No.254

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

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

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

**MARKETING & SUBSCRIPTIONS**
Subscription Manager: Louisa Coleman

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

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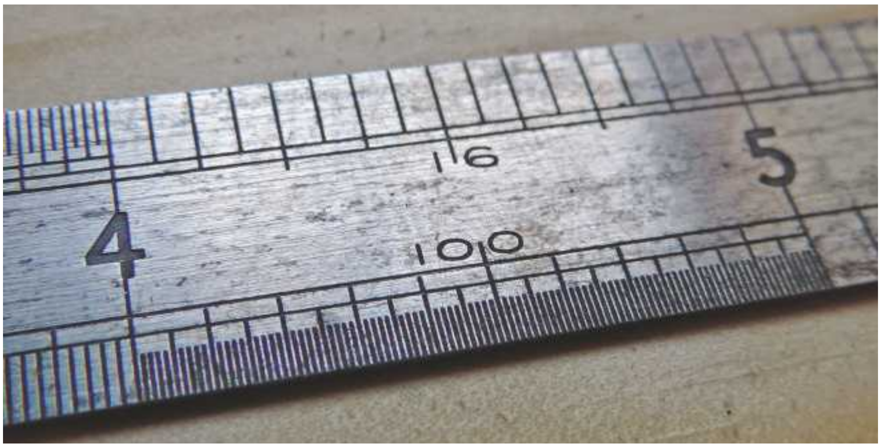
# On the Editor's Bench



## Metric or Imperial?

Back in the 1970s the respected author on engineering (in all sizes) Tubal Cain (Tom Walshaw) wrote that we should get ready to use metric measurements, as imperial stock and machines would soon be unavailable. I think it's only recently, about forty years later, that things like drill sets in imperial sizes are finally starting to become more scarce, and imperial stock is still as easy to source as ever!

Even so I am increasingly getting feedback that younger hobbyists haven't a clue about imperial measurements and that most new machines (in the UK and Europe and most other countries, but not the USA, are metric. Keith Loxley has written asking about a compromise:

"May I make an observation about the excellent presentations and projects you describe. I can work quite happily in the new fangled Napoleonic units (metric), but all my workshop equipment and tools are Imperial. Could you give consideration to developing your drawing in 'dual language'? It would be much tidier than me having to hand scrawl over the relevant diagrams."

The practical problem with 'dual' dimensioning is that unless we use exact equivalents, such as 6.35mm for ¼", the drawings have to be redrawn to suit different stock sizes and every dependent dimension has to be adjusted to suit. This is a lot of extra work for contributors and very prone to errors. It's not something we would wish to do to supplied drawings, because of the many hazards of altering a design without building and proving it! Using CAD to convert a drawing just ends up with everything having inconvenient sizes in the other system.

So, I fear that except in the rare cases where contributors supply articles with dimensioning in both systems, we will only be using one system in each drawing. There is the obvious exception where a drawing is largely in one system, but for reasons such as availability of a bought in item, something has to be dimensioned in the other system.

This leaves open the question of which system we should encourage authors to use. The balance of opinion these days is clearly in favour of metric, and I am starting to encourage contributors to use metric where possible. It does have the advantage of being easier for imperial brains to use metric than the other way around!

With a heavy heart, I am starting to use metric for any new designs of my own – except for historic models of imperially dimensioned prototypes. That said, I am still happy to accept articles and drawings using imperial measurements, as asking an author to convert a proven design made using imperial measurements just risks introducing errors.

But remember, In your own workshop, work with whatever system you are most comfortable with – use cubits if you like - and enjoy your hobby, rather than worrying about which system is best.

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This month's cover features Andrew Johnston machining a hefty helical gear for his traction engine build. See this month's One Man and His Lathe to find out more about Andrew's workshop equipment.


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### THIS MONTH'S BONUS CONTENT

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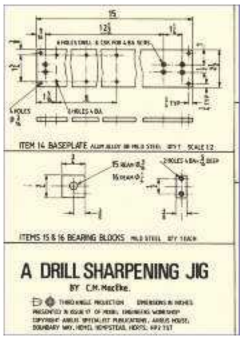
**C M McEke's drill Sharpening Jig 7**
Head for the Article Reprints section of www.model-engineer.co.uk to download this free plan first published in MEW 17, June/July 1993.




Come and join the forum and let us know what you've been making in your workshop!

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- Can you identify forum members' unusual objects? Or do you have one of your own?

**Encouraging New Hobbyists**
- How do you think MEW and the forum can better encourage new people to join the hobby?

**Metal Cutting Mitre Saw**
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# Silver Soldering – A Comprehensive Guide

## David Banham gives a wide-ranging overview of this important technique for metal joining.

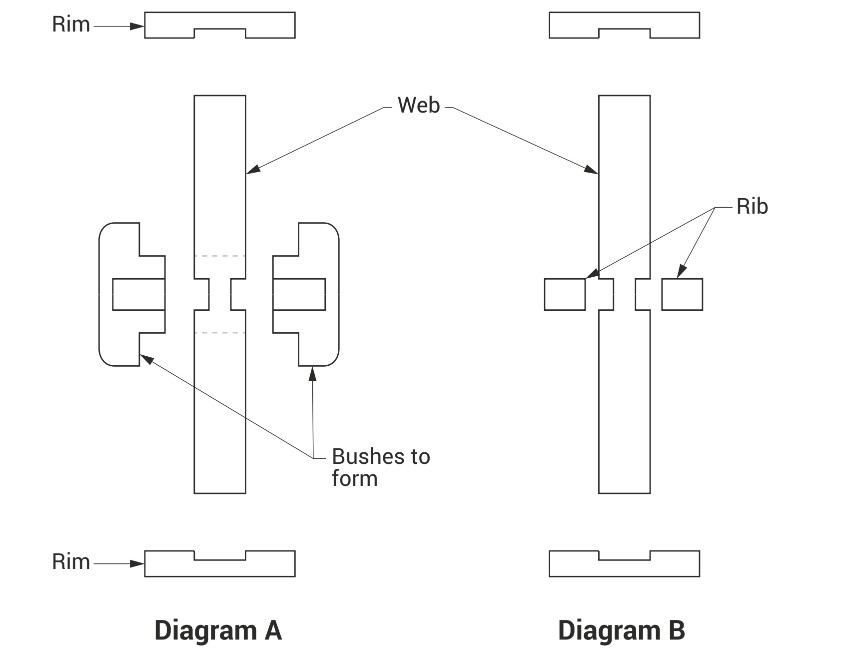
Silver Soldering is sometimes called silver brazing, which seems to be more popular as an expression in North America. Here we discuss silver soldering, but will also provide some guidance on soft soldering and where each type of process is appropriate. While conducting research, it became apparent that when searching the Internet, one should search for both 'silver brazing' and 'silver soldering'.

First it would be useful to sort out some nomenclature. Brazing is the use of brass as the filler material, whilst silver soldering uses a filler mainly composed of a mixture of silver, copper and zinc; soft solder uses a filler that is principally a lead and tin composition and may contain small quantities of silver. Finally, just to complete the picture, welding is the joining of metals by actually fusing the metals to be joined, and these are the terms we will use here in the context of this guide.

Of all the methods of joining metals using a flame or heat, silver soldering offers the greatest flexibility compared to soft soldering, brazing and welding. One useful feature of Silver Soldering is that dissimilar metals can be joined.

