle bolted to the lathe headstock. An aluminum collar is held onto the tube by a socket headed bolt with a spring pressing against the collar. Another collar holds a mushroom headed plunger inserted partway into the tube. This bears against the saddle of the lathe as is approaches the headstock, pushing the plunger and tube back to close the microswitch. The plunger can be adjusted in and out of the tube to set how close the saddle gets before the microswitch is shut. The software then stops sending signals to all 3 stepper motors and effectively shuts down MEGS. Obviously, this is rather reliant on the software working correctly and not having a bug that would cause it to ignore the input from the limit switch which could lead to disaster. It should probably be a system where it physically shuts off power to the auto feed motor so you can guarantee it will work, but as this is not a commercial operation I am happy enough with how it functions at the moment. For the future I intend to install a "kill" button that will remove the power to the electronics to stop everything dead should I need to.

Wiring Details

The die cast project box contains the LCD screen, buttons and Arduino Nano. I used this particular microcontroller as it as very cheap, especially the Chinese made compatible boards. They are only a few pounds or so when bought online. It is also very compact which is not a particular concern as there is a lot of space in the box. It does make it however, fiddly to work with. The Arduino Uno (ref. 11) is a similar board, just in a larger form factor, with sockets to connect wires to, rather than holes you have to solder wires into. This

40



Feed screw clutch.

41

Autofeed limit switch.

might be an easier option as you can buy LCD shields that you can just plug into the Uno. This saves some soldering and simplifies things somewhat. But again, I had a load of Nanos already, so that's what I went with.

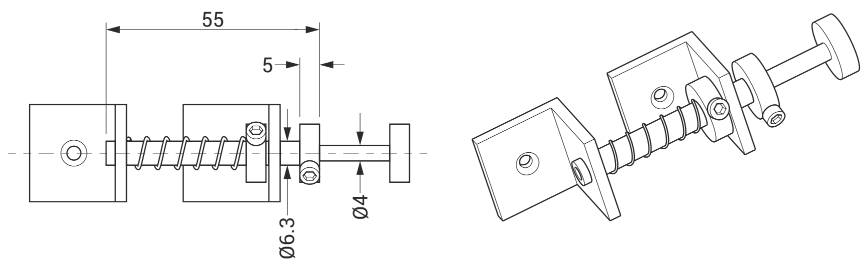
The Arduino is wired by soldering wires to holes around the edge of the board, **fig. 9**. These holes are called "pins" and each has a number or name printed on the board next to it. Some pins are power supply pins and the others are input/output pins. The power pin +5v takes 5volts dc and the GND pin is the negative pin and both are connected to a distribution board. The board has space for multiple positive and negative connections. That board gets its power from a cable with a 2.1mm jack that plugs into the control cabinet. There is also a mini USB socket that is used for programming and can supply power as well.

The input/output pins can be set by the software as either, as their name suggests, to be an input- in which case the software can read the pin and tell if there is voltage applied to the pin or not. These are used to tell if a button has been pushed. If a pin has been set to an output, it can either source or sink current. All this means is when pin is sourcing current it is set high or has been switched on. There is now 5v available at the pin to flow out of the Arduino. When a pin is sinking current it is set low, and the pin is connected internally to negative or ground. The current now flows into the Arduino. The current that the Arduino can source/sink is very low. I limit it to 20 milliamps otherwise damage may occur to the Arduino and you might get the "magic smoke".

The LCD screen I used is a very common type known as a 16x2 (ref.12). This means it can display 2 lines of 16 characters and needs 6 wires to control it plus a 5volt supply and a wire to provide the power to the LED backlight. The backlight needs a resistor of 220ohm between LCD and supply to limit the current to the LED backlight, or that will go pop. The 10k variable resistor is to adjust the contrast. It can be very frustrating to think your screen is not working, and spend a lot of time troubleshooting, only to realise the contrast is turned down. You may hear the voice of experience there.

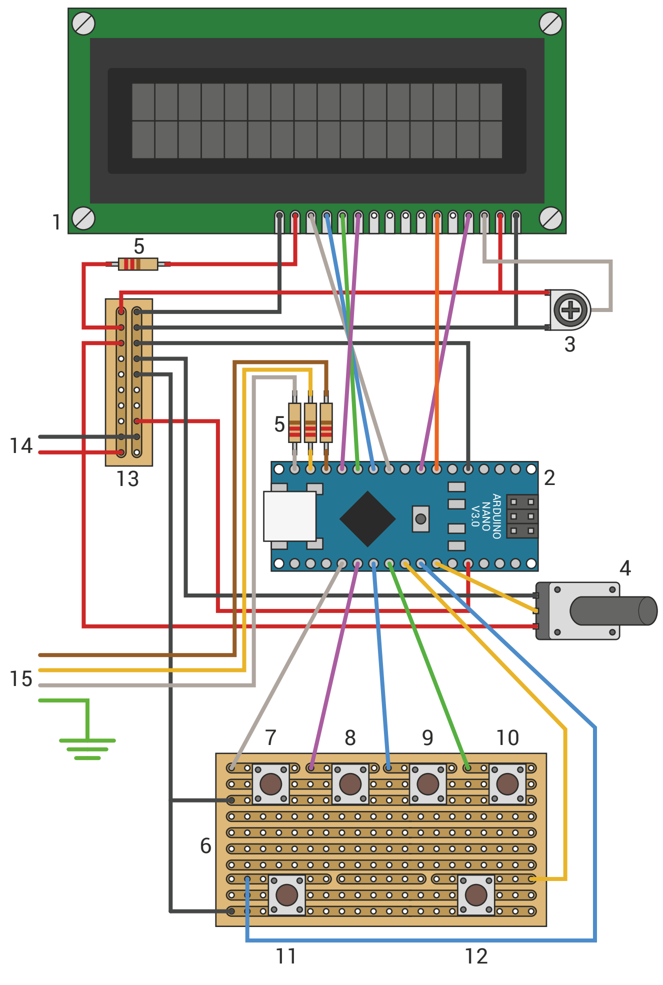
●To be continued

Fig.8



Autofeed limit switch.

Fig.9 *Arduino control box wiring.*



1. 16 x 2 LCD screen
2. Arduino Nano
3. 10kΩ variable resistor (LCD contrast)
4. 10kΩ variable resistor (auto-feed speed control)
5. 220Ω resistor
6. Button stripboard
7. Back button
8. Enter button
9. Down button
10. Up button
11. Start auto-feed button
12. Stop auto-feed button
13. Power distribution board
14. Cable to cabinet (5V DC)
15. Cable to cabinet (stepper motor control)

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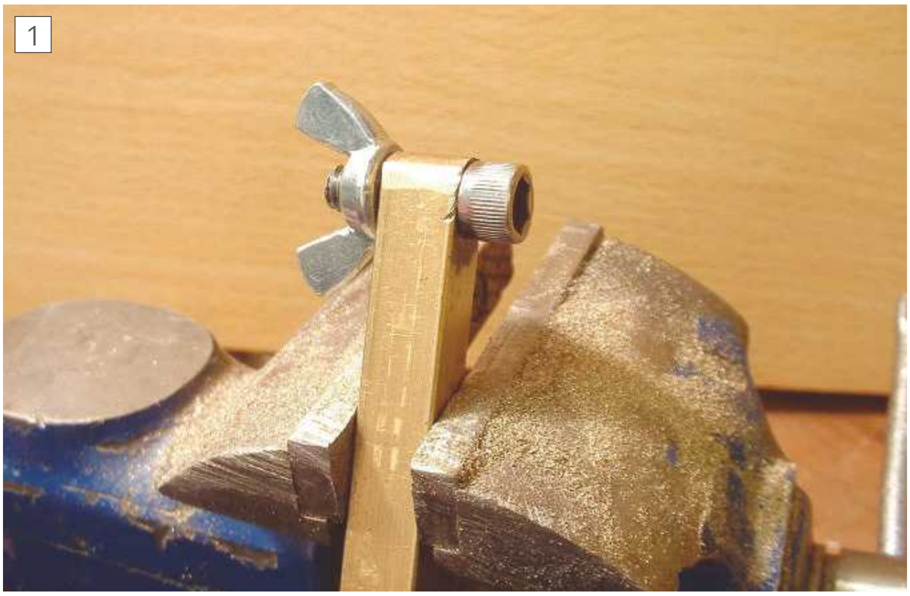
Some Workshop Tips

Rex McHinerney shares some handy workshop tips

Filing Buttons

Filing buttons are a simple, yet astoundingly useful aid to hand shaping components. They are just round discs of metal fitted either side of a hole to guide hand filing and the production of a neat, round end. For a rough and ready result, just using a cap screw or cheesehead screw might be sufficient, **photo 1**, and it is easy to get excellent results with a little more care.

Obviously to get a really good result the button should be exactly the same width as the bar, and the bolt that holds buttons and bar together must be a good fit in all three parts. This is not hard to achieve, even if using a plain screw to hold the parts – but do measure the screw first. Many screws (especially metric ones) are significantly smaller than their nominal top diameter. I prefer to make filing buttons from silver steel, hardened but not tempered. Glass-hard, the file skids off them without damage, and they don't need to be left free to rotate. You can use softer materials, but if you do they need to be able to rotate so the file doesn't wear them away; this means a sloppy fit at the expense of a little accuracy. If you don't have material of the correct diameter just turn some down, the surface finish is not critical. Drill through a good snug fit for the securing screw, and part off two slices. These should not be too thin, like washers, instead aim for similar proportions to a full nut. Use the same drill on the component to be shaped – you can enlarge the hole to a larger size later if required.



1

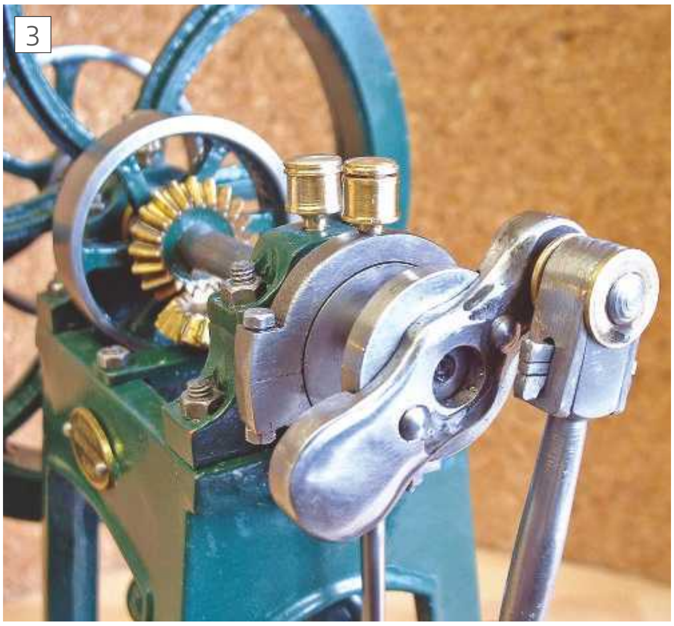
Using a bolt as a filing button

Using the buttons is simplicity itself. Fit hardened buttons securely in place or leave softer ones a running fit. Hold the part securely in a vice and file away, guided by the buttons. Interestingly the buttons control the cut taken by the file, so getting a good finish is usually easy, even with a coarser file than usual.

Normally you would use a flat file, but you can use more than one button to create more complex shapes with other types of file. The balanced crank, **photo 2**, was made using three pairs of buttons in two sizes, and the concave sections between each pair of buttons

2

Shaping crank with buttons



3

Crank shaped using three filing buttons was finished with a half-round file. **Photograph 3** of this crank shows it with its edges profiled, then treated with a sanding drum followed by a felt mop with polishing compound. But where is the hole for fixing the buttons to the balance weight? It has been plugged by a piece of similar steel turned to a driving fit. The plug is invisible after polishing.

