

No.279

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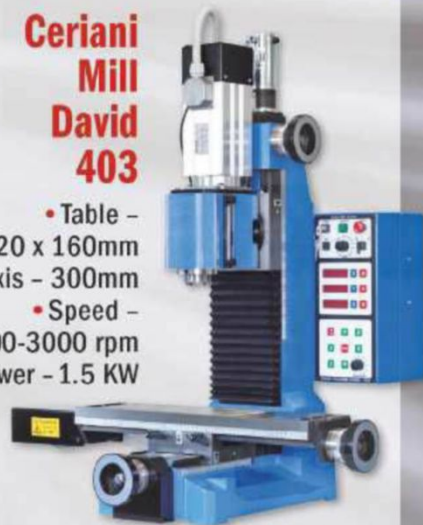
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On the Editor's Bench



The Model Engineer Competition will make a welcome return this May.

Excellent news from Martin Evans and Diane Carney at Model Engineer magazine who can finally confirm that MyTimeMedia are collaborating with the National Model Engineering Exhibition and the Society of Model and Experimental Engineers (SMEE) to stage, once more, the esteemed Model Engineer Competition. The setting will be the ever popular National Model Engineering Exhibition at Doncaster, 10 - 12 May and the competition will be organised and overseen by members of SMEE who will, as always, provide the judging panel.

As in previous years at Sandown and Brooklands, Competition entries will be handled by Mike Law and Steve Eaton.

Time is very short and you have little opportunity to complete a model before May, but the organisers are mindful of this. Your entry need not necessarily be a newly completed model - although they are very welcome - but why not consider entering something that may (or may not) have been seen in exhibition before?

The Model Engineer Competition is open to model engineers throughout the world. Please give it some thought: we look forward to receiving your entry forms by 10th April.

Entry Forms and competition Rules are available to download from the M.E. website Homepage and will be printed in Issue 4607 (1st March) of Model Engineer.

The photo shows Andrew McLeish's 1 1/2" Allchin Royal Chester engine which won the Duke of Edinburgh Trophy in the last competition at Brooklands in 2016.

The Stevenson Trophy

Details of the Stevenson Trophy competition for 2019 are given in this month's On the Wire. Although this is technically separate to the Model Engineer competitions, as it was set up to be judged by a popular vote of members of the forum at www.model-engineer.co.uk, the intention is still to award the trophy at the Doncaster Exhibition.

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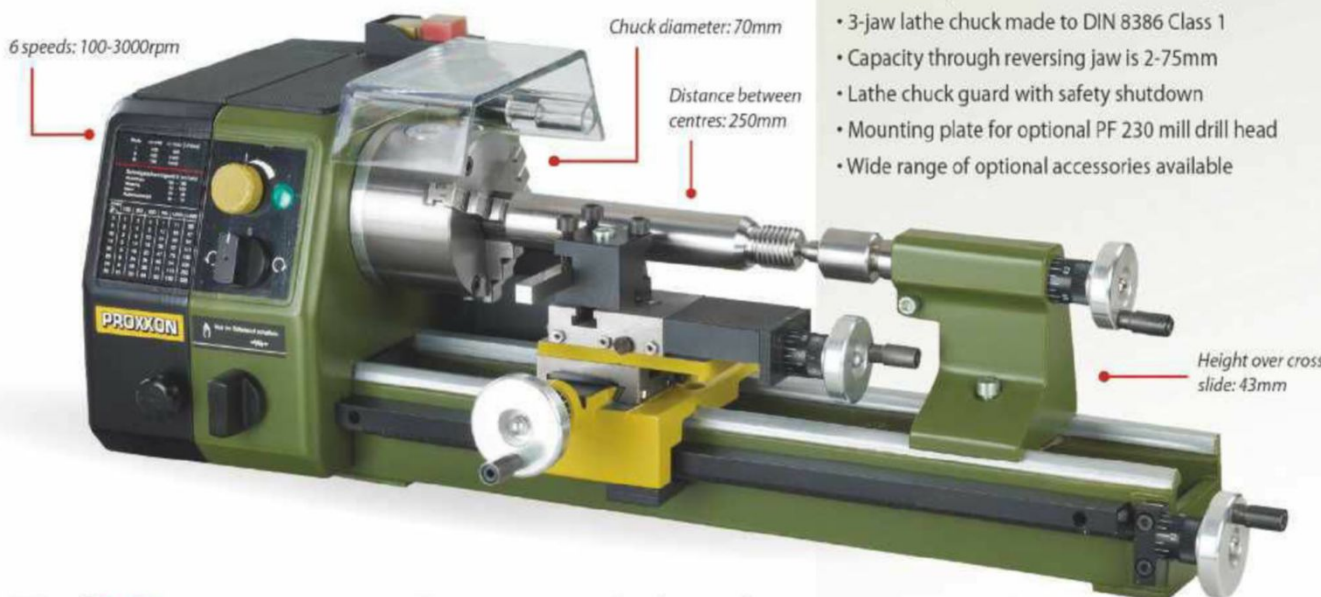
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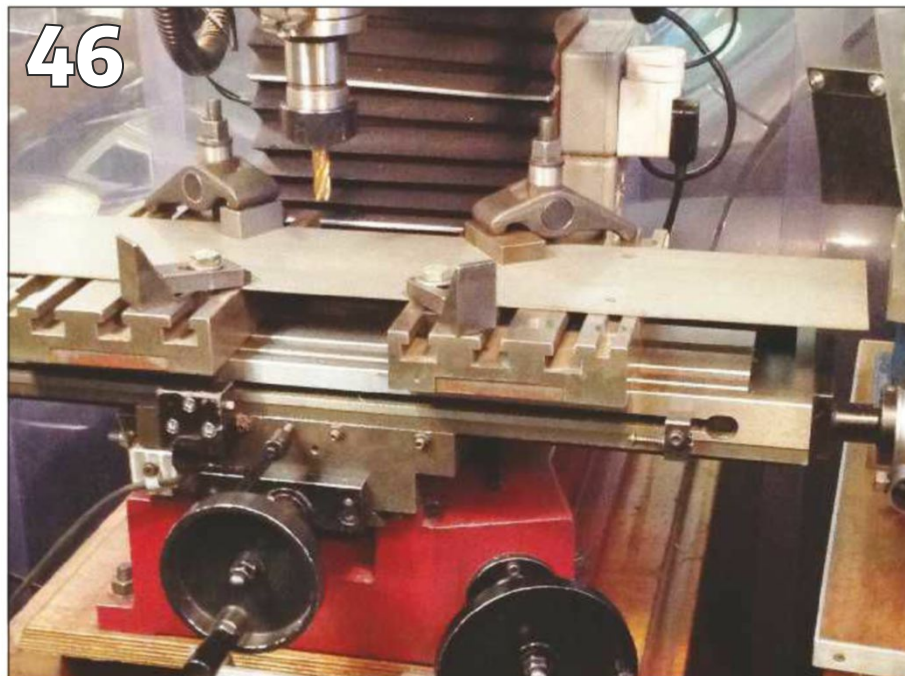
Rob Footitt takes you through completing the scribe and shows how easy it is to modify a part by changing its parameters.

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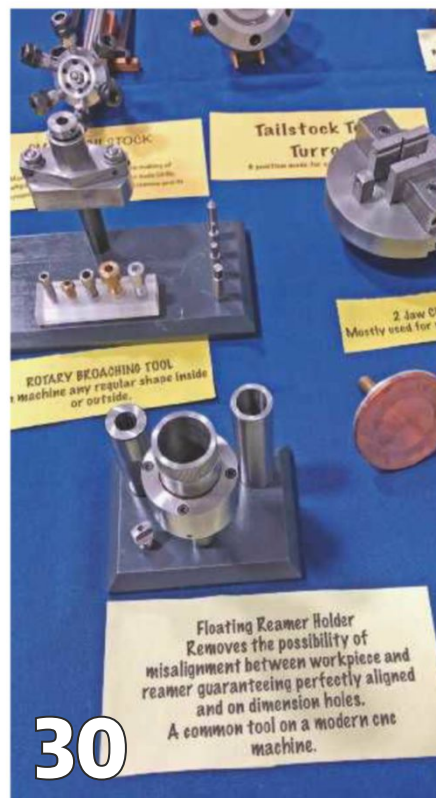
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Stew Hart is known for his excellent designs for beginners' steam engines. This handy trammel should appeal to both novices and old hands.

67 A Collet Collective

Bob Reeve's experience of rationalising a collection of collets gives food for thought on the different options.



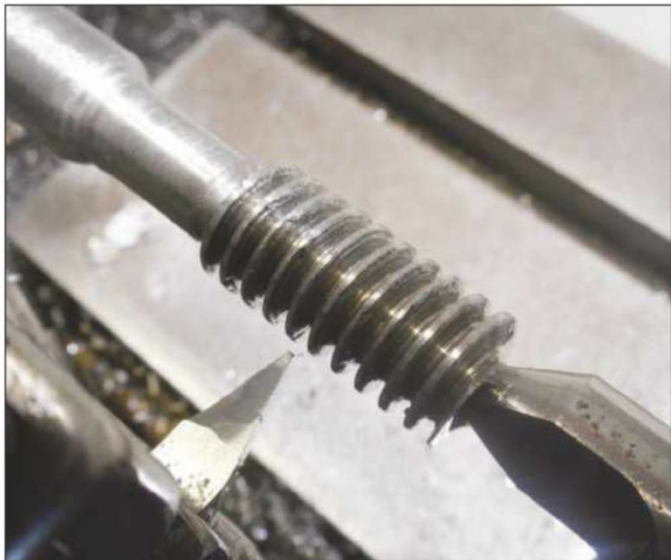
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Any questions? If you have any questions about our Alibre Atom3D, Lathework for Beginners or Milling for Beginners series, or you would like to suggest ideas or topics for future instalments, head over to www.model-engineer.co.uk where there are Forum Topics specially to support the series.

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Tube Notching

- Rather smaller than the tubes in this month's milling article, how best to notch small, thin tubes?

DIY Epoxy Frame based CNC Mill

- Blogging a remarkable build by John MacNamara.

Interference Fit of Bush

- You don't want to do it like that! Pros and cons of interference fits and using a retainer.

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Adding a Tailstock Micrometer Dial to a Myford S7



Graham Meek describes an elegant modification to suite both the Super 7 and Myford 254



Completed dial fitted courtesy Michael Marlow

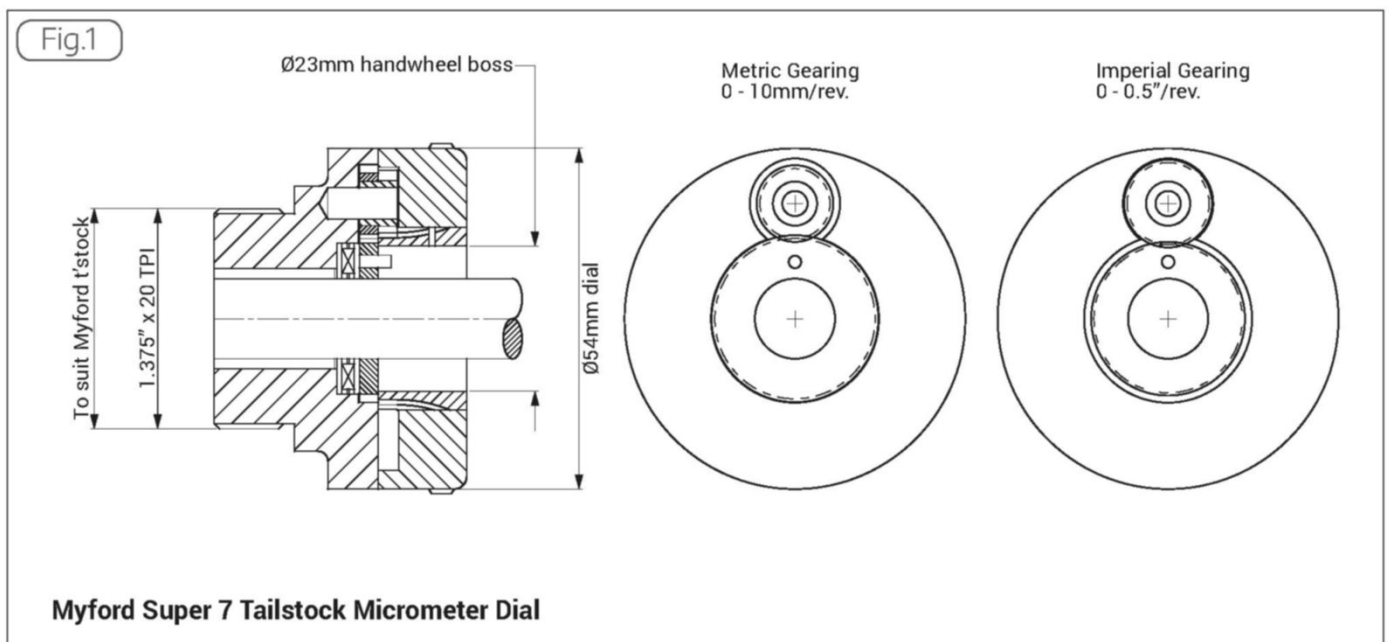


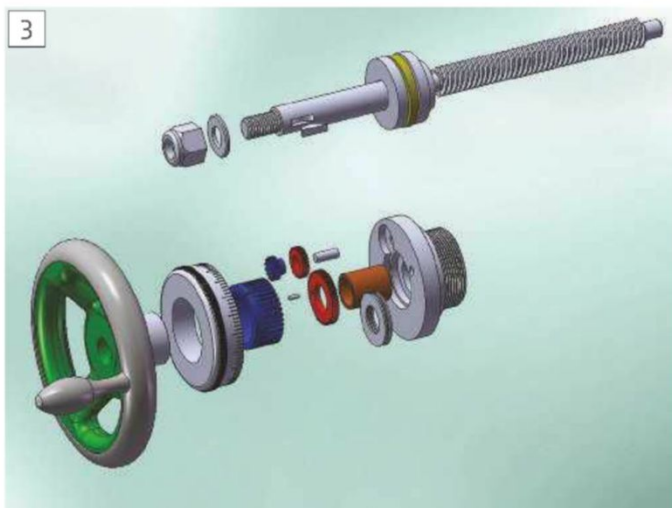
Myford Super 7 Tailstock dial assembly

It was during an exchange of emails with a Forum member, Michael Marlow, that I was asked: "Had I given any thought to making a dial for Super 7 Tailstock along the lines of your Handwheel Dial?" **ref. 1.** My initial response was "No". This was because George Thomas had already produced a micrometer dial for this tailstock, **ref. 2.**

This unfortunately only came in Imperial format due to the tailstock feedscrew being a three-start 0.300" pitch thread. While any dial is better than none at all, I had always felt the 0.300" graduation did not work easily with a tailstock barrel graduated in eighths of an inch. It would have been fine if the barrel graduations had been in tenths

of an inch. No reflection upon GHT's design, he was after all just working with what he had and above all this was an improvement over the standard set-up. Furthermore, the total distance travelled per rev could not easily be converted to metric as this was too little for 8 mm and too much for 7 mm. While 7.5 mm is close, (7.62 mm actual),





Myford Super 7 Tailstock dial exploded view

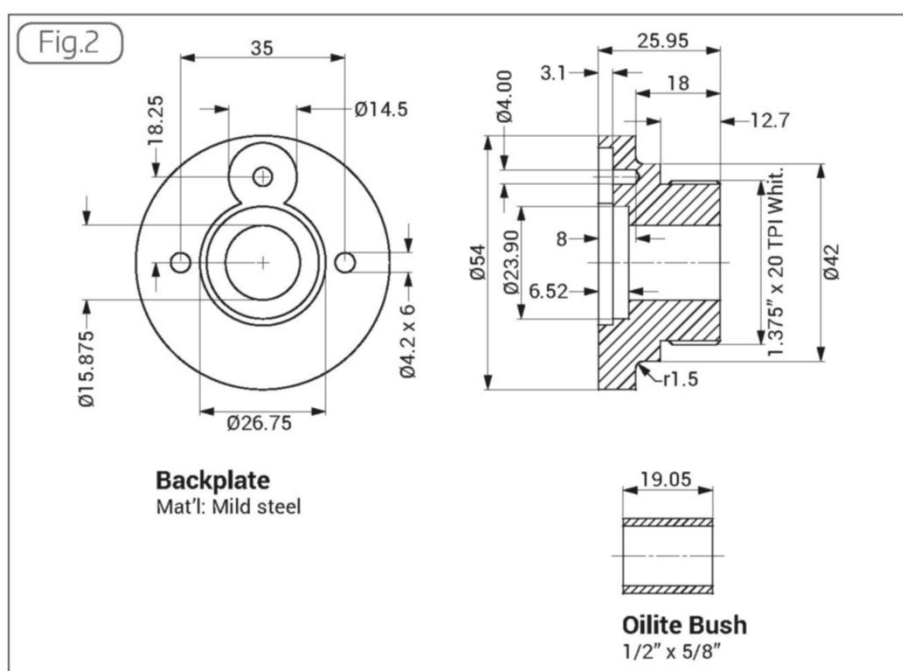


Metric Dial ready to fit

this is hardly a handy number to deal with especially given the metric tailstock is graduated every 5 mm, if my memory serves me correctly.

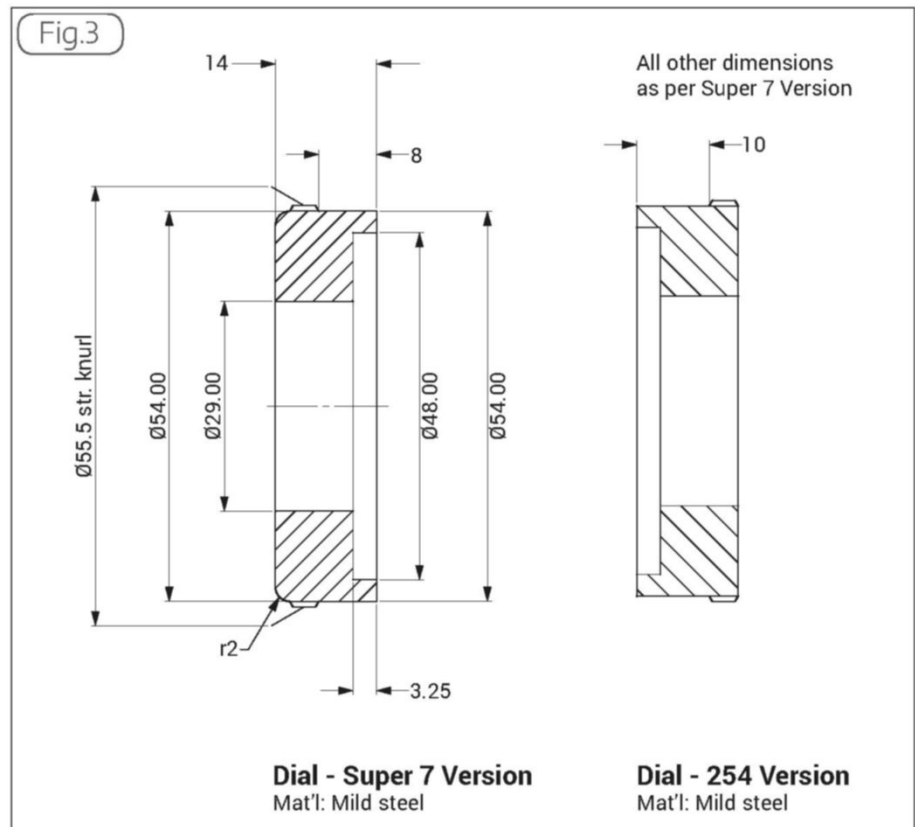
A couple of weeks went by and no further thought was given to the problem. I was of the opinion that George had done the best with what was available and that was that. This view was taken as in the back of my mind I knew adding a geared dial would mean an unnecessarily large dial due to the reduction gears needed inside. This in itself would compromise the tailstock handwheel, with the added risk of nudging such a large dial during use. This then was the rationale behind not proceeding any further, not that I simply did not want to, or that I could not be bothered to, which is how it may have appeared. Then one night while thinking about a totally different gearing problem, a small seed of an idea just popped into my head concerning the above dial. I knew from past experience fate was giving me a nudge, and I started sketching the design you see here, **photos 1 and 2**. The resolution to the large dial problem was to speed up the gearing first and then reduce this using a common reduction that could be used in both versions of the dial. This would mean the larger gears are on the tailstock centre-line and pinions outboard. Unlike the handwheel dial where things are the other way about. Of course, there followed a few head scratching evenings trying to fit it all in.

Not having a Myford Super 7 myself I needed to know what room I had to play with. Knowing Ken Willson had, or did have, one lathe in bits I sent him an email to see if he had any dimensions on the threaded bearing piece that screwed into the rear of the S7 tailstock. Ken came back the following day with what I needed and a couple of days later I had the schematic worked out, **fig. 1, photo 3**. I also enlisted the help of John Slater, with his and Ken's help the calculations were checked just to make sure I had not made a blatantly obvious mistake. I am therefore indebted to Ken and John for their support during this project. John doing some excellent 3D views



Stamping jig for dial

One thing I had wanted to do was keep the dial as small as possible to avoid conflict with the tailstock handwheel. Another was that I wanted the overall design to look as though it had "always been there" or it was how "Myfords" might have done it. I was fortunate to be paid an unwitting complement recently by an author in the USA, who thought my Handwheel Dial was in fact an actual Myford product. An initial ceiling of 50 mm for the maximum dial diameter was set, but after much deliberation I finally had to relax this to 54 mm, **fig. 3**. The final design of the Imperial dial has a travel of 0.500" per revolution of the dial and reads exact, with no errors, assuming a perfect feedscrew. Some deliberation was given as to how this dial should be graduated. GHT had gone for 150 divisions giving 0.002" per division. Although his first thoughts were for 300 divisions giving 0.001" per division, but he later dismissed this idea. For my part I favour fewer divisions rather than more. My eyes seem to get lost with all those lines going by, but then that might just be me. Finally, I settled on 100 divisions which would give 0.005" per division, **photo 4**. Given the barrel is graduated in eighths there are going to be a lot of fractional dimensions ending in 0 or 5. As an example $1/16"$ is 0.0625 and on the dial this works out as two large subdivisions the 0.025" and then the 0.050", plus two small divisions, 0.010" plus half of the next division 0.0025" giving 0.0625" in total. This then, given the larger sized increment per division to start with, still allows us to work to the nearest 0.0005" without too much difficulty. As the 0.005" graduations are 1.6 mm wide, (or $1/16"$, sorry for the mixed dimensions), it is quite easy to subdivide this graduation by 4 or 5 with a reasonable surety that one is not going to be too wide of the mark. Of course, the reader has the choice to alter the number of graduations to suit his or her preferences.



Nothing is carved in stone on that score, you could even add a vernier scale to the backplate.

The Metric dial, **photo 5**, reads 10 mm per revolution of the dial, but there is a slight error from the gear ratio used. As this theoretical error is only 0.00127 mm per revolution of the dial, I am certainly not going to worry about it. Again, the dial is graduated with 100 divisions which gives 0.1 mm per division, slightly less than the imperial design at 0.004" approx. Half a division giving 0.05 mm, and a fifth of a division giving 0.02 mm. Of course, a vernier here could get even finer results,

albeit with an in built miniscule error.

The metric dial was the first design to be worked out and uses all DP gears. While trying to keep commonality between parts for the respective dials. The Imperial dial worked out with an odd Module, (MOD), size at .435 to match the existing DP ratio of the sleeve gear reduction. This is not a problem as the profiles for the single tooth cutters is provided in the drawings. If the reader has access to 58 DP cutters then I am sure these could be used with no problem. However, making the four single point cutters takes me about an hour and the gear tooth form is the nearest thing to a hobbed gear one is likely to get from a form cutter. I used brass for all the gears as the wear on these parts is minimal. They do not carry any real load, just merely driving the dial around. The reader could change the input gear to be steel and retain the brass, or bronze idler. Because the pinion which is pressed, or Loctited into the idler gear, runs on a hardened dowel this could easily be made of steel. The sleeve gear remaining the same in brass or made from bronze.

At the design stage it was decided that the Myford oiler would have to go, along with the tommy bar hole for tightening the backplate into the tailstock body. The reasoning behind this was that the position of the oiler can only be determined once the unit is screwed into place. Sod's Law would dictate that the oiler would need to go where the idler gear pocket was, which would be impossible. Similarly, the tommy bar hole would probably end up where the fiducial line would want to be. The rationale was to remove the need for the oiler by using an "Oilite" bush. Once filled with oil

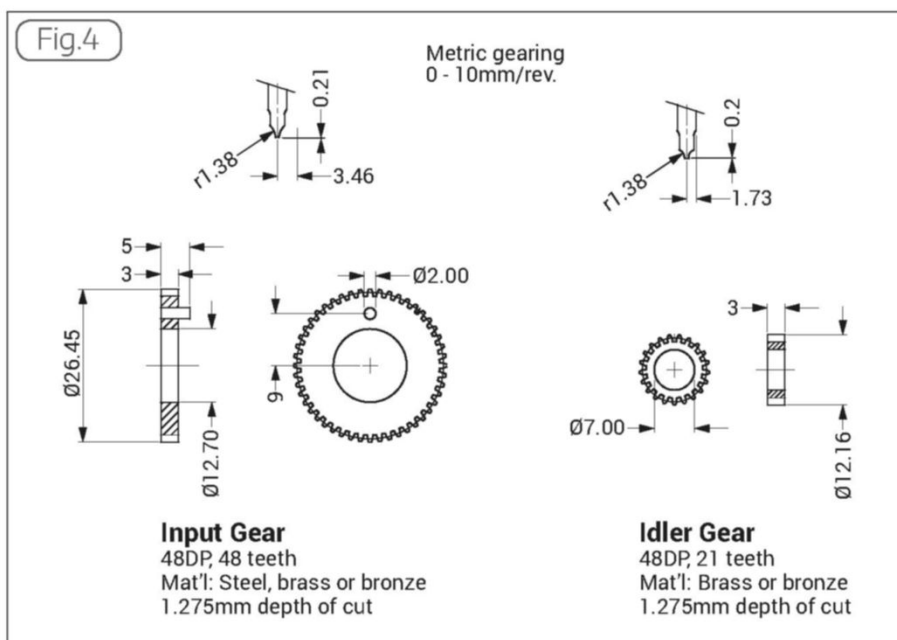
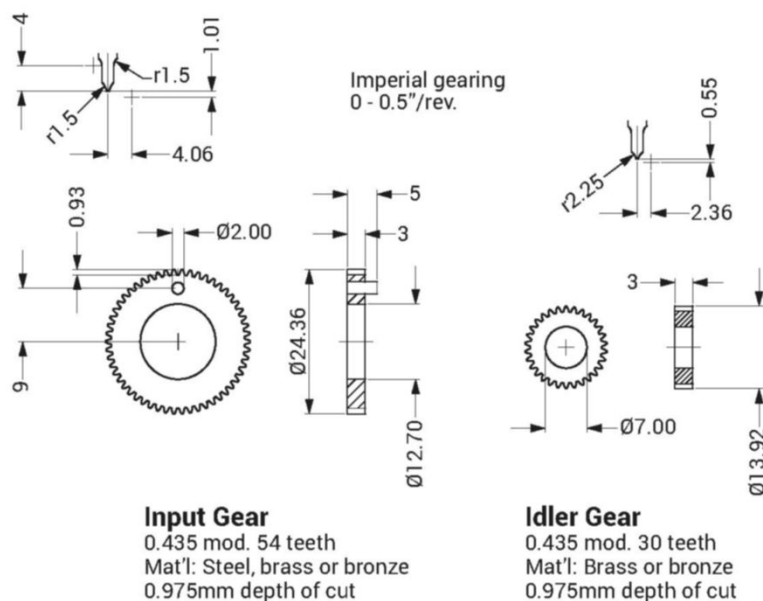


Fig.5



these bushes last for years without further attention. Two holes on the inside face of the backplate to suit a "peg or pin" spanner took care of the tommy bar hole. The centres of the peg spanner holes was chosen to suit a very modestly priced spanner for an angle grinder. I have however provided details for a simple homemade version

Work started in earnest on what I will be calling the Backplate, **fig. 2**, and was made from free cutting mild steel, (FCMS). This is the piece which screws into the tailstock body. It forms the bearing for the feedscrew, and it carries the idler pin. A pocket is also provided for a needle roller thrust bearing, 1 off TC 815 and 2 off TWA 815. There is a further pocket around the idler pin to clear the idler gear. The roller thrust race was added as the face of the handwheel will be reduced to carry the dial. The loss of bearing surface was considered an issue that might put some readers off the design. The needle roller thrust bearing more than makes up for this loss and provides a much better "feel" to the handwheel. The reader will also find after fitting that there is less force required to eject any Morse Taper tooling. On that score be sure to support any taper being ejected after fitting. With over exuberance, by applying the "usual force" to eject a taper prior to fitting. It will be found under the new set-up the taper can exit the barrel at a fair rate of knots. I fitted a similar bearing to my Emco Maximat Super 11 not long after it arrived in 1986, to ease the ejection of tapers. I have never had any problems with this bearing or needed to strip it down since.

One thing that bothered me as a toolmaker, was the fact that the feedscrew bearing was being aligned with the tailstock barrel purely by the thread. Any play in the thread under these circumstances can lead to alignment issues and binding of the feedscrew. Things would have been a whole lot easier if there had been a small spigot register similar to the chuck fitting on the mandrel. The spigot would take care

of the alignment issues and the thread then merely acts as an attachment medium. Some careful consideration was given to sizing this thread given the important duty that was being asked of it.

When the Super 7 was designed there existed 3 classes of fit for screw threads, covered by B.S. 84: 1940. The classes of "Fit" were "Close", "Medium" and "Free". These are all based on the Effective diameter of the thread. Although this standard was later superseded by B.S. 84: 1956, which reduced the classes to two, namely "Medium Class" and "Normal Class". The Close Fit becoming non-preferred and no longer used. With this in mind and given the Myford Super 7 was launched in 1953. I chose to work to a "Close Fit" for the 1.375" by 20 TPI Whitworth form thread. This thread by the way is in itself a "Second Choice", the preferred pitch for this diameter would be 8 TPI and is the normal British Standard Fine, more commonly known as BSF. The calculations were done to work out the measurement over 3-wires for this thread using 0.029" wires. This size was chosen as they were part of a 3-wires set purchased from Arc Euro Trade some years back, (usual disclaimer). Again, the preferred size for this thread would be 0.028", according to my Firth Brown Tools Manual. In my apprenticeship days we used Jobber drill shanks. Three No 70 would be a very close approximation for 0.028". Similarly, No 69 could be used for the 0.029". Not strictly correct I know in this instance, but as the reader would be checking his or her own Myford part initially and working to this dimension. The difference in the "wire" diameter is insignificant as the measurement is after all a comparison between what exists and what is being produced.