It does not have to be an expensive investment to get started with silver soldering. Starting allows you to develop skills, without which your model-making or workshop capabilities will be limited. Many newcomers think that silver soldering will be difficult, but if you follow the guidance here, it will only require you to gain experience, without having a series of initial disasters and disappointments. Comparatively, the author found silver soldering to be slightly harder to master than soft soldering, but simpler than either gas or electric welding.

Fig.1




We will discuss the various tooling options, planning, processes, capabilities, and techniques.

### A Model Making Example of a Silver Soldered Assembly

The beam, shown in **fig. 1**, is one of two beams that are part of a model of the Crossfield Mill Beam Engine, which is preserved by the Northern Mill Engine Society in Bolton, UK. Pictures of the Crossfield engine are available at the society's web site, at www.nmes.org.

The model was constructed by Bill Huxhold in Toronto. Bill made a pair of beams for the engine. Each beam contains about twenty parts. All those parts were made of brass and were silver soldered in one session to complete the beam. Details on how the beam was constructed and soldered are provided later in the article. The beam shown in **photo 1** is seen complete with its trunnions, main bearing and gudgeon pins in place.

If you master silver soldering many model components that at first glance would have to be a casting, can be fabricated from parts

1

*One of a Pair of Fabricated Beams for the Crossfield Engine* that are silver soldered together.

Two advantages of this method over using a casting are:

- The completed part will not have to allow for shrinkage.
- The part may require much less machining, than a casting.

Bill Huxhold builds all his models without the use of castings, and his excellent workmanship can be seen at the The Internet Craftsmanship Museum which can be accessed craftsmanshipmuseum.com/Huxhold.htm .

## Getting Started

If your activities are based on small or very small components (a few ounces of metal), say the maximum size item you will solder on a regular basis is less than 3" by 3" and weighs less 4 or 5 ounces, you could probably manage with a simple little square or circular turntable hearth used by jewellers, and a hand-held torch using propane of MAP gas. Examples of such items would include model boiler and pipe fittings, lubricators, injectors, hand-wheels, various controls, fittings for model boats or aircraft, small cutting tools and hand tools that require soldering. A couple of fire-bricks to act as a screen for the torch flame would also be useful.

If you want to try silver soldering the above set up would be a good starting point for a trial, and would also give you experience and confidence and the same setup can be used for hardening and tempering tools and components.

Many hobbyists and modellers will want to solder somewhat larger components, and guidance for larger capabilities is provided. Some hobbyists may build very large components such as space frames or components for cars which require greater space and more complicated brazing hearths and work-holding capabilities.


BernzOmatic Torch Used by Author


Useful General Purpose Burner - Type 3939


Larger Style Burner for Boilers - Type 2942

## Safety

Whatever your activities, one of your first considerations should be your safety and that of others within the workshop and area. Use common sense!

The following safety equipment is required, most items you likely already have, and use of the items described here is very important:

- Safety glasses with the side protectors, always use them, throughout your time in the workshop, no matter what you are doing! Use them for both silver soldering and handling and when immersing or retrieving pickled items.
- A pair of leather gloves. Use gauntlets when working with larger objects, and transferring items in and out of pickle tanks.
- Wear a suitable apron or smock, leather again works well if doing heavy work.
- Use safety shoes or a substantial pair of leather shoes (hot items dropped on your bare, sandal shod, or slippered feet is very painful!).
- Never leave a lit torch and cylinder unattended, nor leave the cylinder gas valve open when the torch is not in use. Most fuel gasses are heavier than air, and will sink to the lowest level if allowed to leak. They are extremely hard to detect, so ensure you follow this advice.
- Use a torch only in a well-ventilated area. If you are using it inside your workshop the minimum should be an open window and a fan drawing fumes out, or a hood and extractor fan over the silver soldering station.
- Have a fire extinguisher to hand.
- Store gas and oxygen cylinders outside in a well ventilated, and locked shed or locker.
- Do silver soldering and brazing of large work in the open air, or in a well-ventilated building with a hooded and ventilated hearth.
- Do not breathe the fumes from silver soldering. Keep your air supply on the side of the ventilation that does not contain fumes. Do not lean over the components while silver soldering.
- Read all the instructions on manufacturers tooling and supplies.
- Check for leaks and loose connections. Hose, shut-off valves, reducing valves, pipes, and torches should be checked for loose connections and leaks, especially if the equipment has not been used for some time.

## Torches

Prior to dealing with other tooling requirements, we will discuss torches. There are lots of torches available, that are quite capable of silver soldering components within specific categories of size, metal type and weight.

*Very Small Burner for Small Fittings and Parts - Type 3537*

## Small Propane and Butane Torches

There are many small torches available. The advantage is that they weigh very little and are easier to manipulate and control, and are therefore more comfortable to use.

Small propane and butane torches may provide enough heat for very small silver soldering but torches that are normally fuelled with butane will only do the very smallest of silver soldering work, and are generally better suited to soft soldering. Propane and MAP torches can be used for somewhat larger work.

## Smith Little Torch

A second form of small torches made for the jewellery trade are available designed to run on a fuel gas and oxygen. Perhaps the most attractive for the model engineer who works in small sizes is the Smith Little Torch which is available with several nozzles and depending on fuel generates various temperatures at the flame cone, table 1.

| Fuel | Max Temp F |
|---|---|
| Acetylene | 6100 |
| Propane | 4780 |
| Butane | 4995 |
| Hydrogen | 4850 |
| Natural Gas | 4600 |

*Table 1 - Fuel / Maximum Temperature*

These torches equipped with regulators for use with disposable Propane and Oxygen cylinders are available as a kit (Smith Little Torch Kit 23-1014) with 1 nozzle. Five additional Smith nozzles can be obtained, giving a broader range of heating options. Similar generic torches complete with about five different nozzles are available but do not appear to include include regulators for the disposable tanks. (Smiths torches are available in the UK, but it may be easier to obtain other brands of oxy-propane set – Ed.).

The Propane cylinder is painted blue and the Oxygen cylinder is painted red. The two cylinders, fuel and oxygen, are connected to the torch by rubber hoses, with simple regulators attaching the hoses to the tanks (note that different fittings are available for North America, the UK and Europe). The tanks must be used vertically or at an angle of no less than about 30 degrees from the horizontal. The Smith kit comes with a tank support wire frame, or a simple caddy is easy to make.

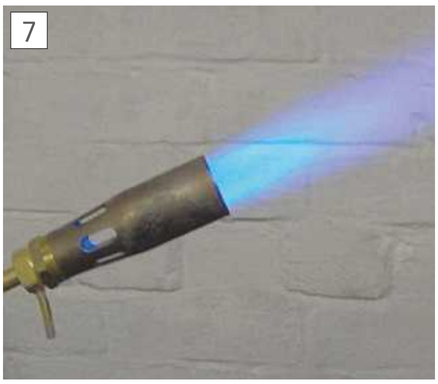
There is an excellent tutorial describing how to set up, and use the Smith Little Torch at desiredcreations.com/howTo_TLLittleTorch.htm . It is important that you have a neutral flame for silver soldering, and this is shown along with other unacceptable flames on their web site.

Full specifications of this torch are available at the Smith web site at smithequipment.com/files/pdf/spec_sheets/Little_Torch.pdf . (Similar small oxy-propane kits are available in the UK)

If you use a Smith, or other small torch with Oxygen, you need to be very careful when heating the parts. Ensure you heat the parts evenly and carefully, as it is easy to apply heat to a single spot and burn away base metal. The best advice is to always keep the flame moving over the work-piece.