Finally, keep your buttons paired up on their matching screw. You will soon build up a neat little collection of useful sizes, and if properly hardened they should last a lifetime.

Centring gauge for a rotary table

The commonest items in the scrap box are offcuts of metal bar too small for most uses but too big to throw away. This simple but handy gauge needs no more than an inch or so of round bar. It can be made from almost any cylindrical piece of scrap as long as it is greater in diameter than the holes in which it will fit!

It is often necessary to position the centre of a rotary table centrally on a mill or lathe. When reasonable accuracy is required, a convenient solution is a simple plug gauge, **photo 4**. Setting up is as simple as popping the gauge into place and matching it to a plain centre in the mandrel.

In my case, I made one shoulder a gentle push fit in the central hole of the rotary table and the other in my faceplate. Naturally, if your rotary table has a tapered bore, rather than a cylindrical bore, then a little more effort will be, required. The gauge may also be held in the jaws of a chuck.

As the device is easily made double ended, make one end to fit the table, and the other to fit your most likely accessory. If the table has a taper socket, start by turning a short stub taper. The locating pins should be turned to 60º internal angle; this makes it easier to match them to a plain centre. They should not be too small, but if you place the pin inside a shallow recess, it will have a little protection. If you turn the gauge by holding the work in a three-jaw chuck, the accuracy of the chuck will be the limiting factor (along with your eyesight!).

In use the gauge is simply fitted to the rotary table and line up with a dead centre or a centralised wiggler (or even a sticky pin). Need I describe a sticky pin? It's just a pin attached to the end of the mill or lathe spindle by a blob of blu-tac or similar. Whilst gently rotating carefully pushing against it with the edge of a ruler or a metal bar will get it to run perfectly true. You should be able to line the end of the pin up the gauge to an accuracy of a few thousandths of an inch, although good light and a magnifying lens may be needed by those less myopic than me!

Finally, a really handy little gadget with a similar purpose can be made by chucking a short piece of silver steel, perhaps ½" diameter, and turning a 60° cone on the end, **photos 5** & **6**. Centre pop it adjacent to jaw number 1, and harden and temper it. This little slave centre will not have the accuracy or rigidity of your proper Morse taper centre, but it will come in handy for all sorts of alignment tasks. You can even put it in a drill chuck and push it into a centre pop to hold a workpiece in accurate alignment whilst it is clamped in place. ■

4

Rotary table alignment device

5

A hardened mini-centre

6

The centre is centre-drilled at the other end

New Motion Nuts for a Tom Senior M1

14

The completed new knee nut

15

Hollow stock as purchased for the Knee Nut

Laurie Leonard restores accuracy to a well worn milling machine. Part 2

The Knee

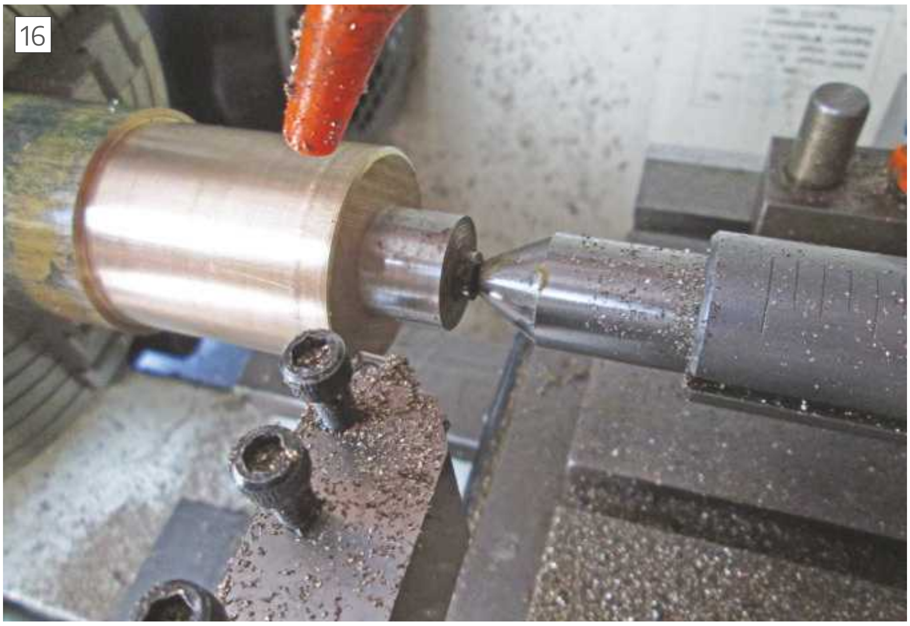
Comparing the as removed nut shown on the left in photo 1 to the new completed nut shown in **photo 14** the major difference is evident. The locating flange is much smaller and does not cover the fixing holes. As mentioned above much time was spent agonising over the waste of material versus the ideal solution of copying the original but it was concluded that the new design would be adequate for the use that the mill was to be put to so it was made to the same dimensions except the size of the top flange.

For cost/waste reasons a hollow section was purchased, **photo 15**, having ensured that the bore of the stock was smaller than the thread core. This created a slight problem of support from the tailstock when machining the outside diameter to size. This was solved, **photo 16**, by turning a slightly tapered plug that was driven into the bore. The later was faced and centre drilled in situ after the stock was mounted in the chuck.

Having turned the portion that would fit inside the knee support casting to size the other end was machined to produce the flange. This was made the same thickness as the original flange and the large diameter of the stock piece only cleaned up to leave it as large as possible. The bore was then opened out to the tapping size of 1” 5 TPI, ACME .

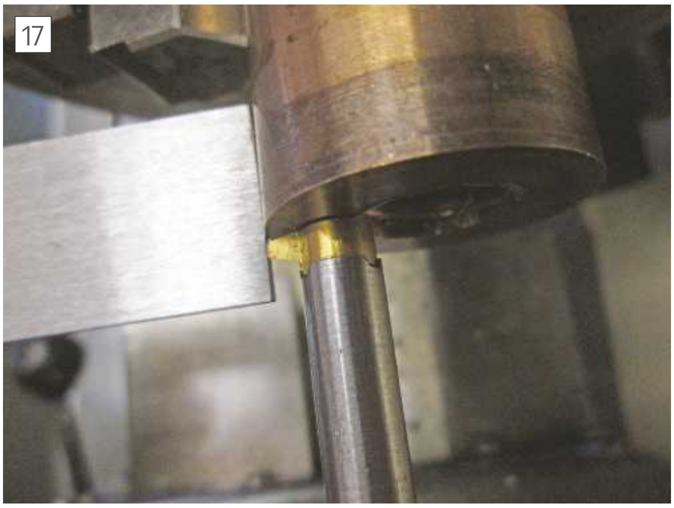
So far so good but it is now necessary to set the feed screw to give the required 5 TPI. On the Myford which has an 8 TPI lead screw and with the standard change wheels, a driver of 40 teeth onto an idler and a driven on the lead screw of 25 teeth will provide the required ratio. It is interesting to note that this is a step up ratio compared to most screw cutting operations and a dummy run with the tool well clear of the work showed that carriage rattled along at a fair old pace even using back gear and a low speed from the variable frequency drive.

The nominal dimensions of the ACME thread form are shown in **fig. 2**. I say nominal as dimensions change with

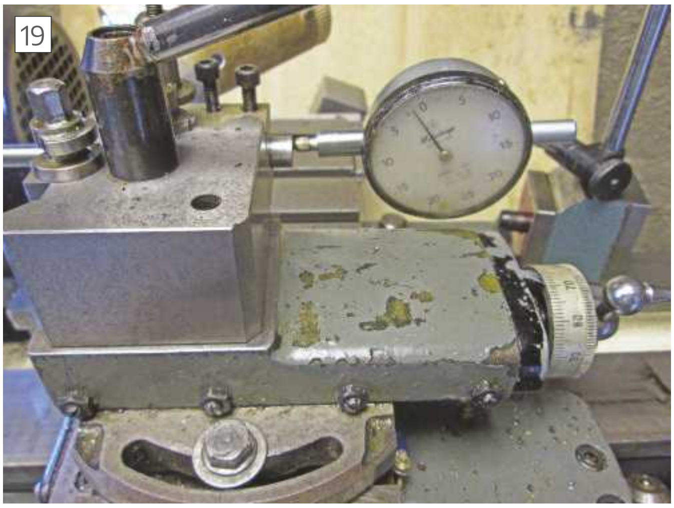


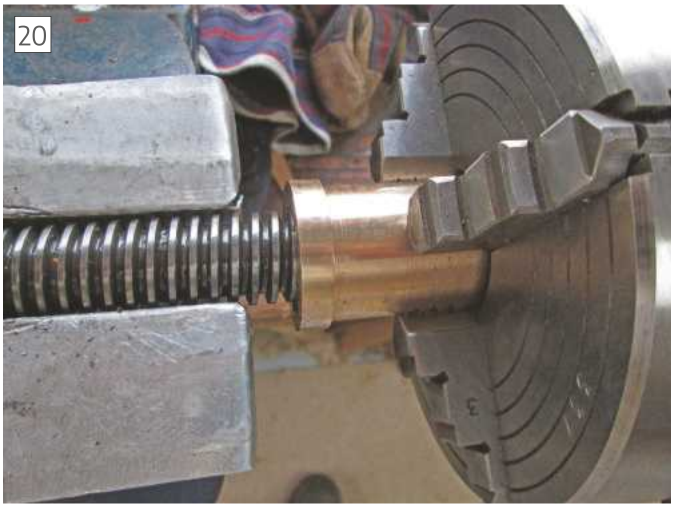
16

Turning the outside diameter of the knee nut showing the temporary plug for the centre


Initial attempt at aligning the ACME threading tool


Aligning the ACME threading tool with clock gauge

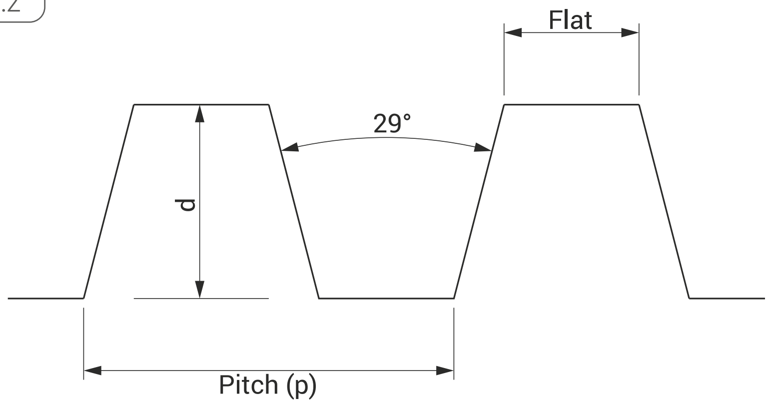

Clock set up on the end of the threading tool to monitor increase in cut


Trial fitting the knee nut on the knee screw

the grade/tolerance attributed to the thread and which source you look at. The formulae were taken from ref. 1. More comprehensive formulae were found in "The Model Engineers' Workshop Data Book", issued with MEW in parts a number of years ago and things like clearances were given for specific threads but 1 inch 5 TPI was not amongst them. As it was intended to cut the thread to fit the existing screw, the latter stages of the process being on a trial fit basis, the formulae shown were deemed adequate for the work. This was further justified having the knowledge that the mating male thread, the existing screw, was bound to worn in a non uniform manner.