Calculations for this dimension were checked and backed up by John Slater. Who also measured a spare part that he had which verified the figure was good to work

to. Four prototypes were made. Three of which worked straight out of the box in that they screwed home with a smooth action. The fourth dial however was a different matter. This would not even look at the tailstock body, meaning it was too big. There was only one thing to do, and that was to have the part back as well as the original Myford bearing piece. Inspection of the thread effective diameter showed that the Myford part was well below what I had set as "my standard". Mounting the offending backplate onto a true mandrel. The thread was "picked up" and machined to match the Myford original, which was 35.00 mm dead over the above wires, or 1.378". I apologise in advance for the mixed dimensions, but I work in Metric units whenever possible. Just so the reader can judge the difference in the thread sizes. Calculations had shown the close fit to be 35.225 mm or 1.3868". My advice to anyone making this attachment would be for them to measure their thread first, or work to the smaller size. Also, the threading operation was the last thing to be done on this part. As the thread diameter was used as a means of holding the part to machine the recess for the roller thrust bearing, the pocket for the idler gear, including the idler dowel hole and the two holes for a peg spanner.

The gears, **figs 4, 5** (and **6** to follow) were all produced as blanks and mounted on various mandrels for the gear profiles to be cut. Mounting on a mandrel is very important when it comes to the sleeve gear. As the slitting operation will undoubtedly throw up a burr in the bore. Having the gear on a mandrel reduces this problem as the mandrel supports the sleeve gear and helps stop the burr from forming. The short slit from the face of the sleeve to connect with the longer slit can be done in the machine vice first, but care needs to be taken to ensure it is on the centreline. Cutting this slit, from the bore to the outside diameter minimises the burrs in the bore. To cut the longer slit the mandrel was held vertically in the machine vice. A vee-block on the moving jaw to aid gripping was used, plus this also ensures the mandrel is on a true vertical. Use could be made of a lathe chuck clamped to the milling table if preferred. When the longer slitting operation is complete be sure to stop the cutter before withdrawing the slitting saw. Release the capscrew holding the part onto the mandrel. End pressure from the clamp will collapse the sleeve gear onto the slitting saw and make withdrawal of the slitting saw very difficult. There is an added risk that the slitting saw might catch and turn the work under these conditions, if this is done with the spindle rotating. The result would be calamitous to say the least, so I advise the reader to err on the side of caution. The outside diameter of the sleeve gear where it locates in the dial bore was left oversize until after the gear was cut. In an attempt to further reduce the effect of burrs from the gear cutting operation.

●To be continued

Scribe a line

YOUR CHANCE TO TALK TO US!

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

Peter Rawlinson

Readers will be sorry to hear that Peter Rawlinson passed on in January. He was a prolific contributor to Model Engineers' Workshop, with some real ingenuity like his spark eroder and resistance soldering device. He also wrote many articles for Model Engineer. I took on MEW a few years after he ceased to write for us, but I greatly enjoyed his articles as a reader. Peter's articles were always interesting and thought provoking and are well worth looking up.



Dear Neil, what I'm offering is my problem-solving procedure to replace the Eclipse round blades no longer available.

After reading Alan Wood – Abrafile Blades, followed by the modification of Axminster – Japanese freeway saw I went and brought a Rod Saw from a local Tile Shop and looked at the required modifications and decided to put that to one side as I had no immediate need.

In the meantime, a friend had given me a Jewellers saw, an "Eclipse" would you believe, having a very fine blade. While left on the workbench I inadvertently dropped a small screwdriver on it and broke the blade, hence it was put in a place where in hindsight it should have been placed on receipt.

Some weeks later the need arose, decisions, decisions.

First was to look at the Rod Saw again, on finding the method of non-adjustable tension, although effective in its intended use, it wasn't going to work, so putting that aside, again.

I looked at my second choice, to get out my original hacksaw frame and the Eclipse round blade, the last survivor, and end clips. Within no time I albeit had duplicated an Eclipse end clip that would take the larger blade.

Deciding to use the new short blade I now found my hacksaw frame wouldn't collapse efficiently enough, problem solved by cutting away the closed end of the handle to allow the frame to pass through the handle and still allowing for longer blade use when required.

End result, with minimal effort everything went well, job done, the downside is they definitely don't perform as well as the original Eclipse blades.

Richard Cains, Tasmania.

Thoughts on MEW 277

Dear Neil, does anyone know what the technical name is for the second from top drill in photo '102' p 47? I have a vague memory that they are 'Hyper' or 'Hypo'- something. I have a set of 'jobbers size' and use them occasionally for 'sticky' materials as they clear such swarf particularly well. I enclose a photo of two 'long series' drills that were in a 'shoe-box' full of assorted drills – blunt / b*****d / chipped / good / new, that I bought for about \$2 in a clearing sale (the 'hyper' or whatever set among them)..... these two can be 'sized' from the 6" rule, I have never had the nerve to use them – a third one that I cannot put a hand on is about the same size, length and of the type mentioned above – I have often wondered what sort of job they are intended for.

Regarding the letter from Andre Rousseau, and for the information of those interested, the method of 'conjugate fractions' to get the gears for $p = 3.1416:1$ using only four gears (of sensible sizes for a lathe) while time consuming is relatively easy. However, if going to 6 gears and using rather more 'sweat of the brow', then $p = 3.14159:1$ is achievable. This gains an accuracy – if your machinery / lead-screw etc. is capable of it, that challenges high class Jig Bore.

After reading your comment below my letter, a swift check on my 'old' "Alibre" drawings shows that whilst some are 'view only' in "Alibre Atom", a surprising number of the simpler ones are fully usable.

Peter King, Christchurch, NZ

Shipping to the 'Offshore Islands'

Dear Neil, Mike Aireton's article in MEW277 recounts the familiar tale of persuading UK suppliers to ship goods to so-called 'Offshore Islands'. I live on the Isle of Man, a tectonic microplate located between the island of Ireland and the somewhat larger outcrop of England. As a Crown Dependency, we are neither part of the UK nor the EU, and yet our postal service and VAT are exactly harmonised with the UK. We have mains water and now even electricity, and letters fly to and fro without impediment. Yet tool suppliers are befuddled when it comes to sending parcels, insisting on charging exorbitant rates, presuming that we live beyond the ballistics of the Royal Mail. But hey, my home is actually closer to Birmingham than is Newcastle upon Tyne! Sometimes too there is a refusal to ship paints, glues and other 'hazardous' items which are listed on websites or eBay. What is the point of even advertising these toxic effluvia if you don't actually want to sell them? I am sure that Mike would agree that some suppliers are missing sales opportunities by putting difficulties in the way.

Finally, one has to ask where are the 'Onshore Islands'? I for one have never seen an island in the middle of a field!

Mark Noel, Isle of Man

Jeremy Moore's Nuts (1)

Dear Neil, I wonder if Jeremy Moore's problem could be solved by the appropriate size of Irwin Bolt Grip? You might be interested to know that the job I used these for some years ago was unscrewing round-headed hammer screws securing corrugated asbestos cement roofing; the alternative was to use an angle grinder which, in hindsight, would not have been a good idea. These screws have a plain, unslotted, hemispherical head and I think were a fairly severe test for the Bolt Grip.

George Winspur, by email.

Jeremy Moore's Nuts (3)

Dear Neil, regarding Jeremy Moore's problem nut; this would be my approach, concentrating on just one nut, initially.

1) Use / Borrow / Buy, a Metrinch or similar Flank Drive socket. (1/2" drive rather than 3/8" – if possible) or ring spanner, to attempt to slacken and remove the nuts.

Machine Mart, Cromwell Tools are possible sources. A sharp jolt with an Impact Driver, or a mallet on the bar or spanner may slacken it.

2) Make new nuts. Hopefully Jeremy will know the thread (probably BSF?) If possible keep the hexagon size the same as the original, for the sake of consistency. Having to use a mixture of Whitworth, and A/F or Metric spanners / keys on a machine can be frustrating and time consuming. Using the wrong tool may be what caused this problem!

3) If the thread is unknown, and 1) did not succeed, or was impossible, it is time to be brutal. Use a hammer and punch or hammer and chisel, to jolt the nut free. Once slackened, it should

Jeremy Moore's Nuts (4)

Dear Neil, I read with interest Jeremy Moore's problem with the top slide nuts on his lathe. When I received my Colchester Bantam it had the same problem the difference being that my top slide was already set at an angle. My solution was to regrind a small cold chisel to an asymmetric point, (see attached sketch), apply it tangentially to the nut and tap with a small hammer. The chisel is about 3 inches long and 1/4 inch wide.

Brian Curle, by email

I would like to clarify that nothing in this issue is intended to imply that Jeremy is not in full possession of his marbles! I can confirm, however, that Brian's suggestion seems to have brought him success.

Jeremy Moore's Nuts (2)

Dear Neil, I had a similar problem some years ago when trying to remove crossarms from pre-war electricity poles. The answer was a nut splitter, a small and cheap device. The hydraulic type work best, there must be many available on the net. Or try the plumbers tool for threaded pipe joints, a Stillson.

Andy King, Minehead, Somerset

come off fairly easily.

4) Failing 3) Use a Nut Splitter to remove one nut.

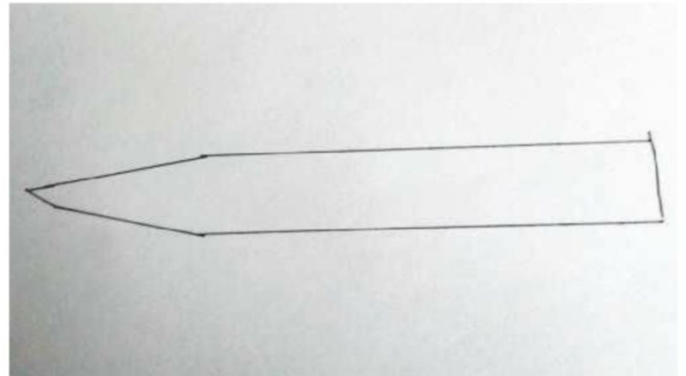
This will allow the thread size and type of the stud to be determined. If no Nut Splitter is available, drill down through the nut (Try not to mark the Cross Slide or the stud) and then use a hammer and chisel to split the nut. Hammer down alongside the drilled hole, rather than radially.

5) Remove the second nut by whatever method was successful on the first. (Preferably, the least brutal!)

6) Ensure that the thread on the studs is in good condition, and then fit the new nuts.

If the worst comes to the worst, it may be necessary to remove the studs and make new ones. It should then be possible to offset the Top Slide, and reclamp it in the required position, to cut the tapers.

Howard Lewis, by email



Organ Pipe Mandrel

Dear Neil, we are an organ building company who use mandrels of various diameters for turning up metal for pipes into the correct shape for us to then to solder up.

I wonder if you happen to have any contacts who may know anybody able to produce a steel or iron mandrel to the dimensions attached please? It can be jointed as many times as is needed and tapped and screwed together again as we have some that are jointed already.

We have plenty of old ones but are really struggling to find

anybody willing to take on the task of making us this new one.

Colin Palmer, Resources Manager, Harrison & Harrison Ltd, Durham

The mandrel in question is 2.2 metres long and tapers from 70mm down to 8mm. If any readers have the ability to turn such a long taper, albeit in sections, as a commercial job, please drop me an email and I will forward it to Colin – Neil.



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A Travelling Crane for The Home Workshop

Roger Froud describes a flexible design that can be adapted for different sized workshops.

Introduction.

The first incarnation of this project was originally done back in 2014 when I needed a method of lifting a heavy rotary table on and off the mill. Making it more flexible seemed sensible, so after much agonising, I decided to go the whole hog and make a full blown travelling crane that covered the whole workshop, **photo 1**.

Although I have some photos from my own installation, they weren't sufficient for an article. Fast forward to today, and my friend has decided that this is a good solution for his extensive workshop, so I decided to document the build and take more photographs which I'll complement with some of my installation. His completed crane is pictured here, lifting a part built 'Duchess'. The turning frame has a detachable lifting bar and sliding link for the crane hook. This allows it to be lifted at the centre of gravity, the link locking naturally to the round bar without any tendency to slide.

My own workshop, **photo 2**, is of modest proportions, being just a single garage with limited headroom. The design allowed the longitudinal beams to be located between the exposed joists. The wooden joists are insufficient to support a significant load, but the pitched roof offered the possibility of using RHS beams in the loft space to carry the load directly on the supporting walls. The beams are supported through the ceiling on threaded rods so that no load is carried by the joists.

Safety and Suitability

Lifting equipment is potentially hazardous, and this design is not certified and is not to be assumed to comply with any safety standards. Any installation is at the builder's risk and discretion. Welding is extensively used in the construction, and this should be carried out by a competent welder. Never lift anything heavier than the maximum load specified, and never place any part of your body under what you're lifting.



A large locomotive moved with ease



Moving a chassis in my workshop



RHS support for single garage

Lifting mechanism

The motorised element is a modified 250Kg scaffold hoist. As supplied, the hoist has a single pulley that halves the lifting speed, but this is too fast for lifting heavy loads. Therefore, a compact 4:1 reduction has been achieved by modifying a 650Kg compact swivel hook. The larger hook is a more useful size in the workshop since it can directly hold straps and can mate with eyes screwed into heavy equipment.

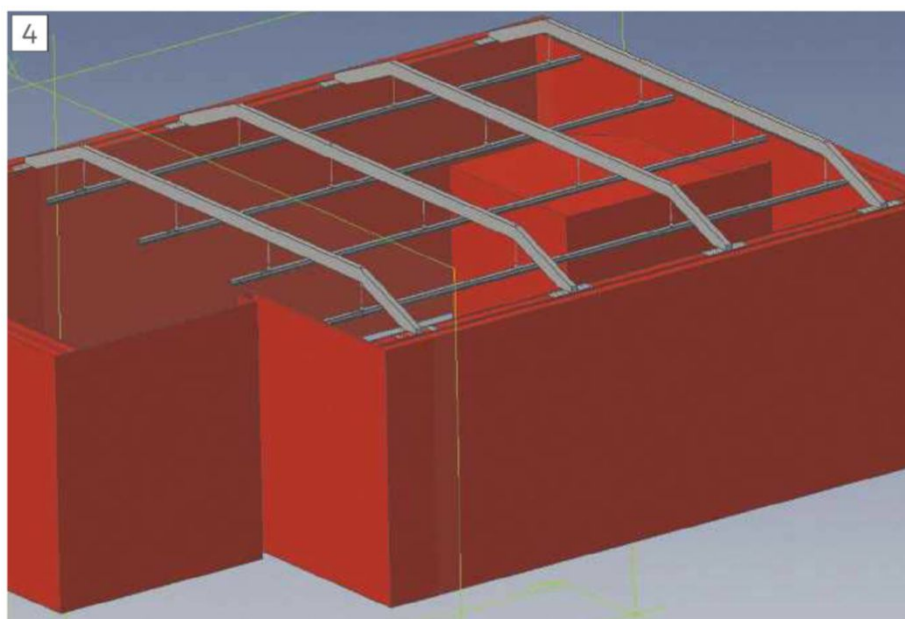
The drawback of using this kind of hoist is that you need to keep tension on the wire to make it wind onto the drum

Intention and scope of this article.

I don't propose to include detailed drawings of everything, there are too many parts for that to be practical in a short article. However, the intention is to provide enough dimensions so that anyone wishing to follow suit should have enough to get the basic proportions right. There are many different scaffold hoists available, and it would be prudent to purchase that first and adapt the dimensions to suit. In short, this article is intended to show a general method of construction that can be adapted to suit larger or smaller workshops using a variety of scaffold hoists and swivel hooks.

Specification.

- 250Kg maximum load
- Travel to suit workshop dimensions
- Electric hoist with pendant control
- Double pulley hook to reduce hoist speed
- Automatic cutout when top position is reached



RHS supporting framework

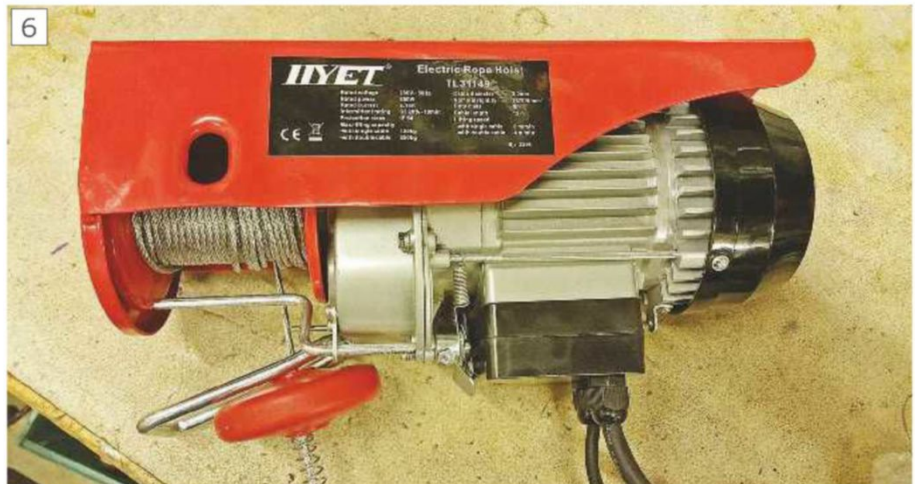


Supports almost ready for the attic

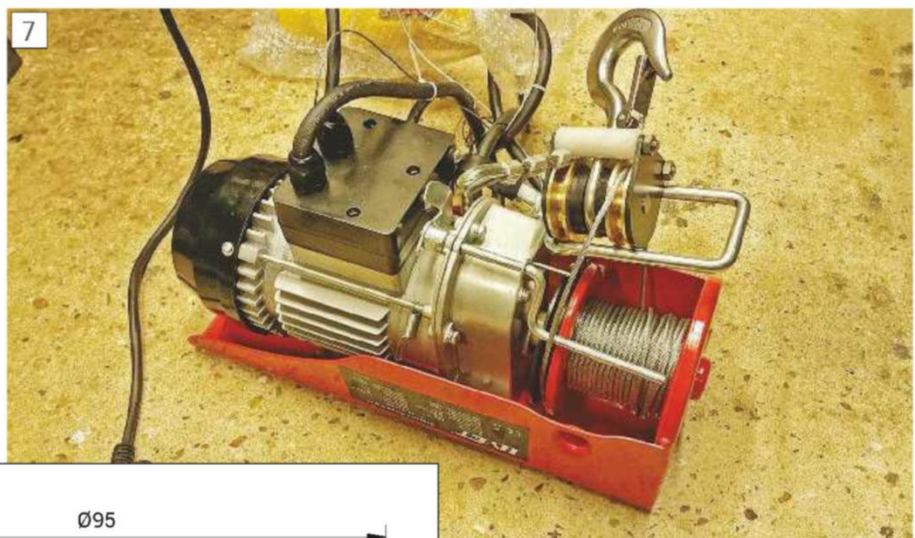
neatly. You soon get the hang of using it though, so it's a small price to pay.

Carriages

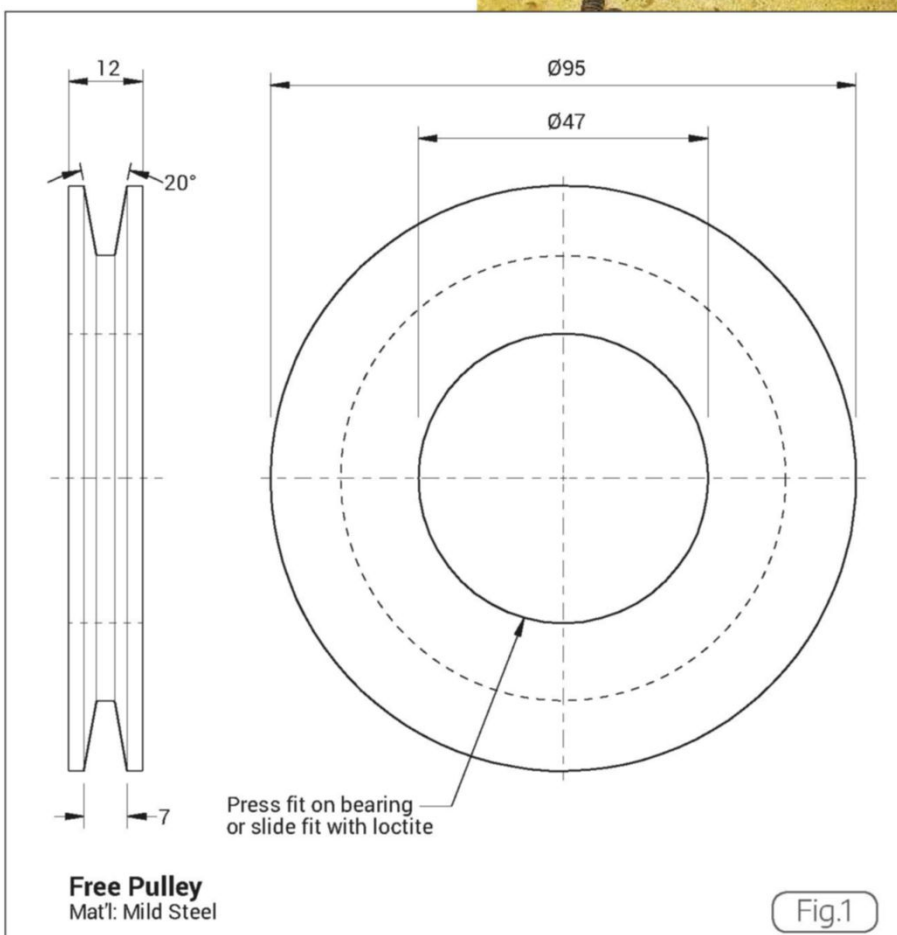
The ideal rails for the carriage to run on



The unmodified scaffold hoist



The modified scaffold hoist



would be 'I' section beams, but these are not available in the small size required. In my own installation, I needed to keep the rails tucked up between the joists because headroom is very limited. The solution was to weld two channel sections back to back to make an 'I' section of the desired size.

The wheels are simply ball bearings that run directly on the flanges of the 'I' section. The flanges are slightly tapered, so the bearings only touch on one edge, but this hasn't proven to be a problem.

The side control of the carriages is done by two fixed ball bearings pressing against the middle of the 'I' section, with an adjustable one in between them on the other side.

It's a very simple arrangement, but it works really well and is one of the most useful and satisfying things I've ever made.

Supporting structure.

The first of these two pictures, **photo 3**, shows the simple arrangement required to support the two longitudinal 'I' beams in my single garage. It consists of two 80mm x 40mm RHS sections that bridge between the two main piers of the side walls above the joists.

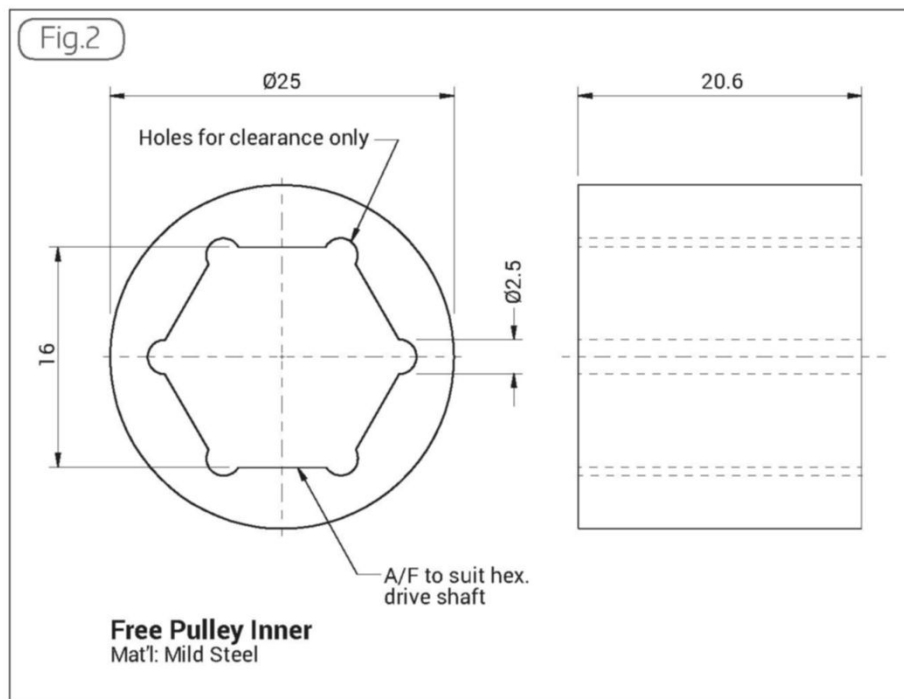
The free ends of the 'I' beams rest on the end walls of the garage so there are four

points of support. My garage only required two 'I' beams for the carriage.

Although a similar arrangement could have been used in the larger workshop, it would have entailed moving water, gas and electrical services if the beams were to rest directly on the workshop walls. Rather than do this, it was decided to follow the slope of the roof with the RHS beams before bridging the gap. This meant that the threaded rods holding the 'I' beams had to be longer and it was necessary to add foot plates to make sure the beams stayed upright. We probably went a bit over the top on that, but better safe than sorry. **Photograph 4** shows the final arrangement, showing the four 'I' beams necessary to support the carriage over such a wide area. The RHS used in this case was 100mm x 50mm.

The picture below shows the completed RHS and 'I' section beams ready for painting. There are bushes tapped M10 welded at intervals on the 'I' section beam where the threaded supporting rods are attached.

The foot plates and gussets were laser cut with tabs to locate them, **photo 5**. Notches



Free pulley with bearing



Modified hoist drum

were machined into the ends of the sloping RHS pieces to locate them.

The feet with one side missing are for the end ones that butt up against the end wall.

The beams were slid into the loft space after removing the first two rows of tiles on the roof.

Modifying the scaffold hoist.

The scaffold hoist was purchased for £75.99 delivered, **photo 6**. The red weight was cut off for this application, but you could leave it on if you have plenty of headroom.

The scaffold hoist needs a free pulley to accommodate a two pulley hook, so the solution chosen was to shorten the drum and fit one onto the same shaft as shown in **photo 7**.

NB:- The AF size of your hoist drive shaft may differ to this drawing. There was a change to metric sizes between the two builds I've done, and the size was different. The free pulley, **fig. 1** and **2**, uses a 25x47x12 shielded bearing so that it runs freely, **photo 8**.

Photograph 9 is the winding drum with 22mm removed from the centre section. A tube was machined to fit inside the drum at the joint which gives it additional strength and makes it easier to line up for welding.

The 650Kg swivel hook was an eBay purchase, this time for £6.55

These are Stainless Steel and used on Yachts. I chose this pattern because I could mount the pulleys on a pin that passes



Swivel hook parts

through the eye to keep it as compact as possible, **fig. 3**.

Again, it would be prudent to buy a suitable swivel hook and making the parts to suit what you can get, **photo 10**.

The pivot shaft is made from Silver Steel, the ends being lightly riveted over to keep it in place. The pulleys are Brass, the centre pieces and end plates are Mild Steel, chemically blacked, **photo 11**.

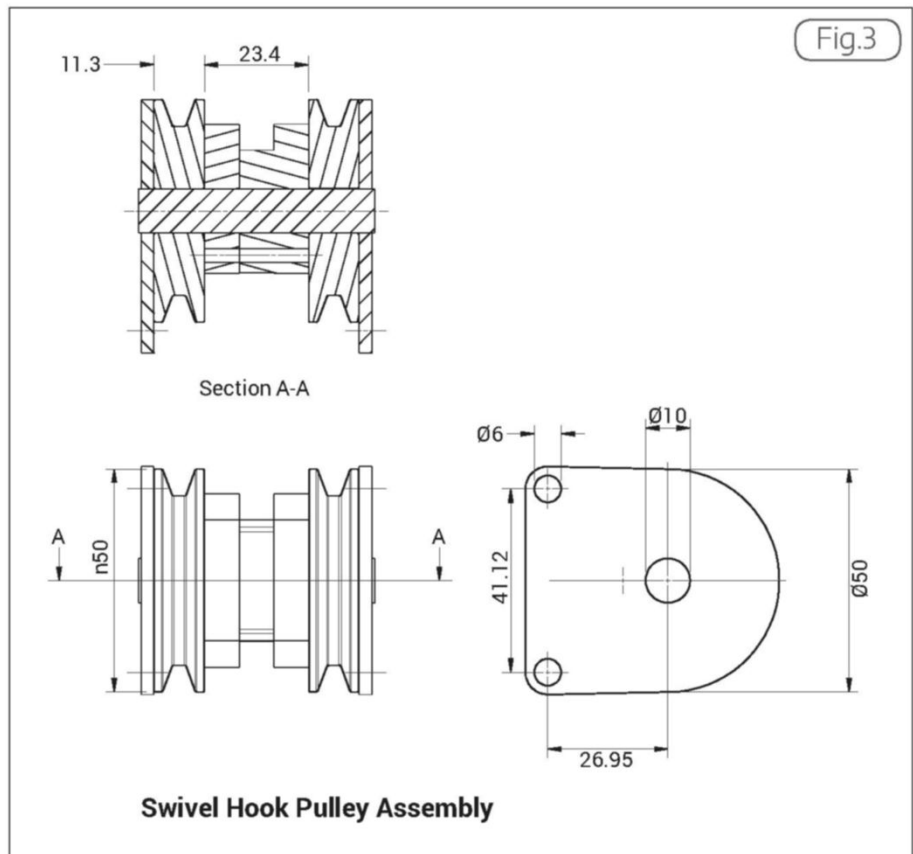
The threaded rods have a Delrin spacer fitted to them to keep the wire rope in the groove. These need a cutout on one side to miss the eye of the hook. I used Nylock nuts to secure them.

Fabricating the hoist carriage.

The carriage is made from 50mm x 40mm angle 5mm thick. The drawing, **fig. 4**, also photo 12, shows the dimensions slightly less than that since it was modelled from the actual stock received.