## Self-blown Torches

These Propane and MAP torches are available in many tool and hardware stores. The author's torch is shown in photo 2. Similar torches are available from other suppliers. They have the advantage of being free standing, with no pipes, regulators, or separate freestanding tanks. This type of kit is an excellent starting point, and it has quite a range of capability. Some also self-ignite via a trigger mechanism, and this is a most useful feature.



*Appropriate Flame from a Sievert Torch*

The higher temperatures available by using MAP may be of assistance when working in the home workshop. An economic package consisting of a self-igniting torch, and a throw-away cylinder of MAP fuel is shown in **photo 2** and is available from many hardware and tool suppliers.

This setup will get you started for small hobby and workshop activity, and will be capable of hardening and tempering, and soft soldering as well.


*Authors Sievert Set-up*

## Sievert Torches

These torches consist of a handle, gas pipe to connect handle to a regulator on a propane tank, a propane tank of the desired size, and various interchangeable burners.

Sievert make a range of handles which take interchangeable burners and burn propane in air. The burn rate can be from a few ounces of propane per hour to several pounds of propane per hour.

The mid-size burner **photo 3**, provides enough heat to silver solder fittings, while the SV2942 burner shown in photo 4, is an example of a larger burner can tackle a small 3/4"scale copper locomotive boiler. The largest burner SV 2944 is 2" in diameter similar in design and shape to **photo 4**, burns 15 lbs of fuel per hour and will use a full tank in slightly over 1 hour of operation when coupled to a standard barbecue tank.

The small 3537 burner, **photo 5**, burns 20 grams (0.7 ounces) of propane per hour. This nozzle was designed for very small work. When attached to the Sievert handle, the torch it is quite light. Note that the same handle can accommodate larger nozzles up to a size fit for 1" scale (5" gauge) model locomotive boilers, such as the SV2944 burner.

A full barbecue size tank holds 20 lbs of fuel and weighs 38 lbs fully filled. Weigh it on a bathroom scale for a good idea of how much fuel you have. You really don't want to start a large job, only to find that you have run out of fuel part way through!

The author's Sievert handle, and one of his seven burners with a 20-pound tank is shown in **photo 6**. This Sievert kit is shown with the handle attached to a medium length neck and a smaller burner. The propane tank gives a good idea of relative sizes.

It is important the burner is functioning properly. The flame should look like **photo 7**. Bear in mind the hottest spot is within the blue cone of the flame and forward of the end of the inner light blue cone.

Finally, keep the tanks turned off at the valve on the top of the tank when not in use, and store them outside.

## Acetylene Torches

Acetylene torches must be used with oxygen, and therefore have two connections one for acetylene and one for oxygen. A set of small tanks, regulators, and a torch for brazing and welding, plus a cutting torch, would represent the 'top of the line' tool for larger work.

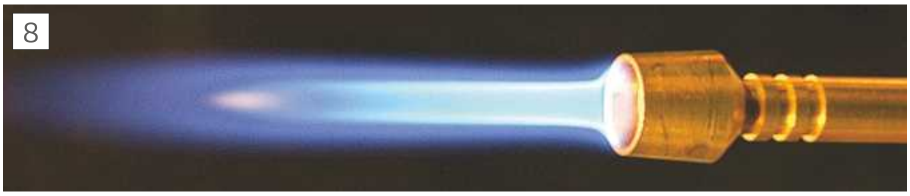
If you propose to conduct very large silver soldering activities regularly, then you should likely invest in oxy-acetylene tanks, and torches. What large means needs answering. While very specific bounds cannot be given, activities such as constructing space frames for vehicles, repairing or constructing objects weighing more than a few pounds, and where heating with a gas torch will not get heat to the joints because of size or the joints, or the ability of the metal object to conduct away the heat supplied by the torch, means you should move up to oxy-acetylene. Oxy-acetylene, for most MEW readers is beyond the scope of normal operation, and is better for those amateurs working to scales of 12 inches to the foot! If you need oxy-acetylene for your workshop activities, before purchasing call a friend with lots of experience, and visit an industrial gasses outlet such as BOC in UK and Linde elsewhere for advice.

You do not necessarily need to buy new equipment. Second hand equipment is an alternative. The two major costs are the regulators and the torch. For secondhand regulators, if the look to be in very good condition and are clean, and the price is right, think about them as an alternative to new, but get them checked at by industrial gas supplier. Second-hand torch handles; one for brazing and one for cutting are often offered for sale. You cannot use the cutting torch handle for brazing. Again look for equipment that has been carefully looked after, and whether there are a selection of nozzles for the brazing torch.

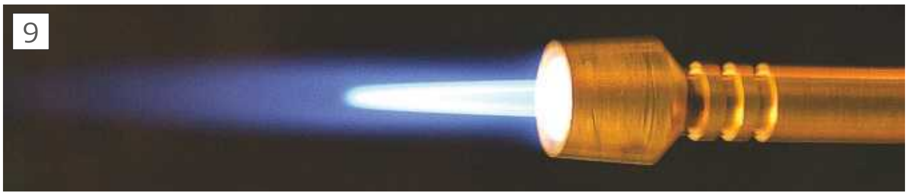
The brazing torch should easily be capable of performing three tasks, silver soldering, brazing using a brass spelter, and welding.

## Torch Fuels

Most fuels gases, discussed here are denser than air, hydrogen (not recommended for home workshop use) being an exception. This means that if you have a leak they will sink to the lowest point, floor level or even down to a lower floor such as a basement or cellar. Follow all supplier recommendations, plus the comments in this document on




*Reducing Flame - Butane*




*Oxidizing Flame - Butane*

safe handling, storage and turning off at the main valve when not in use.

## Propane

A propane torch burns the compressed and liquefied flammable gas propane ($C_3H_8$). The liquefied gas is converted using a reducing valve which is attached to the cylinder. For Sievert torches the regulator allows three settings of 28, 42 and 56 PSI (2 to 4 Bar). The maximum flame temperature a propane torch can achieve with air is 1,995 C / 3,623 F. Some propane torches are also used with a tank of oxygen to achieve a flame temperature of about 2,820 C «Isolated punctuation» / 5,110 F. The temperature in these flames is lower because of incomplete combustion, and other factors, see the quoted temperatures for the Smith Little Torch in Table 1.

## MAPP/MAP

MAPP gas is a trademarked name belonging to Linde Group, earlier to Dow, for a fuel gas based on a stabilized mixture of methylacetylene (propyne) and propadiene. The name comes from the original chemical composition: methyl-acetylene-propagandise propane. . In the spring of 2008, true MAPP gas production ended in North America when production was discontinued at the only remaining plant making it.

Current products labelled "MAPP" or "MAP" are MAPP substitutes, MAP is used as a generic name for UN 1060 stabilized methyl-benzene. These versions are stabilized liquefied petroleum gas (LPG) with high levels of propylene.

MAPP gas was widely regarded as a safer and an easier-to-use substitute for acetylene. MAP gas is often used in combustion with air for brazing and soldering, where it has advantages over competing propane fuel because of its higher combustion temperature.

## Acetylene

Acetylene is mainly manufactured by the partial combustion of methane or as a side product in the ethylene stream from cracking of hydrocarbons. Combustion of acetylene with oxygen produces a flame of over 3300C, 6000F. For the professional, acetylene is probably the fuel of choice, however to the amateur the use of acetylene can pose some problems. The cost of renting or buying cylinders of acetylene and oxygen is quite expensive. Secondly, such equipment should be stored outside the home. The regulators for these tanks and associated hoses and torches are all expensive.