The next hurdle was the fact that a 6 TPI ACME insert was being used as the threading tool for the 5 TPI thread. The insert was purchased as the nearest available at reasonable cost. Although the geometry was correct the length of the tooth flat was wrong as shown in **Table 1**. The calculation shows that the depth of cut has to be increased from the nominal 6TPI of 0.093 inches to 0.110 inches for the 5TPI thread. The insert purchased had a maximum listed depth of cut of 2.63 mm (0.104") which is 6 thou short of the calculated depth of 0.110 but examination of the insert indicated that at least a further 10 thou within profile was available before fouling so enabling the 6 TPI insert to be used for the 5 TPI thread. These last few thou were in the area of the clearance margin and it was again considered that the male thread was worn anyway. Table 1 also shows

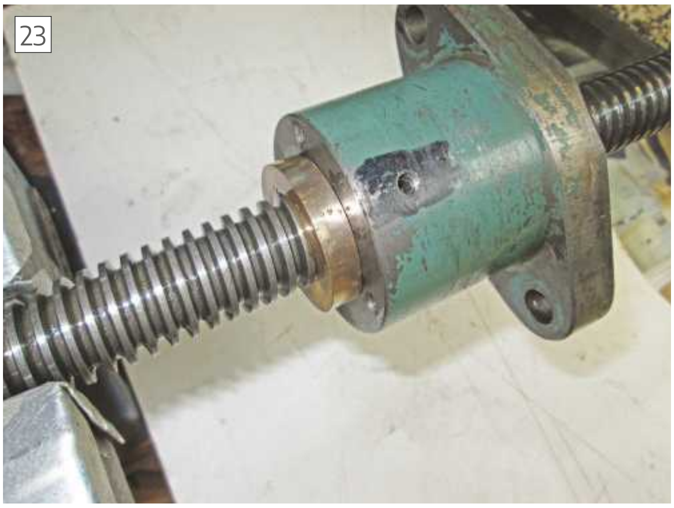
Fig.2



ACME Thread
Depth (d) = 1/2 P + 0.010"
Flat (f) = P x 0.3707


Result of slippage when being too confident trying the knee nut


Using a centre drill to make the locating dimple in the knee nut


Trial fitting of knee nut in the support casting showing the locating grub screw


Knee screw and nut reassembled

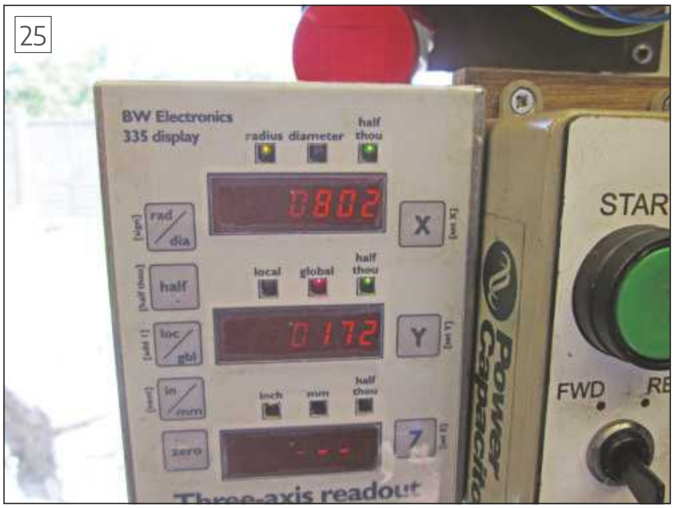
the flat of the 6 TPI insert to be 0.0618 inches whereas 0.0741 inches is needed for the 5 TPI thread to be cut. In practice this meant that after the full depth of cut the flat had to be enlarged by about 0.012 inches.

The thread cutting tool (holder as described in MEW issue 268 fitted with the ACME 6 TPI insert) was mounted in the tool post and set parallel to the line of travel. Initially I found no easy way to do this and resorted to using a straight edge against the tool insert and eyeing it up against the work, **photo 17**. In this view it can be seen that the tool is not yet correctly set as there is a dark wedge between the work and the straight edge. Only after several attempts did the penny drop and a clock gauge was set up as in **photo 18** and the carriage run up and down making adjustments as required until there was no deflection on the clock.

Having cut the thread with the top slide locked as if it were 6 TPI but to the depth required for 5 TPI, a clock gauge was set on the end of the insert holder, **photo 19**. The top slide, which had been checked to ensure travel was parallel to the bed, was released and used to put on the cut to increase the length of the tooth flat, the actual movement on the top slide being shown on the clock gauge. The length of the tooth flat was increased in small intervals to just short of the value calculated in table 1 and the nut, still held in the four jaw chuck, was removed from the lathe and tried on the feed screw which was held in a vice, **photo 20**. A degree of thread engagement was found but very little, so the job was returned to the lathe and a further couple of thou cut put on with the top slide and the fit tried again. Engineers blue was used on the thread to confirm that the depth of cut was sufficient and that the stiff engagement was due to flat length rather than overall diameter restriction. The engagement was expected to be tight and as the trial and error progressed more confidence was gained that the correct fit was being approached but... too confident! Trying to drive the new nut on the feed screw with too much force made the nut slip in the chuck as evidenced by the witness marks showing **photo 21** where the chuck jaws have chewed the surface of the nut with the corresponding production of swarf.

The jaws were released, and the nut repositioned as near a possible back to the original position using the score mark as guidance. The threading tool was fully engaged and adjustment of the top slide carried out to reset the tool to the last cutting position by “feel”. After a few more thou removal the nut was made to screw on and as expected became freer in the normal working range where wear had taken place on the screw itself. It is interesting to note that using a micrometer there was no discernible wear on the diameter of the screw in the central portion.

It was now necessary to address the issue of locating the nut within the casting. As the new flange fell a long way short of the old locating holes in the casting a new approach was necessary. It was argued that the torque



DRO showing 1/2 thou LED

Temporary knee nut retainer

on the nut within the casting would be small provided the slideways were well adjusted and both slideways and feed screw lubricated. The weight of the table assembly would also be bearing down on the flange holding it in contact with the casting so the main consideration was a means of anti-rotation. A single grub screw was fitted in the side of the casting with a dimple being formed with a centre drill, **photo 22**, in the nut (note the score marks where it slipped in the chuck during trial fitting). The completed nut in the casting is shown in **photo 23**, the centre pot marks made for reference to the dimple position. **Photo 24** shows the casting refitted to the mill for testing.

Performance

The mill was reassembled and the gib strips adjusted. Testing showed that the feeds were really smooth, and the knee had stopped lurching but backlash which previously had been up to 10 thou would be the real test. The mill is fitted with a digital read out (DRO) so all feed screws were rotated in a clockwise direction and the three scales zeroed. My DRO, **photo 25**, has an LED which illuminates at the half thou. Each screw was rotated anticlockwise until the corresponding half thou LED illuminated. In each case the corresponding scale on the screw showed between half a thou and a thou. This was a very pleasing result.

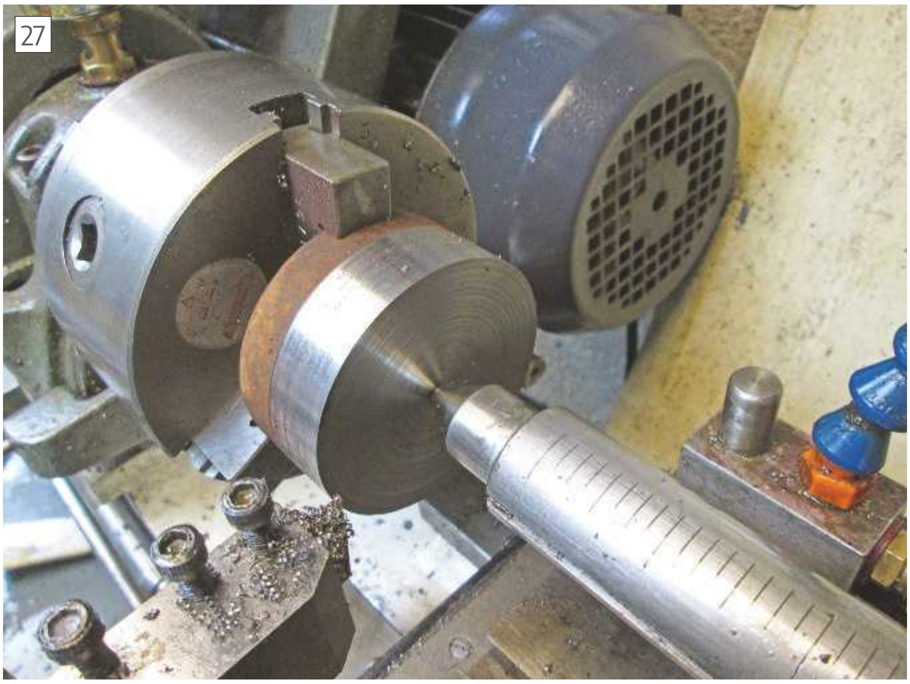
But...

A number of jobs were satisfactorily completed but a time was reached when a job required the knee to be near its lowest limit of travel. Funny things seemed to be happening and backlash had suddenly increased. Investigation was needed to find out what was going on.

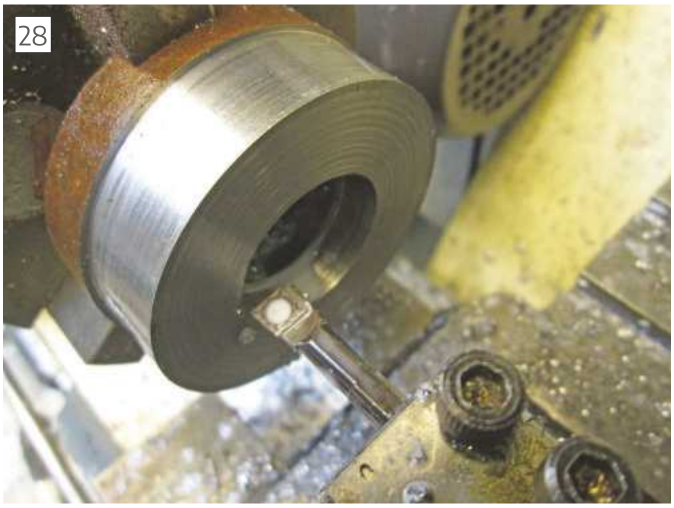
After some head scratching and close inspection, it was discovered that my assumption in relation to the adequacy of using stock material for the knee nut of smaller overall diameter than the original was incorrect. To recap, the original nut was held in the support casting with three bolts through an integral flange. The replacement material was too small on the diameter for the flange to carry the bolts but it had been argued that the weight of the whole table assembly would keep the knee nut in contact with the support casting and that the grub screws would only be needed to prevent the knee nut rotating in the casting.

It was found that at times of operation close to the lower end of travel, instead of the table going down when attempts were made to lower it the knee nut was in fact being wound up out of the casting. Why? It was concluded that this area of the dovetail slide arrangement had minimal wear and that when the gib strips had been reset they were set too tight for this area. As the gib strips needed to be as tight as practically possible the new knee nut had to be positively clamped in place as in the original arrangement. Initially a bodge was carried out as in **photograph 26**. The original bolts were located (never throw anything out!) and short lengths of tube slightly shorter than the depth of the nut flange were made and used in a clamping arrangement with thickish washers. Ok for a temporary solution but the long term fix?

Various set ups were considered but the final solution was to make a clamping collar that would fit over the nut flange and hold it down on



Knee nut retaining collar machining



Knee nut retaining collar machining

Checking the gap to give full seating

the support casting. Ideally the mill should have been dismantled in order to fit a complete circular collar but still recovering from a back operation this was dismissed as "not a good idea". It was thought that a collar with a "keyhole" would serve the purpose and be a lot kinder to my bad back. This was relatively easy to make from an off cut of mild steel. **photo 27** shows the initial machining with **photo 28** showing the finish boring of the recess to house the flange on the knee nut. The position of the holes for the clamping screws were marked on the new clamping collar by inverting the old nut and clamping it on top of the collar and marking it with a drill through the holes in the old nut. The counter bore diameter in the clamping collar was made on the "generous" side as it is not critical but would be messy to subsequently open out if made too small. The clearance holes in the collar could also be opened out if needed to cater for slight out of alignment but this was not required. A piece of the new collar was cut out to clear the knee screw and a test fit was carried out. The collar has to hold the nut hard down in its casting, but I also wanted it to more or less seat on the casting. As expected, there was a slight gap between collar and casting. **Photo 29** shows feelers being used to determine the amount to be turned off the face of the collar. This done the collar seated well, photo 30, and checks using the DRO when raising and lowering at the limits showed the erratic behaviour had been eliminated but the backlash had slightly increased from when it was originally fitted probably as a result of the nut bedding in. The top of the new arrangement was higher than the old integral flange and tests were carried out to make sure that travel had not been reduced (this

Completed collar Installed

potential problem had been foreseen hence the use of cap screws which could have been accommodated in counter bores if this had been required). The limit was found to be the knee main body casting hitting the knee nut casting holding down bolts and no connection with the nut replacement work.

