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- A Handy Depth Stop for Moveable Quills
- How to Machine Watchmakers' Collets
- Carbide Tip Holders to make
- Make a Chainsaw Sharpening Vice
- Universal Toolpost Fixture
- A Tool for Fixing Small Nuts

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Price: £642



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SPECIFICATION:

Distance between centres: 550mm
Taper of spindle bore: MT4
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Motor: 1.5kw
Weight: 230Kg

Price: £2,395

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AMAVM25LV

SPECIFICATION:

Model No: AMAVM25LV (MT3)
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Table size: 700 x 180mm
T-slot size: 12mm
Weight: 120Kg

Price: £1,354

With X-Axis Powerfeed - Price: £1,659

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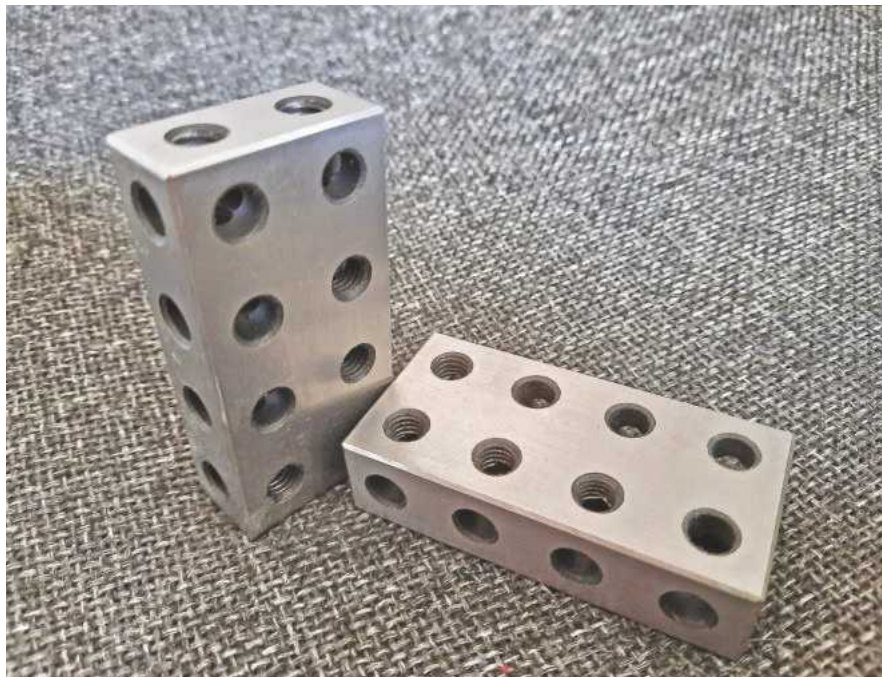


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On the Editor's Bench



Lots Going On.

We've got a really packed issue this month with some really useful articles. My personal favourite is the elegant simplicity of John Purdy's depth stop. Designed for a VMC-type milling machine, it should be possible to adapt it to suit most machines that use a screwed rod as the basis for a depth stop, giving increased accuracy and speed of use.

Have you ever considered writing an article for MEW? Most of the magazine's content is written by readers like John, and like his article you don't have to be describing something complex, if you have a neat gadget, an interesting jig, unusual tool, have solved a tricky problem or can shed light on a handy technique, just write up a page or two of text and add some relevant photos. If you need figures but aren't sure of your drawing skills, remember we have a designer who can tidy them up.

If you are interested, drop me an email – neil.wyatt@mytimemedia.com – and I will send you an 'author pack'. If you have an idea of what you'd like to write about include a short description or even a photo or two, but don't worry if you aren't decided. Remember, we pay for original articles, so it's a great way to help fund your next project!

Staying with the 'packed to the gunnels' theme, thanks to the way the post works over Christmas, the Readers' ads are bulging at the seams in this issue after a bit of a drought. Don't forget, just because there isn't a paper form this month, you can still submit ads by email. Also, as times are changing and many people don't have a landline phone, we have decided to allow mobile phone numbers.

As for my own workshop adventures, I'm slowly organising my new space and have been treating myself to a few new gadgets. I've finally bought a set of 'Stevenson's Metric Blocks', something I should have done years ago! These are hardened and ground blocks for temporary jigs and other purposes like 1-2-3 blocks, but they have the ratio 1:2:4 and several of the holes are tapped to make it easy to join them – the rest being clearance size.

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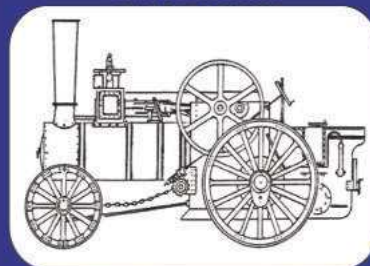
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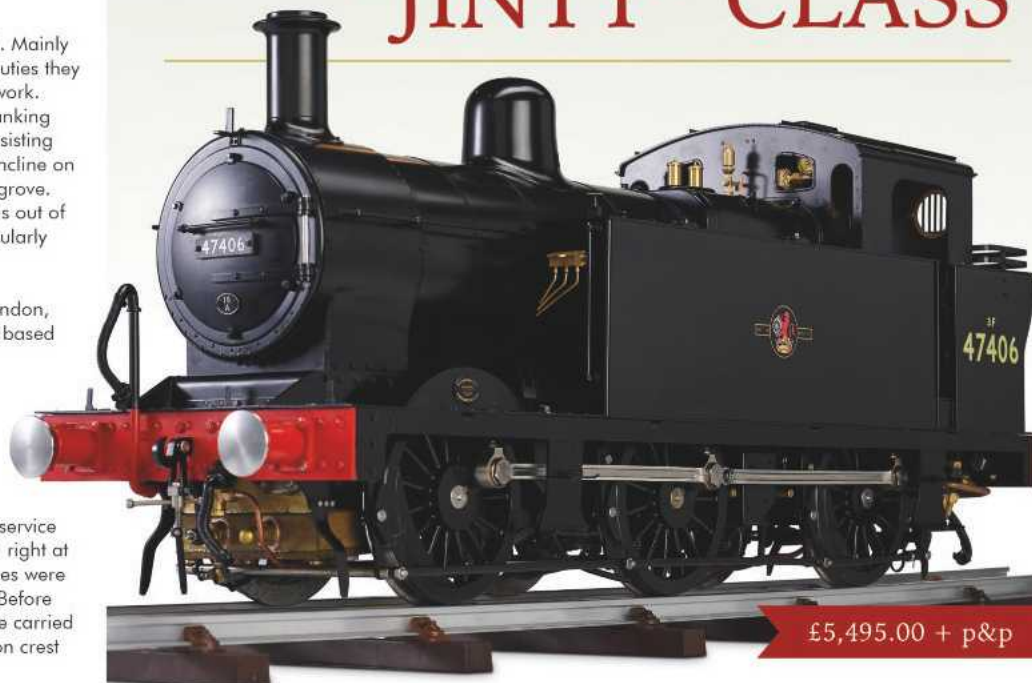
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Coming up...

in our next issue

Our next issue will feature a useful overview of workshop cranes, using a golf trolley motor for milling machine feed and a neat stand for a dial gauge to produce a workshop comparator.



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THIS MONTH'S BONUS CONTENT

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A Searchable Index?

Check out the website for latest news of progress with a searchable index for MEW. MEW Index updated to Issue 312 (February 2022).

Other hot topics on the forum include:

Macro-photography

Some fascinating discussion of different approaches, including photography of workshop articles and much else.

Recommendations for a Keyless Chuck?

What do you think of keyless chucks, and can you share any recommendations or advice?

Lautard's octopus

No, I didn't know what this device was either; it's fascinating to find out.

Come and have a Chat!

As well as plenty of engineering and hobby related discussion, we are happy for forum members to use it to share advice and support. If you feel isolated by the lockdown do join us and be assured of a warm welcome.

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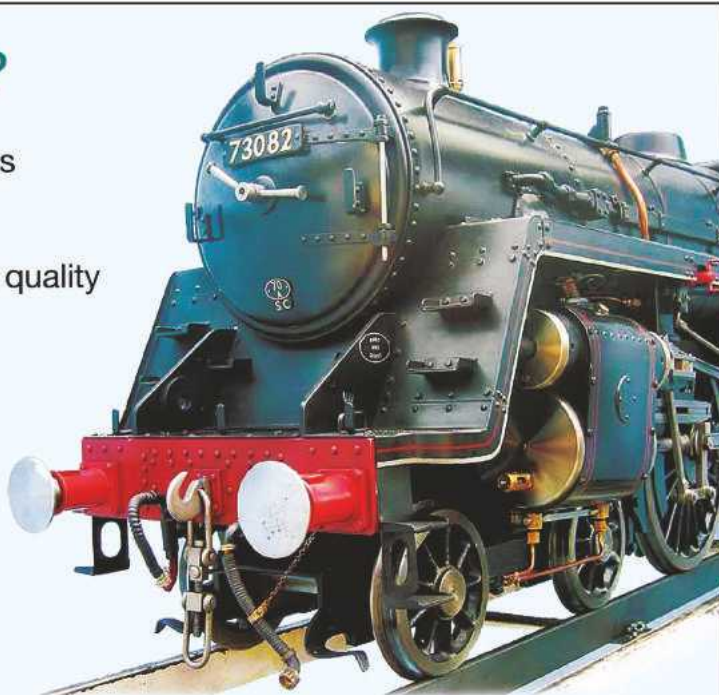
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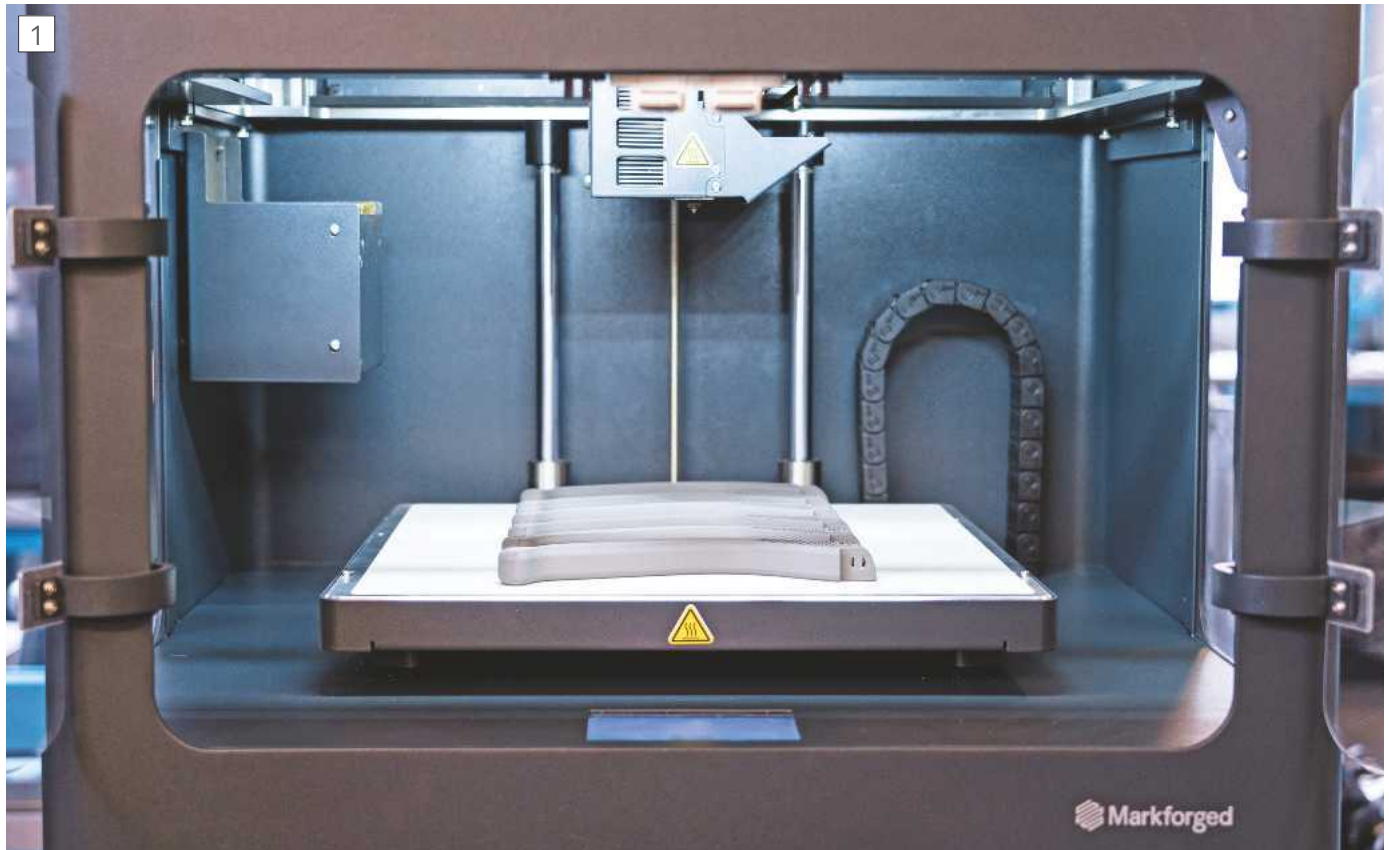
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3D Printing Takes to the Air!



Mark Noel explores the boundaries of what can be achieved with 3D printing in the home workshop.



Markforged 3D printer. Parts are laid down as a matrix of steel powder and resin, then sintered in an oven to leave the metal component.

For a while I had been watching clever people building Reprap 3D printers from a web of cogs, rods, belts and Meccano. Along with most MEW readers I was committed to subtractive machining, whittling away stock materials with my lathe, mill and hand tools to create various contraptions. Tinkering with 3D printing looked like fun but surely printing door knobs and dinosaurs was a distraction from proper engineering?

But then I was asked to review Neil Wyatt's splendid book *3D Printing for Model Engineers* which opened my mind to other possibilities, such as the tools and fixtures, clamps, gears and other widgets that proved useful in his workshop. In this new era of additive machining parts were being created



Stainless steel motorcycle handlebar brake lever printed in a Markforged machine.

constructively, layer by layer, in a wide range of materials.

The possibilities were highlighted when I attended the Mintronics-GoPrint3D demonstration day in 2018, where an impressive suite of printing technologies were on display, as I

reported in MEW 269. Machines from Markforged, Formlabs, Ultimaker and Zortrax were busy fabricating precision parts in plastic, carbon fibre and even stainless steel, some examples of which would be challenging to make using conventional methods, **photos 1 and**



2. The experience was a revelation, and now seemed the time to jump in, but how? There exist only two technologies that are really affordable to the hobby engineer, namely Fused Filament Deposition or FFD, and another process in which liquid resin is solidified by a laser. The experts at GoPrint3D suggested that FFD was now a fully mature technology that had attained limits of resolution and accuracy, while the laser process was (and still is) developing at pace.

FFD printers make the part by extruding a fine molten strand of plastic that builds layers defined by a sophisticated slicing program. In some machines layers can be as thin as 0.1mm, with strands as narrow as 0.25mm, and in a range of pliable or rigid plastics, the most common of which is the hard polymer PLA. Any parts which have steep overhangs must be supported to prevent collapse during printing, and this can be accomplished either with a scaffold of the same material, a brittle 'breakaway' plastic or with PVA which is dissolved away from the finished print in warm water. Most FFD printers drive the plastic stock (in the form of a cord) through a Bowden Tube via a motor-driven feeder behind or inside the printer. In contrast Direct Drive printers incorporate this feeder assembly within the moving extruder head in an effort to achieve greater part accuracy, although the increased inertia can slow the part's build. Whichever configuration is employed it is obvious that two extruders are required to lay down structural plastic plus soluble PVA or a breakaway support material.

Printers that polymerise liquid



Formlabs Form 3 SLA type printer with their Wash and Cure machines.

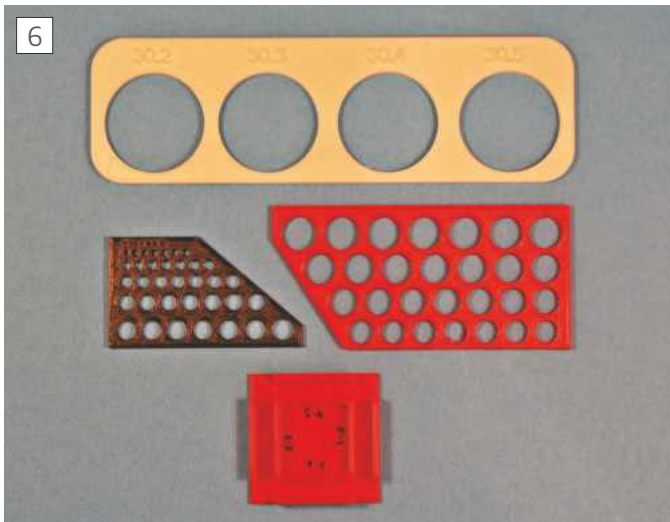


Ultimaker 3 Extended printer. This uses FFD technology and twin extruders.

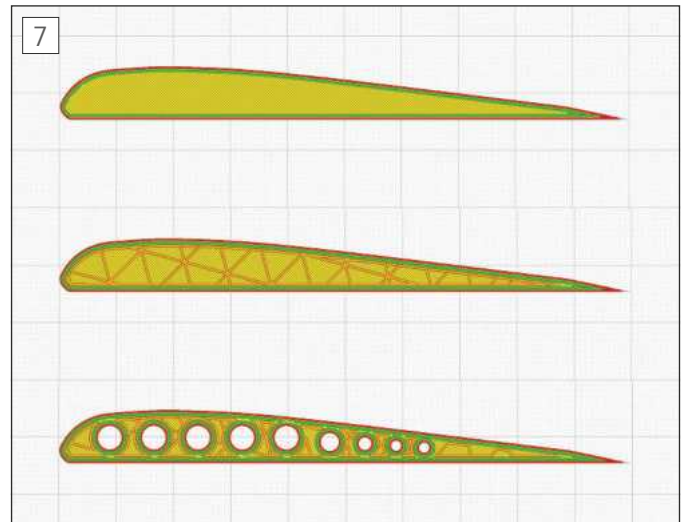
resin to build solid parts also need to support steep overhangs but these scaffolds are grown from the same resin within the one polymer tank. This technology has developed along two competing lines, each with pros and cons and with marked differences in cost. The original (and still current process) is Stereolithography (SLA) in which a set of moveable mirrors scans a narrow UV laser spot over the surface of the liquid resin, 'writing' it into a solid pattern in each layer as the build platform is lowered. The Form 3 printer is an example of this type, **photo 3**. Recently a simpler process has been developed in which these mirrors are replaced by projecting ultraviolet light through a high-resolution LCD which acts as a programmable mask to expose and solidify a complete layer almost instantly. In such Masked Stereolithography Apparatus (MLSA) the print resolution (or size) is limited by the LCD's pixel density, but such machines are cheaper and thus more accessible to the hobbyist. The Prusa SL1 is an example of this second type of machine. (M)SLA type printers can achieve almost flawless prints with layers as thin as 25 microns. However, this process has several downsides that have discouraged uptake in the hobby community. First, the resins are expensive and can decompose in air if left standing for a long time between prints. Secondly, unpolymerised resin must be removed from parts by washing in isopropyl alcohol. Third, there must be no closed cavities in the part that will seal uncured resin and, finally, prints must be cured in a UV chamber or in sunlight to achieve peak strength. Some manufacturers have simplified this workflow by providing



Egg cup designed using Alibre, latticed with Meshmixer, printed in an Ultimaker 3.



6 A selection of gauges printed to determine optimum sizes to incorporate in particular design models.



7 Efforts made to lighten a 100mm long wing rib by adding holes do not always result in less weight as shown in this example. Top 1mm thick, solid = 1 gram. Centre 5mm thick, 20% fill = 3 grams. Bottom 5mm thick 20% fill with holes = 3 grams, i.e. no lighter!

separate or combined wash and cure machines, but still there remain the issues of high running cost and material waste. The Resources section at the end of this article lists several popular printers incorporating the technologies reviewed here.

It is worth highlighting a marked difference in performance between FFD and laser technologies when it comes to printing multiple parts. To extrude 10 copies of a component in an FFD printer will take more than 10 times longer because of the extra movements of the extruder between the several parts. On the other hand (M)SLA printers take the same time whether building 1 or 100 parts because the time to expose each layer is fixed. This consideration might be decisive if choosing a printer whose main task will be to replicate numerous objects such as model railway sleepers, wing ribs, wheel spokes, tank tracks or war games characters. Again, a winning feature of this technology is the extreme resolution possible, such that surfaces appear virtually smooth.

Having made the decision to begin printing dinosaurs (or not!) I recognised that FFD was the logical entry point for me. GoPrint3D (now Additive-X) pointed to Zortrax and Ultimaker as makers of reliable machines based in Europe, although both had premium price tags. By selling my wife for medical experiments I secured enough funds to purchase an Ultimaker 3 Extended, a dual-extruder machine with a generous print volume, **photo 4**. The shipment included reels of Ultimaker's PLA, Breakaway and soluble PVA materials, plus two 0.4mm diameter extruders.

Of course, I do recognise that many relish the challenge of building their own printer either from a kit or from parts available from specialist suppliers, as did Mr Wyatt. Instead, my focus has been on acquiring design skills that lead to functional parts, taking the view that I do not want to *build* a kettle to boil water; I would rather *buy* one to make the coffee.

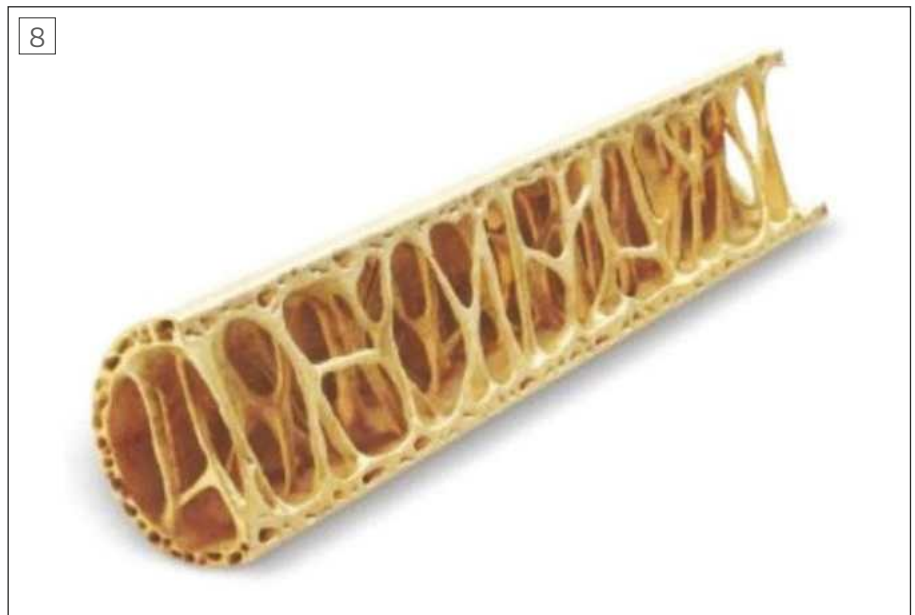
A huge variety of print-ready solid models created by talented folk can be downloaded free from the Internet. As I will show later my needs are rather specific and not fulfilled by free part-models. These must therefore be generated from scratch, with core software tools being FastCAD for 2D drawing and Alibre Design for

3D modelling, with occasional use of Meshmixer to create lattices from 3D solid objects. Finally, Ultimaker's remarkable Cura program converts these solid models into printer instruction files.

Having installed the machine, my very first creation was an egg cup created from a revolved solid in Alibre, pierced using Meshmixer. The egg was extruded by a hen. With buttered soldiers it provides a nourishing start to the day, **photo 5**.

Some Comments on Precision and Accuracy

Textbooks advise that Engineering Precision reflects the ability of a process to reproduce parts that are dimensionally consistent, while



8 Example of a hollow-latticed bird bone that combines strength with low weight.

Engineering Accuracy expresses the extent to which dimensions in a finished part match values in a specification.

In model engineering we are largely concerned with Engineering Accuracy since we usually want one part to fit with another. On the other hand a consistent departure from accuracy with sufficient precision is often acceptable when creating assemblies such links for the tank tracks or railway sleepers mentioned earlier, where small inconsistencies do not affect aesthetics or function.

A recurring issue with FFD printing is ensuring accuracy in the printed part, since dimensions vary according to material choice, print speed, temperature, layer height and nozzle diameter. My solution to this dilemma is to always use Ultimaker Tough PLA with a 0.4mm extruder, and to accept Cura's default print speeds and temperatures. Then the only variable is to alternate between layer heights of 0.1 and 0.15mm depending on the desired surface quality.

As the material extrudes and adheres to the underlying layer it swells and slightly enlarges the horizontal dimension. Cura can compensate for this to some extent with the 'Horizontal Offset' function but the tolerancing still falls short when a snug fit is needed in a recess for a ball bearing for example. My solution has been to print sets of stepped gauges with sizes defined in CAD models. Then the printed gauge size that exactly fits the target object (e.g. a metal shaft) is incorporated in the object model. Several gauges produced for specific projects are shown in **photo 6**.

