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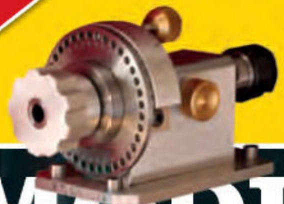

AN ER16 INDEXER

A design for compact milling machines from Bernard Towers

MODEL ENGINEERS' WORKSHOP

THE MAGAZINE FOR HOBBY ENGINEERS, MAKERS AND MODELLERS NOVEMBER 2023 ISSUE 333 WWW.MODEL-ENGINEER.CO.UK

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A Joint History of Model Engineering

Artful Dodges

In the last instalment of John Smith's series he looks at ways of turning a large convex radius.

ROCKET MAN

The inside story of Graham Sykes' world record breaking steam bike.

SERVICING A DTI

Mike Joseph explains how to restore a smooth action to an ageing gauge.

INSIDE THIS PACKED ISSUE:

■ MACHINE LIGHTING – A NO-DRILL SOLUTION FOR SHERLINE MILLING MACHINES. ■ A ROBUST DIVIDING HEAD – MORE DETAILED PLANS AND INSTRUCTIONS. ■ MAKING AND USING YOUR OWN CIRCULAR CLIPS ■ A FILE STORAGE SYSTEM - ALAN BRYAN GETS HIS FILES IN ORDER. ■ YOU'VE BEEN FRAMED – CARLOS DINIZ ON ARCHIVAL TECHNIQUES. ■ ORGANISE YOUR ALLEN KEYS! ■ EMCO MAXIMAT – GRAHAM MEEK'S PRECISION CARRIAGE HANDWHEEL DIAL. ■ A QUARTER ROUND FIXTURE – AL HANSON SIMPLIFIES A TRICKY TASK.
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MODEL ENGINEERS' WORKSHOP

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On the Editor's Bench

New Forum Software

By the time you read this, it is hoped that new software will be up and running for the forum at www.model-engineer.co.uk. The old **site will have gone offline the day we go to press (5 October) and a holding page put up.**

All being well the new site will be up and running by 12 October. Updates will be posted here:

www.mortonsdigital.co.uk/blog/2023/10/02/model-engineer-model-boats-forum-migration-updates/

When the new site goes live, you will need to log in with your email address and password. If that doesn't work, you can do a password reset. We have tested password recovery, so as long as you can access the email address associated with your account you should not have any problems recovering access if you lose your password.

This is partly a response to criticisms of what is now a very old and clunky bespoke system that worked very differently from most other forum software. It had also become hard to maintain and we needed to make it easier for users with mobile phones and tablets to use.

The changes to the appearance and navigation of the forum mean it will take a while to get used to the new layout and controls.

I'd like to than Andy and Darren for their work on the new forum and the volunteers, especially Jason and Dave, for their massive contribution to testing the forum. Many people, especially the volunteer moderators, have put a huge amount of effort into testing and have provided much valuable feedback which has resulted in many changes and improvements, although no doubt there will be further 'tweaks' required.

We know there may still be some issues, so we will be supporting users any problems. If you do have problems, please ask for help – there will be dedicated threads for assistance and a contact form for raising issues. Thanks for your patience, and I am sure that by our next issue, everything will be working smoothly.

Neil Wyatt

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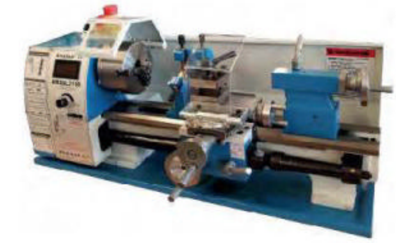

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ON THE COVER

Our cover shows John Smith's setup for large radius turning on his Myford lathe, see pages 54-55.

HOME FEATURES WORKSHOP EVENTS FORUMS ALBUMS

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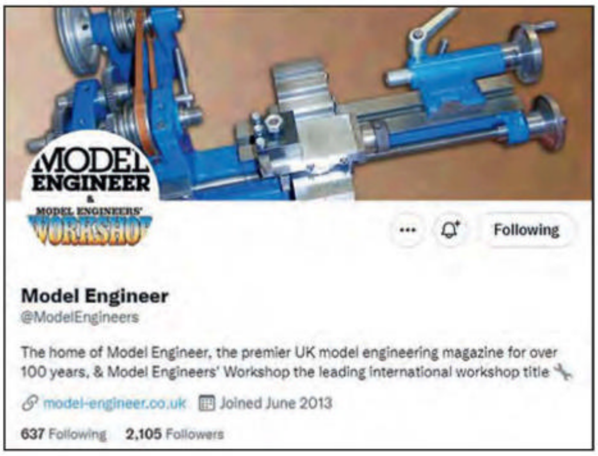


THIS MONTH'S BONUS CONTENT

The Forum is changing!

Log on to the new forum using your existing details. There will be plenty of help and assistance available if you have any questions or issues getting to know your way around the new forum software. We have also set up 'practice' threads so you can try posting images and documents.
www.model-engineer.co.uk

Other hot topics on the forum include:

Oct 2023: FORUM MIGRATION TIMELINE Latest news on the forum changes by Darren H.

Winter Storage Of Locomotives How to keep your model in good condition outside the running season by Chuffer

Best way of moving milling machine What's the best way of safely moving a new milling machine? By Michael Callaghan

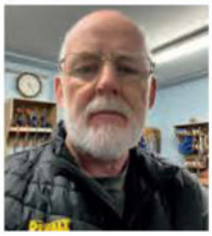
Further Adventures with the Sieg KX3 & KX1 A thread for new owners of these machines, featuring so incredible work, by JasonB

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. Come and join us – it's free to all readers!

CLASSIFIEDS EXTRA SUBSCRIBE ARCHIVE SUPPLIERS

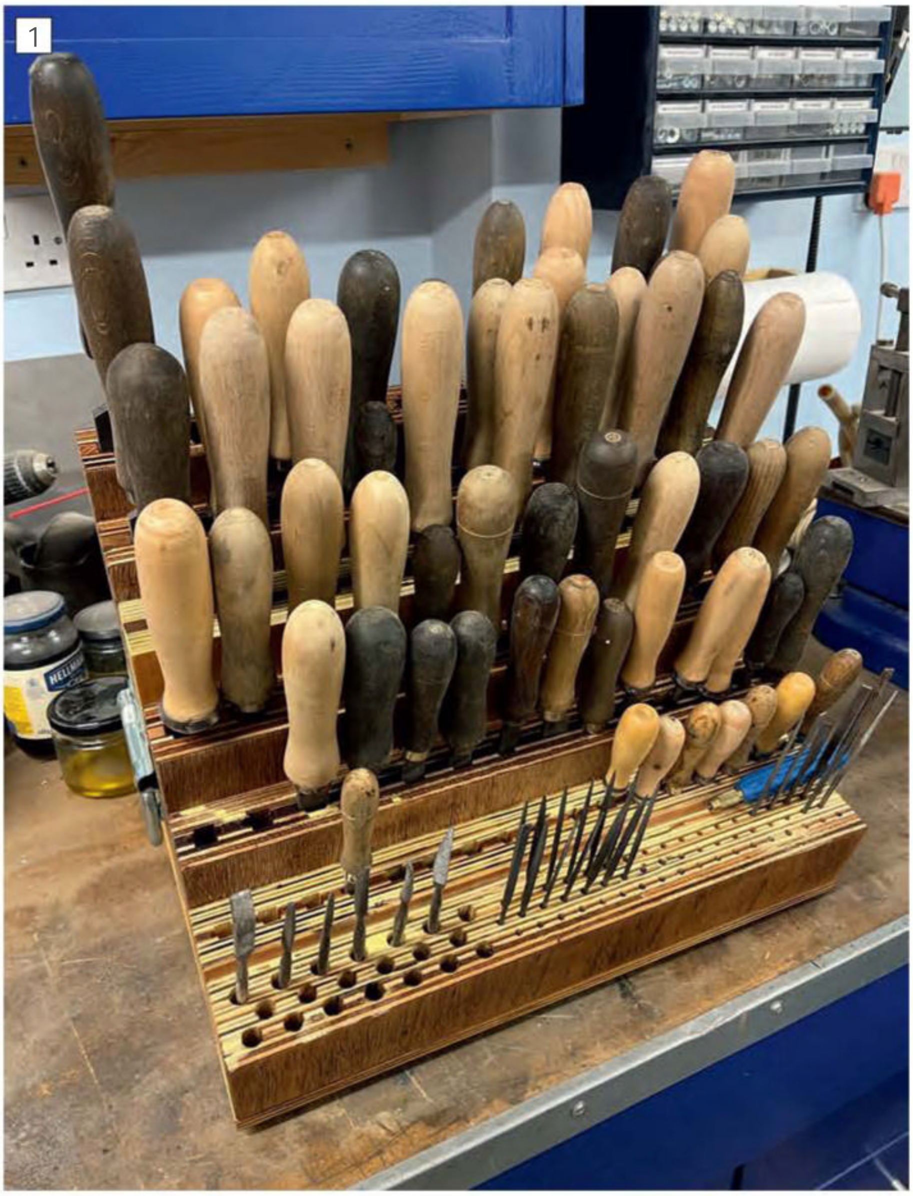
A Metalwork File Storage System, Part 1



Alan Bryan breaks down the process of design and planning behind his file storage system.

I hoard things as far as my wife is concerned. I don't totally disagree with her, but I don't consider that selecting materials which are often discarded as scrap and storing items away for future use which might one day be suitable for my hobby, is hoarding. Over the years I've repeatedly claimed that they will be useful one day and a money saver.

How is that relevant to engineer's metalwork file storage you ask? Well, stick with me and all will become clear as we get deeper into this because I consider that I do prove my point. I may deviate from the primary subject once or twice but persevere please, it's all relevant. In this article, I will touch on several different aspects of engineering, from 3D-CAD, to working with wood, all of it relevant to the product which is a metalwork file storage system, **photo 1**.



1

The file storage system.

A Problem Becomes Apparent

In common with most of us I've accumulated quite a collection of files of varying sizes and sections over the fifty-plus years since I started my apprenticeship. Size always refers to the file's length. Each size includes various sections, and cuts. My collection also includes needle files and a few riffler files. All were previously stored together, without any means of separation from each other, in a drawer in one of my two work benches. That situation was less than ideal for several reasons. Firstly, files are cutting tools and should never be allowed to rub against other hardened objects. Files are expensive and made of hardened steel, so they qualify as being worthy of segregation to prevent any damage or blunting from occurring. The drawer in my work bench clearly wasn't the ideal environment. Secondly, it wasn't always easy to select a particular file for the job in hand since the one that I needed was often buried underneath others. An improvement in storage was called for.

When I planned and built my workshop eight years ago, I made it large enough for what I thought my needs would be going forward. At first it was, and I'm sure you know where I'm coming from here, because it was bigger than any building that I'd had previously. I'd taken opportunities to populate those nice wide and clear open spaces with various other machines as they became available, and it gradually filled up. Then, something had to give and about a


2

The file collection.

year ago, I reluctantly concluded that I had seriously miscalculated how much storage I needed, particularly for the materials which I'd collected (horded?), and how little space I had left to devote to housing them. That decision bought about a reorganisation to try to improve matters which, apart from constructing some wall cupboards, included modifying one of the benches to accommodate metal storage. That decision evicted the file collection from its drawer which meant that it became necessary to provide a better home for them. The situation shown in **photo 1**, clearly wasn't suitable for the long-term.

The Search For Solutions

I had been thinking about various storage possibilities for a long time before the eviction happened, scouring Pinterest and many fora on the internet looking at a vast number of ideas. Many contributors wrote and posted about a multitude of varied ideas, but none were exactly what I was looking for although I did shortlist a small number of potential solutions: -

1. Storage in a series of trays, each tray divided into compartments and each compartment sized to accommodate one file. That directed me to solution two.
2. A tool cabinet, like a toolmaker's tool cabinet, housing the trays as drawers, sitting on the workbench.
3. Drill a hole in each handle and hang each file on a hook affixed to a batten screwed to the wall over the bench.
4. Fix a magnetic strip on the wall over the bench and hang each file from it with the handle at the bottom.
5. A rotating horizontal plate like a "Lazy Susan" arrangement with a series of appropriately shaped holes for the files to drop through thus presenting the handle of each file readily to be withdrawn.
6. Fixed vertical storage using a perforated plate as in 5. but fitted to the top of a plastic bucket which had contained liquid fertiliser in its former life.

Pros and cons of each short-listed item were as follows: -

1. Pro: - Every file would be separated from its neighbour and readily available when the tray was presented unobstructed.
Con: - I would have to store the trays somewhere which meant using a spare drawer which I didn't have. Also, I reasoned that such trays would probably be about a maximum of

30mm high so to maximise drawer space, trays would be stacked within the drawer. Meaning that, if I needed a 14-inch file, the largest tray would probably be at the bottom of the stack so I would have to remove every smaller file tray in the drawer before I could get my hands on it.
2. Pro: -The file-drawer cabinet idea appealed. It would be easy to produce and would keep the files free of workshop dust and air-born dirt.
Con: -It used a far bit of bench space and the cabinet itself would have had a lot of dead space within it because it would need to be approximately 20 inches deep to accommodate a 14-inch file whereas the drawer to house a 4-inch file would have only needed to be 8 inches or so deep.
That firmly established my first and second parameters. Firstly, that convenient accessibility to all sizes, always was very desirable. The second being to use a minimum of bench space.
3. Pro: -Every file would be accessible and easily identifiable, and it wouldn't take long to make.
Con: -All my files have wooden handles; I don't yet possess any of the more modern plastic handled variety. Sometimes a handle will come adrift from the file and needs to be refitted. I haven't fitted many of my files with handles by burning the file into the wood which is an omission that I want to correct in future. I could also visualise a scenario where I came into the workshop one morning to find a detached file blade embedded in something which I had made the day before and foolishly left directly underneath the hanging files. Also, I needed the area of the wall behind the bench for hanging other things on so there was no convenient space available. That idea was quickly rejected.
4. Pro: - The steel that files are made from magnetises very easily so the files would be held securely. Also, hanging like in 3. albeit upside down, files would be easily identifiable. Every file would be accessible and it wouldn't take long to install with nothing to make and no holes to drill in file handles.
Con: -The steel that files are made from magnetises very easily. I know because we used a magnetised rat-tailed file to diligently fish out swarf fragments from the massive steel castings and die bolsters when I was an apprentice in one of the die shops belonging to the British Leyland organisation. During the construction of large press-tools, which were and still are used to produce car body panels, they came back came back from the milling and drill stations brim-full of fragments. I don't want my files to collect the swarf which they produce. Also, I had already ruled out wall hanging due to a space crisis. That idea was quickly rejected too.
5. Pro: -Because of the lack of wall space I had decided at this point that the files would have to occupy a portion of the available bench space. I had seen and quite liked several "Lazy Susan" concepts which concentrated everything into a very compact area. It meant that every file was presented and readily available without moving others out of the way.
Con: - I would need to look down almost directly onto the top of that plate when selecting a file to ensure that I was withdrawing the correct one. Storing them all vertically, the height at which the plate with the slots in it would be located would be established by the longest file. I had calculated that the plate on the top of the "Lazy Susan" would be 1275mm above floor level. Therefore, the top of the handle of a 14-inch file would be at least 200mm above that as would every file stored in the "Lazy Susan". It would be necessary to keep the files near to the front of the bench to be able to see the fie profile clearly. For convenience, if I was to site it near to the rear of the bench top then the files needed to be angled towards the front of the bench. Also, when replacing a file, it would be dropped through the plate and its passage stopped by contact between the handle ferrule and the plate. The repetitive impact eventually would eventually dislodge the file tang from the handle. Also, the ferrule against the plate would obscure the shape of the slot and the tip of the file blade so I wouldn't be able to see which file I was selecting. It needed a series of surfaces between 3.75 inches and 13.75 inches below the top plate for the tips of the file blades to rest against and I couldn't work out an easily manufactured solution to that. Angling it away from the vertical needed a ratchet mechanism, or perhaps a series of sprung detents in a circular path, incorporated into the design of a simple rotating arrangement. I reasoned that the heavier portion of the rack would otherwise always be fall to the bottom. Such a mechanism was too complicated for the task. Plus, to my mind, angling the handles towards the front made the inclusion of a rotating bearing unnecessary. I didn't totally dismiss it though.
6. Rotating plate systems which use a plate perforated appropriately to store collets and which have the rotating axis angled, have two plates pierced with concentric holes to admit entry for the stored items. They are spaced approximately 25mm to 50mm apart to keep the axis of the collet or tool normal to the plate surface and prevent the contents of the rack from contacting each other. I would need to do that with the "Lazy Susan" concept too, especially if I wanted to angle the plate towards me. So, for the bucket idea, because the ends of the hanging files could knock against each other, I decided that I'd need to make two plates, pierced identically and spaced apart but with one slightly smaller on its outside diameter. The top plate would sit in the recess at the lip of the bucket using that ledge to stop it from dropping into the bucket. The diameter of the smaller plate would fit closely inside the bucket 50mm lower inside it thus locating the plates and files perfectly.
Pro: -It would use an area of the bench of approximately 350 mm diameter. A very small footprint indeed! Every file would be visible and easy to select.
Con: -These were six-fold.
a. It would need to be positioned near to the front of the bench to be able to identify each file as in 5.
b. It couldn't be angled towards the operator because the bucket didn't have an angled bottom.
c. Producing the perforated plates would be a time-consuming operation for me or a costly one if I decided to get the plates laser or water jet cut.
d. I didn't know what the life expectancy of the plastic bucket would be and I wanted the solution that I arrived at to be a long term one.

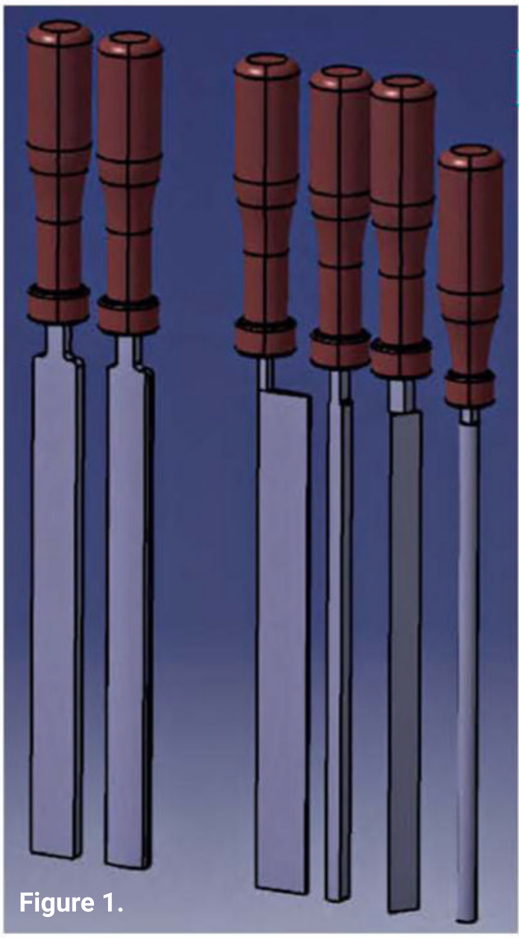


Figure 1.

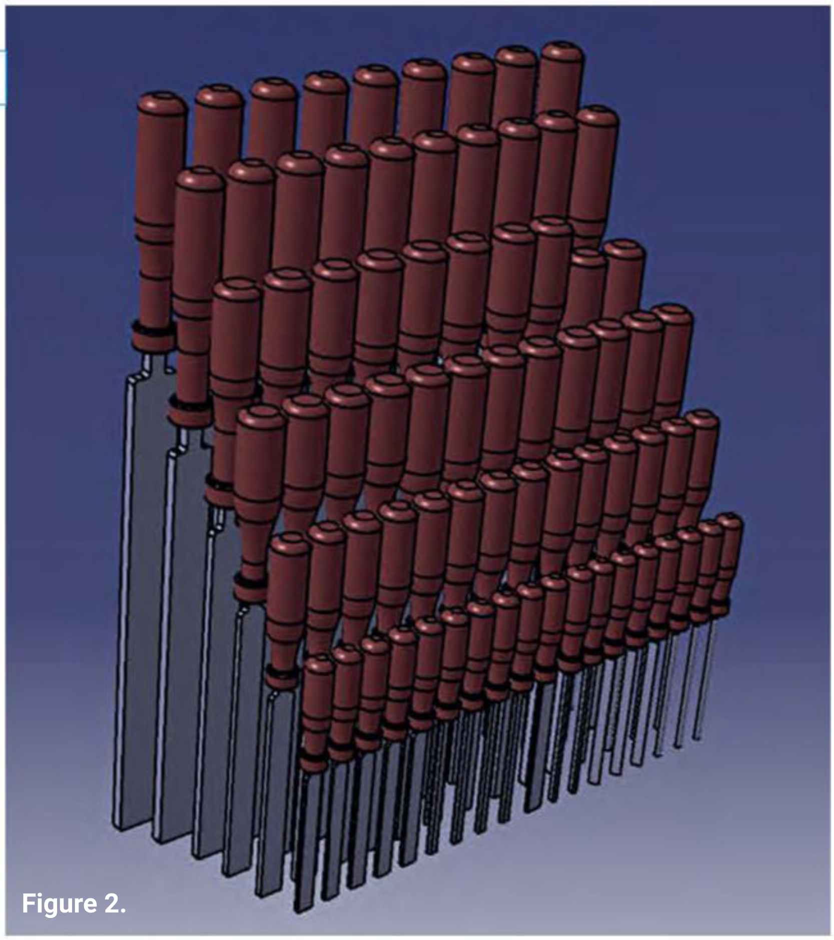


Figure 2.

e. The same problem of preventing the files dropping through until the ferrule contacted the plate applied.
f. I couldn't accommodate the riffler and needle files into the concept.
However, now firmly embedded in my thoughts, the appeal of a small footprint wasn't going to go away.

In-Depth Investigations

I therefore decided to think on the pros and cons a little longer and spent some time sketching out ideas. I also measured the sections of all my files and file handles in preparation for a comprehensive "packaging" study. I needed to find out just how small a space my collection could be packed into and still be protected from each other but remain accessible when required without being blocked by other files.

I've already mentioned that I measured all my files and file handles. I also tried to find what the actual sectional dimensions are of the files that are produced today but I drew a blank on that. All that I was able to ascertain was that English files are produced in 4-inch, 6-inch, 8-inch, 10-inch, 12-inch and 14-inch lengths, with some in 15 and 16-inch lengths also. American pattern files are similar in range (https://www.apextoolgroup.com/content/nicholson-guide-files-and-filing). Swiss pattern files are different though as are other European files. Then of course there are needle files and riffler files as well. With all that in mind I decided to go with what I had, which are all English pattern. I would use the dimensions of my own files to produce a set of virtual files and make a solid model of each file that I owned. Although I simplified the file details somewhat those solid virtual models were to all intents and purposes almost identical in specification to the real part. Every file possessed the material properties of wood for the handle and steel for the blade and the system calculated a virtual mass of each tool which to all intents and purposes was identical to the actual file. I gained a few benefits from that later in the project. **Figure 1** illustrates the range of 14-inch files.

I modelled the 14-inch files first and then copied and modified the data produced to model the smaller sizes and handles. It only took a few hours to produce all the file models. I didn't model the riffler files and needle files though, having reasoned that it wouldn't be necessary after studying those which I had in my collection.

I was now able to check how tightly files could be packed together yet still be accessible. I found that 8-inch files and smaller have a handle which is larger in diameter than the breadth of flat and half round files, but 10-inch and larger flat file blades are wider than the handle diameter. Therefore, all smaller files could be positioned at an equal distance from their neighbours. With the larger sizes, I could space the round, square and triangular files equally apart according to the handle diameters but I couldn't do that to set the distance for the flat and half round files because the spacing was controlled by the blade width. I now had all that I needed to arrange the files in a variety of positions so I could decide on the best storage pattern.

The Crystallisation Of An Idea

I had studied commercially made chef's wooden knife blocks on and

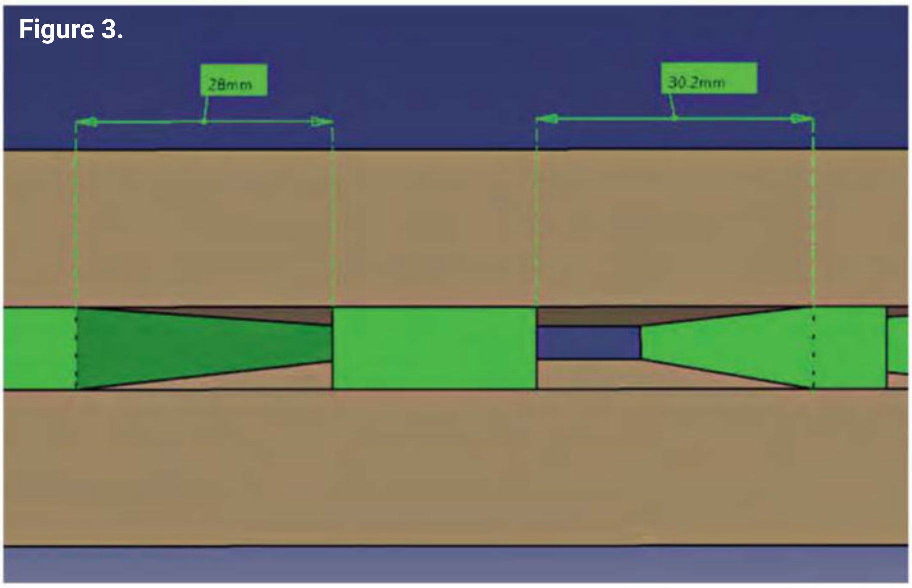


Figure 3.

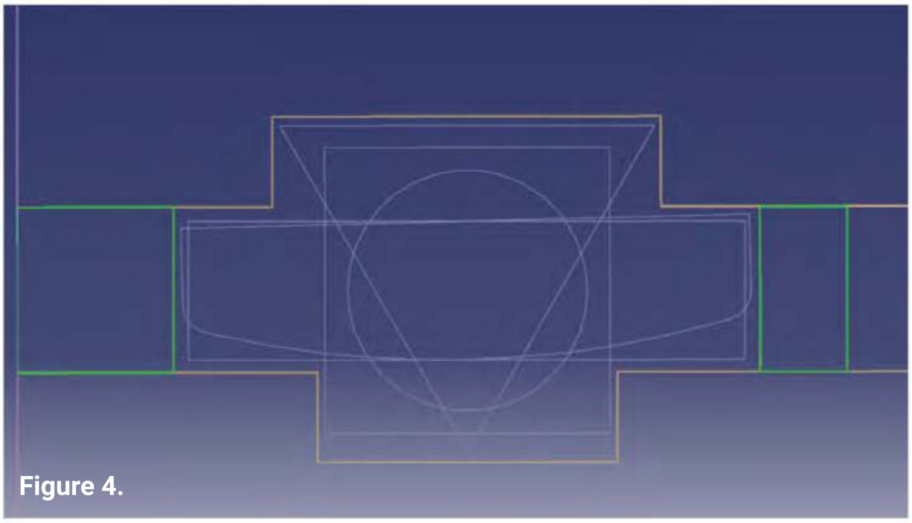


Figure 4.

off for a long time wondering if the principal could be adopted as a file storage solution. I had even tried to sketch out the basis of such a system previously in CAD but had not pursued it further because it didn't look to be a straightforward proposition to manufacture one. Revisiting it now, I realised that it offered the potential to utilise a small footprint and really deserved to be given another go. My previous attempts had centred around the possibility of packing the files into a block in a circular arrangement, but I'd never got any further with it. Then it dawned on me that I could design a stepped arrangement from 4 inches to 14 inches high with each step two inches above the previous step. I also realised that I could include a further step for storing riffler files and needle files. The stepped arrangement meant that the length of the file would be a visual clue of where files belong, each file dropping into a slot with the end of the blade being arrested when it hit the base board. That removed the danger of the file handle being dislodged by repetitive impact between the handle ferrule and a slotted plate. Also, because the step height could be less than the length of the file blade, the handle ferrule would be spaced away from the storage slot and the type of file is visible, thus removing the need to identify which shape of file is being stored in a particular slot. Finally, since knife blocks are often angled towards the chef presenting the handle, ready to be ready to be grasped and withdrawn, I decided to try and incorporate that feature too. Thus, meaning that the block could be positioned towards the rear of the bench rather than occupying space at the front of it.

I therefore repackaged the files to follow that storage principal. What I arrived at is shown in **fig. 2**.

Planning Construction

With the basics of my scheme thus established I now had to decide what to make it from. First and foremost, I decided that the project had to be made from materials which I already possessed and had to use machinery and tooling which I had in my workshop. I'd already ruled out a "Lazy Susan" bearing and CNC profile cutting so it had to be made from materials which I already possessed, and which wouldn't damage the file teeth. That meant wood.

I have a reasonably well-equipped workshop which includes Colchester and Myford lathes, a Bridgeport milling machine, a shaper, drills etc. I also possess various wood working machines and power tools such as a Makita 260mm table saw, a 12-inch disc sander, a ½ inch router plus some others so those controlled what operations I could perform. It's always important to design around what can be produced from one's workshop, so with all that in mind I set to working out a proposal.

I decided that every slot on every step would accommodate all file shapes offered in that length. The exception to that was the knife file which has the centreline of the handle biased towards the widest part of the blade. All the others in my collection have the file blade centreline coincident with the centreline of the handle. I therefore decided to have one slot in each step solely to accommodate a knife file.

Figure 3 illustrates the 10-inch step, the 28mm slot width accommodates flat and half round files, whilst the 30.2mm is for the knife file. That slot also must have a wider spacing from one of its neighbours to accommodate the offset location of the handle.

I also decided that each slot would be the correct section to suit a flat file and a half-round file. Plus, by milling another slot across the middle of the first slot, square, triangular and round files would be accommodated in the same slot without the slot being so wide that the flat file flopped around in it.