Unless you earn you living doing silver soldering and welding, there are probably other areas of the workshop where you could invest rather than getting started with this fuel system.

Note that the threads on acetylene and oxygen bottles are one left-hand, and one right-hand, so that the fuel and oxygen cannot be connected to the wrong regulator. The fuel tank has a left-hand thread, and this is common to Propane and Acetylene tanks. The left-hand thread is marked via a groove in the union nut that attaches the regulator to the tank.

## Using Oxygen with Fuel

The cheapest way to get additional heat is to use Oxygen with your preferred fuel. Oxygen can be provided in cylinders rented or purchased from an industrial gas supplier. An alternative is to use the disposable Oxygen canisters available from hardware stores and some industrial supply houses.


*Torch Lighter using a Flint in a Cup*

While conducting research for the article, I found that one can purchase a pair of very small, but rechargeable Oxygen and Acetylene cylinders in Canada, from a Linde welding supply store (Linde acquired BOC in 2006), and this included the initial charge. These cylinders are about 24" high, and about 5" diameter, and would serve the model engineer. Further, regulators, flashback arrestors, hoses, handle and a couple of brazing tips were less than expected and they have sales were these items are reduced in price for a time. They also have a complete set called Port-A-Pack, weighing less than 15 kg (32 lb) that provides safe cylinder and torch storage.

While disposable cannisters are a possible entry point for very small or occasional usage of oxygen based soldering and brazing, and added flexibility, the cost of disposable cylinders is less viable if you are doing a lot of work. A possible, economic, small space usage solution for the model engineer is available using rechargeable kit as described above. In Canada the break-even point is about eight pairs of the disposable cylinders.

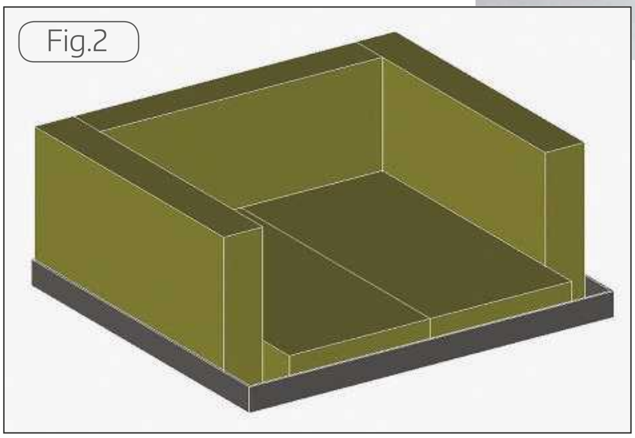
If you propose to use oxygen, you should plan to have the flame adjusted to produce a slightly reducing flame. This is a flame with an excess of fuel mixture over the oxygen, **photo 8**, this type of flame indicates excessive fuel gas. Because the gas mixture contains a slightly greater amount of fuel gas than oxygen it produces a reducing flame that both heats and cleans the metal surface for faster and better brazing. If the flame is producing soot, you have gone much too far with the addition of fuel.

**Photograph 9** shows an oxidising flame caused by using by too much oxygen, which is likely to burn the work.

11

*Alcohol Lamp as a source for Lighting a Small Torch*

Fig.2



## Other Tooling

There are several tools, items of equipment, and supplies required for silver soldering. These items are discussed in this section, along with typical costs for the major items.

## Lighting Torches

Some torches have a self ignition feature, where, when you start the gas, they also ignite the flame (see photo 2). The torch with the red button has three actions, it turns on the gas, lights the torch and twisting the button locks the torch on, so the button does not have to be pressed continuously.

A second option is to use a torch igniter, which is a flint in a cup, the device, shown in **photo 10** works very well, and costs only a few dollars.

Finally, you can light a safety candle or a spirit lamp, as shown in **photo 11**, and use it as a flame source.

The least successful method is to use matches, as the gas from many torches tends to blow the match out, and for lighting fuel with oxygen torches is considered very dangerous.

## Brazing Hearth

The simplest form is a fire-brick or two; however, there are many ideas that can make the work easier and safer.

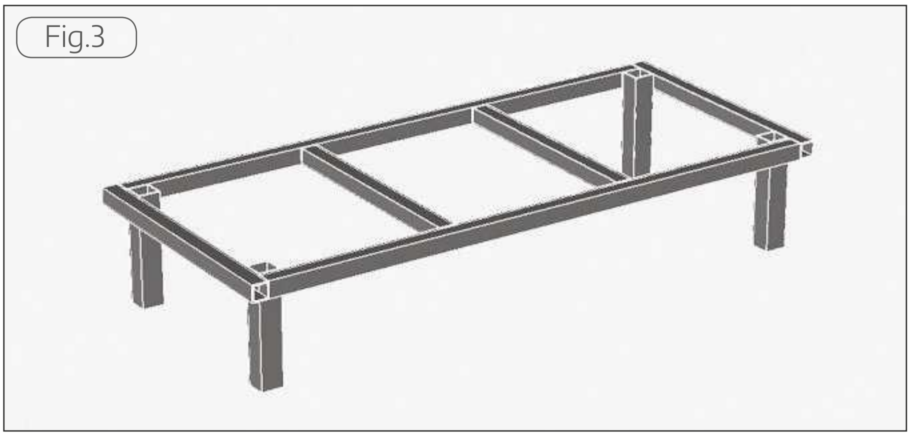
**Figure 2** shows a simple hearth consisting of five fire bricks arranged to provide a hearth and low walls resting on a non-combustible table, such as a metal cooking tray. This setup can be created in a matter of a few minutes and works well for smaller items. The hearth size is 9 by 9".

A simple hearth that is stand-alone or can be placed on a bench is more helpful. You need to be comfortable while working, if you have a lot of work to do, especially when setup of a joint takes much time.

A tubular hearth with short legs, which can be placed on the bench is a most useful general purpose hearth shown in **fig. 3** and **photo 12**. The frame and a picture of the completed hearth, with fire bricks, are shown.

**To be continued**

Fig.3



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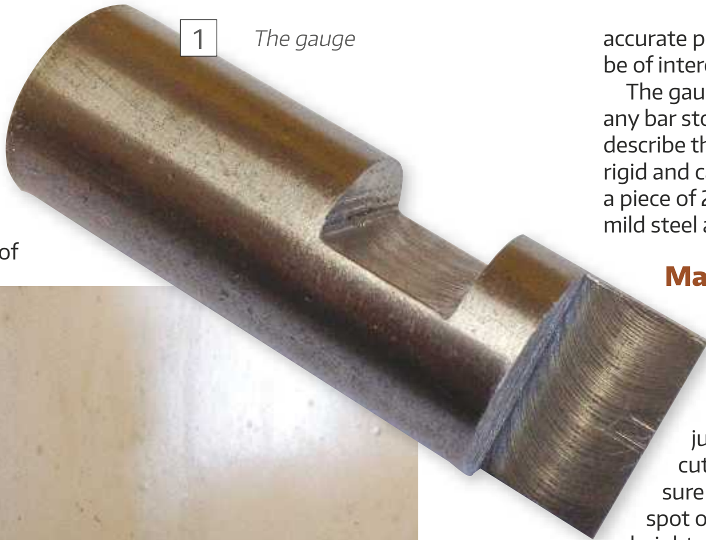
*Authors Transportable Brazing Hearth*

# A Tool Height Gauge

**Mike Turner makes a simple gauge for tool height setting.**

I have been looking for a simple way to make a simple gauge to adjust lathe cutting tools to centre height and in doing so making one which is universal to all lathes regardless of centre height without having to readjust each time or check that the gauge has not moved out of accurate position. I hope the following will be of interest to other readers.