The drawing is only a guide, your scaffold hoist might have fixing holes in a different place or be a different width.

Both carriages are kept in line by three bearings that roll on the central web of the 'I' section beams. The Adjuster Fixed block, **fig. 5**, provided the pivot point for the Adjuster Moving Block, **fig. 6**, which is tensioned with an M5 bolt through the side of the supporting angle.



Swivel hook assembly



Rollers with side adjustment on one side only

The Bearing Support Block, **fig 7**, holds the other two bearings, ie there are two required for each carriage.

Photograph 13 shows the trial assembly of the hoist carriage onto the cross carriage. It's advisable to tack things in place and make sure it all moves as it should before welding it all up for good.

All of the assembly was TIG welded because it was the only equipment readily to hand. MIG welding would probably have been a lot quicker and economic.

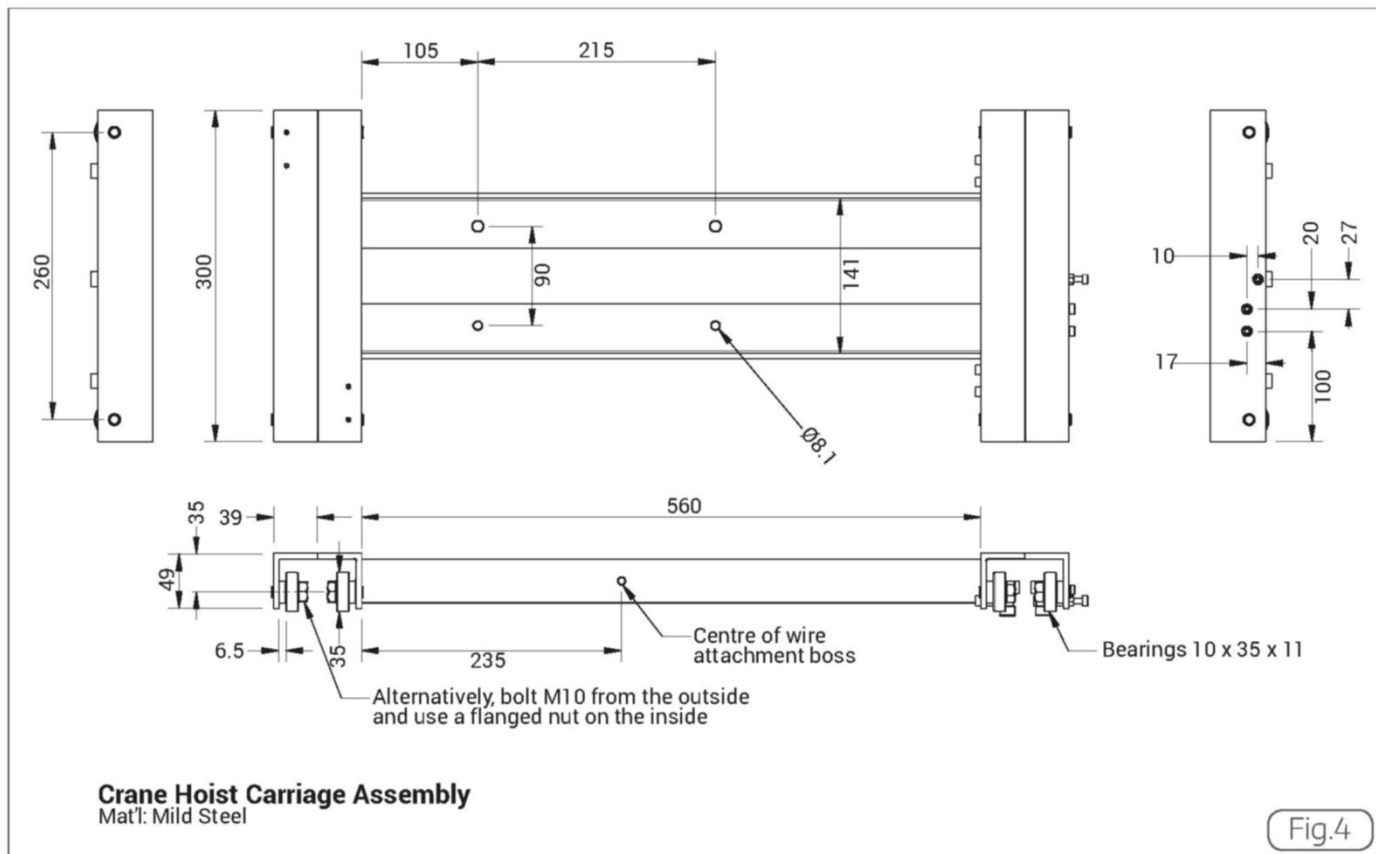
Here you can see the welds that hold the channel sections back to back, making the 'I' section beams. A generous 45 degree chamfer was added to the corner using an angle grinder, the same being used to remove the mill scale from the surface to make welding easier.

Supplying the power.

The scaffold hoist only needs a 3A power supply, so several 3A coiled cables were



Carriage trial assembly



joined in a chain to make a long enough length, **photo 14**. Maybe it's possible to buy longer lengths, but I couldn't find a supplier.

The cables are supported in Nylon braided cord attached to either end of the two carriages with 'U' shaped Delrin pieces and key ring loops connecting them with grub screws across the open end of the 'U'. They slide freely and bunch up nicely when the carriage is moved. All of the materials and parts were sourced through eBay.

In the above photo, you can also see the way that the cross beam in the loft is attached to the wall and the threaded rod that holds the 'I' section beam.

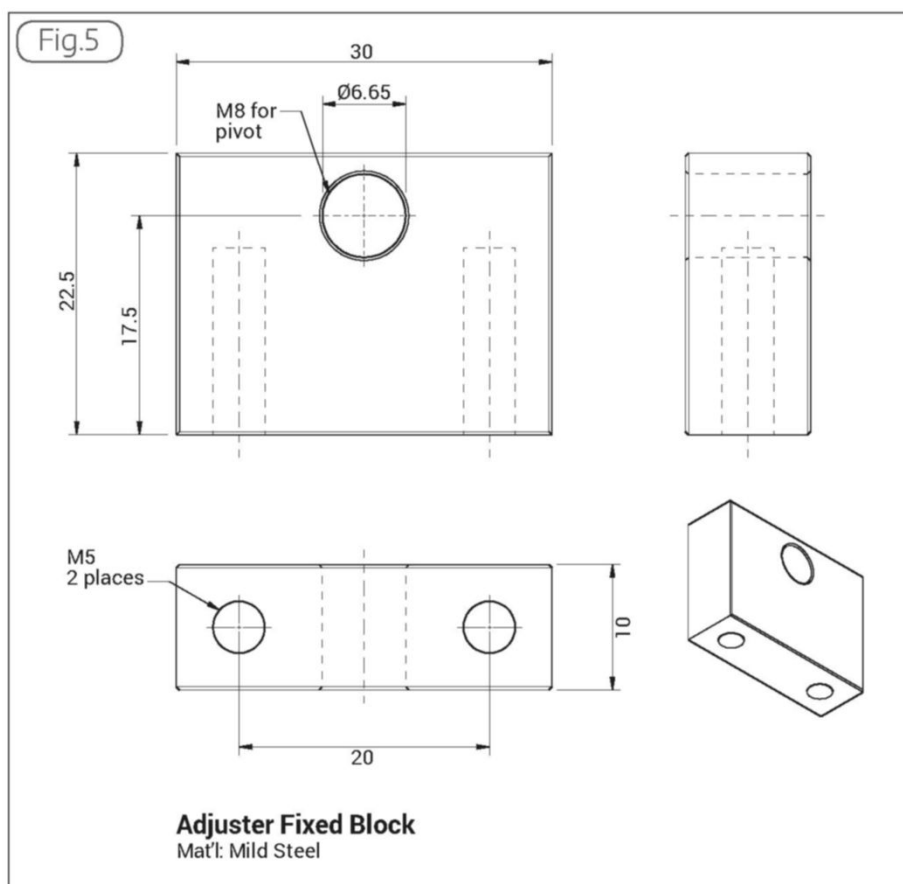
Obviously you need to fuse or have a trip in the supply and a qualified electrician should be used to connect this all up.

Lighting.

The compact nature of the crane means there's not much height for the workshop lights. In an earlier photograph you can see one solution is to relocate strip lights onto the side of the joists instead of below them. That was sufficient to miss



Power cable arrangement



them on my installation.

Photograph 15 shows the elegant low profile LED panels chosen for the larger workshop, giving the appearance of them being skylights. These provide excellent lighting but they are quite expensive. I

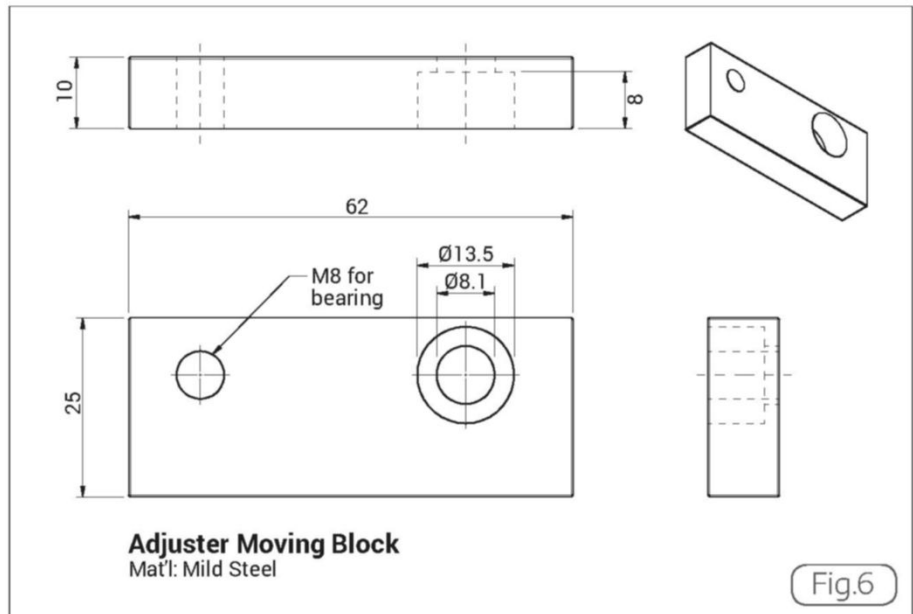
did consider changing over to these in my own workshop, but the most popular and affordable sizes were just too large to fit between the joists. In the end, I opted to fit LED tubes to the existing fluorescent mounts.

Accessories.

I have several heavy items that are very awkward to handle, so for these I've drilled and tapped holes in to take a lifting eye. One of these is the workhead for the Jones and Shipman Tool and Cutter Grinder workhead, and the other is a rotary table that's very heavy.

A most useful attachment is the one in **photo 16**, which is a sturdy lifting tray. As shown, it's being used with an MDF insert to support a chuck while I attach it to the lathe. The idea was to make something universal, and the same item is used for moving heavy vices and magnetic chucks around too.

A selection of lifting straps are a useful addition, as are a variety of shackles. The lifting capacity is sufficient to handle small lathes and has proven invaluable when removing the head from the Milling machine.

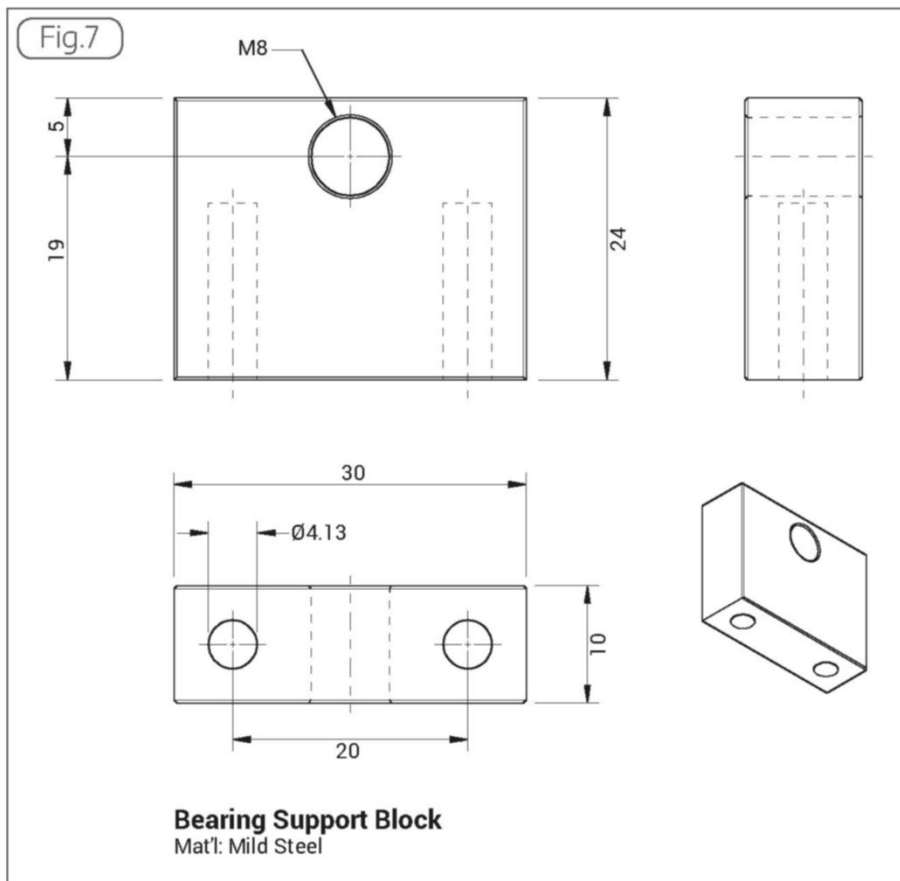


Crane adapted for the large workshop

Summing up.

This is clearly not a five minute job, and in the case of the large workshop it was a major upheaval. However, once you've had one in the workshop, you will wonder how you ever managed without it. The design is simple and within the capabilities of most builders.

I can honestly say that it's the most worthwhile and useful thing I've ever made, and I use it most days for one thing or another. Advancing years and fear of hurting our backs prompted these installations and hopefully they will enable us to continue our hobby for decades to come. ■



On the **Wire** **NEWS** from the World of **Hobby Engineering**

The John Stevenson Trophy 2019



A large number of readers and forum members contributed to a trophy in memory of John Stevenson to be "Awarded for Excellence in Practical and Useful Workshop Equipment". In 2018 after a vote by forum members the trophy was awarded to John Ashton.

This year we are simplifying the competition process. **Any reader or forum member may enter their own work.** A short list will then be prepared by the organisers, so that award of the cup can be judged by a popular vote. Voting will be via a poll on the forum and open to all.

The winner will be announced and awarded the John Stevenson Trophy at the National Model Engineering Exhibition in Doncaster in May 2019.

Entries must be emailed to neil.wyatt@mytimemedia.com no later than 20 April 2019. Naturally, we have to have some formal rules for the competition, these are:

All entries must be a piece of practical workshop equipment i.e. a tool, jig, fixture or a modification to or accessory for an existing piece of equipment. One entry per person. All entries to the competition must be your own work (commercial parts are allowable) and not have been entered to the competition before.

A short list of entries will be selected by the competition organisers, a group of people who knew John and are familiar with his views on workshop equipment.

Criteria for inclusion on the shortlist will be that the tooling is practical and capable of being used for accurate work in a home workshop setting. It should demonstrate ingenuity, good design, economical use of materials and be appropriately finished for its function.

By entering you confirm your permission to feature the entry in the magazines or on the forum. If practical, you will be invited to display your entry at the National Model Engineering Exhibition in Doncaster.

The winner will be selected by a popular vote by forum members. Readers who join the forum in order to vote will be allowed to do so. Voting will be strictly one vote per person.

In the event that the judges consider invalid votes have been cast or that an attempt has been made to unduly influence the result of the vote any questionable votes will be disregarded or entries may be disqualified.

The trophy will remain the property of the competition organisers. The winner will take responsibility for ensuring safekeeping of the trophy until the next exhibition. The trophy must be returned in good condition, in the supplied packaging, in good time for award to the winner of the subsequent competition.

The winner may arrange for their name and the year of the award to be professionally engraved on the base of the trophy at their own cost.

No alternative prizes, cash payments or awards will be made. In all matters relating to the competition, decisions made by the organisers are final.



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Restoring an old Norton screwcutting gearbox on a Hendey lathe



Brian Wood brings an old lathe back into order.

Summary

This US made lathe was an eBay find in a farm workshop near York. It is a 12-inch swing lathe of 5 feet overall length. The lathe is fitted with an early example of Norton's selective screwcutting gearbox, the first commercial application of his patented design. At the time it represented the latest technology available, replacing the older method of setting up change wheel gearing for the screw pitches it covered.

The gearbox needed a major rebuild to bring it back to working condition. As work on it progressed, the leadscrew was found to be both bent and gouged over a considerable length; that too needed rectification. Interestingly, the leadscrew also appears to be made in two pieces, a discovery that dictated a change to the overall repair plan.

The article describes the work done to salvage both gearbox and leadscrew; it also describes the simple method used to straighten the leadscrew without using a press.

Introduction

Photograph 1 is a view of the lathe at the farm, dumped in a poorly lit area of their workshop where it was half buried in paper sacks and other general rubbish. The level of filth it had acquired over the years had to be experienced to be believed.

Photograph 2 can only give a general impression of how dirty it was; in places it was good fractions of an inch thick.

By contrast, after rubbing it over with a rag, the thread pitch information plate shone like a beacon through all this grime. It is a beautifully crisp casting in bronze, with two colours of enamel infill and secured to the gearbox casting with four small hard brass pins. **Photograph 3** shows it in close up.

I levered off the plate for safe keeping making old paint removal and cleaning easier. With the plate off, **photo 4** shows what looked like a mould identity mark hidden below.

Hendeyman (ref. 1) has a very detailed company record of drawings and other such useful reference material for pretty well anything produced by the company over a 66-year time scale



Lathe in place at the farm (Chris Mills)



Clean me up a bit please (Chris Mills)

and he confirmed the mark to be as suspected. Tracing back from the bed serial number 5119, the machine was recorded as completed on 31st July 1902 and shipped to Hendey's London agents, Charles Churchill, as part of a large supply order in the summer of that year. It was

also supplied with the taper turning attachment.

The whole machine is therefore 115 years old and at an interesting stage of evolution, particularly from the point of view of gearbox development. The gearbox on this lathe was made long before the addition of range selection gearing on Hendey machinery which appeared from about 1918.

That refinement was built into a second smaller housing between the change wheels and the gearbox and trebled the screwcutting pitches available from the central twelve step gear cone to give thirty-six directly selectable screw cutting pitches.

This gearbox is the basic one stage device as described in Norton's patent of March 1892, a copy of which is shown in **photo 5**. It produced twelve imperial screwcutting thread pitches individually selectable from the twelve step gear cone keyed onto the leadscrew. The other pitches it can provide are only available by rearranging the change wheels which supply the drive down to the gearbox. For this gearbox there were three choices of change wheel ratio listed on the thread pitch plate, viz, 1:4, 1:1 and 4:1, together with one variation, using a 69 tooth change wheel, to yield a pitch of 11.5 tpi.

Those steps are very broad [by a factor of 2 compared to modern practice] and to expect the coarse pitch performance of less than 2 tpi as suggested by the pitch plate is in my view being over ambitious and demanding on a lathe of this capacity.

Having done another recovery job for the same owner on a much younger gearbox fitted to a very different British made lathe, I was pleased to be asked to assist in the recovery of this machine and be given a free hand to repair the gearbox as necessary. The brief was to return the gearbox to the condition of a working museum exhibit; it is most unlikely to be used again for workshop production.

Some design peculiarities

Rather surprisingly, no provision at all was made for compound gearing to expand the useful scope of pitch output from the gearbox. This is even though only five years prior to fitting gearboxes to lathes, Hendey sold very similarly sized lathes equipped for compound change wheel use. Those lathes were supplied with a good complement of change wheels in a slotted store made for them in the hollow support leg below the headstock.

The pitch of 11.5 tpi will seem odd in the UK, it is an American pipe thread pitch used for 1.0, 1.25, 1.5 and 2-inch pipe sizes. Those sizes and many more are cut at 11 tpi to suit British pipe thread standards, and



Cast bronze thread plate



Gearbox casting identity mark

6 12-inch x 5 foot Hendey-Norton Lathe (28" between centres)			
Backgear Ratio	10.4 : 1	Screwcutting	1.75 to 96 threads per inch
Belt Cone Diameters	2.725", 4.25", 5.875", 7.5"	Countershaft Pulleys	9 inches x 2.75 inches
Drive Belt Width	1.75 inches	Countershaft Speeds	150, 225 or 350 rpm
Spindle Hole	7/8 inches	Lengths of Bed	4, 5, 6, & 9 feet
Front Bearing Taper	17/8" to 23/8" x 311/16" long	Swing over Carriage	7.25 inches (5 inches over rise-and-fall carriage)
Back Bearing Taper	113/16 to 23/16 x 27/8 long	Tool Size	3/8 inch x 3/4 inch
Tailstock Barrel Dia.	11/2 inches	Leadscrew Pitch	7 threads per inch
Spindle Nose	17/8" inches x 8 tpi	Centres	No. 2 Morse
Centre Bush	No. 4 Morse	Taper Turning	13 inches & 15 degrees

The machine specification from Hendey's catalogue (www.lathes.co.uk)

quite conveniently, 11 tpi is a pitch already provided by the gearbox.

Because this machine was destined for export to the UK market it seems a little short-sighted of the company to send it out ill equipped for UK standards. For instance, instead of a 69 tooth wheel, by using a 57 tooth wheel instead, combined with a 14 tpi gearbox setting, the lathe would then cut 19 tpi threads to suit other English pipe thread pitches.

The 69T wheel was missing anyway, so its absence is hardly a serious matter. Of more significance perhaps, the taper turning attachment was also missing.

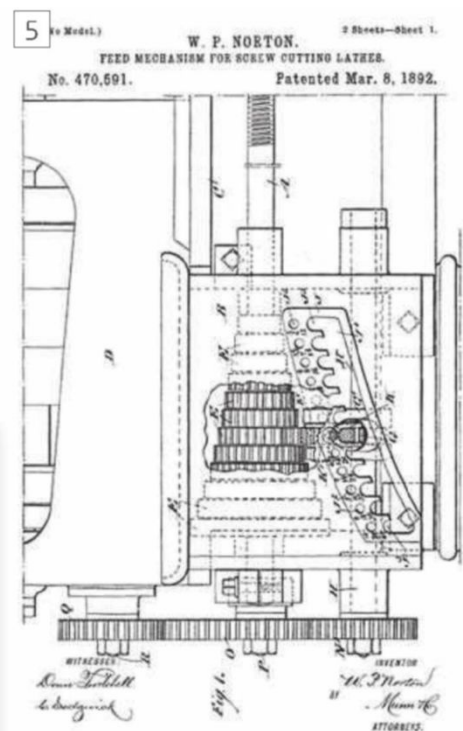
A brief manufacturing history

As this lathe is of some historical interest as well as being a restoration project, it was

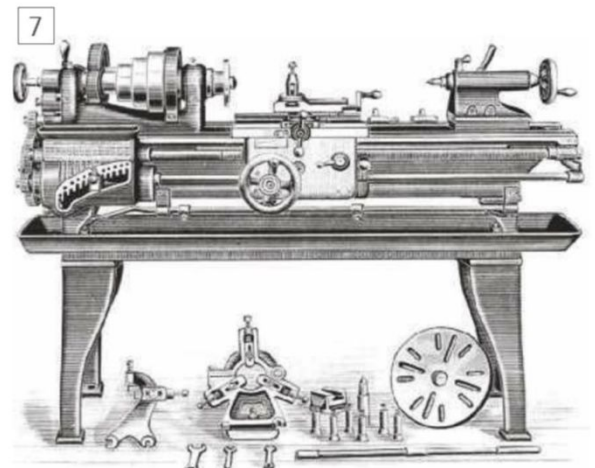
thought appropriate to describe a little of the company history behind its creation.

The Hendey Machine Company of Torrington, Connecticut began business about 1872 as a fledgling backyard operation run by two brothers making wood turning lathes. As the business grew, the company activities quickly progressed to making metal working machinery. Fast forward several years and Hendey was the first manufacturer to both recognise and utilise the potential offered by Norton's selective screwcutting gearbox.

In developing his design, he drew on the work of others,



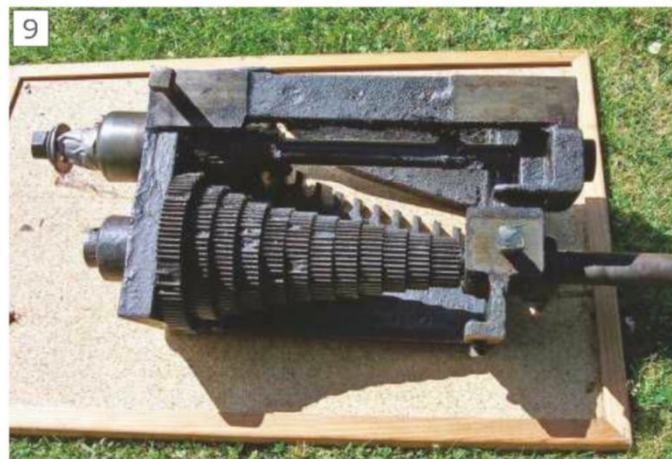
Wendell P Norton's patent of March 1892 (The United States Patent and Trademark Office)



An illustration from that catalogue page (www.lathes.co.uk) ➤



The gearbox after removal from the lathe



Showing the degree of gearbox damage

but notably that of John Humphreys, who in 1868 had patented the concept of a cone of gears from which to select ratios. Norton however was the first whose ideas gave rise to a practical, fully enclosed and commercially viable device, incorporating within the housing simple and reliable gear selection from the gear cone.

He started working for Hendey's in 1886 and from then on he would have developed and refined his ideas for a gearbox design. Hendey began fitting Norton gearboxes to their lathes in 1892, the very same year in which the patent was issued. For them to have been tooled up in readiness for the launch is pretty clear evidence that they had been involved in Norton's ideas right from the time he started working for them.

He would have needed their support for the development work, prototyping in all its forms and so on and they could well have funded the cost of applying for the patent, having grasped the commercial value of his ideas.

Soon after this introduction, Hendey went on to offer for sale a family of lathes, all fitted with the same general gearbox design, on machines that ranged in size from 12 to 32 inches diameter of swing over the bed. The gearing inside the gearbox was varied to suit the pitch of the leadscrews that were fitted.

This range of lathes was marketed under the new joint company name of Hendey-



The damaged cone gears

Norton; Norton was now a director in the newly named company. He had also moved to Torrington from Mount Vernon near New York and would have been on hand at the firm full time. The confidence all this demonstrated in the new technology by a well respected manufacturer of the time propelled Norton forward to international recognition. Selective screwcutting

gearboxes are still known by the Norton name today, 125 years later.

Photograph 6 is a copy of the specification for this actual machine, taken from the family of related machines in the Hendey-Norton catalogue of these early lathes. **Photograph 7** is the supporting catalogue illustration of the lathe as it was normally supplied.

In the UK, it must now be a rare survivor and the seller recalled from way back the lathe being used in his grandfather's blacksmithing days from when he bought it perhaps 80 years ago. After his grandfather died, the lathe came to the farm where it was used for many years for making simple parts like bearing bushes for the farm equipment repair business run by his father. When his father died, the business passed into the seller's hands and for a while the lathe continued to be used for such jobs. That sort of machining is now being sent out as sub-contract work to others having more up to date equipment and the lathe became surplus to requirements.

Damage tally

The damage to the gearbox was quite extensive, I have broken it down into three main categories.

The gearbox

Photograph 8 is a general view of the gearbox after removal from the lathe and



The 96T cone gear



The 56T idler gear



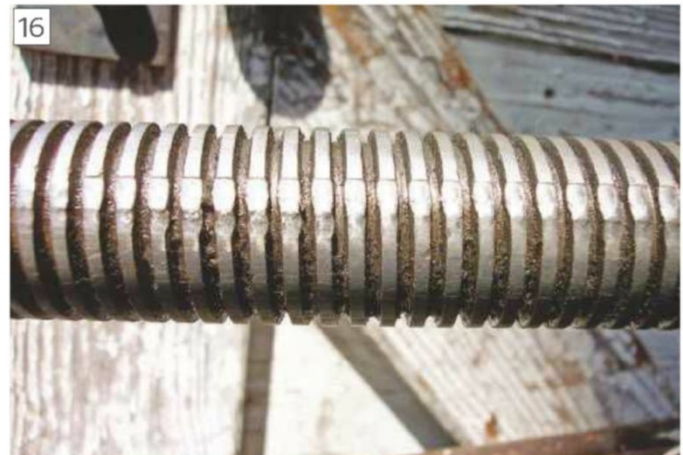
The 28T input gear



Detail showing the swaging over of gear teeth



Fractured weld on the cast iron selector handle



Damage to leadscrew

photo 9 is the view seen inside from the open back and with the top cover removed. Even without any cleaning, it is obviously very badly damaged and completely unusable.

The leadscrew has a full length keyway which is used to drive the saddle for powered surfacing feeds; without a working gearbox that function was also inoperative. As a result, the lathe had for a long time been reduced to purely manual operation.

Photograph 10 shows the gears that made up the cone; many of them have whole sections of teeth stripped off. And this was the first surprise of several built into the gearbox; the seven larger diameter gears were all made in cast iron. **Photograph 11** shows the cleaned up 96 tooth gear from that set in a bit more detail, it is quite obviously a casting.

The five smaller diameter gears which provided the coarsest pitches were made as expected in steel. They all have damage to some extent, but it is bad practice to run worn gearing with new, so they needed replacing as well.

Meshing with these cone gears is the transfer gear which runs on its own short shaft in the selector block. It is a 56 tooth steel gear, shown here in **photo 12**. All the upper section of the gear teeth has been worn away by a process almost like crude milling, leaving rough and stumpy apologies of gear teeth in the lower part.

The abuse it had received had also spread out the shoulders of the teeth; I had to hammer it out of the close fitting slot cut for it in the selector block.

The selector block is supported and guided by the gearbox input shaft, fitted through it below the transfer gear. This shaft has a keyway slot cut down its length which drives the steel input gear (with its key) that is also trapped in place in the selector block. In use it runs in constant mesh with the transfer gear.