The versatility of each slot when the secondary slot is added is shown in **fig. 4**

● To be continued

Workshops of the Past

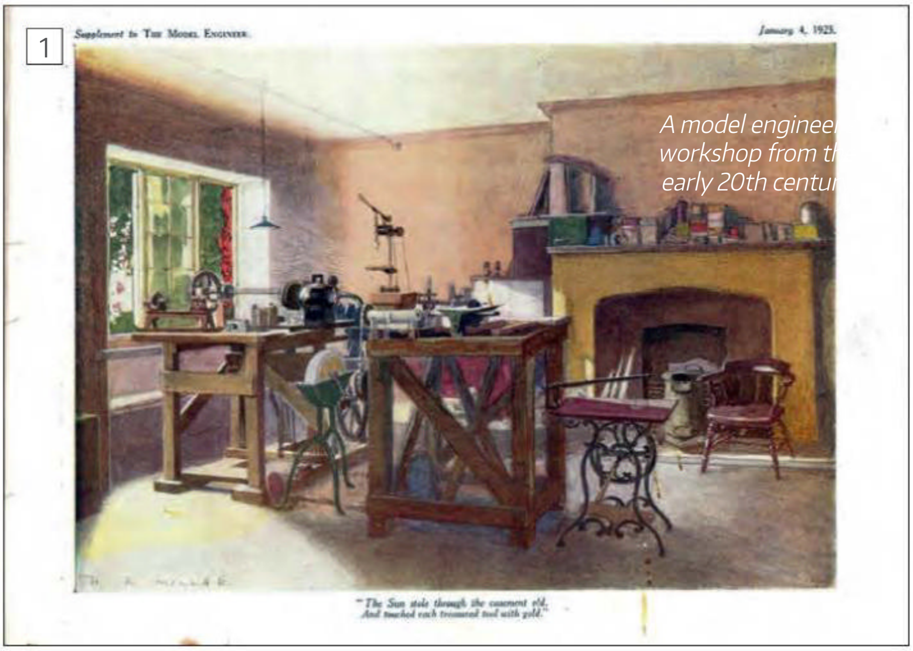
Model engineering emerged as a hobby in the 19th century, Skilled factory workers wanted to use their abilities to make things for themselves, and often the designers and supervisors in the factories wanted a creative outlet as well. Even in the early 20th century, electricity was the exception, rather than the rule so most workshops would be powered by 'foot power' or the fortunate might have a steam or IC engine driving an overhead shaft from which several different machines could be powered.

Our picture, **photo 1** shows a romanticised early modeller's workshop painted by H. R. Millar. On the left is a treadle powered lathe of quite large capacity, with a much smaller miniature lathe in front of it. Next to the lathe is a hand-cranked whetstone grinding wheel – imagine trying to sharpen accurately while cranking the handle! It is difficult to be sure what items are on the other bench, but at the right is a treadle fretsaw. This would have been used for thin metal as well as wooden sheet, fretwork was a very popular hobby activity.

In the background is a sensitive drilling machine, it isn't clear if it is foot powered or it may have a small electric motor – the workshop does have electricity as there is a light fitting on two bare live wires suspended from the ceiling! Such a lamp could be moved back and forth to concentrate the light where it was wanted. Storage is limited, a many-drawered traditional tool cabinet beside the drill and all sorts of random items piled on the mantel piece.

The 'Super Adept' lathe, **photos 2** and **3,** was first produced in the 1930s by FW Portass limited. Even for its time it was a primitive machine, yet machines such as these provided an inexpensive route into model engineering for many people. It is sobering to see some of the models made in workshops like this and such modest equipment. This is testimony to the exceptional levels of craftsmanship shown by hobbyists in the past.

1



A model enginee workshop from th early 20th centu

2

Super Adept lathe

3

A 1932 advert for the Super Adept lathe.

Reconditioning DTI Gauges

Mike Joseph offers some guidance on the tricky task of bringing sticky dial test indicators into good working order.

Dial test indicators, DTIs, are available second hand but are often sticky, i.e. not moving cleanly (most of mine were). This is simple to rectify with gentle oiling at the correct points. I felt that a complete dismantle and service was not necessary because DTIs are only occasionally used, unlike clocks and they were all very clean internally. The tools are illustrated in **photo 1** and are:

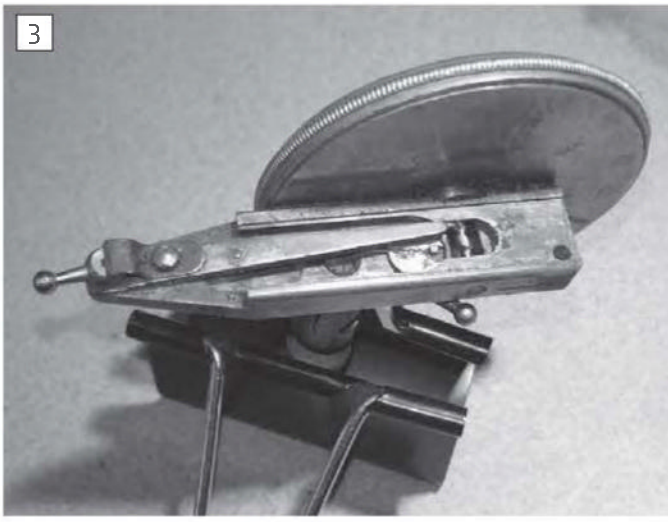
- Superglue, medium viscosity
- Pocket watch oil
- Oil pot (a small lid will do the job)
- Foldback clip, small vice or similar to hold the DTI
- Watchmakers' screwdrivers
- Pegwood or fine toothpick
- Watch hand remover
- Pliers
- Small screw driver (1/8'' blade or so).

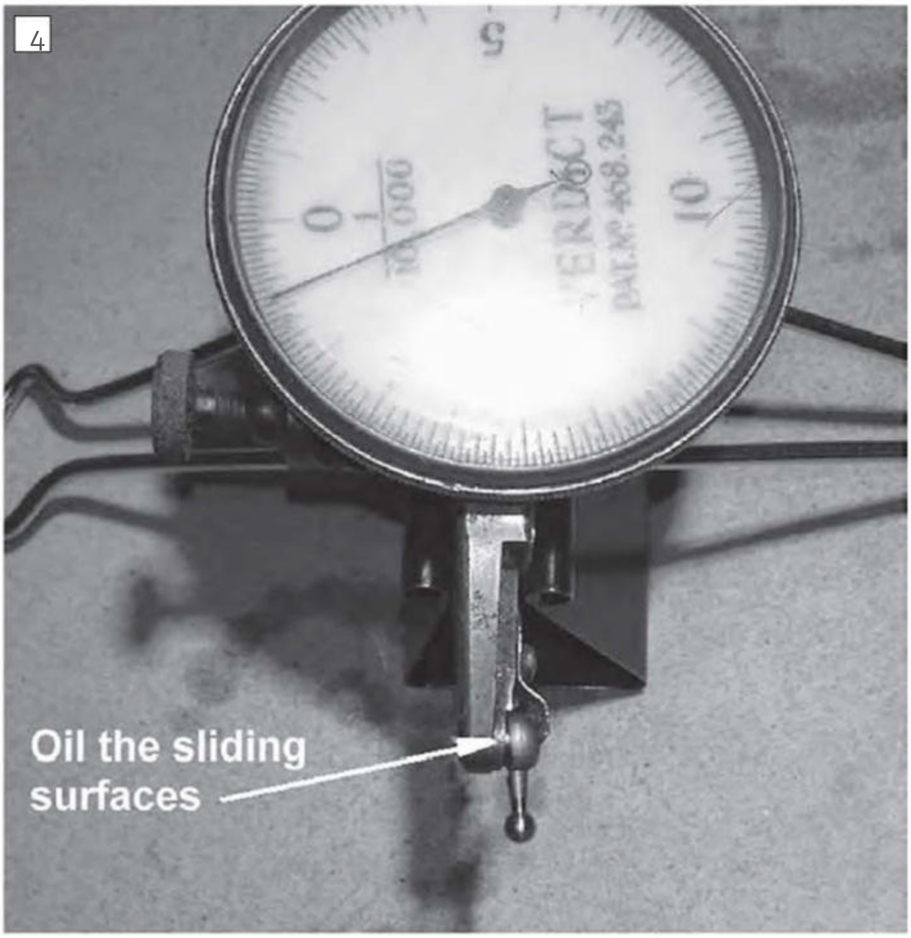
The only items unlikely to be in an engineer's tool kit are the watch hand remover, and the pocket watch oil. The oil pot contains a couple of drops from the oil jar (decanted to prevent contamination) and the pegwood or toothpick is used to apply a very fine drop of oil.

Two types of gauge are covered, the lever (dial test indicator) and the plunger operated (dial gauge), **photo 2**. The lever type is the easiest to deal with: in **photo 3** once the cover is removed, there is a moving arm and spiral gear. Do not lubricate this since


Tools used.

Two different types of DTI.


Lever type DTI.



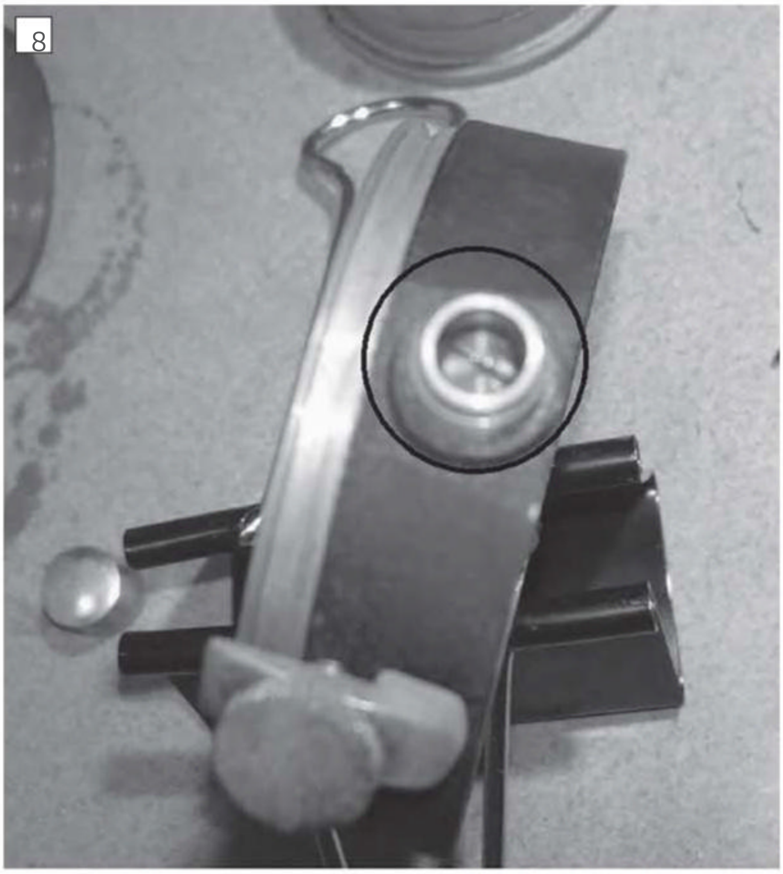
Put a tiny, tiny touch of oil on the lever pivot.

oil attracts dust and forms a very good grinding paste – clock gears are never oiled, only the pivots – it will only need a light touch of oil on the sliding faces, **photo 4**.

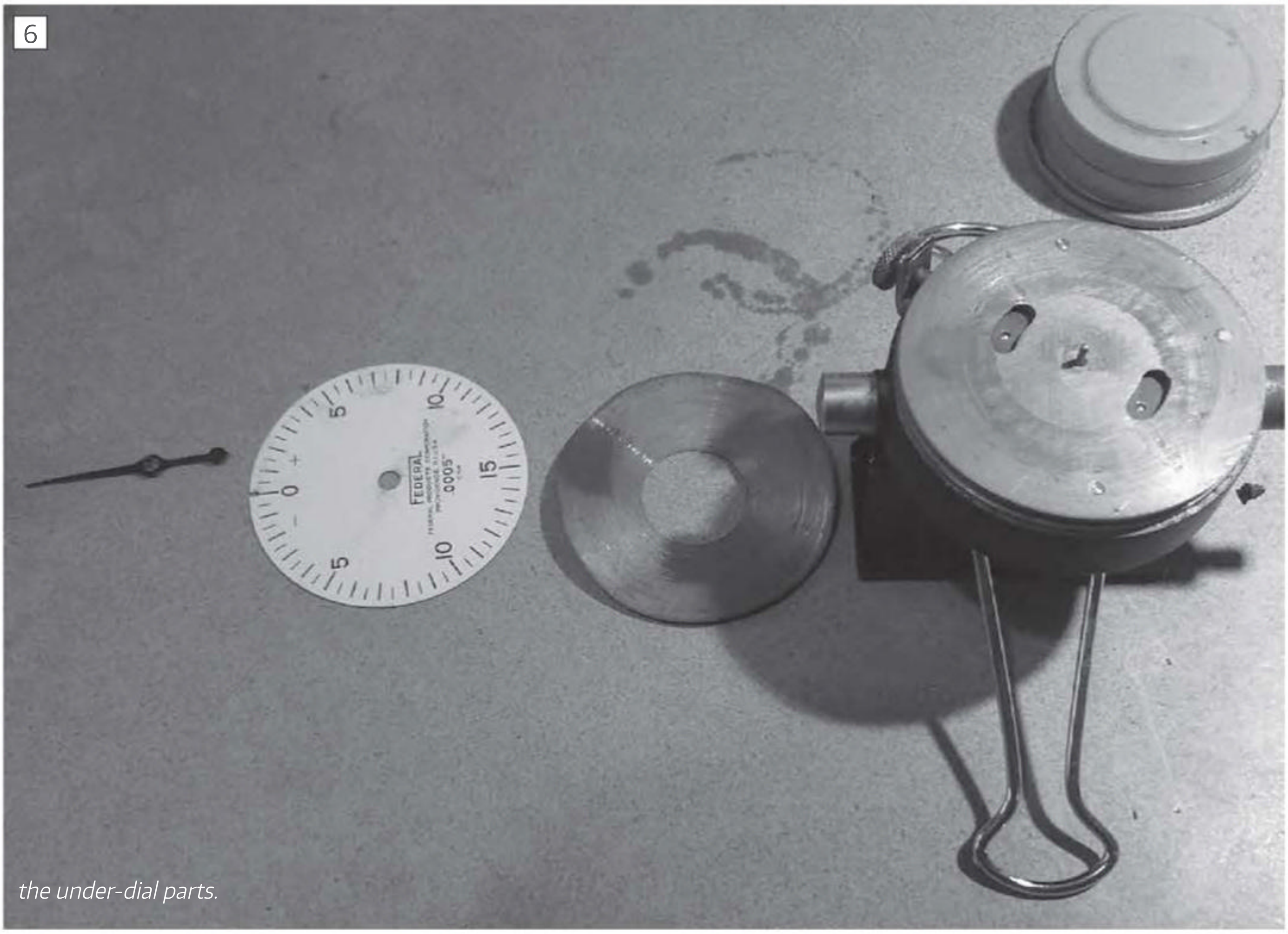
The plunger type needs to be partially dismantled. After taking off the slip ring and glass cover (usually held on by one or more screws), use the watch hand remover to prise off the hand, **photo 5**. It may be possible to use a set of fine pry bars – with paper between them and the dial to prevent scratching. Interestingly, in this example, the hand appeared to be upside down but was definitely tapered that way and would not go on the 'normal' way. **Photograph 6** shows what is under the dial, a spring to press the dial against the underside of the slip ring.

Remove the dust cap shown on the left of the dial, **photo 7**, and remove the retaining screw, **photo 8**. There are two screws to be removed that adjust the engagement of the rack and hold the works in place, **photo 9**. Next, the pin that secures one end of the return spring has to be unscrewed and then displaced as shown, **photo 10**, to allow

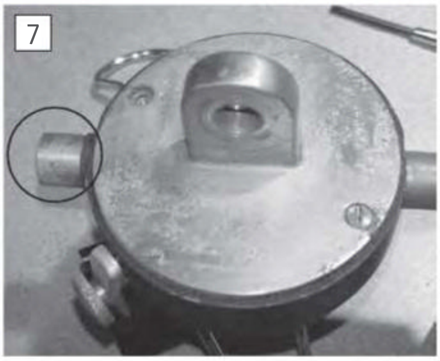
Using the watch hand removal tool.



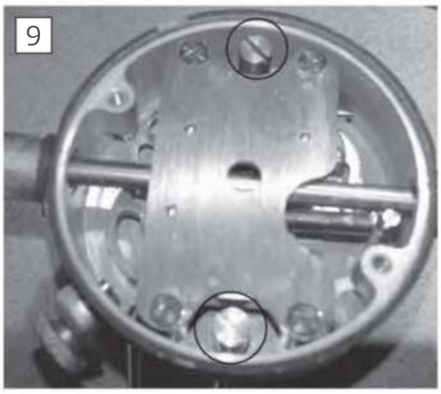
Remove the retaining screw inside.



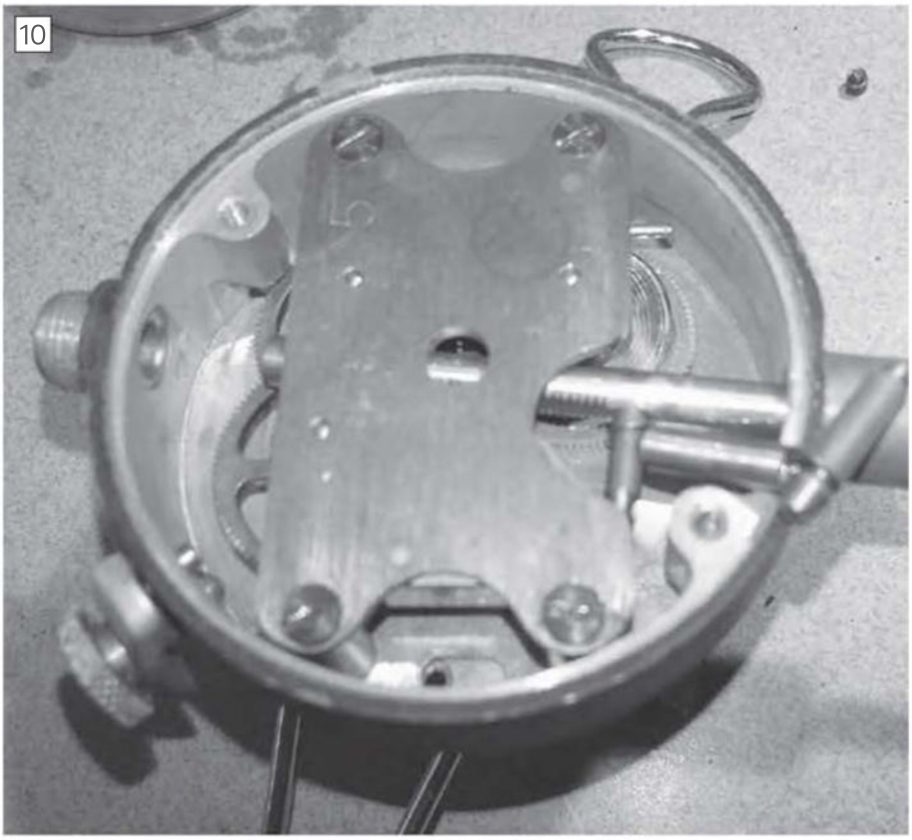
the under-dial parts.



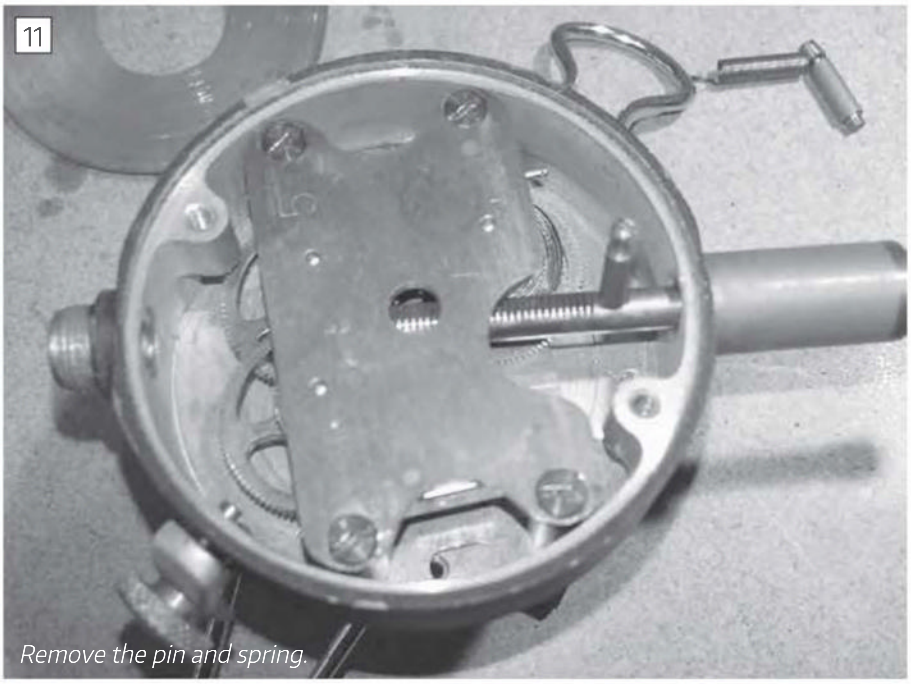
Remove the dust cap on the extreme left, circled.



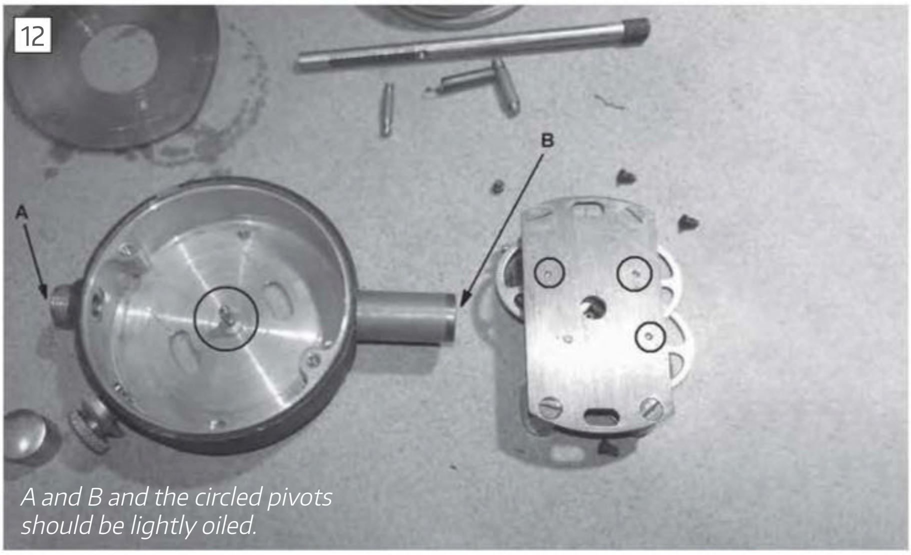
Remove the two engagement screws.



Twist the movement.


11

Remove the pin and spring.

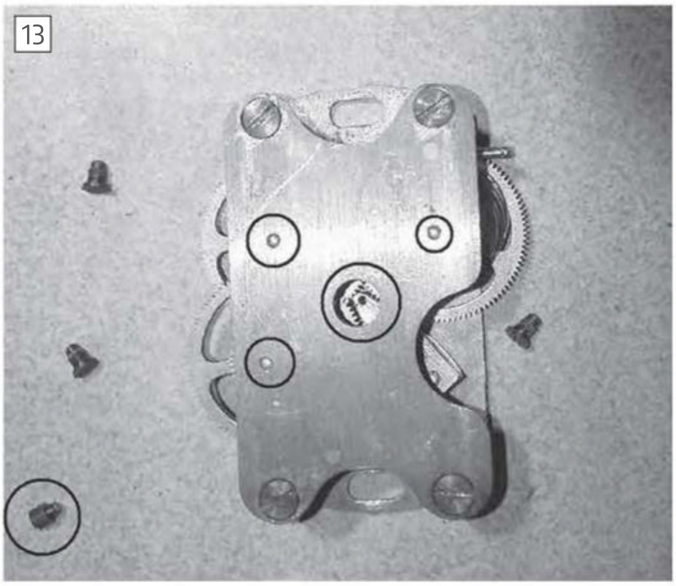


A and B and the circled pivots should be lightly oiled.

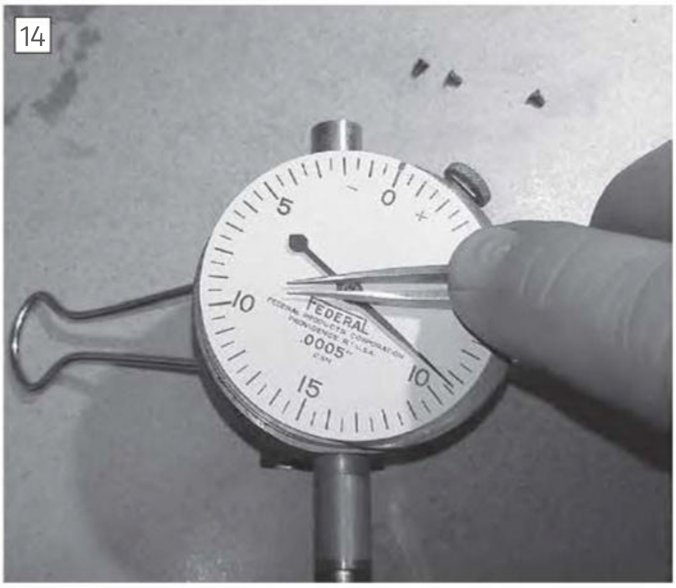
the arm to be moved right across so that the other pin and the spring can be unscrewed, **photo 11**; the rack is also shown in this view.

Photograph 12 shows the works and the pivot points to be oiled – note that in this case the final arbor was integral with the main case and needs a drop of oil. Also shown, points A and B, will need a small drop of oil on the arm's bearings. **Photo 13** shows the other side and its oiling points, one of which supports the final arbor – that one deep in the works! The circled screw popped out of the case when opened and is not part of the DTI at all – it must have dropped in there during manufacture! The other three screws retain the slip ring.

Clean the glass and dial before replacing the hand and slip ring. Re-assembly is the reverse of the dismantling, except that in **photo 14** I show my method for replacing the hand using tweezers. Finally, the superglue was used on one DTI to hold the glass in place, either it was under-sized or perhaps the acetate had shrunk over the years. Since it has lasted all this time without attention, I don't think that I will be too bothered if I cannot remove the glass in about another 50 or 60 years! ∎


13

Reverse side of the movement showing oiling points.



Re-assembly.

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 may be out of date or describe practices or materials that we would not use today either because much better ways are available of for safety reasons. 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.

Beginner's Workshop

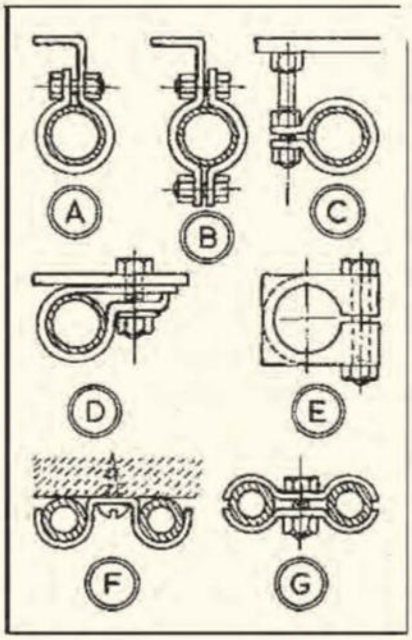
By GEOMETER

CIRCULAR CLIPS

ALTHOUGH OBTAINABLE in variety, commercial clips for circular sections do not meet all needs---either because of size or type so, on occasion, it is necessary to make such items.

The widest variety in commercial clips is, perhaps, those for rubber joints and one of the best known is the " worm drive " type. This consists essentially of a band with shallow teeth on the outside; one end is fixed to a small housing and the other is pulled through the housing by a screw or "worm" engaging with the teeth.

In another type of clip the band is much' thinner, making two turns; the free end passes through the slit of a substantial split pin and tightening is effected by rolling the band round the pin-turning this with a punch through the eye. Clips may also consist of bands of springy wire provided with eyes to accept screws or bolts.



Simple clips can be made from flat strip of suitable thickness and width -if necessary cut from sheet material in small sizes. For a clip as at *A*, the depth of the small lug is set with pliers, the strip rolled round a bar to shape it; then the other lug is set, leaving a length for a supporting piece if required. The hole for the bolt is drilled with the clip off the bar and the lugs are clamped together. The clip at *B* can be made in similar fashion. This type with two bolts or screws avoids the necessity for springing open to fit it-if free access to slip it on from the end of the circular section is not available. A simple clip can have support from a stud or bolt as at C.

For a single supporting clip used on a flat surface an important feature is the turned-over " lip " at the free end of the lug, *D*. With this, tightening the bolt pulls the clip firmly on the circular section, providing secure support.

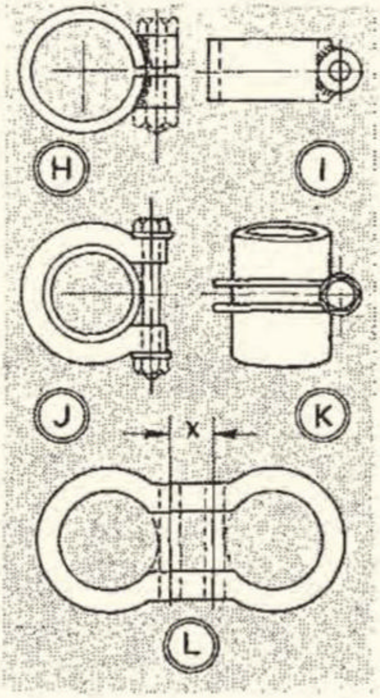
Duralumin hint

A clip for a true machined circular section can be made from rectangular bar stock as at *E*. In duralumin, it is not too heavy or laborious to make. The bore is drilled in the bar, and reamed if possible, or the cut off piece can be machined in an independent chuck. The cross hole for the bolt is drilled, and careful work with a slitting saw-not hacksaw-produces a neat slit. Corners can be rounded as required.

Light clips for holding a pair of wires or steadying two pipes can be arranged as *F* and G, turning from strip or sheet metal, and using a single 'screw or bolt for fixing. When attaching to thin metal. work a self-tapping screw can be used after drilling the core hole.