The gauge, **photo 1**, can be made out of any bar stock around 20mm diameter. I will describe the sizes I used but they are not rigid and can be varied by the maker. Chuck a piece of 20mm diameter x 60mm long mild steel and face both ends.



1 *The gauge*

## Machining the flats

Place the bar in the chuck of a dividing head and using a milling machine with a 12mm cutter in it, mill half the diameter of the bar for a distance just short of the diameter of the cutter from the end of the bar. Make sure the remaining half diameter is spot on as this is what makes the tool height accurate.


2 *If well made, the gauge is as accurate as the 3-jaw chuck it is held in.*

3 *Setting the gauge with an engineer's square*


*Setting a tool to the gauge*


*Making a facing cut with a Diamond Tool Holder*

Move the cutter along the bar so that there is approximately a 6mm gap between the two flats then turn the bar through 90 degrees using the dividing head and mill a flat 6mm deep and after removing all machining rags that is the gauge completed, **photo 2**.

Place the gauge in the chuck with both flats protruding and using an engineers square offer the blade of the square up to the second flat with the first flat facing down and the stock of the square on the slide ways, **photo 3**.

This will position the first flat exactly horizontal and at centre height. I have found it works very well on the diamond tangential tool bit holder because all you have to do is slacken the hexagon clamp screw and slide the tool bit point up to the flat so it touches and retighten the screw, **photo 4**.

**Photograph 5** shows a bar being faced and no resulting pip, **photo 6**. ■


*Proof of the pudding – no pip!*

# One Man and his Lathe

## Andrew Johnstone and his Harrison M300

### Background
My engineering background is in electronics and signal processing. But I have always been interested in machining and metalwork, buying my first lathe while at school. That lathe was sold when I left home to go to university. After moving into a bungalow with a double garage some years ago, I was able to start assembling a workshop again.

### Harrison M300 Lathe
Before buying the basic machine tools, my thoughts turned to what to build. I chose a traction engine and reading comments on various forums 4" scale seemed to be a good compromise between practicality, in terms of driving, and the size of machinery required. I wanted something more complex than a single but not a showman's or double crank compound. I settled on the Burrell single crank compound. Having had a bad experience with a set of castings for a hit 'n' miss engine I wanted a casting supplier that I could visit. I selected John Rex at Miniature Steam. Although 120 miles away from me, in Pontefract, he is conveniently located a couple of miles off the A1, a route I travel regularly to go flying in the Cheviots in Northumberland.

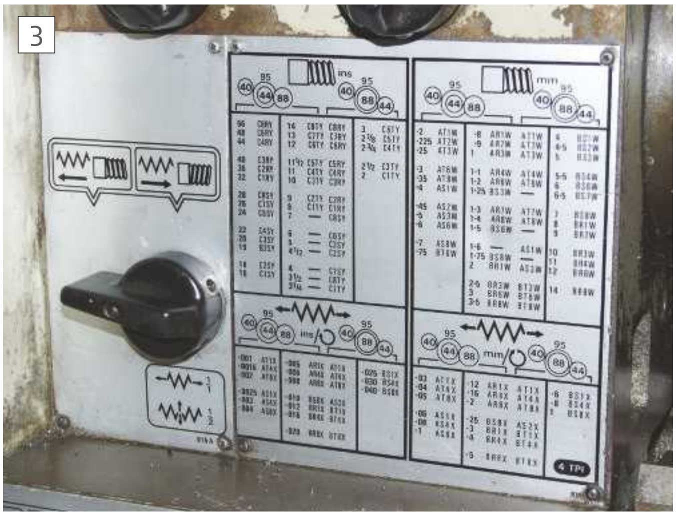

Harrison M300 Lathe

The choice of engine set parameters for the lathe. I needed to be able to turn the final drive gears at 14.8" outside diameter (OD) and the flywheel at 16" OD. I also needed to be able to turn the front and rear axles at about 30" long. The larger diameters could be in a gap, so I started looking at lathes around 6" centre height and 30-40" between centres. I didn't want to buy new so that limited me to secondhand, ideally British or US. I had no firm preference for imperial or metric, although imperial would be better as I was likely to be screwcutting mainly imperial threads. Looking on lathes.co.uk the Harrison M300 stood out. This is a popular lathe and regularly appears on the second-hand market. Accessories are also widely available. A version of the lathe is still in production, so spares are readily available, albeit expensive.

The older M300s came in several variants; metric or imperial, between centres of 25" or 40", and with or without a gapped bed. The centre height is actually 6½", or 330mm, so slightly bigger than the 300 designation would imply. My specification was ideally imperial, with 40" between centres and a gap piece both essential. In this configuration the lathe weighs about 685kg including manufacturers stand.


Headstock Controls

### Acquiring the Lathe
Having decided on the type of lathe I started looking on the secondhand market. Eventually a suitable M300 was advertised by G&M in Ashington, along with a choice of Bridgeport mills, which I had decided to make my basic milling capability. I looked at two M300s at G&M, one 25" between centres for comparison. Although the shorter bed lathe was better equipped with QC front and rear toolposts, and looked cleaner, bed wear was apparent. So I settled on the larger lathe. I insisted on seeing it powered so we could run the geared head at all speeds in case of any gross faults. Since I was buying both the imperial Harrison M300 and a metric Bridgeport some deal sweeteners were thrown in; a machine vice for the mill, free delivery to Cambridge, and best of all, a Burnerd EC collet chuck and a full set of collets. The lathe came with 3 and 4 jaw chucks, and a fixed steady. The lathe is shown in **photo 1**, a 6" rule is perched on the toolpost.



*Threading and Feed Plate*

*Toolpost Indexing Plate*

The lathe came with an integral stand containing all the electrical equipment (415V 3-phase), a coolant tank and pump and a handy storage shelf at the front. The storage shelf has a lift up door, but the key had long since been lost so I leave it open.

Some years ago, when I bought a new set of bed wipers for the saddle and tailstock from Harrison I checked with them when the lathe was manufactured - it was in 1980. The serial number is stamped on the front face of the bedways at the tailstock end.

## Controls

Having made the decision to install a 415V 3-phase supply at home, wiring the lathe in was straightforward. The lathe is permanently connected to the supply via a switch box. The white switch box can be partially seen in photo 1 top left by the chuck guard. The 3hp motor drives a countershaft via three V-belts and from there the headstock is geared. A total of 12 speeds cover 40 rpm to 2500rpm in roughly geometric progression. I rarely run in top speed, partly because of gear noise. Since the headstock is geared full power is available throughout the speed range, allowing heavy cuts to be made at low speeds on larger work pieces.

The headstock controls are shown in **photo 2**. The top two levers control the spindle speed according to the chart above them, consisting of three ranges selected by the lefthand lever and four speeds within each range selected by the righthand lever. The black lever mid way down on the left controls the direction of the leadscrew and feedshaft, effectively acting as the tumbler gears.