The input gear is a small steel gear of 28 teeth and it was very badly mangled as can be seen in photo 13; it even has sections of broken cast iron teeth embedded into it; one piece was swaged into place and photo 14 shows the side view of the distorted tooth holding that piece in place.

The gearbox selector handle
The nice tear drop shaped cast iron handle with its bronze latch was broken off flush with the mouth of the inclined selector ramp on the gearbox front. **Photograph 15** shows this has had at least one unsuccessful weld repair attempt on the cast iron attachment stalk.

Rail enthusiasts will feel very much at home with the latching handle design, similar versions are used in railway signal boxes. Its use on Hendey gearboxes remained a design feature of theirs up to at least the mid 1940s.

Despite all this damage, the shafts within

the gearbox have remained straight, but taken all in all, the gearbox repair has been more of a recovery from a train crash than the hoped-for cleaning and overhaul job.

The leadscrew

The damage to the leadscrew was not visible until it had been cleaned from a thick layer of black grease, dead spiders, dust and other such 'lubricants'. **Photograph 16** shows the surface damage thus revealed; the wear/gouge mark is some 12 inches long on the left-hand side of the leadscrew and about 0.010 inches deep; it coincides with a bend in the leadscrew.

It had been rubbing for a long time on the side of the exit hole made for it through the lathe apron, producing rough burrs on the leadscrew. Linear gouging of the leadscrew with carriage movement would have been made any attempt at fine carriage movement imprecise close to the chuck. Motion was rough to say the least when winding the carriage by hand.

Because the leadscrew is an integral part of the gearbox, it is also the output shaft, the gearbox/leadscrew combination had to be withdrawn from the lathe apron with some care to avoid internal damage to the apron as it was lifted away from its location on the bed.

●To be continued

Lowmex 2018

Julie Williams reports on workshop-related exhibits at this popular regional model engineering exhibition



Turret turning attachment (Photo by Brian Sinfield)



Some of Bernie Towers exhibits

The 5th Lowestoft Model Engineering Exhibition (Lowmex) took place in October; organised by a sub-committee of the Halesworth and District Model Engineering Society (H.D.M.E.S.). Within the five years, the event has become the biggest exhibition of its kind in East Anglia.

It had all the things that you would expect to find at a model engineering exhibition (and more) and there were several things that would be of interest to Workshop enthusiasts.

Andy Lockwood brought a collection of workshop items to display, including a miniature turret turning attachment, which is used by replacing the compound slide on the lathe, **photo 1**.

Bernie Towers, from Phoenix Model Engineers, had made a host



Making a 16mm copper boiler



WWII Lathe made from a gunsight.

of useful workshop tooling, a small selection are shown in **photo 2**. Two items in particular that caused a lot of interest, were his rotary broaching tool with several tools and demonstration pieces, Bernie spent a lot of time explaining how this tool works to broach regular shaped holes. Also on display was his floating reaming attachment, which removes any misalignment between a reamer and the workpiece.

There was a small exhibit showing the construction of a small copper boiler – 'Making a Copper Boiler and Forming the End Plates', **photo 3** – made and exhibited by Andy Belcher. It is a boiler for a gas fired 16mm Cracker oscillating loco.

Then there was a small lathe, **photo 4**, again exhibited by Andy Belcher. It was made from a WWII German Anti-Aircraft Predictor (known as a 'height and range finder' by the British army) by Staff Sergeant John Edgar Davis R.E.M.E.

Billeted in Mohne, John Davis's task, at the time, was to recover and repair equipment from the front line – which was getting further away as the Allies advanced. Bored, he made himself the lathe. He got it back to the UK by dismantling it and packing it round with an old uniform. He then put it into a German ammunition box, labelled it "Deceased Officer's Kit" and sent it to his wife (he had thought to inform her beforehand!).

Back in the UK, he used the lathe to make various things and then passed it on to his son who also made his first models using it.

Lowmex has made a small profit each year, including this year, which has been donated to the local charity S.O.L.D. (Special Objectives for Local Disabled) This year another local charity provided the snacks, teas and coffees; The Lowestoft Thursday Club, which provides social activities for adults with learning disabilities,

For more photos and information, visit www.lowmex.co.uk ■

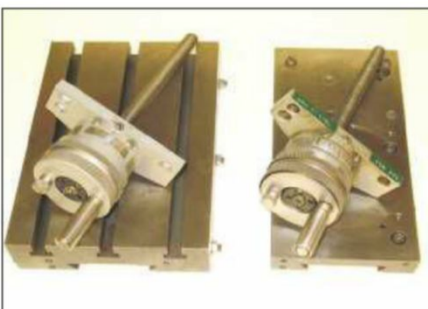
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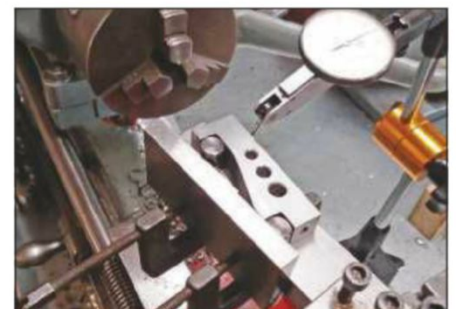
The May issue, number 280, of Model Engineers' Workshop seems to have a musical theme:



Cross Slide Story from **Peter Shaw**.



As the Worm Turns by **Peter Barker**.



Sine Bar (by the Arbour?) with **David George**.

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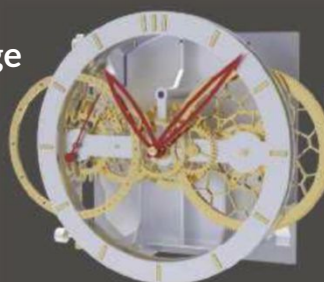
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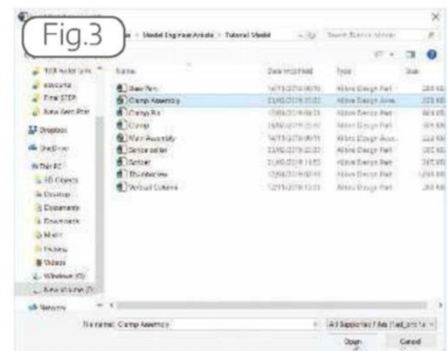
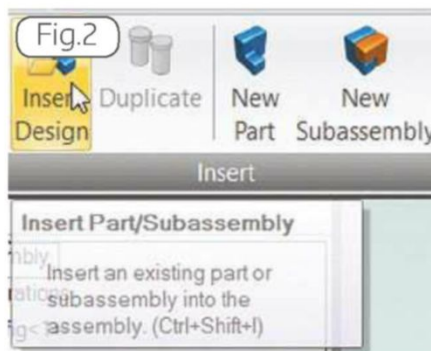
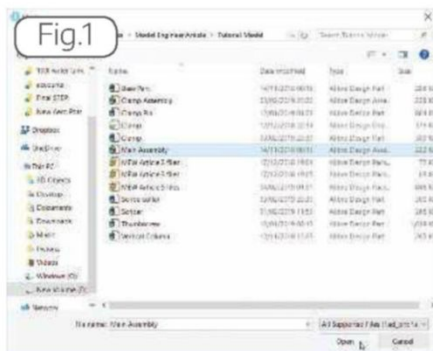
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To accompany the free six-month license available to every MEW reader, Robert Footitt starts a tutorial series to introduce you to working with Alibre Atom3D. If you haven't downloaded your free licence yet, visit www.alibre.com/MEW For extra information on the series including files to support the tutorials, other examples and links to useful resources visit www.model-engineer.co.uk/alibreatom3d - Part 6



In the last article we created another two components, the 'scriber' and 'scriber collar', featuring the sweep function. We also created an assembly; the 'clamp assembly'. In this article we will finish the 'main assembly', using the 'clamp assembly' we created in the last article as a sub-assembly. We will also look into editing parts from within the assembly.

Finish the 'Main Assembly'

Start up Alibre Atom 3D, then open the 'Main Assembly' we created in article 2 of this series, **fig. 1**. Click on the 'Insert Design' button, located in the 'Insert' section of the assembly toolbar as shown in **fig. 2**.

Select the 'Clamp Assembly' we created in the last article and click 'Open' as shown in **fig. 3**. Left click to place a copy of the 'clamp assembly' into the 'main assembly' and click 'Finish' as shown in **fig. 4**.

The 'Clamp Assembly' is added to the design explorer as a single item and is treated as a single component. Clicking



on the '+' symbol next to it's listing in the design explorer allows you to view all of its constituent parts. Click on the 'Quick' button, located under the 'Constrain' section of the assembly toolbar to open up the Assembly Constraints tool as shown in **fig. 5**.

Create a constraint between the clamp and the vertical column as detailed in **fig. 6**:

A: With the Assembly Constraints tool open, left click on the cylindrical face on the inside of the clamp, and the cylindrical

face on the outside of the vertical column components as shown.

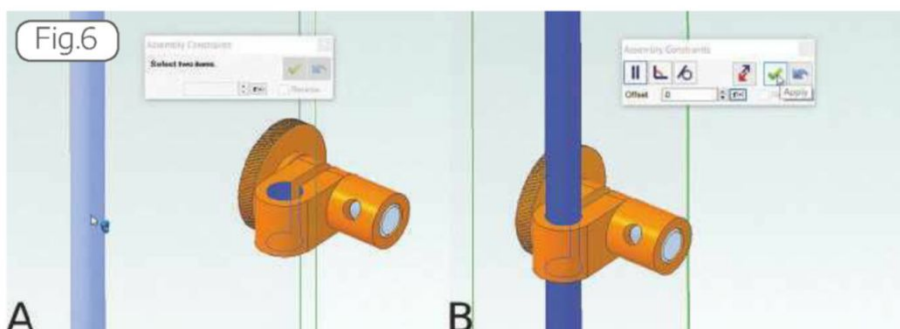
B: The clamp will move to line up with the vertical column. Click the green tick to apply the constraint.

Next, create an angle constraint between the side of the clamp and the assembly Z-X plane as shown in **fig. 7**:

A: With the Assembly Constraints tool open, select the flat face on the side of the clamp component.

B: Next click on the edge of the assembly 'X-Z' plane alternatively select the X-Z plane from the design explorer on the left. Note at this point the constraints in the design explorer will turn red as the default option for the assembly constraints tool is align, which is not possible due to existing align constraint between the vertical column and clamp.

C: Click on the angle button to change the constraint type from an align to an angle. The clamp will rotate to a 90 degree position and the errors in the design



explorer should now be resolved.

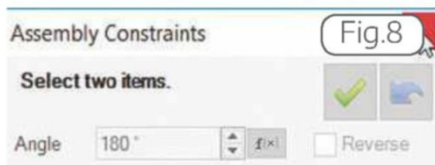
D: Change the value in the angle box to 180 degrees, and click the green tick to apply the constraint. The clamp will rotate back to its original orientation and there should be no constraint errors in the design explorer.

Click the red cross in the top right corner of the Assembly Constraints box to close the tool as shown in **fig. 8**.

In a large assembly, it is often helpful to rename some of the constraints that control critical positions. We can rename the angle constraint we just created as detailed in **fig. 9**:

A: Right click on the angle constraint we just created in the design explorer on the left the default name is 'Angle1', and left click on 'Edit'.

B: This brings up the 'Assembly Constraints' window. Delete the contents of the 'Label' box.



C: Change the label to read 'Clamp Angle' then click 'OK'

D: The constraint is now named 'Clamp Angle' which makes it much easier to identify from the rest of the constraints.

Next, create a constraint to control the vertical position of the clamp assembly as detailed in **fig. 10**:

A: Open the 'Assembly Constraints'



tool by clicking on the 'Quick' button, then select the top flat face of the base component as shown.

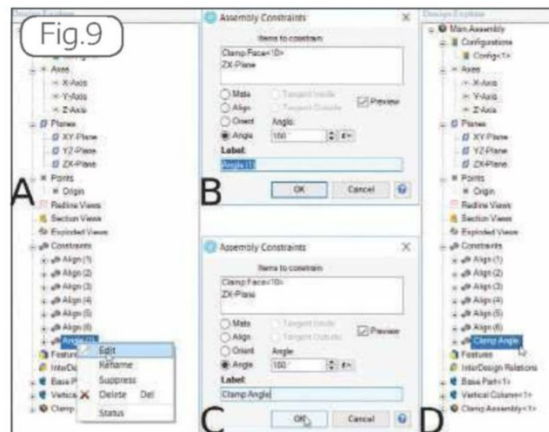
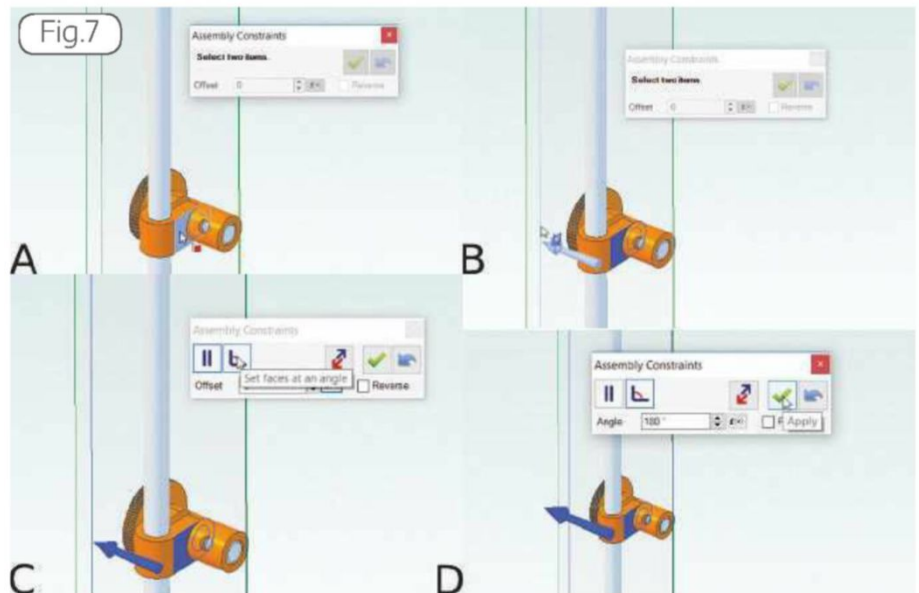
B: Rotate the view slightly such that you can see the underside flat face of the clamp, then left click on this face.

C: The clamp will move down the vertical column so the face is in contact with the base component. Click in the 'Offset' box, and change the value from 0 the default option to 100, then click the green tick to accept the constraint. The clamp will slide up the vertical column to just over the mid point.

It would also be helpful to rename this constraint as it controls the vertical position of the clamp. **Figure 11** shows a short cut method to change the name of the constraint:

A: Right click on the constraint created in the previous step currently labelled 'Mate1' then click on 'Rename'

B: This will enable a text edit mode



B: Next, select the vertical plane running through the middle of the scriber collar.

C: The scriber should rotate around so that the two planes line up, with the angled end of scriber facing up as shown. Note that if the angled end of the scriber faces down, hit the 'Flip' button in the Assembly Constraint tool to flip the scriber the other way up. Once the scriber is positioned correctly, click on the green tick to accept the constraint.

Now create a constraint between the cylindrical face on outside of the angled section of the scriber, and the cylindrical face on the inside of the collar as shown in fig. 16. Click on the green tick to accept the constraint, see fig. 17.

We now need one additional constraint to control the depth of the scriber, which is created as shown in **fig. 18**:

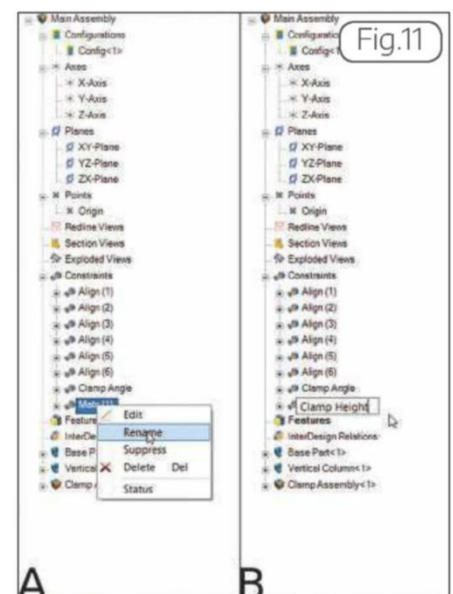
A: Select the vertical reference plane for the scriber as shown

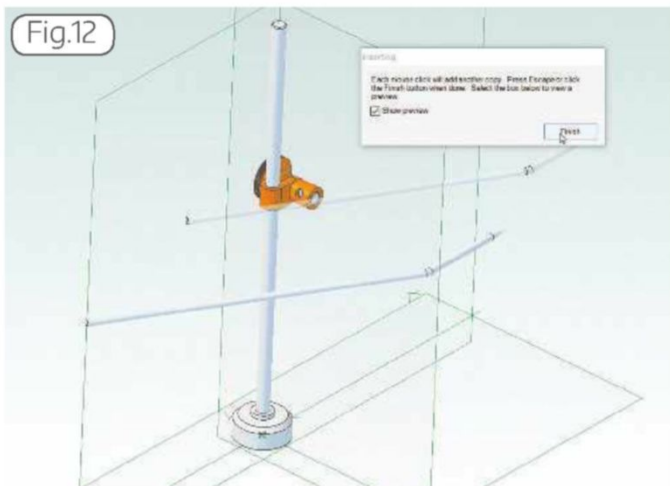
directly in the design explorer. Change label to read 'Clamp Height' and press the return key on your keyboard to accept the new label.

Next, we can bring in the 'Scriber' component we created in the previous article. Click on the 'Insert Design' button, select the scriber and click 'Open'. Left click to place a single copy into the assembly then click 'Finish' as shown in **fig. 12**. Right click on a face of the scriber, and select the 'Show Reference Geometry' option to make the construction planes for the scriber visible see **fig. 13**. Do the same for the 'Scriber Collar' component, **fig. 14**, the scriber collar and scriber with reference geometry shown.

Apply a constraint between the reference planes for the scriber and scriber collar as detailed in **fig. 15**:

A: With the Assembly Constraints tool open, select the large horizontal plane for the scriber as shown.





B: Select the cylindrical face on the outside of the scribe collar. Note Alibre Atom 3D will now centre the plane on the collar.

C: Change the value in offset to 50mm, and then tick the 'Reverse' check box. The scribe should move to the position shown, click on the green tick to accept the constraint and then close the Assembly Constraints tool.

Note: When creating a constraint between a flat face or plane and a cylindrical face, Alibre Atom 3D aligns the plane with the centre axis of the cylindrical face, any offsets are measured from the centre axis of the cylinder.

Rename the constraint we just created default label 'Align 8' to 'Scribe Depth' as shown see **fig. 19**. At this point I would recommend turning off the reference geometry for the scribe and scribe collar as shown in **fig. 20** to do this, right click on the part you want to disable the

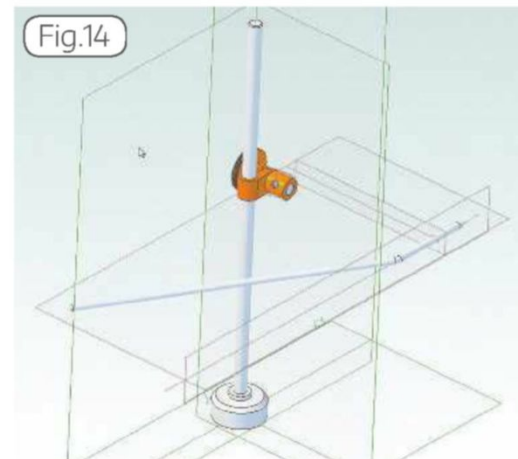
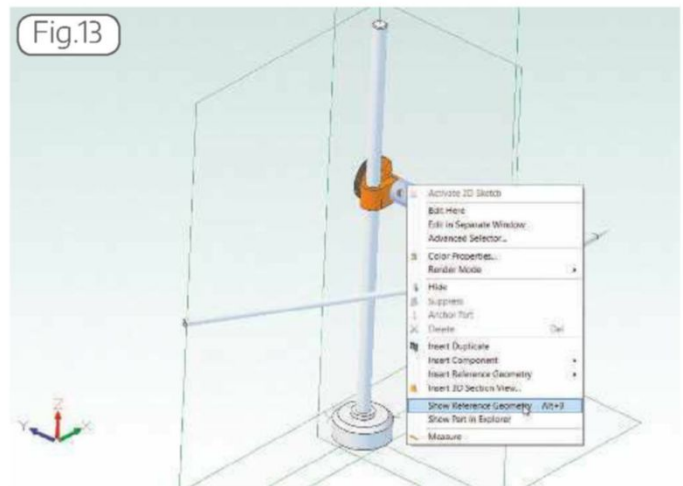
reference geometry for, then uncheck 'Show Reference Geometry'.

Editing an Assembly Constraint

The assembly is set up so that we can easily adjust the position of the clamp assembly and scribe as desired. To change the angle of the clamp, right click on the 'Clamp Angle' constraint from the design explorer on the left, and left click on 'Edit' as shown in **fig. 21**. In the 'Assembly Constraints' window, change the value in 'Angle' to 135 degrees, then click 'OK' as shown, **fig. 22**.

Figure 23: the clamp assembly is now rotated to 135 degrees. Note that due to the constraints used, the scribe moves with the clamp.

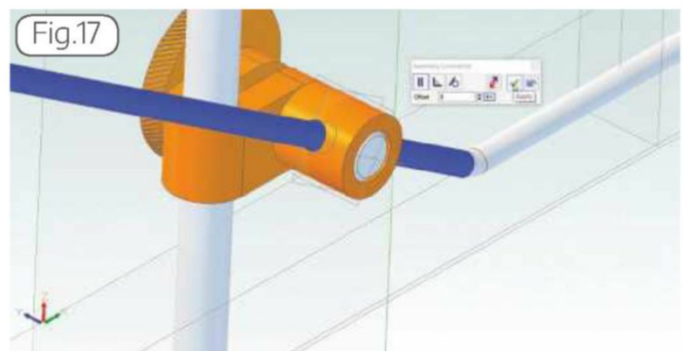
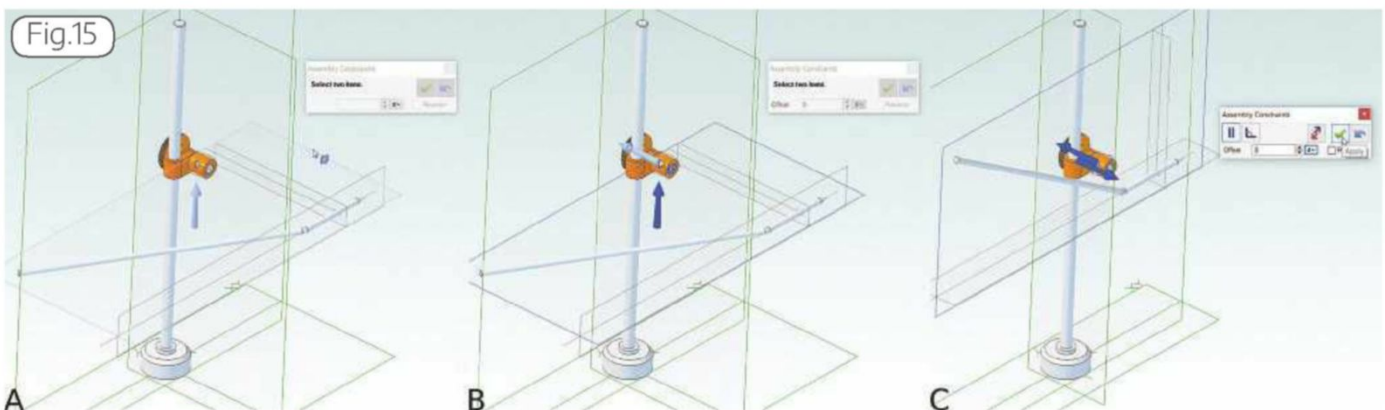
Save the assembly the save option is found under the 'Alibre Atom 3D' roundel, top left. There are no new components and the location of the assembly is already set so we can simply click 'OK' on the save

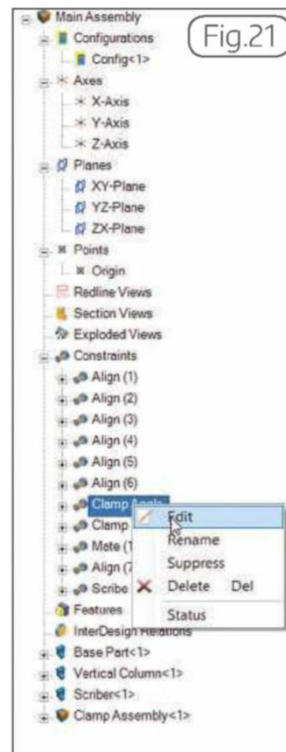
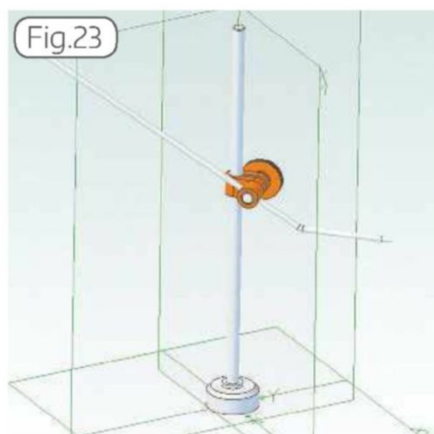
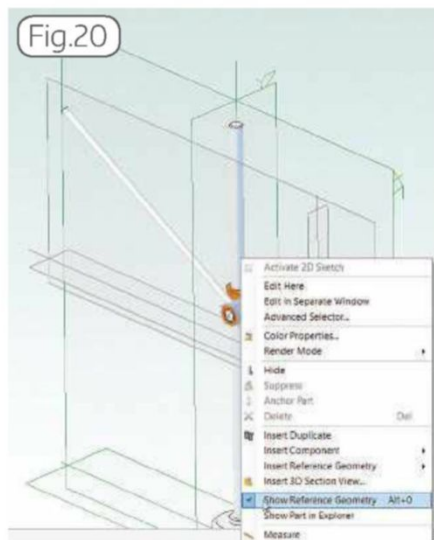
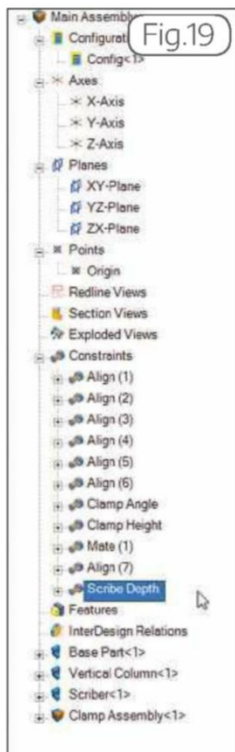
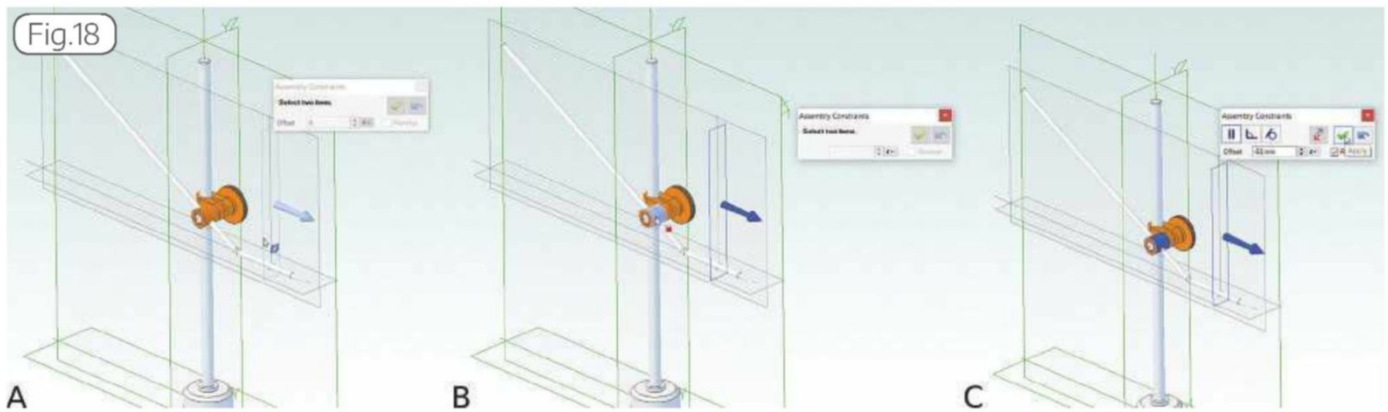


window as shown in **fig. 24**. Keep the assembly open.

Editing The 'Base' Component

There are two approaches to editing a





component that is used in an assembly. The simplest approach is to edit the part file independently of the assembly as follows:

- With the assembly closed, open up the part file to be edited.
- Make the desired changes to the part, save and then close the part.
- Open the assembly, the latest version of the part is loaded, and the assembly will update accordingly.

The other option is to edit the part from within the assembly, which can be very helpful in situations such as:

- Creating parts that have to fit closely together.
- When designing linkages, hinges or other arrangements where the dimensions of one part directly impact the position of another.
- When designing things such as casings that have to enclose other components.

This type of editing is referred to as 'in context', the following is an example of an in context edit for the base component:

Now that we have assembled the whole mini scribe, the base looks rather smaller compared to the size of the rest of the model and would likely be unstable in use. To counter this, we can modify the base to provide more stability.

Right click on the base component in the main assembly window, then left click on the 'Edit Here' option as shown in **fig. 25**. The main toolbar changes to the part editor, and the model tree for the base component is visible in the design explorer on the left, **fig. 26**. Note that the rest of the assembly is also shown in the tree, and the appearance of the other components in the assembly are changed to semi transparent to differentiate them from the part being edited, which remains solid.