When heating is available for brazing or welding very accurate, light and powerful steel clips can be fabricated from tube or washers-depending on the width required. Such clips can be in sizes from the smallest upwards.

Tube or washer should be of the



internal diameter required or bored out in a lathe to size. The boss for bolt or screw can be smaller tube or rod drilled out, the hole being continually cleared or tapped halfway for a setscrew. Filed on the outside to suit the diameter of tube or washer the boss is then brazed or welded on. Finally, boss and tube are cut through. Diagrams H and I show end and plan views of a clip made from steel tube. One from a washer would be narrower, with the boss overlapping the sides.

Either clip must be fitted from the end of the circular section to be clamped, since opening the clip would spoil it. The alternative-permitting easy assembling and dismantling-is bosses each side of the clip, using two bolts, as for that at *B*.

At *J* and K are end and plan views of a clip from sheet metal, while L depicts the opened-out shape before bending. Marked with dividers the outside is sheared and filed, and the inside carefully chain drilled and filed.

Distance from the centre of the clamping bolt when the clip is bent is equal to the diameter of the bolt plus the thickness of the material multiplied by 1.57. Splaying is prevented by using washers under the bolt and nut. ❑

Scribe a line

YOUR CHANCE TO TALK TO US!

Readers! We want to hear from you! Drop us a line sharing your advice, questions or opinions. Why not send us a picture of your latest workshop creation, or that strange tool you found in a boot sale? Email your contributions to **meweditor@mortons.co.uk.**

Lathe Speed Sensors

Dear Neil, Keith Fisk makes the valid point regarding the use of Hall Effect sensors for lathe speed monitoring in that they are of rugged design and immune to contamination from dirt or fluids. Those that we are likely to use on lathes will have been designed for use in the engine bay of motor vehicles so can easily cope with the heat, vibration and oils we have in our workshops.

However, I do not think that we should be unduly worried about the material from which the gears are made as it would be impossible for us to use them at their maximum frequency, typically 100 kHz, and unlikely that they would be used with a gear that compromises their magnetic performance. Most articles describe the target gear for the sensor as having rectangular teeth 0.1" wide with 0.1" space between and manufactured from high permeability material. This is equivalent to a gear with a CP of 5 and a DP of 15.7. For a target gear designed purely for use with the sensor these parameters can be met but the gears we are likely to be using have to combine being the sensor target with their normal function of being a simple involute form gear wheel. Three factors allow us to work outside the ideal parameters, first, the pulse rates are very low in electronic terms, second, it is not too important if the odd pulse is missed and third we are not interested in accurate measurement of the rotation angle, merely the rotational speed. My own speed monitor uses a 16DP gear as target, which works perfectly giving a stable and accurate reading.

Since writing the above I have moved my sensor from its working position to a temporary mounting using a 20DP change wheel as target. It gives a reading, obviously not an accurate speed reading, but the interesting point is that the reading is not stable suggesting that pulses are being lost. So it seems that these Hall Effect devices need a target gear with a maximum DP of around 16 as indicated in their specifications.

Chris Gardiner, Chelmsford

Sourcing Hall Effect Sensors

Dear Neil, I was very interested in the tip relating to rev counter sensor in the above issue. Having made, a very loose term, one using a plywood disc, magnet and reed switch, I thought that the tip gave a very neat solution. The problem is that I have not found a reasonably priced sensor. I note the reader lives in New Zealand but even allowing for imports I could not find one. Perhaps you have an idea of a source of supply, either directly or via your contacts.

Laurie Leonard, by email

Hi Laurie, for my own speed sensors, made some twenty years ago, I used 'Logic Level Hall Effect Sensors'. An internet search of this phrase should turn up something that will work as a substitute for the reed switch with minimal additional components – Neil.

Woodscrew Sizes

Dear Neil, I have a woodworking pocket book which contains a section on woodscrews. To find the gauge of the most common sizes the following is useful. Measure across the diameter of the head in 16ths. of an inch. Double the number of sixteenths and then subtract two. This will give the gauge number. Apparently, the range of gauges was from 0000 to 50. I wonder if anyone has used those at the extremes? Of course we have now moved to metric sizes.

Ian Varty, by email

This Month's Mystery Tool

Dear Neil, I wonder if anyone out there knows what this is? Okay, so I know it's an 'ammer. A claw hammer, in fact, but the inch, or so, wide gap in the head suggests that there's a piece missing, which your average, bog-standard, everyday claw hammer don't usually have. Furthermore, it has a hollow handle into which the small chisel tool thingy snaps into. I can't remember where I got it from, or why, but I'm intrigued to know what it's for. I've had a number of interesting suggestions, I've had barbed wiring tool, cobbling tool, leather working tool, blacksmithing tool for doing horseshoes, railway worker's tool, and many more but no consensus.

I was hoping that it was maybe an 'Orbitoclast', which was a spooky pseudo-medical tool invented by Dr Walter Freeman for performing transorbital lobotomies on the go, but research on this has sadly led nowhere. A shame really as I'd sort of fancied reviving the practice and setting up in business - hey ho!

Anyway, if you know what it is, and what it's for, please do let me know. Funny responses are, of course, as always, more than welcome as long as they're towards the upper end of the 'gasping for oxygen - nails down the blackboard' continuum, but informative answers would be greatly appreciated.

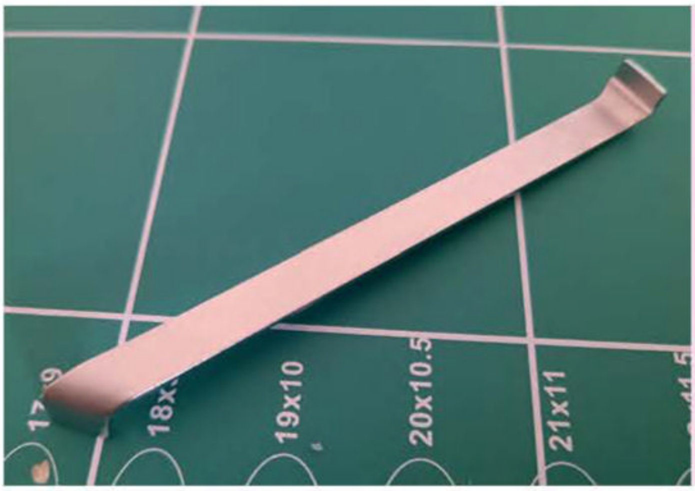
Ray Thompson, via Facebook.

Old Brace and Bit

Dear Neil, I have another photo. Previously, I sent a photograph of an old wood screw that had a slight taper to a blunt end.

To use it a pilot hole would need to be drilled, most probably using a 'spoon bit' as shown. This is a 3/16 inch one and would have been suitable.

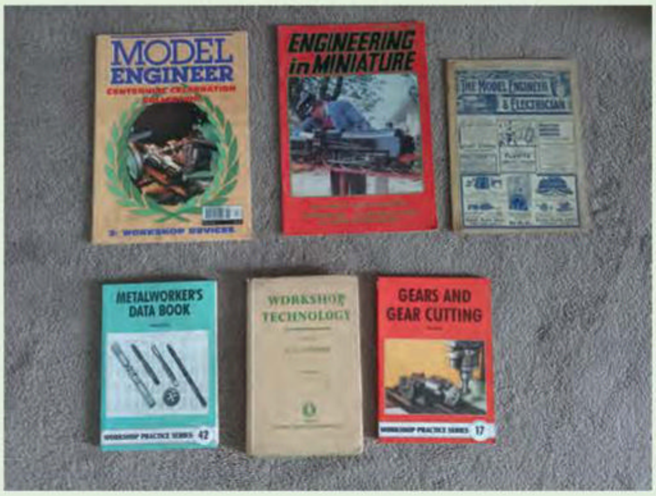
William Waddilove, by email.



Last Month's Mystery Tool

Dear Readers, last month I shared a mystery tool myself, and not one reader got its identification right! It is a Stewmac truss rod adjustment tool, used for carefully adjusting the neck profile of vintage style Fender guitars and basses. These have the truss rod adjustment nut sunk into the heel of the neck and barely accessible in a small pocket. Alternatives to the tool are bodging around with a screwdriver and risking damage, or removing the neck completely.

Neil Wyatt, Editor



Offer of Magazines, Books and Patterns

Dear Neil, I hope you can help, I have thirteen boxes of model engineer magazines from 1908 – 2009 and various others also three sacks full of wood templates for use when casting as my dad was a pattern maker, I also have a few plans . I don't want anything for them, but someone will have to pick them up from Sunderland. I asked at my local model engineer club but they said they don't have the room. Or if you can let me know of anyone who wants them as I don't really want to throw them away.

John Baird, Sunderland

"Houston we have a problem!"

Dear Neil, I had an "Oh, drat!" moment when I read Ken Lonie's article (pages 9-130, MEW Issue #331). I've had the very same project kicking around for my mind for several years but credit to Ken, he beat me to it! Unfortunately, there's something 'screwy' in his numbers; gear tooth counting is about as interesting as watching paint dry but if you're careful the photo on page 12 - and particularly, that on page 11 clearly show a tooth count of 108 teeth, NOT the number of 104 he informs on page 9. "Huh??" clearly something doesn't add-up, not to mention the incorrect DP number of 8. He describes his dissatisfaction with the amount of backlash so maybe this is a contributing factor but by far the biggest reason for his table's backlash is that he may not have appreciated the necessity to 'throat' the gear teeth tips which will allow the worm to mesh more deeply into the ring-gear - machining a bigger worm for a future project as he describes I don't think is going to fix this problem. The scallops he needs to remove from the gear tips will, of course, not be perfect semi-circles due to the helix engagement angle of the worm. The best way to accomplish this is to use a Dremel type of grinder fitted with a cylindrical grinding tip with a diameter only fractionally larger than the axial core diameter of the worm held in a tilting fixture set to the helix angle, indexing each individual teeth as you go (has your lathe got enough swing or you mill table enough traverse?). Tipped cutting tools won't work for this task.

I will share with readers one useful piece of advice I had intended for my flywheel ring-gear, rotary-table conversion project: choose a 144-tooth ring gear (these are plentiful and readily available). Why? Because if you machine a two-start worm then one full rotation of the handle will rotate the table exactly 5° - a nice round number for ease-of-use and easy indexing.

Andre ROUSSEAU, New Zealand

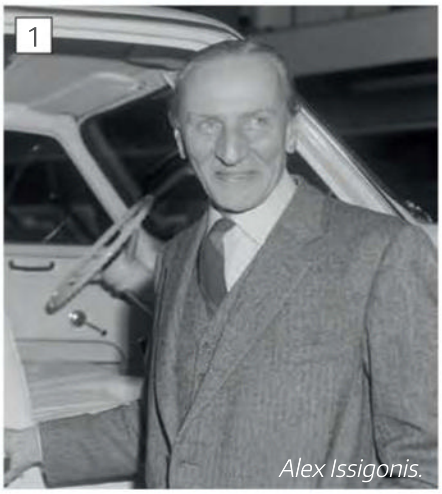
Batch Parts Tip

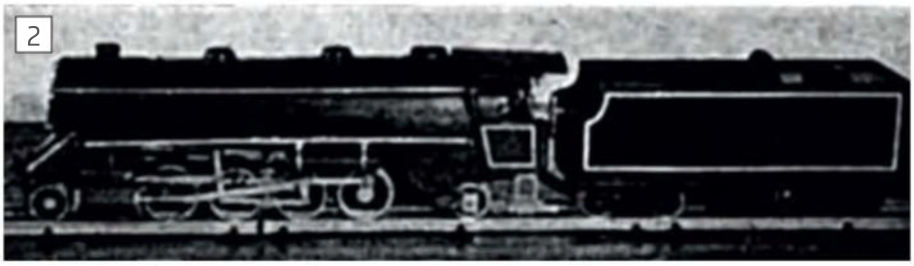
Dear Neil, I have lost a small screw holding the wiper clamp on the LH side of my Super7 saddle. I thought that the price asked for a batch of replacements was steep. As I need more experience at screw and bolt making for future model making, I decided to make my own. Point is, whatever you are setting up a machine for, it's the biggest consumer of workshop time. Once set up, I make a batch of 10 where only a few are needed. In this case, one got used and the rest stored with VPI paper in a small container in a box of small Myford parts so will be quickly findable when/if next needed.

John Coleman, by email

Tales from the Workshop

Alec Issigonis


Alex Issigonis.


One of his two spirit fired locos featured in Model Engineer in November 1960.

Many readers of MEW will be familiar with Sir Alexander Issigonis, **photo 1**, as the designer of the most iconic British car of all time – the Mini. Issigonis's family was of Greek origin, but his father had naturalised as a British citizen as an engineering student in the last years of the 19th century. After his father's death he and his mother moved to the UK in 1923. Despite struggling to complete his engineering degree, he went on to be an engineer and designer at Humber, Austin and then Morris Motors, where he worked on the suspension for the Morris 10 and the Morris Minor. Autin and Morris merged to form the British Motor Corporation and it was there that he designed the Mini, although the simple rubber cone suspension that gave the Mini it's exceptional roadholding was designed by Alex Moulton (of folding bicycle fame). He also designed the Austin 1800 and Maxi.

Issigonis was also a model engineer. The O-gauge locomotive in **photo 2** was one of two largely constructed for him by Mr R. H. Cox. Cox built the chassis and boiler, and Issigonis added the cab, running boards, various details and built the tender. Apparently, the piston valve cylinders of one locomotive were copied from a Bassett Lowke Mogul in Issigonis's possession. He insisted on large spirit fired boilers with a tender tank in order to get long running times.

In our Next Issue

Coming up in issue 334, December 2023

On sale 17 November 2023

Contents subject to change


Laurie Leonard rescues a cracked die.


Warren Williams celebrates 50 years of George H. Thomas's Universal Pillar Tool.


Malcolm Tierney describes a robust rear toolpost design.

To pre-order your next copy of MEW visit www.classicmagazines.co.uk or call 01507 529 529

DON'T MISS THIS GREAT ISSUE-SEE PAGE 54-55 FOR OUR LATEST SUBSCRIPTION OFFER

Readers' Tips

Allen Key Organisation

TIP OF THE MONTH WINNER!

This month's winner is Mike Matthews from Kent with his approach to solving Allen key confusion (Allen wrench for out transatlantic readers).

Just an idea for your readers tips. I was recently using a mixture of Imperial and Metric Allen Keys and got heartily fed up with picking the wrong ones!

To identify different types I put heat shrink sleeving on the Imperial keys as illustrated. If it is shrunk on around the bend in the key, it won't come off and individuals can develop their own colour code.

Pretty trivial, but my goodness does it save irritation.

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 600 words and a picture or drawing. Don't forget to include your address! Every month we'll choose a winner for the *Tip of the Month* will win £30 **in gift vouchers from Chester Machine Tools**. Visit **www.chesterhobbystore.com** to plan how to spend yours!

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

Compact Dividing Head Part 2

Chris Hallaway designed and made this Compact Dividing Head (CDH) about thirty years ago for use with hobby size milling machines.

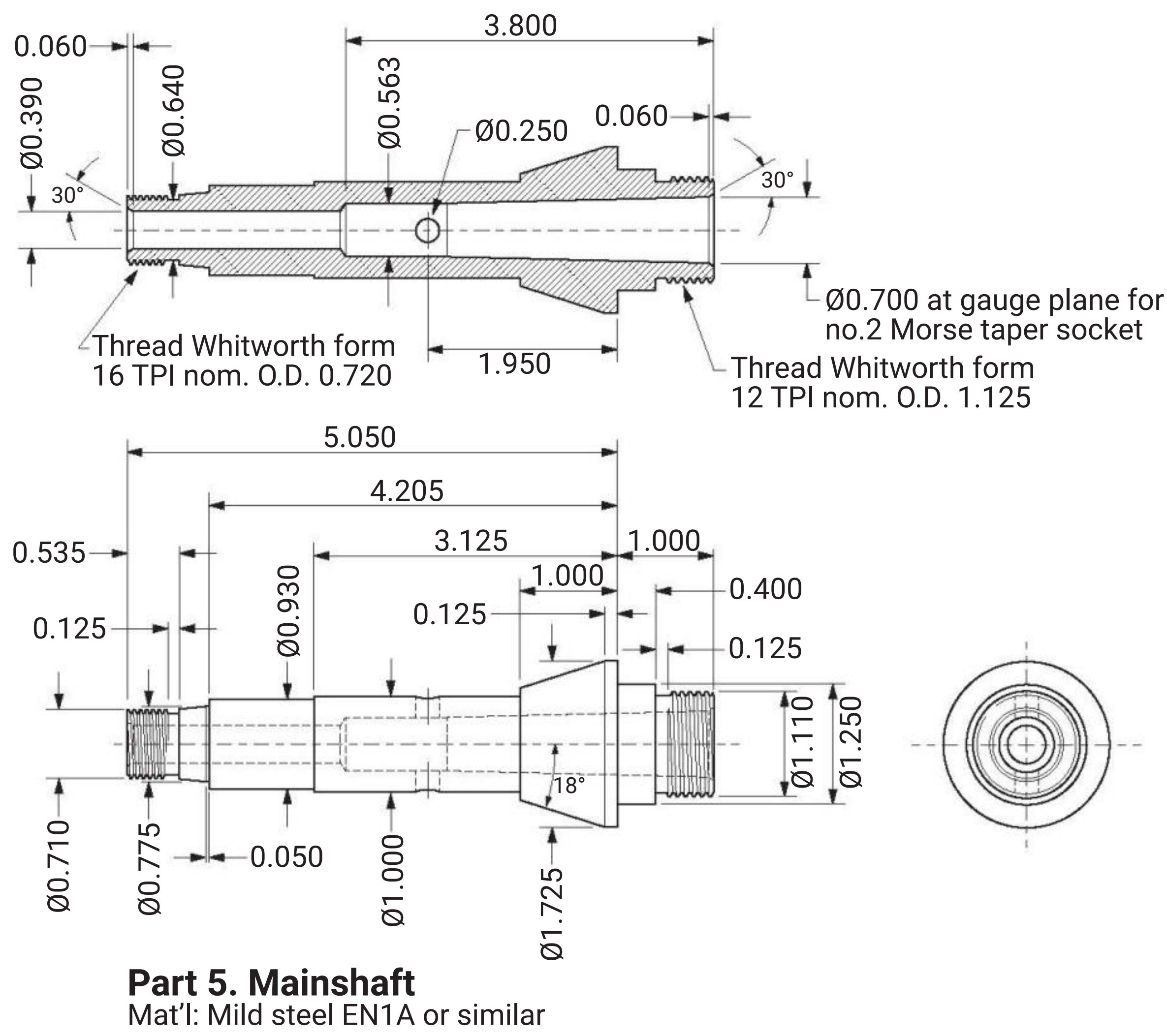


Figure 8. The mainshaft.

Finally enlarge the hole for the Clamp Bar capscrew to drawing dimension which will allow the Clamp Bars to self-align on the Mainshaft.

5 Mainshaft

The mainshaft is shown in **fig. 7**, making this before the body can help with achieving the required accuracy of fits. Start with oversize material so that a possibly work hardened layer can be turned away to relieve internal stresses.

Mount in the 3-jaw chuck and face the front of the bar. Drill 0.500 diameter by 4.000 deep and form the 30 deg chamfer for a lathe centre on the edge of the hole.

Turn end for end in the chuck, face to length and drill a 9.9 mm hole to meet the previous drilling and again form the 30 degree chamfer to take a lathe centre.

Mount between centres and turn and screwcut the external surfaces to drawing dimensions. See the notes below.

Make sure that the locating spigot is as close as you can manage to

Boring the mainshaft.

1.250 inches diameter. It's even worth checking your mike against the locating spigot on your lathe which will be spot on.

Mount the rear of the mainshaft by its 0.930 diameter in the 4-jaw chuck and support the front on a fixed steady located between headstock and saddle and bearing on the 1.250 diameter, **photo 4**. Ensure alignment using a tailstock centre to set the fixed steady jaws and by clocking the 0.930 diameter. Bore out to 0.563 diameter followed by the No2 Morse taper and finish with the 30 deg chamfer on the bore mouth.

You may need to explore the internet, back issues of MEW and the standard books (L.H. Sparey, G.H.Thomas, etc. with apologies to more recent authors whom I have not explored) to find advice on machining and matching the three tapers.

Finally drill the cross hole which is provided to assist with last ditch attempts in removing reluctant fittings from the Myford spindle nose should the need arise. The Mainshaft would need to be removed from the Body to access this hole.

Notes on cutting the mainshaft fastening threads

Although the nominal diameter of the 12 threads per inch (tpi) Myford thread is 1.125 inches., the drawing shows a blank diameter of 1.110 inches. The reason for this is that Whitworth form threads are designed to have rounded crests on male threads that fit into similarly rounded roots on female threads. Unless special tools are used, threads screwcut in the lathe from a blank of nominal diameter will have sharp edges to the crests which, when the rest of the thread is correctly cut, will bind on the roots of the female thread.

The solution is either to get busy on the corners with a file or much better, since the rounded crest performs no useful function, reduce the blank diameter to eliminate the rounded crest as shown here.

Measure the thread on your lathe spindle using three wires and use this measurement in cutting the Myford thread on the mainshaft. The resulting thread will not be a close fit thus ensuring that mounted items are located by the 1.250 diameter and the shoulder on the shaft only.

Less care need be taken with the 16 tpi 0.720 inches nominal diameter thread on the rear end of the shaft as the female thread can be cut to an easy fit by trial and error.

For Whitworth form threads (i.e. BSW, BSF, BSP, etc.) the general formula for measurement over three wires is:

Dm = Do – 1.601 p + 3.166 d inches

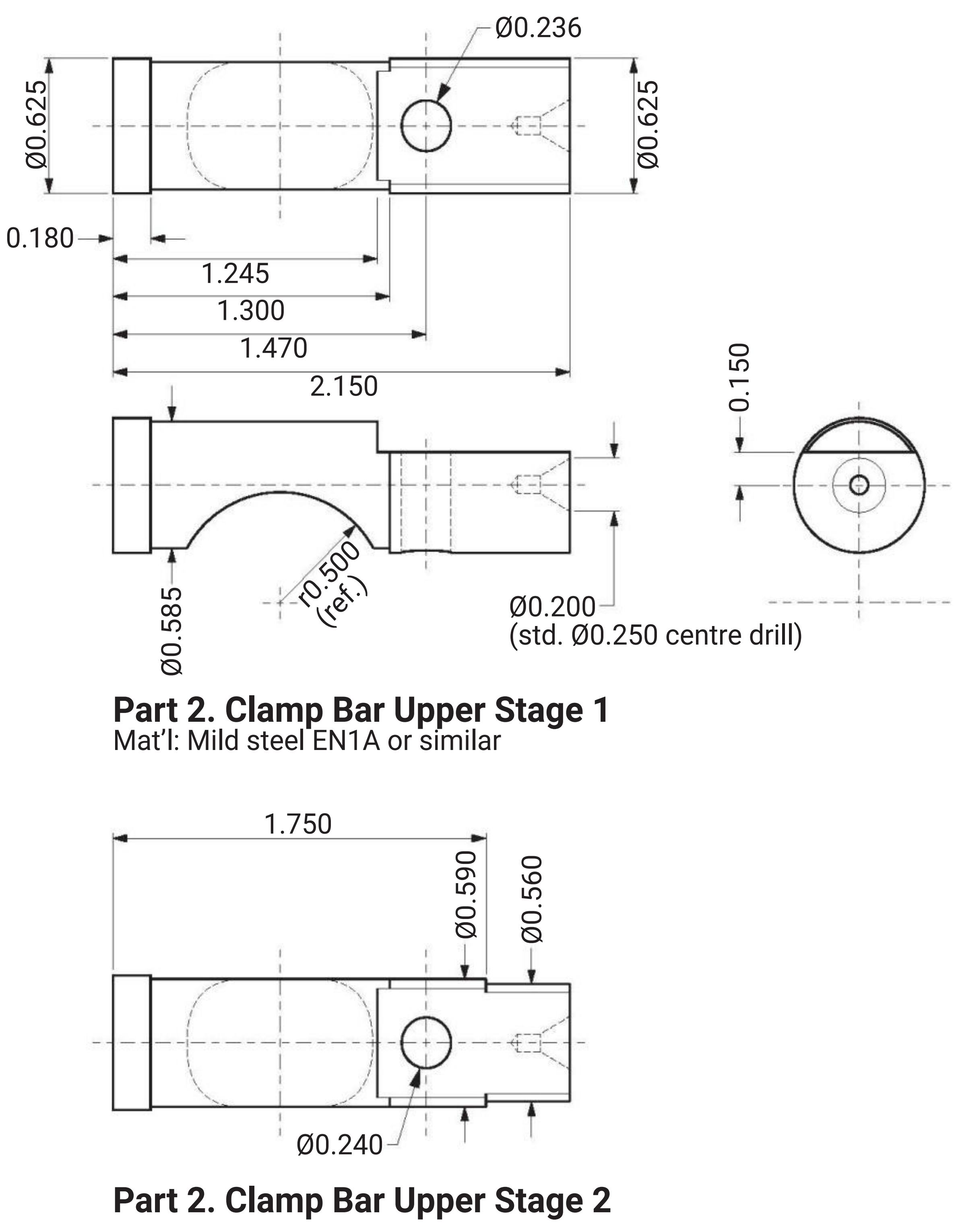


Figure 9.Upper clamp bar.

Where:
Dm = measurement over the wires, inches
Do = **nominal OD** of the male thread (**not** the reduced diameter), inches
p = pitch of the thread, inches
d = diameter of measuring wires which should be between 0.55 and 0.80 x p, inches

For the Myford thread Do = **1.125** inches, p = **0.0833** inches and d should then lie between 0.046 and 0.067 inches

Therefore **Dm** = 1.125 – 1.601 x 0.0833 + 3.166 x d = **0.992 + 3.166 d** inches.

For example, if the diameter of the available wires is 0.0625 inches Dm = 1.190 inches.

For the Rear end thread Do = **0.720**

inches, p = **0.0625** inches and d should then lie between 0.034 and 0.050 inches.

Therefore **Dm** = **0.620 + 3.166 d** inches.

For example, if the diameter of the available wires is 0.050 inches Dm = 0.778 inches.

On a practical note, on large threads, such as the Myford thread discussed here, it is sometimes found during cutting that the final thread nearest the chuck is tight compared with the rest. This is probably due to the tool being pushed towards the chuck, within the leadscrew thread backlash, by cutting pressure on the tool from only the right-hand flank of the thread as the tool enters the undercut. In the rest of the thread there is cutting pressure predominantly from the left-hand side of the thread.

The solution is easy, keep gentle hand pressure on the toolpost towards the tailstock to maintain engagement with the same flank of the leadscrew thread throughout the cutting operation.

2 Clamp Bar Upper

Stage 1. Refer to **fig. 9**. If using bright cold rolled bar, it's probably a good idea to start with oversize material to ensure that the compressed surface layer is removed. If this isn't done distortion is likely as a result of forming the 0.500 radius. Using the 3-jaw chuck (or a collet), face, centre drill and then turn 0.625 diameter by 1.100 inches long to an easy fit in the Body. Reverse in the chuck, face to length and turn the short 0.625 diameter and 0.575 diameter recess. Machine the face and hole for the capscrew.

This is now the stage at which the Clamp Bars should be clamped and bored in the Body. Take it easy when approaching the final dimension as large burrs thrown up will make it difficult to extract the Clamp Bars from the Body.

Stage 2. Subsequently grip the short 0.625 dia. in the chuck, support the other end with a centre in the tailstock and turn to final drawing dimensions. Make sure that the edges of the 0.625 diameter are well rounded so that the Clamp Bar can easily articulate the small amount needed to clamp the Mainshaft.

3 Clamp Bar Lower

As for the Upper Clamp Bar but with a tapped hole, etc. for the M6 capscrew, see **fig. 11.**

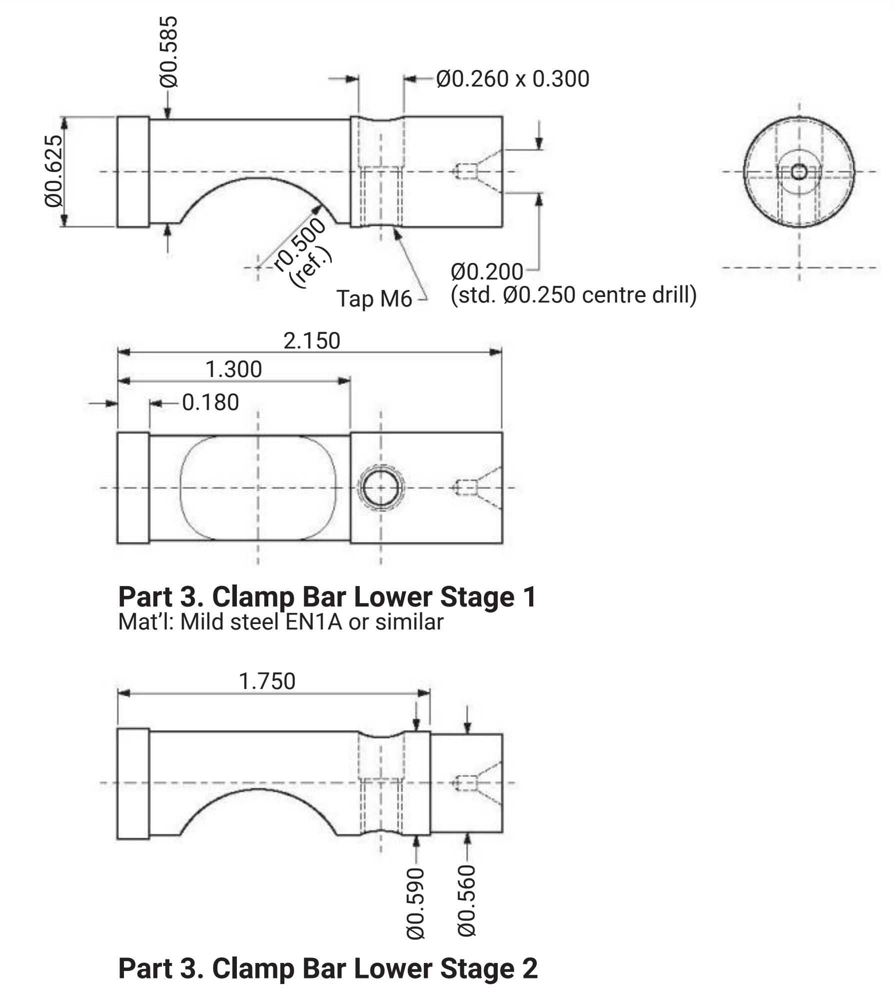


Figure 10. Lower clamp bar.