Conclusion

After a fair bit of effort was it worth it? Result: smooth and significantly reduced backlash! ∎

References

1 *Myford Series 7 Manual*, Ian Brady.(My Copy: Argus Books 1982)

Table 1	ACME profile formulae	
1" Diameter Thread	6TPI	5TPI
Pitch (p) = 1/TPI	0.1667	0.2000
Flat (f) = 0.3707 x P	0.0618	0.0741
Depth (d) = 0.5P + 0.01	0.0933	0.1100
Dimension in inches		

From the Archives:

A Quick and Easy Tangential Tool Holder

Michael Cox's design was extremely popular when it appeared in issue 179 of MEW, February 2011

There is much interest in tangential tool holders not only on the Model Engineer website but on many others. The big advantage of tangential tooling is that tool grinding is very quick and easy since only one face needs to be ground. I find that using a tangential tool holder, I can make deeper cuts than with conventional tooling and others have reported the same.

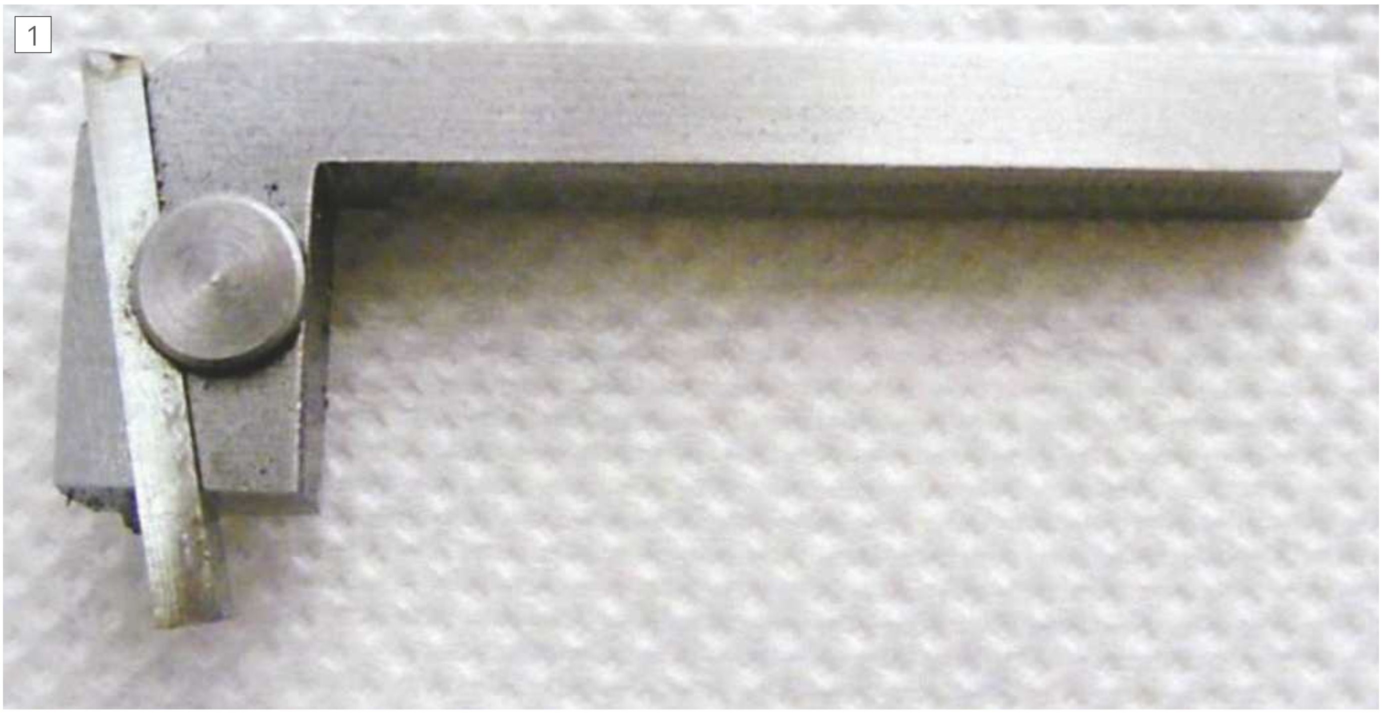
Commercial tool holders are available but are costly. There have been a number of designs published in the past that can be home-made. All the previous designs that I have seen require complex angles to be set up for milling the slot for the tool. The design presented here avoids setting up complex angles so making the tool holder easily and quickly made.

Mike Cox's Update

I made this tangential toolholder back in early 2011. Since then it has been the tool I use for 95% of my lathe work. The only times I use other toolholders are:

- When making heavy intermittent cuts, because the tool tends to get hammered down in the holder.
- When it is physically impossible to access the surface to be machined with the tangential toolholder.
- When carrying out special operations such as parting, chamfering and knurling.
- When making left handed cuts. I still have not made a left handed version.

In use the toolholder has performed well and no modifications have been made.

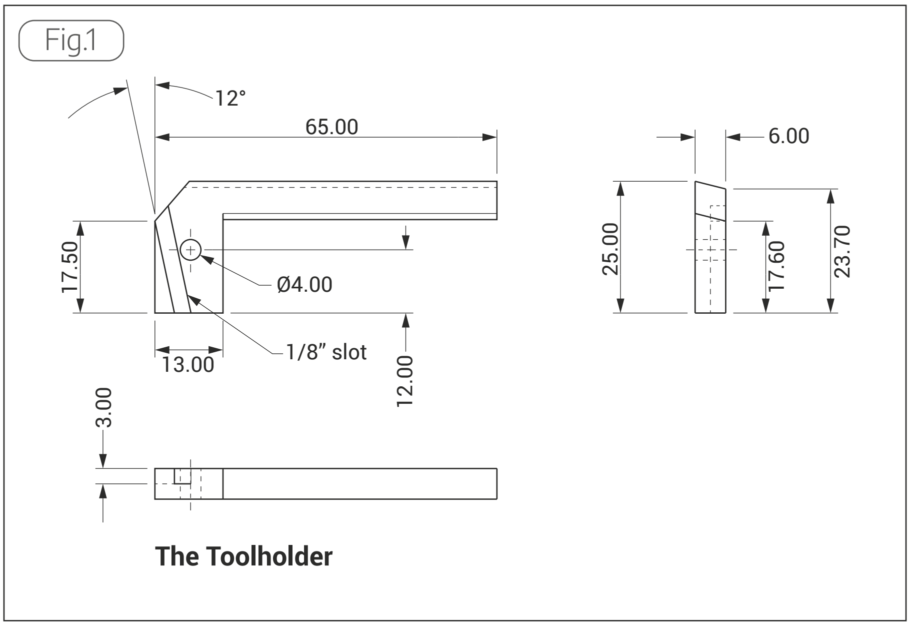


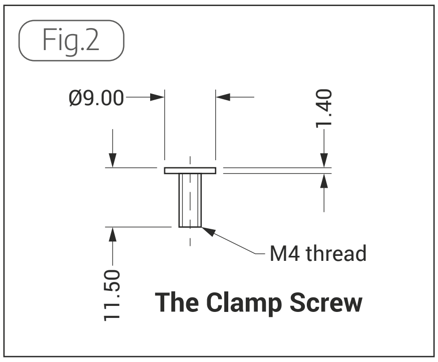
The finished tool holder

Note the parallelogram shaped shank

The tool holder was made for my Asian mini-lathe and uses a 1/8 inch square HSS tool. It could easily be scaled up to accept larger tools for use on larger lathes. **Photograph 1** shows the finished tool holder. It can be seen that the tool is clamped in a slot using an M4 screw and that the tool is angled at 12 degrees to the front of the tool holder. In order to obtain the 12 degree tilt of the tool in the other direction the shank of the tool holder is parallelogram shaped as shown in **photo 2**. In the photo, the tool holder is shown upside down lying on the top edge of the shank in order to show the inclination of the tool.

> The design presented here avoids setting up complex angles so making the tool holder easily and quickly made.



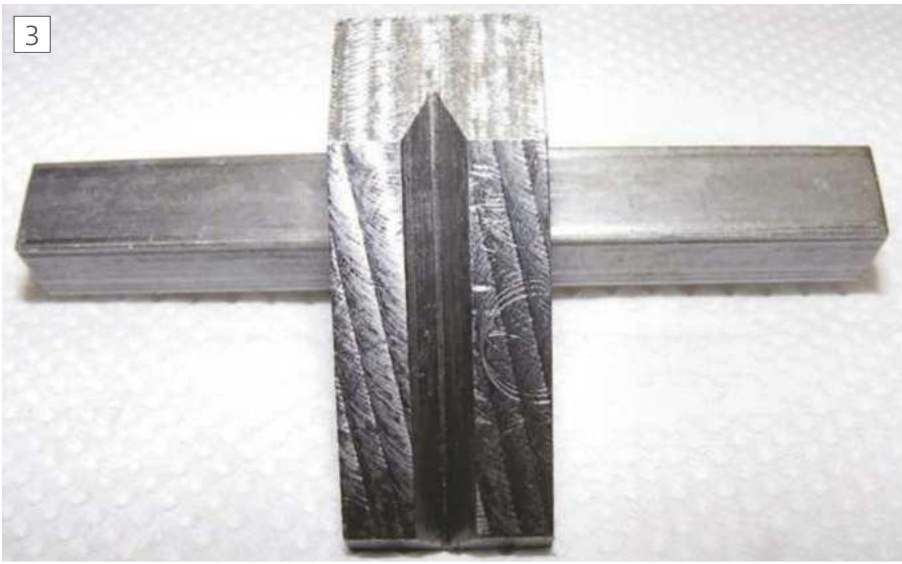


Construction

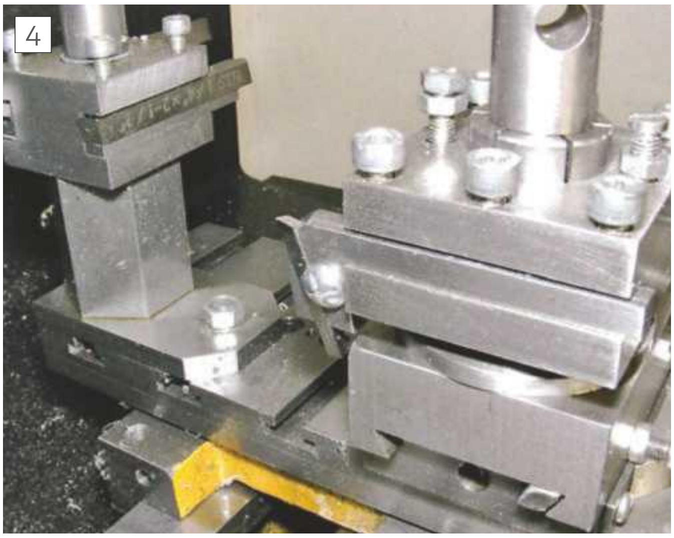
The tool holder was made from a piece of 6 x 25mm mild steel bar 65mm long (**fig 1**). This was clamped in a milling vice set at an angle of 12 degrees to the X or Y axis and the slot was milled with a 3mm milling cutter to a depth of 3mm. The slot was enlarged laterally until a 1/8 inch square piece of HSS was a snug fit. The tool must protrude slightly above the surface of the tool holder so that it can be held by the clamp screw. The hole was also drilled for the clamp screw.