*Basic Accessories*

*Capstan Unit*

The lathe has a conventional gear train at the headstock end down to a gearbox where selections for feeds and screwcutting are made using the three black levers at the bottom and the silver rotary 8-way switch. The lefthand lever has three positions A, B and C, the middle lever has three positions R, S and T and the righthand lever has three positions W, X and Y. Details of the feeds, and threads, for the varying positions of the three levers and rotary knob are shown in **photo 3**. Feedrates vary from 0.001" to 0.040" per rev. To get the higher feeds gears have to be swapped in the gear train, as shown on the chart, changing the ratio by 4 to 1. Feeds in the intermediate ranges can use either setup. The metric feeds are identical to the imperial, simply listed as the nearest conversion. Feedrates always have the lefthand lever in A or B. For imperial screwcutting the lefthand lever is in C. Threads range from 56tpi to 2tpi. The only puzzle is the 2-7/8 tpi thread, which equates to 4¼" and 4½" BSW. This isn't listed on the thread dial indicator, so it's not clear how you would cut it. Presumably the half-nuts would need to be left engaged as for cutting metric threads.

Metric threads use the left lever in A or B but the right lever is always in W. As befits cutting metric threads on an imperial lathe the half-nuts are normally left engaged throughout the cutting process. The range of metric pitches is 0.2mm to 14mm, covering all the common pitches. As far as I can see from the exploded assembly drawings the metric conversion uses the ratio 33/26, which is 1.26923 instead of the exact 1.27, about a 0.06% error.

Although not on the plate, but shown in the manual, substitution of a 56-tooth gear


*Hydraulic Copy Unit*


*Flywheel*

in the gear train allows a range of diametric pitch and module threads to be cut, plus some extra imperial threads. Again looking at the gearbox exploded diagram it seems that the ratio 22/28 = 0.785714 is used as an approximation for $\pi/4$, an error of 0.04%. Although I haven't needed to cut diametric or module pitches yet, I have acquired the 56-tooth gear on eBay at a reasonable price, just in case.

Saddle controls are standard, the saddle traverse could be specified as left or right, although left seems to be most common. Since I'm left handed it falls conveniently for me. The only disadvantage can be a stream of hot swarf. One just has to put up with it, as wearing gloves around rotating machinery is not safe. The traverse handle can also be disengaged when power feed is engaged, but I don't use this facility. Under the cross-slide handle is a sliding knob, in for traversing and out for facing. Facing feedrates are half those listed in the chart. The spring-loaded lever at the bottom engages and disengages the feed. It only requires a light touch to disengage irrespective of the cutting load. The lathe has separate leadscrew and drive shafts, the leadscrew only being used for screwcutting. Looking at photo 1 the half nut lever for screwcutting is on the right of the saddle and the lever with the red knob at the extreme right is for power, down for forward and up for reverse. The headstock has a D1-4 fitting, so running in reverse is not an issue.

The saddle has a lock using a bolt on the right-hand side. Both the cross slide and top slide can be locked via socket head grubscrews. All the locks are very effective. To avoid having to search for tools I keep a small adjustable spanner and a set of metric Allen keys next to the lathe.

The toolpost is a conventional four-way. It has one useful feature; underneath is a serrated disc so the toolpost can be readily set at angles in 7½° steps, **photo 4**. This makes it easy to machine a non-critical chamfer and then go back to parallel turning without losing position on the cross slide dial.

The tailstock is conventional; conveniently it has a dial on the handwheel and a metric and imperial scale engraved on the barrel. I would admit to getting confused by the imperial barrel scale. It is marked in eighths, but I keep reading it as tenths of an inch. The tailstock barrel is MT3, while the main spindle is MT5. A short MT5 to MT3 sleeve was supplied as standard, and was included in my purchase.

## Accessories

In addition to 3 jaw, 4 jaw and collet chucks in common with most lathes the Harrison M300 has standard accessories available such as faceplates and fixed and travelling steadies, **photo 5**. The rule on the larger faceplate is 12". The advantage of the smaller faceplate is that the gap piece does not need to be removed. However, the limited number and length of slots make it less useful than might be supposed. Although not clear the larger faceplate has a speed limitation of 1050rpm and the smaller of 1200rpm. I've never run either at more than 540 rpm.

The fixed steady came with the lathe, the travelling steady was picked up from a trader at a Model Engineer exhibition. The 18" faceplate was bought from a commercial dealer and the 12" faceplate was bought on Ebay. Other items are available that I do not have such as rear toolposts, taper turning and multistop bed stops. Of these the one I would like would be the multistop bed stop. They do appear infrequently on Ebay but so far have gone for silly money, so I'll probably end up making one.

Removing and replacing the gap piece is, in theory, fairly simple; it located by a taper pin and held by three bolts into the bed and a small setscrew pushing against the headstock. It took me a long time to work out the correct procedure for replacing the gap piece. Early on when using the lathe I was concerned that the lathe didn't seem to turn parallel near the headstock. I spent a lot of time with precision levels on the saddle and adjusting the jacking bolts on the cabinet but to no avail. What really threw me was that the lathe turned taper at the headstock end (about 5 thou in 3 inches), but seemed to bore parallel to a much greater accuracy.

It was only after I'd turned the journals on my traction engine front axle, out near the tailstock, and measured them as parallel to within a couple of tenths that the light began to dawn. Further tests showed that the taper only occurred when the saddle reached the removable gap piece. Removing and refitting the gap piece while being scrupulously careful about cleanliness and stoning any potential burrs solved the problem.

As befits an industrial lathe there were accessories available, from third party


*Final Drive Gear*

10

*Front Axle*

suppliers, that are not common on lathes intended for the hobbyist market. In photo 1, on the right of the saddle, is an Ainjest high speed threading unit, which replaces the thread dial indicator. This allows any imperial thread (on an imperial lathe) to be cut at high speed using a trip bar under the bed to automatically disconnect its own half nuts. It is possible to thread to within a few thou of an internal shoulder at several hundred rpm. This is a great time saver, as well as allowing higher surface speeds better suited to carbide threading inserts. The Ainjest high speed threading unit has been written up in more detail in a previous issue of MEW, ref. 1.

Also available were capstan units, in my case made by Akron Machine Tool of Milton Keynes and bought on Ebay, **photo 6**. Capstan tooling has been built up over the years, primarily from Ebay.

Another, less common, industrial accessory is the hydraulic copy unit, also bought on eBay, **photo 7**. This allows repetitive machining of parts using hydraulic pressure to drive a tool, with the tool position controlled by following either a master part or a flat sheet metal pattern. The fitting and use of this accessory has also been previously written up in MEW, ref. 2.

While many of the accessories are third party, fitting them to the lathe is greatly simplified by features built into the lathe from manufacture. For instance the bed already has holes for mounting the trip bar for the Ainjest unit and the saddle is predrilled and tapped to accept the unit itself. The rear of the bed has a machined face with tapped holes to accept the dovetailed bar that holds the supports for the template or pattern that the hydraulic copy unit uses as the master. Clearly there were arrangements made between the lathe and accessory manufacturers.

## Using the Lathe

Generally, all the controls fall conveniently to hand. The power lever on the saddle is particularly useful. The exception is the coolant pump switch, which is on the end of the cabinet at the headstock end. However, coolant is only used with HSS drills and for parting off, except in cast iron and brass, so it is not an issue for me.

11

*Small Items*

The lathe has an emergency off button on the left hand side of the headstock, just visible in photo 1, and a stamp bar cum brake bar along the front under the cabinet cupboard.