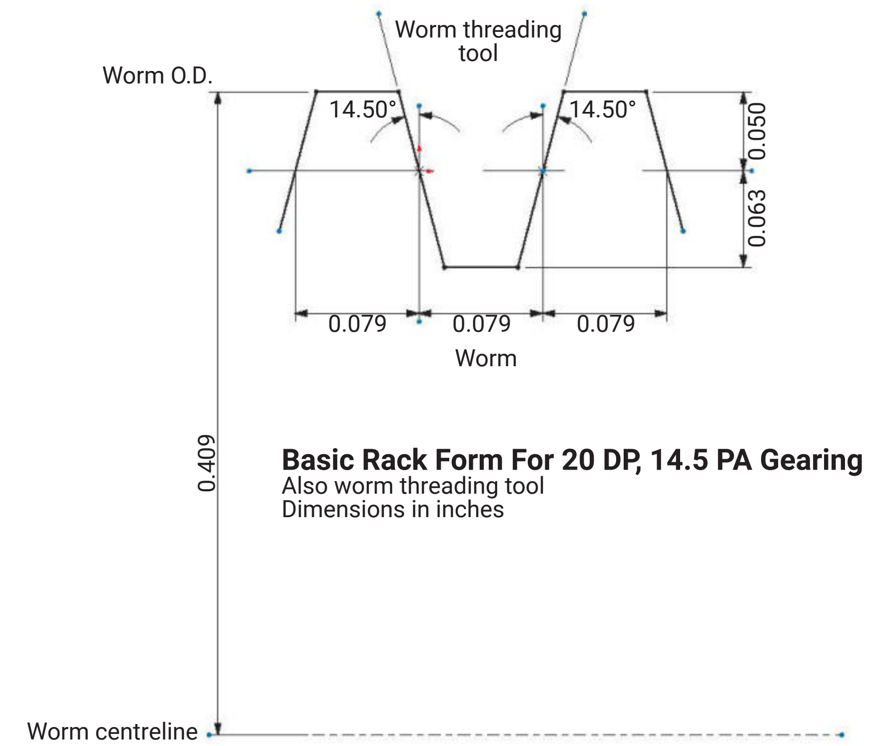


Figure 11. Worm calculation.

Table 3 Two Example Worm Pitch Calculations

Using Standard Myford ML7 & S7 Changewheel Set				
	Tumbler Stud	**First Bracket Stud**	**Second Bracket Stud**	**Leadscrew**
Driver	**70**	**60**	**45**	
Driven		**50**	**40**	**75**
Resulting Pitch, Pw	= 70 x 60 x 45 x 0.125 / (50 x 40 x 75) = **0.15750** inches			
Helix angle, Alpha	= acos (0.15708 / 0.15750) = **4.19** degrees			
Important Note	**0.15750 inches = 4.0005 mm**			
Using Myford ML7 & S7 QC Gearbox				
Replace standard **24** t.gear on Tumbler Stud with **34** t.gear				
	Select 9 t.p.i.			
Resulting Pitch, Pw	= 34 / (24 x 9) = **0.15741** inches			
Helix angle, Alpha	= acos (0.15708 / 0.15741) = **3.70** degrees			

Table 4 Worm worked out for 4 degrees Helix Angle.

Helix angle, Alpha	= **4.00** degrees
Inferred Worm Pitch, Pw	= 0.15708 / cos(4.00) = **0.15746** inches
Worm Pitch diameter, Dp	= 0.15746 / (π x tan(4.00)) = **0.717** inches
Worm Outside diameter, Do	= 0.15746 / (π x tan(4.00)) + 0.1 = **0.817** inches
Min Worm Root diameter, Dr	= 0.717 - 0.125 = **0.592** inches
Wormgear and Worm Centres, Lc	= (60 / 20 + 0.717) / 2 = **1.858** inches.

33 Wormshaft

The Worm and its integral shaft is shown in **fig. 10** basically a between centres turning and screwcutting exercise. The Worm itself is a coarse thread whose form is the basic 20 DP, 14.5 degree PA rack. The difficulty comes in selecting the pitch and, from that, the diameter of the worm. Because the thread is presented to the gear at its helix angle, the pitch of the Worm needs to be slightly larger than the pitch of the gear**.**

The following section explains how suitable pitches is calculated.

The pitch of the wormgear is 0.15708 (π / 20) and **table 3** shows two gear trains worked out for Myford lathes which give pitches which are slightly larger than this.

The angle at which the Worm must be presented to the plane of the wormgear (alpha) is such that:

cos(alpha) = Pg/Pw

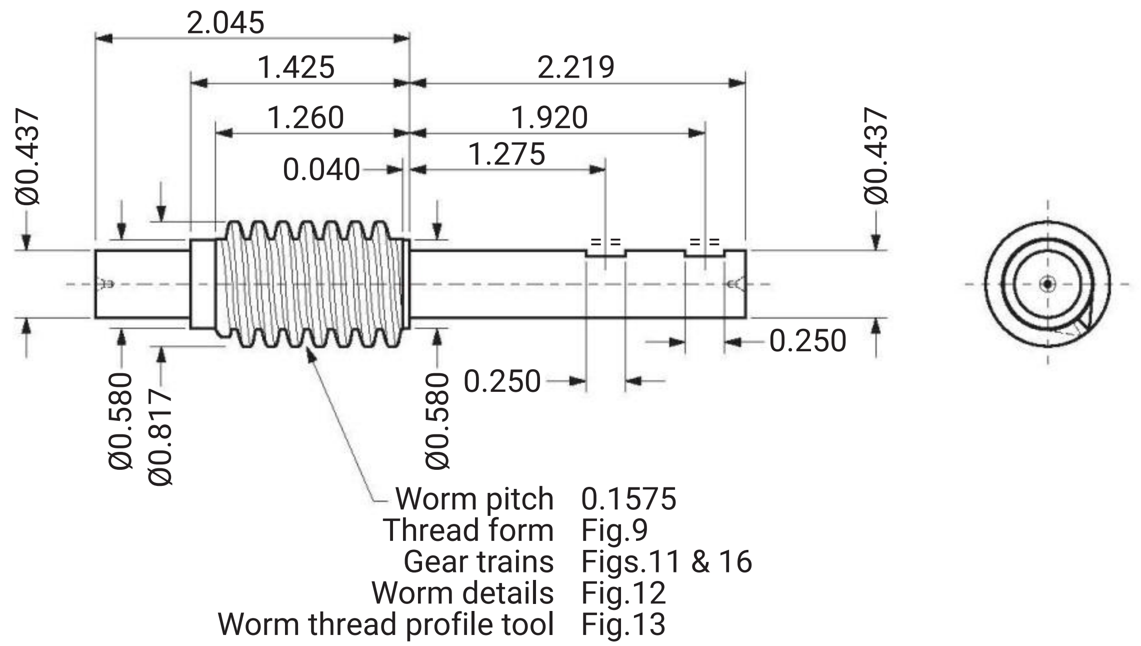
Where:

Pg is the pitch of the Wormgear, inches.

Pw is the pitch of the Worm, inches.

This ensures that the pitch of the Worm measured in the plane of the Wormgear equals the pitch of the Wormgear.

But this angle **(alpha)** is also the helix angle of the Worm and the combination of helix angle and pitch gives us the



Part 33. Worm Shaft

Mat'l: Mild steel EN1A or similar

Figure 12. Wormshaft.

diameter of the Worm.

Pw = Dp x π x tan(alpha) inches

So **Dp = Pw / (π x tan(alpha))** inches

Where **Dp** is the diameter of the pitch circle of the Worm, inches

For 20DP, 14.5 PA gears and worms (this case) the outside diameter, **Do**, is greater than the pitch diameter by 0.100 inches

So **Do = Dp + 0.100** inches

The final information needed is the distance between the Centre Line of the Wormgear (60 teeth) and the Centre Line of the Worm, **Lc**

Lc = (60/20 + Dp) / 2 inches

In practice, it is unlikely that with our equipment we would be able to either make or measure the two example pitches calculated in table 3 to an accuracy which would allow us to tell the difference between them. What the calculation does tell us is the sort of helix angle we should be aiming for. In this case 4.00 degrees would be a reasonable choice.

In **table 4** the information above is used to work out details for the worm with a helix angle of 4 degrees shown in **fig. 12,** the wormshaft drawing.

Backlash can be adjusted on assembly making use of clearance on the Wormshaft Bearing Block screws.

My suggested sequence is to turn the blank to drawing leaving an allowance of say 0.005 inches on diameter on the 0.437 inch diameters for finishing prior to cutting the Worm thread. Finishing to the remainder of the drawing details and dimensions needs no further comment.

It is straight forward, particularly if you have some sort of jig, to grind the angled faces of the form tool depicted in **fig. 13** but not so easy to form the nose of the tool accurate to length (better to be longer rather than shorter than specified as this ensures root clearance). The effect of any inaccuracy in this dimension can be nullified by making a final check on the Worm using the 3-wire method as for screw threads, **table 5** gives the necessary information for doing this.

Having completed the turning to size and threading, the job should be finished by securing the Wormshaft Thrust Collar **fig. 14** in place with retainer and, when this is set, finally skimming the thrust face between centres.

Table 5 Worm Measurement over Wires

General Equation for measurement over 3 wires for 20 DP 14.5 PA Worm
Dm = Dp – 0.3037 + 4.9939 d
Dm = measurement over wires, inches
Dp = Worm Pitch Diameter, inches
d = Wire diameter in range 0.085 to 0.103, inches
For the Worm worked out in **figure 12** where Dp = 0.717, inches
Dm = 0.4133 + 4.9939 d

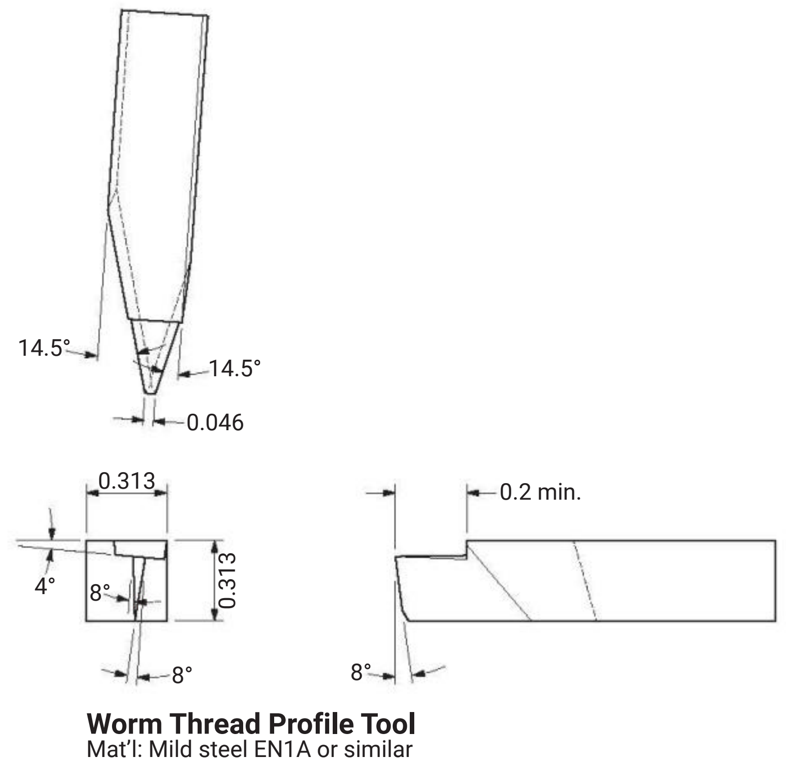


Figure 13. Thread form tool.

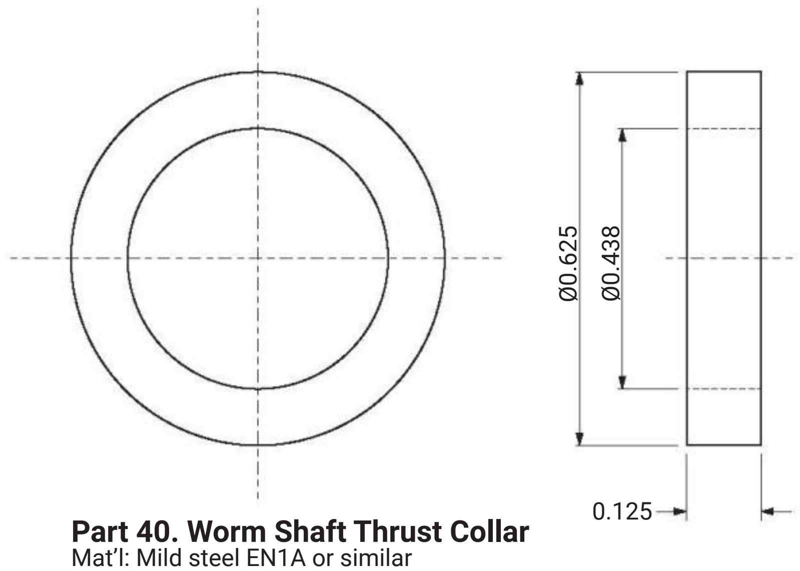


Figure 14. Thrust collar.

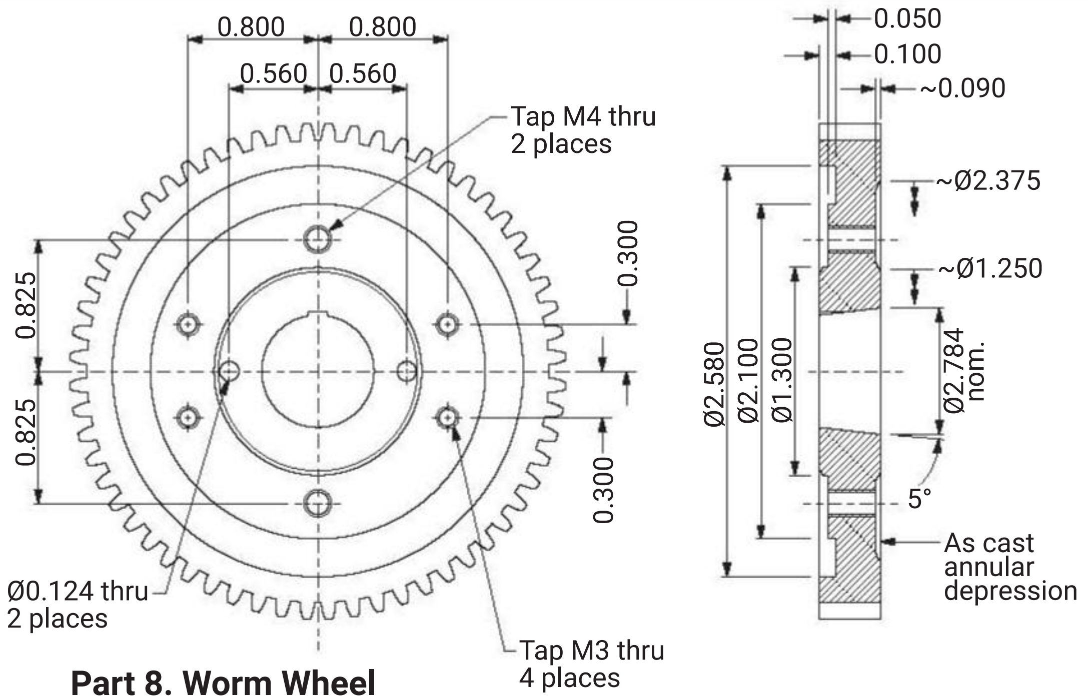


Figure 15. Worm gear.

8 Wormwheel

Shown in **fig. 15**, use a purchased 60 tooth Myford 7 changewheel (20 DP, 14.5 PA) as the basis for the part.

The first job is to mount the changewheel in the lathe as concentrically as possible. For most this will entail gripping on the tops of the teeth in the 4-jaw chuck (with suitable packing to avoid damaging them) and clocking on the bore but, if you suspect eccentricity between bore and the hobbed teeth, the following method is appropriate.

Prepare four identical pegs whose diameter lies in the range 0.085 – 0.098 inches and which are round to close limits (e.g. silver steel or turned rods) and which are about 0.625 inches long. Set the pegs into four equally spaced tooth spaces fixing temporarily with Blutac or plasticine and lining the peg ends up with the back face of the gear. Mount the assembly in the 4 jaw so that the pegs lie under the jaws and the front face of the gear lies in line with front faces of the jaws. The protruding ends of the pegs can now be clocked, and appropriate adjustments made, **fig 16.**

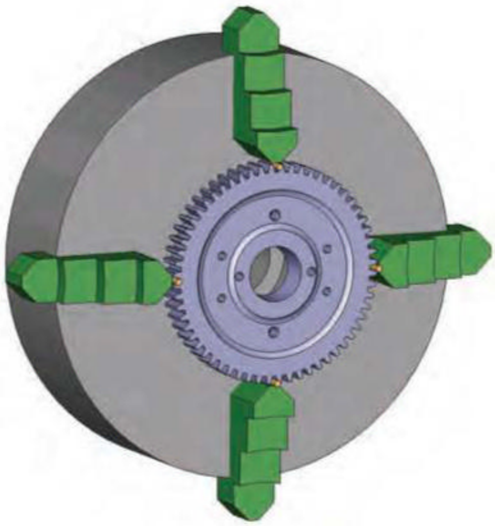


Figure 16. Setup for machining worm gear.

Machine the tapered central bore using the Mainshaft as a gauge. Adjust the topslide angle so that the tapers are reasonably well matched. Put on cuts by moving the lathe saddle along the bed in small increments (possibly measuring with a clock gauge) so that traversing the topslide takes off very thin layers. Measure progress by monitoring the gap between the back of the wormwheel and the shaft shoulder with feeler gauges. Stop when this gap is about 0.003 inches.

Subsequently, on final assembly, tightening the Tube Nut should push the Wormwheel against the Mainshaft shoulder at the same time creating sufficient interference between the taper parts to transmit adequate torque. Note that the Clamp Bars should be tightened when carrying out this operation to avoid excessive loads on the Wormgear and Worm teeth.

Reverse the Wormgear in the 4-jaw gripping on the teeth (with suitable packing to avoid damaging them) and clocking on the tapered bore to run true. Machine the details as drawn but cutting the face outboard of the 1.370 diameter deeper if the cast face does not at first clean up.

Finish by drilling and tapping the various holes to drawing.

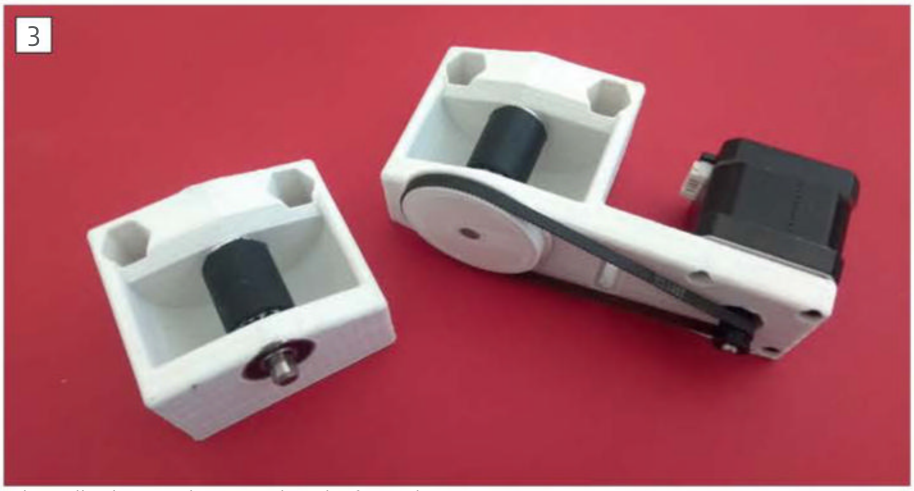
● To be continued

The Third Dimension

MEW editor Neil Wyatt introduces an occasional series looking at different approaches to engineering challenges.

Telescope mounted on the equatorial platform

Woodworking, metalworking and 3D printing combined.



The roller boxes showing the platform drive.

I have to admit to a fascination with using alternative or unusual techniques and technologies in my workshop projects, not just traditional metalworking skills. I'm particularly interested in 3D printing, but I use a much wider range of techniques.

A nice example of a project using many different techniques is an equatorial platform I built for my large 10" Dobsonian telescope. At nearly six feet long and over a foot in diameter, it's designed to site on a rotating platform and be 'nudged' to follow targets as they move across the sky. The equatorial platform automates this process and is much smoother allowing the telescope to be used for astrophotography and making observations much easier.

The basic design is a flat board that pivots on a spindle aligned with the earth's axis (effectively pointing at the North Star). The boards were made from thick plywood, so it all started with simple woodworking. The spindle was turned from stainless steel to fit ball races held in 3D printed blocks. To guide the motion accurately two sectors were designed in Alibre Atom 3D as well as 3D printed housings for rollers – one of which is fitted with a stepper motor and a reduction system using printed toothed pulleys. By keeping the centre of gravity close to but below the spindle axis, the system is stable and only modest power is needed to move the heavy scope.

The control system, used to tune the speed to match the stars or the moon, is based on an Arduino with a keypad shield and is housed in a 3D printed box. Other elements include adjustable feet and limit switches. Mixing woodworking, metalworking, 3D printing and electronics meant a quite ambitious project could be competed rapidly and cheaply, and yes – it works!

Steam Motorcycles

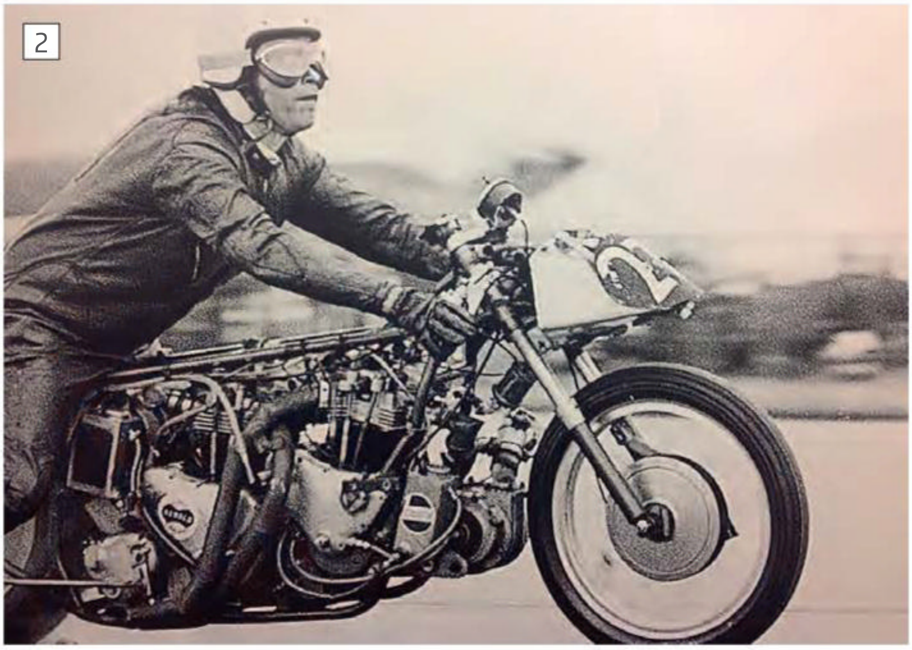
Not all readers of Model Engineers' Workshop are model engineers! Many of our readers have interests in other aspects of engineering.

A past contributor to Model Engineers Workshop, Paul Windross, **photo 1**, who first came to our attention as a builder of record holding flash steam hydroplanes. Paul also has a past history as one of the fastest Britains on a motorcycle. With much past success on sprint bikes, he was one of the first people to exceed 200mph on a motorbike, **photo 2.**

Paul saw a steam motorbike at the 2015 Model Engineering exhibition in Harrogate. As a biker flash and steam hydroplane builder, this must have planted the seed of an idea in Paul's mind. Over recent years he has been working on his own flash steam motorcycle, **photo 3**. The engine, **photo 4,** is an advanced design and it is planned to fit it into the frame of a Honda Blackbird, **photo 5**. Paul is getting a bit long in the tooth for racing, but he says "I will do a test run to start with but have a volunteer (idiot) for competition runs, [I] have told him he will need asbestos underpants."

Recently Paul drew our attention to a remarkable new steam bike designed to break the steam bike speed record. Unlike Paul's home workshop machine, Team Force of Nature has taken a different approach to the challenge.

Paul Windross with one of his hydroplanes.



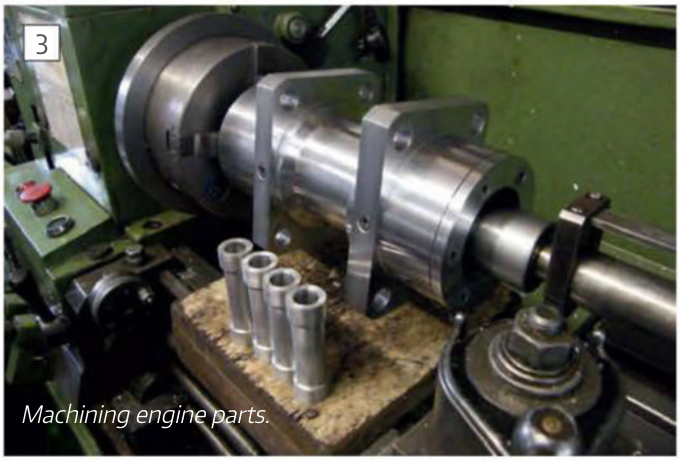
Paul on a sprint bike back in the early 1970s.

Team Force of Nature:

The force of nature team is a small family-run precision engineering company, Graham Sykes and his wife, Diane.

Chief designer and engineer Graham Sykes, **photo 6,** has been involved in straight-line motorsport since 1979. Graham has worked on many prestigious projects including six years as race engineer for Vauxhall's championship-winning British and European Touring Car Team, engineer and key team member for the 'Firestorm' jet-powered dragster and is currently part of the engineering team working on '52 Express', a world land speed record motorcycle. Graham is the current British land speed record holder for a 3-wheeled vehicle achieved with his self-designed and engineered V8 engined 'Syko'.

The 'Force of Nature' bike works by superheating pure water to create pressure, it takes three hours to do this. Once the correct pressure is achieved the water is then passed through a specially shaped nozzle, the superheated water flashes to steam as it escapes through the de Laval nozzle creating rocket



Machining engine parts.

The unconventional steam engine.

propulsion until the bike's pressure vessel is empty, **photo 7**. The heat is generated by using hydrogenated vegetable oil to reach 200°C and 30 bar pressure.

Graham and Force of Nature set a new world record for a steam powered motorcycle on the 21 May 2023, **photo 8**. Ratified by the UK&ITA Governing body for UK and European land speed records at Elvington Speed Week they achieved the standing 1/8 mile in 3.878 seconds, with an exit Speed 163.8 mph. The bike peaked at around 180mph after the 1/8 mile but that doesn't count for the record.

Graham told us "In fact we have gone faster still two weekends ago; on 17th September we clocked a speed of 185.8 mph in the standing 1/8 mile and this weekend we have run a standing 1/8 in 3.4 seconds at 183 mph and a standing 1/4 in 6.1 seconds. [This makes] us the second fastest accelerating motorcycle in the world with a 60ft of 0.91 seconds, 330ft 2.36 seconds and 660ft (1/8th mile) in 3.407 seconds. That's only 0.007 seconds away from being the quickest ever in the 60 ft.

All this using water and vegetable oil as fuel!"

The fastest rider and bike over 60 ft are Eric Teboul on his Hydrogen Peroxide Rocket bike. Next year Force of Nature will have a much better pressure vessel, outlets, valves and nozzles to work with and the team are aiming to improve on this year's times and speeds.

The amazing records set by Graham Sykes probably mean a world record for a steam propelled bicycle is now beyond the reach of Paul's design, but Bill Barne's 2014 record of 80.509mph remains the record for a piston-based steam bike. We wish Paul every success in his continued record chasing!

Offering the engine up to the frame.

Graham Sykes

Force of Nature's superheated steam exhaust leaves a trail of water vapour.

In action at Melbourne Raceway.

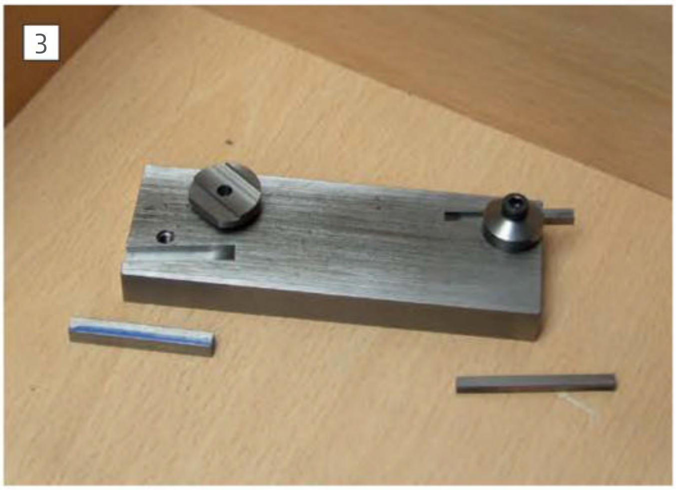
Squaring the Circle Part 2

Graham Meek makes some custom gears to solve a handwheel conundrum.

These gears as they stand have no backlash. In order to create backlash, or play in any gear train it is just a simple matter of cutting the teeth slightly deeper. As a very rough rule of thumb for every extra 0.025mm in depth this gives 0.08mm of backlash. Years gone by the commercial gear cutters used to come with the depth of cut etched or stamped on the side, in the form of "D+f". Where "f" is the extra increment to give the desired backlash. Sadly these days, given we have laser printing, this information has been omitted on those new cutters I have purchased. One other point to make about the designed gear form is that this is the correct form for that particular gear. This is as close to a generated form, i.e., hobbed form, that it is possible to get with a form tool cutter. The result of making these gears this way is that they are very smooth running in operation.