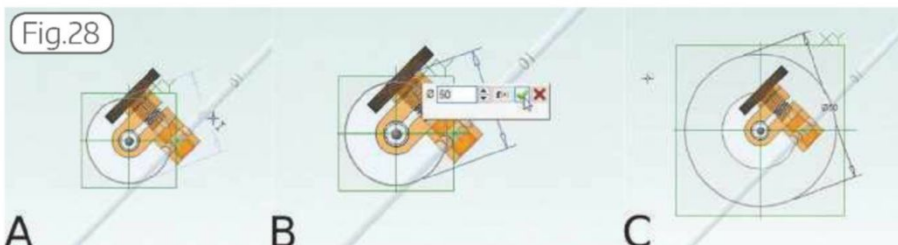
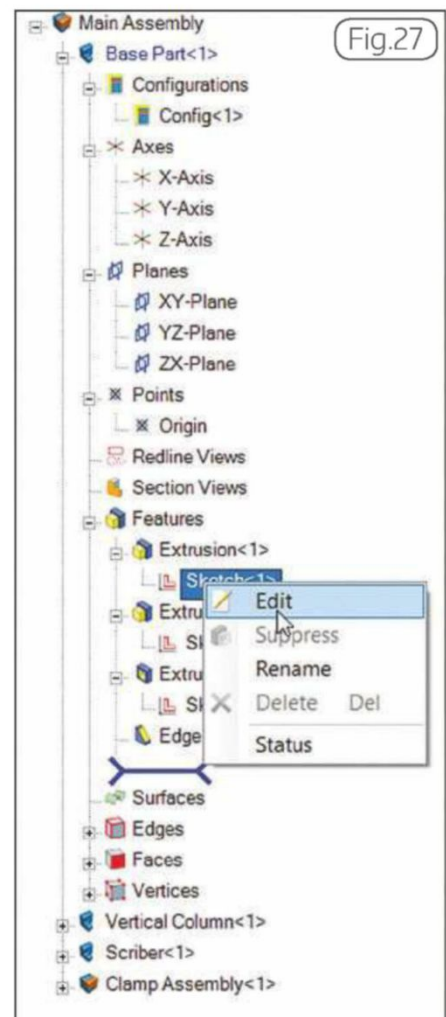
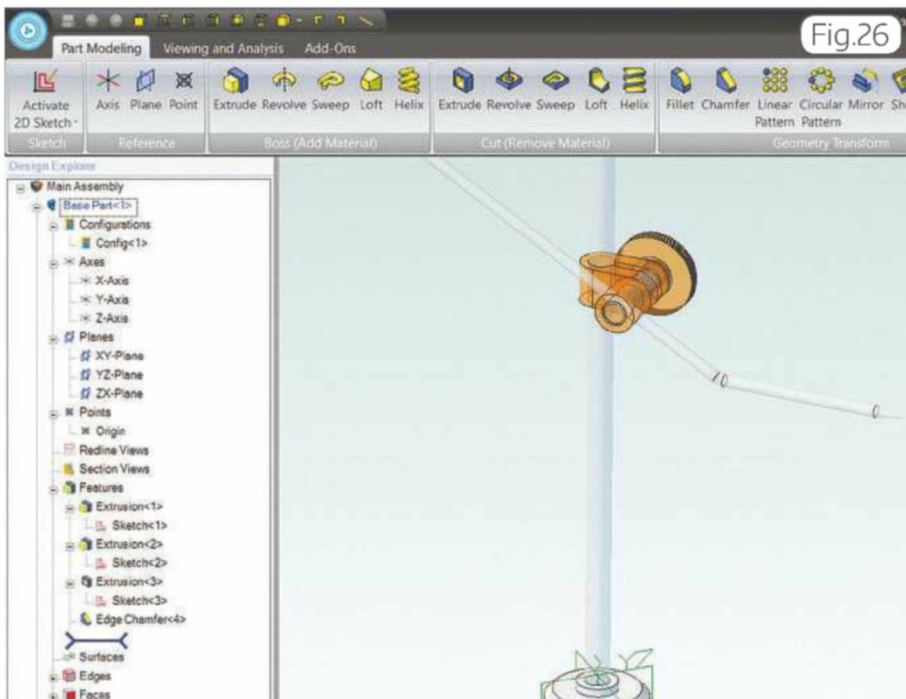
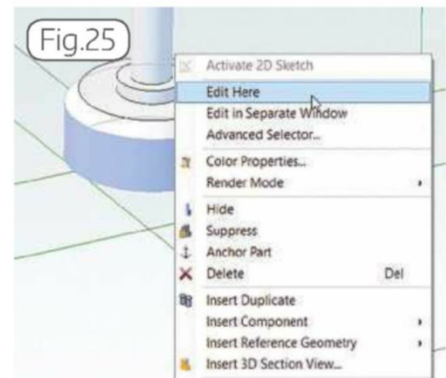
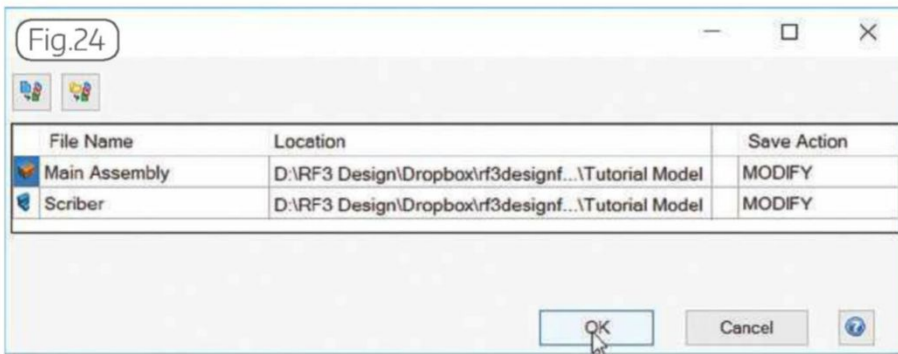
To change the diameter of the base, we need to modify the sketch for the initial extrusion we used to create it. Locate 'Sketch<1>' in the base model, right click on it and left click on 'Edit' as shown in **fig. 27**. We can now change the diameter of the base sketch as detailed in **fig. 28**:

- A: Double click on the 25mm diameter dimension.
- B: Change the value in the diameter box to 50, then click the green tick to accept the change.

C: The diameter of the sketch will update to the new value. Click on 'Deactivate Sketch' to exit sketch mode. The base extrusion will now change to the new diameter, **fig. 29**, however as this was the first feature in the model tree, the other features are currently hidden. Click on the 'Generate to Last Feature' button located top right of the 'Part Modelling' toolbar, to rebuild the remaining features of the base part.

The base part updated with the new diameter is shown in **fig. 31**. Now that we are happy with the changes to the base, we need to exit the part editor and return to the assembly workspace. Right click on 'Base Part<1>' in the design explorer on the left and uncheck 'Edit Part/Subassembly' as shown in **fig. 32** to deactivate the part edit mode.

This brings us back into the assembly workspace, **fig. 33**. Note that the modelling features of the base are no longer visible in the design explorer on the left, and that the appearance of the other components has reverted to the standard solid display.



Click on the Alibre Atom 3D roundel and then click on 'Save' to save the changes as shown in **fig. 34**. Note that when editing parts from within the assembly, you save the changes by saving the whole assembly rather than the part itself. The save dialogue will come up, **fig 35**, note that the 'Base Part' is listed with a 'Save Action' of 'MODIFY' to indicate that this part is being updated.

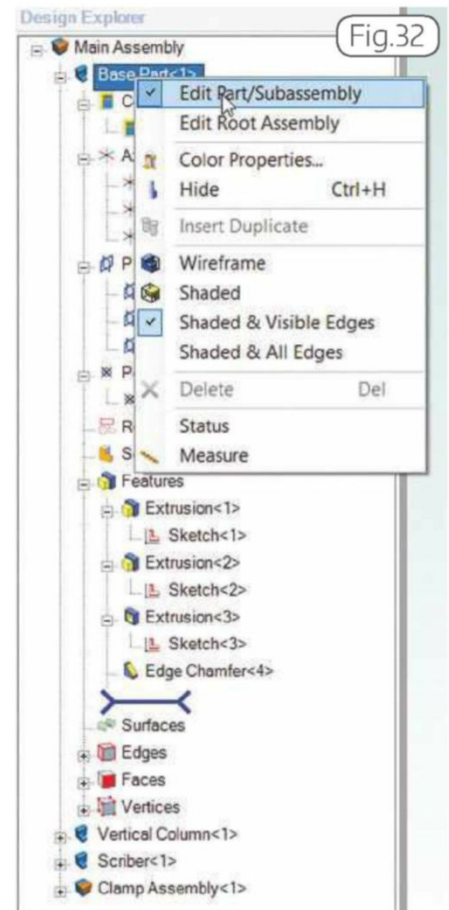
Summary

In this series we have created a set of parts and assemblies for the 'Mini Scribe' model, covered the basics of 2D drawings and looked at in context editing. This covers a good cross section of the functionality available in Alibre Atom 3D and shows a typical modelling work flow.

Here are a few pointers when working on your own designs:

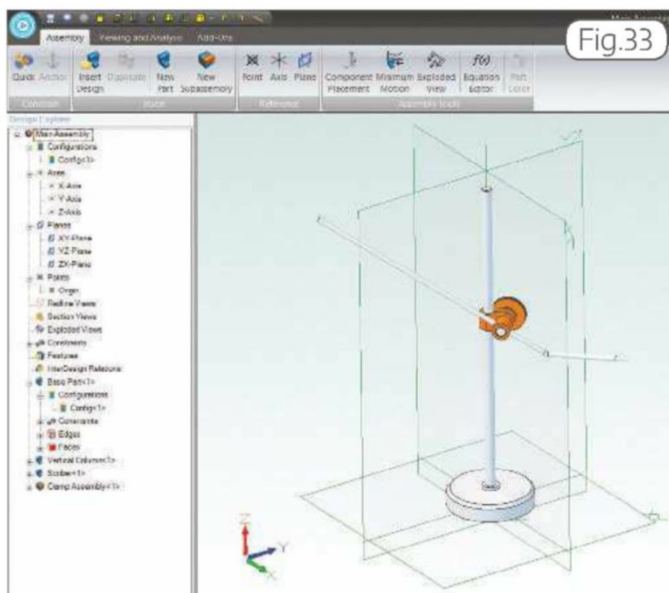


- If you are unsure whether you should be creating a design as a single part or an assembly, keep in mind how the finished item will be manufactured. If it is created as a single item either cut from a blank of material or 3D printed as a single piece then it should be created as a part. If it is made from multiple components then make the individual pieces as parts, and then combine them in an assembly.
- When creating a new part, your first sketch must be positioned in relation to the origin the software gives you. Subsequent sketches can then be positioned against the part itself, and always remember to fully define your sketches.
- All sketches and features used to create a part are listed in the 'Design Explorer' on

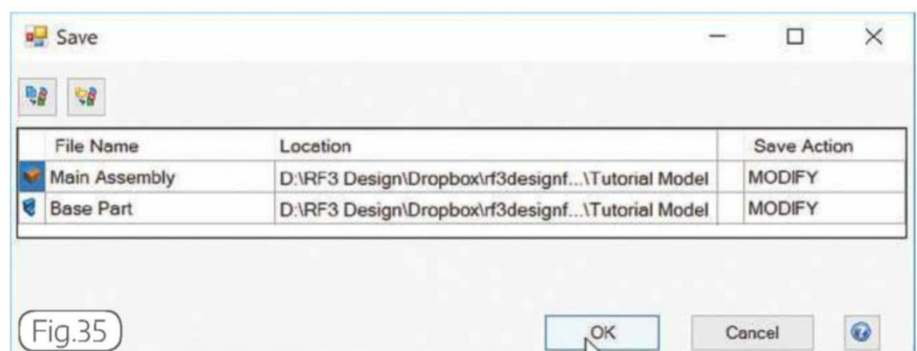


the left hand side of the screen. If you need to make a change to your design, remember you can edit any of these sketches or features by right clicking on the item in the tree and selecting 'Edit'. Once you've made your changes, remember to click on the 'Generate to last feature' button to return the model to the end of the feature tree.

● When creating a new assembly, always constrain the first component to the assembly construction planes. This is often easiest using the part reference planes, which can be made visible by right clicking on the part and choosing the 'Show Reference Geometry' option.



Thank you to everyone who has taken the time to work through the series with me. I suggest you continue working with Alibre Atom3D, explore some of the examples available at www.model-engineer.co.uk/AlibreAtom3d and experiment with creating some parts and assemblies of your own. ■



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Getting One's Teeth into Some Gears



Howard Lewis achieves a finer feed rate on his Mini Lathe

On Stub Mandrel's website, there is a file to 3D print 100 Tooth gears for a mini lathe, ref. 1. Despite, lacking 3D printing facilities, the opportunity to refine the feed rate seemed a good idea, so some thought was given to the means of doing it, using materials to hand.

It has to be admitted that whilst most of the turning could have been done on the mini lathe, a larger lathe was used. In this instance, I would have found facing the raw material to thickness very difficult on a mini lathe.

Starting with 8mm thick material should have been the obvious method.

Materials

In stock was some Acrylic sheet, but it was only 6mm thick, rather than the required 8mm, so that was a non starter. There was also some unidentified yellow plastic, but this would require reducing from 12mm to 8mm, so the mind turned to using metal. The first thought was to make four gears (two for my lathe and two for a friend) from a couple of piston blanks that had been in



The plastic blanks



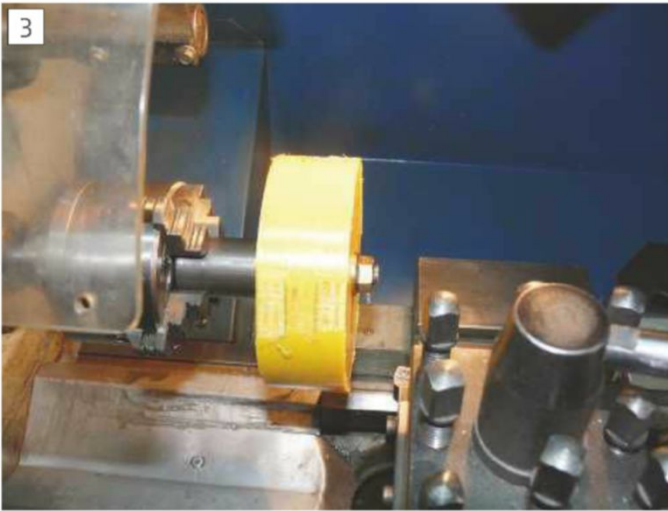
The arbor

stock, awaiting use as raw material.

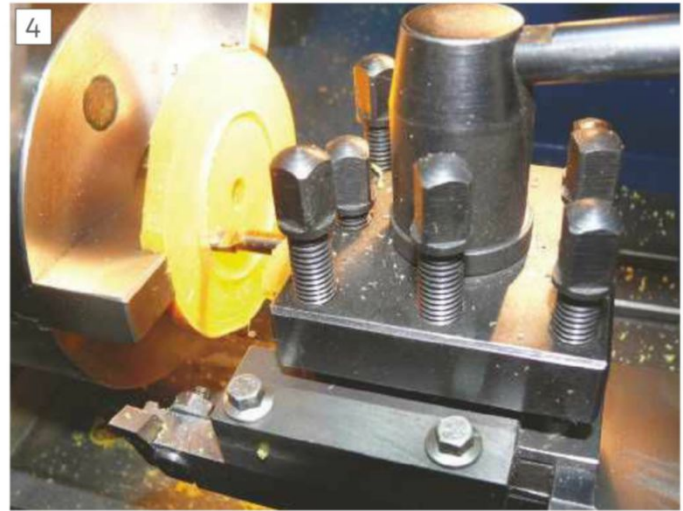
There was sufficient material to make four gear blanks, so work commenced. The material was forged, hard anodised, Aluminium alloy, some 107mm in diameter.

Turning Operations

Most of the turning work on pistons is done with the bottom of the skirt located on a bung located on a register turned inside the bottom of the skirt. This seemed to be too short to provide a certain location for the equipment available, so the crown of the blank was gripped, and the register set to run true, in the four jaw chuck. The register was then turned deeper, so that it could be used to locate the blank on the jaws of the four jaw chuck, to centre it, by clocking the top land of the piston. The blank was pulled onto the chuck jaws by a M12 drawbar acting on a piece of bar through the gudgeon pin bore. Having done, this the O D was turned down to the 102mm diameter required for MOD 1, 100T gears.



Rounding the blanks



Facing the blanks

Finishing the cut with a new blade resulted in a blank which tapered so markedly towards the bottom of the cut that it was unusable.

The centre area was drilled and reamed 12mm diameter before cutting a 1.5mm deep 3mm wide keyway.

Since I did not fancy parting to a depth of some 45mm, the blanks were then transferred to the Bandsaw. There seemed to be more than enough material to cut two overlength blanks from each piston. All seemed to go well, until the second gear blank was being cut, when the blade broke. Finishing the cut with a new blade resulted in a blank which tapered so markedly towards the bottom of the cut that it was unuseable.

The same expensive and frustrating events happened when I tried to saw the second piston blank, so the 12mm plastic became the chosen raw material, and was sawn into very rough approximations to oversized squares, **photo 1**.

Having roughly marked out the centre of each, and scribed a circle, 102mm diameter, to denote the size of the gear, each piece was centred in the 4 jaw chuck, to be drilled and reamed to 12mm. A keyway was then cut, again, using the slotting tool designed by the late Peter Robinson. The casting for this had been obtained from College Engineering Supplies.

When this work had been completed for all the blanks, a 12mm diameter arbor was made up, with, with an M10 thread for clamping, onto which the four pieces



Turning to final diameter

would be mounted for subsequent operations. The end of the arbor was centre drilled, to allow support whilst the teeth were being cut, **photo 2**.

The four pieces were then turned until there was just sufficient circular O D to allow each piece to be clamped in a 3 jaw chuck, **photo 3**.

Each piece was then faced to the required 8mm thickness; stopping the feed just before the boring tool contacted the chuck jaws, photo 4. This was only required because the raw material was thicker than the required 8mm.

The arbor was placed in a small four jaw chuck, carried on a 2MT arbor, and fitted with adaptor sleeves to suit the mandrel on the BL 12-24. The four-jaw chuck was then adjusted until the 12mm diameter ran true to within 0.0005 inches or less.

Once this had been done, all the pieces were fitted to the arbor, and turned down to 102mm diameter, **photo 5**.

Preparing to Cut the Gears

The rotary table was set up on the surface table so that the centre height could be determined.

A finger clock was attached to the height gauge, and with the height gauge set to the minimum reading of 2 inches, zeroed on the table. The height gauge was raised until the finger clock again read zero when passed over the top of an arbor of known diameter, **photo 6**.

The radius of the arbor was deducted from (height gauge reading, minus the initial 2 inch reading), to find the centre height of the rotary table. In the case of my HV6, this was exactly 4 inches. The thickness of the 1 MOD No.2 gear cutter was measured, and half of this dimension subtracted from 4 inches.

A setting piece was prepared from a piece of inch diameter silver steel, faced flat at one end and drilled and tapped $\frac{1}{2} \times 40$ tpi at the other. A matching male $\frac{1}{2} \times 40$ tpi



Determining centre height



Adjusting assembly

piece was made and fitted with a knurled locking nut.

This assembly was then adjusted to the dimension calculated to bring the centre line of the cutter to the centre height of the rotary table, **photo 7**. The quill of the mill/drill was then adjusted against this fixture, to bring the centreline of the gear cutter to the centre height of the rotary table, **photo 8**.

Cutting the Gears

The small 4 jaw chuck, arbor and workpiece were removed from the lathe, and the adaptor sleeves removed so that the 2MT shank could be fitted to the rotary table. The rotary table was set up so that the arbor would be rotated 3.6 degrees, by moving the handle 18 holes on a 20 hole dividing plate, and the tailstock engaged to provide support.

The table of the mill/drill was then advanced, in the Y axis, until the Cutter just touched the surface of the plastic blank,



Aligning cutter

and the dial set to zero. Having moved the table, in the X axis, to bring the cutter clear of the work, the table was then moved in the Y axis to produce a depth of cut of 2.16 mm (0.085 inch), and locked.

With the rotary table locked on the zero position, the table was advanced in the X axis, to make the first cut. Once the stationary cutter had been withdrawn to the starting point, (set by the table stops) the rotary table was unlocked and advanced by 18 holes on the 20 hole plate, before being relocked, ready for the next cut. This procedure was repeated until all 100 teeth had been produced, **photo 9**.

After all the teeth had been cut, the arbor was removed from the Mill/Drill, and work started to remove all the burrs from what now looked like a yellow plastic sea urchin! Removing the burrs with a Stanley knife took as long as cutting the teeth, but the end result is shown in, **photo 10**.

Fitting the Gears

This was when a problem came to light. The primary gear, effectively a 100/20T compound gear would not fit properly on the stud on my lathe. This was because the banjo was clamped by a M8 nut and washer which held the gear away from the correct engagement position. The way chosen to circumvent this problem was to remove the double ended stud and turn away the long outer M8 thread, before drilling and tapping M6, some 10mm deep. The intention was to clamp the banjo using a M6 capscrew.

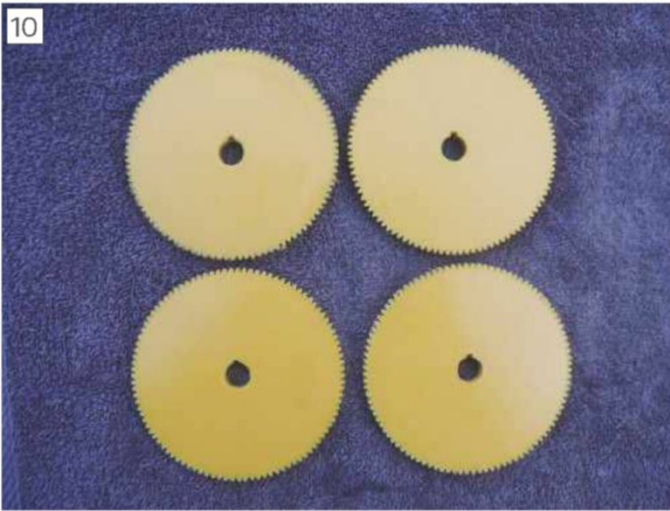
However, this still fouled the gear, so that the banjo could not be swung to mesh with the second 100T gear, on the Leadscrew. Reducing the diameter of the head of the capscrew from 10mm to 7.5mm did not solve the problem.

The head of a M6 roofing/gutter screw, lightly faced, allowed the gears to mesh, but could only be nipped with difficulty, requiring the gears to be removed to tighten it. Even then the engagement of the screwdriver was minimal, so this was not a good solution.

The Editor suggested using a



Cutting teeth



Finished gears



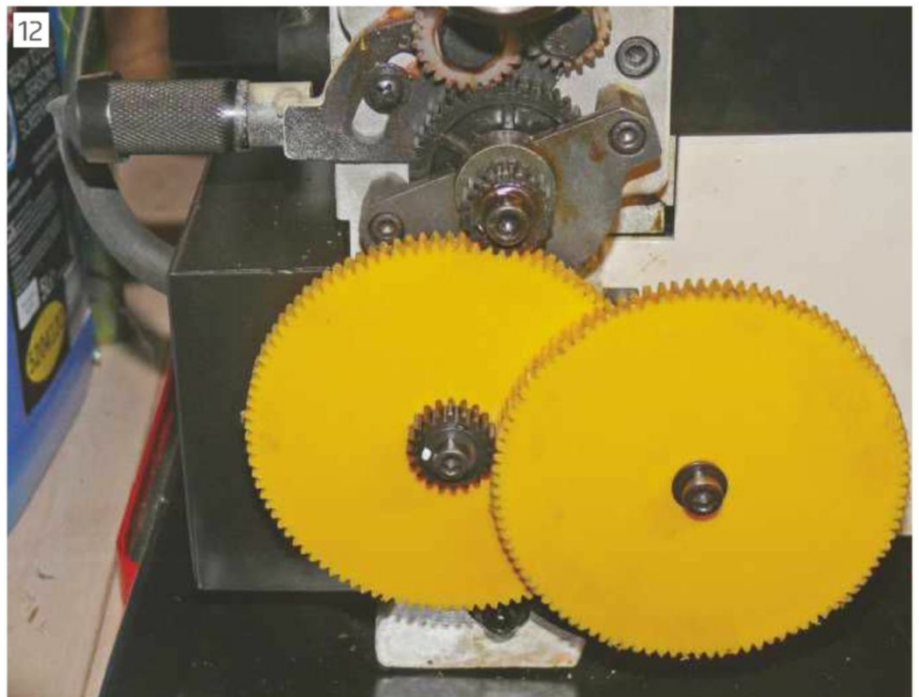
Modified banjo fixings

hexagon headed fastener as a means of overcoming the problem. A hexagon head M6 setscrew was shortened to 11mm, (to maximise thread engagement in the modified clamping stud) and checked that it would clamp the banjo firmly. Once this had been confirmed, the head of the setscrew was faced to ensure that, with its washer, the combined stand out did not exceed the 4mm thickness of the flange on the Stud for the primary compound gear, **photo 11**.

With all the gears fitted and meshed, without the retaining capscrews, it was possible to use a 10mm spanner to tighten both the nut on the Stud, and the thin headed setscrew for clamping the banjo.

With retaining capscrews in place, the resulting gear train is shown in **photo 12**. Backlash was set by running a piece of paper through each mesh before final clamping in position.

With a 100T gear on the Leadscrew, an 80/20T gear on the Stud would allow all gears to be meshed and clamped,



Gears fitted



Slot in cover

without modifying the banjo clamp, but the compound gear protrudes towards of the back of the lathe and prevents the gear cover being fitted. The 100/20T compound gear train set up makes this even worse, necessitating the gear cover having a large slot cut in the rear side of the cover.

On my lathe, the slot needed to be 60mm wide, (40mm measured from the edge of the lower part of the cover), starting 135mm from the top of the cover, and extending to 220mm from the top, to allow the cover to be put in place, **photo 13**.

Since the gear protrudes, it ought to be covered, and so a sheet steel blank was made up, as shown in **photo 14**, with the dimensions in mm, pencilled in. The 5mm clearance holes, the preliminary centre punch holes are just visible in the centre of the 15mm wide areas, should be drilled before bending begins.

It important to make the bends in the

right order and orientation, (otherwise you end up as I did, initially, with a mirror image of what is required, and having to remake all the bends).

My method was to bend up the 40 x 25, and the 40 x 40 ends of the box first, followed by the 90 x 25, and 90 x 40 sides. This leaves the 40 x 15 and 90 x 15 fixing tabs to be bent. These are likely to have to be made manually in a vice, rather than in a Bending Brake. Hopefully, you will make a neater job of the sheet metalwork, than I did, before giving it a coat of paint.

Once the paint is dry, the cover can be placed on the plastic gear cover, and aligned with the edge, ready for drilling the 5mm clearance holes. My method was to drill the lower one, using the short M5 setscrew and nut to hold the metal in place while the next hole is drilled. Another M5 setscrew and nut will hold the cover so that the third hole can be drilled.

When all three setscrews and nuts have

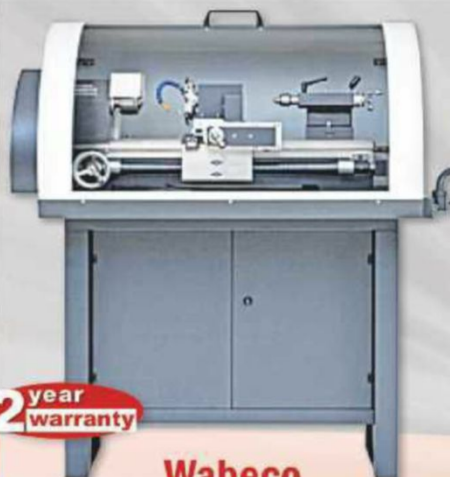
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Living with a SIEG SX3 Milling Machine

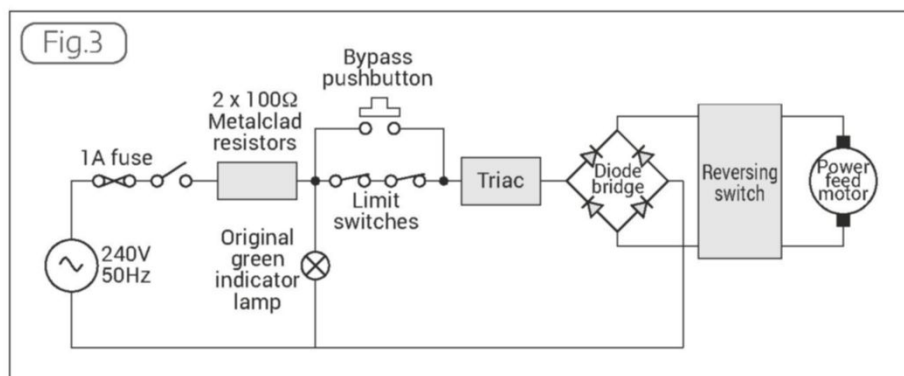
Austin Hughes recalls experiences over eight years of using this popular benchtop machine - Part 2

I began to realise that the end was nigh when the rapid-reverse began to be heralded by howling noises from beneath the table, and sure enough the next time I forgot to unlock the table, the motor started but the table remained stationary. After a coffee to cheer me up, I recalled that amongst their extensive spares Arc stocked feed nuts, but I was very disappointed to find that their website said they were temporarily out of stock. However, when I telephoned to see how long I might have to wait, I was delighted to learn that they had one that could be in the post that day!

I should mention that there are small potentiometers on the pcb labelled 'torque' and 'speed'. Most closed-loop d.c. motor drives provide these facilities, to allow adjustment of the current-limit (and hence the maximum torque) and the maximum voltage (and hence maximum speed) respectively, but I have not altered either and do not intend to unless I encounter further problems.

A budget power feed

When I was part way through writing this account, I remembered that a year or two ago my fellow REMAP colleague Jim said that his SX3 power feed had packed up, and asked Mike (also with REMAP) for help



to make a (cheaper) replacement, which they duly did. It struck me it might be good to say a bit about it while we are on the subject, so I asked for some details to pass on (for those not wanting to resort to DIY there is now a new design of power feed available for the SX3).

It seems that they decided to forgo the benefits of having closed-loop control and logic circuitry in favour of simplicity and low cost, and after some experimentation (they had nothing much to guide them) they settled on the simple mains-voltage circuit shown in **fig. 3**. All of the components are readily available, and the total cost is below £20.

Speed control is provided using a 60/400W triac dimmer switch, the output voltage of which is determined by the integral control knob and on/off switch. The output from the dimmer is rectified by the full-wave diode bridge, and then fed to the motor via the original reversing switch. The whole unit uses mains-level voltages and needs to be insulated and earthed as live, if

you don't feel competent to make it, ask a friend who is to help.