Obviously the lathe is capable of all the normal machining functions one would expect. So I will show some parts that push the lathe towards its limits. Two examples of large diameter turning are the traction engine flywheel at 16" OD, **photo 8**, and final drive gears at 14.8" OD, **photo 9**. In both cases note the steel spigots bolted to the faceplate. These spigots provide the drive to the castings and help to locate it radially. That leaves the clamps to simply hold the casting to the faceplate rather than provide the friction to drive the part as well. Longer items can be machined either with tailstock support, **photo 10**, or using the fixed steady.

Despite the size of the lathe, small parts can be machined, for example M4 nuts and brass oilers, **photo 11**. The oilers have a 5/16" x 32tpi ME thread, screwcut using the Ainjest unit, and have a 1/32" thru hole.

An example of using the hydraulic copy unit is shown in **photo 12**, machining the end of a ball on a valve rod coupler. The sheet metal pattern can be seen bottom right.

## Conclusion

I have been very happy with the Harrison M300, and do not regret buying it. It has done all that I have asked, and has also survived without complaint, or damage, some embarrassing operator errors. As a result of it's longevity and popularity accessories are widely available, and I have added considerably to the basic lathe over the years. It has proved easy to use with quick speed changes and simple changes of feedrates or conversion to screwcutting. So far, I haven't needed to screwcut a thread that isn't in the chart.

The key question is would I buy the same again? Without hesitation the answer is yes. ■


Ref 1: Fitting, Repairing and Using an Ainjest High-speed Threading Unit - MEW No.225 February 2015

Ref 2: Fitting and Using a Hydraulic Copying Unit - MEW No.167 September 2010


12

*Machining a Ball*




20

# An Emergency Repair

## After a nasty lathe crash Howard Lewis had to put a few things right.

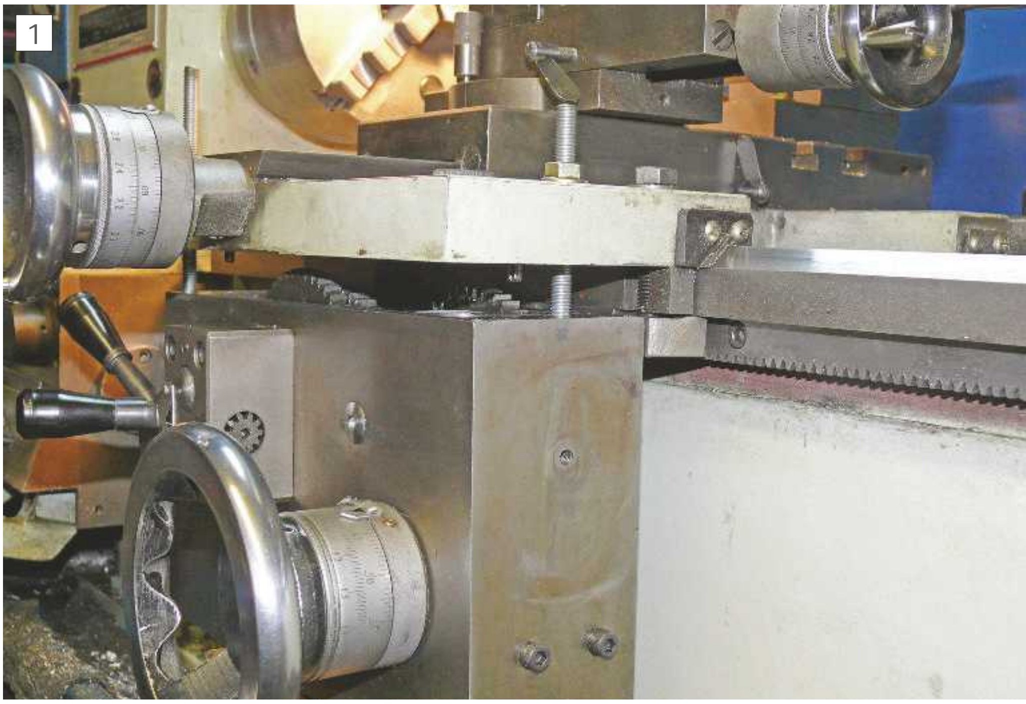
Whilst turning down an MT3 blank arbor, foolishly, I paid more attention to the cutting tool than to the position of the saddle. Everything came to an abrupt halt, when the saddle collided with the headstock. Despite disengaging all the power feed levers, the saddle was almost immovable. Obviously, I had a major problem.

Looking behind the apron, it was clear that the pinion that engaged the rack was badly bent. What follows is what damage had been done, and the actions involved in recovering from this disaster.

Having to strip down something of which I had no knowledge was very daunting. Help came from a poster on the model engineer forum, called Geoff, who, it turned out lived in the next county. Very kindly, he sent me detailed instructions on how to remove the apron and investigate the damage. My lathe is an Engineers Toolroom BL12/24, which is a cousin to the Warco BH600 and the Chester Craftsman, so some of what follows may be applicable to those machines.

When I contacted one of the importers, it became clear that my misfortune was by no means an isolated case and spares were available from stock.

However, having concerns over the strength of the material originally used in my machine, I considered making parts to effect a repair. This would certainly involve purchasing a gear cutter and when the damaged parts had been examined, it was decided to use silver steel for the shaft. I felt that a replacement could be made which would be a little stronger, and at about half the cost, excluding my time. I also decided to modify the rack, to try to prevent any further recurrences.



1

Loosening the apron

2

Damage to the rack

## Strip down

These follow, generally, the instructions sent by Geoff, but list my actions, in perhaps more detail.

If it needs saying, put the parts removed in a safe place, so that they do not become lost or damaged pending reassembly.

1) Slacken the small grubscrew holding the cover over the thrust bearings on the leadscrew, and slide back along the leadscrew.
2) Remove the thread indicator dial, and its capscrew.
3) Remove the two long m8 capscrews that retain the bearing block at the tailstock end of the bed. This is located to the bed by two rollpins, so must be carefully levered away from the bed. Gentle levering behind the leadscrew and feedshaft may be effective. If you cause any bruising, do not forget to remove it before reassembly.
4) Drive out the 5mm rollpin through the leadscrew coupling, and remove the leadscrew. This may very well involve some "wriggling", as it is a tight fit in the output shaft from the Norton gearbox.
5) Drive out the 5mm rollpin from the feedshaft coupling, and remove the feedshaft. Again, some wriggling may be needed.
6) Remove two diagonally placed M8 capscrews from the top of the saddle.
7) Into the two vacant holes, screw a length of M8 studding , (because they were to hand I used a 4" (100mm) and a 6" (150mm) piece) onto these, place a flat washer and screw down a nut, to about 6 mm above the surface of the saddle.
8) Slacken the other two capscrews, and gently tap them with a mallet, to push the apron off the rollpins that locate it to the saddle. This will probably need reiteration of the slacken/tap procedure until the studs are carrying the apron, clear of the rollpins, **photo 1**.
9) Place one or more wood blocks beneath the apron and slacken the nuts on the studding, to lower the apron onto the wood.

10) When the apron is resting safely on the wood, so that it will not fall or tip, remove the two lengths of studding.

11) Carefully lift the apron away, (bear in mind that it is not light weight), and place on a clean bench, to inspect the damage. In my case, the pinion was very obviously bent.

12) Rotate the handwheel to bring the 5mm rollpin in the output gear to the vertical position, and drive it out with a parallel punch, or piece of 5mm rod. It will need to be recovered from the bottom of the apron.

13) Hopefully, it should now be possible to remove the shaft through the output gear. In my case it was not, without the use of a punch and mallet.