Some Comments on Strength and Weight

As this article's title suggests, I use 3D printing to create gadgets that take to the air, and therefore every design aims for a compromise between strength and weight, with aesthetics sometimes being



Model aircraft built using printed parts and carbon fibre.



Left, 1943 Gibson Girl kite and right, 2021 Gibson Boy.

a factor. Surprisingly, the experience of merging solid modelling with 3D printing soon produces a marked change in mindset away from the subtractive machining experience, where formerly one would think:

"How can I design a part that can be made with the tools that I have?"

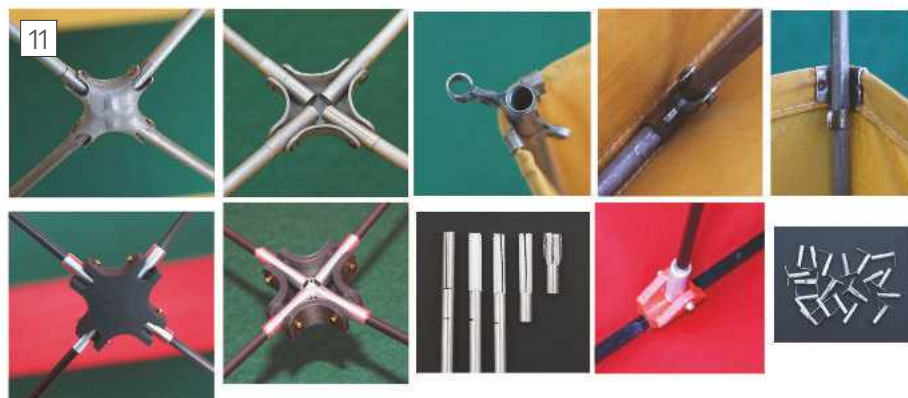
to:
"What would I like to make given the freedom that I now have?"

3D printing software provides new opportunities for distributing load within a part by configuring light internal mesh

structures that are usually impossible to create with subtractive machining. This can result in significant weight savings over a solid object but, nevertheless, care is needed when trying to lighten things still further by adding holes. This is demonstrated by comparing various designs of the wing rib shown in **photo 7**.

Thickening a solid rib to increase stiffness clearly succeeds at the expense of weight. Since bending stress is confined largely to the skin, stiffness is largely maintained by instead filling this thicker rib with a hollow lattice, which significantly reduces the weight. However, when an attempt is made to reduce weight still further by piercing this rib with holes there may be no further reduction in weight. This is because each hole is circumscribed by a skin with mass equal to (or sometimes greater than) the mesh it replaced! Hence experimentation is required to make a light part fit for function and our birds have solved this problem by growing hollow-latticed bones using 3D osteoblast deposition technology or ODT, as seen in **photo 8**.

Ultimaker's Cura, Zortrax's Z-Suite and other slicing softwares include numerous



Top: Details in the frame of the Gibson Girl kite. Bottom: details in the frame of the Gibson Boy.

configurations for infill geometry, while specialist programs can predict bending and buckling strengths in such complex structures. n-Topology is possibly the most advanced public code that combines design and analysis of optimum mesh structures. However, if like me, you are not a power-user, then FreeCAD includes a stress-strain analysis 'Workbench', while a similar module is available for Alibre.

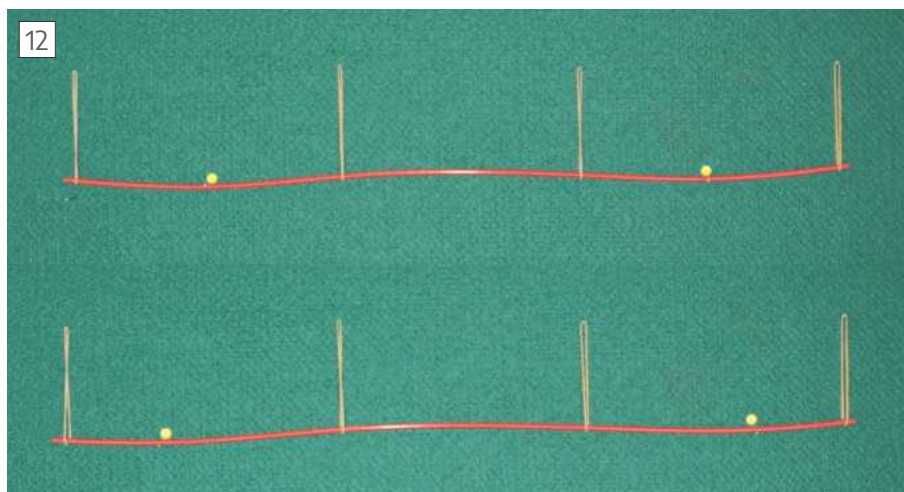
3D Printed Flying Machines

As a small boy and the son of an aviator, I was immersed in a world of aeronautics and was hugely excited on hearing that a Frenchman had just flown across the Channel. Mon dieu! The rotter!

The potential of 3D printing rekindled my interest in flying machines and led to me building the RC model aircraft shown in **photo 9**. Rather than use balsa and doped tissue, this aircraft incorporates pultruded carbon tubes for spars and longerons, PLA for ribs and bulk heads, with Oracover film over the flying surfaces. This aircraft as fully modelled in Alibre and assembled on jigs that were also 3D printed. Being my first attempt, it has turned out too heavy to stay airborne at anything below Mach 3 but the experience provides pointers to making lighter designs in future.

As a child R.A.F. stores provided me with all sorts of toys with which to tinker, including gyroscopes, radar sets and motors. However, the most precious item was an original, unused, Gibson Girl kite made by the Bendix Corporation in 1943, of which an estimated 13,000 were made, **photo 10**. These were installed in Bomber Command dingys, the idea being that downed aircrew could fly a radio aerial to sufficient height that rescue teams could find them. The kite is 3' tall and stows in a metal canister, together with a length of line, with printed instructions on how to assemble and launch it. The kite is extraordinarily well designed and constructed of the lightest materials available at the time, and it is clear that Bendix must have anticipated a massive wartime demand when you see evidence for their investment in the specialist tooling needed for mass production, **photo 11**.

The kite frame comprises $\frac{3}{8}$ " aircraft-grade aluminium. The structure splits into equal halves with the joints swaged and butted to click securely into place, and the two sails are sprung taut by over-centre 'spiders' with custom stampings and forgings in light alloy. The 8 hinges are actually soldered in place, a process that I thought had only recently become



Simulated scale model of the Bending Beam Problem addressed by Bendix in order to optimise the frame shape in their Gibson Girl kite. In this model the beam is represented by a flexible red PVC rod; elastic bands represent the tension forces exerted by the sail's seams, and the yellow pins represent the points where the spiders attach to the beam. Top: bending which occurs when the attachments are midway between the seams. Bottom: bending which occurs when the attachments are shifted outwards to the same relative positions as in the Gibson Girl kite - this forces a better aerofoil profile to the sails.



Replica of the Bumblenaut sub-orbital space capsule. Notice the retro rocket and high resistance handle. On loan from the Space Pioneers Gallery of the London Science Museum.

possible for light alloys. A glance at the spider's position reveals that the hinge connections to the longerons are not at the midpoint of the sails, as you might expect, but are positioned outboard in order to force a more aerofoil camber to the sails. This is demonstrated in the scale simulation of **photo 12**.

Airbase stores kindly gifted me 1km of braided nylon line, all of which was deployed one day to loft my kite above R.A.F. Wattisham. Eventually this was spotted on radar and all Lightning fighter aircraft were immediately grounded until the Military Police



Replica of the capillary-bubbling altimeter. As the unit ascends air expands from the larger reservoir through the narrow tube and bubbles into water contained in the smaller reservoir. During the descent water is drawn up the tube to a level that records the peak altitude. Patent Still Pending.

discovered the pilot (aged 8) lurking in a garden of the Officers' Married Quarters.

Around this time space exploration had become the New Frontier and I joined the cosmic race by building a

prototype capsule for launch on a sub-orbital flight aboard the Gibson Girl. An exact replica of this module is shown in **photo 13**. It was equipped with a viewing window, retro rocket, escape hatch and a blob of space-certified honey to nourish the Bumblenaut whom I caught, briefed, and ushered into the capsule. The unpressurised vehicle was drawn up the line by a drogue chute on a slip ring and the peak height recorded by my own design of capillary-bubbling altimeter, a replica of which is shown in **photo 14**.

Only one flight took place and the media (my Dad) gathered at touchdown to discover that the bumblebee had ejected safely and had returned to Mission Control in her hive.

Just like me, the Gibson Girl has become a fragile antique - tired, faded and rather ragged (witness author's picture). Not wishing to fly it any more, I set about designing a 1m tall replica using modern composites, 3D printing and light nylon fabric, to be called the Gibson Boy, as seen in photo 10. A full Alibre model of the frame was designed using 5mm carbon tube for the longerons and 3mm tube for the spiders. Aluminium clips to tether the sail to the frame were cut and shaped from 6mm OD aluminium tube. Outermost spider hinges and line tether points were



Carbon-nylon composite spider hub printed by Additive-X in a Markforged machine. An aluminium disc is bonded to the centre to act as a hard bearing plate for the ends of the spider arms.

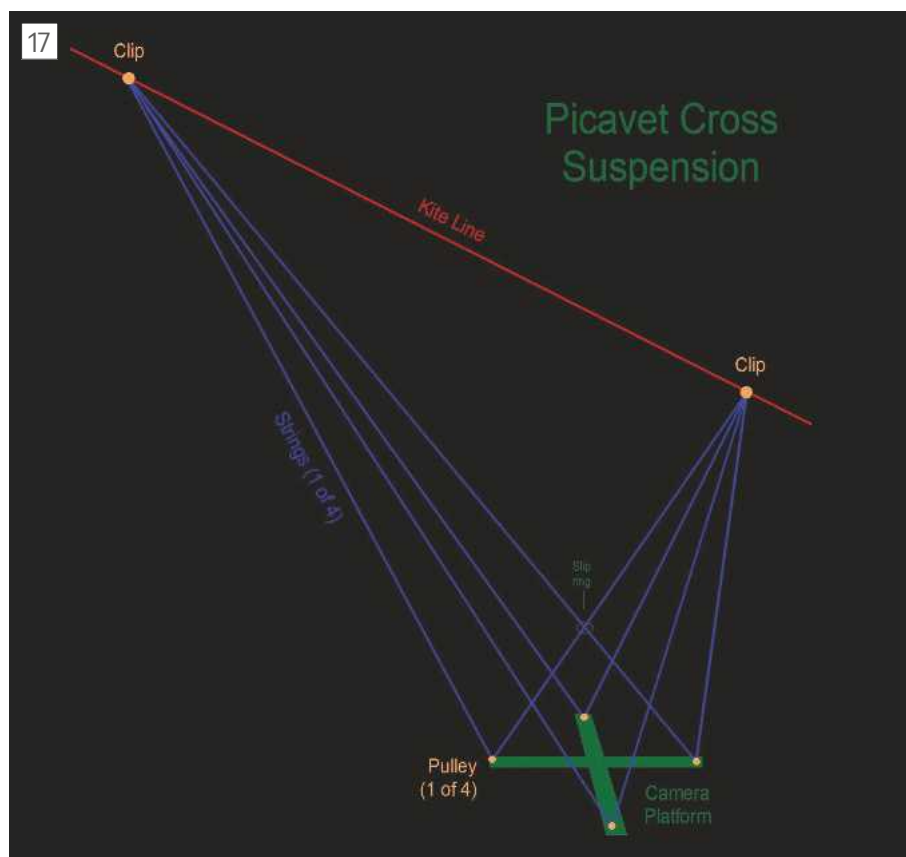


Alpine Delta Conyne kite by Into the Wind, USA.

printed in Tough PLA, with brass pins for all pivots, photo 11. A critical factor is to choose an over-centre angle of the spiders that ensures good sail tension without collapse of the mechanism under aerodynamic forces, and an angle of 30° was found to be satisfactory. The 4-way spider's hub is the most highly stressed component when the sail is tensioned, and for maximum strength these were printed in nylon-carbon composite by Additive-X using a Markforged machine. The resulting parts are about 3x stronger than if made of Tough PLA and have impeccable surface finish as seen in **photo 15**.

Sewing the sail was an unusual departure for this hobby engineer and it proved challenging to cut the precise lengths that ensured optimum tension when the spiders were sprung. The fact that Gibson Girl sails could be stitched consistently and taut in huge numbers is evidence again for major tooling investment by the Bendix Corporation.

My two box kites provided a springboard to the fascinating hobby of Kite Aerial Photography (KAP) which unites interests in design, engineering, electronics, meteorology, video and of course 3D printing. In contrast to flying a consumer drone for imaging, KAP provides genuine opportunities for innovation, particularly with regards to camera stabilisation and control. Of course, a drone is more maneuverable and can provide GPS navigation and astonishing camera stability, but flight durations are limited (~25 minutes) and the firmware enforces a limit to the peak altitude. Kites on the other hand can climb higher (the record is 16,038 feet), lift greater loads and fly for as long as there is a breeze. For the worldwide KAP community it is these factors that make



Picavet Cross type of suspension.

the hobby attractive.

My 'lifters' are two 9-foot span, framed delta kites - known for their steep flying angles and heavy lifting potential, such as my 9' span Delta Conyne seen in **photo 16**. Because kites swerve as the wind changes direction it is common practice to attach the camera gear 20-30m down the line where the catenary is more stable. Of course, anything hanging from the line is free to swing in the horizontal plane unless steps are taken to dampen this movement. Alternatively, the suspended camera can be mounted in a device that somehow maintains a constant bearing. Either or both of these approaches are commonly used.

A New Type of Camera Suspension

Most KAP enthusiasts suspend cameras using a stabiliser invented by Pierre Picavet in 1912. The payload is attached to a cross-shaped platform with pulleys at the four corners, from which strings

reference for a suspension than the 'effective gravity' seen by a Picavet.

The new suspension is light, folds up easily, and the design includes adapters for attaching various modules such as cameras, panning motors, altimeters and GPS sensors. The upper TriTaper jamming socket is inspired by the familiar Morse Socket and usually carries an altimeter or roll stabiliser. Experiments found that a 4° taper in this printed socket produced enough grab while the triangular section prevents rotation. Gadgets printed with TriTaper adapters can be stacked, adding multiple functions to an aerial mission. The 60cm long carbon beam attaches to the line by 3D printed Capstan Wraps with teeth that prevent slippage.

Creating the suspension pulleys encountered an issue with FFD printing where a good surface finish is hard to achieve on the underside of steep overhangs as seen in **photo 20**. This is because the required support leaves ragged scars along the



New type of Aeronaut suspension made of 3D printed parts and carbon fibre tube. The altimeter is fitted into the TriTaper socket at top, while the PanGimal unit and camera is attached at the bottom.

points of attachment with filament droops between them. The problem is lessened as the support density increases but at the expense of more scarring and increased difficulty in removing that support.

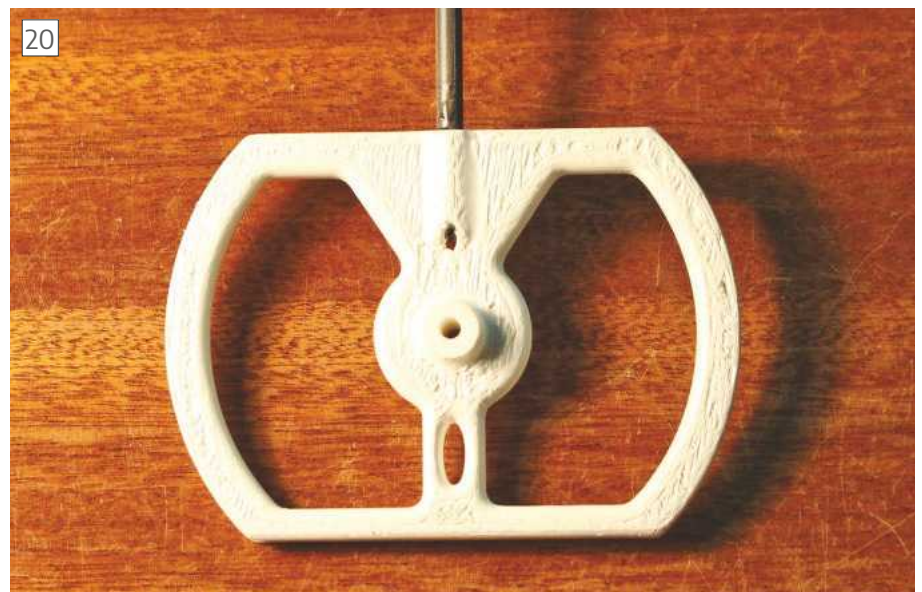
●To be continued



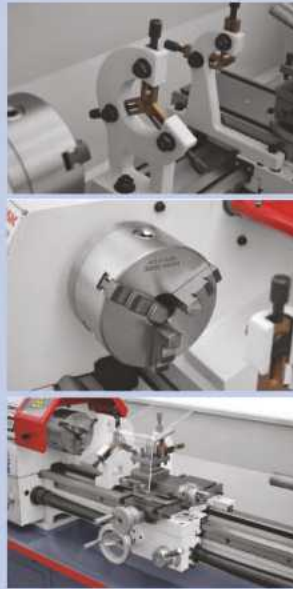
Sequence of images showing how the geometry of the aeronaut suspension maintains the camera (to be attached at the bottom) at a constant angle relative to the kite line.

extend to clips on the kite line as shown in **photo 17**. The geometry is such that the platform settles horizontally under the force of gravity, but it is prone to spin since there is no rigid connection to the taut kite line. Also, the platform remains free to swing about a horizontal axis, although aerodynamic damping can control this movement to some extent.

After 119 years it seemed time for a rethink and this led to my Aeronaut Suspension which is easy to rig, compact and provides excellent stability. It incorporates only two pivots and is built of stiff carbon fibre and 3D printed parts, **photo 18**. It is effectively a twin-pulley parallelogram which ensures that a camera fixed to the lower pulley maintains a fixed angle to the kite line, as shown in **photo 19**. The taut line generally provides a more stable



An attempt at printing one of the suspension pulleys as a single supported part resulted in a poor surface on the underside, even after painting.



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This lathe is compliant with all European regulations and standards.

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125mm 3 Jaw Chuck, 4 Way Tool post, Travelling Steady, Fixed Steady, Dead Centres, Left/right Jaws, Spanners, Tools, Change Gears, Machine Base

Manufacturer	Cormak
Model	Tytan 750 Universal Lathe
Condition	New
Swing over bed	250mm
Swing over cross slide	150mm
Centre width	750mm
Bed width	135mm
Spindle bore	26mm
Spindle tip	MT4
Spindle speed (smooth adjustment)	50–2250 rpm
Metric thread	(18) 0.2–3.5 mm/rev
Inch thread	(21) 8–56 threads/inch
Longitudinal feed	0.07 -0.4mm/rev
Tool holder	4-Way
Tool holder Dimensions	12 x 12mm
Maximum cross support travel	70 mm
Maximum transverse support travel	110 mm
Maximum longitudinal support travel	650 mm
Tailstock Quill Diameter	30 mm
Tailstock spindle travel	60 mm
Tailstock quill taper	MT2
Motor power	1.1kW / 230V
Dimensions (with base)	1350×560×1250 mm
Weight	205 kg

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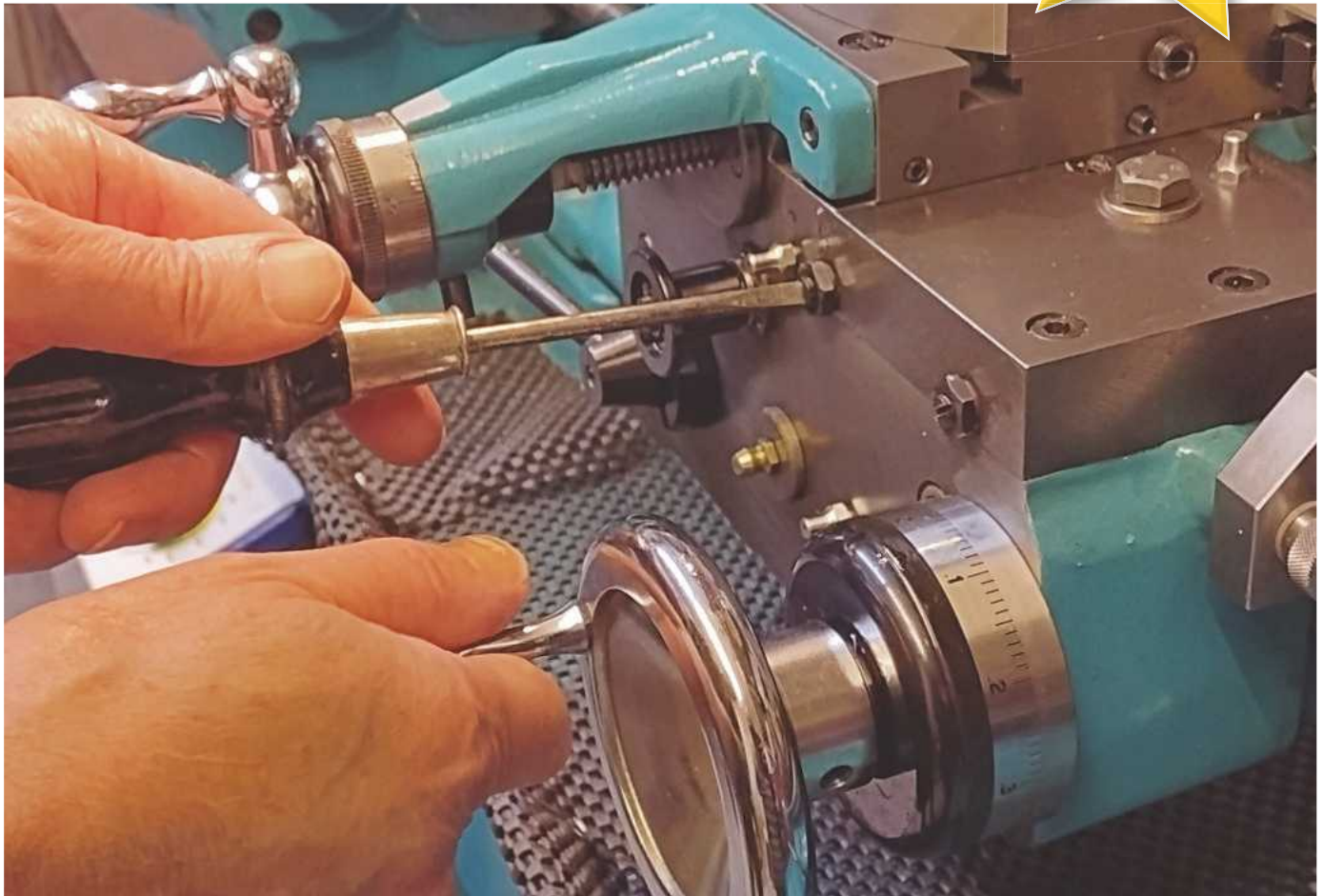
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Readers' Tips



Easier adjustment of Saddle Gib Strips

TIP OF
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WINNER!



This month's winner is Andrew Moyes with a tip for making the adjustment of saddle gib strips easier.

Here is a simple tip for owners of Myford and similar lathes. It makes adjustment of the saddle gib screws much easier. This can be a three-handed operation with one hand turning and holding the gib screw, another tightening the locknut while a third is required to turn the saddle handwheel to test the adjustment.

The modification is to add a fibre washer under the gib adjuster locknuts. The locknuts are tightened to the point where they perform their task, but it is still possible to turn the screw. The screw is adjusted back and forth with the screwdriver in the left hand while the right hand traverses the saddle. A very precise point of adjustment can then be found easily.

The screws on the Myford are $\frac{1}{4}$ " BSF. I found 6mm bore fibre washers were a good tight fit on the screws, which is ideal in this application. The washers came in a box of assorted sizes bought at the local discount supermarket.