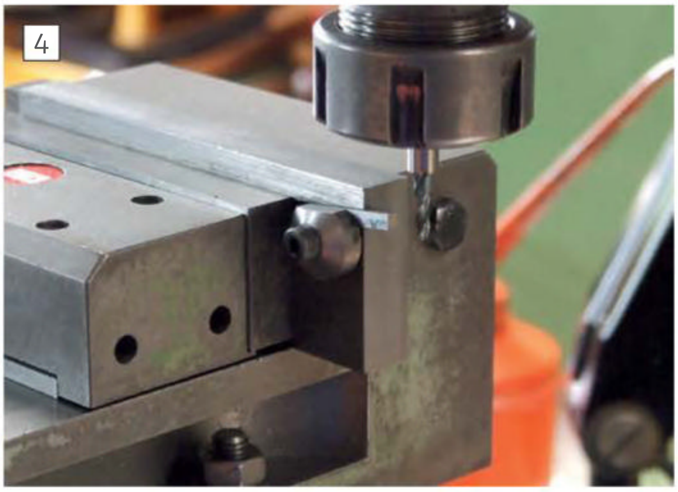
However for this application it would be advantageous to have no, or as little backlash in the system as possible. To this end I worked to the basic whole depth of the gear tooth, and just to make sure I cut one delrin idler gear shallow on depth by 0.03mm, while the other was cut to full depth. As it worked out the full depth gear gave no backlash, but I still have the larger one should any wear take place.

I feel a few words on making the single tooth gear cutters might not go amiss. Judging by the number of enquiries via



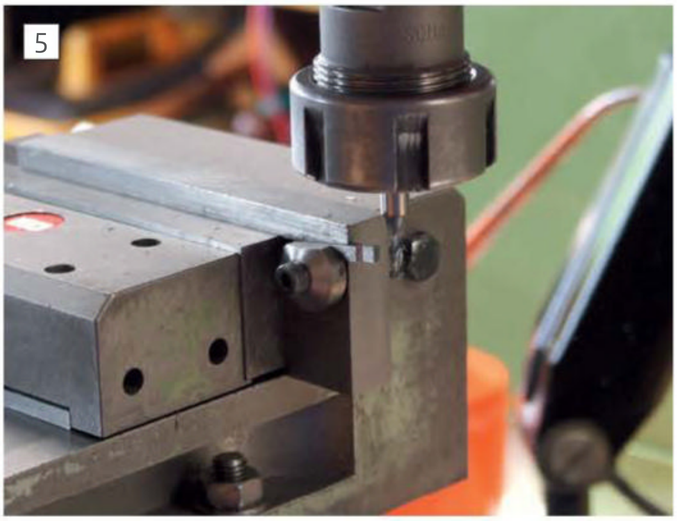
3

Gear cutter profiling jig.



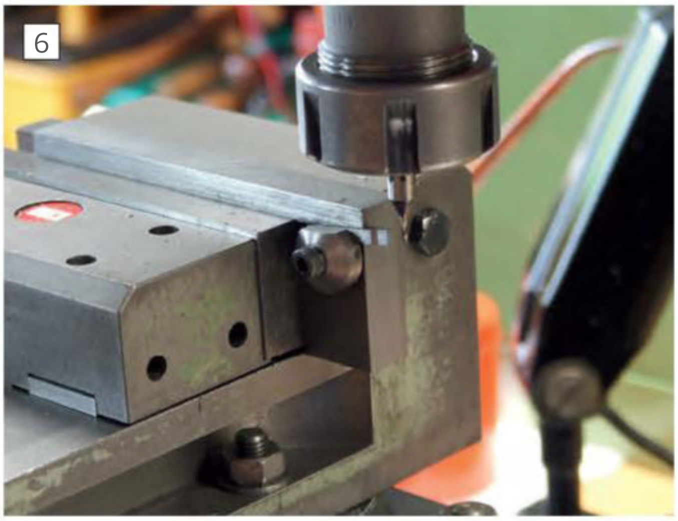
4

Cleaning up the end face with a 3 mm Endmill.



5

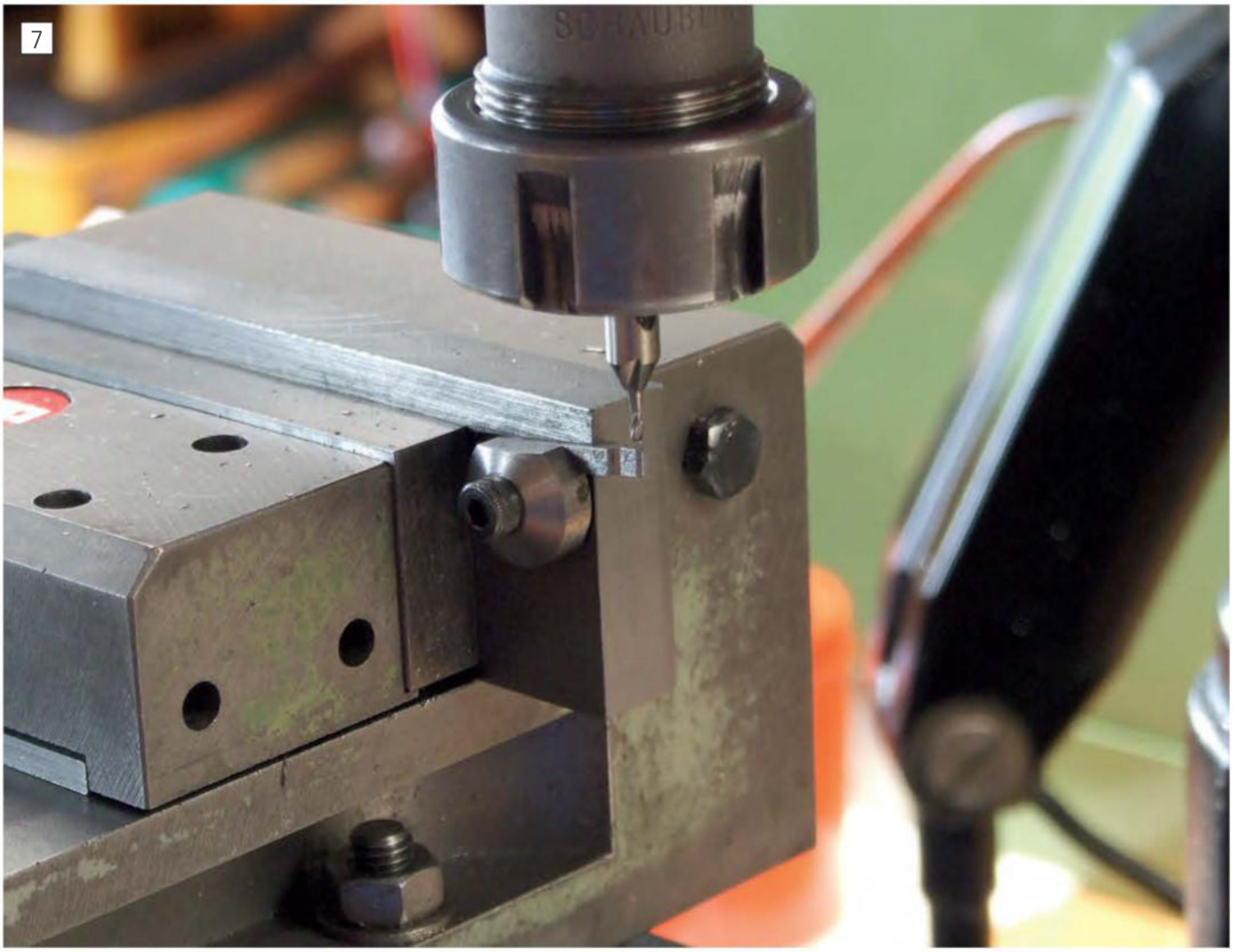
Reducing the width of the cutter blank to take the gear profile.



6

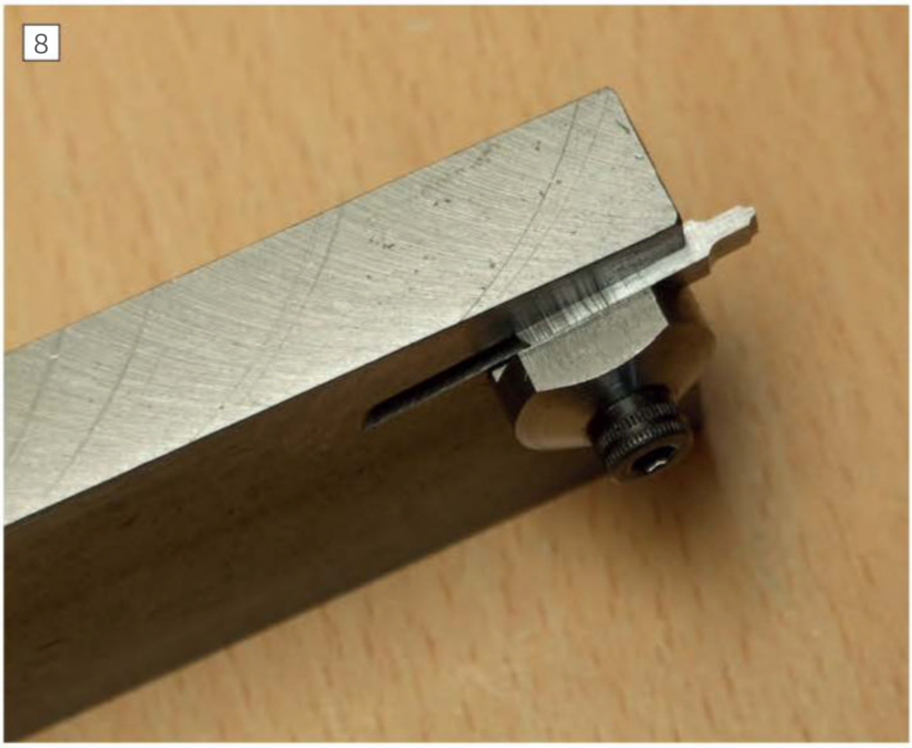
Taking a light skim across the end face with 0.0625 diameter cutter.

7



Machining the last profile with the 0.0625 diameter cutter.

8



The final finished profile.

Forums, emails, letters and telephone calls, I have received. Most readers do not appear to understand how to make these simple cutters. Several of those who I have spoken to over the telephone have said they thought the information was for making circular gear cutters using "buttons" to form the flank radius. An example of this kind of gear cutter manufacture can be found in "Gears and Gear Cutting" by Ivan Law, Chapter 12 "Making Gear cutters". My approach uses endmills or slot drills instead of the buttons and is based on a method described by Philip Duclos in "The Home Shop Machinist". Where he was describing the manufacture of the gears for an "Odds 'n Ends Hit 'n Miss Engine", November/December 1986.

I have taken a series of photographs, **photos 3** to **8**, that show in essence the procedure for making these simple gear cutters. I had better add that these photographs show the production of ›

Using milling cutter to approximate a circular involute cutter.

Setup for single point cutter.

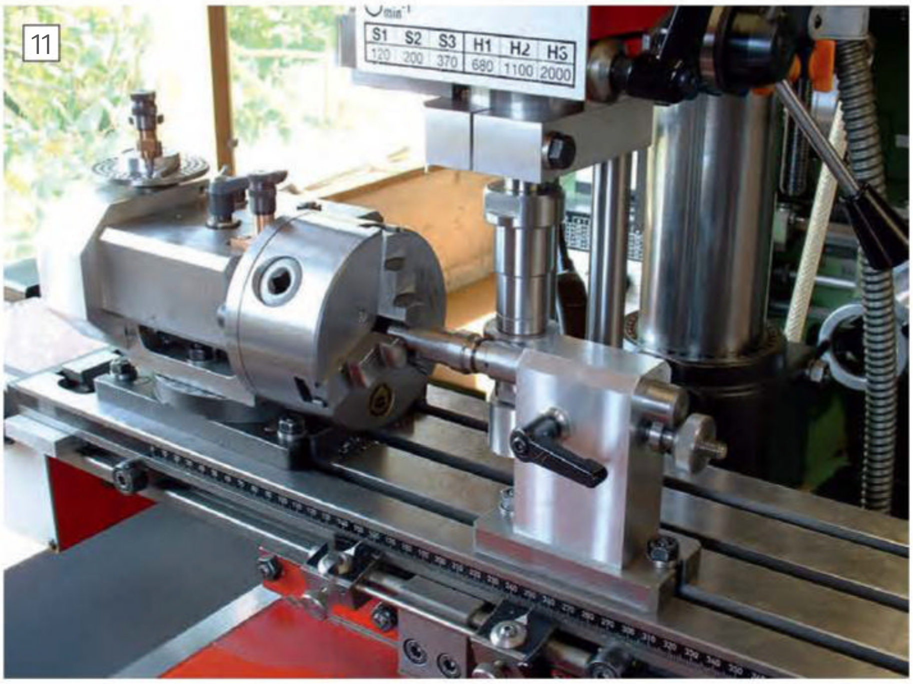
a 0.4 MOD gear cutter for my centring attachment, not the gears in question. Rather than hold the cutter bit in the machine vice each time I have made a simple jig that holds blanks of ⅛" or 3/16" square gauge plate, or silver steel if obtainable, at 10-degree angle to the horizontal. This angle I find suits most applications, but if more clearance is required it is a simple matter to tip the jig in the machine vice to gain the additional clearance. The slot in the jig is produced such that the centre-line of each size of gear cutter blank is 12mm from the fixed jaw of the machine vice. I always work with my Y-Axis feedscrew "zeroed out" on the fixed jaw of my machine vice. As the pitch of the feedscrew on my Emco FB 2 Milling machine is 3mm then the centre-line of the gear cutter blank is automatically zero on the dial. This then makes positioning for the offsets for the cutter radii a simple matter. As regards the position in the X-axis plane this is taken care of by the diameter of the cutter being used. The blank is cleaned up on the end using the required cutter. The table is then moved half the diameter of that cutter towards the gear cutter blank. The centre-line of the spindle will then be directly over the edge of the cutter blank. The feedscrew dial is then set to zero at that position. I had better add that this assumes the X-axis feedscrew has been turned in the same direction during the cleaning up cut on the end face. When working on the Y-axis the backlash also needs to be kept going in the same direction. While sometimes the theoretical cutter radius may come out as an odd dimension, in practice the nearest Imperial or metric cutter will do the job. After all the radius being used is only an approximation to the involute curve. Some slight additional variations in cutter radii will not cause any great problems. However if the reader should want to be pedantic, the exact required size can be achieved with the use of a boring head. By first boring a hole to the required diameter in a piece of scrap material. Then without disturbing this setting using, the boring head is used to clean up the tooth faces after they have been roughed out by the nearest available milling cutter.

It will be found the best results are obtained by feeding the cutter downwards into the work. It is better to "stand off" from the desired coordinate slightly to cater for cutter wander, plus if using an endmill the cutting edge length on the end of the mill may not be long enough to remove the required material in one cut. A small clean-up cut at the desired coordinates gives a good finish and it ensures there is no side loading on the cutter. Which with a blunt cutter might have made a gear cutter that was oversize on the form required. Which would actually remove more metal from the gear than was necessary. There is no reason why this form of gear cutter manufacture cannot be applied to a circular cutter, **photo 9**.

The cutter when finished is hardened and tempered in the normal way. Heat the blank until little blisters form on the steel and then quench in Oil for Gauge Plate, or Brine for Silver Steel. After polishing the flat faces I usually grip the hardened cutter blank in a pair of long nosed pliers, (picked up at a second-hand tool stall in a local market), such that the cutting end is in the pliers and

I apply the torch flame to the free end watching for the tempering colours to just reach the cutting edge. I stop when Light Straw has reached the cutting edge. This ensures that the shank of the cutter is softer and less likely to break. This cutter is then rubbed on an oilstone on the top surface and then mounted in a holder that goes on my milling arbour, details of these holders and the milling arbour can be found in past articles or my book "Projects for your Workshop Vol 1". A general idea of the set-up can be seen in **photo 10**.

The next problem to raise its head was that there was no provision on the Emco or my own design of dividing head, **photo 11**, to cut 37 teeth. This was overcome by using AutoCad and the array command to drawing a new 37 hole indexing plate. measuring off the coordinates on the drawing for each hole with reference to the indexing plate centre, a table of coordinates was prepared to drill the circle of holes on the FB 2. Some may think this method is fraught with errors, but the resulting indexing plate did not show up any pitch errors and the dividing head indexing pin entered every hole.



Dividing 37-tooth gear.

Getting back to the design you may recall I mentioned the Symonds nut on the end of the handwheel pinion shaft was used to adjust end float. Looking at the general arrangement in **fig. 13**, the reader will see this threaded portion is now buried inside the handwheel dial

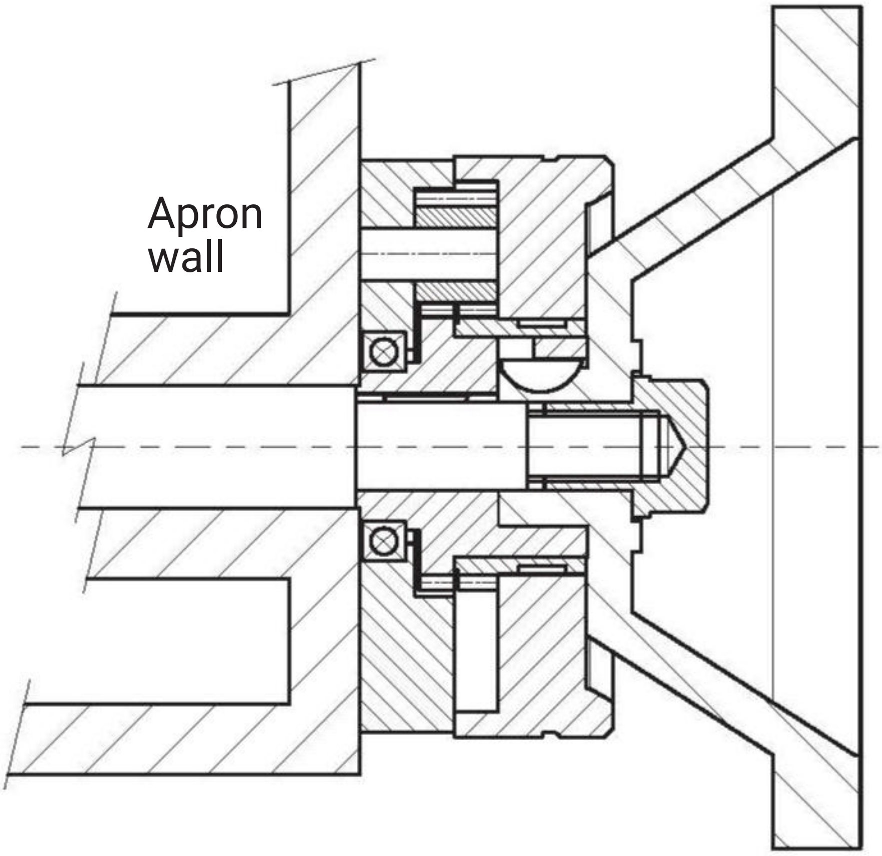


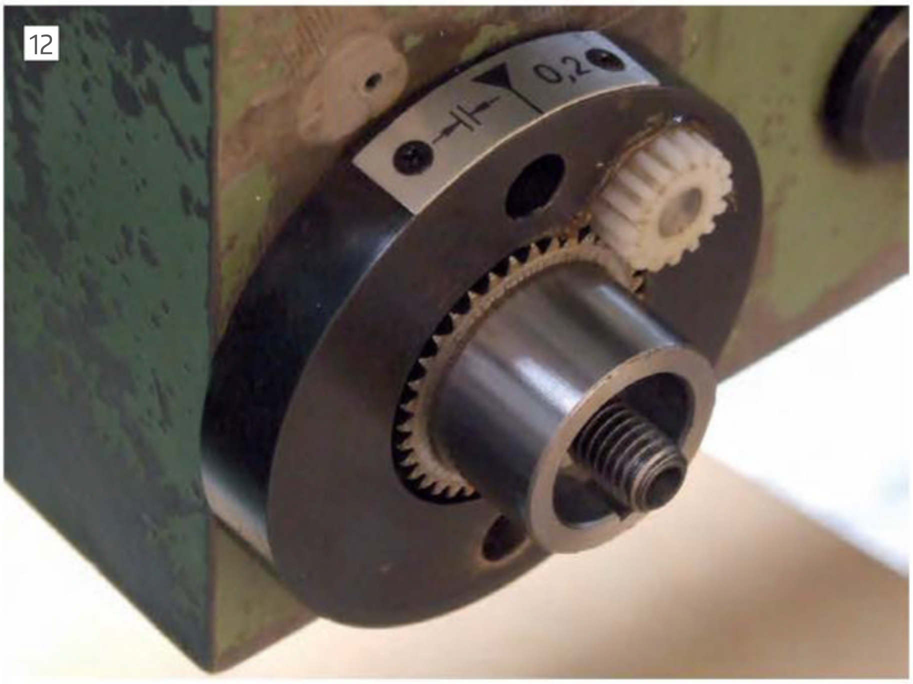
Figure 13.

assembly. To overcome this problem the pinion shaft is now free of any endwise adjustment. A small step on the end of the Input gear makes contact with the end of the pinion shaft and makes sure this end is below the apron wall surface. Thus ensuring that when the nut securing the the handwheel is locked up, the whole assembly is not locked up solid. Any end float in the assembly is taken care of by the ball race and careful attention to the respective lengths on the drawing. The unit is further restricted by the dial backplate as this is attached to the apron wall by two M4 cheese head screws, **photo 12**. Care needs to be exercised when drilling the apron as the wall thickness is not too great and it is not desirable to introduce swarf into the apron gear box. These retaining holes are spotted through one at a time when the dial assembly is about to be fitted to the machine. Temporarily introducing a spacer, (a couple of thick washers), between the backplate and the apron wall will permit the backplate to be locked in position for the purpose of spotting the first hole. Just remember that there is a ball race, (6803 RS), in this assembly when tightening the nut, it only requires ''nipping up''. A depth stop made to suit the tapping drill to limit the depth to no more than 6mm is to be recommended.

It goes without saying that attention must be paid to the concentricity of all the components. Carrying out as much machining at one setting before parting off and finishing the component off on a known true mandrel will take care of this requirement. Taking time to make a good job of a mandrel pays dividends on jobs like these. Not only can the mandrel be used for turning purposes, but they can also be used in the dividing head to cut gears, or machine facets on workpieces.

The reader will see from the drawings that he Input gear has two keyways. The keyways in the Input gear were cut in the lathe using a lever operated attachment I made many years ago, **photo 13**. This photograph was taken during the manufacture of the Super 7 handwheel dial designed many years ago. It will also be noted that the existing keyway in the Emco handwheel plays no part in transmitting the drive to the pinion shaft. This is taken care of by a Woodruff key in the handwheel boss. This boss incidentally needs to be reduced in diameter to give a good bearing area in the input gear. As well as to get rid of the existing undercut which used to house the friction spring. The boss was further reduced to make the wall thickness in the Input gear a little stronger. The outer face of the Input gear is what takes the locking forces of the Securing Nut/Bolt. If this wall section were too thin it could go barrel shaped under the clamping forces, thereby locking the unit solid. To enable the machining of the handwheel a spare part was obtained, but with careful planning the handwheel from the tailstock could be borrowed or used during the machining process. Cutting the Woodruff key seat also needs careful planning. Having set this job up once to cut this key seat I found the body of the collet chuck fouled the Rib of the handwheel. Luckily I spotted my error before starting to cut metal and no damage was done. This resulted in a reset, finally cutting the key seat at 45 degrees to the handwheel ribs. The key

12



Dial backplate with one gear and pinion visible.

13

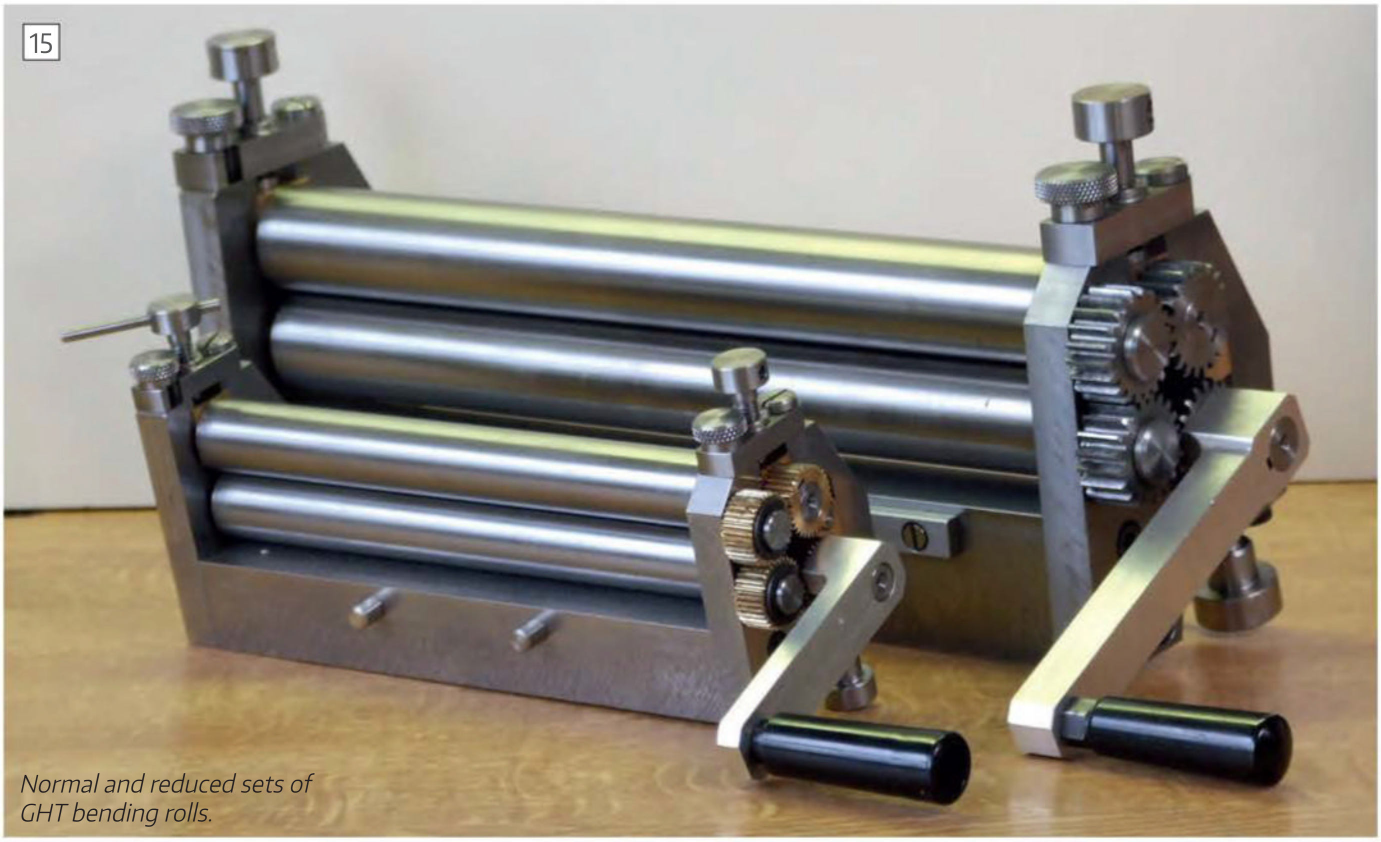
Using lever attachment to cut keyway.


14
Stamping dial with jig.

seat is purposely offset on the 10mm shoulder, i.e., not central. This is because a 10 x 3mm Woodruff key cutter is usually 10.5mm in diameter. Thus if the key seat was put in at 5mm from the face the cutter would promptly cut a gash in the face of the handwheel, or worse. This dimension also means the Woodruff key needs to be shortened on the one side so as not to foul the inside face of the input gear on assembly.

To utilise my existing stamping jig, **photo 14**, used on the Super 7 design, the inside of the dial is bored out to 60.25mm diameter by 5mm deep. This clears the teeth of the Sleeve gear. The outer edge of the dial is also bored out to mimic the existing Emco handwheel dial. I decided at the outset to take advantage of the larger material to hand and make the dial larger in diameter. This does mean the dial overhangs the Apron wall whereas before it didn't. As luck would have it the increase in diameter, and therefore the circumference, means the additional divisions for the extra millimetre of travel work out the same width as the original Emco design. There being 100 divisions in total, giving 0.2mm per division. It is very easy to subdivide these divisions to get 0.1 or even 0.05mm increments if desired.

The reader may be wondering what the two centrelines shown at 42 degrees on the outside diameter of the backplate are for. These are the locations of two small holes that will take the original modified Emco index plate. This plate was gently eased off the Apron wall using a wide Craft tool blade in my X-acto handle. The index plate was then machined to remove the two ears of the curve which originally followed the original dial circumference. Once this was completed the existing holes in the plate were drilled and countersunk to take the attachment screws. These are small self-tapping screws salvaged from a VHS recorder long ago. The plate was then passed through my small set of George Thomas bending rolls, **photo 15**, to form the


15
Normal and reduced sets of GHT bending rolls.

radius to match the dial backplate. There is no position given for the index plate holes on the backplate with reference to the dial face, as each index plate will be machined slightly differently. Having set the backplate up on a mandrel in the dividing head and indexing the first hole position. The index plate is offered up to the backplate, while a small turned pin in the drill chuck is lowered via the quill to locate in the respective countersunk hole. Moving the milling table on the X-axis will position the index plate to where it is needed. Securing the index plate in this hole the second hole can be indexed round in the dividing head and drilled. Just to be on the safe side offer up the turned pin to make sure the hole lines up. The outside diameter of the backplate was purposely made smaller by two thicknesses of the Index plate. Thereby having the dial division and the index line on the same level. Should the reader decide to do away with this index plate and engrave a line for the index mark, then the backplate can be turned to the same diameter as the dial.