The excess material (approximately 52 x 17mm) was then removed with a hacksaw and all the edges cleaned up with a file. The front corner was also sawn off at about 50 degrees to the front of the tool holder and then filed smooth.

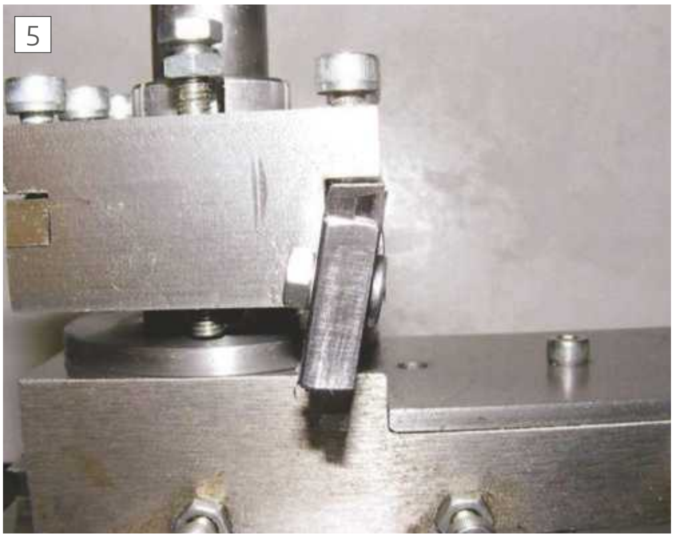
The parallelogram shaped shank was then made. This can be done by mounting the tool holder in a tilting



The tool grinding jig

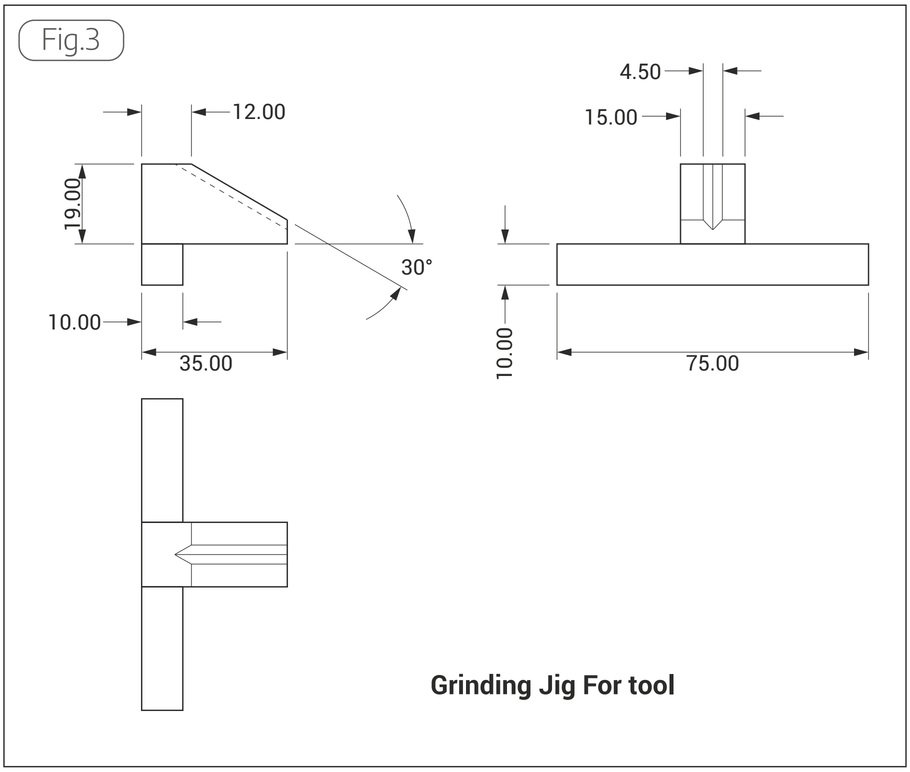


The tool holder mounted on the lathe



Looking at the tool from the end

The tangential tool is a universal tool that can be used for turning or facing a workpiece without adjusting the angle of the tool in the tool post



vice at 12 degrees from the horizontal and then milling away the excess material on both sides of the shank. This was the method I used. However there is relatively little material to remove and it could be done by hand filing. The 12 degree angle is not critical and as long as it is about right (+/- 2 degrees) the tool holder will work.

The clamp screw was made from an M4 screw with a large head. The head was turned down to the dimensions shown in **fig 2** and the screw was then cut to length.

Tool grinding jig

The tip of the tool is ground at an angle of 30 degrees. To facilitate this grinding operation a simple jig was made (**photo 3**). This has a Vee groove angled at 30 degrees. The bar at the back is used to guide the jig against the edge of the grinding rest. The dimensions of my jig are given in **fig 3** although these may need to be changed to suit other grinding rests. In use the tool is lightly clamped in the vee groove with a finger and the bar is held against the edge of the grinding rest. The tool is advanced by finger pressure onto the grinding wheel to form the 30 degree tip.

Use

The tangential tool holder is shown mounted on my tool post in **photo 4**. **Photograph 5** is another view of the mounted tool holder. The forward inclination given to the tool by the parallelogram shaped shank is clearly visible.

The tangential tool is a universal tool that can be used for turning or facing a workpiece without adjusting the angle of the tool in the tool post. I routinely take 1mm cuts with it whereas with conventional tooling my lathe struggles with more than 0.5mm cuts. The best surface finish is obtained by very lightly stoning the tip of the tool to a small radius after grinding. ■

Scribe a Line continued from page 17

Memories of Jack Radford Designs

Dear Neil, as a new subscriber to MEW, and having just received Issue No.295, I don't know if this is the correct way of contacting 'Scribe-a-Line'? (it is – Ed.)

However, I was interested to read the article regarding a 'Machine of the Future'. The contributor, Geoff Harding comments on his Murad 'Bormilathe' which reminded me of the design by the late Jack Radford for 'Elevating Heads for the Lathe' which somewhat emulated the Murad innovation on the Myford Super 7. Jack Radford published a number of original designs in Model Engineer in the late 1960's and early 1970's, some of whose principles were later incorporated into designs by the late George Thomas. All of the Radford designs were republished in 1998 in a compendium entitled 'Improvements and Accessories for Your Lathe', although in my personal opinion many are at the very limit of what can conveniently produced even in an exceptionally well equipped home workshop. However, I accept that there are highly skilled and knowledgeable amateurs out there who are quite capable of constructing all of Radford's designs.

But this may, regrettably, contribute to the fact that castings for Radford's designs are not commercially available (to the best of my knowledge) and has lead me to have bespoke patterns and castings made in the past simply to permit the construction of some exceptionally useful and successful devices. I am currently working on Radford's 'Worm-Wheel Hobbing Attachment', the castings for which were kindly given to me by an elderly amateur tool-maker who was not going to be able to complete the device and I am in the process of making the patterns for the 'Thread Milling Attachment' having received a 'definite maybe' from a local foundry that it will do the casting for me.

I am a great admirer of the late Jack Radford and I am certain others readers, who may not be quite so familiar with his work, would be well rewarded should they chose to investigate his designs for future consideration. BTW, although only mentioned but never described by Radford, I have made my interpretation of his 'Indexable Catch-Plate' which conveniently allows the cutting of multiple start threads and worms. Radford stated that any number of starts could be achieved with it but my humble effort is graduated only to a maximum of six and I doubt that practicably it could ever be used to cut more than two or possibly three starts. He doesn't mention an indexable chuck back-plate for work-holding when cutting the corresponding internal threads – now that thought has just given me an idea!

Chris Crew, Lincolnshire.

Jack Radford's book is still available, I received a copy one Christmas, what may put off some modern readers is the need to make patterns and get castings made for his more advanced designs – Neil.

Coincidence

Dear Neil, I just thought I would share a coincidence with you, I hope you don't mind. You may recall that in the article I submitted I alluded to the fact that I had got the bug from assisting a neighbour in his shed. I also mentioned that he had built me a bench from a photograph I showed him. Well the other day I was sorting through some paperwork and lo and behold I found the original catalogue (Photo attached). What is perhaps more revealing is the price of the bench that my pocket money could not stretch to, it was 40 years ago according to the date on the catalogue. Like us all I horde things and they turn up quite coincidentally.

Stuart McPherson, by email

Choosing Steels

Dear Neil, a couple of comments and queries about MEW issues 293 – 295 and the article in 293 regarding choosing steels. There appears to be a popular misunderstanding of the significance of the T in the designations of EN steels. It appears that this is believed to indicate that the material has been heat treated but although true it is intended to indicate a range of tensile strengths with the letter designator ranging from P indicating UTS 540/690 MPa to Z indicating UTS 1540 min MPa. Since achieving mechanical properties is dependant on both steel chemistry and component dimensions this introduces the concept of limiting ruling section based on a bar diameter of a specific teel grade which can achieve a particular tensile strength on heat treatment (ranges P to Z). If we take two of the material examples in your article EN8 and EN19 both can be heat treated to condition R but the limiting ruling sections differ considerably EN8R |(080M40R) limiting ruling section 19mm; EN19R (709M40R) 254mm.

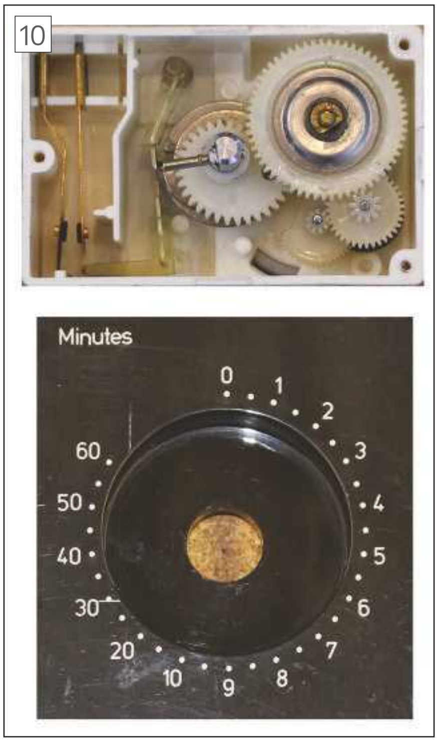
John Clipstone, Derbyshire

Constructing the MEWsonic: a homemade ultrasonic cleaner

Mark Noel shows how you can build your own sonic cleaning tank from readily available parts - Part 2

Being of a curious nature, I had to investigate further, discovering that the ingenious mechanism includes a pair of enmeshed snail gears configured to provide this 'molluscular' movement (**photo 10**). For this project the 60 minute timer seen left in photo 9 was used, with similar units being available new from eBay. Only four connections are required: two for the 240V mains synchronous motor, and two for the internal microswitch which is becomes open when the shaft turns fully anticlockwise.

The completed MEWsonic Professional. The blue flexi-tube on the right is for sucking cleaning fluid from the tank, while the one on the left is used to suspend parts for cleaning.

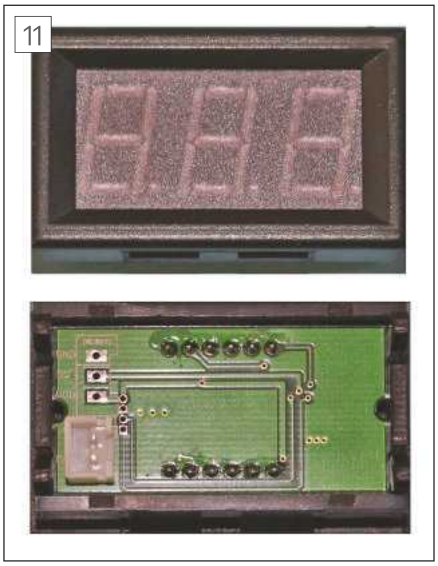


Details of the dual-rate Sankyo timer seen in the centre of photo 9. A pair of snail gears with two distinct radii are meshed to generate a fast, then a slow rate of rotation. The markings on the associated dial show how this rate suddenly changes after 10 minutes.