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

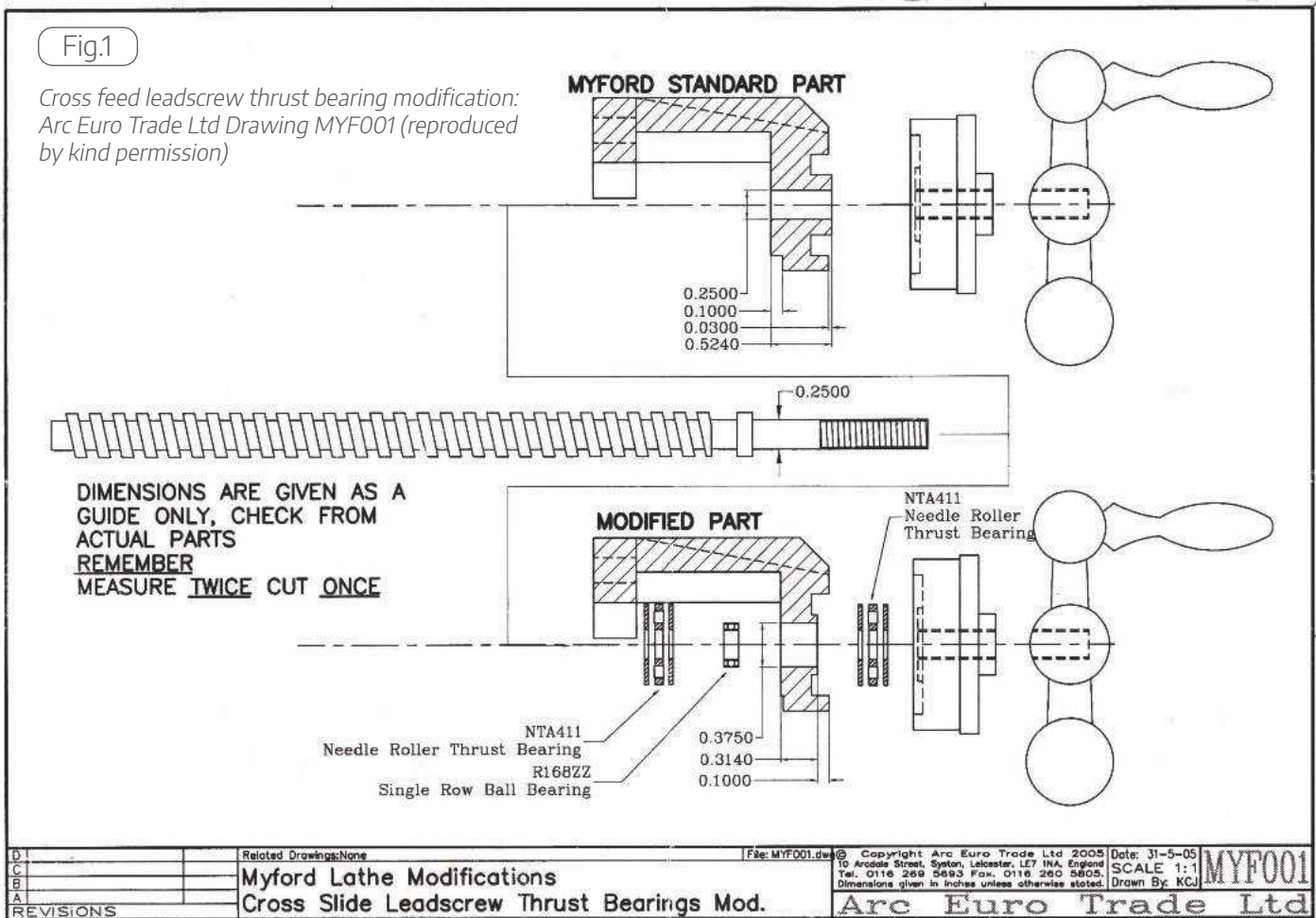
Email your workshop tips to neil.wyatt@mytimemedia.com marking them 'Readers Tips', and you could be a winner. Try to keep your tip to no more than 400 words and a picture or drawing. Don't forget to include your address! Every month I'll chose a selection for publication and the one chosen as *Tip of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

Please note that the first prize of Chester Vouchers is only available to UK readers. You can make multiple entries, but we reserve the right not to award repeat prizes to the same person in order to encourage new entrants. All prizes are at the discretion of the Editor.

A Myford Lathe Bearing Modification



Laurie Leonard explains how he modified the Cross Slide Leadscrew Thrust on his Seven Series lathe.



Over the years I have “tidied” up my second(?) hand Myford 7 which has included a bed regrind and new nuts for the cross slide and top slide. However, I have felt, literally, that the cross slide in particular has always felt rough. The “feel” probably comes from the fibre washer that acts as a thrust washer and takes the clamping force when adjusting the leadscrew play.

Looking through the Arc Euro Trade Catalogue, **fig. 1** (reproduced by kind permission), I noticed that they were marketing a kit to replace the fibre washer with needle roller thrust bearings fitted each side of the support

casting and a ball bearing inserted into the support casting to carry the leadscrew. I purchased a kit which included a detailed drawing, **fig. 2** of the modifications necessary to accommodate the new parts. Having studied the drawing, I then considered how to carry out the work. I summarise below how I achieved the necessary machining.

Approach

Photograph 1 shows the casting which supports the end of the leadscrew and is the part which has to be machined. The work, detailed in **fig. 2**, involves opening out the hole that carries the

leadscrew to accommodate the new ball bearing and machining a recess in the casting front and back faces to take the needle thrust bearings. The amount to be removed from each face was calculated from measurements taken from the casting and details shown on the drawing. I quote from the drawing “Dimensions are given as a guide only, check from actual parts”.

I confirmed that the leadscrew diameter was to drawing. Assuming my micrometer is accurate, **photo 2** shows that my leadscrew to be marginally under the 0.25 inch which may be true given the age of the machine and



Cross slide leadscrew casting – the subject of the machining exercise

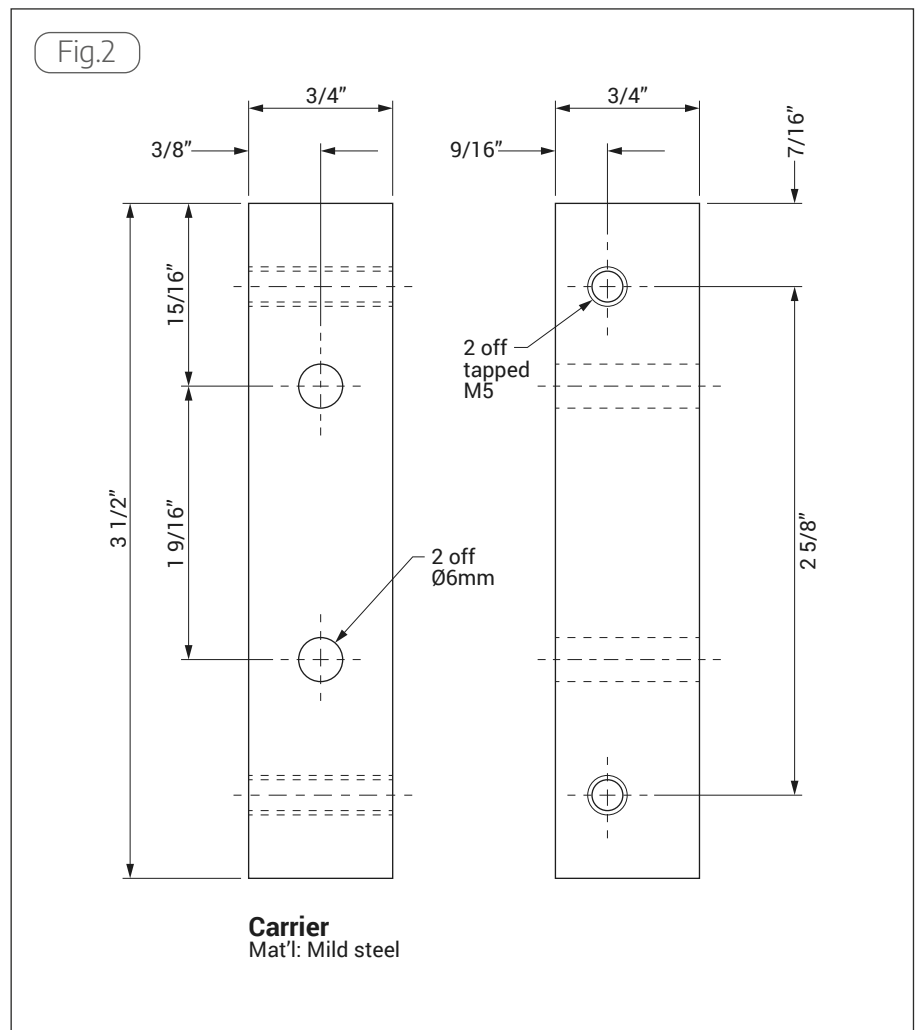
I have a vertical slide for my Myford which has spent most of its life oiled in a bag, unused, and this seemed to be an ideal opportunity to use it.

possible/probably wear. I decided to go with it despite the implied accuracy shown on the drawing. This diameter mates with the internal bore of the ball bearing and no problems were encountered on assembly.

Photograph 3 shows the outer surface of the casting that has to be machined. The paint was removed to



Checking the diameter of the leadscrew shaft



provide a datum face, **photo 4**, and it can be seen in both these photographs that a lot of wear had taken place probably due to the ingress of swarf. A similar story of wear on the inner face is illustrated in **photo 5**. The nature of the machining task can be seen from these photographs. The use of my Tom Senior M1 mill was considered but thought to be a bit of an overkill.

I have a vertical slide for my Myford which has spent most of its life oiled in a bag, unused, and this seemed to be an ideal opportunity to use it. The next point was how to mount the casting on the slide. A carrier was made from a piece of $\frac{3}{4}$ inch square bright mild steel. Figure 2 shows dimensions of the carrier made for my casting.

Great, I had a plan. The feed screws

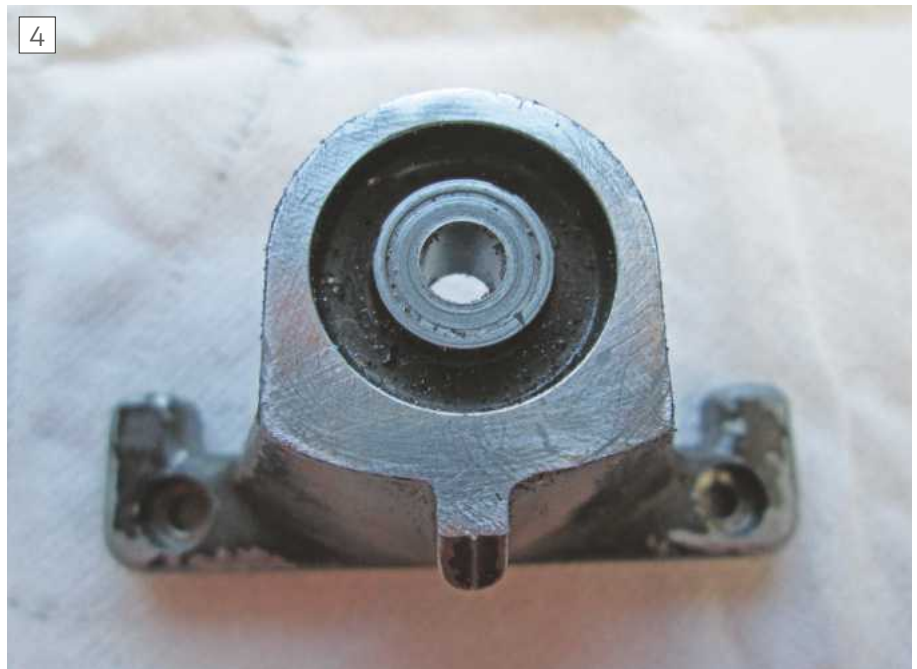


Outer thrust face of the casting showing wear

on the lathe would enable lining up adjustment and to put cuts on in the X and Y planes and the vertical slide would provide for similar facilities in the Z plane but... the leadscrew for the X plane would not be anchored because its support was being machined. To overcome this a temporary support was made from a "handy" piece of steel plate. A series of measurements was taken and a hardboard template from a paper pattern/drawing was made prior to making the steel. When this was offered to the lathe it did not fit! I had assumed a symmetrical layout about the leadscrew where as the gib strips upset this. Trying to fit the drawing over the casting locations with a view to its modification resulted in damage to the holes, **photo 6**, but indicated the directions they needed to be moved in. A new paper pattern was made "in situ" by retracting the lead screw so that its end was in the same plane as the holes in the cross slide then offering a piece of paper up to it and then marking the end of the leadscrew and the two holes in the cross slide by tapping the locations with a ball ended hammer. A new set of holes were drilled in the hardboard pattern, circled in black, **photo 7**, and the locations confirmed by once again offering the hardboard pattern to the lathe. Having now got the holes in the right geometry a piece of thin steel plate (from the scrap box which explains the extra holes) was drilled using the hardboard pattern, **photo 8**. With the new plate in position the slide was reassembled, and we were back in business, **photo 9**.

On with the Job

Accuracy is important on this job. The vertical slide was set up on the cross



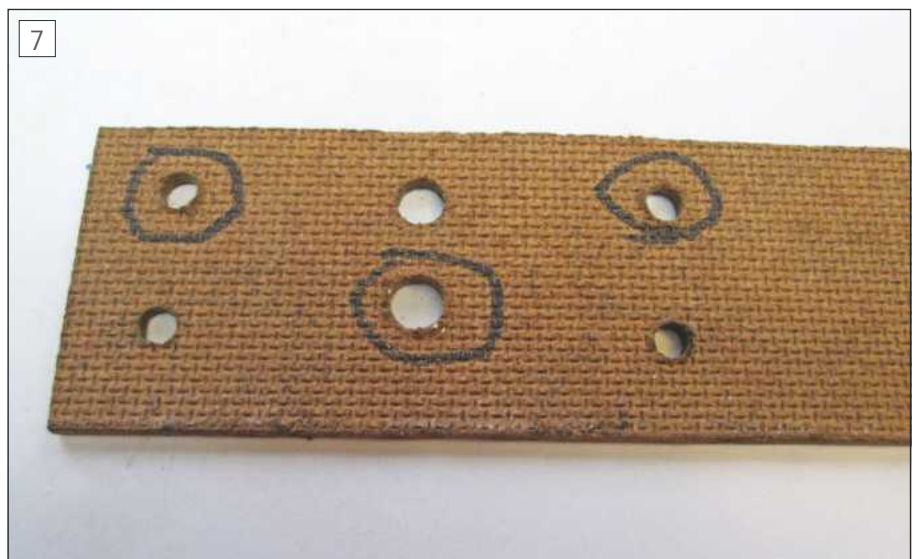
Outer face of the casting cleaned up ready to take measurements



Inner face of the casting showing wear



Paper pattern showing errors in layout



Re-drilled hardboard template – ringed holes the correct ones

slide ensuring that the T slot face was parallel to the lathe axis. A clock mounted on the lathe bed was used to check this by moving the carriage along the bed with the clock sensor resting on the vertical slide. In the vertical plane the accuracy of one axis is dependent on the inbuilt accuracy of the vertical slide. In the other axis it is the alignment of the carrier on the slide that needs to be accurately set. Once again, a clock was used to set the carrier perpendicular for each set up. An instance of setting is shown in **photo 10** where the gauge is also located on the lathe bed with the sensor resting on the carrier. The vertical slide is then moved to check that the carrier is vertical the latter being adjusted until it is after which it is hardened in place.

With preliminary alignments completed and the casting mounted



Utilising the template to drill the holes in the temporary support plate



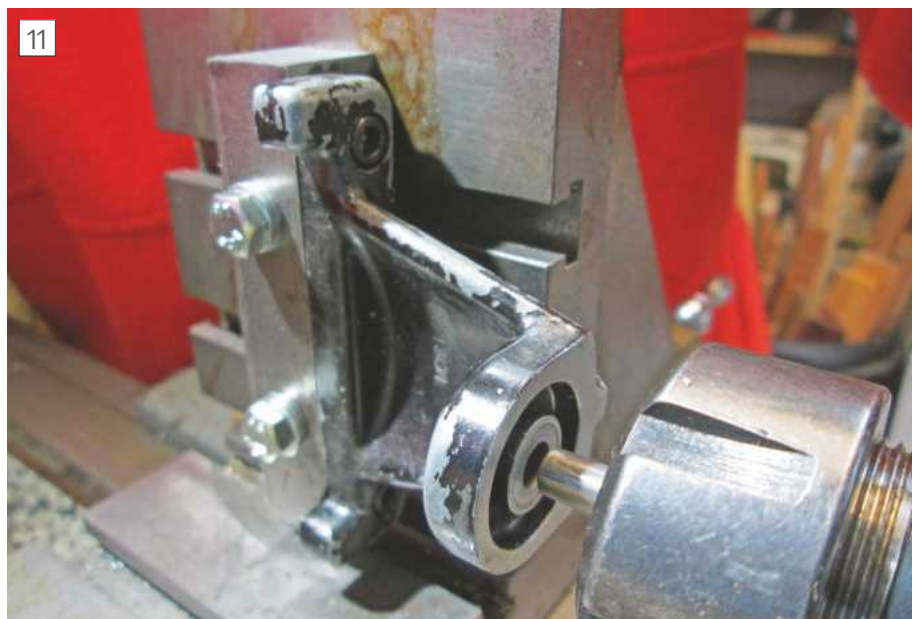
Temporary support plate assembled ready for lathe operation



Utilising a clock gauge to set the job carrier vertical

on the carrier the leadscrew hole was centralised utilising a piece of dimensionally checked 0.25 inch rod held in an E25 collet, **photo 11**. The hole was then opened with a suitable drill, **photo 12**, and reamed to size. The recess to cater for the needle thrust bearing was then milled to the calculated depth, **photo 13**.

The casting was then reversed and reset on the carrier for the recess to be machined on the other face, **photo 14**. I had mounted the vertical slide nearest the operator on the cross slide and this was not clever for observing the work in progress. I had marked the extent of the milling necessary to cater for the diameter of the thrust bearing but did not machine to my mark (my eyesight is not clever) and had to reset the job to take the last bit off, **photo 15**. The ball bearing can be seen,



Centralising the outside end of the casting



Opening the hole in the casting ready for reaming to final size



Milling the outside needle thrust bearing recess



Milling the inside needle thrust bearing recess



Trial assembly showing the partial fit of the ball bearing and that the milling had not been carried out to the mark

partially inserted, in this photograph. The machined casting with ball bearing inserted is shown in **photo 16**.

Conclusion

Having rebuilt the cross slide with the new bearings, the leadscrew play was adjusted. The smoothness of operation with the new thrust bearings is really noticeable. Despite making new leadscrew nuts there is still play in them so it is questionable if backlash has improved but I am confident that there is not any present in the thrust bearing assembly. For the cost and time (it was a good learning exercise in the use of the vertical slide for me) the job was very worthwhile. ■

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Work finished, ball bearing inserted, and ready for final assembly

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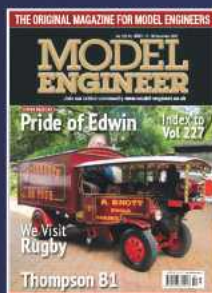
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New and Mk V Boring and Facing Heads



Graham Meek introduces new versions of his boring and facing head design

As with all my designs I have provided details for making single point cutters to produce these gears. This is the route I always take, because those gears cut by these form tools produce very smooth-running gears. Which for this particular application is a most desirable quality. This is because each gear tooth profile is the correct form for that particular number of teeth. The form is as close to a hobbed gear that one is likely to get using a single point cutter. Some people do not like the interrupted cut of the single point cutter, but I can assure the reader that any interrupted cut was hardly perceptible at 370 RPM. The cutters sliced through the mild steel and bronze blanks leaving a very good finish in their wake.

The worm gear was originally intended to be made entirely from Phos Bronze, but initial testing showed that this material was not up to the duty that the slipping ball bearing clutch was imposing. Subsequently the worm gear was made into a composite component with the upper portion having the drilled holes and incorporating the dial friction spring, this portion being made from Silver steel, (or drill rod). This was the reason why the Emco dial friction spring was abandoned. Please note that the drilled holes are shown on the drawing as being spotfaced and not as shown in the prototype in photo 3. This spotface ensures the ball bearing has a continuous ring of contact around each hole. Rather than just two points of contact on the extremity of the diameter when the holes are not spotfaced. The spotfaces also have a further benefit in that any damage caused around the hole during use will not affect the bearing surface. The worm is still made from phos bronze, the two items being pressed together. Here I need to insert a few cautionary words. The press fit allowance does not want to be overdone, else the silver steel / drill rod ring will close-in the bore of the softer worm gear.

These parts can be secured with Loctite Retainer if this is preferred but

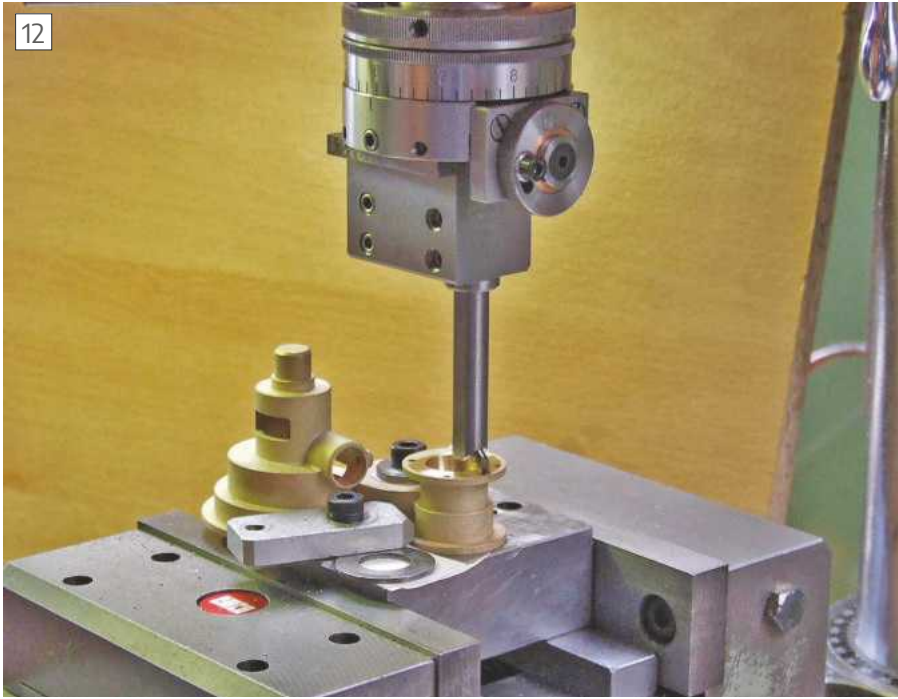


Half size boring head.

the spring section to supply the friction for the dial needs to be raised slightly in order to stop the Loctite adhering to this portion as well.

However do not be overzealous when raising the spring section, it is far better to do this in stages, such that the dial will just slide with the least amount of force. The spring section is cut into the silver steel in such a way that the dial moves more easily with the numbers on the dial ascending, than it does with the numbers descending. This dial movement also ensures the backlash in the system is also eliminated during Zero setting. While holding the feed

ring the amount of effort to move the dial should not trip the feed ring clutch, hence my caution on setting the friction spring in stages. That is not to say this clutch should be set such that if it were on a cordless drill it would drive home woodscrews. A high setting on the clutch will put an enormous strain on the gear train, feedscrew, etc, before the clutch slips when the stop is contacted. This strain is to be avoided in the interests of safety. On this note, I would also like to urge the constructor to use some form of stop bar for the torque bar to impinge against when using the facing facility. Far better for the stop bar



Facing the Clayton transfer case mounting face, using my new boring head in facing mode.

to bend and the machine stall than it is to lose one or more fingers in the event of something catastrophic going wrong.

While we are discussing the dial and feed ring settings there is another adjustment that was added after the initial boring head trials. When using the boring head on my Clayton Timber Wagon conversion. It was noticed that the dial would always counter-rotate as the spindle was set in motion. The counter rotation was not a lot and was merely due to the backlash in the system. This is down to the moments of inertia at play as the spindle starts. The dial is free to rotate on the boring head. As the machine starts the body moves instantaneously but the dial momentarily stays still. Until the backlash has been taken up, then this too rotates. However the rotation of the dial is in the opposite direction to which the feed is normally applied. When the spindle stops the dial is in a different position to when it started. Why the dial does not carry on when the spindle stops has always been a mystery. No doubt Mr Murphy, or Mr Sod have something to do with this. This is not a problem if you know that this is what is happening; and can easily remember the last setting. This can however be very annoying, if like me, the readers short term memory plays tricks. To overcome this a spring loaded Tufnol adjustable pad was added to apply a slight amount of friction to the dial. This is adjusted only until the added drag of the Tufnol pad is felt. Moving the dial to and fro

slightly it should be possible to detect the clearance between the pad and the counterbore that the pad sits in. If this adjustment is overdone it has a knock on effect. In that the dial friction spring needs to be set at a higher setting. This then leads to the feed clutch needing to be set higher, and so on. Therefore I would advise getting the dial and the feed ring sorted out first as I did and attend to the tufnol pad last. It is possible to access this adjustment without any dismantling. Ensure the underside face of the dial and Tufnol pad are free from oil or grease on assembly is another key point.