When it came to "blacking" of the dial to enhance the clarity of the divisions and numbers, as well as form some corrosion protection for the backplate two options were open. One was to have the parts blacked commercially, but upon enquiring the minimum order price this was a non-starter. The other was to purchase one of the many blacking kits available and do the job in-house. Having loads of chemicals about the workshop which I would only use once in a blue moon was another thing I was not keen on. Eventually after much searching, I found an antiquing fluid for blackening brass, "Curator" antiquing fluid, (the usual disclaimer). Reading through the product info and the instructions for use, it is stated that the solution can be used on steel. The solution can also be used as is, or diluted and the item immersed. At a 10 to 1 dilution rate 20 ml of the product would give me enough solution to immerse the dial in a small plastic tub. The procedure takes 2 minutes to do, and the results are as shown in the photographs. I have to admit I was sceptical of the 2 minutes and the fact that I could use this on steel as well, but I am one confirmed user now. Plus I have only one 150 ml bottle in storage with 130 ml left for another day which will get used on some brass parts I have in mind for my Clayton timber tractor.

In use the only thing that needs to be remembered is to adjust the dial in the opposite direction to the direction of carriage travel at the time. While making sure the handwheel is static and if anything being gently urged in the direction of travel. Plus all dimensional cuts are finished with a manual input, i.e., not allowed to be established using the feed mechanism as this will give an error due to the backlash not being taken out of the system. Which incidentally on my lathe is all in the apron gearbox as no backlash exists in the dial assembly.

In use I have been unable to detect any indicated error over several turns of the dial, plus the mistakes due to mental arithmetic have dropped to zero. The addition of the radial ball bearing has made the whole carriage movement feel silky smooth. My only regret is that I wish I had carried out this mod sooner. ■

When you frame it, do it right!

Marcos Diniz, in Portugal, looks at a job most of us tackle at some time, even if it isn't a typical workshop task.

Our friend Neil asked me for an article "off the beaten track". I'd say you can't get much farther from the beaten track and still keep the workshop in sight. So, here goes...

The way you frame a document, be it a manuscript, drawing, watercolour, print or whatever, on paper or parchment, may seriously affect its fate and the enjoyment you derive from it.

What I intend here is to give you a few hints on the not-to-do things that are often not avoided when you have the work done inexpertly. Seriously, it's the detail that counts, if you want to prolong not only the "life" of your document but its "youth" as well.

A very important ground rule is always to use materials that may be easily and completely removed so that, at any time, should there be a reason to want to reverse the process, it can be done. For instance, never use solvent-based synthetic glues, or even emulsions like the PVA white glue you use for wood. Their complete removal is practically impossible, there will always be residues among the paper fibres, even if you wash it in a river of solvent.

First of all, it should never be framed without a protective mat, made of alkaline cardboard (meaning it carries a "load" of calcium carbonate that will to some extent neutralize the acidification due to degradation of the pulp it's made of, something that is virtually inevitable, no matter how carefully preserved and stored). It may also be described as "acid-free". You need to bear in mind that not all cardboard so described is actually adequate. Price may be an indicator, to some extent, but you shouldn't take it for granted that all expensive cardboard will be safe.

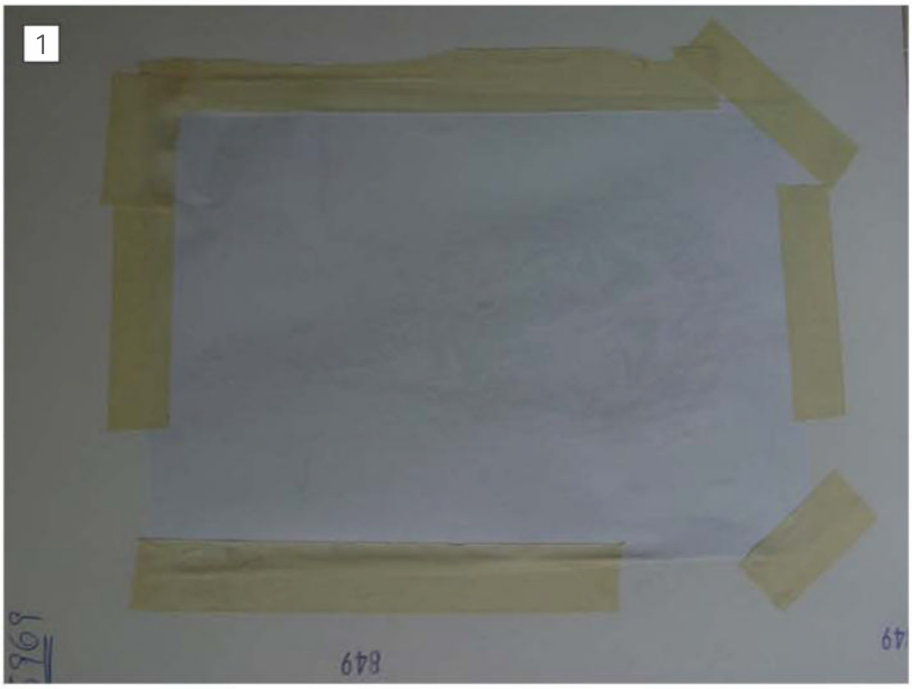
How do you go about it then? My advice is, ask someone who knows. Normally, a good paper dealer should be able to help in this matter. Or, there are many good paper conservators in the UK, and I hope I'm not being too optimistic when I say they should be glad to help you. I know I always was; after all, someone interested in the things that interest me deserves my help, and who knows, might even one day become a customer.

And there's always the Paper Conservation Institute, the British Library and so forth. You can't go wrong there. And even in their lofty heights, they are very helpful.

Back to the mat, bear in mind that a good mat has **two** parts: the front or "window", and, to my mind much more important even if you don't see it, the back.

Frequently the back gets "forgotten" and the document is simply scotch-taped to the back of the window and placed in the frame in direct contact with the Platex, MDF or whatever rubbish is used to close the frame. The consequences of this sorry accumulation of mistakes will become apparent in a few years, maybe even less, **photo 1**.

The function of the back is precisely to create a barrier (it should be alkaline as well, and never too thin although it can be thinner than the front) to keep your precious document as isolated as possible from the back of the frame, where now you can use a less-than-perfect board, although I would prefer one of the lighter "sandwiches" with a kind of foam inside and thin cardboard outside. They may be found under the name of "architect board" (architects use it for models) or some such. They come in different thicknesses (about 5mm or ¼" is fine) and aren't too expensive. And, when you cut it, please make sure it fits the frame very closely. Any gaps



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Please don't frame things like this!

will later become a way in for all sorts of undesirable insects, dust and so forth. Mind you, always use a very sharp blade to cut it, even a "reasonably sharp" one will not cut it cleanly, it isn't rigid enough.

As for the way you fix the document to the mat, please don't use any of the many tapes in the "Scotch" extended family. I've "rubbed elbows" with many kinds and never found one I really could trust, no matter how "magic" they were claimed to be. This could be because I have (in these matters at least) a nasty suspicious mind, but the better-safe-than-sorry rule works perfectly well here.

The two pieces of the mat are generally hinged with some kind of tape. This is acceptable if the tape doesn't contact your document. It is often necessary to remove the hinge completely. Should this be necessary, pull the tape in a way that will bring with it the cardboard surface, ensuring no residue of the glue stays there.

As to those tapes, I found that as a rule the tape, or the glue, or both will eventually stain the document, a stain that means they degraded the paper they contacted. Not only that, but they are also often extremely difficult to remove, requiring the use of nasty solvents, usually far less than good for your health, to say the least. if you manage to remove them completely, which is, as stated above, practically impossible.

Use instead a rather thin "Japanese paper" (it most likely never even came close to Japan, but should be easy to find in good paper dealers or shops specializing in model aeroplane building). The advantage of this type of paper is that it's "sort of" hand made, meaning the cellulose fibres aren't all parallel, making the paper stronger in any direction, while not being made from wood pulp, it is practically free from lignin (the supporting part of wood, which becomes brown and acidic; this is why paper made from wood pulp, that includes lignin, tends to become brown and brittle).

Let's go back to the "window" for a moment. Its function is mostly cosmetic, and the choice of colour is up to you. I tend to prefer neutral colours that won't "compete" with the piece you are framing, but it is just my preference, not important for conserving the document. Also part of its function is creating an empty space that will allow the document to "breathe". Paper, or parchment, like all organic materials will absorb or lose moisture, adapting to the atmospheric conditions, which may involve dimensional changes. It therefore needs room to "move". And it'll help to keep the document from sticking to the glass (photos will do that given half a chance, but other documents may as well). As to margin width, it is mostly a matter of taste. I'd say about 15 to 20% of the opening, maybe 4cm to 8cm (1 ½" x 3 1/4") for sides and top. There is a tendency to add 1cm to the lower margin. Or you may choose not to.

And we come to another problem: what should you use for glue? For ages I used Tylose MH300 (a "semi-synthetic" molecule rather similar to that of cellulose, and well-behaved from a conservation point of view) that I had to buy in 25 kilo packages, not perhaps very practical for you. But, with a bit of luck, I expect you'll find it in much smaller quantities in the UK market.

There may be a good ready-made glue for sale in the UK that I don't know of, or maybe you can ask for advice when you're looking for the alkaline board and/or the architect board. Unfortunately most makers won't give any information on components of the available glues, meaning that you'd better beware. Look for a shop specializing in stuff for restoration/conservation, which should be easier to find in the UK than down here. Paper conservation is a rather recent discipline and concepts tend to change. For instance, when I began to study it, PVA (poly-vinyl-alcohol) was great. Long before I finished the course it had been demoted to horrible. One can get very suspicious about variations from the safe path... and it is used as the gum for stamps the world over. And I strongly suspect it is present in most of the commercial glues sold for paper. Hence my reticence on the subject.

If worst comes to worst, you can make a sort of starch paste, but, if you do, please use rice starch (or rice flour if you must), not wheat flour that contains gluten. I confess I have no opinion on the suitability of corn flour; I never tried it or read anything about it that I recall.

Now tear (as opposed to "cut"; this will leave irregular edges that won't be as noticeable) two pieces of "Japanese" paper about 4cm x 3cm (1 ½" x 1 ¼"), apply paste to only half the height (use as small a quantity as you dare; the water will distort your document) and glue them on the back upper edge of the document, not too close to the side edges. A bone folder helps to ensure good adherence. Placing the glued areas to dry between absorbent paper, under a flat weight may help reduce the distortion. Once dry, place the document face-up on the mat-back and keep it there with a weight. Cut two pieces of the same paper, about 6cm x 2.5cm (2 3/8" x 1") apply a normal quantity of glue and place them on the upper parts of the hinges. You should have something like **photo 2**.

Please note that you hardly see the hinges. That's intentional, of course. But you can see their outline, under the fixing pieces of paper. The hinge sizes can change according to the weight and dimensions of the document. In fact, after framing they'll be there just for insurance; we need them mostly to keep the document in place during the framing process. Now you have something like **photo 3**.

Once you've fixed the document to the mat you can organize the various pieces thus:

- glass plate
- mat front
- document
- mat back
- board that closes the frame

These are positioned in the frame and nailed in place. The nails should be driven in as close and parallel to the back as possible. (Careful- the wood may split! If you are lucky enough to own an ancient frame of very hard wood, lignum-vitae or the like, you may need to drill pilot holes to help) The gaps, however small, between back and frame, should be covered with some kind of tape. Even the nastiest kinds won't do any harm in this location, but you probably can find paper tape with a gummed back, which works very well.

You can use the same glass plate used in windows without any inconvenience. For very precious pieces you may choose to use a kind of plate that will filter UV radiation, but it is very expensive and generally hard to find. And there is glass

Nice neat hinges.

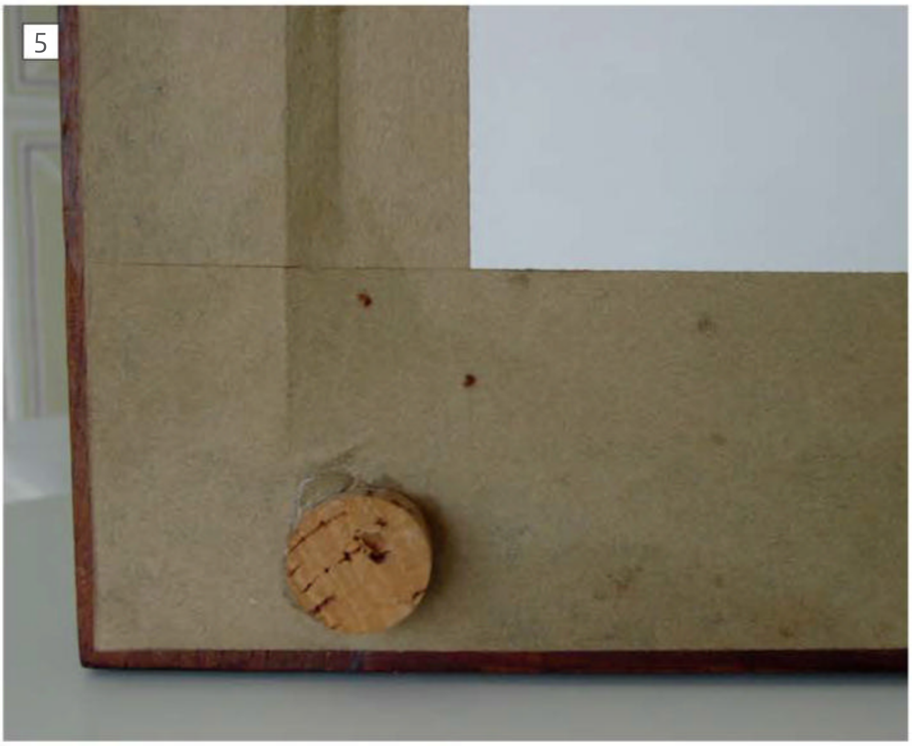
plate treated in a way that it looks as if it isn't there at all. It costs an arm and a leg, of course.

Once the framing is complete, you have to hang the frame. My choice is to use two eye-screws of suitable size. I like to place them about 10cm (4") from the top, or not more than 1/3 of the height of the frame, if it is very small, for stability. Leave the ring almost horizontal, with the opening closer to the frame edge (should there be an accidental reason for the "eye" to open a bit, the cable will still stay in place; "details", remember?).

I've found the best "rope" to use is 2.5mm2 electric cable, preferably the single-wire type. It will take a lot of weight (within reason, of course) and the insulation makes sure it won't stain the wall. For very light frames you may safely use 1.5mm2 cable. Again for stability, but also for looks, I prefer to leave the cable as short as possible, almost straight across.

Ready for the frame.

Suspension wire and sealing tape.



A good excuse to carefully empty some wine bottles.

Or there is plastic covered steel wire if you prefer, **photo 4,** which also shows the sealing tape. Actual rope isn't very dependable. Either the natural fibres get rusty and break or the nylon stretches more than I like.

On the lower corners of the frame, about 5cm (2'') from the edges, stick spacers (I use pieces of cork from wine bottles, a nice way to reuse them) about 5 to 8mm thick (3/16 to 5/16''). This will keep the frame away from the wall, so that air will circulate and humidity will stay away. And this way the frame will stay upright and it won't stain the wall, **photo 5**.

All that is left is the hanging part and I won't presume to give you advice on that. But, please make sure you pick a spot free from humidity, away from direct sunlight, and especially, far from sources of heat or cold.

And I hope you'll enjoy the result for a very long time. ∎

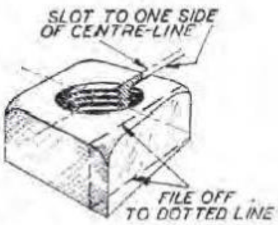
From the Model Engineer Archive

To celebrate 125 years of Model Engineer magazine and the Society of Model and Experimental Engineers, each issue in 2023 features fascinating historic content from Model Engineer relevant to workshops, tools or techniques. This month we feature a thread chaser from volume 106, number 2660, May 15 1952 and advice on aligning lathe centres from volume 187, number 4157, in 2001.

HOW TO MAKE THREAD CHASERS

by C. Gaunt

MANY screw-cutting operations require the use of a thread chaser for finishing the thread to correct form, and these are very expensive to buy, but I have found them very easy to make and inexpensive if one can obtain suitable scrap steel. I make use of steel from worn out spades, which are obtained without



difficulty from the local scrap yard, or if you live in the country, as I do, a visit to the village dump will usually provide the necessary material.

The steel should, first of all be annealed, which is usually done in the kitchen fire by heating it till it is red hot and allowing it to cool slightly in the ashes. It can then be cut up into pieces about 4 in. long by 3/8 in. wide.

The thickness is usually about 3/32 in., which is sufficient for most small chasers.

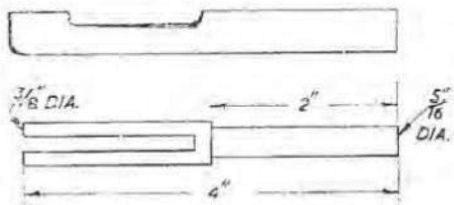
If any square nuts of a suitable pitch to suit the chaser required are available, these can be utilised, but if not, short ends of flat bar 1/4 in. or 5/16 in. thick can be drilled and tapped near the ends; but assuming that a nut is obtained, a line should be scribed exactly across the centre and a

slot on one side of this line is then cut through the nut, thick enough to take the steel strips. The end of a strip of steel should then be bevelled, and put into the slot, allowing it to project slightly past the thread.

The nut or bar is then screwed up tightly in the vice and a taper tap run through the hole; this will produce a perfectly good external chaser.

For an internal chaser, a clearance gap is filed in the side of the strip; it is held side-ways in the nut and dealt with as before.

To temper the chasers, I use the domestic washing-up basin, with about 3/4 in. water in it. The chaser is heated to a bright red and the threaded end plunged straight into the water vertically till it has cooled down to a black: it is then dropped flat in the water. This leaves the cutting edge dead hard, and it must then be tempered by polishing the surface and holding



on a piece of hot iron or over a spirit lamp until the end turns to a very pale straw colour.

A suitable handle to hold the chasers can be made as follows: a piece of 3/8 in. diameter mild-steel is turned down to 5/16 in. for a length of 2 in. from one end, the other end being slotted to the thickness of the tools for a length of 1 3/4 in. The collar is then made 3/4 in. outside diameter × 3/8 in. bore, and a hole drilled and tapped for a set-screw. The handle may be turned from wood, 4 in. long bored 1/4 in. diameter to a depth of 2 in. to press on to the shank of the holder, and a piece of 3/8 in. inside diameter tube slipped on to the handle to locate the collar near the front end. This will hold the chaser quite securely and at the same time make it very easy to change the tools at short notice.

I have made a good number of these chasers at various times, and they cut quite efficiently, probably better for model engineering purposes than the comparatively heavy and clumsy commercial article.

I use old spades for quite a number of purposes which may interest readers of THE MODEL ENGINEER, including milling cutters. Another very suitable material for this purpose is that from broken springs of road vehicles, and old valve springs, straightened out, provide material for cutters as used in boring bars and similar purposes.

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PETE'S PAGE

ALIGNING LATHE CENTRES

Peter Spenlove-Spenlove discusses the alignment of lathe headstock and tailstock centres and describes techniques for checking and setting them for accurate working.

Most of us start our hobby by obtaining a lathe. It may be a modern precision machine which, when delivered will have all its parts carefully set up by the original manufacturers, but many of us will start with an old model made, perhaps, in the pre-WW2 years.

Whatever else, both types should be equipped with two 60deg. Morse tapered centres which are necessary when turning work between centres, hence the term 'centre lathe'. If the tips of each centre, one in the tailstock and the other in the headstock can meet, point to point *exactly*, one can turn parallel work. However, on some old lathes which were made down to a price for home workshops there could be a basic fault. The headstock spindle (mandrel) taper could be slightly eccentric. A modern well-made hardened Morse centre would not then rotate truly. This problem was well-known and acceptable in those days and it was usual for a *soft* centre to be provided for the headstock. It was similar to a regular centre in all other respects except that it had not been hardened. For precision work the turner was expected to fit the soft centre into the clean headstock spindle socket and take a careful skim from the 60deg. cone point with the top-slide set over.

Once this had been done, the tip was perfectly true, but if the centre was taken out and put back later, the error could be worse. It was normal practise therefore to stamp a mark on the centre and another mark on the collar behind the chuck locating area of the spindle or on the end of the spindle adjacent to the mark on the centre. These marks showed at a glance where to replace the centre each time in the future.

It is not unusual for this method to be adopted today. For accurate working between centres, grip a piece of bar in a less than perfect 3-jaw chuck, machine a 60deg. cone point on it and then leave it in place in the chuck until all subsquent between-centres work has been completed.

Another problem found on used lathes concerns the set-over tailstock. Those not yet fully conversant with lathes may not realise that part of the tailstock can be moved a small amount *across* the bed as well as slid along it. This is a special feature which enables long gently tapered work to be turned between centres. After the tapered work is finished, the tailstock should always be reset to its central position, which is not always easy on the cheaper centre lathe. It is possible to check that the two tips meet but it is not easy to do this accurately by eye. The usual technique is to make a series of test turnings of a bar mounted between centres. It is only necessary to machine a register at each end of the test bar at the same setting of the tool. After the cut has been taken, both ends of the bar are carefully checked with a micrometer, and when both readings are the same, the bar is parallel and the tailstock is central again.

The following method is an old machinist's dodge. It is not perfect, but usually adequate when turning short parts which are mounted on toolmakers' mandrels including such items as pulleys, gear blanks, collars, and the like. All you need is a piece of flat bright mild steel bar about $^{3}/_{8}$in. thick. The width can be anything from $^{3}/_{8}$in. (square bar) to $^{3}/_{4}$in. or even more. Clamp it to the drilling machine table and drill a $^{3}/_{16}$in. hole through close to one end. Use a centre drill to cut a clean chamfer of no more than $^{1}/_{32}$in. to remove any burrs, using the drill press for an even cut. Hand scraping is not accurate enough. Thinner material can be used and a smaller hole drilled, of course, but be sure that when placed into each end of the hole, the tips of the 60deg. Morse centres do not touch. The tests which follow can be carried out more accurately with a dial test indicator but I have in mind the newcomer who has yet to buy his dial gauge.

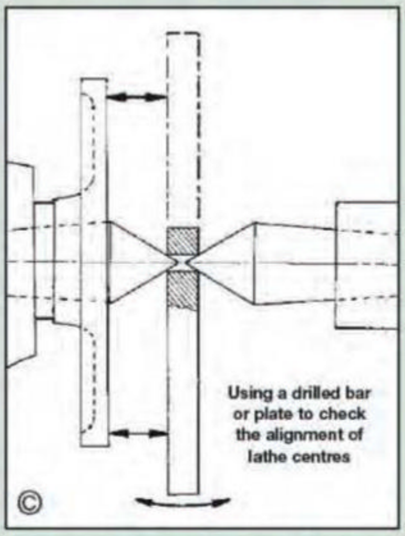
First fit the face plate and then both centres into cleaned sockets. *Never* try cleaning the headstock mandrel taper socket with the lathe running; *always* isolate the power supply first! Bring up the tailstock and gently nip the prepared plate/bar between the centres.

Test 1: Slowly rotate the mandrel by hand, but stop the bar from turning by the use of light finger pressure. If the bar can be seen to move towards and away from the face plate while you turn the mandrel, you have an out-of-true mandrel centre. If the centre is soft, skim it to get it to run true. If the centre is a new hardened one of known quality, any movement of the test bar is due to the mandrel socket itself. Old worn lathes with wear or dirt forcing a true centre out of line can be corrected by cleaning and using the soft centre which should be available from our usual suppliers; don't forget to mark it for correct replacement in the future.

Test 2: This test checks the alignment of the tailstock provided that test 1 is satisfactory. Using the same set-up, this time swing the bar around by hand for a full revolution. Note the gap between the outer end of the bar and the rim of the stationary face plate. If this gap alters, the tailstock centre is off-centre. If the gap varies at the back and front (3 o'clock and 9 o'clock on the faceplate) adjust the tailstock offset screws to centralise the tailstock.

This procedure may be considered a normal job, but if the gaps at 12 o'clock and 6 o'clock, i.e. when the bar is up and down, are unequal, there is trouble! If the tailstock centre is too high or too low, there could be dirt in the sleeve or under the tailstock, or it could be an indication of wear. It is even possible that you are checking a very old lathe on which a replacement tailstock has been fitted in place of a missing original.

Early lathes were not produced to the exact interchangeable standards to which we have become accustomed with modern methods of production. A certain amount of selection and fitting would have taken place during assembly. When the lathe assmbly was complete, each major part might be stamped with a machine number before dismantling, cleaning and painting. These numbers are usually the assembly number within a batch and only serve to aid the machine fitter to re-assemble the lathe, i.e., he would be able to pick the correct tailstock for the bed from the freshly painted batch. Other cast-on numbers were usually foundry pattern numbers.



Using a drilled bar or plate to check the alignment of lathe centres

These lathes were seldom given serial numbers, being known as, for instance 'Adept $1^{5}/_{8}$in.', 'Winfield $4^{1}/_{4}$in.', etc. The figure is the centre height above the bed. (USA makers use 'swing' which is double the UK figure, i.e., 'Winfield $8^{1}/_{2}$in.')

By the way, in Test 2, I have assumed that the face plate is true. Clean the threads and register face and the plain diameter of the mandrel nose and face plate. Fit it carefully and, when running, note any wobble. If there is, remove and clean it again, especially in the vees of the face plate threads. Re-fit and test again. If it still runs with a slight wobble, consider facing it true using a keen tool and the cross-slide feed with the saddle locked so that the tool can cut without the face-plate slots jarring the saddle back along the bed. Lock the top-slide by temporarily tightening the gib strip screws. If the cross-slide gibs are a little slack, adjust these too so that the cross-slide screw is slightly stiffer than for normal work. Use a freshly sharpened tool and a low spindle speed.

Turning a 6in. to 8in. cast iron face plate with slots is quite a demanding job for an old vintage lathe. If the face plate was part of the original kit sent out by the manufacturer, it is doubtful that the error will be much: 5-10 thou. probably at most. Feed the tool slowly and evenly across but don't let it rub. If the high speed steel tool fails part way across, try using a sharp carbide tipped tool ground as for turning brass. If you have a choice of grades, ask for a tough grade or tell the supplier the type of work, i.e., "light finishing with intermittent cutting on a cast iron face plate with slots."

18+

WHAT IS AVAXHOME?

On the Wire

NEWS from the World of Engineering

News from "Peter's Railway"

Chris Vine, author of the Peter's Railway books has been in touch about a new series of videos:

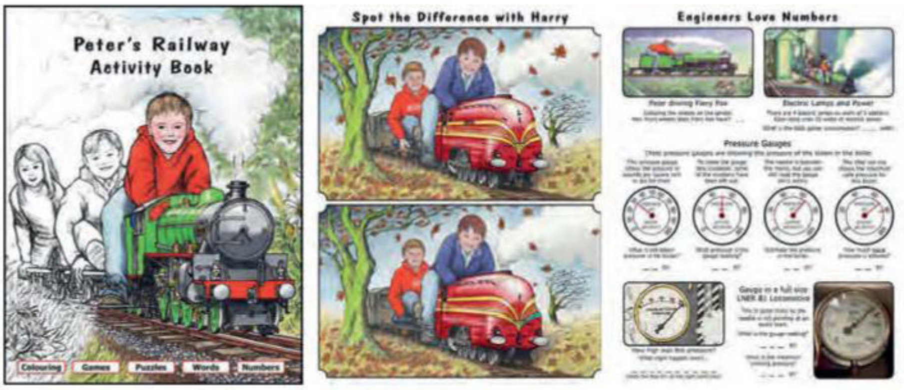
"This summer we've been having fun making videos for our YouTube channel https://youtube.com/@PetersRailway. How to make Clupet piston rings (for Bongo) is a bit specialised and we expected only 10 views. With over 140k views in a month, it has been the surprise hit of the year!"

The most recent film is about getting Bongo ready for running, I hope you enjoy Raising Steam. With 140k views in only a few days, YouTube is clearly a good way to spread the word."

Now I will have to make some more films, especially one about the new turning loop on the railway!"

The video about clupet rings is quite fascinating and I'm sure it will be of interest to MEW readers.

With Christmas coming, the Peter's Railway books are a great idea for budding young engineers. The Activity Book pictured is packed full of trains, colouring and engineering puzzles. Some of the activities are easy, others are more challenging. Perfect for sharing with an adult! It is £4.99 and available from www.petersrailway.com.



New Machine Mart Catalogue

The new Autumn-Winter Machine Mart catalogue is out and ready in time for Christmas!

The 492-page catalogue is full to the brim with tools, machinery and equipment for your workshop, whether you're a hobbyist, DIY enthusiast or professional tradesmen.

This latest edition of the catalogue, the 71st in total, includes over 1,000 price cuts and new products.

With over 5,000 products in the catalogue, and over 15,000 'Xtra' products online, you'll be sure to find what you need at Machine Mart.

So get your free copy of the new catalogue! Simply go online to www.machinemart.co.uk, visit one of Machine Mart's 65 superstores nationwide or call 0844 880 1265.

Extreme E and the FIA announce plans for first-ever off-road hydrogen racing world championship

We've had news regarding progress with zero-carbon motor racing. While world championship motor racing may be a relatively small source of emissions, just as with Formula One the engineering challenges involved help drive innovations that influence the development of the vehicles we drive.

Extreme H, is a newly branded hydrogen-powered off-road SUV championship, to commence from 2025. The Fédération Internationale de l'Automobile (FIA) and Extreme E have signed a Memorandum of Understanding setting out a framework to create the first-ever hydrogen off-road racing world championship.

The aim is for the hydrogen series, Extreme H, to become an FIA Championship from its inaugural season in 2025, with the intention that it will become an FIA World Championship from 2026.

In addition, the pathway outlines that in 2024 Extreme E, currently an FIA International Series, would be recognised as an FIA Championship.

Extreme H would join the company of just seven other official FIA World Championships, which includes ABB FIA Formula E World Championship. This planned pathway to FIA World Championship status demonstrates the series' progression since its inception in 2021 and a strong statement of intent for its growth towards its hydrogen-powered future. Development of the Extreme H series is underway, with plans advanced to have a prototype launched later this year ahead of the first season in 2025.

Asteroid Sample Return Mission Success

After years of anticipation and hard work by NASA's OSIRIS-REx (Origins, Spectral Interpretation, Resource Identification and Security – Regolith Explorer) team, a capsule of rocks and dust collected from asteroid Bennu finally is on Earth. It landed on Sunday 24 September in the Utah desert.