They knew that dimmers are designed for incandescent lamps, which are resistive, not for d.c. motors, whose armatures can have significant inductance. They also knew that whenever the current in an inductive circuit is suddenly interrupted (e.g. by switching off), a high voltage is produced: often it shows in the form of an arc across the terminals of the switch. The semiconductors in the dimmer would probably not tolerate the high voltage generated if the armature current was suddenly switched off, but fortunately, when the dimmer switch is opened and its current falls suddenly to zero, the armature current, sustained by the inductive stored energy, can transfer to an upward path through two diodes in the bridge while it decays safely to zero.

If the dimmer had been supplied directly at 240 V, the maximum d.c. voltage would far exceed the motor rating of 150 V, so a crude but effective way of limiting the maximum on-load voltage is provided by the two 100



Top view of old table



Bottom view of old table



Ω series power resistors, which are also effective in limiting the fault current through the dimmer in the event of a short-circuit at the motor end.

Originally, each of the two limit switches fed the low-voltage control logic, but in the budget circuit they are in series, so that when the table reaches either limit, the motor supply is interrupted, and the table stops. This simpler set up means that the switches are at mains voltage (for which they are rated), but the price to be paid for the simplicity is that to get the table moving again it is necessary to press the bypass pushbutton until the table moves away from its limit – in practice not a problem at all.

Apparently, it did not take much experimentation to arrive at a satisfactory circuit, but the greatest challenge was to get it all in the box. The multiplicity of wires between motor, reversing switch, limit switches and diode bridge makes for a real bird's nest. Initially it was thought that the resistors should be rated at 5W (but see below), so metalclad ones were mounted on the steel end grille to provide a heat sink.

Happily, this arrangement has proved entirely trouble-free, at least until I asked for a few details. What happened then provided a short term worry for Jim and Mike, but at least left me feeling that I am not alone in making silly mistakes.

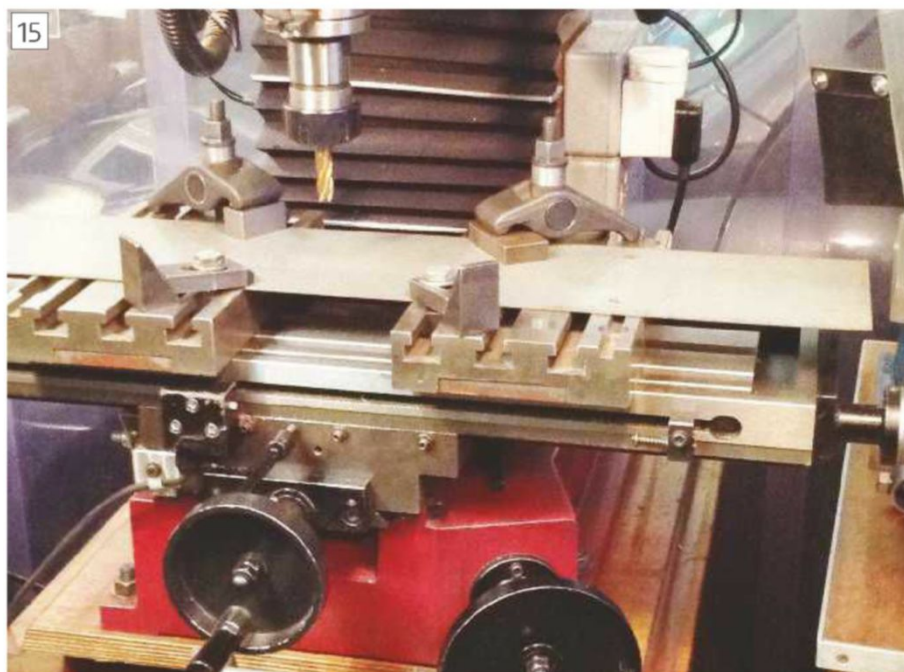
It seems that in the process of digging up some details for me, they went to Jim's workshop and tried out the power feed. Nothing moved, even with full speed dialled, but there were electrical noises afoot, and quite soon smoke started to issue from the box, then nothing. After isolating everything and opening-up, they found that the power resistors had become so hot that the soldered connections had melted, and the wires had come adrift. When they tried to move the table manually, the penny dropped – the table locking lever had been left hard on the last time the mill had been used.

With the benefit of the knowledge that I had gained earlier, we can see that with the motor at rest (i.e. when there is no back e.m.f.), the motor's armature resistance of 26Ω (barely significant in comparison with the external 200Ω resistors) gives a total of 226Ω , so the current will have been about 1A – not enough to harm the motor, or blow the input fuse, but at 100W each, enough to cook the 5W resistors! Happily, after cooling down, and re-soldering, all was well.

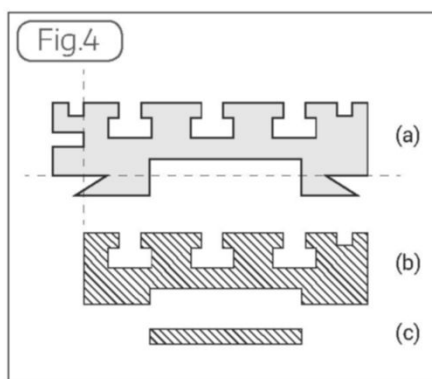
This prompted a re-think and based on my finding that the normal motor current is about 0.35A, the dissipation in each resistor will be $(0.35)^2 \times 100 = 12.25$ W. Given that the motor operates for relative short periods, we agreed that 10 W resistors would be a better bet – but how the larger ones will be squeezed into the box remains to be seen.

Life in the old table

As new, the SX3 table measures 550 x 160 mm, but it soon becomes apparent that when the travel limit switches are fitted, the cutter cannot reach the ends of the table. In addition, my deeper power-



Set up for wide material



feed box further slightly reduced the rightward movement, so that the maximum continuous run of the cutter was only about 280 mm. (The travel can be extended significantly by removing the limit switch plungers and exercising great care as the

table reaches the mechanical limit, but with long jobs I usually resorted to the less-than-ideal approach of re-positioning the workpiece).

When I discovered that Arc offer an 'extra-long table' measuring 700 x 160 mm, I jumped at the prospect of an extra 150mm of travel, taking the useful span to about 430mm; I bought one; and have been delighted with the extra freedom. The new table comes with a longer leadscrew and is easy to fit: an extra length of transducer 'slider' was required for the DRO.

The old table is a substantial lump of cast iron, and was far too good to consign to the bits box: instead it has been turned into two very useful work-holding aids. I know that few people will find themselves in the same position as me, but a few details might be useful in similar situations.

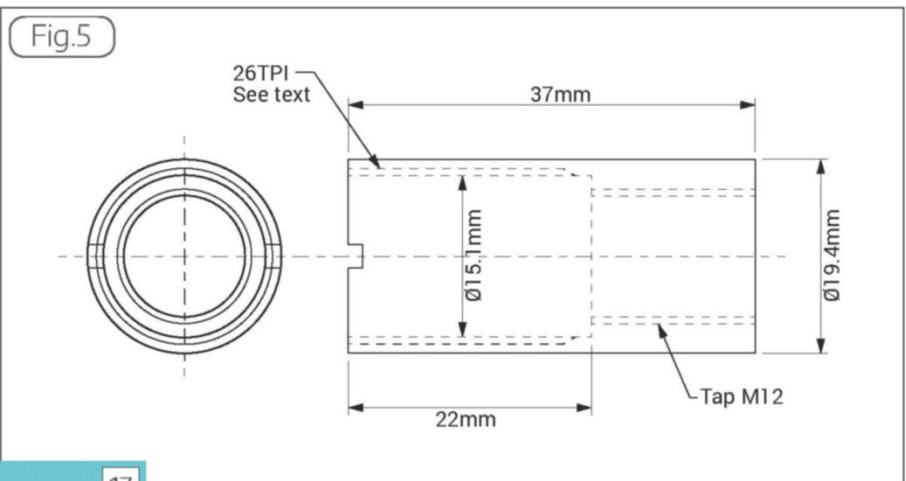
The maximum width of workpiece that



Boxford collet adapter

can be clamped using the T-slots is 75mm. I wanted a bigger range. I therefore set out to make what are in effect 'range extenders', by chopping the old bed in half and removing the unslotted end regions with a machine saw.

A cross section of the table is shown at (a) in **fig. 4**. I then used a slitting saw to cut along the dotted lines in (a) to remove the dovetails and the front groove, leaving the hatched shape shown in (b). Lengths of the surplus dovetail section (c) were cut and screwed transversely to strengthen each 'mini-table' (though I doubt if this was really necessary), and finally it was turned over and skimmed with a fly-cutter.



Boxford adapter assembled

Top and bottom views of the two mini-tables are shown in **photos 13** and **14** respectively.

The pattern of drilling and counter-boring for socket cap screws reflects my ongoing experience and was designed to allow the two mini-tables to be fitted along or perpendicular to the mill table, or to attach horizontally or vertically to my biggest angle plate. All of the holes pass through webs adjacent to the T-slots and are small enough not to weaken the structure to any significant extent.

A typical application (albeit contrived for the purpose of this article) is shown in **photo 15**, where a slot is to be cut in a long and wide piece of steel sheet, which overhangs the ends of the table and is far too wide for clamps to be mounted along its sides. The effective 'working width' is greatly increased by mounting the two bases perpendicular to the table, so that conventional clamping can then be applied at appropriate points. (I would normally back a thin sheet with a piece of hardwood secured with toolmakers clamps, particularly when drilling – but this picture is only to make a point.)

Boxford Synergy

The mill is metric, and my lathe is an imperial Boxford, so they are not natural bedfellows, but I have made some adapters to allow them to share each other's assets.

Prior to having the mill, I used the Boxford milling attachment (a beautifully made piece of kit) and amassed a good selection of cutters with imperial shanks. These fit Boxford collets (which appear to be identical to 3C ones) which in turn go

into a 3MT adapter in the headstock. The threaded male end of these collets engages with the female thread on the hollow Boxford drawbar, which when tightened pulls both collet and adapter into the headstock. The fact that long lengths of bar of up to 1/2 inch diameter can be fed through the hollow

drawbar is a useful feature when turning repetitive items.

When I bought the mill, I acquired a 3MT holder and basic set of metric 'Chinese' collets: they are similar in principle to ER but their range is more restricted, so they were not suitable for any of the imperial cutters. Given that the mill has a 3MT spindle it seemed obvious to explore how the Boxford adapter could be held in the mill, and it turned out to be a simple matter of designing a fitting to allow the 12mm male end of the solid Sieg drawbar to couple to the 3C collets.

The sketch (**Figure 5**) shows the fitting, made from mild steel. I was able to check that the male thread on the 3-C collets was 26 TPI, but I have not been able to find the thread form. However, I cut the female thread on the adapter with a 60° tool and continued increasing the depth of cut until it fits sweetly on the collets, and it has been

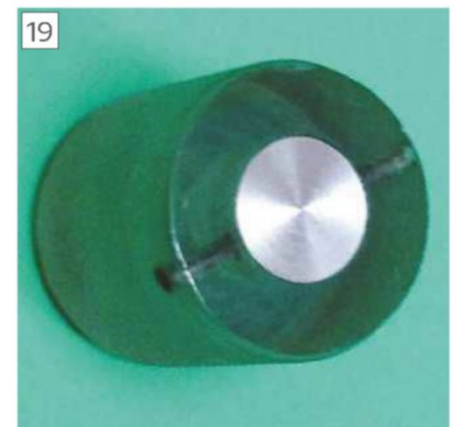
fine. The length of thread on the collet is 15mm, so the 22mm suggested is not really necessary. The other end is M12 to match the Sieg drawbar. The notches in one end were cut in case the adapter became stuck on the drawbar or inside the spindle, but happily they have never been used.

The Boxford MT3 collet holder, a 3-C collet and the adapter are shown in **photo 16**, and **photo 17** shows them assembled (with an M12 screw standing in for the Sieg drawbar). An unanticipated bonus of this holder is that it projects a much shorter distance from the end of the quill than an ER collet holder, and hence contributes to improved rigidity. This set-up has seen a lot of use because as already mentioned I already had a good stock of imperial cutters, whereas the complementary synergy, where the metric tooling for the mill (e.g. ER32 collets in an MT3 holder) is used far less often in the Lathe.

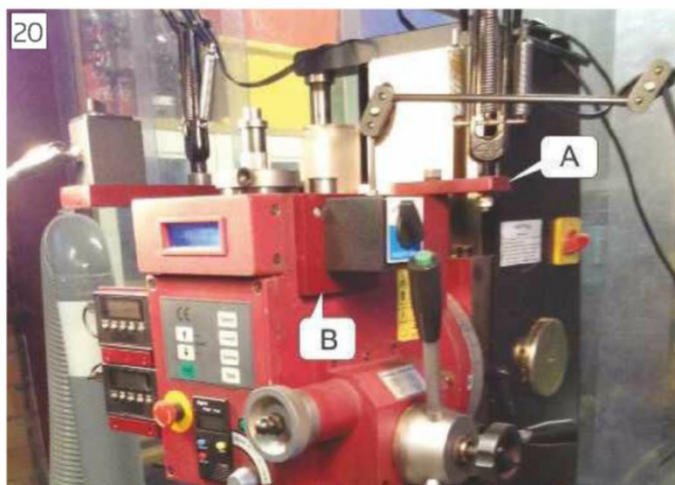
The mill drawbar is slightly too long for use in the lathe mandrel, but all that is needed to allow it to pull an MT3 tool into the lathe's headstock is a small spacing collar with a spigot. The one shown in photo 22 was made from a piece of brass tubing, with a spigot turned to fit into the outboard end of the Boxford mandrel, but it would be better with a smaller bore that just cleared the mill drawbar to provide better concentricity while the drawbar is being tightened.



Handle for use with keyless chuck



Acrylic handle



Mill head



Accessory bracket

Keyless chuck

When keyless chucks began to emerge on power tools, I was sceptical, but it only took one day with a new 10.8 V drill/drive to convince me otherwise, and it was not long before I was the proud possessor of a 16mm MT3 version for the mill.

It seemed very stiff from the outset, it being difficult to turn the knurled portion while holding the MT3 taper. I could see no way of adjusting it, so I hoped it would ease with lubrication and use, but it didn't. I soon tired of having to use a spanner to hold the spindle, so the chuck went back into a drawer and I reverted to the conventional one.

Several years later, the chuck came to light and I decided that since it had been no use to me, no harm would come from stripping it down to see if it could be adjusted. A c-spanner looked essential, but I didn't have one to fit, so before resorting to a hammer and soft drift I sought guidance on line and quickly realised my unbranded one was an Albrecht clone. Among the videos describing Albrecht-type chuck rebuilding, my favourite (www.youtube.com/watch?v=h_jQ7-UiWgl) runs for over 40 minutes and explains each stage in detail: it is very helpful to know in advance which bits have left-hand threads, and when ball-bearings are about to drop out!

I was disappointed to find no obvious reason for the stiffness but having cleaned and reassembled it as per the video, the action was just right, the mill spindle having enough friction to hold the body of the chuck still while the jaws were being adjusted. However, I felt it was still necessary to use a spanner to hold the splined upper end of the spindle while the chuck was finally hand-tightened.

To make it easier, I knurled a piece of acrylic of about the same diameter as the chuck body and bored out the body so that it drops over the splines on the spindle. Projecting axially from the closed end of the acrylic cylinder is a male hexagon which engages with the end of the drawbar and is just visible in **photo 18**. The steel insert with the projecting hexagon is secured by means of two long grub screws that are visible in **photo 19**.

In practice the acrylic block makes it easy to hold the spindle when tightening or loosening the keyless chuck, and when not in use it can safely be left on top of the head, where it is easy to find. I should stress that it is not intended for tightening the drawbar, which needs more torque and is done with the large Allen key supplied with the mill.

Paraphernalia

I prefer the colour spectrum of traditional incandescent bulbs rather than LED's, so a couple of old Anglepoise lamps serve to provide easy-to-position lighting.

The heavy bases of both lamps were removed, and the right-hand one was mounted on a mild steel bar screwed to the top of the cast-iron head, as shown at (A) in **photo 20**.

On measuring the diameter of the deeply recessed access holes for the socket screws that hold the top of the head to the body, I found that they were just right, so fixing the support bar with two shortish screws was easy. This lamp moves up and down with the head, so the light typically remains on the cutting tool.

The left hand lamp, **photo 21**, is mounted on a radial slotted section of a swinging arm made of tubular steel that can also be moved up and down on a length of round mild steel, which in turn is supported from a piece of channel iron bolted to the top of the mill column. This lamp does not move with the head, so typically remains focussed on the table.

Also mounted on the left hand swinging arm is a protective screen, attached via its lever-operated magnetic base. My wife calls swarf of all types 'curly-wurlies' and is not keen on seeing any beyond the workshop door, so I find it advisable to use several screens to prevent chips etc. from shooting out over the floor and finding their way into the soles of my shoes.

When I first got the screens, I fastened them to the top or sides

of the cast-iron head, but because the surface is not uniformly smooth, the grip is unreliable. The left-hand one therefore sits on the smooth surface of the tubular swinging arm (see photo 21), while the right-hand one can be mounted with its first link facing either upwards or outwards on the machined face of a rectangular piece of 10mm thick steel screwed to the side of the head (see (B) in photo 20).

The concertina bellows are also an addition, and are the ones suggested on the Arc website. When they arrived, I could not see any way of fitting them to the column dovetails apart from taking off the head so that the bellows could slide down the column. Feeling rather stupid I checked with the supplier and they confirmed that they knew no other way. I was not keen to remove the head, so I cut away just enough of the card-like material at each end and forced the bellows onto the column, securing them at top and bottom with lightweight brackets. Happily, they have worked well ever since.

Finally, I want to thank my REMAP friend Jim for something small but invaluable. Jim got his SX3 after trying mine, and later made both of us one of the little stainless steel T shaped item shown in the lower part of **photo 22**: it is perfect for cleaning out the table slots, and every SX3 owner should have one. ■



Ring and T-piece

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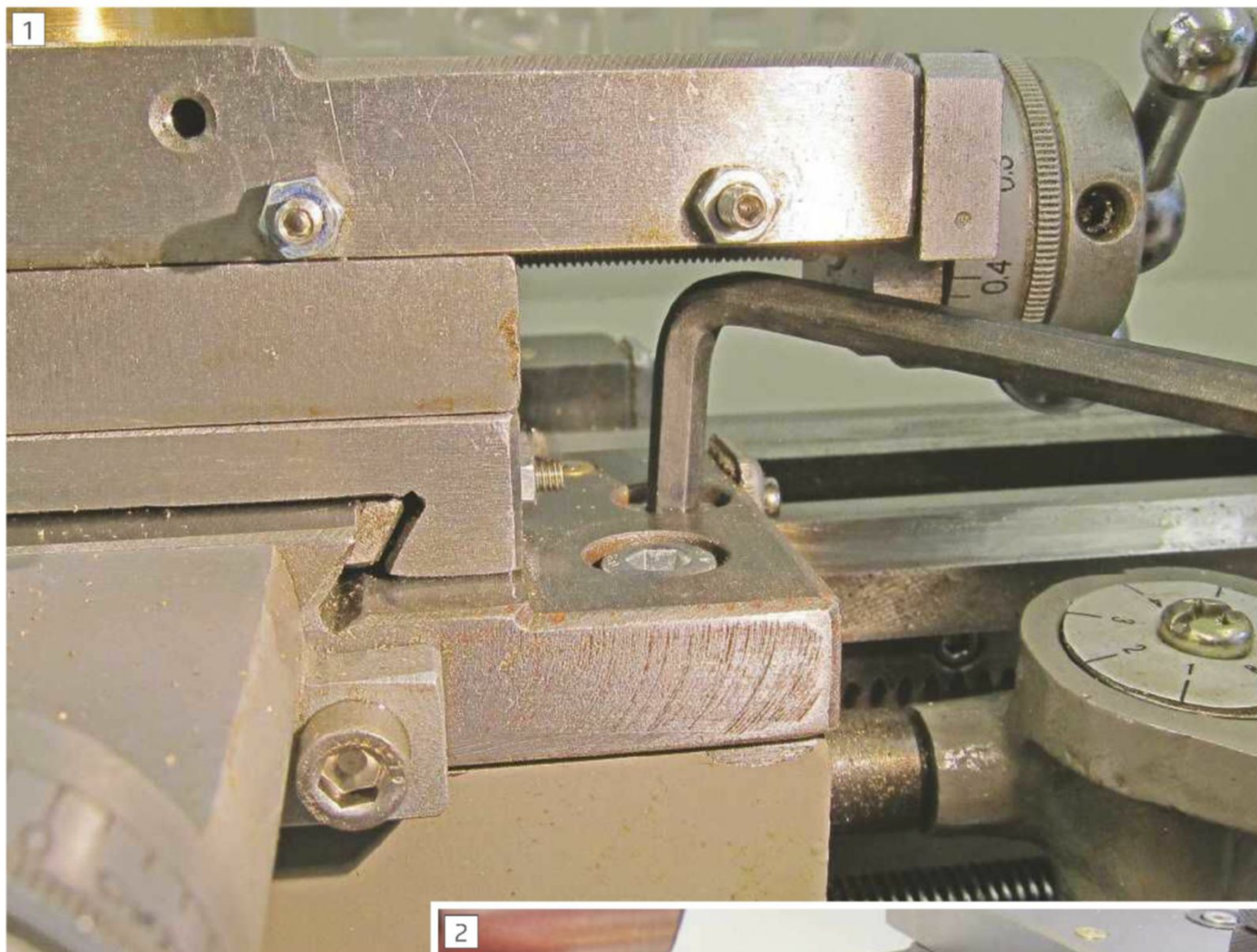


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An Improved Carriage Lock



Existing carriage lock screw.

Chris Taylor suggests and improvement to improve carriage locking that can be adapted to several similar lathes

Since acquiring my Chester DB7V8 lathe, I've made quite a few modifications, improvements and adjustments to it, but one I find most useful is an improved carriage lock. There is an existing facility to lock the carriage, but the screw is located in a very awkward place below the top slide and works on one side of the bed, **photo 1**.

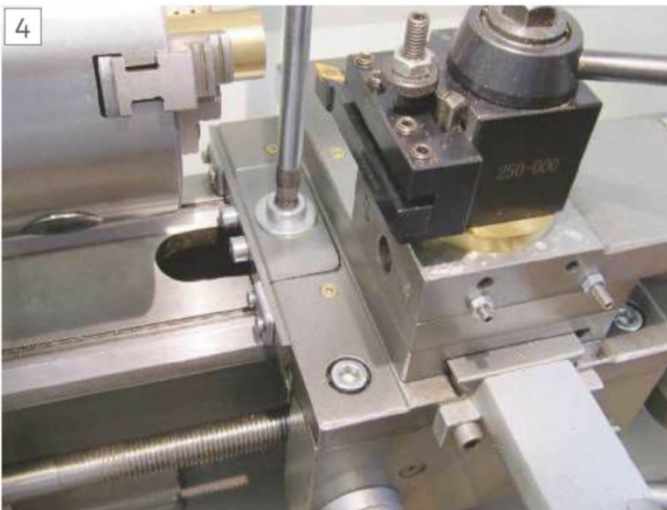
I had previously fitted a flat bar across



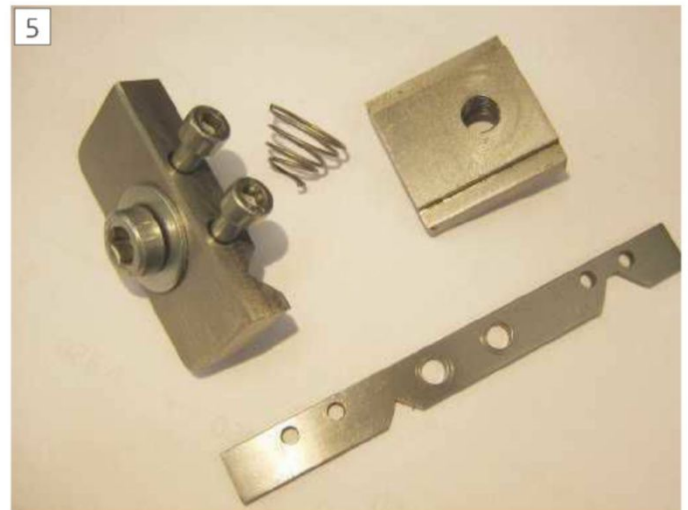
Tapped holes for steady, cross bar and depth stop.



The completed arrangement.



Locking the carriage.



The components.

the cut-out at the front of the carriage, screwed into existing tappings, to catch my new depth stop, which otherwise landed on the edge of the felt wiper covers, **photo 2**, and I realised that the two existing tapped holes in the carriage for the travelling steady could be utilised for something else.

I machined and filed a block of 1/2" mild steel to fit the gap and drilled it to receive

longer bolts, then machined another block to fit below the bed secured by an M10 bolt, spring-loaded to keep it clear when loosened, (I could have used the casting supplied with the steady, but it was a bit rough). **Photograph 3** shows the completed arrangement.

If I need to turn a large diameter piece, I can remove the setup in a couple of minutes, no modifications to the lathe are

involved, it's very rigid and it's easy and convenient to lock and unlock with a long handled ball-ended hex key, **photo 4**. The components are shown on **photo 5**. ■

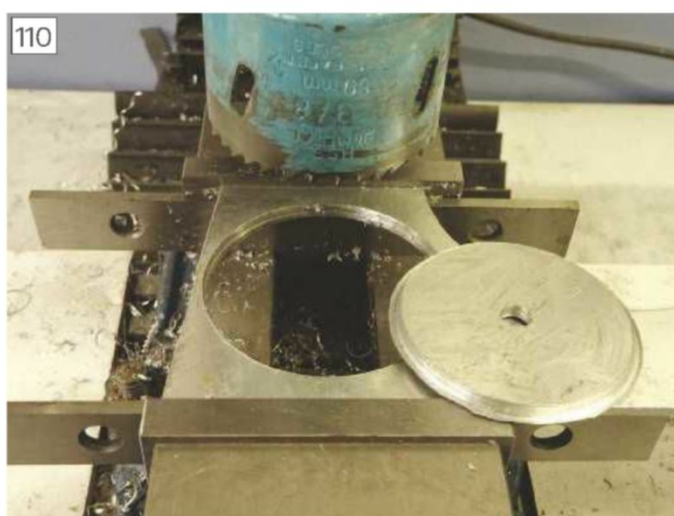
Milling for Beginners



PART 10 - LARGER HOLES AND USE OF BORING HEADS

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This month Jason Ballamy looks into even larger holes as well as finding other uses for a boring head



Hole saw in use



Cope cutting end of pipe with hole saw

Hole Saws

When a larger hole is needed particularly in thin sheet material where accuracy of diameter and surface finish is not too critical then a hole saw is ideal for the job. They are usually "bi-metal" which means a ring with high speed steel teeth is joined to the mild steel cylindrical body with a thicker top disk that is threaded to fit an arbor, larger diameter cutters over about 30mm will also have two drive holes in this disc that engage with retractable pins on the arbor. There is also a through hole in the arbor to take a pilot drill that is retained by

a grub screw in a cross drilled hole.

Speeds should be based on the diameter of the saw, but you may have to run above this as the smaller mills can lack torque at the very slow speeds needed for the large saws. Use a suitable cutting lubricant and withdraw the saw often as there is not a lot of room for swarf to escape once the saw cut is deeper than the gullet between the teeth, **photo 110**.

If your interests lay more with hobbies that need round tubular fabrications rather than model engineering a hole saw can also be used to produce a cope cut when joining

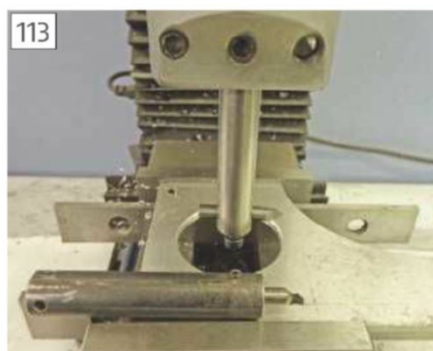
two tubes as shown in **photo 111**. Angled copes can also be produced simply by mounting the work at an angle or if you mill has the facility to tilt the head that will also produce a similar cut.

Boring Heads

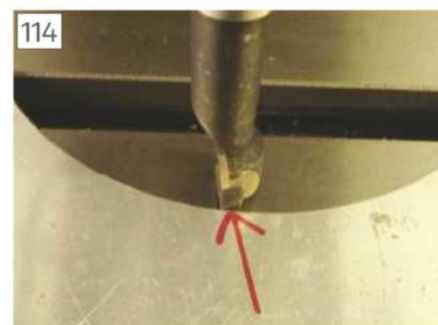
A boring head is the best choice where there is a need for a more accurately sized hole and/or a deeper hole as the finished diameter can be finely adjusted and depending on the cutting tool and travel of the machine then much deeper holes are possible than with a hole saw.