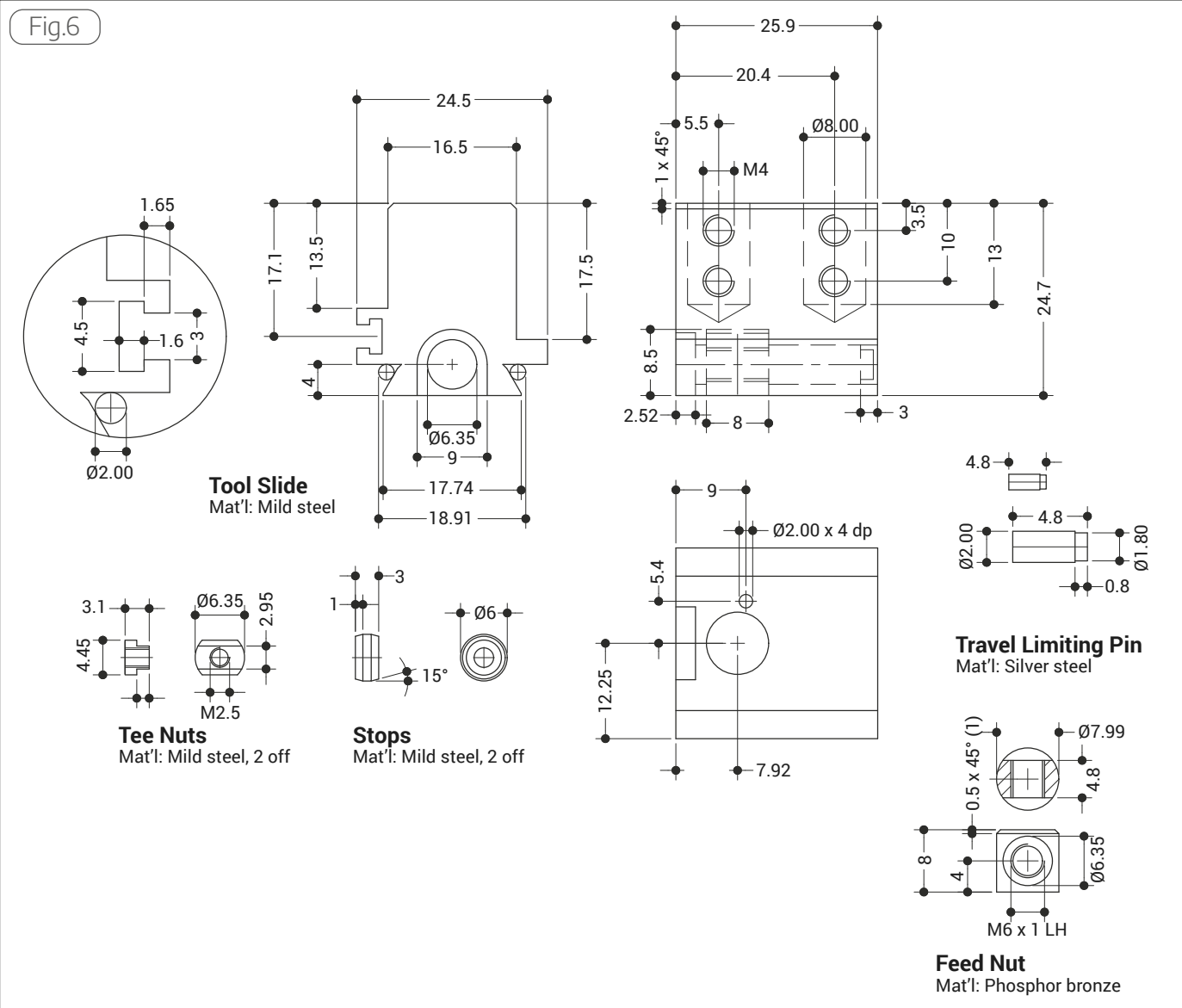
While I have shown a No 2 Morse taper arbor in the drawings, photo 8 showed the B&F fitted with a BT 20 for the Manix. One requirement of the arbor is that it needs to be a good fit in the main body, any slop here will not be good for rigidity or the finish in the bore. Practice on a stub end of material to get the size just right. A plain parallel shank on a boring head of this size is quite satisfactory. Provided this can be held in something like an R8 collet where there would be minimal overhang. Holding the boring head in a collet, in a Morse taper collet holder is greatly increasing the overhang and asking for vibration problems while boring. Plus this arrangement is seriously reducing the spindle nose to table work envelope, something that might be important one day, especially on the smaller machines. I did make a half size plain version of the Emco plain boring head to hold in my

ESX 25 collet holder, this was purely to get access to a hole where a larger bodied boring head could not. **Photograph 11** is included to show how the overhang of the boring tool in this set-up is well within the length of a standard 16mm shank end mill held in the same collet chuck and is therefore not being compromised on the rigidity front.

Assembly of the boring head is fairly straightforward. There are few points to watch out for which might catch out the unwary. The 10-tooth worm and output gears are designed to be assembled with 0.1mm of endfloat in the scalloped bush. To ensure this happens the 2mm Silver steel axle needs to have the worm gear fitted first, either using a press fit or with Loctite. Some Lithium based grease should be used to lubricate the scalloped bush bore before pressing or using Loctite for the Colpos 90 output gear. The output gears are then finally pressed home using a small arbor press with a feeler blade. Or a paper washer is interposed between the scalloped bearing and the output gear and a trace of Loctite Retainer used to secure the output gear. The paper washer can then be teased out once the Loctite is set. If this washer is a good fit on the 2mm shaft it will help stop the migration of Loctite into the scalloped bush. The two scalloped bushes and their gears are retained in the main body with two M2 allen grub screws. The two stub axles that carry the intermediate steel idler gears are secured in the main body with Loctite Retainer. The two gears are retained on the axle by the end plate on final assembly. However, during initial assembly these gears have a nasty habit of slipping off the axle and onto the floor, so a dab of grease here is a must. The E Clips shown in photo 4 are for the 50mm B&F Head design.

In order to assemble the selector ring bush a special spanner is required to tighten the bush. Prior to this the two M3X6 cheese head screws need to be inserted into the endplate along with the small spring, (this came from an old lock barrel), and the 2mm steel ball for the selector mechanism. Some grease will be found handy to hold the spring and the ball in place, as well as some light oil on the bush. Hold the spanner initially to screw in the bush. When it comes to tightening the bush be sure to keep pressure on the special spanner to ensure this does not slip out of engagement and ruin your work, as well as your chances of undoing the bush. It will be found easier to hold the spanner in the bench vice while performing this

Fig.6



last task. This bush does not need to be done up tight, just merely locked in position.

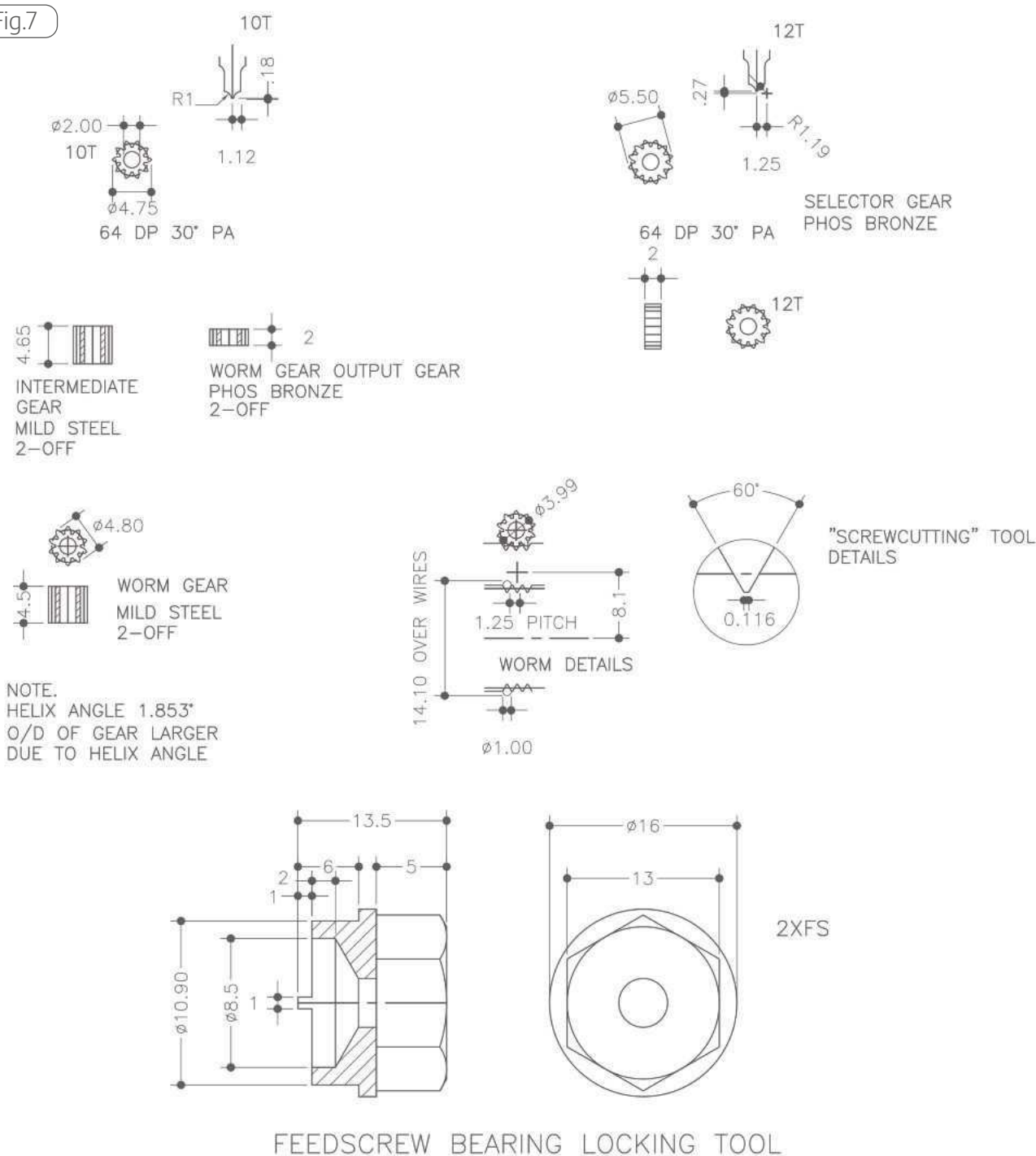
Fitting the feedscrew and setting the axial play is best attended to next. The outside diameter of the countersunk threaded collar needs to be matched to the constructor's micrometer spanner, within reason. As does the hole in the side of the collar. The sizes shown are for a Mitutoyo micrometer. The modified countersunk M3 screw provides the locking medium after the adjustment is deemed satisfactory. Be sure to check that the countersunk screw is locking up on the collar; and not the end of the feedscrew, or the adjustment will change. The collar will need to be held with the micrometer spanner to counter the tightening forces of the Allen key.

The axle that holds the 12-tooth selector gear is retained in the selector ring with Loctite, note the flat to miss the head of the bearing bush. The

gear remains captive by use of a circlip groove, but this is no commercial circlip. Instead, there is a disc of Delrin 0.20mm thick with a 1.85mm hole drilled in the centre. This disc is pressed over the end of the shaft, I found a BA box spanner ideal for applying pressure whilst doing this. The disc then drops into the undercut, fit this item only when the constructor is satisfied with the freedom of the set-up, getting the Delrin washer off is a real pain. Before the end plate can be assembled to the body, it is necessary to fit the arbor, as the arbor securing Allen screw is hidden beneath this plate. Lubricate the worm with light machine oil, but do not over do the lubrication before offering up the worm feed ring and dial assembly. The 2mm wide key needs to be a nice easy slide fit in both keyways but not loose. These keys can be troublesome to stay put, but a small centre pop on one side can keep them in their place.

The tool slide has a small pin on the underside to restrict the slide travel, this can be secured with a drop of Loctite Retainer once the slide has been checked to see that this pin does not foul the bottom of the groove in the main body. The phos bronze feedscrew nut is slipped into the tool slide after applying some grease to the thread. With the tool slide in the main body. The feedscrew is now threaded into the feedscrew nut until the endplate retaining screws are about to engage the threads in the main body. These need gentle coaxing into the threads, a couple of turns on each at a time, until they are just nipped up. Using the 2mm Allen key bring the tool slide up against the endplate. Release the cheese head screws and centralise the endplate with reference to the flat on each side of the endplate with reference to the main body. If the dimensions have been adhered to then a faint witness line should be visible each side of the

Fig.7



endplate. A gap exists between the dial and the endplate when this is assembled onto the main body. The design gap is 0.35mm, using feeler blades of this dimension set the plate vertically. As the 12-tooth gear protrudes slightly above the endplate this needs to be out of the neutral position. Otherwise, a false setting may be made. Nip the cheese head screws up and check to see if the tumbler gear will go easily from one direction to the other. It may be found the gear teeth meet "end on" and will not permit engagement. Rotate the

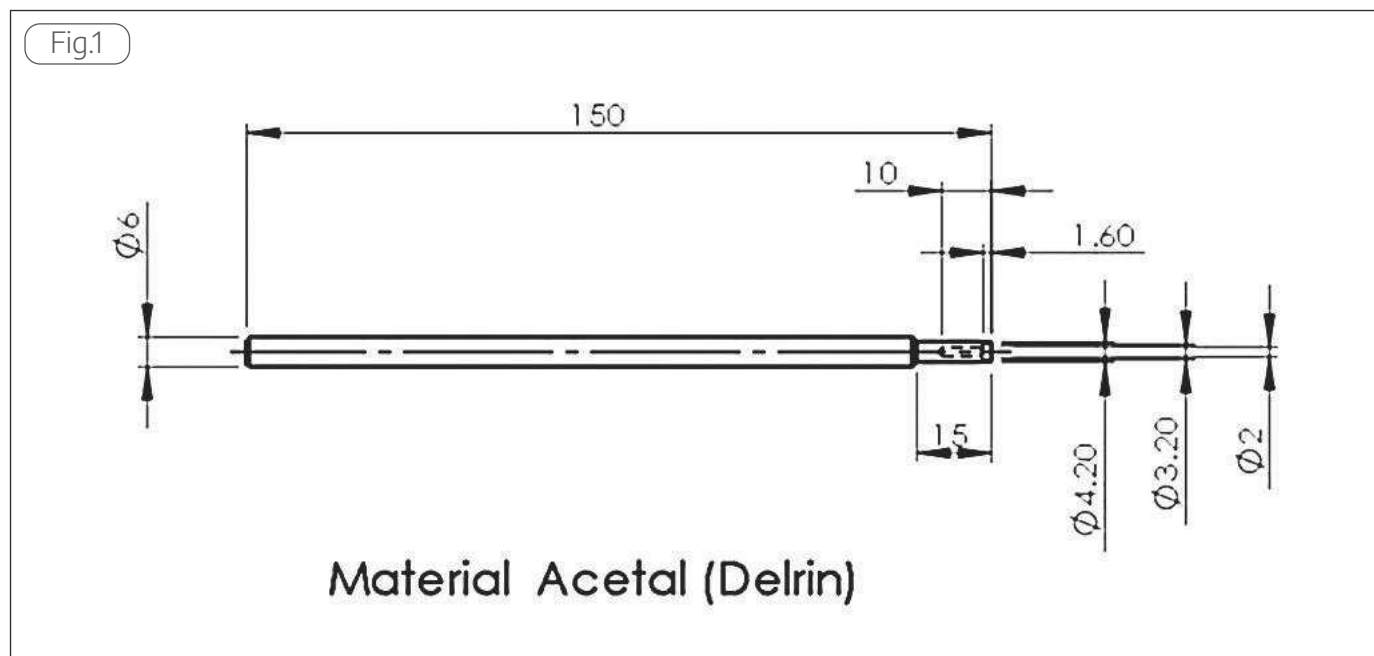
feed ring while trying to engage that particular feed direction and it should drop in. If there is any difficulty engaging in either direction increase the feeler blade setting in 0.05mm increments until the selector will easily go from one direction to the other. Record this setting for future reference, the setting on my head was above the design setting, so do not be worried if the measured setting is solely dependent on the position of the feedscrew hole with reference to this edge to start with. Now try your

handy work, the feed ring should be silky smooth with no hint of tightness and irrespective of which feed direction is selected the feed ring should not show any resistance in either direction. Be sure to tighten the two cheese head screws. When all the checks are complete the last thing to do now is put the boring and facing head to work **photo 12**.

Finally, my thanks to John Slater for the 3D views that accompany this article, as well as his help and encouragement whilst making this diminutive boring head. ■

A Simple Nut Starter

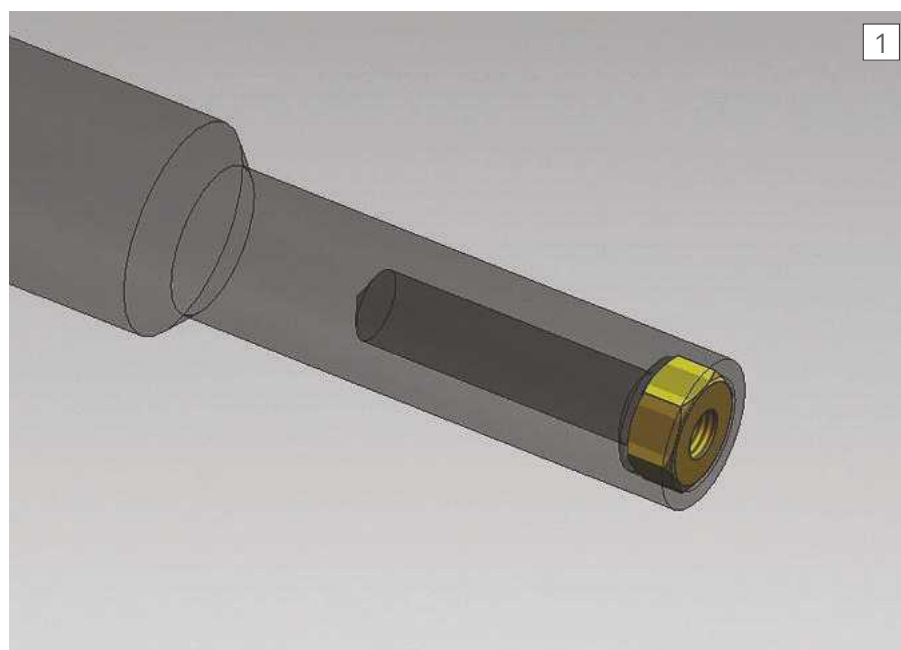
Phil Missing describes a handy little tool for working with tiny fixings.



Over the past few years working on my 2" Scale Fowler traction engine I have found handling and fitting some of the smaller fasteners becoming more difficult and I thought this tool may be of interest to others who perhaps are experiencing similar difficulties.

I don't possess a set of BA nut runners or a universal nut starter, but even if I did, I'm not sure they would be the best solution, what I needed was a tool that held a nut firmly so that it doesn't drop without using Blu-Tack etc. before threading it on to the screw. It needed to be a small diameter tool so that it could fit into a confined space, and it had to be quick to make because I needed it now! to avoid any further frustration while trying to fit some 10 BA brass nuts.

My solution was a simple turning job. I had some short lengths of 6 mm Acetal (Delrin) rod, so I made a tool about 150mm long and by drilling the end 10BA clearance diameter and deeper than the projecting stud then counter drilling 3.2 (just over 10BA A/F size) x 1.6 (approx. depth of the nut), **fig. 1**. Then by reducing the outside diameter of the rod to 4.2mm the tool could clear the nearby metalwork and the reduction of the wall thickness



How the nut starter grasps the nut.

allows the plastic to stretch and fit snugly over the nut.

I load the Nut Starter by first placing a nut on a firm flat surface and press the tool on to it until the nut is held firmly and flush with the end, **photo 1**. The nut is then ready to screw onto a stud or screw in any orientation without fear of dropping it.

After tightening the nut until it's "hand tight" I then remove the tool it and if necessary, finally tighten the nut with an open-ended spanner.

This technique could clearly be adapted to suit various nut sizes. ■

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BEGINNERS WORKSHOP

These articles by Geometer (Ian Bradley) were written about half a century ago. While they contain much good advice, they also contain references to things that are out of date or describe practices or materials that we would not use today either because much better ways are available or for safety reasons. In particular, never use abrasive cloth on a lathe without a backing board. These articles are offered for their historic interest and because they may inspire more modern approaches as well as reminding us how our hobby was practiced in the past.

Polishing metal surfaces

GEOMETER explains the theory and practice of obtaining highly polished surfaces and mentions some of the snags

PRECISION COUPLED to good quality of surface finish is the object of beginner and expert alike in metal work, and often the one fails less from lack of skill than from lack of knowledge of what to attempt. Even the practical expert's knowledge may be limited to workshop procedure and not reinforced by the elementary laws of reflection of light.

For purpose of explanation, light rays are regarded as proceeding in parallel straight lines to a surface, upon striking which they are reflected. The rays striking the surface are the *incident* rays, and those leaving are the *reflected* rays. In regard to the surface, the angle of the *reflected* rays is always exactly the same as that of the *incident* rays.

The "surface" for individual or small numbers of "rays is very small

and if a large area, generally flat, consists of numerous facets or small surfaces tilted at different angles, the parallel *incident* rays are scattered, as *reflected* rays. Thus, on observation, such a surface will not appear "bright" or polished.

In diagrams A, B and C are three types of surface, and the *incident* rays are 1, 2, 3, 4 and the reflected rays 1', 2', 3', 4'.

At A, the surface is both flat and smooth and polished so that light striking it is reflected towards the observer. At B, the surface is not flat, but has been polished so that although it is smooth (to the touch) the light is scattered, and some areas appear brighter than others. At C, there is a series of uniform ridges, such as might be produced in a machining process, say, on a lathe, and the light is scattered according to the formation of the ridges.

Where the depth of such ridging can be kept small by fine machining, grinding or draw-filing, a surface such as C, generally flat though not polished, is superior to an uneven polished surface such as B.

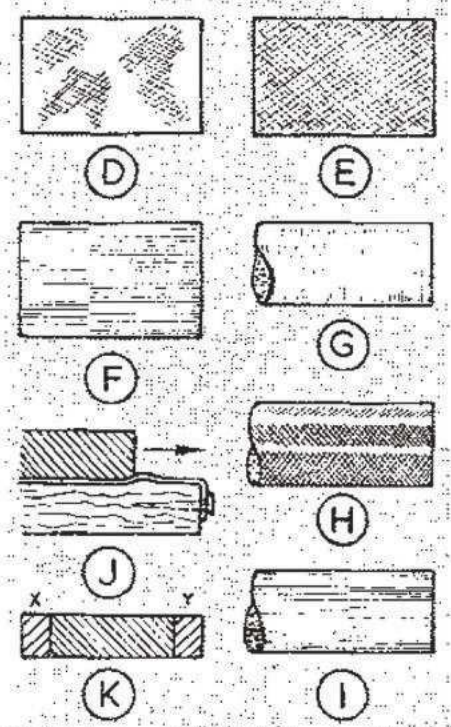
Smoothing and polishing

Before a surface can be polished, it must be reduced below the level of the deepest scratch or pit mark, or this will remain to mar the finish. Work can then proceed by hand with abrasive cloth in descending fineness to the stage where, using worn cloth, no further improvement is possible. Then cloths or felt and liquid metal polish can be used.

On a polishing spindle, work can be finished with emery bobs and polishing mops. In either case, a result as at B would follow from the formation of hills and hollows.

Eliminating waviness

For best results, large geometrical errors or waviness must be eliminated as well as pitting. Careful diagonal filing, D, reveals high spots, and continued produces a surface as at

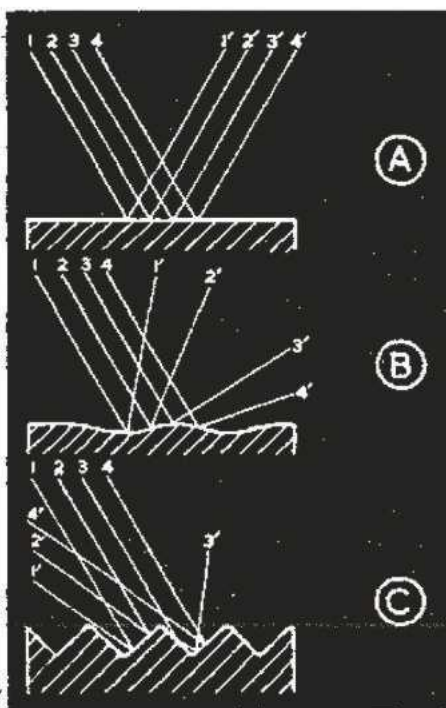


E-which is attractive when fine files are used. Uni-directional filing or draw-filing produces a finish as F, as is often done on tools.

Round work revolved in a lathe can be polished with abrasive cloth, but the waviness is perpetuated in a series of rings, G. Rapidly oscillating the cloth results in a criss-cross pattern, H, tending to show waviness and eventually reduce it. Maximum effect in this respect follows, however, from using a fine file, or abrasive cloth wrapped over a file. Abrasive cloth used lengthwise on a rod produces a longitudinal pattern, I, revealing machining or grinding marks.

Flat surfaces on a component can be smoothed and polished by laying a sheet of abrasive cloth on a flat metal surface (surface plate or lathe bed), or a piece of thick glass, and rubbing the component on it.

Care is necessary not to round the edges of component polishing in this manner, through the cloth pushing up slightly, J. This effect is commonly avoided as at K, through a block or strip of metal, x, and y, being each end of, the component, all faces level.