Within an hour and a half, the capsule was transported by helicopter to a temporary clean room set up in a hangar on the training range, where it now is connected to a continuous flow of nitrogen.

Getting the sample under a "nitrogen purge" was one of the OSIRIS-REx team's most critical tasks. Nitrogen doesn't interact with most other chemicals, and a continuous flow of it into the sample container inside the capsule will keep out earthly contaminants to leave the sample pure for scientific analyses.

The returned samples collected from Bennu will help scientists worldwide make discoveries to better understand planet formation and the origin of organics and water that led to life on Earth, as well as benefit all of humanity by learning more about potentially hazardous asteroids.

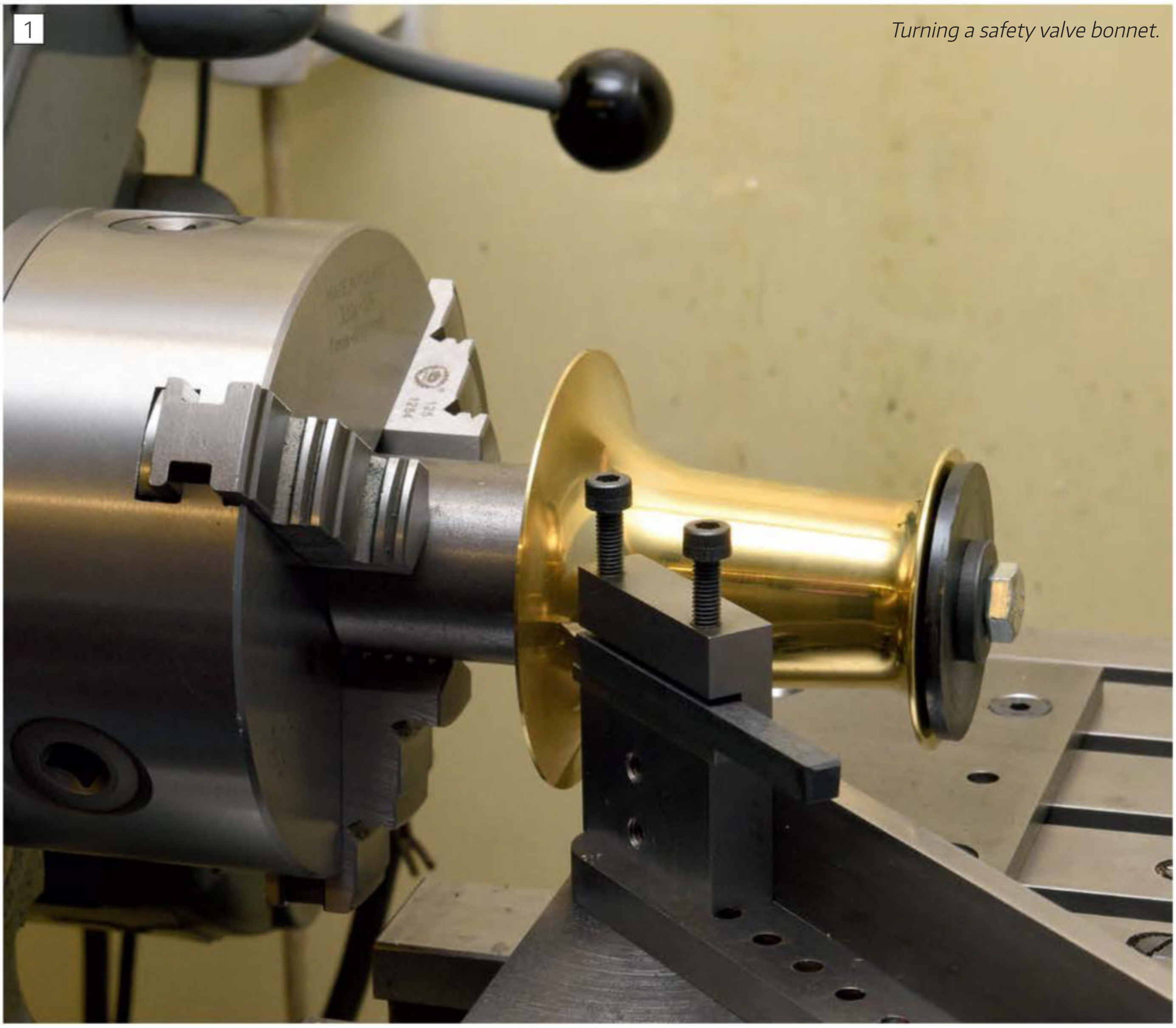
Artful Dodge #13 –

Turning large convex and concave radii

Essential reading for beginners and valuable to old hands, this series by the late John Smith shares some of his wealth of skill and experience from over half a century in hobby engineering. We conclude with advice on turning large curved surfaces.

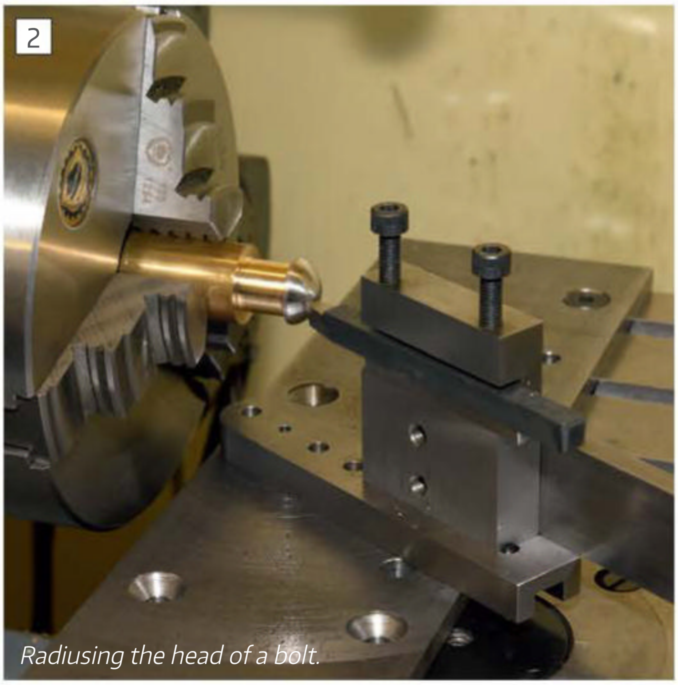
For turning medium to large concave and convex radii, another radius turning attachment is required. Several have been described in this magazine over the years. I hope that a few photographs of my attachments will suffice. **Photograph 1** shows the most-used attachment set up to turn a concave radius on a safety valve bonnet.

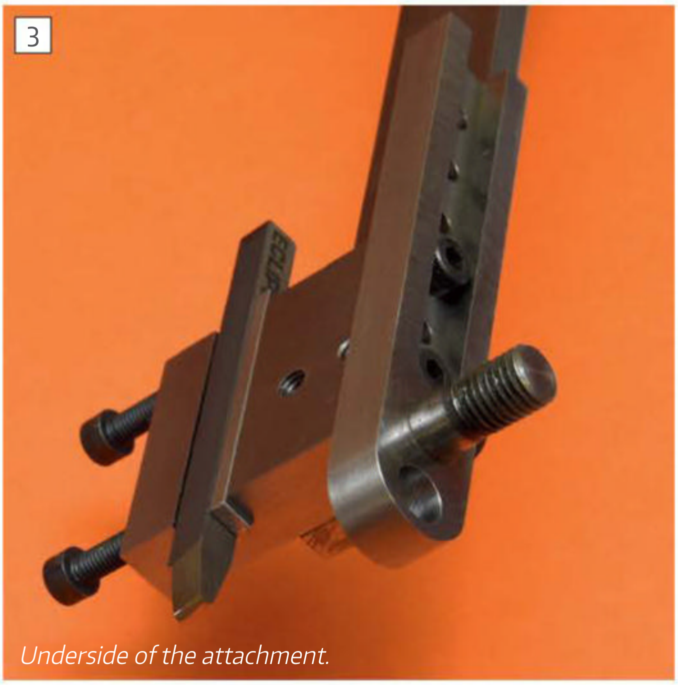
The attachment features a body into which a bolt is secured with retainer, the unthreaded portion of the bolt turning in a pivot hole in a ¼" thick bright mild steel plate bolted to the cross-slide. A



1

Turning a safety valve bonnet.


Radiusing the head of a bolt.


Underside of the attachment.

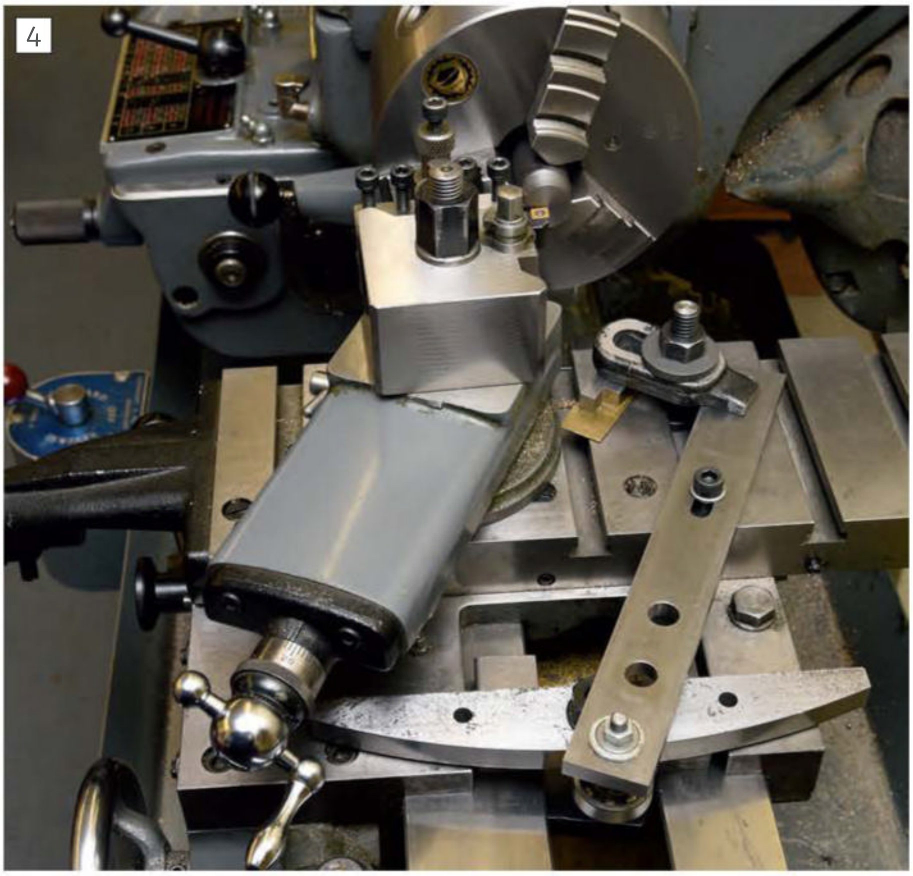
tool-holder can be bolted to the body in one of several positions, depending upon the radius required. A bright mild steel "handle" can be bolted to the tool-holder. A 1/8"D hole in the top surface of the bolt can hold a 1/8"D dowel pin; this eases the task of setting a required convex radius.

Photograph 2 shows the attachment cutting a convex radius to form the head of a shouldered stainless steel bolt. The attachment was originally made such that it could be rotated by means of a hand-wheel and a lead-screw, but I found that operation by hand using a long handle gave a better "feel". **Photograph 3** shows the underside of the attachment body. This attachment can cut convex and concave radii between about 1/8"D and 1¾"D. It produces a very good finish when used with a round-nosed tool.

The final attachment is excellent for turning really large radii such as that on the smokebox door of a locomotive. **Photograph 4** shows the general arrangement. A radius template, milled on the rotary table to the desired radius minus half the diameter of the ball race, is bolted to the lathe bed on ½" spacers so that the saddle is free to move underneath it. The bottom part of a fixed steady provides the bolt.

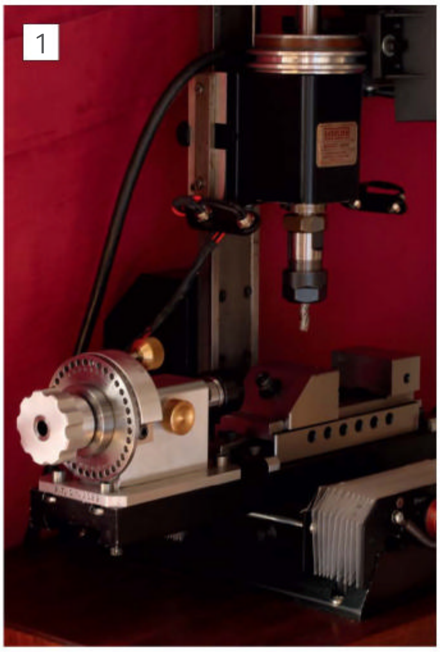
A bar with a small ball race attached to a spigot is clamped to the cross slide. Using gentle anti-clockwise pressure on the saddle hand-wheel, the ball race is held in contact with the radius template as the cross-slide is traversed in. The saddle and the tool follows the radius template and the correct radius, with a nice finish, is produced on the workpiece. Photograph 4 shows the attachment being set up so that the tool and the ball race are both on the lathe centre-line.

This attachment can also cut large concave radii. One of these days I would really like to cut a parabolic mirror from aluminium plate to see if the quality of machining might be sufficient to make a usable reflecting telescope. I just need to figure out how to cut a parabolic template! Any ideas?


Attachment for really large radii (or radiuses).

ER16 INDEXER

Bernard Towers regularly uses a 5C type indexer, but had nothing similar for his Sherline mill, so he made this compact ER16 indexer.



1

ER 16 indexer on the Sherline mill.

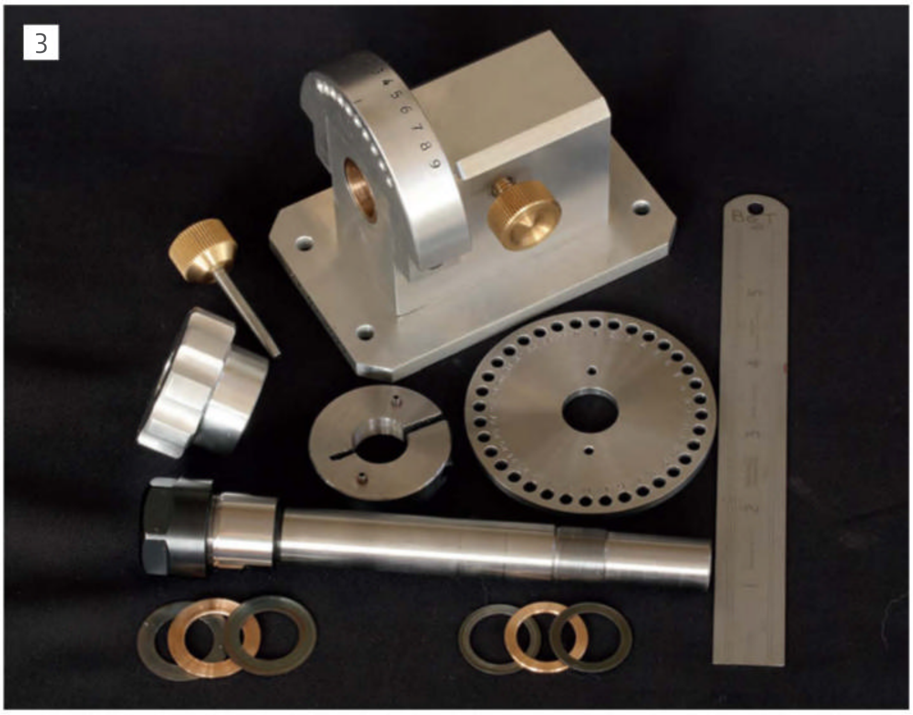
2

Commercially made 5C indexer for comparison.

Making this indexer, **photo 1,** also gave me the opportunity to have the dividing plate at the opposite end, keeping the dividing holes free of swarf. My 5C indexer has a swarf guard plate fitted, **photo 2**.

The indexer uses a commercially available ER16 collet chuck with a 16mm straight shank that is 150mm long. This leaves plenty of material to play with. The one I bought is quite tough, but it is possible to open the through hole to 10mm if drilled slowly with cutting oil. That way you can get long pieces of work in.

Aluminium has been used for the main body components, with bushes fitted to the main shaft to prevent wear. The dimensions for fixing to the machine bed are to suit my mill but can be put wherever you require them. The dividing plate is steel as is the adjustment nut, with two roll pins to act as positive drive to the main shaft. A little note about the shaft and nut thread, it is 16mm in diameter but is screwcut 40 tpi to give fine adjustment for end float. (Sorry about the mixed dimensions but the 40 tpi can be swapped for a metric pitch if you prefer). **Figures 1** and **2** and **photo 3** show the component parts**.**



3

Component parts.

Most of the body parts are straight forward, but I would recommend lapping the main shaft bushes for a good fit. I find when testing things like shafts for

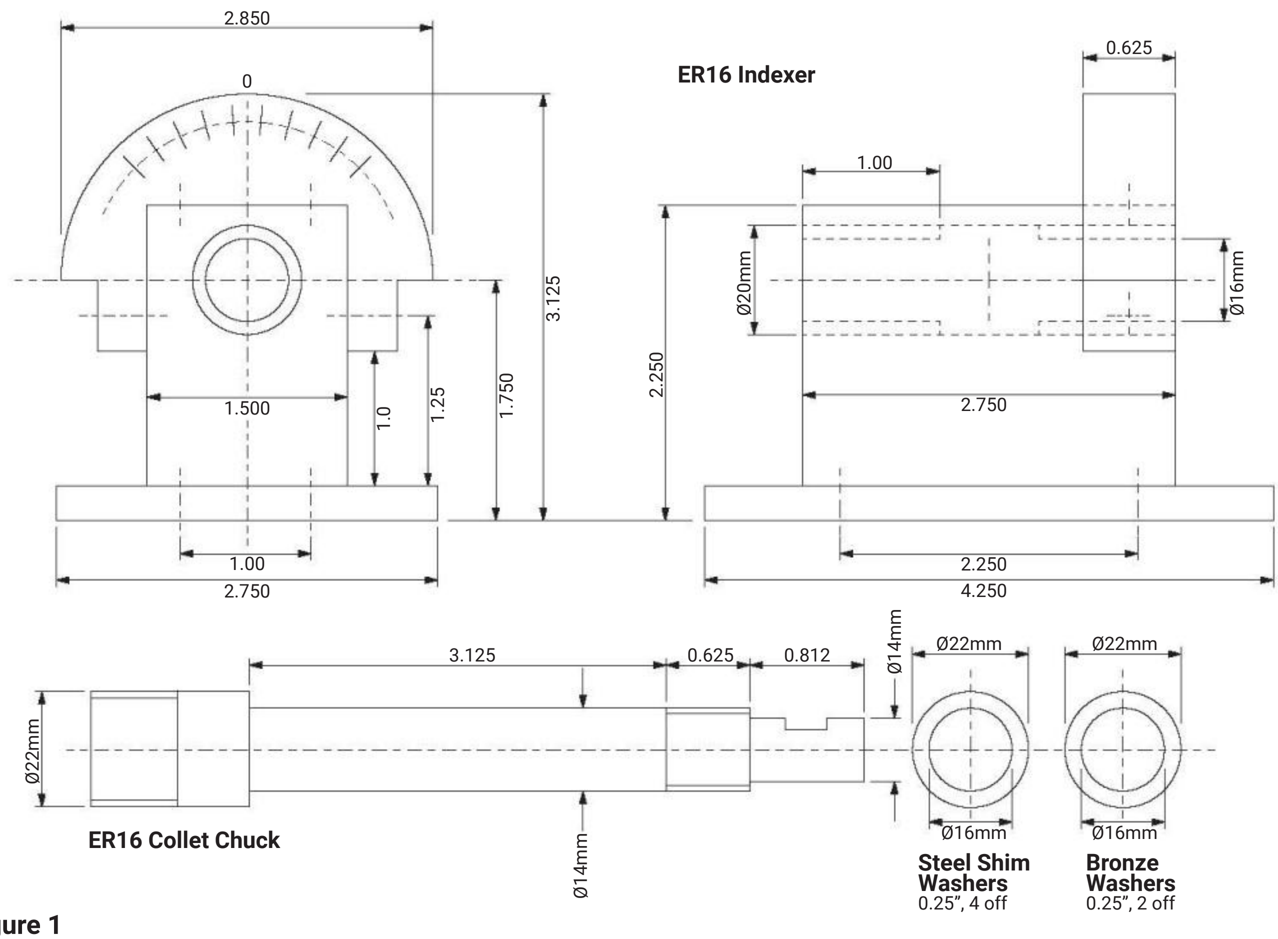


Figure 1

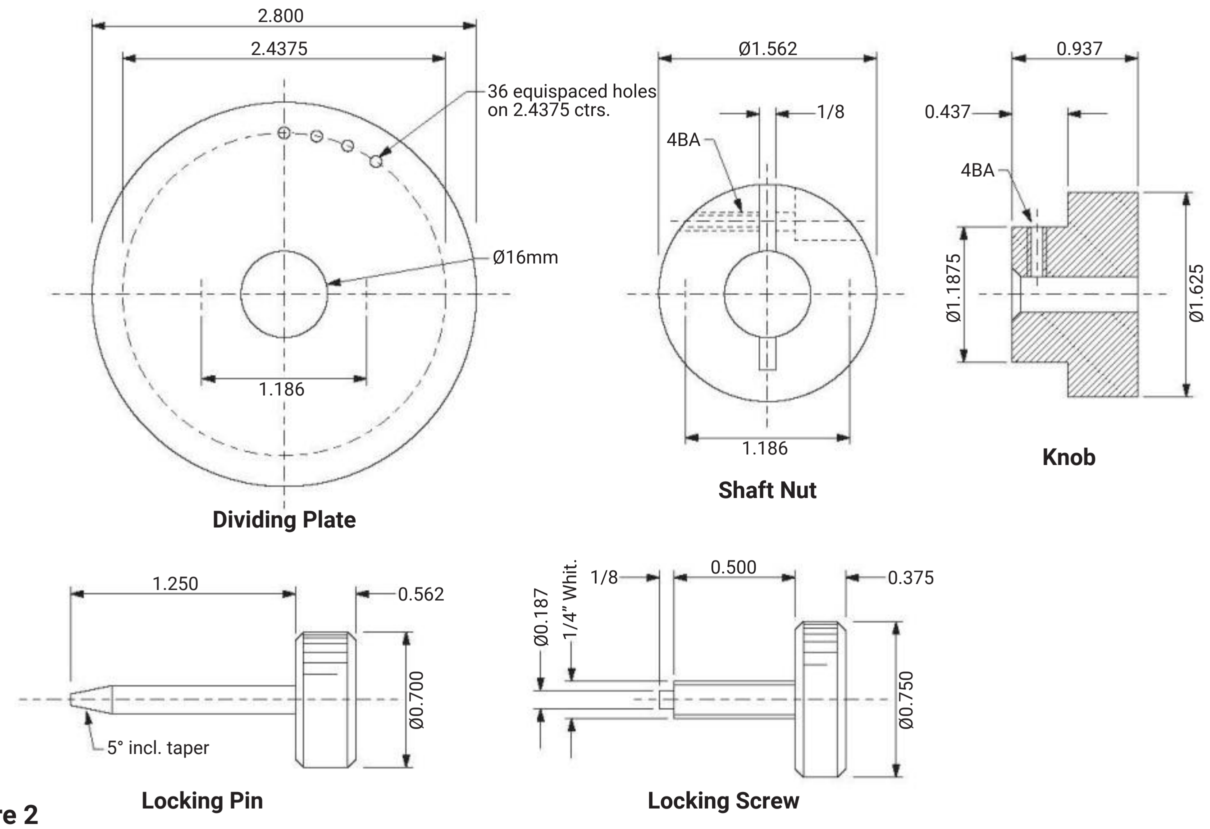
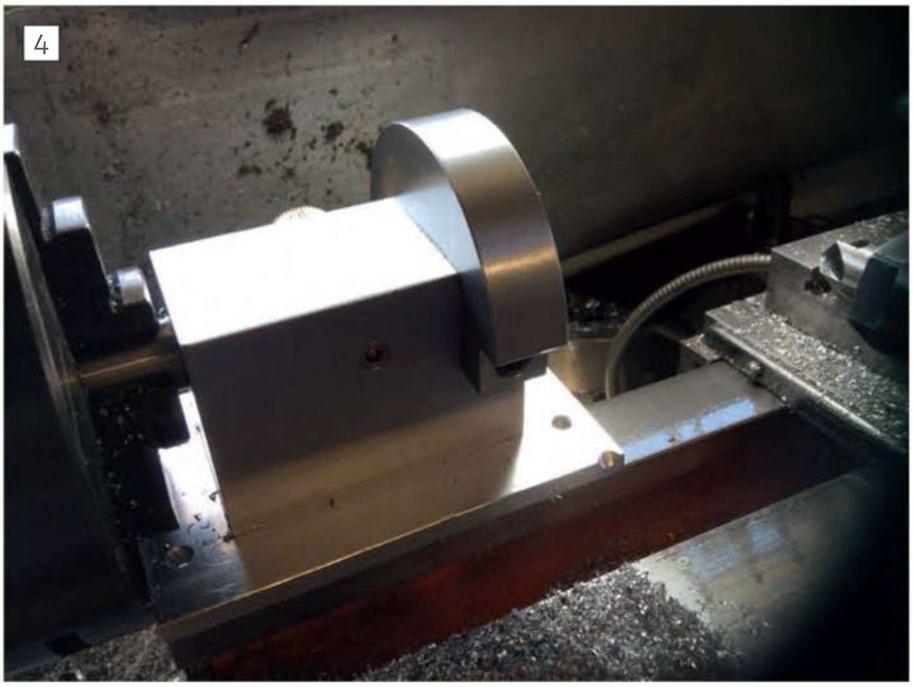


Figure 2

fit, that a little EP oil will allow assembly sooner than if components are left dry. I have helicoiled the locking screw thread in the body, just because I had them, and to prevent wear in the aluminium body. Directly opposite the locking screw on the other side of the body is a 1/4 inch oiler to lubricate the main shaft.

The main body of the indexer, **photo 4,** was prepared on the shaper, mostly because it gives such a good finish. The base plate was cut out roughly and oversized for finishing after bolting to the body. Both sets of holes for this were done in the mill with a DRO, and 5mm countersunk socket heads used to bolt together. After bolting, two roll pins were fitted for repeatable location. Once together the main body was used as a datum, to finish machining the baseplate to the correct dimensions. After this stage the machine mounting holes can be drilled, again using the body datums so when bolted to the mill everything is in line. The body and base plate can now be mounted on an angle plate in the mill or on to the lathe cross slide for boring the through hole for the main shaft. This is bored and then reamed to 20mm to give a bush wall of 2mm. If these are made in advance they can be pulled into position whilst the body is still mounted, enabling you to bore and finally hone the bushes to size. There is a gap between the two bushes to enable storage of some lubrication.

The quadrant is made from a piece of aluminium 3" x 2 1/4" x 5/8". It has a centrally located channel milled into it the width of the main body (a close fit) and 1" deep. Vertically it has two 2.5mm roll pins pressed in, and two M5 cap heads screwing it to the sides of the main body. When I machined the quadrant outer curve the body was mounted in the lathe on a mandrel, and I used a tool post milling attachment turning the lathe backwards and forwards by hand till the correct dimension was reached, **photo 5**. The body was mounted vertically in the mill and centred. This is where some calculation is needed (thank goodness for a DRO) Firstly the radius has to be entered and then set for forty holes with a start angle of 4.5 degrees, as you do not need a centrally positioned hole. The thing to remember here is

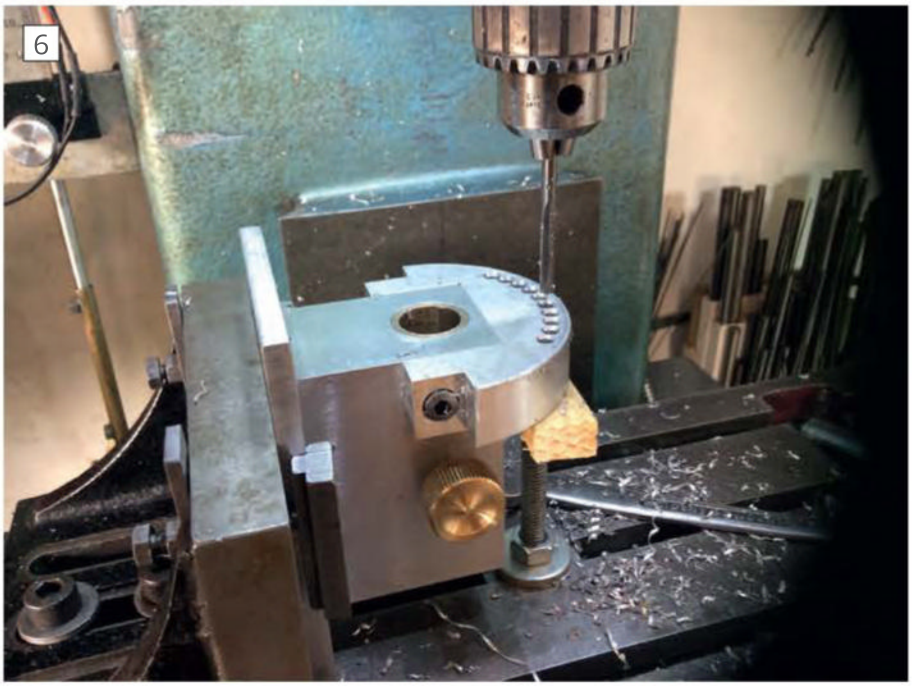


Main body.