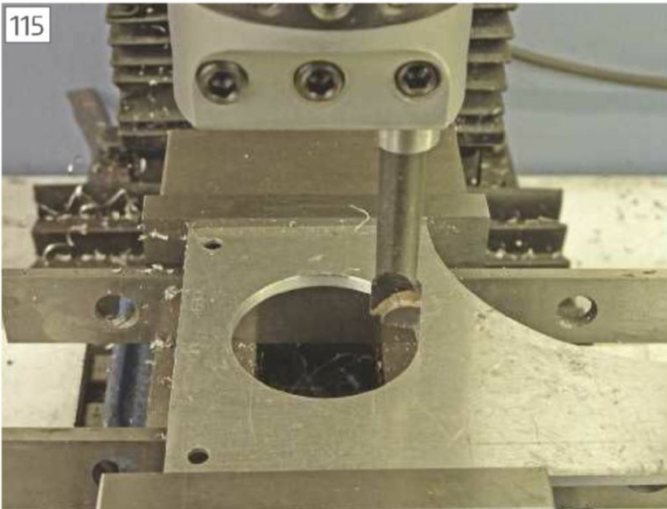
HSS, Brazed and Insert Boring head tools



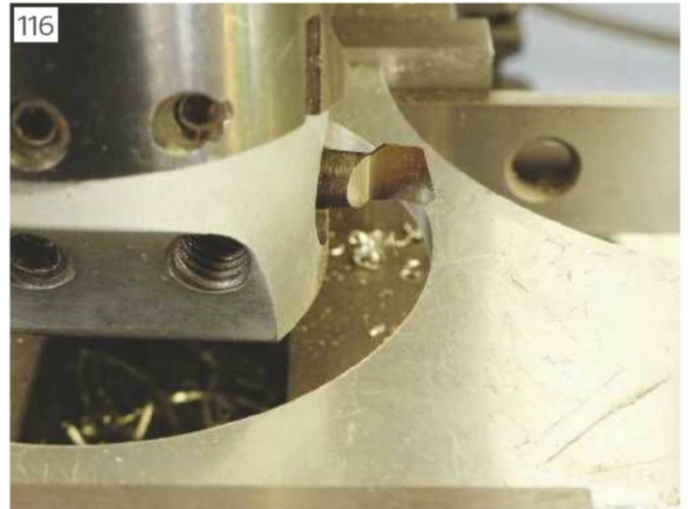
Home made tool bit holders



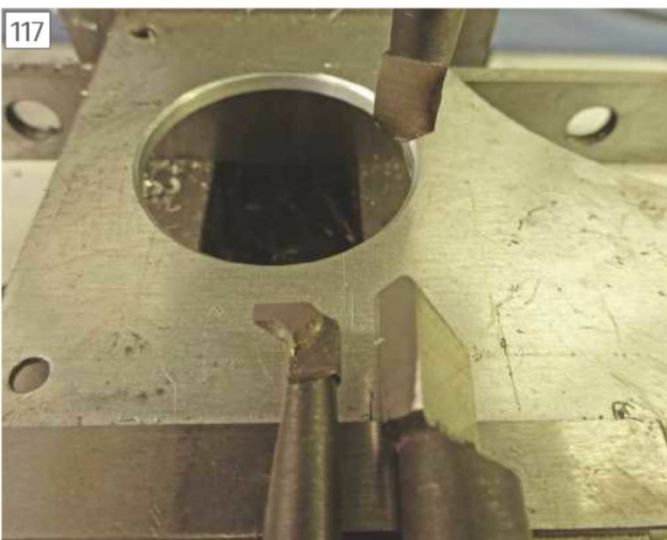
Ensure back of tool has clearance where arrowed



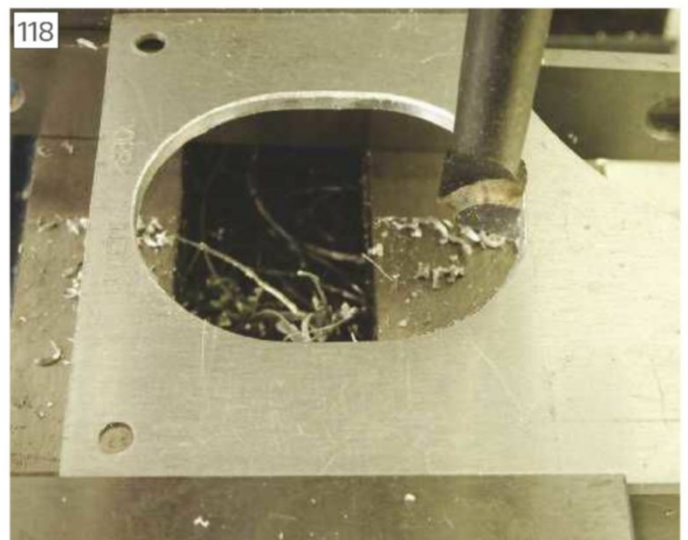
Typical bored hole



Tool held in horizontal hole for larger diameter work



Chamfer tool in use



Machining a slot with the boring head

Most boring heads tend to be supplied with some cutters possibly HSS but more likely brazed carbide tipped ones. At the very least these will require a quick touch up with a diamond slip before use but may also need some grinding if the supplied shapes don't suit the job in hand and in the case of the brazed tips will need a green grit or diamond wheel on your grinder.

Photograph 112, from left, shows HSS, brazed and indexable cutting tools with the later having the advantage that the position of the tool is easier to set as the flat where the grub screw that retains the cutter bears will ensure that the tip is presented at the correct angle to the surface being cut which can be a bit fiddly to get right at first with the ground tools.

It is also possible to buy or easily make your own tool holders that take pieces of tool steel, they simply consist of a suitable diameter bar to fit the holes in the boring head that is drilled and reamed to take a round tool bit and cross drilled for a retaining grub screw. These holders are generally stiffer than the ones shown previously due to their constant thickness and can be used for undercuts or profiled cuts with the added bonus that the bits

are quicker to grind being relatively small. **Photograph 113** shows two such tool holders one for use in the vertical holes the

other for large holes using the horizontal hole in the head.

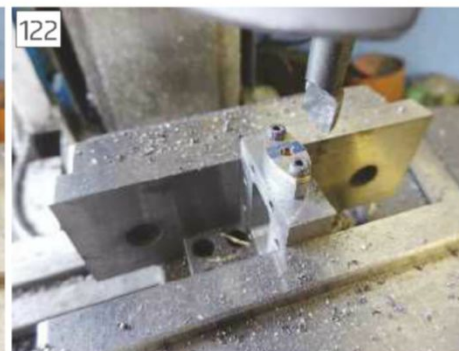
In use a suitably sized tool is mounted in



Machining a concave surface



Shaping an oval boss with an external cuts



the most appropriate hole in the head to avoid having the dovetail slide extended too far and rotated so that the rear of the tool does not rub on the edge of the pilot hole, this is less of an issue as the hole diameter increases but can need additional clearance grinding off the tool when boring small holes, **photograph 114**. Speed should again be based on the diameter of the cut but you may well have to reduce that as the head can become unbalanced as it is adjusted further out and/or a large tool is mounted off to the side. It is then just a matter of feeding the head down into the hole to make a cut, retracting and stopping the machine, you can then wind on the next cut using the scale on the heads adjusting screw and carry on like that until the desired diameter is reached, **photo 115**. Where the hole exceeds the diameter of the head a more rigid setup can be had by mounting the tool in the heads horizontal through hole as that keeps the tool overhang as small as possible while keeping as much of the dovetail engaged as the whole of the boring head can be fed into the hole, **photo 116**.

Although the resulting holes can be cleaned up with a deburring tool after cutting sometimes a nicer job can be had if the hole is finished with a small chamfer much like you would just touch the edge of a smaller hole with a countersink bit. This can be done with a suitably ground tool that can be put into the boring head while the work is still setup. **photo 117** shows such a tool being used that will work in both vertical and horizontal orientations and also do external corners along with ones for grooving and producing a rounded fillet. A similar chamfer can be added to the exit side of a hole by using one of the round bars with a tool bit suitably ground to cut the 45-degree angle.

Use of a boring head does not need to be restricted to just making round holes. Large oval slots are easily produced by moving the work along in increments and making a series of plunge cuts once the desired end radius has been reached. Although when magnified the "straight" sides of the slot will be a series of scallops in practice they are straight enough for most things provided the work is moved in small enough increments and the effect

Safety

A boring head can become quite out of balance due to the offset mass so make sure you select a low speed or turn the variable speed right down before turning on to avoid excess vibrations if it is run too fast. Although this may not affect the cut it can be quite distracting when tools and other items start to fall off the bench and shelves!

Also take care to keep away from the moving parts which can be impossible to see at speed, make use of any chuck or other guards that may be fitted to the machine. Make sure that everything has come to a stop before reaching in with a key to wind on the next cut.

becomes less as the diameter increases, **photo 118**.

They can also be used to form a concave surface on a part such as the underside of a chimney saddle or as shown in **photo 119** a cope cut on a block of brass that will form the valve block on a fabricated steam cylinder. To set the radius of a cut like this first use an edge finder to locate the flat uncut edge and zero the hand wheel or DRO when the spindle is above the edge. Then move away by the desired radius, you can now adjust the head so the cutting tool just kisses the flat surface by slowly increasing the setting while swinging the cutter back and forth by hand at which point the head can be locked at that setting. It is then just a matter of put on

the cuts by advancing the work towards the spindle until the whole surface is being swept by the tool.

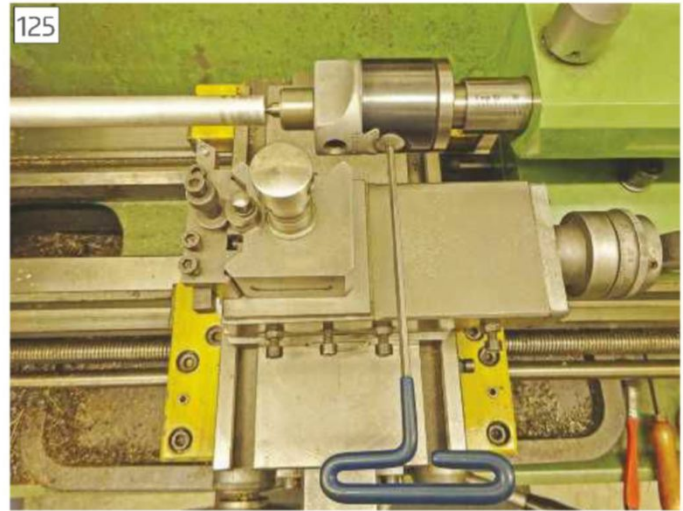
With a suitably ground tool it is also possible to cut externally with the head to form a round or convex feature on a part that may not fit on the lathe. It is better to grind a tool and keep the usual clockwise rotation of the head rather than try and make do with a supplied tool and run in reverse as a lot of boring heads screw onto their tapered shanks and you run the risk of having the head come loose by running backwards. **Photos 120 to 122** show a boss and gland being shaped in this way, firstly reducing the diameter of the boss to match the diameter of the gland. Then while swinging a larger diameter moving to



Alternative MT3 and R8 Arbors



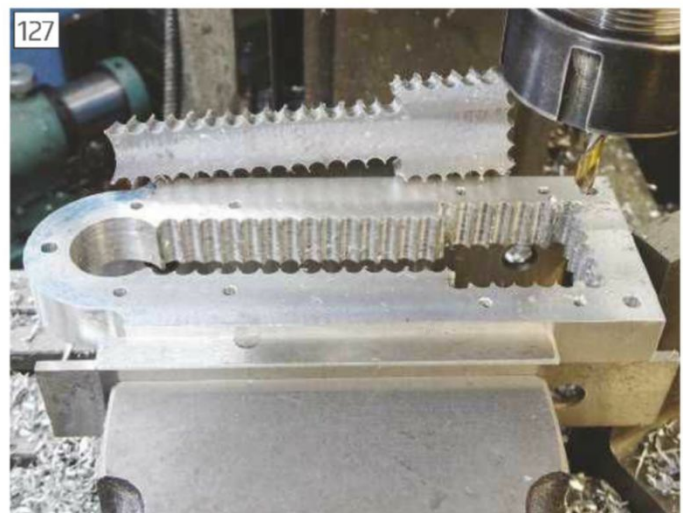
Using the boring head in the lathe



Boring head used to offset tailstock support



Stitch drilling out circular waste



Stitch drilling waste with straight runs of holes

one side followed by the other to machine the two sides. The final step is to blend the four curved faces with a file to form a small radius at the ends

Without drifting too far into lathe work there will come a time when a part may be too tall to fit on the mill and allow enough room for a boring head and bar to fit above. If your mill has a different taper to your lathe, then it is worth checking if additional arbors are available for your chosen head at the time of purchase so that it can be used in either machine.

Photograph 123 shows both MT3 and R8 arbors that fit a common head and **photo 124** shows it in use with the work set up on the lathe's tee slotted cross slide.

The other thing that it can be used for on a lathe is as a means of offsetting the tailstock support for taper turning which avoids the need to disturb the tailstock that may have taken some time to adjust to ensure work between centres is parallel. The head can be inserted into the tailstock with the dovetails set horizontal and a small parallel shank centre placed in its middle hole. You can then easily and accurately adjust the offset by turning the heads feed screw with a key which is far easier than moving the tailstock sideways

or using an offset centre which has no fine adjustment facility **photo 125**.

Stitch Drilling

Before a hole can be cut with a boring head a clearance hole will be needed, if under 25mm then these can be drilled with reduced shank "blacksmiths" drills or step drills if working on thinner material. Once you get over 25mm a hole saw can be used on thin work if you have one, if not or when the work becomes thicker the process known as "stitch drilling" can be used to remove most of the waste material without having to convert it all to swarf. It consists of drilling a series of small holes typically 5-6mm diameter that just touch each other so that one hole just breaks into the edge of the one before. If done right the waste disc left in the middle should just drop out though it often needs a quick tap with a copper mallet.

If you have access to Cad and a DRO it is a simple matter of working out how many holes of your chosen size will form a complete ring inside the finished hole with about 1.0mm clear to the finished diameter. This can then be entered into the dro and the co-ordinates used to position each hole which if drilled with a stub length split

point drill won't require spot drilling first. If you don't have a DRO then use dividers to mark a circle the radius of your drill bit plus 1.0mm inside the finished holes edge and then set the dividers to the drill diameter and step off around the line, punch the intersections of the marks and drill **photo 126**.

Stitch drilling can also be used for removing waste with straight edges, for simplicity use a drill bit whose diameter can easily be divided by the pitch of the mills lead screws so something like a 5mm drill for a 2mm pitch leadscrew or 1/4" for a 10tpi one and it is just a matter of feeding 2 1/2 turns of the hand wheel to space each hole **photo 127**. ■

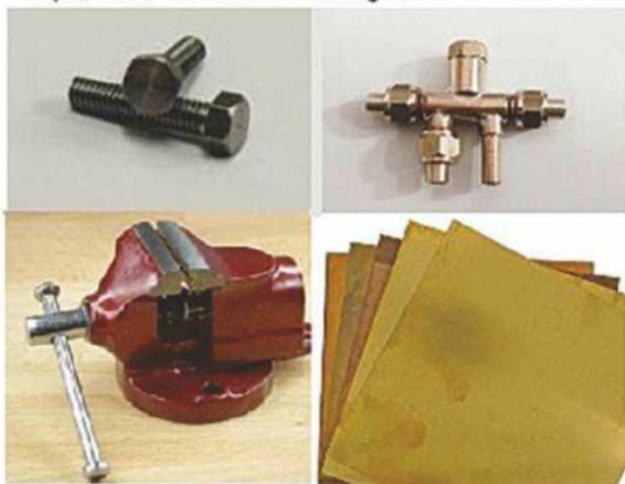
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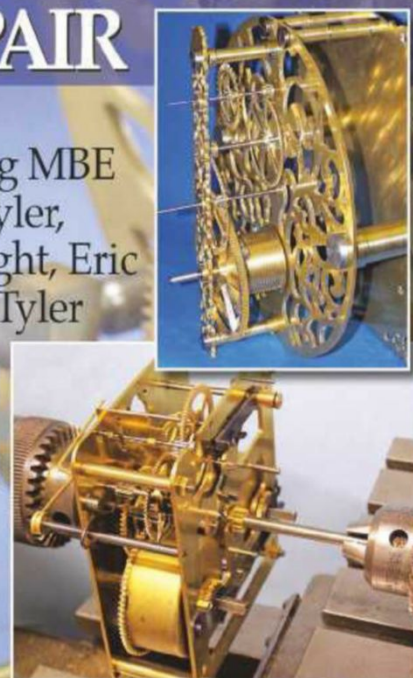
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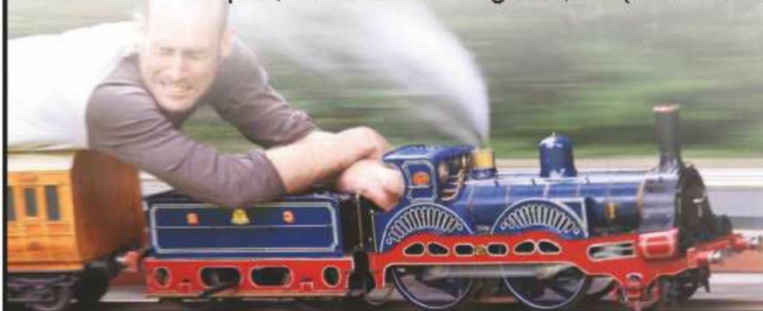
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Readers' Tips



A Handle Extension

TIP OF
THE MONTH
WINNER!



This month our lucky winner of £30 in Chester gift vouchers is Ian Strickland, who has an idea for anyone struggling to cope with a larger machine.

Herewith two photos of an adaption I made some years ago for my milling machine of which featured in articles back in 2015 on how I restored and improved my old Trident Mill. Attached is a photo to jog your memory. You may remember I displayed it at the MEX at Sandown Park.

The subject of this email is a removable handle extension for the X axis. Its is 4.5" long and reduces the effort need to turn the hand wheel, which is especially important as my muscles are not as strong as they used to be when I was much younger! I'm now 75 going on 76. Also fitting power feed is not practical for me.

The handle comprises a bent arm offsetting the handle enough so that one's hand doesn't clip the fixed handle. The boss is silver soldered on, and in use it slips over the end of the feed screw shaft. The wooden handle is a file handle.

I made a longer one 6.5" long for the Y axis. They are interchangeable.



Ian Strickland

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Make a Beam Compass



Stewart Hart gives a step by step guide to making this tool for marking out larger jobs



The trammel



Turning the pencil holder

Beam Compass or as we use to call them Trammels, but I think Beam Compass is a better description – as the man said it does exactly what it says on the tin. You may be wondering what use this old fashion drawing and marking out instrument is in this modern age of Computers. Well the answer to that is quite simple; in order to model the valve gear of the 5" gauge loco I'm building I need to draw large arcs. My lap top is just too small to be able to see what's going on at the intersections, and my pension just doesn't run to buying a large monitor:

so it's good old pen and paper to the rescue, **photo 1**.

I have a set of old second hand set drawing instruments but to be honest they are far from being accurate enough for the job in hand, what I wanted was something that will be robust enough to draw an accurate 12" radius without wobbling about and losing accuracy. The design I came up with is based around a 5/16" (8mm) Hexagon beam, I chose a hexagon beam because it will have a readymade flat down it length for clamping the pointers to, see **fig. 1** for all

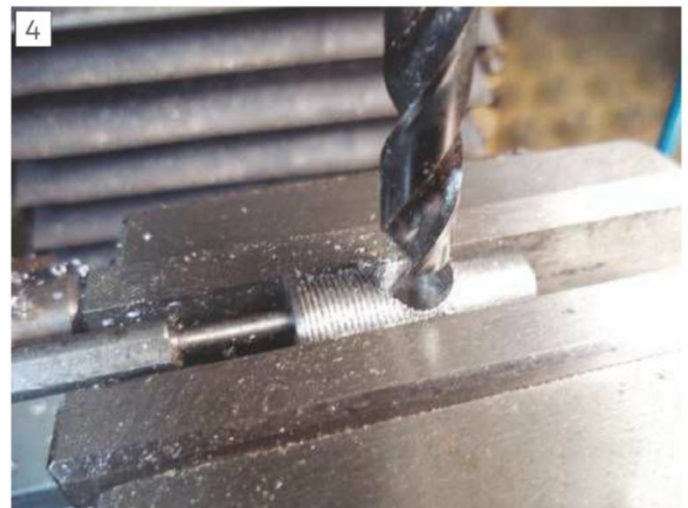
parts.

I made my Compass from aluminium but brass or steel will do just as well, in fact I can remember the marking out table in our heavy machining department having a Trammel with a hardwood beam.

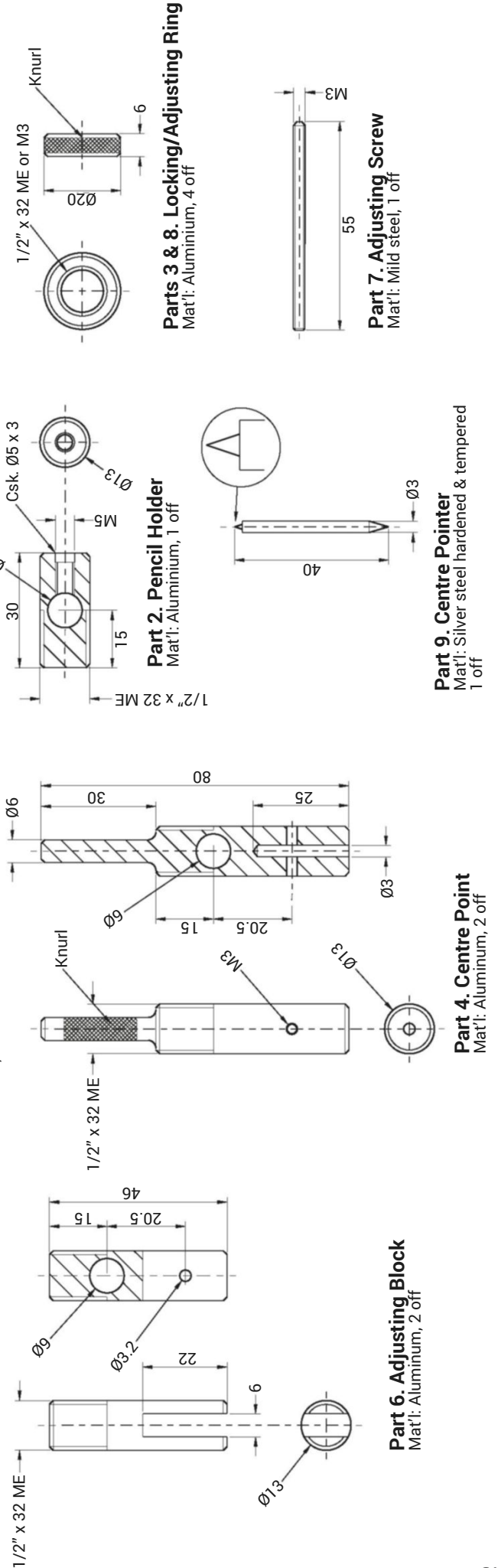
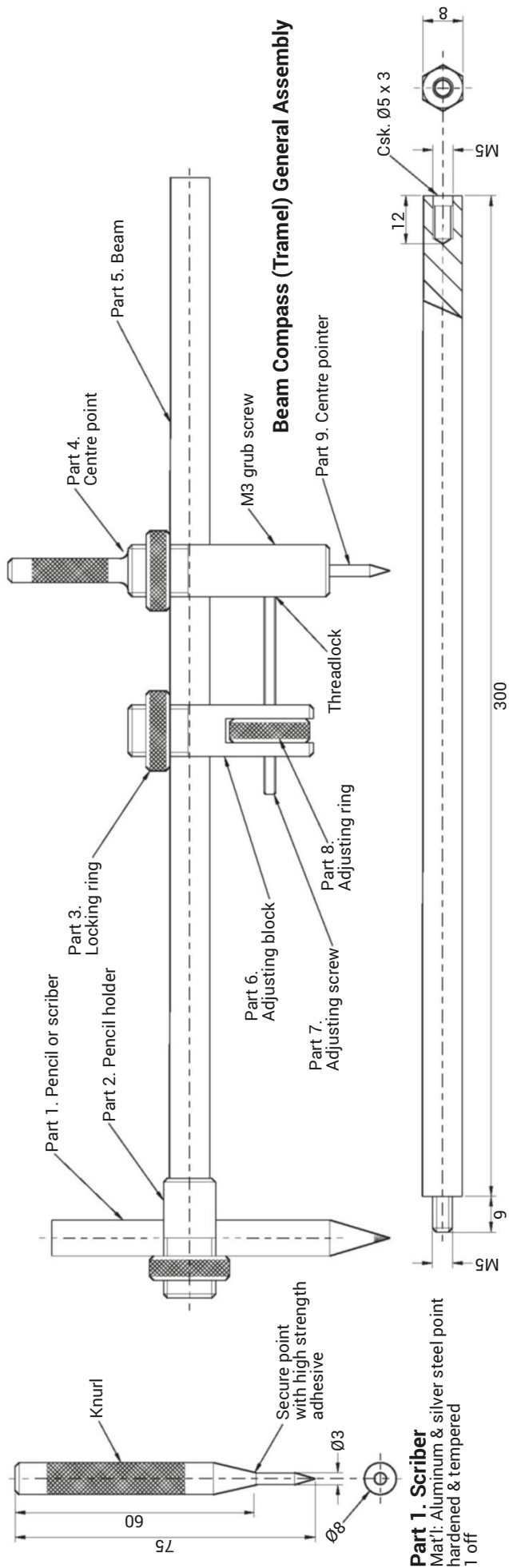
As I was waiting for the delivery of the hexagon bar I made a start on **part 2**, the pencil holder this was made from 1/2" aluminium. Face the bar off and thread 1/2" by 32 ME for a length of 15mm, part off and face to length and drill and tap M5 and add a nice deep 5mm countersink so that the beam will screw up against the



Ream the bore

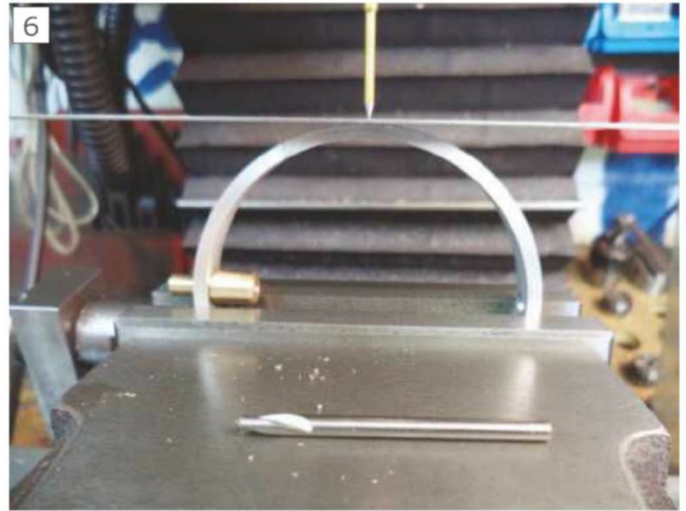


Cross drill





Knurling



Finding the centre of a large radius



Preparing slot by drilling



Mill or file to finish the slot

face. Then over onto the drill and on the centre line drill through 9mm diameter, **photos 2, 3 and 4.**

Part 4 the centre point is made of the same $\frac{1}{2}$ " bar, centre drill and using a running steady turn down to 6mm for a length of 30mm and give it a medium knurl. If you don't have a knurling tool it won't harm omit the knurl. Part off and face to length, centre drill and drill 3mm by 25mm deep. Onto the drill and drill the 9mm cross hole and without removing from the vice, drill and tap the M3 cross hole, **photo 5.**

Here's a little trick you may not have seen before, for finding the centre of a bar. All you have to do is balance a steel rule on the bar and trap it down with a point and adjust until it looks level to the Mk1 eyeball, you'd be amazed at how accurate this method is, **photo 6.**

Adjusting block, **part 6**, this is similar to the first two parts so you should be getting good at them by now, Face and thread $\frac{1}{2}$ " by 32 ME part off, face to length and drill the two cross holes. To cut the 6mm slot so that it is correctly aligned with the cross holes all you have to do is pass a piece of bar through one of the cross holes and rest it across the

vice jaws. You can level it up by eye as that isn't too critical. On the centre line, put in a number of evenly spaced centre drills then follow these up with a 5mm

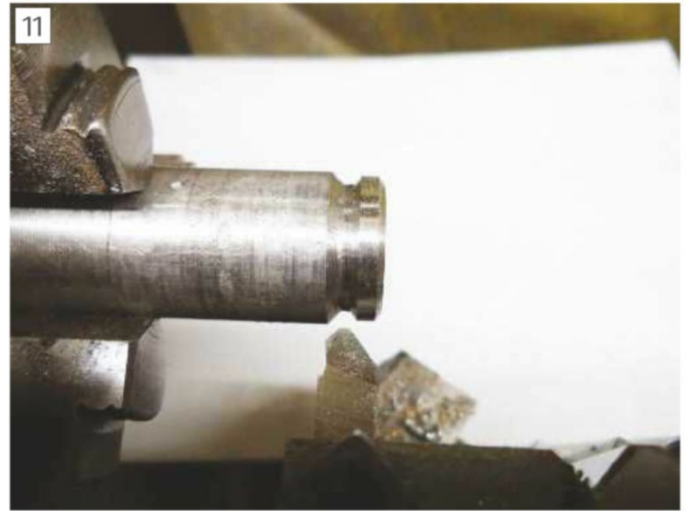
drill and finish off with a 6mm slot drill, if you don't have the luxury of a mill, you can simply drill through and then with an hacksaw and files cut the slot out, it's not



Milling finger grips



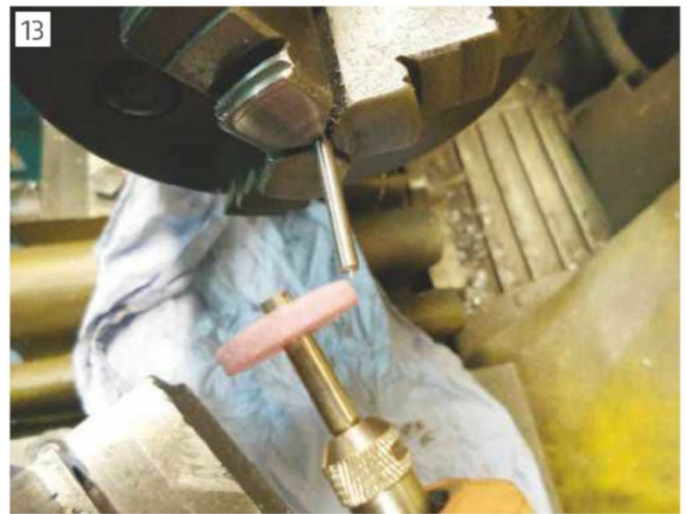
Parting to length



Chamfering both sides of a parting groove



Threading M5



Grinding end taper using rotary tool

too fussy, **photos 7 and 8.**

I made the locking rings, **part 3**, and the adjusting ring, **part 8**, from 1" diameter aluminium turned down to

22mm diameter for length of at least 40mm to make all four rings and knurled along this length. Instead of knurling I decided to mill twelve finger grips along

the length of the bar with a 1/4" bull nosed slot drill using the spin indexer. Load the bar back into the lathe, drill and tap the smaller M3 hole for the adjusting ring first, add some neat chamfers and part off to length. Then drill and tap the locking rings 1/2" by 32ME, chamfer and part off to length **photos 9 and 10.**