Universal Tool Post Fixture



18 Riveting T nut to Bolt



19 Completed tool post clamp and Riser Block



20 Completed Universal Tool Post Fixture



21 Slitting Saw Holder

Stewart Hart makes a lathe tool post grinder with a number of other applications - Part 2

Again, the tool post clamping bolt will be made to suit your lathe, mine was threaded M10 with a T nut to suit my tool post riveted to the bolt. That's it the fixture is completed all you need now are some tool holders, **photo 20**.

Because the fixture is used in different orientations you have to be careful with the motor direction, you have to ensure

that the direction of travel will not create forces that will unscrew the holder you can do this by changing the orientation or reversing the motor by simply swapping the wiring round; reversing the polarity of the motor.

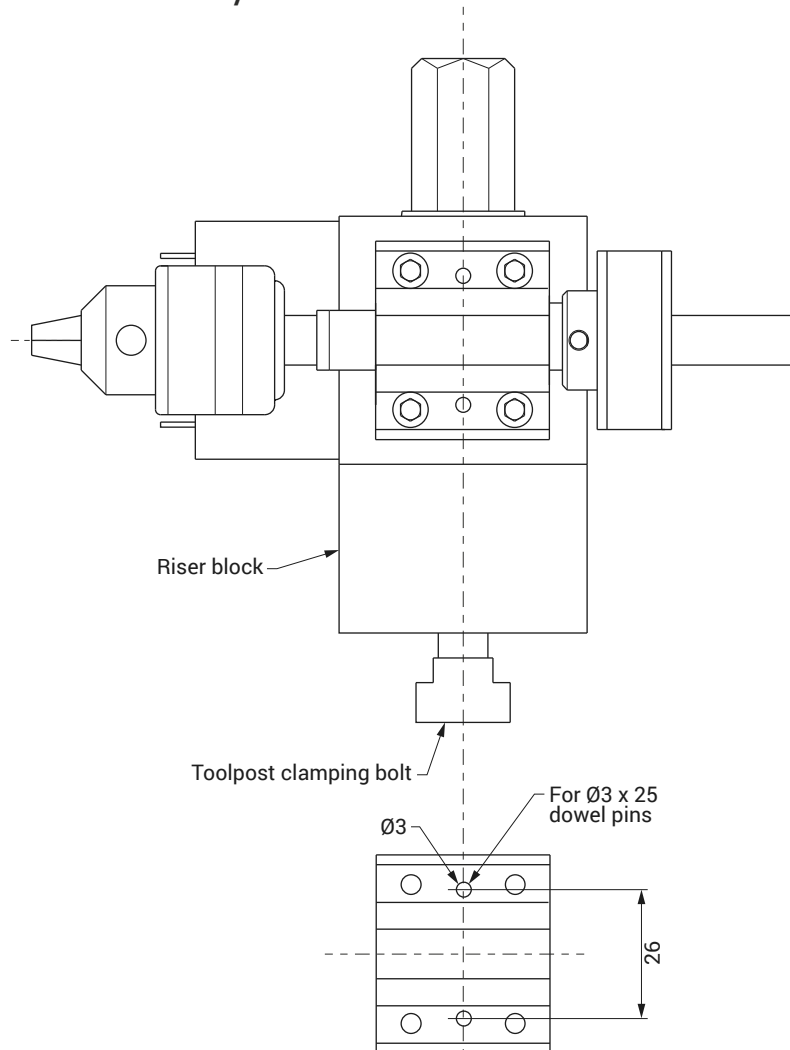
One end of the fixture has the drill chuck permanently in place the other end has the 10 mm shaft for fixing tool holders. The kit comes complete with a slitting saw holder that may also be used for thin cut off grinding disc, this holder comes with a left hand clamping nut, **photo 21**.

The ER16 collet holder is available on line but it comes with an 8 mm through bore, to open this up to 10 mm first

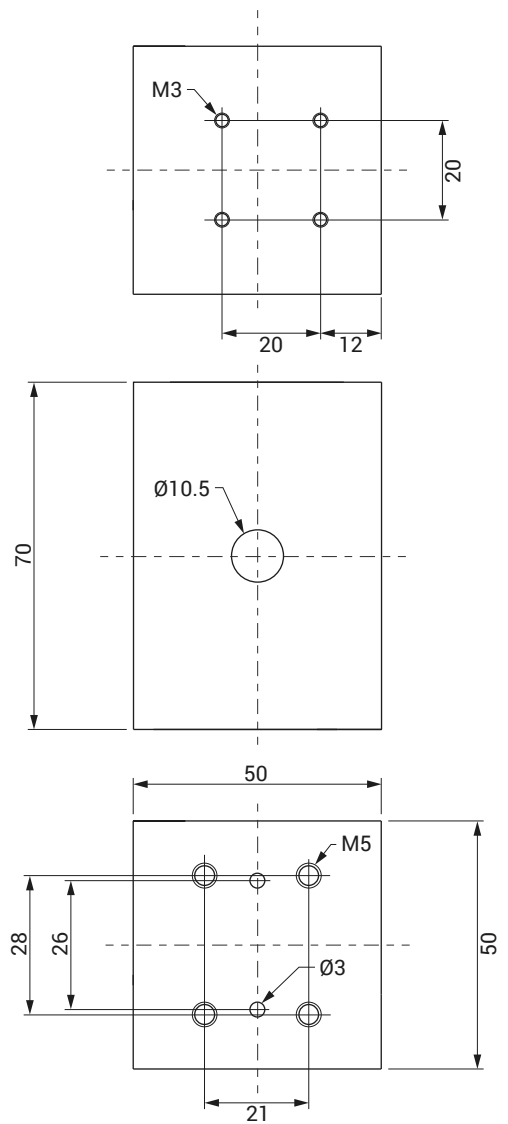
clock the taper bore true in a four-jaw chuck. To ensure that 10 mm diameter is concentric to the taper it is best to bore out to 9.5 mm diameter then to ream 10 mm. The material has been heat treated but I found that it was tough rather than hard and perfectly machinable, **photos 22, 23 and 24**.

The grinding wheel arbour was made for a 75 mm diameter by 10 mm wide and 8 mm bore wheel, it was a wheel I had stashed away that would meet my requirements. You have to be careful when mounting a grinding wheel, it can be dangerous if done wrongly; you also have to be careful not to exceed the wheels safe operating speed. The

General Assembly Front View



Modification To Bearing Housing



Mounting Block
Mat'l: 2" sq. aluminium
1 off



ER16 Collet Holder



Clocking taper in Collet Holder True



Reaming 10 mm after boring to 9.5mm



Using Fixture for the first time to cross drill for grub screws



Parting Off

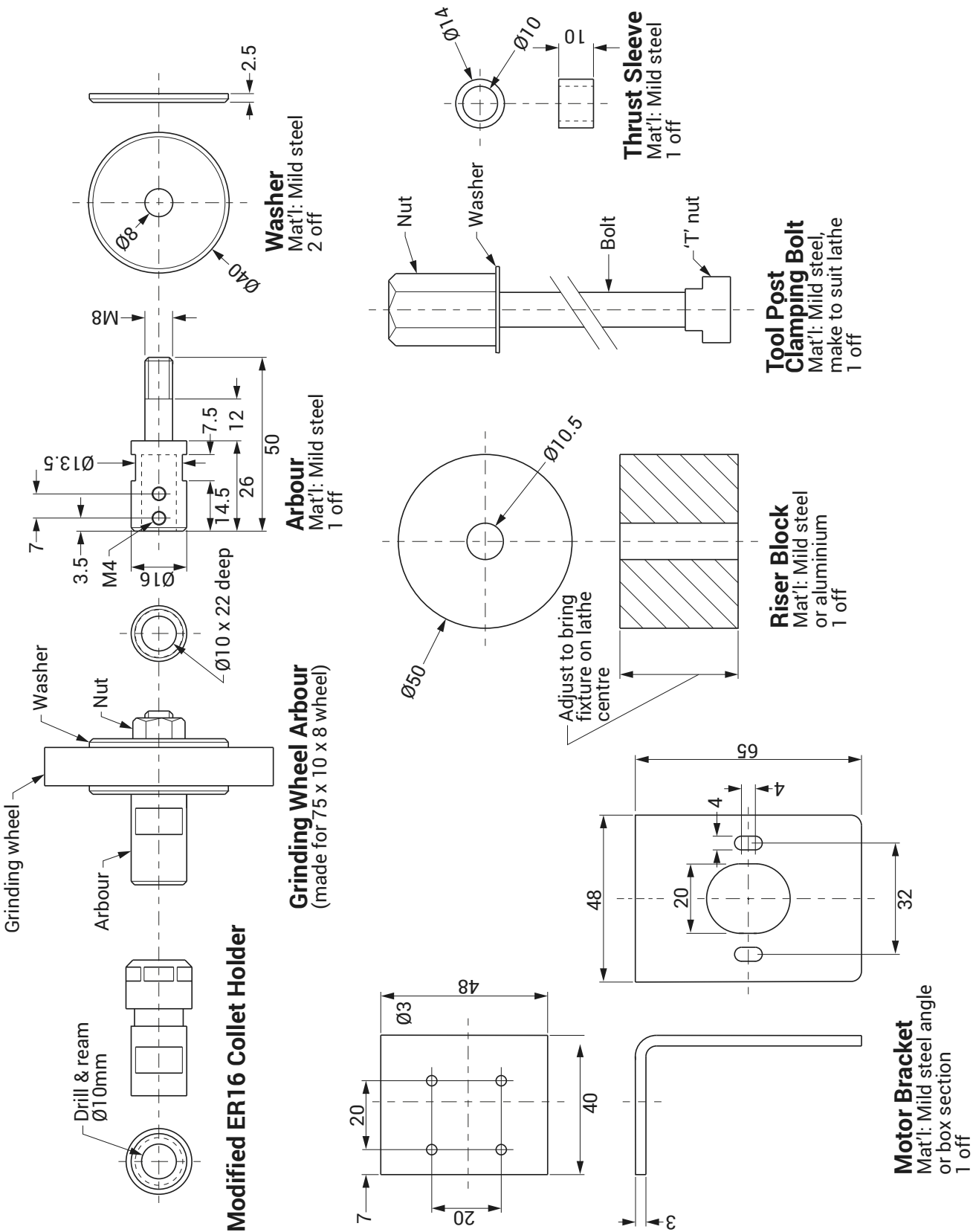


Clocking spare spindle true in four jaw chuck



Arbour held on spindle for turning down to 8mm

Modification To Er16 Holder

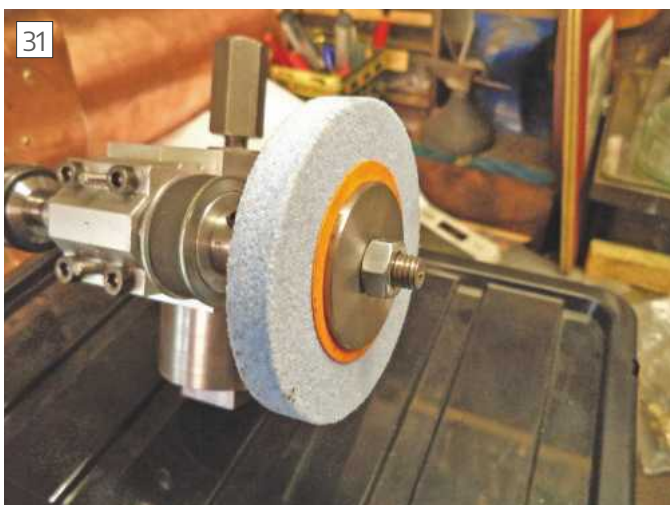




Slice cut off 40 mm diameter bar



Washer drilled and face using soft jaws



Completed Arbour with correctly mounted wheel



Set up for cutting key way with ER16 Collet holder and 3 mm slot drill

arbour is made from mild steel, the first job is to face and turn the outside diameter and drill and ream the bore 10mm. You now have an opportunity to test the cross-hole drilling capability of the fixture by using it to first centre then to drill for the M4 grub screws and part off, **photos 25 and 26**.

I had a spare spindle so I clocked this up true in the four-jaw and fixed the arbour to it using the grub screws and turned it down to the wheel size of 8 mm and threaded M8 with a die, doing it this way will ensure that the wheel will run true, you could do it just as easily by turning a 10 mm mandrel up,

photos 27 and 28.

I next made the washers; I cut two 3 mm thick slices off a 40 mm diameter bar using the band saw, then gripping the slices in the chuck using soft jaws they were faced off and drilled then flipped round and faced off to thickness. That's the grinding wheel



Test Piece showing cross drilled hole and key way cut



Set up for cutting screw driver slot



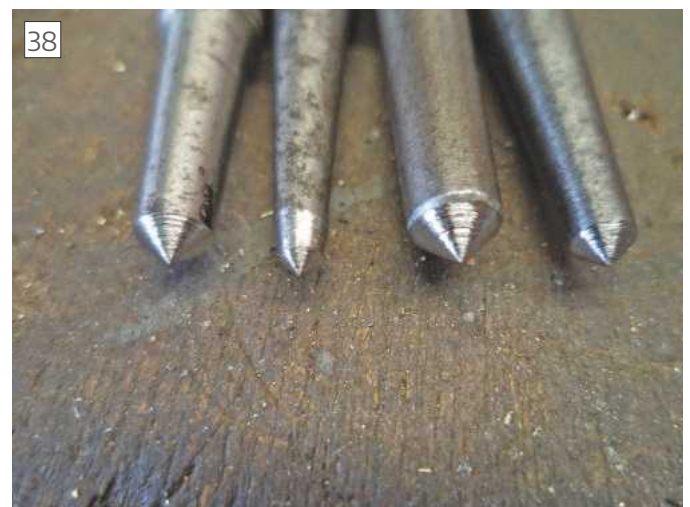
35
Slotted Screws



36
Regrinding worn dead centre



37
Reground Centre



38
Sharpened Centre punches

about complete, there just one thing to add always mount a grinding wheel using a thick card blotter washer between the wheel and the steel washers, **photos 29, 30 and 31.**

The fixture has multiple uses beyond cross drilling, including:

With an end mill in the ER16 collet it can be used to cut a key way in a bar, **photos 32 and 33.**

With a slitting saw it can be used to cut nice neat screwdriver slots in screws, **photos 34 and 35.**

As a tool post grinder, it can regrind worn dead centres, sharpen centre punches and with a stone point you can grind worn bell mouthed chuck jaws true, **photos 36, 37 and 38.**

That's just some of the jobs that I've done with the fixture and I'm sure there are lots more, I've seen a video of a similar fixture being used to cut spur gears, so it's an extremely useful bit of kit for the home workshop. ■

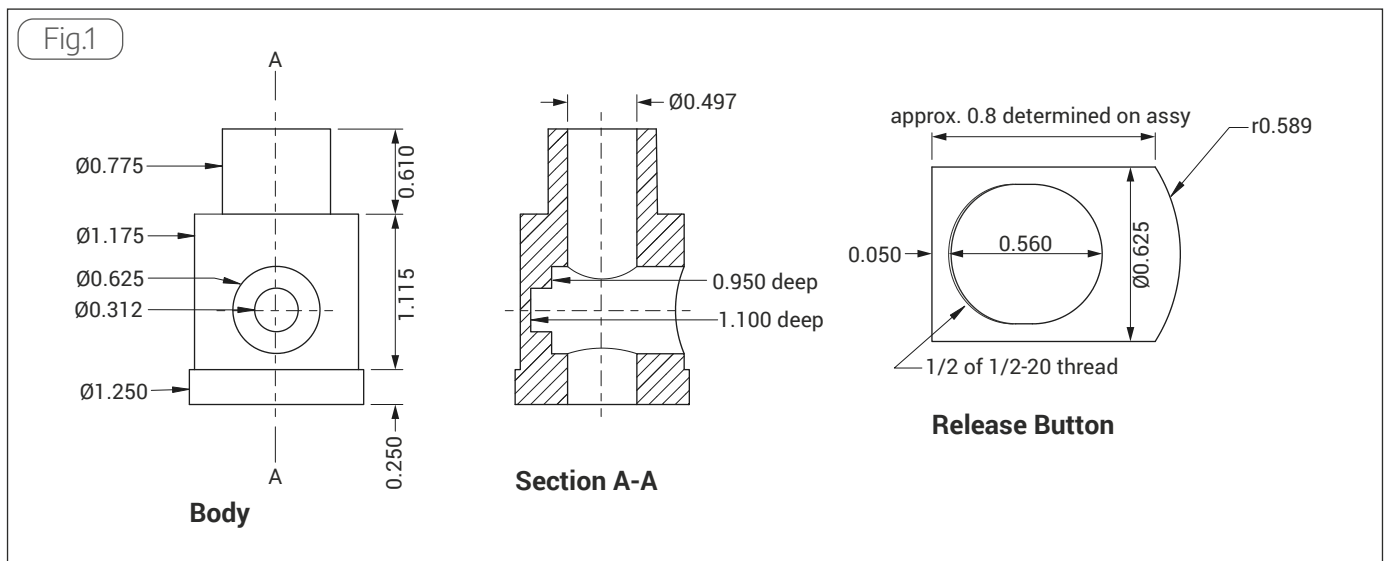


39
Worn Bell Mouthed chuck jaws ground true

A Quick Stop for Moveable Quill Machines



John Purdy worked with a friend to design this neat depth stop for the adjustable quill on his VMC style mill, easily adaptable to many other mills and drills.

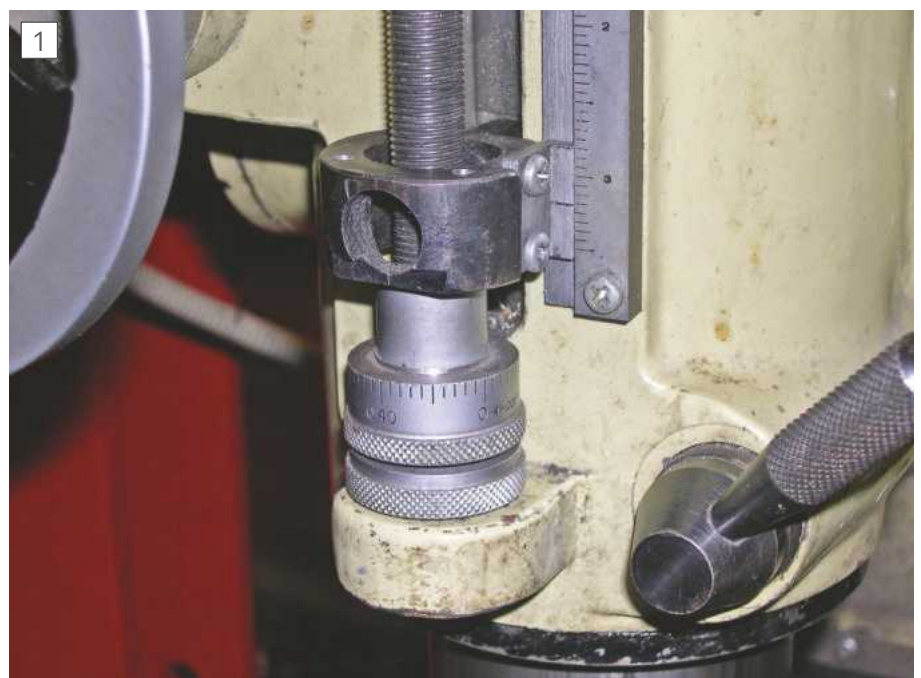


In common with many other mills my VMC style mill has a quill stop that consists of a threaded collar on $\frac{1}{2}$ - 20 UNF threaded rod. I have found that it always seems to be in the wrong position and is a pain to run it up or down the rod to set it, hence it doesn't get used as often as it might. There is a commercial version of a quick setting stop but it is relatively expensive, and I find it hard to justify for the small convenience it would provide.

A short while back, Phil, a friend of mine, also a model engineer, asked if I knew how these quick adjusting stops worked as he wanted one for his mill, which is similar to mine only smaller. He can't use the commercial one as the rod on his is threaded 12 x 1.0mm. After numerous discussions back and forth we came up with a design that looked feasible. It consists of a main body and a spring-loaded button to engage or release the body from the threaded rod. Phil made one for his mill, and although it worked, he wasn't satisfied with it, so he made another with some improvements which worked much better. He then offered to make one for my mill.

What follows is a description of its manufacture. **Figure 1** shows the details of the stop. Note all dimensions quoted are for my mill and should be adjusted as required for the mill in question. The

governing dimensions are the thread size, the max diameter that can be accommodated on the rod without interfering with the head casting, and the distance from the stop collar on the



Original quill stop with the quill at the maximum downward travel



New stop installed on the mill



The parts of the new stop

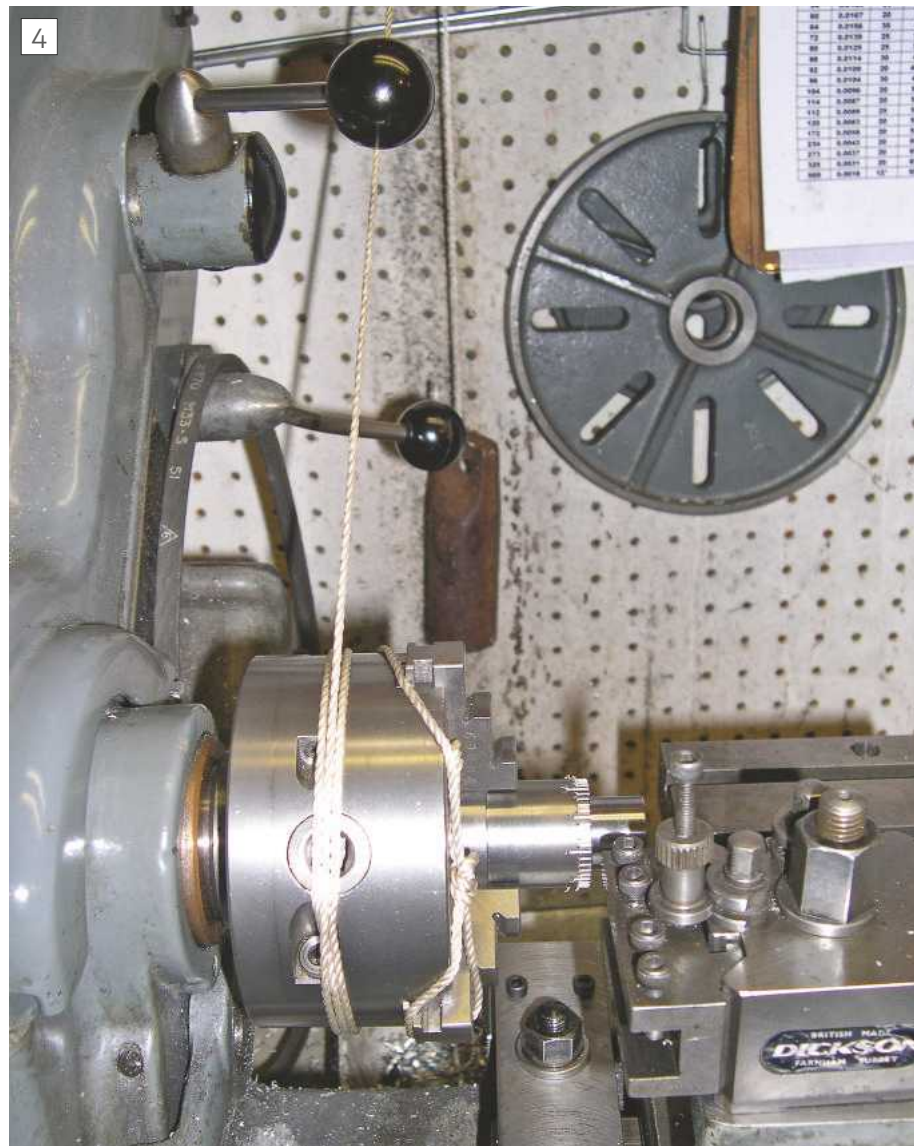
quill to the casting at the bottom of threaded rod with the quill at its lowest travel. Those dimensions on my mill are $1\frac{3}{32}$ " and $1\frac{5}{8}$ " respectively.

Photograph 1 shows the original stop on my mill with the quill at the maximum downward travel, **photo 2** the new stop installed on the mill, and **photo 3** the parts of the stop.

To construct the stop a piece of $1\frac{1}{4}$ " FCMS was chucked it the 3 jaw and the end faced and drilled down $2\frac{1}{4}$ " in stages to $1\frac{3}{64}$ ". It was then bored to 0.497" for a close sliding fit on the $\frac{1}{2}$ - 20 threaded rod. Phil had found with his first attempt that this hole has to be a close fit on the thread for good action. As my thread measured 0.4956" it was bored to 0.497". Next the two outer diameters were turned to size, and the $1\frac{1}{4}$ " skimmed for about $\frac{1}{2}$ " to give a true surface for the knurling.