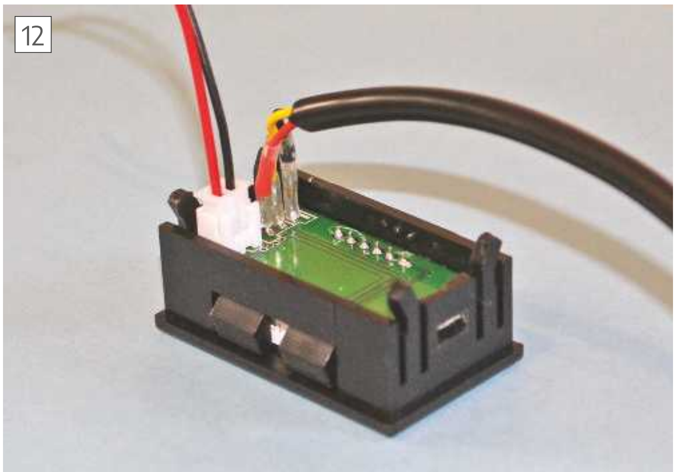
The temperature display uses a Maxim DS18B20 one-wire digital sensor sealed within a cylindrical stainless steel tube, and a 3-digit display spanning -55 to 125ºC with a resolution of 0.1ºC, sourced as a complete package from eBay (**photo 11**). Connection of the sensor is rather fiddly since three pin headers must first be soldered to pads on the rear of the unit using a fine tipped iron. Shrink sleeve was used to give strain relief between the sensor wires and these pin headers, as seen in **photo 12**. Although the instructions that came with the unit specified a 12V supply, it operates reliably down to 5V, which means that it can be connected to the always-on +5V Standby line of the ATX supply (Fig. 1). This is useful because it means that the temperature will continue to be displayed even when the main 12V output of the ATX is disabled by the thermal limit switches, as will be discussed later.

Photo 13 shows the various adhesives and other agents needed to assemble the ultrasonic cleaner. These include:

- Kapton high temperature tape to secure parts against the tank wall.
- Clear silicone adhesive, most varieties



Front and rear of the temperature display module. Three pads at the top on the rear are for connecting the sensor. The lower block is for providing 5V - 12V power using the snap connector provided.



Wiring completed to the display module, with pin headers and shrink sleeve used to join the sensor to the circuit board.

Various adhesives etc needed to assemble the cleaner, plus a pocket lighter for flame polishing acrylic.

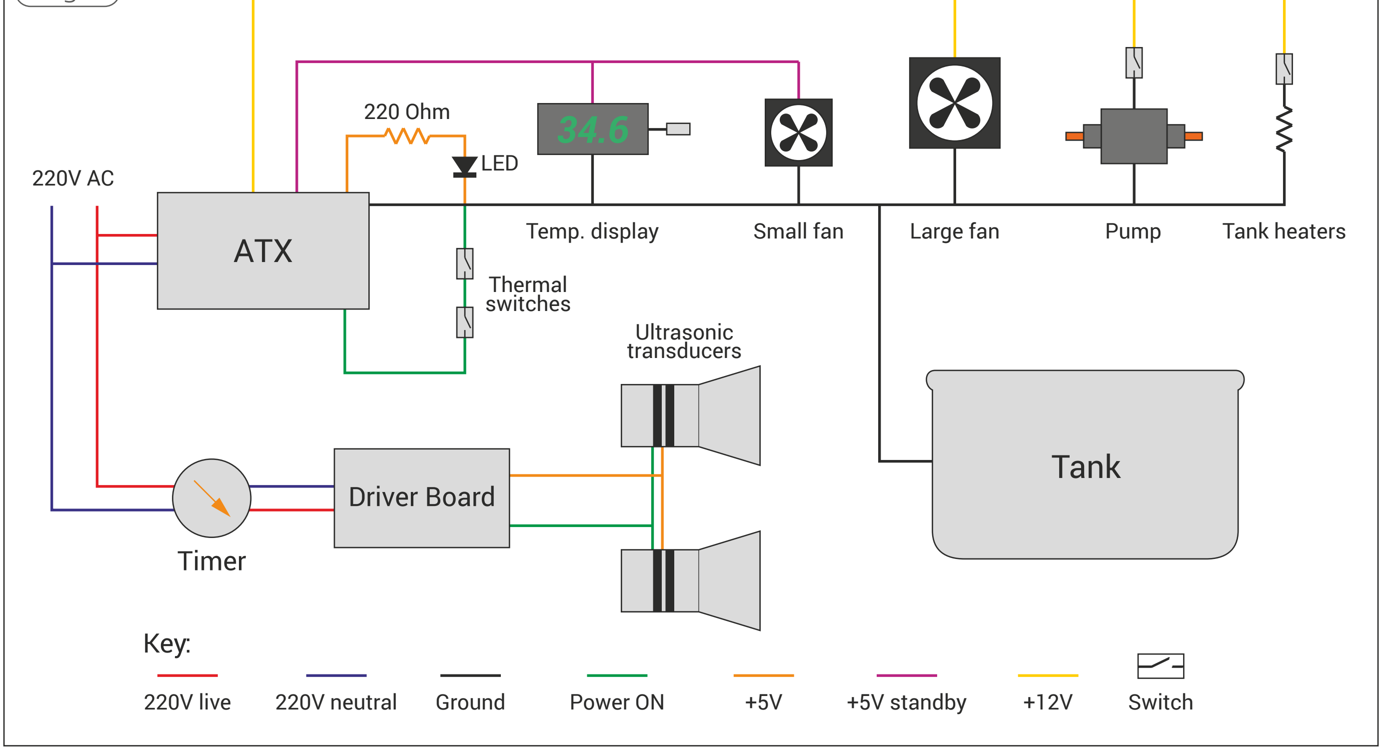
of which tolerate high temperatures. Silicone was used to provide a seal between the transducers and the underside of the tank, and between the holding screws and the inside of the tank.

- 5 minute epoxy resin to bond the tank to the CamdenBoss box.
- Shrink sleeve and/or Hellerman rubbers for stress relief of electrical connections.
- Plastic Weld for bonding ABS parts.
- M10 x 1mm Carbon steel die used to make the 2 custom brass cap screws for fastening the transducers. The design is shown in **Fig 2**.
- Nail varnish.

Nail varnish? Yes, this fast-drying cellulose lacquer finds many uses in my workshop, and in the field; for coating coil windings, repairing tissue damage on model planes and for lacquering nuts as a quick thread lock. In this project a thin coat of varnish was used to restore the sheen on rough edges of the ABS box after cutting and sanding. The problem, Gentlemen, is how to acquire this magical elixir? Be courageous and take the lift to the third floor department marked 'Lingerie and Cosmetics', and stride boldly through the lace and frillies until you come face to face with the supermodel behind the Cosmetics Counter. Ask for two bottles of nail polish "for my wife". Under no circumstances say that you intend to lacquer your nuts, since this will trigger a call to Security. Then beat a speedy retreat back to the man cave with your lifetime's supply.

Fig 1 shows the complete circuit diagram and **photo 14** shows which wires from the ATX main board connector are involved in this application. All unused wires were trimmed short and made safe by sealing the ends with shrink sleeve. A pair of wires were soldered to the 240V Live and Neutral inputs inside the ATX case and threaded out alongside the main wire bundle to provide power to the

Fig.1



Circuit diagram of the ultrasonic cleaner. Wire colours correspond to those referred to in the text and shown in photo 14.

WHAT IS
AVAXHOME?

18+

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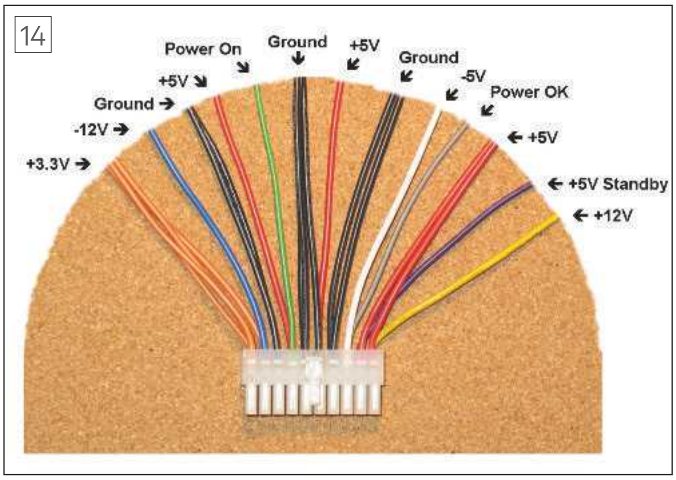
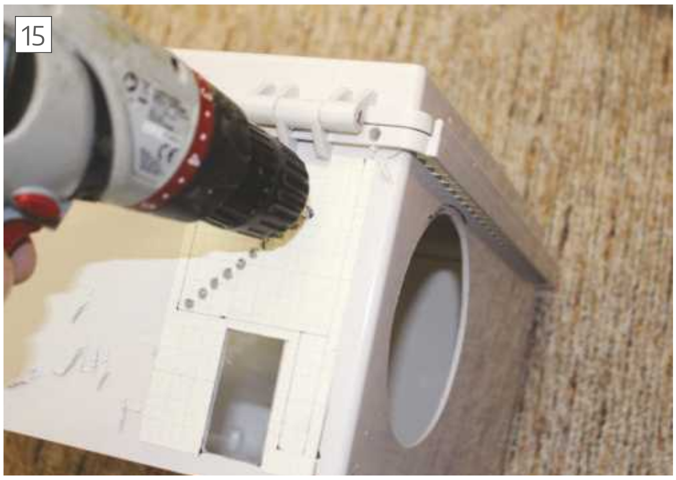


Close up of the ATX wire bundle that supplies the larger PC mainboard connector (reproduced from my article in MEW 226). Wires used in this project were: Ground (black), 12V (yellow), 5V (red), 5V Standby (purple) and Power on (green).

15



Graph paper makes a handy template for drilling a matrix of holes.

Allendale board, via the timer switch. A very useful feature of ATX supplies is that a large current on the 12V line can be controlled by the simple action of bringing the Power On line down to Ground. In this instance the temperature generated by the 12V heaters is monitored by the thermal limit switches which open at 45ºC, disconnecting the Power On line, thus terminating 12V current and hence the heat. Two thermal switches are used in series to provide a guarantee that at least two points on the tank wall (and hence the fluid) do not get too hot. Switches with higher ratings are available should you wish to raise this threshold. The remainder of the circuit is simple and should be self-evident. An earth patch comprising a wired copper pad is held against the tank wall with Kapton tape as a precaution should high voltages from the ultrasonic transducers somehow leak onto the metal surface.

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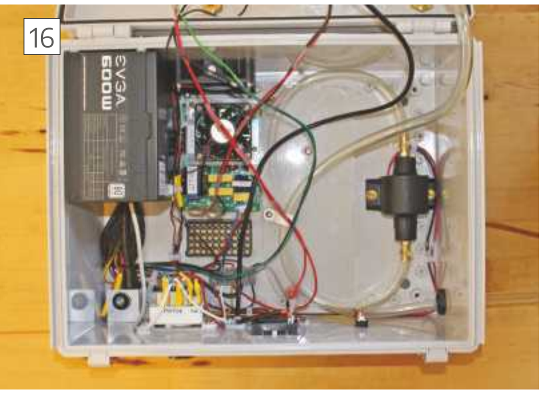


Internal layout of the ultrasonic cleaner. Note the two fans for cooling the driver board and the parts for folding the discharge pipe in the technologically advanced Tube Retract Guidance System.