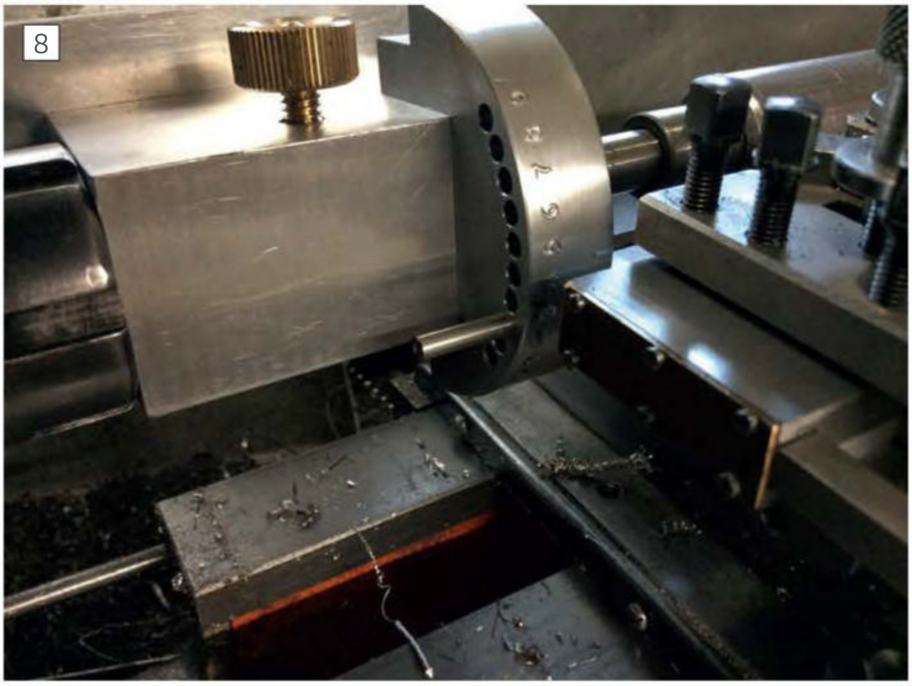
Milling quadrant on the lathe.

that you only want ten of the forty holes, five to one side of the centre and five to the other side so you need to drill and ream holes 1 to 5 and 36 to 40. The 4.5 degrees is the vernier part of the indexer that allows you to divide the space between the dividing plate holes into 10 parts equalling 1 degree for each, **photo 6**.

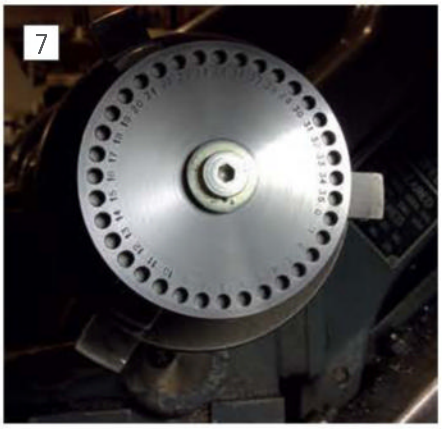
The dividing plate holes are first drilled 3.5mm, ready to be a taper ream fit for the pin. The pin is from 5/32" or 4mm stainless steel, whichever you have the reamer for. At this point when you machine the taper onto the end of the pin, leave the compound slide set, and taper a piece of silver steel to make a D bit. This will ensure that the parts match. When reaming the holes, only go far enough to have the pin flush with the far side of the plate. The dividing plate is tapered from the opposite side to the stamped numbers. My numbers were stamped with a little jig set in the toolpost, that goes for both the plate and the body, **photos 7** and **8.**



Index holes on quadrant.



Numbered quadrant.



Numbered index plate.

The markings on the body just need a little thought to make sure that they are the right way round. Firstly you need a fiducial mark on the centre line facing the dividing plate. Then, on the side that the indexing pin enters, the first hole needs to be 4.5deg to the left or right of centre. It does not matter as this will become your zero for the rest of the holes. The rest of the holes (ten in total) are nine degrees apart, so five on one side of the fiducial mark and five on the other.

The main shaft as mentioned earlier, is a commercial product, ER16 nose with a 16mm shaft 150mm long. It needs a thread screw cutting on to it to facilitate adjustment of the end float. I chose 40tpi as it is nice and fine for adjustment purposes, and even though the shaft is metric, just cut the thread to the correct depth and make the nut to fit. The piece of the shaft after the nut is reduced in diameter to accommodate the knob and has a flat machined on it to be the location for the knob's grub screw.

The nut does two jobs. It allows end float adjustment and also positive drive to the dividing plate, and the two are held in close contact by the fact that there should be little or no end float. The nut is screw cut then drilled and counterbored for a clamp screw (I used a 4ba socket head.) It is then split through one side and half of the other making clamping a simple matter. The drive pin holes can also be drilled either from the dividing plate holes by putting it on a mandrel or using the DRO on your mill. I used 2.5 mm roll pins, but silver steel will do the same job, this can be seen in photo 2.

The index pin is a piece of 316 stainless bar, with the taper machined on at the same time as machining the D bit blank, with the brass knurled knob either pressed in or secured in position with retainer. The knob seems quite large, but it makes it easier to handle. Try to polish the pin for a good fit in the quadrant as this gives the head added rigidity.

The rear knob is an exercise in whatever takes your fancy, as some people like knurling, but personally I like the scalloped version when the knobs go over about an inch in diameter. This needs to be a nice sliding fit on the rear of the main shaft with a grub screw fitted on the reduced diameter part to marry up with the flat on the shaft. This is where you may want to make your final decision on the finished length of the main shaft.

The locking screw is a plain turning and milling job, but as I mentioned earlier the body is helicoiled for longevity and I already had them in the drawer.

The oiler is just a plain 1/4-inch push in type, again from the bottomless drawer. ∎

A Fixture For Splicing Quarter Round

Al Hanson wanted a solution to simplify neat joins in what we know as 'quadrant trim moulding' in the UK.

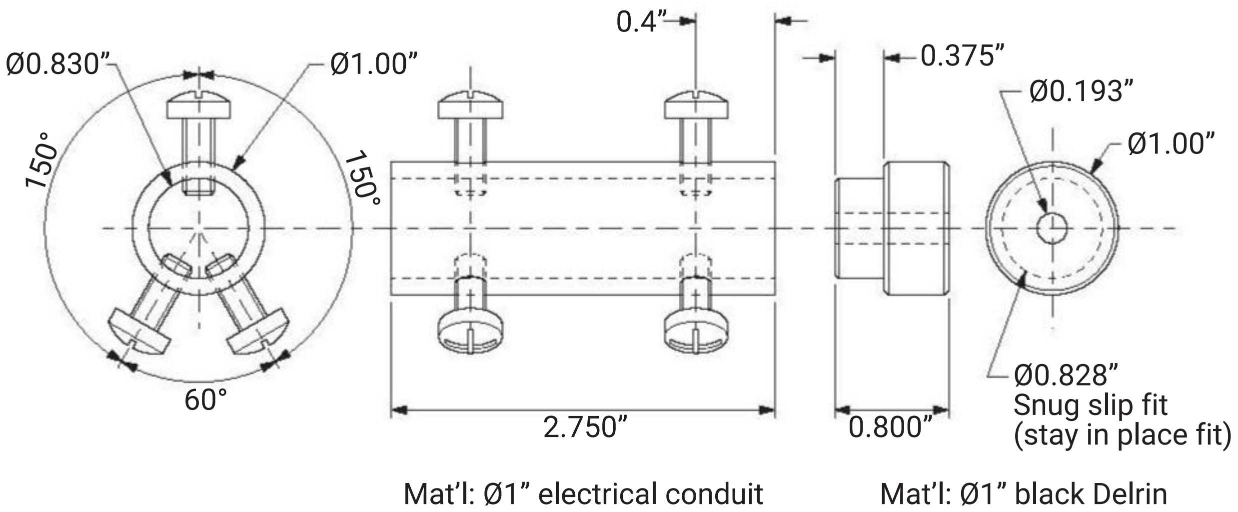


Figure 1

When faced with a half inch quarter round splicing job, (I've done this before), I found it very difficult to drill into each side and have the halves line up, **photo 1**, (a new floor). Last time I need to splice, I drilled the long side, as close to centre as I could, then kept drilling the short side, until they lined up well. I use 3/16'' dowel pegs, **photos 2** and **3**. This time I would take the time to design and machine a fixture! **Figure 1** shows the details, the device is shown in use in **photo 4**.

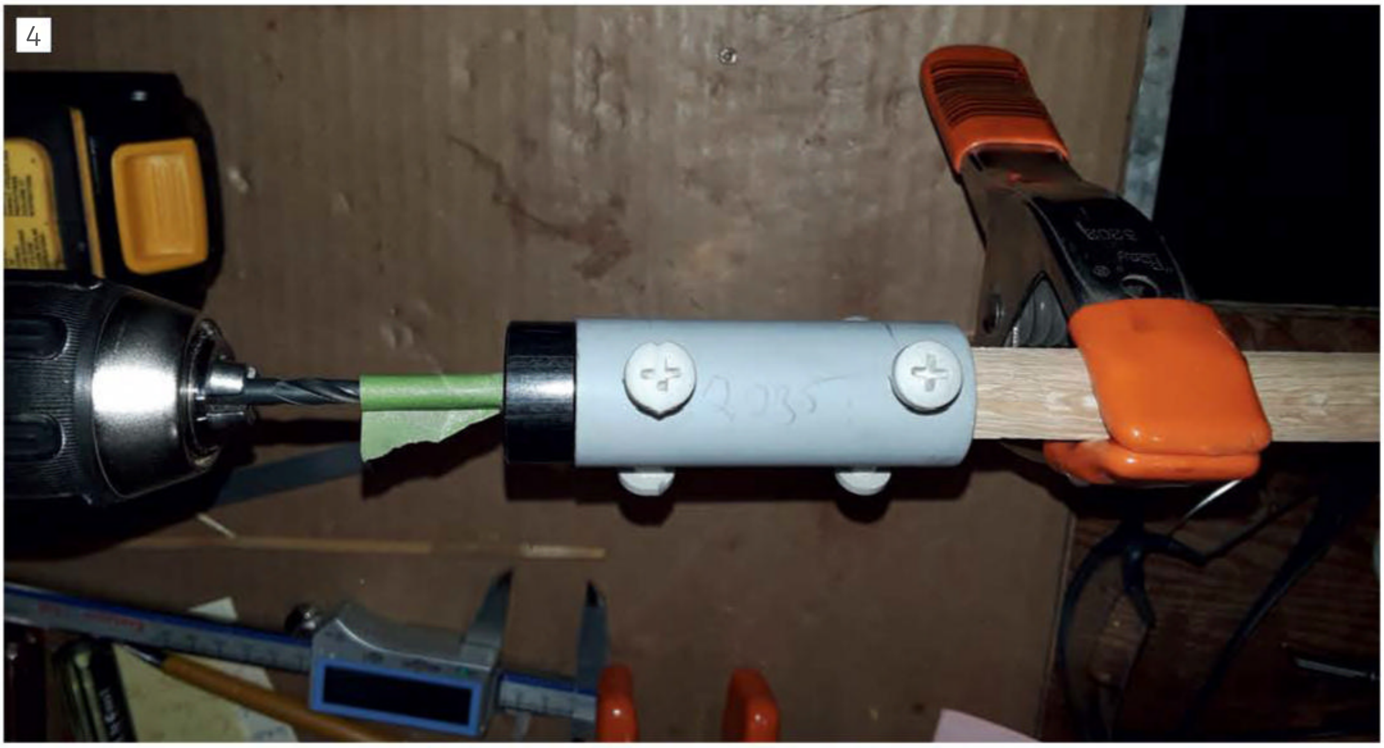
I used a short piece of one-inch electrical conduit, and some 6mm x 1.0mm license plate screws, provided by my 'Jif peanut butter' hardware and parts collection. My old boss called his tray of screws, nuts and bolts his wish box! Anyway, the peanut butter jars provide more organization than that. One only new piece was the drill guide, **photos 5** and **6**, which is from a rod

1

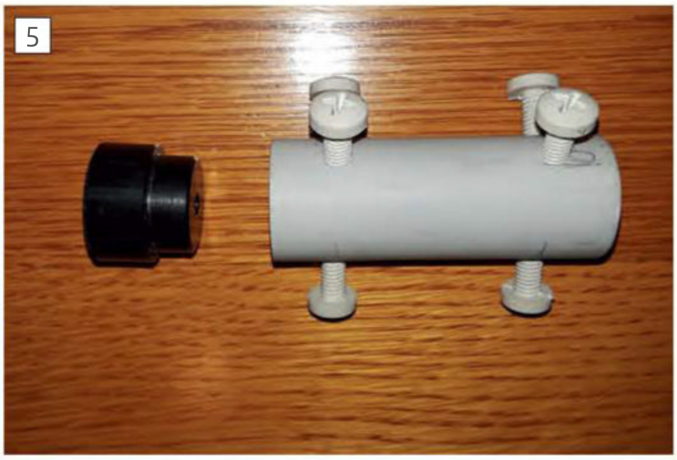
Splice joint.

Dowel peg.

Making a joint.



Fixture in use.



Delrin cap.

Arrangement of screws.

Clamping orientation.

of one-inch Delrin that I happened to have on hand. The sketch shows the pertinent dimensions and spacing. I thought that drilling and tapping the electrical conduit, with two screws 60 degrees apart, to engage the quarter rounds right angle section, then the third screw to engage the centre of the round, **photo 7**, would make aligning the quarter round in the centre of the conduit, easy. The plastic screws won't mar the oak quarter round. If it did, I'm going to sand, stain and polyurethane anyway. All our woodwork and the furniture I've made over the years are stained and polyurethane varnished with the same finish. It's such good public relations, (PR), to impress the Domestic Authority with the attributes of the lathe and milling machine from time to time.

I used the lathe to face off the electrical conduit, and to bore out the I.D both ends so they were the same dimension. Then to turn up the drill guide, and to bore it out 0.193, for guiding the drill bit. I used the mill and a 5c Collet block for boring and tapping the conduit. ∎

A Machine Light

Alan Donovan makes a work light for the Warco WM18 Milling Machine (and maybe others).

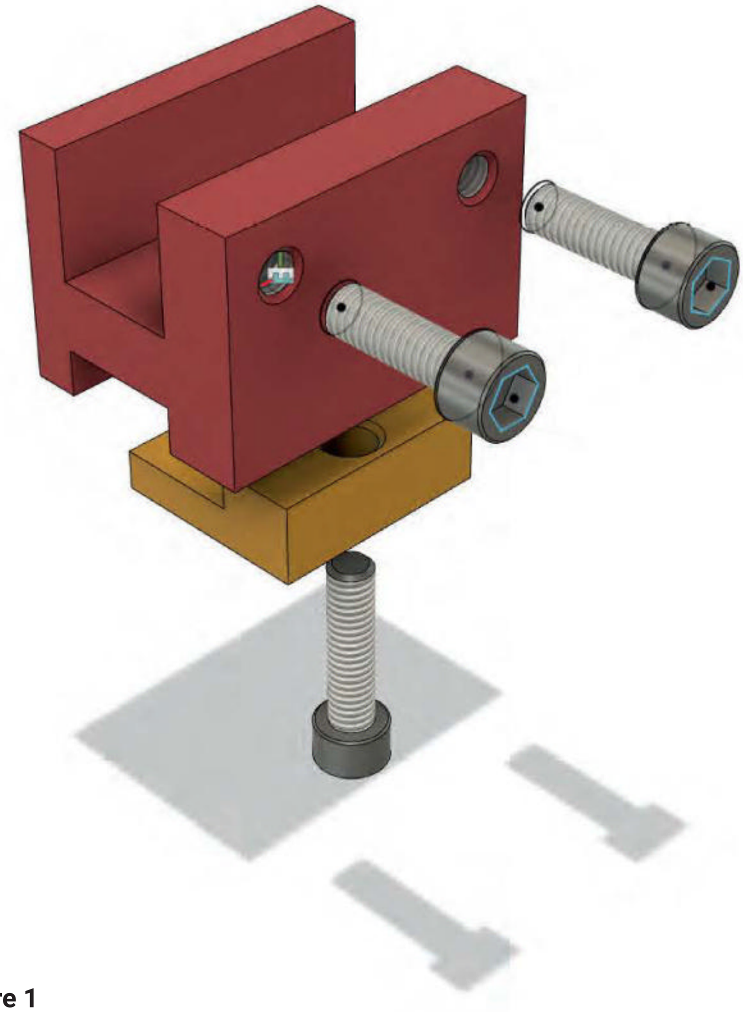


Figure 1

I have a Warco WM18 milling machine which stands against the back wall of my garage. My garage has no windows, so all lighting is artificial. I have a four foot fluorescent strip light mounted high up, behind the milling machine, but as you would expect there still remains a shadowy area cast directly in the work area by the milling machine column and head.

I decided that this could be improved. I also decided that the solution should not require the milling machine to be machined in any way (i.e. no tapped holes, machined flats etc). While undertaking the family shop at a certain supermarket that has various offerings 'in the middle of' I found some under-cupboard LED lighting strips complete with transformer unit and on/off switch. This seemed a viable solution.

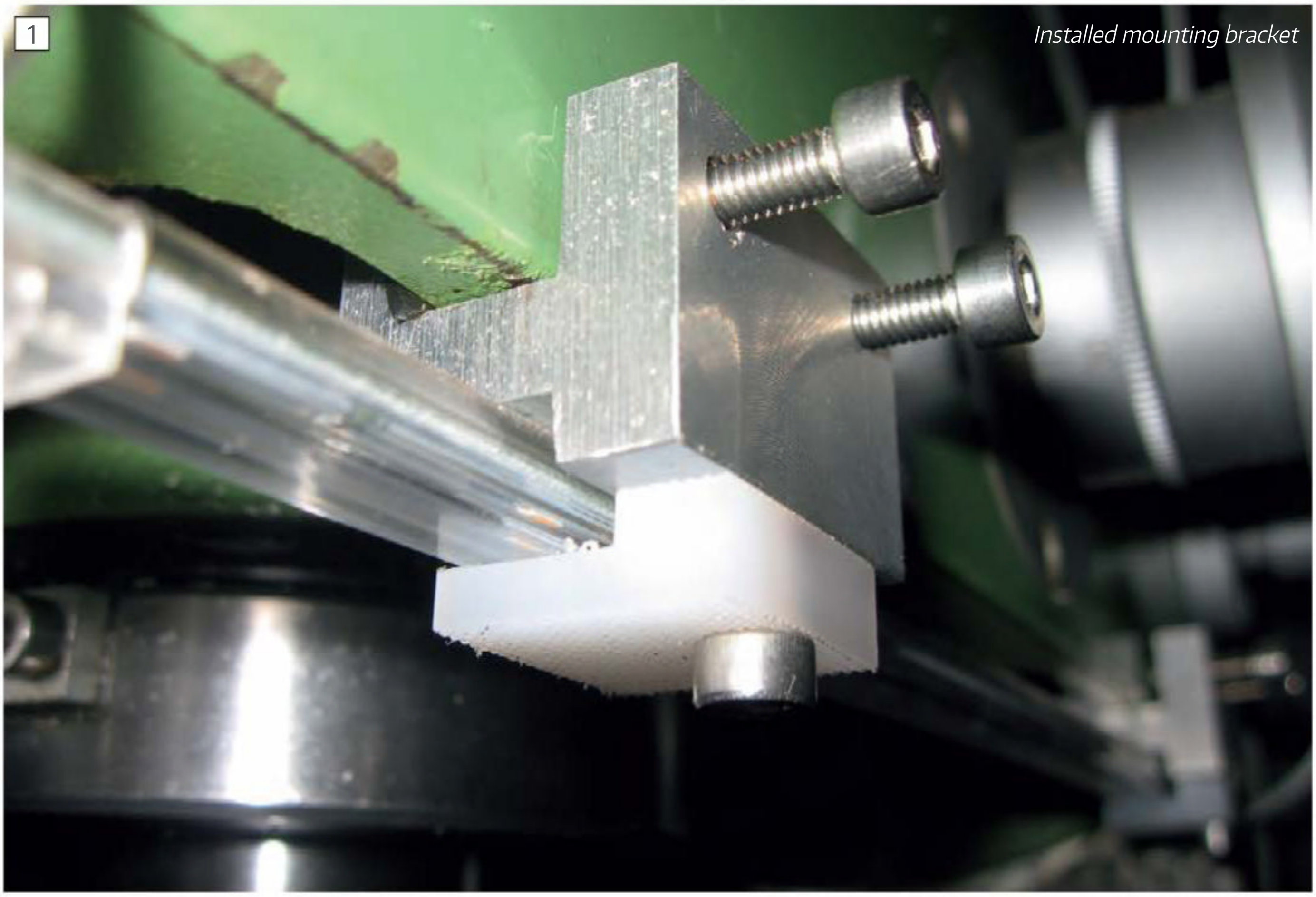
I initially trialled the LEDs by fixing them to the underside of the milling machine with double sided foam adhesive tape. The light levels were good, but the adhesive very rapidly degraded so a mechanical solution was definitely necessary.

The milling machine head is a casting such that the lower part of the sides take the form of two cast webs. So it seemed to me that I could clamp the LEDs to these side walls via some small brackets with clamping screws, thus avoiding drilling and tapping into the milling machine head casting. The LED lighting strips would face downwards directly over the work area thus providing light just where it is needed most. The design of the bracket was quite simple and only four were required – two per side. They were machined from aluminium.

Figure 1 shows an exploded view of the finished bracket assembly. The slot in the upper part of the bracket is offset from the centre of the block and is machined to suit the thickness of the lower walls on the milling machine head casting.

The thicker upper wall to the bracket is intended to be on the outside of the Milling machine and has two M4 holes for the clamping screws. The lower slot in the bracket retains the LED strip and has a clamp plate that holds the LED strip in position. This is held in position by one M4 screw. The clamp plate is manufactured from plastic, cut and machined from one of the inexpensive white 'food chopping boards' that most supermarkets sell. The LED strip stands proud of the lower slot, so the clamp plate needs to be recessed to suit. The recess is sized to give a comfortable 'nip' to the LED strip, when it is secured in position, but not so tight that it may be damaged. This may require careful measurement of the LED strip together with the slot and clamp dimensions plus a little 'trial and error' to get this right. The softness and flexibility of the plastic does help protect the LED strip from damage.

The cables on the LED strips were shortened to provide a compact installation. When reassembling make sure you have the LED strips the correct way round as (I found) they will not work if fitted backwards. A trial run will ensure you get this right.



Installed mounting bracket

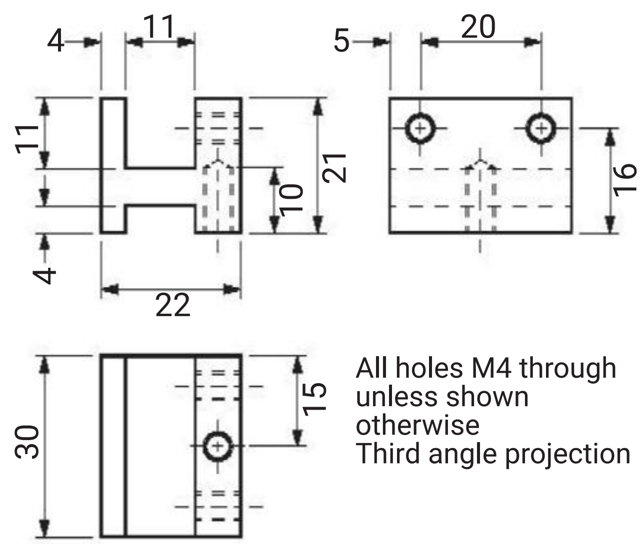


Figure 2

Installed LED strips

Photograph 1 shows the installed bracket complete with LED strip and plastic clamp. Shorter clamp screws to the installed bracket will give a neater appearance. **Figure 2** provides the dimensions I used for the clamp bracket for my milling machine. I doubt these dimensions will be common to all the milling machines of this style, but I am sure you can adjust the basic design to suit your own needs. **Photograph 2** shows the installed LED strips on the underside of the milling machine head.

I am pleased with the end result as it is a compact arrangement, the lights do not obstruct the work area and the light levels are good without any reflected glare. Shorter clamp screws to the blocks would look neater, but that is easily remedied.

These LED strips were a little long on final assembly, but an alternative supplier may have shorter LED strips. ■

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Tools and Machinery

- Engine crane, max capacity 1,000kg. Only used for moving workshop machinery. Near new condition, £50. Collect only from DN3 area. **T. 01302 835174. Doncaster.**

- Warco 2F floor standing pillar drill (purchased 2009), 12 speed 180- 2770 rpm, 240V, 750W, little used, plus robust 100mm drill vice, £145, buyer collects. **T. 07910 038360. Eastwood, Nottingham.**

- 7-Inch Perfecto shaper. See Model Engineer 24 June 2016. **T. 07954 105391. Leeds.**

Models

- 5- inch gauge steam locomotive. I believe it is a speedy loco and the name is "Pippa. I know it has had a new boiler put in it and from what I can tell is in great condition. The boiler was put in 2019 and has hardly been used. It has a boiler certificate, also a certificate for the hydraulic tests and a record of previous test. £4,500. **T. 02392 373196. Fareham, Hampshire.**

- Foden 3inch scale steam waggon part built most parts, but boiler needed. £1600ono. Note this is corrected phone number. **T. 07885345346. Kirkbean.**

Parts and Materials

- 7 1/4" GWR 1366 pannier tank chassis for sale. Cylinders, wheels, coupling and connecting rods, eccentrics and straps and buffers fitted. For full details and price please phone Gerry. **T. 01268 734147. Wickford, Essex.**

- Pre-owned but never used 5" gauge model boiler including smoke box barrel for any of the three Shay logging locomotives designs. All professionally copper welded with pressure test certificate. £2000 buyer collects. **T. 07736764202. Hinckley.**

Magazines, Books and Plans

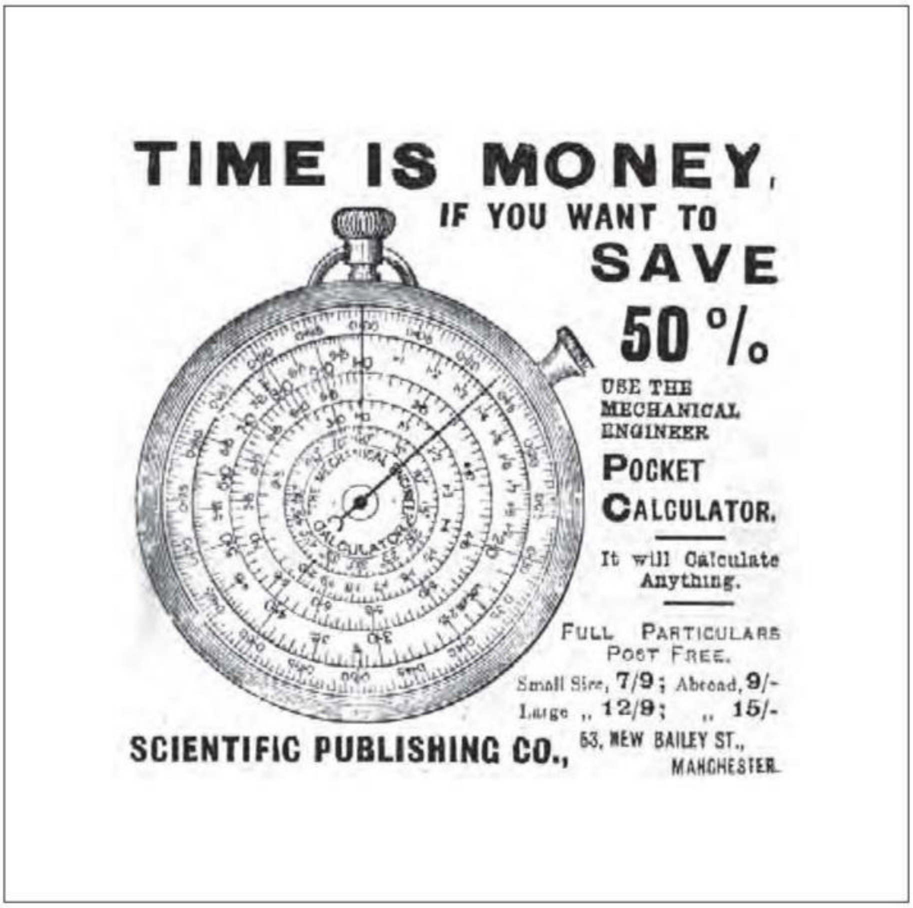
- I have 13 boxes of model engineer magazines from 1908 – 2009 and various others also three sacks full of wood templates for use when casting as my dad was a pattern maker, I also have a few plans. I don't want anything for them, but someone will have to pick them up. **T. 07981905485. Sunderland**

Wanted

- Engineers wanted to produce small batch runs of parts from drawings or patterns. Turning, milling and screw cutting required. Suit retired person with good workshop who enjoys a challenge. Good rates of pay. **T. 07860 175087. Warwickshire.**

- Looking for someone to machine some parts for an unfinished project I have purchased. Within reasonable distance of Norwich. (150 miles) material supplied. **Email bnunn472@btinternet.com. T. 01953 718531. Norwich.**

Wanted Cowells ME Lathe with accessories, must be in excellent condition, also interested in a Cowells Milling Machine. **T. 01986 835776. Lowestoft, Suffolk.**



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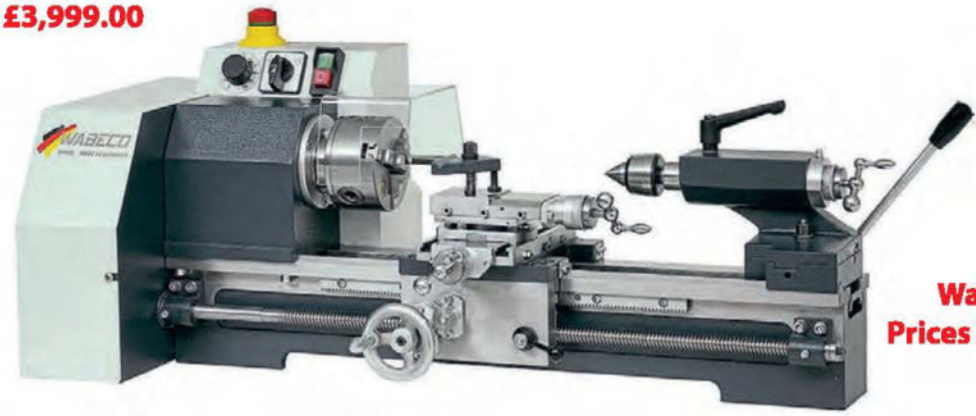

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