The piece was transferred to the mill vice and clamped horizontally on a couple of parallels. The spindle was centred on the 1.175" diameter at a point $11/16$ " back from the front face of the 1.175" diameter section to form the hole for the release button. This was drilled to a point depth of 0.950" in stages to $\frac{1}{2}$ " diameter, then opened up to $\frac{5}{8}$ " by plunging down a $\frac{5}{8}$ " end mill to a depth of 0.950" to create a flat bottomed hole. A $\frac{5}{16}$ " slot drill was then used to make a 0.150" deep pocket for the spring. The body was cut off the bar and the cut face cleaned up to leave the $1\frac{1}{4}$ " dia. for the knurl $\frac{1}{4}$ " wide.

To make the release button some $\frac{5}{8}$ " dia. FCMS (free cutting mild steel such as EN1A Pb) was clamped horizontally on parallels in the mill vice and a $\frac{19}{64}$ " (tapping size for $\frac{1}{2}$ -20) hole was drilled centrally through, about $\frac{1}{8}$ " from one end. It was then tapped $\frac{1}{2}$ -20. A $\frac{3}{8}$ " end mill was used to elongate the hole away



Cutting the graduations

from the end of the rod to remove the treads on that side. This was followed by a $\frac{1}{2}$ " end mill to form an oval hole, smooth at one end and with half of the $\frac{1}{2}$ -20 threads at the other. The length

of the oval was checked by inserting the threaded rod and ensuring that when moved toward the smooth end, that the threads totally disengaged, and the rod moved freely up and down. In my

example the elongated hole is 0.560" long. The end of the parent rod was skimmed back in the lathe to leave a minimum thickness from the thread, 0.050" in my case.

After a suitable spring was found (the one in mine is .275 X 1/2" and consists of 5 turns of .021" dia. wire), the unit was assembled on the threaded rod and checked that when the button (still part of the rod it was made from) was pressed in, the unit disengaged from the thread and could be easily moved up and down. When satisfactory, and with the threads engaged, the profile of the outer surface of the body was marked on the protruding part of the rod. The embryo release button was cut off, and the end profiled back to the scribed line. It could be left square as long as there is sufficient clearance to the head casting for it to rotate around the threaded rod when installed.

Lastly the graduations at the top of the body (in my case 50, giving 0.001" increments) and the knurling were completed. The graduations were made 0.225" long for the 10s, 0.175" for the 5s, and 0.125" for the units,



The indexing setup for graduating

numbers are 1/16". The knurl I used was a "medium" of 21 TPI.

The end result is a stop that, when the button is pressed in can be easily

slid up and down the rod but as soon as the button is released locks solidly onto the rod and can be rotated for fine adjustment. ■

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Triple Oscillator

Hotspur builds a three-cylinder oscillating steam engine capable of running in either direction.

Driving Truck

Tim Coles presents a 7 1/4 inch gauge driving truck, designed to carry two people and conforming to a prototypical outline.

Gearbox

Ted Hansen decides to replace the transmission in Westbury's Aveling road roller with something a bit closer to the prototype.

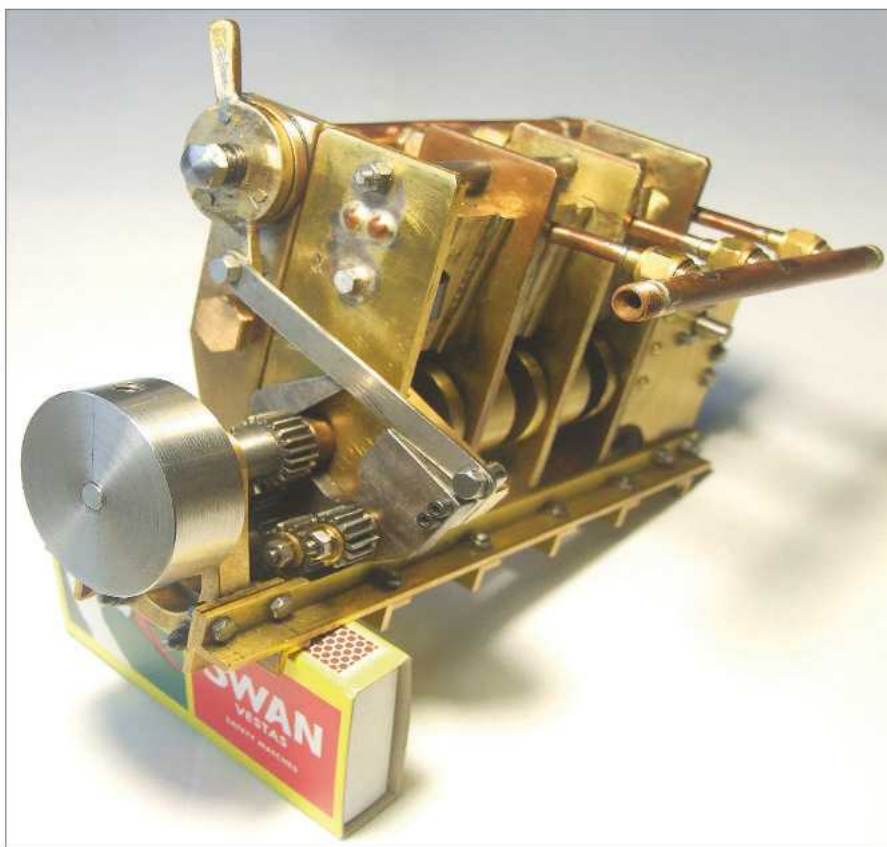
Astronomical Clock

Adrian Garner completes the case for his astronomical bracket clock.

Bike

Patrick Hendra describes his lockdown project – the restoration of a 1947 *Vincent Rapide* motorbike.

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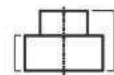
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Watchmaker's Lathe Collets

Adrian Rawson explains how he went about making a series of small collets for a vintage lathe.

My current interest in exploring the use of a watchmaker's lathe is exposing some of the pros and cons of working at small scale. Whilst stock sizes tend to be greatly reduced, many processes require the aid of magnification and a steady hand. But I'm hoping that this addition to my small workshop will prove invaluable if not challenging.

The lathe I acquired is a BTM 8 millimetre. My research shows me that these were made for the war effort in the 1940's but stayed in production for civilian use well into the 1950's. The one I picked up from eBay had its original box and most of its accessories. However, on closer inspection I discovered that the included collets were a mixed bag of originals and replacements, but a good selection of the smaller sizes were there. Having set myself a challenge to make a cylinder escapement for a broken watch, I ordered up a selection of blue steel. When it arrived, it consisted mainly of large diameter (2.5mm ~ 3mm) lengths, that none of my collets could hold.

Having previously made a couple of collets for the Myford lathe, I decided to have a go at these. In principle they seemed straight forward as the only taper involved is a short 20-degree slope easily cut with the top-slide set over at a 20 degree angle. The problem I faced



Internal thread tool

was how to slit the collet once it was formed. This had to be done on the lathe as I don't have a mill. For the Myford collets I'd made a crude collet vice that I could grip in a chuck mounted on a divider. So, I followed a similar approach for the watchmaker's collets.

Making the collet vice

The design for the collet vice is shown in **fig. 1**. This basically mimics the headstock on the watchmaker's lathe, as it includes the taper, the guide slot locator and the drawbar.

The collet itself is shown at the top followed by a section through the complete vice and collet. Note the two 3mm grub-screws set so as to engage with collet guide slot which is only 2mm wide. This proved not to be a problem with the grub-screws I had which were

narrower at their ends. Although I used two, I think one would be sufficient and obviate the need to get two in perfect alignment. Note the length of the slits in the body are shown as 23mm. This was based on using a 3 inch slitting saw and I've shown its arc on the drawing. A smaller diameter saw would require less to achieve the required length of slit in the collet. The overall length of the vice is shown as 60mm, which in my set up was just enough. The step in the drawbar isn't really necessary and could be 7.9mm for all its length up to



Slitting set up

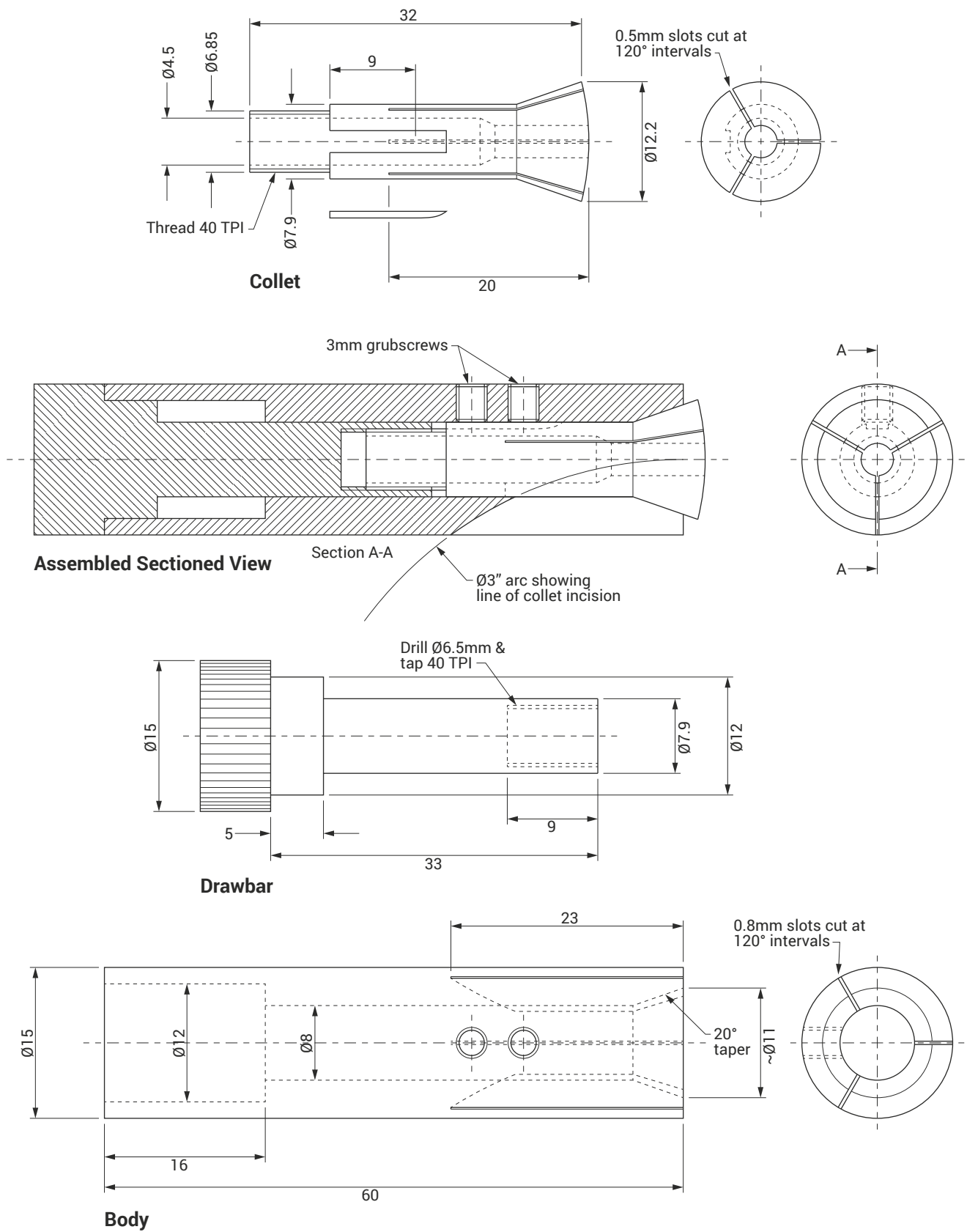


Finished collet holder



Machined and threaded collet

Fig.1



the knurled part. The most difficult operation when making the collet vice was cutting the internal thread in the drawbar. I achieved this with a cutter made from a discarded milling tool as shown in **photo 1**. The actual thread pitch on BTM collets is quoted as 0.625mm which equates to 40.64 TPI. Further research showed me that there are 'WW' and 'B8' collet types which have slightly different thread geometries. However, the BTM specification shown in fig. 2 (from www.lathes.co.uk and used with their permission) seems to fall somewhere in the middle, so I used 40 TPI which worked just fine. I turned the lathe manually to cut the thread, testing it on a collet as I went. I knurled the head of the drawbar and made sure it was slightly less in diameter than the body of the vice, so that it wouldn't interfere when chucked.

Once the vice body and drawbar were fully machined and shown to hold a collet firmly, I mounted it in the divider chuck and cut three 0.8mm slots 120 degrees apart, slightly bigger than the slots on the watchmaker's collet which are 0.5mm. When doing this it's very important to have the object running concentrically on the divider and central to the slitting saw. The set up I used is shown in, **photo 2**.

Photograph 3 shows the finished item. The flanges on the vice body are not needed, they were left over from an aborted Myford collet that I used as my stock. Also, the drawbar shown was made from two pieces silver soldered together.



Drilling to depth



Shaping the face

Fig.2

8mm LATHE COLLETS

Dimensions in Millimetres unless otherwise indicated.

Lathe or Collet Manufacturer	Length	Head Diameter	Thread Length	Thread Diameter	Thread Pitch	Thread Form	Keyway Width
BERGEON	33.5	13.0	8.5	6.82	0.625	WF	2.0
BOLEY - original for Dreadnought	33.0	12.2	8.5	0.270"	0.625	SI	2.0
BOLEY - later for WW lathes	34.0	12.8	8.5	0.275"	40 t.p.i.	WF	2.0
BOLEY & LEINEN	35.0	12.8	9.0	0.270"	40 t.p.i.	WF	2.0
CRAWFORD 2104 - BOLEY & LEINEN	34.0	12.8	8.5	0.270"	40 t.p.i.	WF	1.85
B.T.M. & CRAWFORD 54	32.0	12.2	8.5	0.270"	0.625	SI	1.85
COWELLS	33.5	13.0	8.5	6.82	0.625	WF	1.9
I.M.E.	35.0	12.5	9.0	6.82	0.625	WF	2.0
LEVIN	1.312"	0.50"	0.320"	0.275"	40 t.p.i.	NS	0.075"
LORCH & CRAWFORD 2807	34.0	12.5	9.0	0.275"	0.625	SI	2.0
LORCH - later etched logo	33.0	12.5	9.0	0.270"	0.625	SI	1.85
PULTRA No.10 - 'CONFLX' (CF1)	33.0	12.0	10.5	0.2716"	0.625	SI	1.85
SCHAUBLIN B8	33.5	13.0	8.5	6.82	0.625	WF	1.9
SINCERE CLOCKS/BaiRui/VECTOR	33.5	13.0	8.5	7.00	0.75	M	2.0
STAR	33.0	13.0	8.5	0.270"	40 t.p.i.	WF	2.0
SOUTHERN WATCH & CLOCK SUPPLIES	33.0	12.5	9.0	6.82	0.625	WF	2.0
WEBSTER-WHITCOMB	32.0	12.2	n/a	0.270"	0.625	SI	n/a
WOLF JAHN - 1	35.5	13.2	9.0	0.275"	40 t.p.i.	WF	1.9
CRAWFORD 3378 - WOLF JAHN	34.0	13.2	9.0	0.270"	40 t.p.i.	WF	1.85
WOLF JAHN - 2	35.0	13.2	9.5	0.270"	0.625	WF	1.9



Boring to size

Making a collet

The starting point for BTM collets is a half-inch free cutting steel bar held in the chuck with about 40mm protruding. The dimensions used should be copied from an original collet, and some typical examples are shown in **fig. 2**.

The machined collet body with threaded section is shown in **photo 4**. The 40 TPI thread was checked for suitability with the drawbar from the watchmaker's lathe as cutting progressed. To cut the locating slot I used a 2mm wide parting tool set on its side in the tool holder. Having set its centre at centre height, I locked the chuck and planed the slot out with a few careful passes of the tool, increasing the depth with each pass. The final stage is to drill a 4.5mm (in my case) hole to a depth taken from an existing collet, **photo 5**.

Now the collet can be parted off leaving 3mm or so for shaping the face. It is then chucked by its body and the face shaped using a form tool copied from an original, **photo 6**.

I also drilled a centre hole in the collet at this point. Ideally the collet should be drilled on the watchmaker's lathe, but mine doesn't have a drilling attachment. Also, as I was making a 3mm collet I decided to bore it on the watchmaker's lathe to guarantee concentricity.

Photograph 7 shows this using a boring tool made from a discarded tap.

The next stage is to cut the three slits in the collet using a 0.5mm slitting saw. The collet is mounted in the collet vice and set up centrally in the divider's chuck. I slipped a piece of well-fitting blue steel in the collet to use as a guide for centring the saw. If this isn't done with care the slits won't meet in the



Slitting the collet

middle. I also used the blue steel to set the depth of the cut making sure that the full circumference of the saw/arbour combination was checked to find any high point. Once this is done the depth of cut can be set, as required, by moving the set up towards the saw. In my case, with a 3mm collet, this wasn't so critical, but smaller diameters would be more demanding. Then it's just a matter of cutting the three slits to reach the length

of the slots previously cut in the vice, **photo 8**.

A finished collet is shown alongside an original in **photo 9**. I think it should be possible to make a 0.5mm collet with extreme care and attention, but 1mm is probably as far as I would take it.

Finally, the collet may be case

hardened to give extra durability. I used case hardening powder, which proved to be a straight forward process of heating to cherry red before dipping in the powder. Its recommended that this is repeated a couple of times before a final quench from red hot into cold water. ■



Finished 3mm collet



In our Next Issue

Coming up in issue 314

On Sale 18th March 2022

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**Look out for your copy of MEW 314,
the April 2022 issue:**



Peter King looks at workshop cranes.



Robert Trethewey adapts a golf trolley motor for a milling machine feed.



Howard Lewis describes his design for a workshop comparator.

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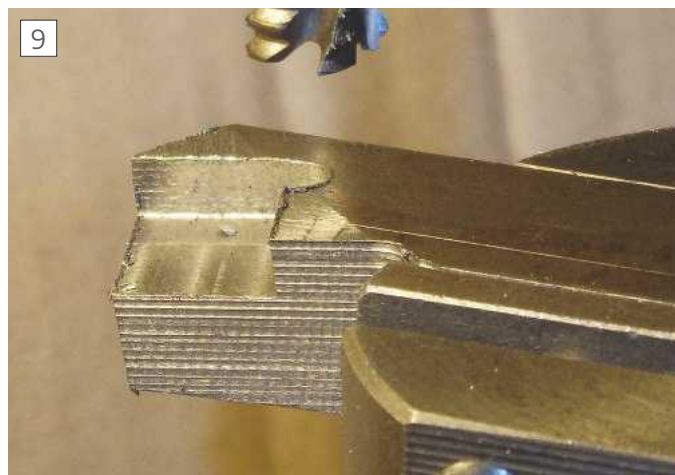
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Making external turning TC tip holders



Jacques Maurel explains his technique for making tungsten carbide lathe tools using commercial tips. Part 2



Machine surface 4 to give clearance.



Roughing out surface 9.

Seventh step: machining surface 4: set $R1 = +40^\circ$ (as for step three) with the same ripping mill (longitudinal feed) see **photo 9**.

Eighth step: machining surface 7: set $R1 = -5^\circ$ with the ripping mill (longitudinal feeding).

Ninth step: take out the universal vice, the part is tightened directly in the machine vice and surface 9 roughed with the ripping mill see **photo 10**.

Tenth step: the universal vice and part are set in the drilling machine's vice ($R3 = -45^\circ$ and $R2 = -8.5^\circ$) and a tip used for spotting the hole position with a 5.1mm diameter drill. The hole is then drilled to 4.3mm diameter and tapped diameter M5, see **photo 11**.

Eleventh step: plain vertical milling of the remaining surface 9.

Steps six to nine and step eleven can be done by sawing and filing as these surfaces are just for clearing the tool holder under or aside the tip.

Tip set screw: made from a standard FHc/90 M5-15 (flat head) screw quality 8-8 (minimum), see fig. 5. It's also



Spotting hole, note use of universal vice from Issue 306.

possible to use a "dome head" screw CBHc M5-15, the head turned to 7mm diameter and chamfered as seen on **photo 12**.

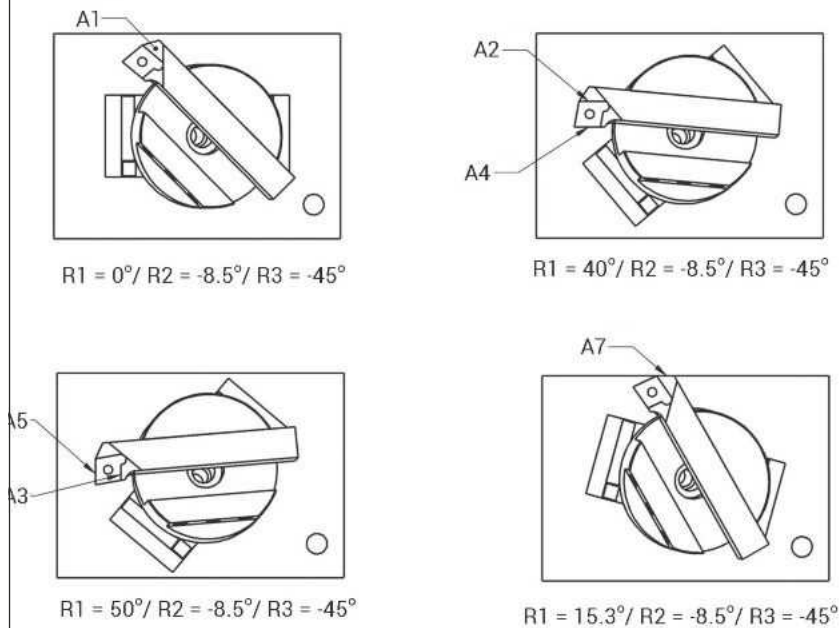
Making the turning and dressing tool with C tip: SCLNR 15 15 H 12 (see fig. 6)

Follow the previous steps with the help of **drawing 7**.

Making the finishing turning tool with T tip: STJNR 15 15 H 12 (see **fig. 8**)

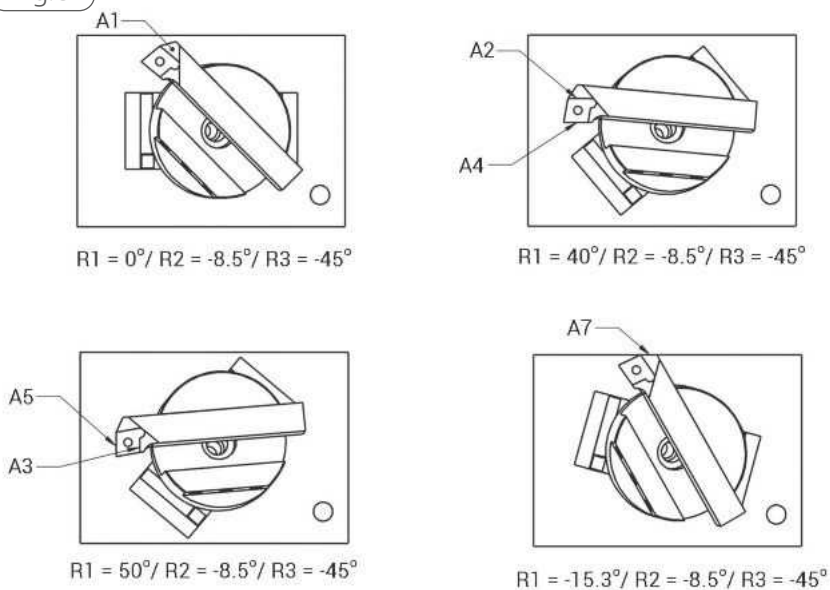
Again, follow the previous steps with the help of drawing 9. A special

Fig.7



Machining Angles For Toolholder SCLNR 15 15 H 12

Fig.8



Machining Angles For Toolholder SCLNR 15 15 H 12

set screw is necessary, described on fig. 10 (showing a hex imprint and a possible plain slot for driving), the spotting and first hole should be made with a 3.8mm diameter drill. This tool works well, but if you want a two-side restraint for the tip, it's easy to do see **photo 13**.

Another less useful, external tip holder that I've made, is shown in **photo 14**.

For turning with the obtuse angle of C tips: SCBNR 15 15H 12 see **fig. 11** and **12**.

Using C tips with a 45° angle for chamfering: SCSNR 15 15 H 12. This tool is of no use as chatter always occurs when chamfering, so I won't give any description.

Making a special tool using triangle 2 tip already described. The conception was made to get 5° front and side rake



Modification of fixing screw.

This tool works well but makes ribbon like chips (on ductile materials) as no chip breaker is available.

angle (so 6° are remaining for the front and side relief) see **figs 13, 14** and **15**. The tip is locked by a clamp with a CBHc M4- 15 cheese head screw. The side contact between tip and tip holder is along two lines (11° relief not taken in account). This tool works well but makes ribbon like chips (on ductile materials) as no chip breaker is available. It appears these tips were designed for milling cutters.

The quick and easy way:

If you are in a hurry and don't want to make a standard tip holder see **fig 16** and **photo 15**:

The 8.5° angle is necessary to get the good clearance (from the toolmaker's catalog). The tip is set in the fashion described by Bob Loader (see **ref. 1**):



Holder for triangular tip, note tab to give restraint along two sides.