Here's another little trick for putting the chamfers on the rings, make yourself a form tool, use it to chamfer the front, then before you part off chamfer the back, and at the same time you will be chamfering the front of the next ring, this way you won't have the problem of trying to chuck the thin part for chamfering the back, **photo 11.**

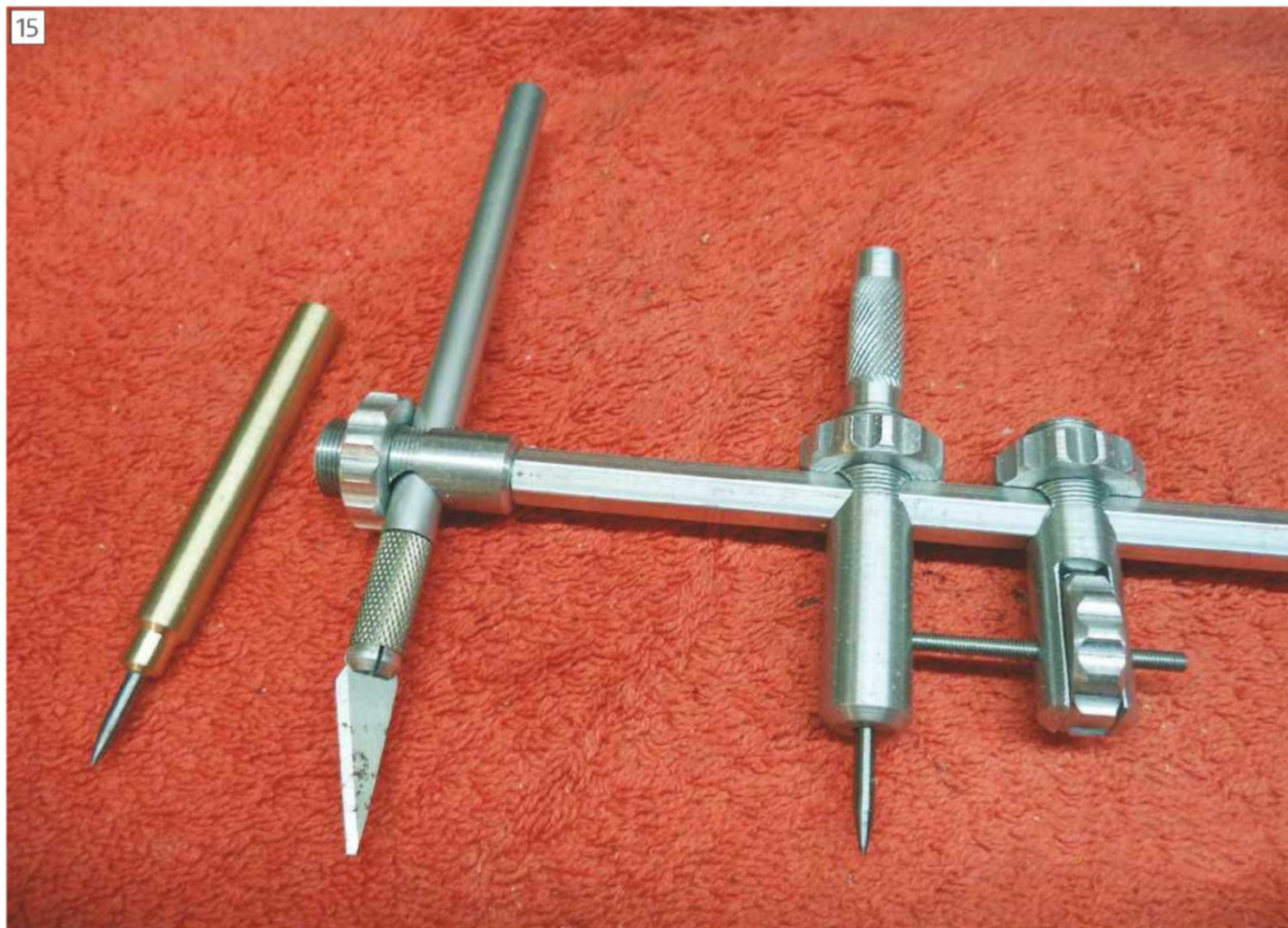
Beam, **part 5.** You can make the beams any length, I made mine 300mm, screwed together I can draw 1M diameter circles, I doubt very much if I'll ever need to draw a circle that size. All you have to do is turn and thread one end M5 and drill and tap the other M5 the second beam only needs the male thread, **photo 12.**

Part 9 is the centre pointer, made from 3mm silver steel hardened and tempered. Grind the points by spinning in the lathe and using a hand held "Dremel". I've drawn two different types of points the tapered point is for use on metal parts, the small



Scriber

15



Scalpel fitted to trammel

16



The finished 'business end'

17



The box

stepped point is for use on paper, **photo 13**.

An ordinary pencil can be used on paper, for metal you'll need a scribe **Part 1**, I made mine from a short length of 9mm diameter brass, simple drill down the centre 3mm and fix the hardened and tempered silver steel point with high strength Loctite. Again, sharpen the point with a "Dremel", **photo 14**.

The trammel can also be used for cutting out circular gaskets by replacing the scribe with a scalpel, **photo 15**.

Adjusting screw, **part 7**, is just a length of mild steel M3 studding held in place with thread lock and the centre pointer is held in place with an M3 grub screw, you may have to ease the slot out a bit to enable the adjusting ring to turn smoothly. That's more or less it, job done, only one thing is missing - a nice little instrument like this is deserving a Box. Nothing too complicated just glue and screwed, **photos 16 and 17**.

When you're working on a long term

project like a locomotive, you do get fed up working on the same thing, with the end a long way away, so it's nice to get distracted from time to time with a little project like this, with the excuse that it is contributing to the long term objective. I've certainly enjoyed designing and making this trammel and I'm hoping that you will find it of use, it's a project I would definitely recommend for a beginner to gain experience, as it's got lots of basic turning, threading, drilling and hand work. ■

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A Collet Collective



Bob Reeve decided to rationalise his collect addiction – and failed!

My first collets were by Myford for my lathe of the day, an ML7. They were never used a lot and went when I sold the Myford at least four decades ago. So how had it come about that I now seemed surrounded by collets? Lots and lots of collets, but where had they all come from? Were they all necessary and was I making best use of them? Could I possibly need any more? Not yet the stuff of nightmares, with serried ranks of clanking collets marching across my dreamscape. But it was heading that way. Time to take stock, rationalise where possible and have some sort of strategy as to when and where I needed collets.

Looking back, the acquisition of new machine tools seemed to have a strong influence on the rise of the collet empire. The Myford was replaced by a Colchester Bantam which was not new and came with a fairly comprehensive set of imperial 3C collets manufactured by Crawford Collets, **photo 1**. The bottom four rows are the original imperial collets up to $\frac{3}{4}$ " diameter and the next row up are four metric collets acquired later. The top row are not collets, but die-holders for a tailstock tapping attachment. They just happen to live there!

Photograph 2 shows an individual 3C collet and its closing sleeve which has a 4MT external taper. Note the anti-rotation slot in the collet which engages with a small key inside the sleeve.

I got on better with the 3C collets: no nose piece to fiddle with and a hollow drawbar for long workpieces, plus an oversized hand wheel to pull up the collet without needing a spanner. A transmission brake held the spindle stationary while tightening was in progress.

When the Colchester began to show signs of its age it was replaced by a Harrison M300. Fortunately, I had realised that, since both of these were made by companies that were part of the 600 Group, there was a good chance that accessories would transfer from one to the other with minimal alteration, so I retained the collets and draw bar, which turned out to be a very fortuitous decision. The modifications required were minimal. A spacing washer and an open ended 5 to 4MT sleeve to take the 3C closer. At the time I couldn't buy the sleeve and made one by cutting the tang off a closed sleeve with an abrasive wheel. **Photograph 3** shows the completed set with a 3C collet screwed into the end of the hollow drawbar.

In the meantime, I had acquired a venerable Pallas milling machine, with no collets, which was dully replaced by a Thiel



3C Collets



3C collet & closer



Drawbar, collet & 5MT sleeve

Duplex which seemed to require more than its fair share of collets. The Thiel is a twin spindle machine with short 5MT bores and a series of adaptors for other Morse tapers, **photo 4**. Each adaptor has a captive Whitworth drawbar which, if unscrewed, will eject the tooling.

With this miller came a set of Imperial collets in both 3 and 4MT sizes, **photo 5**.



Thiel 4MT adaptor

Note that the sizes covered by the two sets do not overlap.

To further complicate matters, at the time, the UK was going metric. While I did my best to resist the change, my previously imperial equipment began to be infiltrated by metric newcomers. By the time I had converted a Sieg X3 to CNC, it was clear that metric movement was gathering momentum and



Thiel 3 & 4MT collet set.



Metric & Imperial 2MT collets.



X3 Metric collets



Quorn collets

might prevail. My defence of an imperial workshop might yet prove to be untenable. So, since the X3 had metric ballscrews and a MT3 spindle, I went off to buy some metric MT3 collets, **photo 6**. I considered it a bonus that I was able to obtain them with Whitworth drawbar threads for compatibility with the Thiel.

Further breaches in the imperial defences were inflicted by my rotary tables. One for the Thiel and a CNC one for the X3. They both had 2MT bores and I had no 2MT collets! Since the battle between imperial and metric was still indecisive, I bought both! **Photograph 7** shows the result (all with imperial drawbar threads). The components

near the hinges are fittings for the rotary tables.

Readers with an accounting disposition might have counted around 60 collets by now, but there are more. **Photograph 8** shows the collets I made for the Quorn tool and cutter grinder at home in their storage case. **Photograph 9** includes an assortment of collets made to fit a boring head and boring bars to George Thomas' designs, thus taking the score to the mid 70s. If pushed, I could undoubtedly find some more; those holding the cutters for my slotting head and boring heads come to mind, plus a few more for grinding spindles and routers.

Having taken stock, I now needed to

review, when and where the collets were used. Perhaps being a little more critical as to whether they were the best choice for that particular application.

I had more Morse taper collets than any other type. A review of their relevant characteristics seemed a good place to start:

- Readily available in sizes 2-4MT and occasionally in MT1 with imperial or metric bore sizes, but I have yet to find or need an MT5 collet.
- They are not expensive especially if purchased in sets. However, there are gaps in many sets that are difficult to fill as I found out when I needed a 7mm collet, see later.
- MT collets usually have internal threads which are unlikely to be a problem when holding cutters but could prevent longer workpieces passing through the collet.
- The drawbar threads are usually available in imperial (Whit and Unified) and metric but the coverage is not complete.
- If an MT collet is used for cutters, then the tool overhang is likely to be minimised.
- They are inherently well balanced when used with end mills and the like. As the high spindle speeds needed for carbide tooling become available on hobby machines, this is becoming increasingly important.
- They are usually single bore size collets i.e. not intended to grip items of different sizes even only slightly different from the specified nominal size.
- They do not always grip well for some low speed, high torque operations such as tapping large diameter threads.
- Morse tapers are locking tapers and sometimes require considerable force to separate them. Impact loads such as a hammer blow may damage spindle bearings. Beware tightening a cold MT



Boring bar & Boring head collets



3MT toolholders



3MT toolholder with ER11 collets

- collet &/or tool into a hot spindle.
 - Because of the shallow taper, there is considerable drawback when the collet is tightened.
 - Tool height cannot easily be pre-set for CNC machines.
 - They lack an anti-rotation feature, so binding drawbar threads can sometimes be troublesome.
- By way of a comparison, the non-Morse taper collets with larger angle tapers such as 3C and 5C:
- Do not suffer as much from the locking problem.
 - Have external or both internal and external threads and so can be used with long workpieces.
 - Have comparable size ranges e.g. 4MT and 5C will accept 1" or 25mm diameter
 - Vary in price greatly, with a used obsolete 3C costing about four times that of a new 5C.
 - Have an anti-rotation slot which can sometimes be useful.

I should perhaps mention the R8 was the collet, used in Bridgeport and similar machines. These sit somewhere between 5C and MT. In retrospect these might have been a better choice for the X3 but would have lacked interchangeability with other machines.

I don't pretend that my review has been exhaustive, but so my thinking so far is:

1. If the machine tool or attachment has a Morse taper spindle, use it with collets. Try



New 4MT metric collets



Collet and carbide tool with 20mm shank

to avoid chucks that fit into the spindle taper and need yet more collets to make them work e.g. Autolock chucks (but see below).

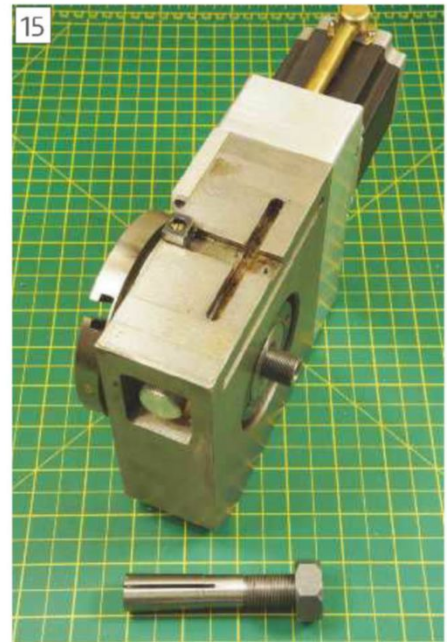
2. If it is required to grip a wide range of sizes, as in the case of twist drills, then avoid single size collets and use collets which accommodate a range of sizes (usually double tapers).

3. Standardise on drawbar threads and the drawbar itself as far as possible.

4. Where there is a large Morse taper bore in a spindle, ensure there are open ended adaptors available that will take the smaller



Thiel 4MT adaptor with alternative drawbars



CNC rotary table with 7mm collets

tapers and allow a drawbar to be used with the smaller collets.

5. An organised storage system is needed with each collet having its own location. A cardboard box full of collets would waste a lot of time, as would be a separate container for each collet-(see below).

I then considered each machine tool in turn to see how the above related to it. Starting with the X3, Morse taper collets were not ideal for holding tools in the spindle. I would use MT3 taper shank tool holders dedicated to a single size cutter i.e. no collets at all, **photo 10**.

For those not familiar with running a CNC milling machine I should point out that the number of tools needing a holder is considerable. The X3 is not fitted with an auto-toolchanger and my programs are relatively short, but I frequently have 6 tools in play. An industrial machine might have a carousel of 50 tools, and I did come across



M300 Drawbar & adaptors for 2-4MT collets



3C & (larger) 5C collets



Tempering the MT sleeve



Shortened 5MT sleeve in ring holder



Screw cutting the collet adaptor



Checking the thread



Machining the bore

one that had a tool magazine larger than a double garage. For the complex part that was being machined, the cycle time was measured in days. Just thinking about the cost of the tooling produced a nasty pain near my wallet

Secondly, again on the X3, there was the problem of coping with a huge number of drill sizes. A 5mm diameter drill could be mounted in a Morse taper collet or a taper shank tool holder or a conventional drill chuck on an MT shank. But, for example, the tapping size for an M5 thread is 4.2mm diameter. This is not a standard collet or taper shank size. A drill in a chuck would work but be expensive if there were many sizes. In addition, the tool overhang for a large drill might severely limit the workspace available beneath the tool.

To my chagrin, the solution for up to 6mm diameter was yet more collets. This time in the form of an ER 11 collet in a mini holder on an MT3 shank with a Jacobs taper to match the holder, **photo 11**. The Collet is slit from both ends giving it more flexibility. The 4mm diameter collet required in my example had a 1mm range so will hold 4 to 5mm diameter. However, this set up is really only for drilling and is not recommended for milling. The cost of the ER 11 combination with one collet has risen to around £30, so not an inexpensive solution, but versatile. There are of course a range of ER collet formats and a similar argument may apply to them all.

Toolholding in the Thiel is more straightforward. It can be a collet or the taper shank tool holders described above and there is no requirement for pre-set tool heights and drill chucks are perfectly acceptable. Consequently, all of the X3 tooling will fit the Thiel but not v.v. I have used an Autolock chuck on occasion, where the spindle was obstructed; but most of

the time it would be unnecessary and just takes up space. Most of the time, my Autolock chucks slumber peacefully in their cases.

At that point I had no capability to hold the larger metric cutters in the Thiel. The existing 4MT collets would hold up to 1" diameter shanks, but the 3MT metric collets mentioned earlier would only accommodate up to 18mm. An investment in MT4 metric collets was required, **photo 12**. I should perhaps point out that the demise of MT4 collets has been greatly exaggerated. Imperial, **ref. 1**, and metric sizes, **ref. 2**, are available, but possibly not from the UK (subject to the usual disclaimer).

However, the original Imperial collets had Whitworth drawbar threads, and I could only find metric collets with metric threads. The penalty for this was that I had to make a new metric captive drawbar for the Thiel.

Photograph 13 shows the Thiel 4MT adaptor dismantled to show its component parts with the new metric drawbar on the left and identifiable by the red dot on the end.

This gave access to the larger industrial cutters that occasionally come on the surplus market at knock down prices.

Photograph 14 shows a long reach, solid carbide cutter with 20mm shank alongside a 20mm MT4 collet. The cutter was mine for about £10. The price of such a cutter new would be about the same cost as my metric 4MT collet set.

For those wondering why such a cutter might be necessary, look at the control box I was machining in **ref. 3**. I wish this cutter had been available for that.

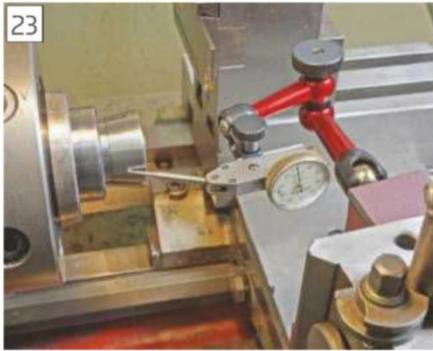
There was a slight complication when it came to the review of my rotary tables. The larger table for the Thiel can only be used horizontally and there is sufficient room underneath to get a drawbar in the back of a 2MT collet fitted to the centre

bore. The CNC rotary table however, could also be used vertically (i.e. axis horizontal).

Photograph 15 shows the table in this orientation together with some 7mm 2MT collets. Therein was the first problem, 7mm collets are not part of the usual standard set and are apparently made by the same company that makes hens teeth. They are very hard to find. When I did find one it was with a metric drawbar thread while, all of the others are imperial. Hence the red band to identify this deviant collet.

There was the additional problem that I needed to have a 7mm silver steel rod passing through the table to machine it. I therefore needed a collet with an external thread to be able to do this. Even the Hen's Teeth Co. could not help, so I had to make my own. One is shown mounted in the table and another is at the bottom with its matching drawnut. More collets!

Probably the greatest success from all this introspection came with an appraisal of the Harrison M300. I could not use any collets other than the obsolete 3Cs with it. With a little ingenuity, there were an awful lot of MT collets that could be utilised more. I started by buying some open ended MT sleeves. MT5 to MT3 was available (whereas when I looked previously MT5 to MT4 was not) and so was MT3 to MT2. That opened up the possibility of utilising collets from 2MT to 4 MT by making a few simple drawbar adaptors. **Photograph 16** shows collets from 4MT to 2 MT and a 3C collet, all with their respective adaptors above. Note that the deviant 2MT collet with a metric drawbar was accommodated by having interchangeable threaded rods (shown alongside). The new open ended MT sleeves are shown left of top centre. A new aluminium spacer necessary to compensate for the longer MT collets is shown below and right of the hand wheel.



Setting the taper



Drawbar adaptor & closer for 5C collet



5C collet assembled to drawbar



Concentricity test

The 3MT collet adaptor (second from right) is apparently more complex than the others. This was the first made and I was a little cautious about the exact length of the threaded coupling, so made it over-length and adjustable. It proved to be unnecessary and could now be shortened; if I ever get around to it.

This should have been the end of the story, but there was one thing still niggling me. That was the lone 5C collet shown right of a 3C collet in **photo 17**. It had been sitting at the back of my bench for well over a year. 5C collets are relatively inexpensive, typically less than £7 for a round one. I had bought a 1" diameter one in the hope of finding a way to replace the ridiculously expensive 3C collets and take advantage of the 5C's economy and greater range which includes square and hexagonal.

The first step was to search for a 5MT to 5C converter, but if such an animal exists, I could not find it. So the next option was to make one. I bought a used 5MT to 4MT adaptor for £2 from the very last ME exhibition at Harrogate and started work. These adaptors are hardened to around 60-65 Rc. and it was unlikely that I would be able to machine it even with carbide tooling. The first stage was to temper the tang to enable it to be sawn off. **Photograph 18** shows the tempering colours run just past the ejector slot. Some vigorous exercise with a hacksaw followed, then the shortened adaptor was mounted in a ring with a 5MT bore so that it could be held in a 4-jaw chuck.

At this stage, the metallurgical properties of the material to be machined were more than a bit uncertain. The original material specification was unknown and the subsequent heat treatment could have been through hardening or case hardening. Added to these uncertainties, tempering with a propane torch was nowhere near

as controlled as the temperature controlled, forced circulation tempering oven that a commercial heat treatment would have used.

However, all went well, and **photo 19** shows the machining in progress for the recess where the external drawbar will locate. Note the semi-circular pockets which were the remains of the ejector slot. The material was machineable, but much tougher than a mild steel and I was glad of the carbide tooling.

Before starting on the bore for the 5C collet I made an embryo drawbar in mild steel, which was easier to machine than the adaptor. Perhaps as well, because it required an internal 20 tpi. thread up to a shoulder, **photo 20**. Always one of the more exciting machining operations!

Note that the boring bar is held in an eccentric collet (G. H. Thomas design) and the boring bar has a central push rod clamping the tool bit. So, for those following the relevant thread on the ME website, the boring bar is in tension. The clip on the bar itself is a simple indicator to mark the depth of the thread required.

As the thread neared the correct size, the 5C collet could be screwed in as a check.

Photograph 21 was taken while the thread was still a little tight and needed another pass or two.

For the bore and taper of the adaptor to be machined the sleeve needed to be tempered as a separate operation. After the initial machining it was now a much more uniform cross section which assisted in achieving a uniform temper.

It was then fitted into the MT5 spindle of the Harrison and machined in position. The toughness of the material required a very stiff boring bar and a carbide tip.

Photograph 22 shows the boring operation in progress. I think that was the first occasion in this millennium that I had cause to use such a large boring bar. Even then, it required multiple passes to take all the spring out of the tool. Note the traces of engineers' blue in the bore where I had been checking for tight spots.

Once the 5C collet was a sliding fit in its bore, I could use the collet itself to set over the topside to the appropriate angle. For this operation it was important that the indicator stylus was exactly on the centre line, **photo 23**. With the angle set, boring the taper was straightforward.

The only operations remaining were to

part off the embryo drawbar and machine the external thread to fit in the original drawbar with its hand wheel.

As yet I have not implemented the small key to engage with the anti-rotation slot in the 5C collet. So far it has proved unnecessary but could still be fitted if needed.

The individual components can be seen in **photo 24** plus a 1" diameter silver steel bar that I had inserted through the 5C collet to check clearances. The drawbar with hand wheel is on the left

I should point out that, at this stage, neither the adaptor nor the hollow drawbar will take a long 1" diameter workpiece. It would be possible to make a larger diameter drawbar to accommodate such a workpiece, but so far it has not proved necessary. **Photograph 25** shows the same components loosely assembled.

Photograph 26 shows the final concentricity test. The results were not entirely consistent, but it was possible to get better than 0.0001" TIR at the collet and 6" from it. The worst case was about ten times the error (TIR 0.001"), but that was still better than my 3-jaw chuck.

In retrospect, my review has resulted in more collets rather than less. But this has been more than compensated for by gains in versatility.

I remain slightly surprised at the lack of availability for open-ended MT5 to 4 sleeves and of the MT5 to 5C adaptor. The Harrison M300 has been around for a while and there are a lot of them in hobby workshops. Have I been looking in the wrong place or have our usual suppliers missed a trick?

I am however, pleased to report that the threat of collet nightmares has receded. My dreamscape now has gregarious groups of collets happily exchanging roles, one with another. A sort of collet collective intent on getting the job done. ■

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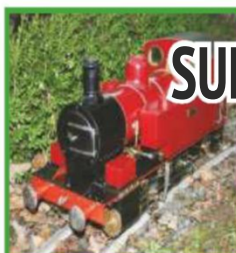
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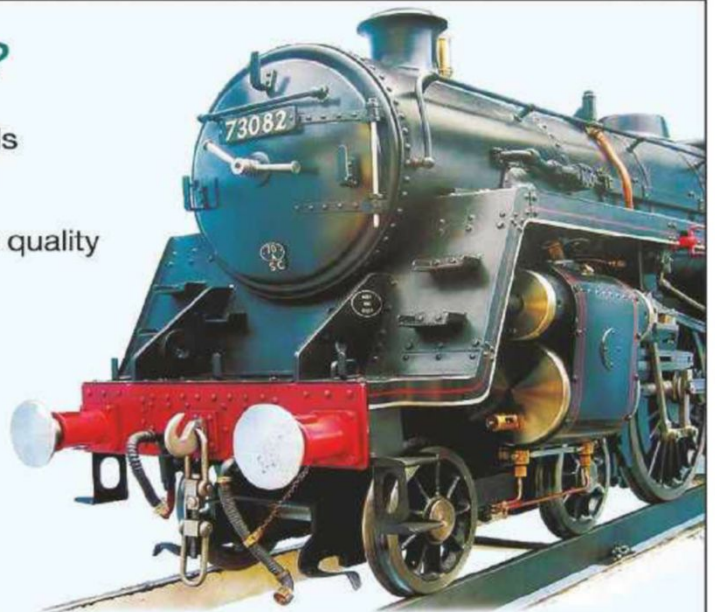
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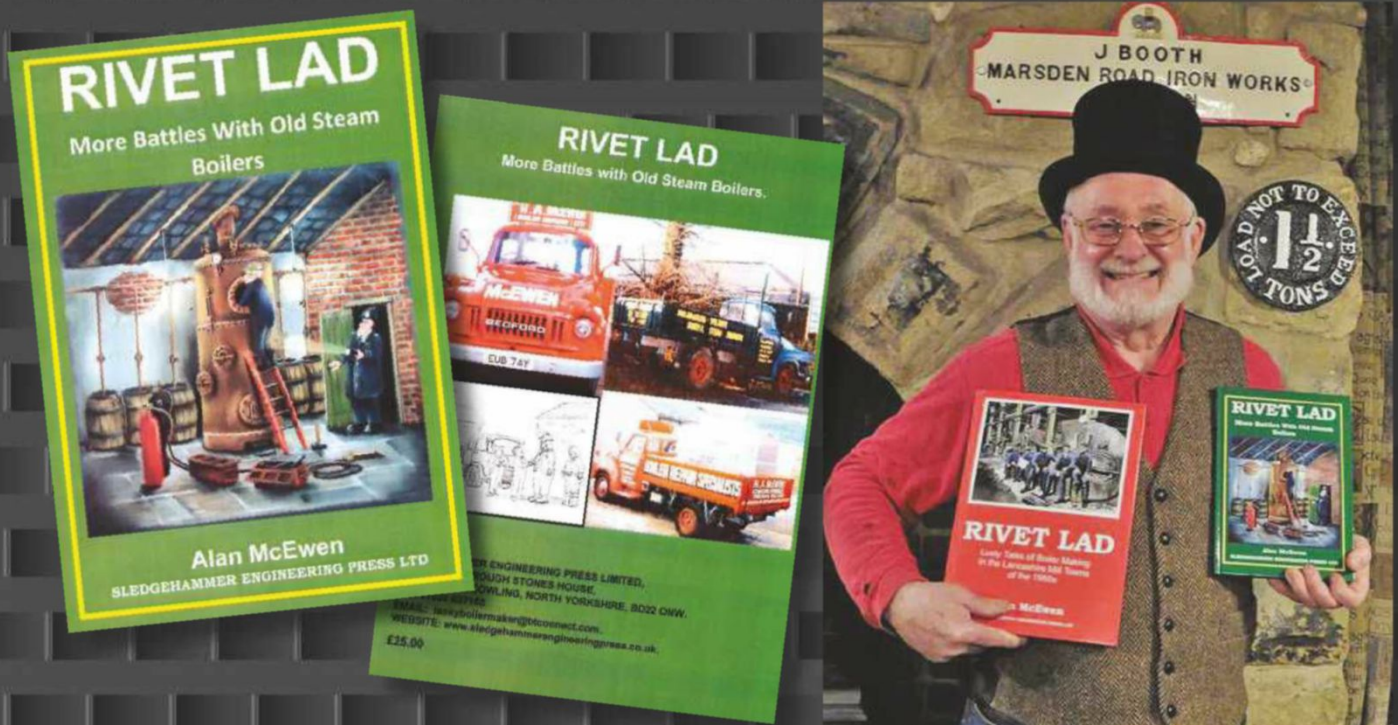
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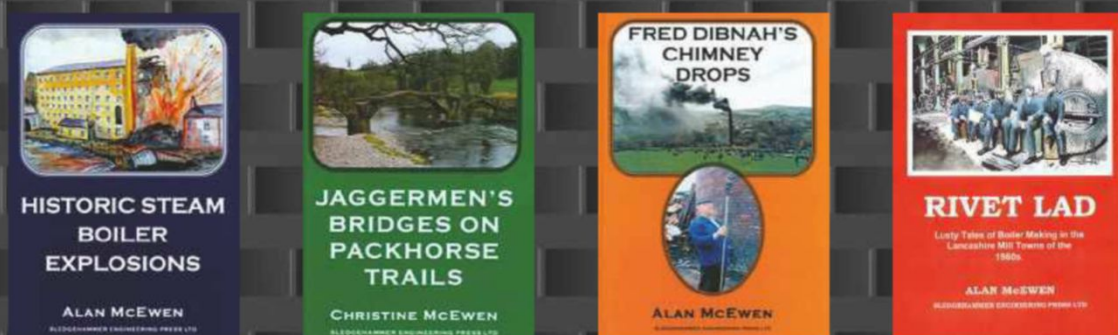
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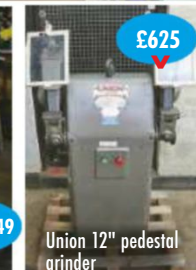
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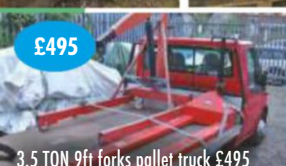
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