Openings were cut in the enclosure to fit the various switches, ventilation ports and rubber feet. Round holes in ABS are easily cut using centre, cone or step drills, while a jig saw was used to make the larger holes for the pan and the ATX vent port. Into the latter was fitted the tumble drier grille using Plastic Weld to bond the part. The two bullet carriers were glued into holes cut in the base of the box and act as grilles for cool air directed onto the ultrasonic driver board. **Photo 15** shows how graph paper provided a handy template for drilling the matrix of holes in the rear of the box through which the ATX could exhale.

Photo 16 shows the internal layout that includes twin fans to cool the Allendale driver board, the larger one powered from the (enabled) 12V supply, the smaller one from the (always-on) 5V Standby line. This arrangement ensures that the board always receives cool air even when the 12V heater line is disabled by the limit switches. Also seen in this image is the pump installation and the unique Tube Retract Guidance System. The PVC tube exits the enclosure via a cable gland which can be tightened to clamp it in either the retracted or in the extended position when fluid is to be discharged, and this tube is guided into a loop when retracted by the Perspex cover and red pillars. Fluid is drawn into the pump from another folding tube connected to one of the flexible coolant pipes on top of the enclosure which can be angled

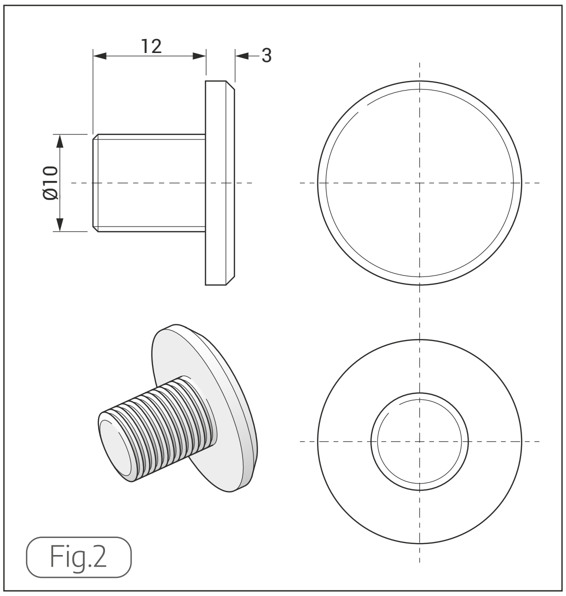


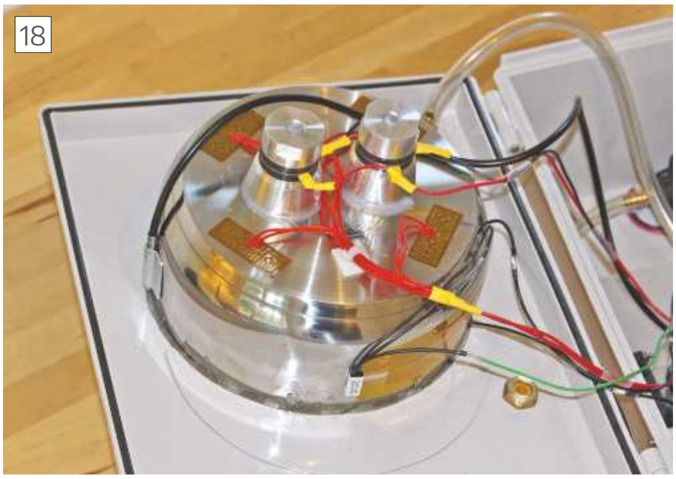
Fig.2

downwards to suck every last drop of cleaning fluid from the tank (photo 1).

As an aside, readers may be interested to learn that the Perspex tube guide was sawn from a piece of 6mm thick diffuser plate recycled from a defunct LCD television - another source of useful materials. The sawn

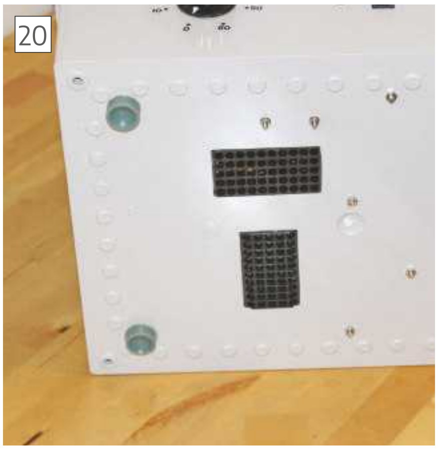
17

Flame polishing the sawn edge of acrylic that forms the tube guide.



Close up of the tank before covering with insulating foam, showing the transducers, heater foils, a limit switch, temperature sensor and earthing tab attached with kapton tape.

Rear of the ultrasonic cleaner with mains connection and vents for fans cooling the ATX power supply and ultrasonic driver board.



Ventilation ducts underneath the box made from .22 bullet carriers. These direct cooling air to the the ultrasonic driver board.

Right hand side of the box with the cable gland that acts as an in-out lock for the Tube Retract Guidance System.

edge was dressed with sandpaper but still remained rough despite my best efforts. Although this part is not be seen once the machine was fully assembled, as is the case with my hair, I do like everything to be perfect. The solution was to smooth the edge to a mirror finish by flame polishing, a process which involves using a flame to partially melt the surface of the rough acrylic. It does take some practice to obtain the best result - passing only the blue reducing part of the flame

CAUTION. This project involves fitting circuits and devices that handle 240V mains and higher A.C. voltages which will be hazardous if not properly protected. If you are not qualified to ensure adequate safety in this construction then you are advised to seek professional help in completing the installation.

along the edge (photo 17). There are several demonstrations of this method on YouTube and it is a skill worth perfecting. Flame polishing works best on acrylic, with ABS reacting to the heat by simply bubbling and charring. Do not attempt to use the method on PVC, since this plastic will release hazardous chlorine fumes when heated.

Photo 18 shows the tank with transducers and other items attached, before adding a Jubilee strap for security and wrapping with insulating foam, while **photos 19** and **20** show the ventilation ports on the sides and underneath the box - these made from the .22 bullet carriers! The right hand side of the box is where the drain pipe exits and is locked in the extended or retracted state by a cable clamp (**photo 21**). The MEWsonic was completed by adding Letraset labels to various switches and dials, protecting these with slips of self-adhesive book cover film. In photo 1 a second flexible coolant pipe is seen to the left of the tank: this can be used as a crane to suspend light articles, while heavier parts are normally placed in a plastic basket. It is essential that items to be cleaned never rest on the base of the tank since this greatly reduces the transmission of ultrasound and hence the effectiveness of the cleaning process.

I hope that this article encourages other people to consider building their own ultrasonic workshop cleaner, since all the required parts are readily available and quite inexpensive. It would not be necessary to include the pump, heaters and temperature sensor in order to create something that is simpler and yet still accomplishes the same task, refurbishing tools and saving you a bob or two. As you disappear into your workshop to begin this project don't forget to tell everyone that you are busy with Government Work! ■

Resources

www.allendale-ultrasonics.co.uk for ultrasonic transducers, driver board and Kapton tape
www.rapidonline.com for ABS box part no. 30-7423, rocker switches part no. 75-0730, cable gland part no. 04-1926
eBay for 10W 12V foil heaters, 10mm foam insulation, thermal limit switches, digital temperature sensor, 12V fuel pump and flexible coolant pipes
www.amazon.co.uk Search for: EVGA 600 W1, 80+ WHITE 600W. Also search for: 3 Piece Steamer Set 22cm - Stainless Steel Mirror Polishing Finish
Your local field sports shop for 22 calibre rifle cartridges in plastic carriers. However, you will need a firearms certificate to obtain these!

On the Wire NEWS from the World of Hobby Engineering

Envision Virgin Racing to recreate 11-year-old's winning Formula E car design

Eleven-year-old Kitty Thwaite is to have the climate change livery she designed for Envision Virgin Racing's Formula E car recreated in full and put on display, after beating more than 3,100 entries in the team's global art competition.

Held in partnership with National Geographic Kids and children's illustrator Rob Biddulph (creator of the online series '#DrawWithRob'), the sustainability focused art competition challenged children to draw the all-electric race car through an instructional video and then create their own nature-led custom car designs.

Judged by the team's Managing Director Sylvain Filippi and Managing Director of Nat Geo Kids Peter Johnson, both were impressed with Kitty's thought-provoking design which features a variety of endangered animals set on a background of a 'warming planet', together with the message 'land, air or sea, all animals are precious to me'.

"It will be absolutely amazing to see my design for real," said Kitty who lives in Tetford in Lincolnshire, UK, and attends the Edward Richardson Primary School. "We learn about recycling and emissions at school and I care about the environment a lot. I love drawing animals too; pandas are my favourite!"

To add to the excitement, Kitty was informed of the news on this evening's BBC flagship programme the One Show where she appeared live in front of an audience of around five million, together with her mother Alison. As part of her prize, Kitty will also receive tickets to a Formula E race next year and a video message from one of the team's drivers. The top three entrants also received a subscription to children's magazine National Geographic Kids.

"Our competition aimed to raise awareness of the effects of climate change to a younger audience, whilst providing a bit of fun and light relief to parents during the lockdown period," said Filippi. "Everyone at Envision Virgin Racing cares passionately about the environment, which is why we run numerous initiatives like this one under our Race Against Climate Change programme. As a father of two myself, I was very inspired by Kitty's drawing and I'd like to extend my congratulations to her and my thanks to everyone involved."

Formula E – the world's first fully-electric racing series – is next in action on August 5th in Berlin when the current season resumes with six races over nine days following a five-month hiatus.

SMEE Workshops Re-open

After a lot of hard work and preparation to enable social distancing the Society of Model and Experimental Engineers workshops are again available for use of members, but with the following restrictions / safety facilities. Members should have received full details by email, but other readers may be interested in some of the precautions taken:

- There will be a maximum of 6 people at any session. You must pre-book.
- The sessions will be Tuesday, Thursday and Sunday, normal times.
- There are markings on the floor to enable correct social distancing to be maintained.
- There is hand sanitizer available.
- Surfaces are being regularly cleaned and disinfected.
- Disposable gloves are available.
- If you wish to use a face covering, please bring your own.

The photos show some of the measuring equipment and machinery in the workshops and available for members to use. You can find out more about the SMEE at **www.sm-ee.co.uk**.

Machine Mart Conditioner/ Dehumidifier/Fans

These mobile units combine air conditioner, dehumidifier and multi-speed fan into a useful 3-in-1 unit. These models can provide quick, effective & efficient cooling or drying in any home or office.

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Models in this range start from £262.80 Inc. VAT.

Visit **www.machinemart.co.uk** for more details.

Modelling has been saving grace of Britain's mental health in lockdown

The countrywide lockdown brought about by the Coronavirus pandemic has had a considerable impact on life across the UK, and whilst the lockdown restrictions are beginning to ease week by week, the pandemic has undeniably contributed to what was already a significant mental health crisis.

With millions of Brits confined to their homes and many suffering job losses or being placed on furlough, reports of mental health incidents have risen and the extended period of uncertainty has disrupted the nation's routines, work and leisure activities essential to maintaining mental stability and wellbeing. However, the quarantine has inspired a nation of people to discover the myriad benefits to be gleaned from creative pursuits.

New nationally representative research carried out by creators of the desktop factory Mayku, has found that over 1.5 million people in Britain have experienced a significant mental wellbeing benefit from discovering or developing a hobby in model making in lockdown.