Fig.9

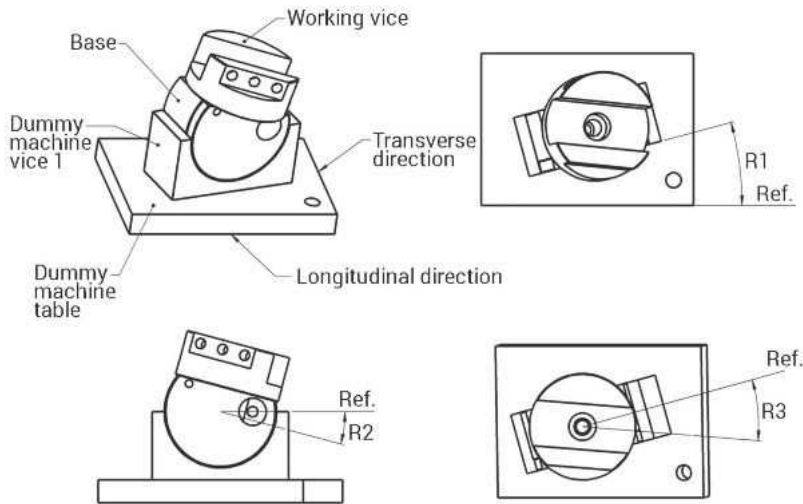


Fig.10

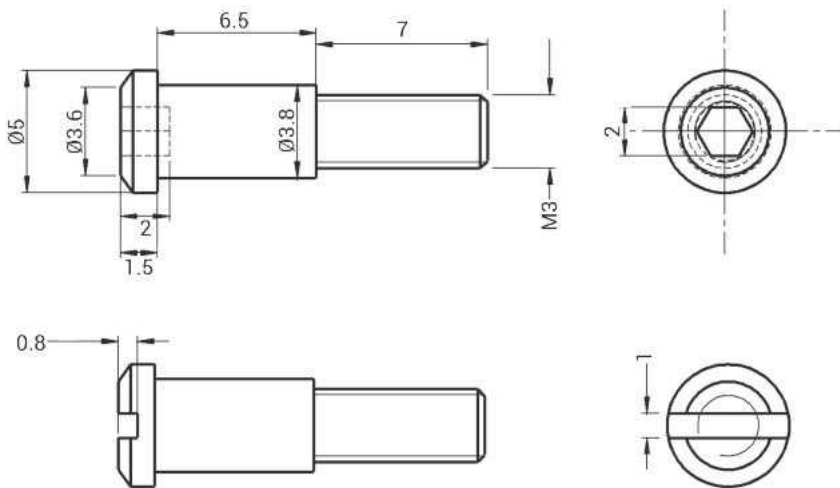


Fig.11

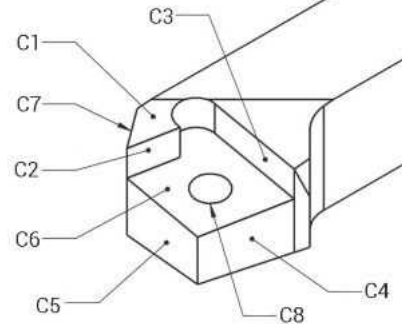
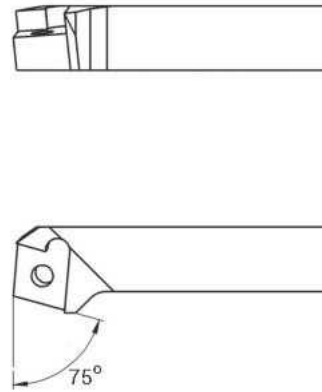
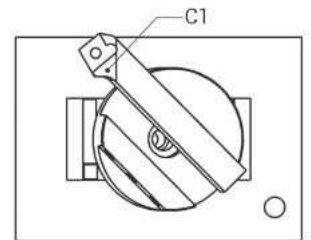
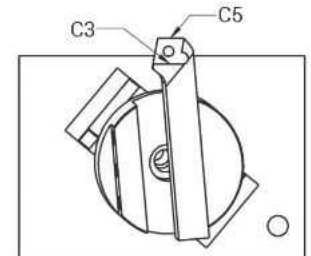


Fig.12



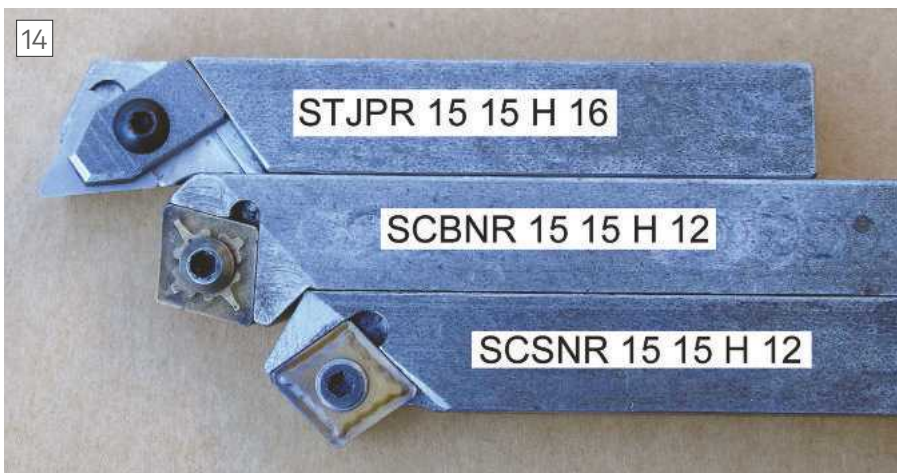
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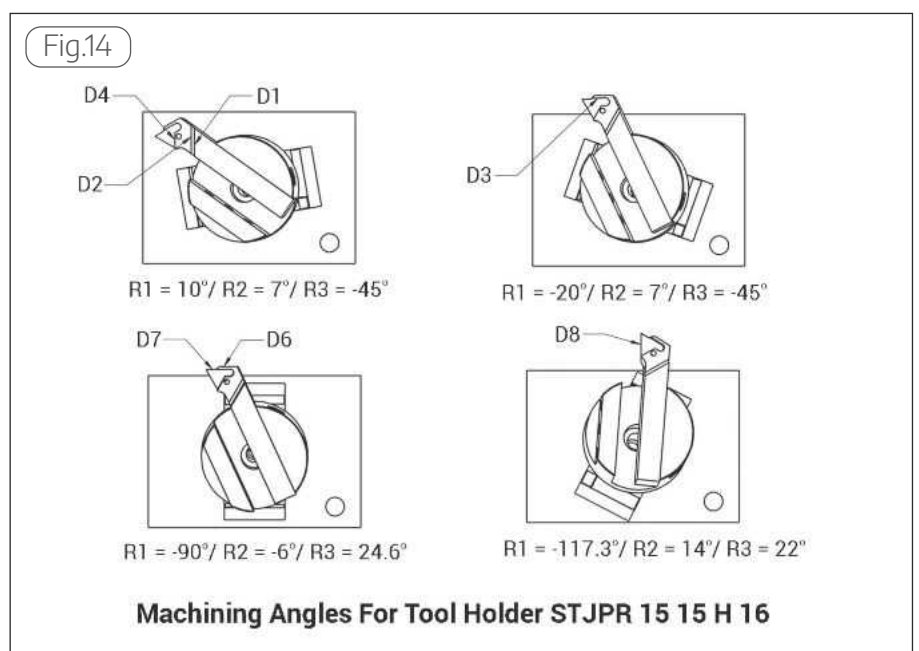
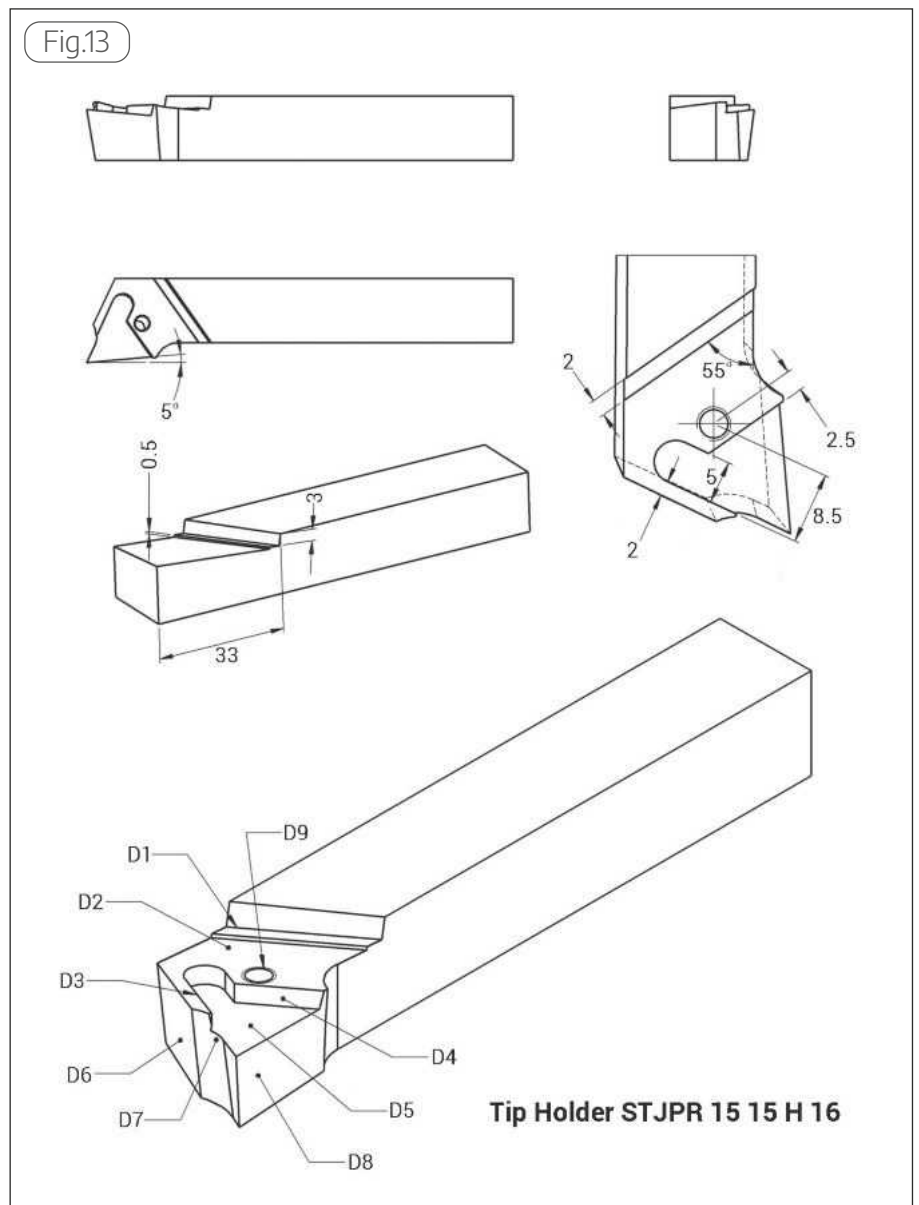
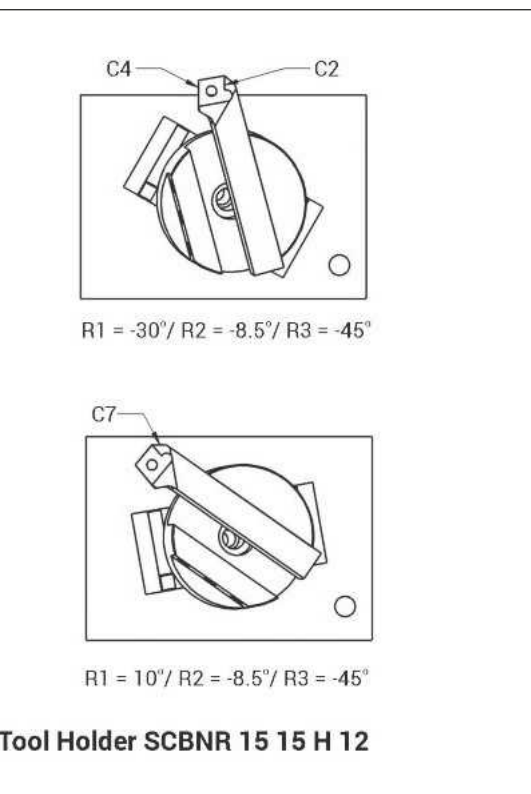
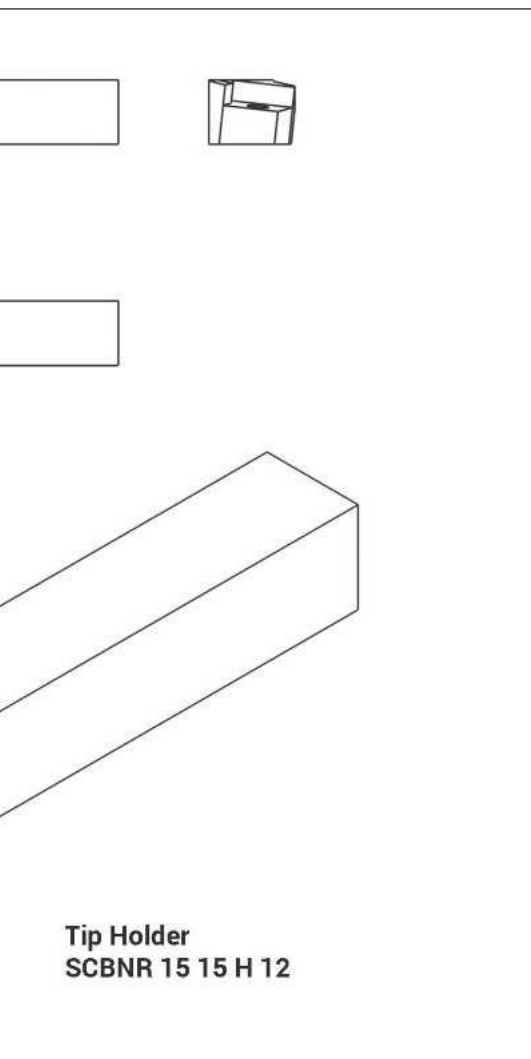
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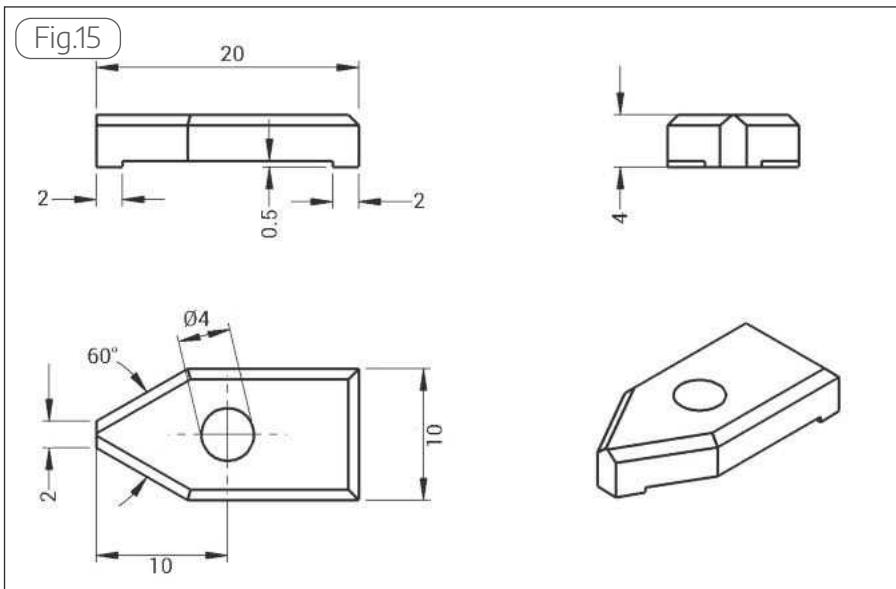
Machining Angles For

14



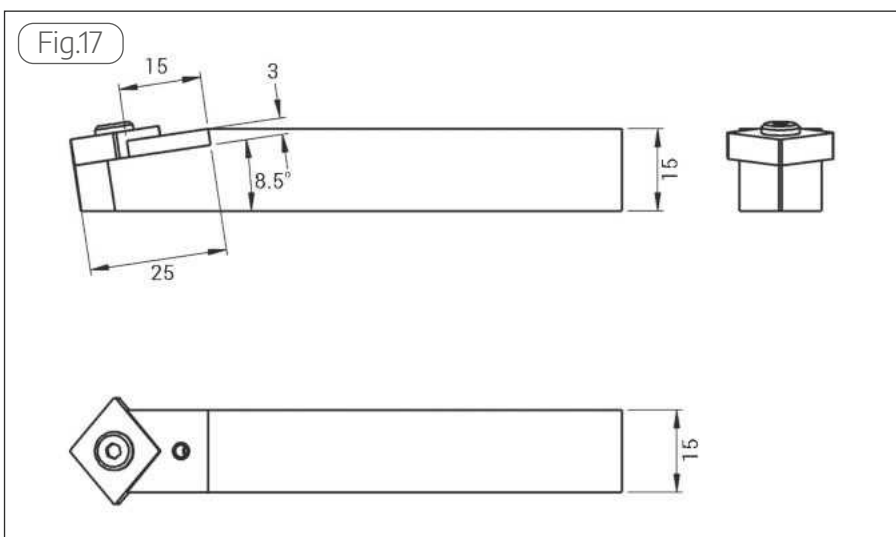
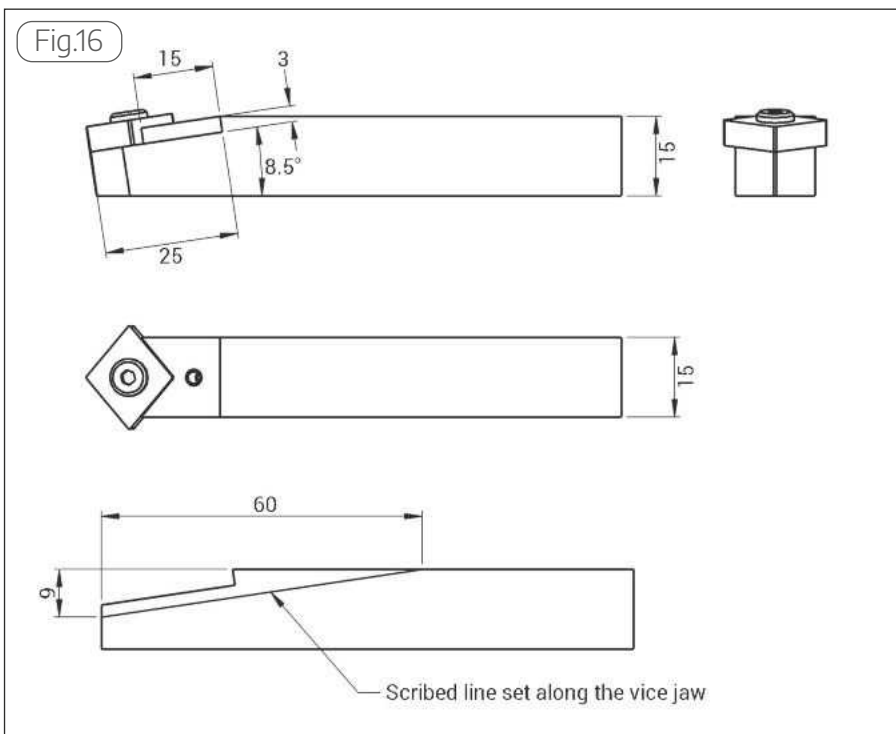
A further selection of tips and holders.





Simple tool holder using a shaped plate to register the tip position.

Set on a tip contacting the fence and mark the tip contour with a scribe, take out the tip, saw and file the tip holder front part along the marked lines.



a fence is made from a sawn and filed piece of 3mm sheet locked to the plane by a 3mm diameter pin.

To get the 8.5° angle, mark a line (see **fig. 17**) on the blank side (15mm square CRS 100mm long) and set this line along the vice jaw edge before tightening. Set on a tip contacting the fence and mark the tip contour with a scribe, take out the tip, saw and file the tip holder front part along the marked lines. With this tool, you'll have to turn your tool post to get a dressing or a turning position for the tip. ■

References

Ref 1: "Inexpensive tungsten carbide tooling" Workshop practice series N°32.

Scribe a line

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

Gib Strips

Dear Neil, I regret that I do not enjoy internet access and I do not have a telephone answering machine; I rely on British Mail for all communication.

I am writing to ask if you might consider printing an article about making and installing gib strips, in Model Engineers' Workshop magazine. I recognise that there have been instructions concerning the making and installation of jib strips, in various pieces of workshop equipment featured in past issues of the magazine, but I have failed to understand exactly how this was done. My understanding is that gib strips are vital for eliminating what I call 'slip' in ways, in order to ensure that any 'carriages' travel precisely and accurately and, thus, produce precise and accurate work.

M. Hopkins, Middlesex.

I'm sure an article on this topic would be of interest to many readers. If anyone feels they could write such a guide, please contact me by email – Neil.

Which Unimat

Dear Neil, I received MEW 310 and I saw the article on building an x-y table for the Unimat. It is only referenced to as Unimat without model designation. Sort of like referring to a Myford. I am interested as I own both an SL model and Unimat 3. I have a separate milling head and column for the Unimat 3. With the information so far I cannot discern what model the table was designed for although I am leaning toward the Unimat 3.

Ken Biddle, by email

Hi Ken, I believe Terry Gorin has a bar bed SL 1000, rather than the cast bed Mk 3.

The reason for not putting a model number is that the table should be useable with almost any Unimat with milling capability as well as many other machines – Neil.

Angle Iron

Dear Neil, Doug Farrant of Essex is asking for suppliers of 20 x 20 x 3 mm angle iron at reasonable prices. I suggest he tries M-Machine who are geared to our needs and do mail order. They sell that size in black angle in 300 mm lengths as one-offs for what I think is a reasonable price and are also more than happy to supply in longer lengths if that is what Doug needs, he was not specific on that detail.

Their website is **www.m-machine-metals.co.uk**, 01325 381300.

Brian Wood by email.

Evolution of the Lathe

Dear Neil, I live in Australia, and I have been given some back issues of your magazine. In The April/May 1993 issue, there is an article on 'Evolution of the Lathe' part one. I guess that the part 2 was in the February/March 1993 issue, and I was interested in obtaining a copy of this article. If it might be available, can I have a copy and I am willing to pay for any cost.

Warwick Ward, Australia

Hi Warwick, The articles you're looking for appeared in Model Engineers Workshop magazine, Issue 15, Feb/Mar 1993 p.58, Issue 16, Apr/May 1993 p.46. If any readers have a copy of Issue 16 available, please email me and I will pass details on.

Useful Information

In this issue we have an article on watchmaker's lathe collets that includes a table from Tony Griffith's website **www.lathes.co.uk**. When checking with Tony about using this table he suggested that the page **www.lathes.co.uk/collets/** might be useful to readers. The whole website is a mine of useful information for anyone seeking information on lathes or to identify some unknown machine.

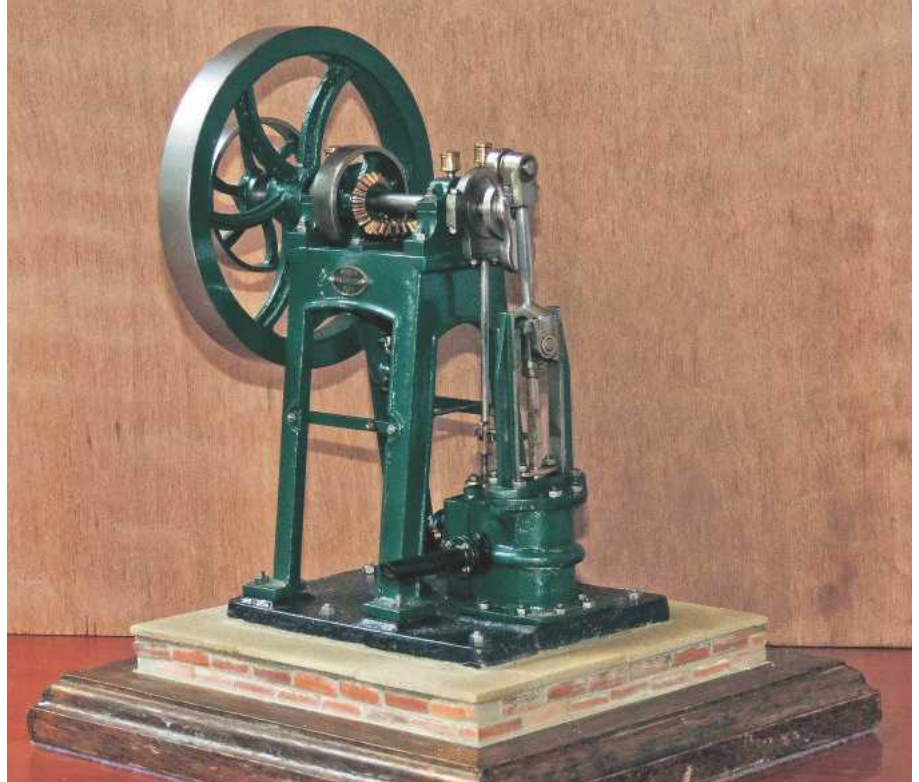
Machining Castings



Stub Mandrel offers an introduction for beginners.

Many engineering models, **photo 1**, include complex-shaped parts so, just as in the prototypes, you will find that 'unmachined kits' usually include a number of castings, **photo 2**. Machining castings can be rather daunting. There are three main challenges: marking out the castings, holding it for machining and the machining itself. All of these will become easier if you start by identifying a 'reference' face on the casting, ideally a flat surface that will allow you to place the casting on a surface plater or other solid surface. Use a file to remove any high spots until you can sit the casting down without it rocking. If you then coat a dark casting with white paint (even tippex!) it becomes easier to scratch accurate lines using a surface gauge or a set-square and scribe to help you see where to machine. Bear in mind that castings are not precision components before machining, so take care that everything will 'fit' into the casting. One example is the bore of a steam cylinder or a flywheel it pays top take care to ensure that the centre of the bore is as accurately positioned relative to the outer rim as possible to get a good appearance.

Although some castings may have a round 'chucking piece' this is rarely accurate enough to allow you to mount the casting in a three-jaw chuck. A better approach is to use a four-jaw chuck. You may need to mount some



Norden, a model steam engine largely machined from castings.

castings on a lathe faceplate, if you use clamps make sure that us use more than one and placed so the casting can't shift. Don't forget to fit a counterweight if the casting unbalances the lathe.

For milling you may find that castings don't fit comfortably in a vice, so be

prepare to clamp them down to the mill table instead. A layer of aper or thin card between the casting and the table or faceplate can help increase grip and allow for minor irregularities.

Once the casting is marked out and securely held, machining should be great challenge, however, cast iron often has a hard 'skin' and sometimes very hard 'chill spots' on edges or corners caused by the casting cooling down too fast. To get trough the skin it pays to use a carbide tool and a decent depth of cut to get down to the softer metal beneath. While a 'skin' is normal, excessive chill spots, that become apparent as bright silvery patches that the tool just skids over, are a fault and should be discussed with your supplier.

Another possible fault are 'blow holes' or cavities. These may be impossible to spot before machining. Most suppliers will exchange a badly affected casting, but if you have already carried out a lot of work when you discover one, you may prefer to use a little ingenuity to provide a solution, such as fitting a screwed in metal plug or using JB Weld to fill the hole. ■



A set of castings from Blackgates Models for the Norden steam engine, mostly in cast iron but including a bronze eccentric strap.

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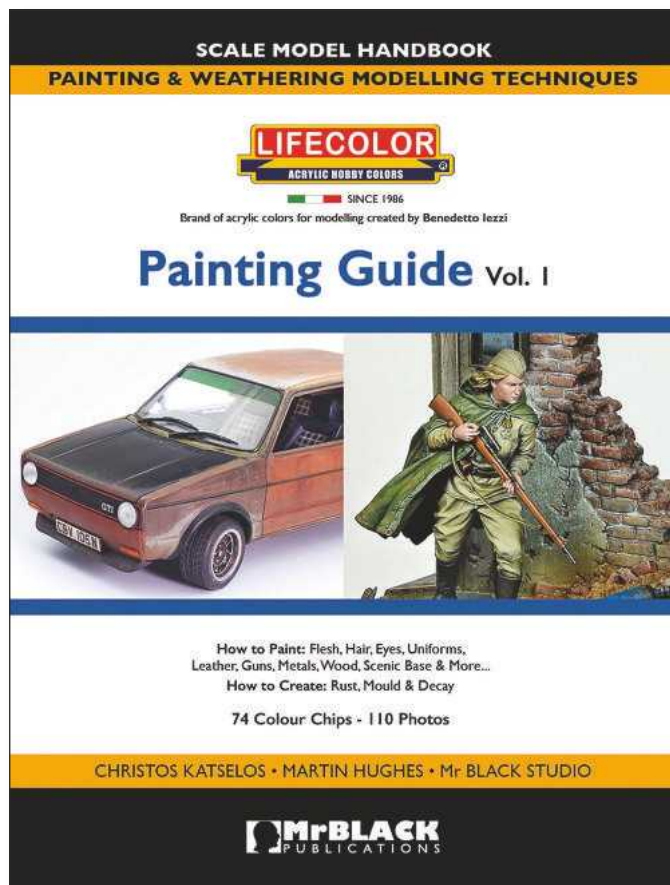
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A Tap Guide Holder



Keith Keen shows a useful and simply made holder for the alignment of larger size taps using a Hall (bar) type tap wrench and a spring tapping guide.

The tap guide holder is shown in **photo 1**, in use in a mill/drill with a bar wrench and an M10 tap, and with a spring tapping guide for alignment and to provide a downward pressure for thread cutting.

The use of a spring tapping guide with a chuck ended tap wrench is, of course, well known, and very convenient for the smaller tap sizes. **Photograph 2** shows Eclipse chuck type tap wrenches that can be used for tap sizes of about M2 to M6. The important thing about these, as can be seen in the photo, is that there is a concentric recess in the top which will allow a spring tapping guide, situated in the mill/drill or drill chuck, to hold the tap 'square on' to the pre-drilled hole in the workpiece. But for larger tap sizes, a bar (Hall type) tap wrench does not provide a top recess or hole for 'square on' tap alignment with a spring tapping guide, and that is the purpose of the simple holder arrangement shown here.

The holder is essentially a slotted block which fits around the bar wrench and has concentric holes for the tap shank and a spring tapping guide.

Photograph 3 shows two that I made for the M8 and M10 taps that I have, along with a Hall tap wrench and a spring tapping guide. The spring tapping guide was obtained from Arc Euro Trade (part number



A holder in use in a mill/drill.



Eclipse chuck type tap wrenches.



Two holders, for M8 and M10 taps, with a Hall bar type tap wrench and a spring tapping guide.

060-250-03200), but there are also other suppliers that can provide these. **Photograph 4** shows the bar wrench and a tap fitted into a holder.

Figure 1 shows the design of the two tap guide holders that I made for my M8 and M10 tap sets. Of course, the dimensions might not be suitable for another make of bar wrench, and the design does not have to be exactly as shown anyway. This particular configuration came about because of the material I had available, which was 1.5 inch diameter brass bar. For my M8 and M10 tap sets, I found that 8.1mm and 10mm ID holes in the lower

sections of the holders gave good sliding fits for the shanks of the taps that I have.

Making the Holders

The holders were made from 1.5 inch (38.1mm) diameter brass bar in the way described below. Mild steel might have been better, as it is cheaper, but brass bar was what I had.

The first step was to turn a cylinder of 36mm diameter and 40mm length in the lathe using the three jaw self-centring chuck. So, a piece of the brass rod was initially cut off to around 70mm in length, and the ends of this were faced off in the lathe. This was then turned to a diameter of 36mm for a length of about 42mm from the free end, and then this end section was cut off using first a parting tool and then a hacksaw (with suitable protection above the lathe bed). The removed cylindrical section was then faced off in the lathe down to a length of 40mm.

The next steps were carried out in the



The bar wrench and a tap fitted into a holder.

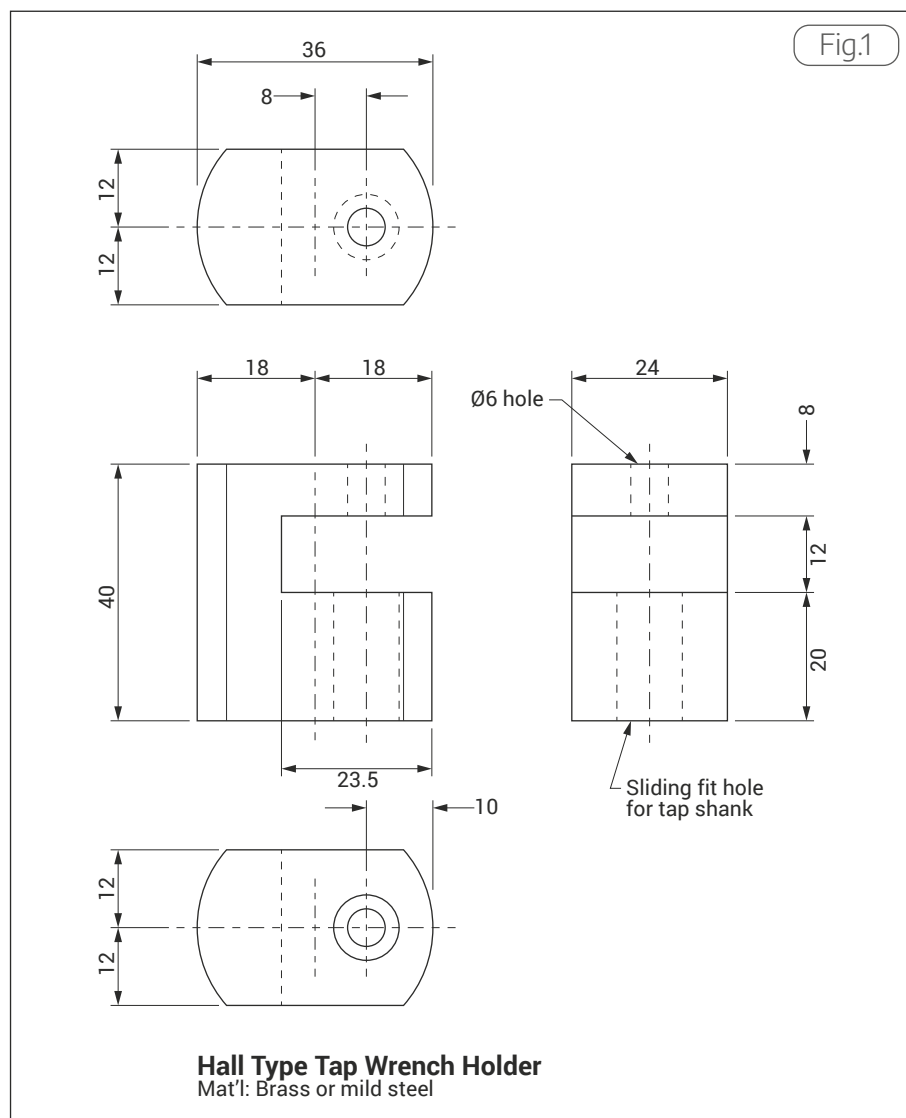
vertical milling machine with a machine vice aligned on the XY table with jaw faces in the X axis direction.

The cylinder was placed in the vice with Y orientation along its main axis and the flat ends against the vice jaws, and with a flat plywood support piece under the cylinder, to give a height protrusion of about 10mm above the top of the vice

jaws. A horizontal flat was then milled in the upper round section of the cylinder to a depth of 6mm from the top with an endmill cutter. This flat surface was then used as a lower reference plane to produce a parallel 6mm deep flat on the other side of the cylinder in the same way, using a thicker plywood support.

For the next operation the modified cylinder with its side flats was relocated in the milling vice with its central axis again with Y orientation, but with the surfaces of the flats having Z orientation, i.e. being vertical. The way that this was set up was to hold two small precision blocks in place around the workpiece while the vice was tightened, and to then remove the blocks. The 12mm wide slot was then milled out to a depth of 23.5mm, using a 12mm slot drill, in three stages of 6mm depth and a final stage of 5.5mm depth. Prior to this, an edge finder had been used to reference the face of the fixed vice jaw, to establish the required Y axis position for milling out the slot.

The final procedure was to drill the concentric holes in the top and bottom of the modified cylinder workpiece. This was easy enough because the flat surfaces on the workpiece ensured vertical alignment in the milling vice. An edge finder was used to determine the required hole positions, with the 12mm offset from the fixed vice jaw being found first, and then the 10mm offset in the X direction from the curved workpiece edge being established. An optical touch point sensor (with a light to show contact) was used for the edge finding. The upper 6mm diameter hole was drilled first, and then the workpiece was inverted in the milling vice with the same surface against the fixed vice jaw as before, to ensure that the 12mm Y offset was still valid for hole concentricity, and then the 10mm X offset was re-established for the concentric lower hole with the edge finder. ■



1

Finished vice.

A Chainsaw Chain Vice

Will Doggett describes a robust chainsaw sharpening accessory.

The Concept and evolution

The reason for making this vice, **photo 1**, was I have several spare chains that required to be sharpened. I would normally do this on the saw's guide bar without removing the chain when the chain is not cutting as it should. This is just a wipe over with a file to keep it sharp.

But as these chains required a little more sharpening, I didn't want to put them on the chainsaw bar as these chains required a little more than a light rub with a file.

This is when I came up with the idea of a vice specifically for sharpening chainsaw chains free from the saw bar as it is possible to remove more material when the chain is held securely as it is in a vice.

The first thought was to have some 50 x 50mm angle about 300mm long, I used this length of angle so that it is possible to sharpen more than one tooth at a time.

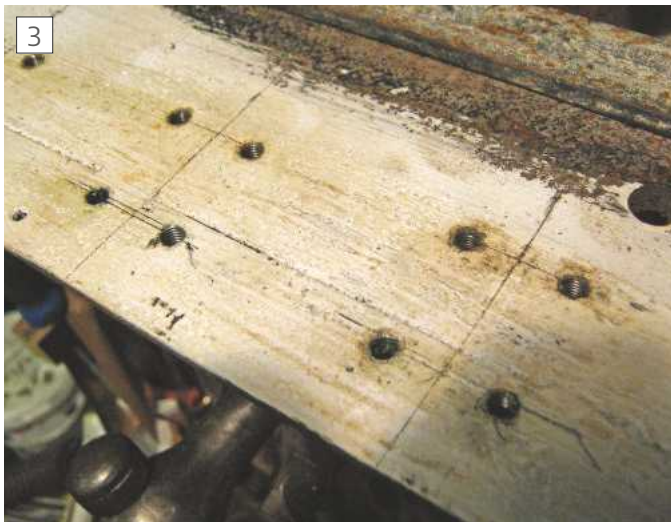
I held the angle in the normal bench vice and using the vice jaws to close the angle onto the chains drive links, but this was less than successful because although the chain was held at the vice



Face of backing with centre lines for clamps.

jaw area it was not at the ends of the angle making filing difficult in this area. The angle nearest me was also getting in the way of the file handle, so a solution was required.

The angle was used is fairly rigid over several mm of length but in this setup it requires more clamping support at the ends, as there was some deflection in the end area with the vice only method. ➤



Tapped clamp holes on backing piece.



Clamping bar and backing.



Additional backing pieces for screw after welding.



Clamping bar holding screw.

I then thought how about a larger piece of angle for the main support that could be held in the bench vice and a lighter clamping bar but this time clamped with several clamps fixed to the main angle pushing the clamping bar this in turn will hold the chains drive links as before but this time at the ends as well as the centre, also the smaller clamping bar mean the file handle is not interfered with when filing.

I then proceeded to try a larger piece of angle in the vice and using several vice clamps held the clamping bar and chain in position, with success this time. This setup was not going to work with loose clamps as this was so fiddly to setup.

I decided to use some overcentre clamps fixed to the base angle to push the clamping bar instead of the vice and the vice clamps. The main support would still be held in the bench vice, but the vice will not be used for clamping the clamp bar just to support the main chain vice angle.

Now onto constructing the chain vice; this is a very much a design as you go approach and is described and shown in the paragraphs and photos that follow rather than sketches.

Construction of the basic vice

The first part to be made was the back angle part. This was cut from piece of 70 x 90mm angle to length of 300mm the ends were cleaned up with a file. Next two pieces of 25 x 6mm flat were cut to 300mm. One is for the clamping bar, the other is to be welded onto the 90mm section to bring it to 115mm this extra length is to accommodate the overcenter clamps that are to be attached on this face. The extension piece was welded to the bottom of the 90mm leg of the angle and the welding was then cleaned up with an angle grinder.

After which the now 115mm face was given a coat of water based white primer after this was dry the position of the holes marked out. **Photograph 2** shows the paint and the marking out

lines. The reason I used white primer as substitute to the white marking paint that is normally used in industry for marking out black steel and castings is it is much easier to see the lines on hot rolled steel, rather than using marking out blue which is normally used on bright steel. As the angle is used or second hand, the large and small holes will be filled later with weld.

The position of the overcenter clamp's fixing holes were then worked out by holding one in position with the top of the arm just below the top edge of the backing angle. This gave me the centre of the main plate and it was possible to mark out the position of the holes.

The holes were then drilled and tapped M5 for the fixing screws that are going to hold the clamps to the base, these are shown in **photo 3**.

The clamping bar was then put in position on the backing angle with it on its side to get an idea of what was required to use it in this position, **photo 4**.

The idea was to hold the clamping bar in position with some sort of fixing but able to have a floating action on the bar without a large gap, so that it would be easy to put the drive links in with the clamps retracted.

The fixings that I used were two M5 cap head screws, one at each end, with springs between the base and the clamping bar over the screws to push the clamping bar open. The only problem was there is no position for the spring to go then the clamp is in its closed position as the backing angle is too thin to accommodate the spring recess and the thread for the holding screws. The solution was to put a piece 25 x 25 x 6 mm at both ends so there was room for a hole to accommodate the springs and thread for the holding screws. This part is shown welded to the backing part in photo 5 before cleaning up. The holes for the springs will be in the backing angle and the thread for the screws will be in the extra piece at the top and back of the base angle.

The next operation was to drill two holes at each end of the backing pieces for the M5 support screws and tap them, then make the clearance holes for the springs.

The temporarily fitted spring and screw were put in place to check the operating of this arrangement and the free movement of the bar.

Photograph 6 shows the screw tightened to check the springs close into their holes as required.

One of the overcentre clamps was then fitted and a chain was put in the vice to check the vice worked, **photo 7**. With a bit of setting up on the overcentre clamps, it was looking good in operation but there is a long way to go yet as you can see.

The two parts – the backing part and



Checking setup with chain in position.

the clamping bar – were then stripped down and up in a citric acid bath for 48 hours to remove the rust.

After the bath the two parts were washed in water to remove the acid and dirt then dried with a cloth and sprayed with a water displacement fluid.

Photograph 8 shows the two parts after cleaning held in the bench vice with the clamping bar in position, the object bottom left in the photo is the bench vice jaw.

Refinements

Having cleaned the backing piece, I decided to reduce the top 70mm part to 35mm as this makes it more balanced in proportions. To do this I clamped the now 115mm side on the milling machine bed and using a slitting saw cut away

the unwanted part with the mill running as slowly as it would run. With a large amount of coolant this job was rather messy, so no photos were taken of this operation. The finished machining is shown in **photo 9** with the clamping bar roughly in position.

The two ends were the next to be tackled as I intended to round off the ends of the two parts this will allow the chain to move over the ends more easily the width of the backing piece was too wide on the top to do this so I decided to taper the ends, the backing piece was held in the bandsaw and the ends were removed at an angle of 45 degrees, **photo 10** shows the finished cut angle at the right hand end.

Moving on, how to hold the jig away from the bench vice to stop the chain



After cleaning in acid.



The reduced backing top end at 35mm.



Backing after the angles were cut.



Radius on the end started.



The cutting tool used for reducing screw length.



The 20mm screw before cutting to length.

getting tangled on the bench vice handle? I used some more of the 70 x 90mm angle and cut it to 75mm wide. The 90mm part was welded to the bottom edge of the backing piece and the 70mm that is down is held in the bench vice. At the same time I welded and filled the two stray holes in the back piece and cleaned up with a grinder.

With the clamping piece in position and tightened up the ends have radiused put on them this is to help when moving the chain along to sharpen the next set of teeth, because if the ends were left it would be very difficult to move the chain without dragging over the ends.

Photograph 11 shows one of the radii partly done.

The screws that are to hold the overcenter clamps were too long at 20mm. I didn't want them sticking out at the back of the backing angle as it is not good engineering practice, so they were required to be reduced to 10mm. The screws were held in the bench vice by the head and the tool that I used to shorten them was a multi-tool using a small cutting wheel in the chuck.

Photograph 12 shows the tool ready for use and the screw before shortening, **photo 13**. The screw at the required length of 10mm is in **photo 14**. The screws were then deburred and used to hold the clamps in position on the backing piece after final painting.

Cosmetics

Now the engineering is done the painting can be begin the only paint that I had that was suitable was some red car spray paint so I gave both parts a first coat of this. After it was dry I went to spray them again, but the can was empty so resorted to brush painting with some different red paint. After a couple of days when the paint had dried properly, I assembled the vice.

Additional features

The addition of a filing guide was the next part to be made this consisted of a piece galvanized steel salvaged from an old cooker back although not really required I thought it would make the vice more interesting and it is handy to have.

The galvanized plate was cut out and

two angles were scribed on it at 20deg and 30deg one set to the left and one set to the right. **Photograph 15** shows the plate after marking out and **photo 16** shows it fitted with M4 screws.

The lines are there to help keeping the file at the correct angle when sharpening the chains as most chains that I have come across are sharpened at somewhere near these angles.

Although the filing guide is not really required it is a cosmetic feature as the filing kits have markings on the file guide themselves.

The only other bit of kit required is one of the filing kits especially for hand filing chainsaw blades and the skill to use them. These are available in farm supply shops and on the internet the sort of things required are shown in **photo 17**.

Sharpening note

The following information is how I did it and in no way a definitive way as the reader can make their own decisions as to how to they sharpen their own chainsaw chains.



After cutting the screw to the correct length.



The Filing guide with angles showing.



The Filing guide screwed into position.



Chainsaw files and guide kit.

One of the things that I was told was always file the teeth away from the cutting face of the tooth as shown in **sketch 1** the red arrow showing the direction of the stroke for the file this is to stop a burr from forming on the cutting face of the individual teeth this helps to get a clean cut with the chain.

The internet is a good place to start looking for information on sharpening chainsaw chains, if this is the first time the reader is going to sharpen a chain, with videos and other sources of information, also safety notes on using a chainsaw if this is required.

Conclusion

This vice doesn't have an engineering purpose in the normal way we think of a vice, as it intended for more horticultural use and as such will probably be one of the most unused pieces of equipment in the engineering workshop.

The cost of this vice to me was under £9 this was for the overcenter clamps, these I got from the internet the part number is GH-201-B. All the other material I had in my workshop, but if the reader wishes to



make one of these vices the basic design can be changed to suit the materials to hand in their workshop.

The big advantage of this vice is it holds the chain securely and not like the chain bar does. There is movement when sharpening the chain on the chain bar, so this method is only really to keep the chain sharp.

To repair a chain that requires full sharpening with more metal to be removed it is a lot easier to use this vice as it holds the chain and it will not move

about when sharpening it.

Why would you make this vice? Well personally I do have a chainsaw, so do both my sons and I have used it to sharpen all the spare chains that I have and some of my sons' as well. When I was using the saw and cut into a piece of wire, I thought that I had damaged several teeth; as it was only producing sawdust and not chippings. With one of the spares that I have I took the chain off the chainsaw and replaced it, this was easier than stopping sawing part way through a job to sharpen the blade on the saw.

Safety note

When handling chainsaw chains it is a very good idea to wear gloves as the chain can very easily cut your hands even before sharpening and especially so after sharpening the chain has been completed. I put some on before I remove the chain and only take them off after the chain is back on the chain bar and adjusted and ready to use, guess how I know. ■

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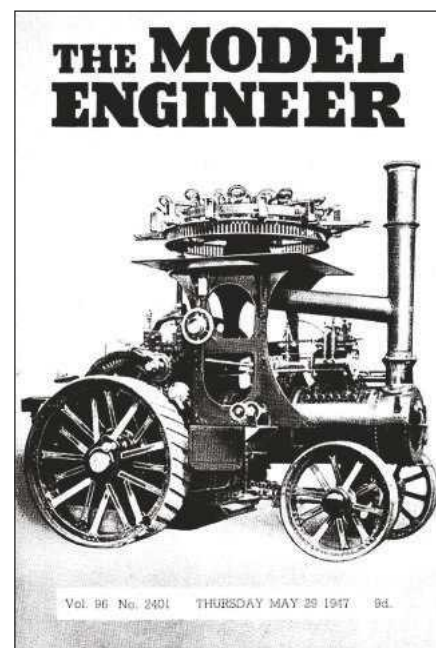
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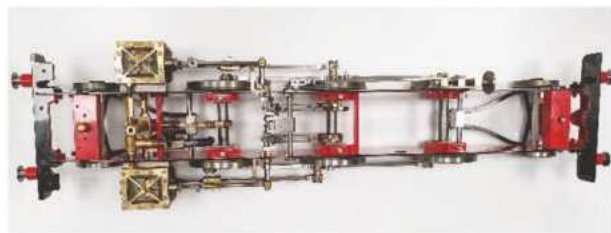
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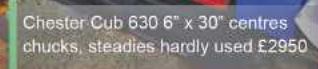
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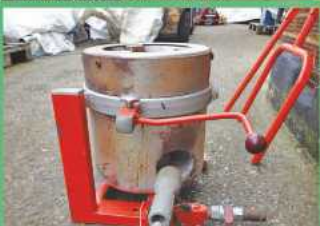
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