Making grit blasting cabinets

Stuart Walker responds to a request for information on larger grit blasting cabinets

Introduction

Following Graham Meek's article on a small workshop grit blasting cabinet, a request appeared in Scribe Line for advice about building a much bigger cabinet suitable for motor cycle restoration and large-scale models. Over the last decade I have used several different cabinets and made my own, **photo 1**, which works well but is not perfect, and I'm happy to pass on the knowledge that I've gained to help others find a better solution for their own particular needs.

In essence, hard grit blasting is used for typically removing old, brittle paint and corrosion from ferrous metals in preparation for painting or galvanising, through to a range of softer grits intended for non-ferrous metals to produce a range of textured finishes. All these processes can be undertaken using the type of blast cabinets discussed in this article. Some restorers favour the use of soda blasting which can be undertaken in the same sort of cabinet or

1

The author's kit-based grit blasting cabinet

2

Typical soda blasting kit for outside use

3

Typical twin fronted blast cabinet

The author's cabinet with loosely fitted hopper - found to be 5mm too short and needing a make-up strip to achieve a good seal

Hole saws with button locators

M6. screws with large diameter washers for securing hole cutting buttons.

Plywood base with castors

open blasting as shown in **photo 2** but requires a different gun and feed system. I have no experience of using this process but I understand that the big plus for soda blasting is that it only cleans, does not erode the base material and is simply washed of with hot water to leave a clean surface free of any abrasive material which would typically cause problems inside engines and gearboxes if normal grit basting techniques were used.

Size and shape of cabinets

Compromises have to be made between the amount of available workshop space that the blast cabinet will occupy and the size of items you need to blast. Where long items need to be treated it is possible to make a side by side twin cabinet as show in **photo 3**. Bearing in mind you have to reach through small port holes to hold the gun and manipulate the parts, the maximum size of a single cabinet should not be much more than 600 deep by 600 high and 1000 long. Alternatively, outside open blasting might be possible on a dry windy day, provided the inevitable dust is not going to cause pollution problems. Do be aware that the removal of old lead-based paints by grinding or blast cleaning will produce toxic dust that will induce irreversible lead poisoning. Where open blasting is used to remove non-toxic coatings, it's advisable to use loose hanging tarpaulin sheets as a background to slow down and deflect the grit overspray and collect it on a ground covering tarpaulin. This may well allow some grit retrieval from what is normally considered a total loss process. As a point of passing interest, when grit blasting is used on full size boat hulls and the like, wet blasting is often used but it does require special equipment to deliver high pressure water to propel the grit, and in the case of steel surfaces, special wet primers are used to prevent surface corrosion before the normal protective coatings are applied. It is possible to use a domestic jet washer where manufacturers supply special adaptors, but progress is very slow and considered impractical for most purposes.

Probably, the best alternative for dealing with items that are too large for your cabinet is to seek the services of a professional grit blasting contractor who has larger, walk-in cabinets.

Cabinet design

Whilst the concept of totally enclosed grit blasting within a cabinet is straightforward enough, like most things the devil is in the detail. Many of the difficulties may be overcome by using a flatpack kit and indeed this is what I did some few years ago when I purchased a sheet metal kit from Anglo Scott Abrasive who I found to be very helpful, but unfortunately, like so many small companies, they're no longer trading. However, to help you rationalise your own design I offer the following:

1½ inch dia. flanged collector resin bonded into the bottom of the hopper

Collector head with bottom drain plug and tap adjustable air mixing valve.

Frame and cladding

I'd recommend the use of fabrication using folded galvanised sheet steel, but this depends upon the bending equipment you have available in your workshop and if you can find a kit provider or a local sheet metal fabricator willing to help out - typically, they would make items like air conditioning ductwork. Close fitting joints are important to help achieve good dust proof seals without having to resort to messy fillers, see **photo 4**. It was suggested to me that pop rivets be used but I found it difficult to get a satisfactory joint and in the end used M4 button head socket screws with locknuts at approximately 120mm centres.

I ran into problems trying to cut neat holes for pipe glands through the galvanised sheeting as the pilot hole tended to enlarge as the saw teeth tried to get a grip. By way of resolution I turned up buttons that fitted the inside of the saw to form a guide. These were secured in place with M6 screws and backing washers that were larger than the holes being cut, which produced clean neat holes as shown in **photos 5** and **6**.

Should you have sheet metal folding issues, a welded steel angle or box section frame would produce a suitable frame for securing flat sheet cladding.

Although my cabinet was largely made from mostly 0.8 thick galvanised sheet, I used some timber and plywood for shelving and to stiffen the base. I also designed the base so that it could be moved around on castors or jacked down to sit on its fixed feet, see **photo 7**. The castors have been so convenient that I wouldn't recommend messing about with the jacking modification.

Alternatively, a satisfactory cabinet can be made from plywood. I'd advise against the use of cheap shuttering ply. The ideal would be the expensive resin

Internal view of my completed cabinet with gun resting outside to accommodate easy removal of the work and the expanded metal floor

impregnated birchwood ply but, as a compromise, I'd suggest good quality exterior grade plywood. It's important that you achieve a good smooth finish to the internal surfaces to ensure that there are no ledges for the grit to collect on and that it can smoothly return down the sides of the collecting cone. To achieve this end, I'd recommend an epoxy based resin that can be used for joint bonding, filleting internal corners and sealing the surface of the wood in preparation for a smooth hard coat finish. I'd also recommend providing a sacrificial sheet of steel to the inside back face of the cabinet.

Regardless of the material you choose to work with, a steep slope to the sides of the collecting cone in the base are very important and 45 degrees should be considered a bare minimum. Whilst the back and front panels on mine just about meet that criteria, the side slopes are less which means that friction tends to hold back the grit and I have to resort to banging the hopper sides every now and again to keep the grit flowing.
To work well, the hopper should only contain a minimal amount of grit with new grit being added on a regular basis - this will ensure that an even blend of fresh and used grit is available to provide a consistent finish. The grit pick up at the base of the cone can be simply made with screwed water pipe fittings as shown in **photos 8** and **9**. The valve on the top lets air into the suction line to achieve the correct balance of air and grit and needs to be fine tuned under working conditions. More fancy versions are available, but I've not felt the need to change.

Floor fabric and support

The floor usually sits at the top of the hopper but if additional height is needed inside the cabinet it can be moved a small way down inside the hopper. The floor fabric should, on the one hand, enable the spent grit to easily fall through, and also adequately support the component being blasted. Where heavy castings need to be treated, supplementary support bars will be required under the normally self-supporting floor fabric, which would typically be made from: welded steel mesh, perforated or expanded sheet steel. Mine is made from the latter and if you use the same make sure it spans front to back for maximum stiffness, **photo 10**.

●To be continued

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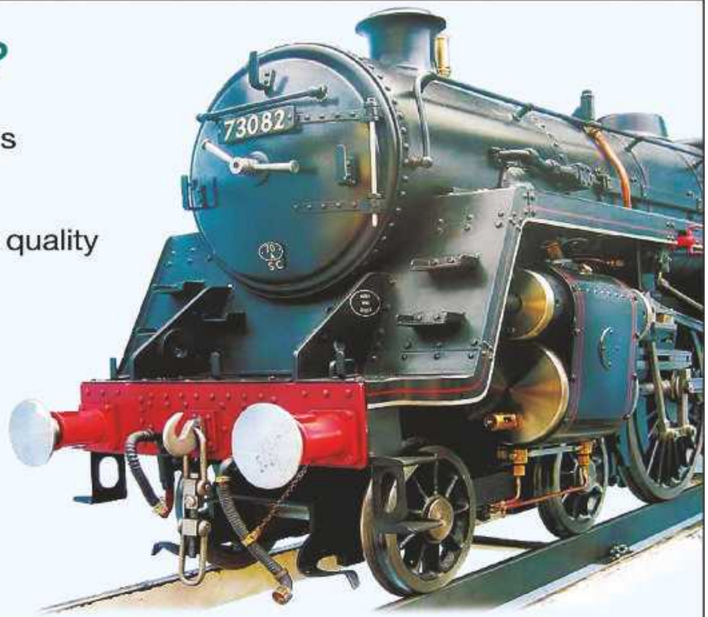

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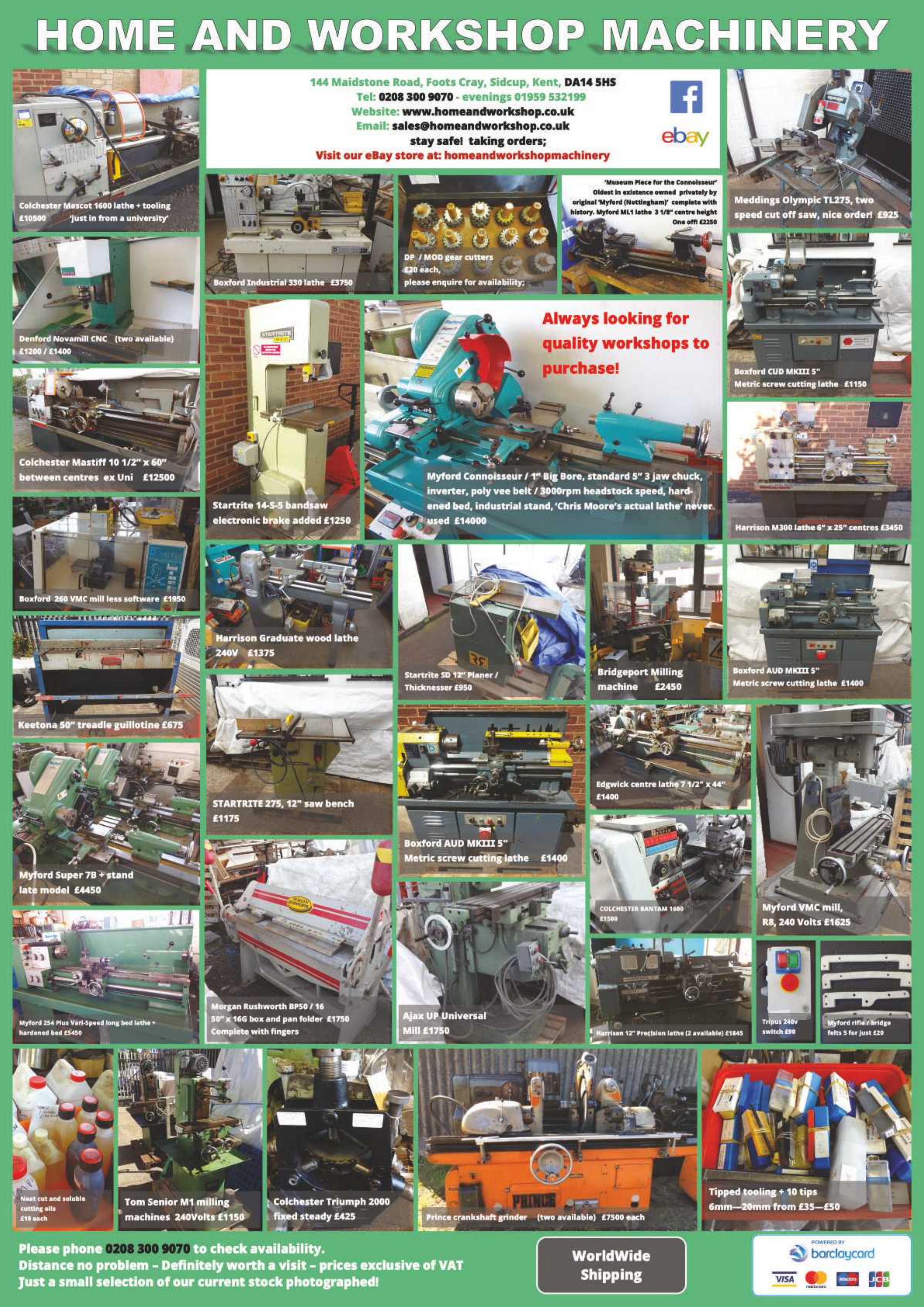
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