14) Ascertain the extent of the damage. In my case, not only was the pinion bent outside the apron, but the shaft was also bent. It soon became apparent that it was not possible to straighten either the pinion or the shaft, so replacement was the only option. At this point, having made attempts to straighten the shaft, the concerns over the material confirmed the decision to make replacement parts.

15) Inspect the rack; on mine the third tooth was badly damaged, and the fourth bruised, **photo 2**

## Making the Parts

It has been said that the Centre lathe is the only machine tool capable of reproducing itself, and this was the case here. The lathe was used for all the turning work involved in the repair; positioning the saddle by hand and, perforce, using hand feed for the top slide and cross slide.

The shaft was measured and found to be 15.98mm diameter, so a length of 16mm diameter silver steel was purchased. The teeth on pinion were counted, and remains of the pinion measured, in an attempt to determine what type of gear it was. Ivan Law's book (gears and gear cutting) was an invaluable help, in making the calculations to identify the gear. Since other gears on the lathe were known to be 1.25 mod, initial thoughts were this would be the same, but it soon became clear that the gear was, in fact 1.5 mod. Consequently, a 1.5 mod no.8 gear cutter was purchased. Fortunately, I had a 3mt arbor on which it could be mounted.

Having measured the pinion/shaft, it was decided to make the replacement gear with a tooth width of 19mm (¾ inch), and the silver steel was cut to a little over length, so that the finished part would be same length as the original.

The blank for the gear was turned up in the 3-jaw chuck, since at this stage, absolute concentricity was not vital. The outer end was turned down to 3/8 inch diameter for one inch. The outer diameter (OD) was left well oversize for the eventual gear od of 22.5mm, and parted off. The blank was then held on the 3/8 inch diameter to be faced to ¾ inch long.

Since the pinion and its shaft were located by the output gear contacting the inner face of the apron and by the shoulder on the shaft contacting the outer face, the position of the hole for the rollpin through the output gear was important.

3

*Measuring the position of the rollpin*

4

*Fitting the gear blank to the new shaft*

This was found by clamping the original shaft into a vee block, with the end of the shaft resting on parallels on the surface table, and placing a 5mm brass pin in the hole through the shaft. A finger clock, on the height gauge, was zeroed on the upper surface of the pin, and the reading noted. The height gauge was reset on the top of the parallels, so that the clock again read zero, and the new setting noted.

From the difference between these readings was subtracted half the diameter of the brass pin, to give the distance from the rollpin hole to the outer end of the shaft, **photo 3**.

The new shaft was held in the vice, centred under the spindle of the mill/drill, and a wiggler used to find the inner end of the new shaft. The table was then indexed to the dimension found, and a 5mm hole drilled, and deburred.

The normal 3 jaw chuck was replaced by a small 4-jaw chuck on an MT2 Myford thread/register arbor. With the aid of adaptor sleeves, this was mounted into the 5MT mandrel of the lathe.

The silver steel was centred in this, and the end faced before being centre drilled.

For purely cosmetic reasons, (to look like the original) the end of the shaft was then machined to a radius, which appeared to be 10mm.

Once this was done, the shaft was reversed, re-centred and faced off to length. (in my case 4 inches). Then it was centre drilled and opened up to 3/8 inch diameter, to a depth of just over an inch.

Without removing the shaft from the chuck, Loctite retainer was applied to the drilling, and the shank of the gear blank, before pressing the blank into the drilling in the shaft.

It was ensured that the blank stayed fully engaged, by maintaining pressure to ensure that no air remained trapped that would move the blank outwards once pressure was removed, **photo 4**.

Left overnight for the Loctite to cure, the gear blank was turned to 22.5 mm diameter, and centre drilled. Then the 4-jaw chuck on the 2mt arbor was moved to the rotary table on the mill/drill, and the tailstock employed to provide support to the gear blank.

Having moved the cutter to the centreline of the shaft, the table was moved forward until the cutter just cut a cigarette paper held to the blank with oil.

The table stops were set to allow minimum overtravel beyond each end of the blank. The rotary table was set to zero, and locked, and the fingers on the dividing plate set to the figure quoted on the chart for the plate in use, to give 13 divisions.


5

*Making one of several 13 tooth gears!*

With the cutter rotating at minimum speed the table was gently advanced the 3.4mm (0.127") depth of cut (d + f) for a 1.5 mod gear. This brought the cutter into slight contact with the ¾" (19.05mm) diameter barrel of the tailstock. The y travel of the table was locked, and a slow feed of the table away from the tailstock on the x axis began. Having reached the other stop, cutter rotation was stopped, and the table rewound, and the tailstock barrel withdrawn slightly. The rotary table was then unlocked and rotated according to the chart for the table, before being relocked, and tailstock barrel reengaged. Subsequent cuts were taken, until thirteen teeth had been made, **photo 5**.

But, the last tooth was visibly thicker than the others! So everything had to be stripped down, and returned to the lathe to drill out the scrap gear. Fortunately, the remains of the shank of the blank came out as the 3/8" drill was withdrawn. A drill was used, manually, to clear the remains of the Loctite. Another gear blank was made up and the processes repeated. Thinking that I had miscounted the holes (30 on a 39 hole plate) for the finger setting this was checked and reset. The second gear cut showed the same thick final tooth as had the first!

It must be that I had miscounted one of the six turns? So all this was repeated. Again, the final tooth was thicker than the rest.

This shook my confidence in the chart. A holiday from machining was taken for a day or more, to make up an excel spreadsheet to calculate the turns and holes for each ring of holes on each of the division plates.

This suggested that there were eight erroneous or missing settings in the chart, including the one for 13 divisions, which should have been 6 turns and 36 holes, not 6 turns and 30 holes, on a 39-hole plate (a corrected chart produced by Howard for his HV6 rotary table is downloadable at www.model-engineer.co.uk/HV6 - Ed.)

Having made yet another gear blank and Loctited it into the shaft, a gear was cut using the spreadsheet settings, resulting in a gear with equally spaced teeth.

The new shaft and gear were trial fitted into the apron, using a 5mm drill to locate the output gear on the shaft. With the output gear held against the inner faceoff the apron, the gap between the outer face of the apron and the inner face of the gear was measured. (checking the original gear/shaft indicated that this would be of the order of 21mm, as was found to be the case). A piece of 7/8 inch diameter brass was drilled and then fine bored, until the 16mm silver steel was a close fit. It was then parted off and reversed on the 3 jaw chuck, and faced off to provide a few thou endfloat for the new shaft in the apron. I felt that the closely fitting spacer will also enhance resistance to bending.

A comparison of the new shaft/gear, and the spacer, with the original shaft, after my futile attempts to straighten it is shown in **photo 6**. The apron, with the new shaft/gear and spacer fitted, ready for refitting is shown in **photo 7**.

## The rack

This was already known to be damaged, (as shown in photo 1) so it was removed. This entailed removing the two pads from beneath the saddle, and the saddle locking bolt and pad. The two pads were marked, so that they would be replaced in their original position. The three capscrews, securing the rack were removed, and starting at the damaged headstock end, it was gently levered off the three locating rollpins.

Once off, examination showed that the first two teeth had never engaged with the pinion, and the next two were damaged. Since the intention was to remove teeth, to prevent saddle to headstock contact, the first four teeth were removed. The mill/drill was still set up for gear cutting, so an angle grinder removed the bulk of these teeth, followed by filing to below the bottom of the teeth.

## Incidentals

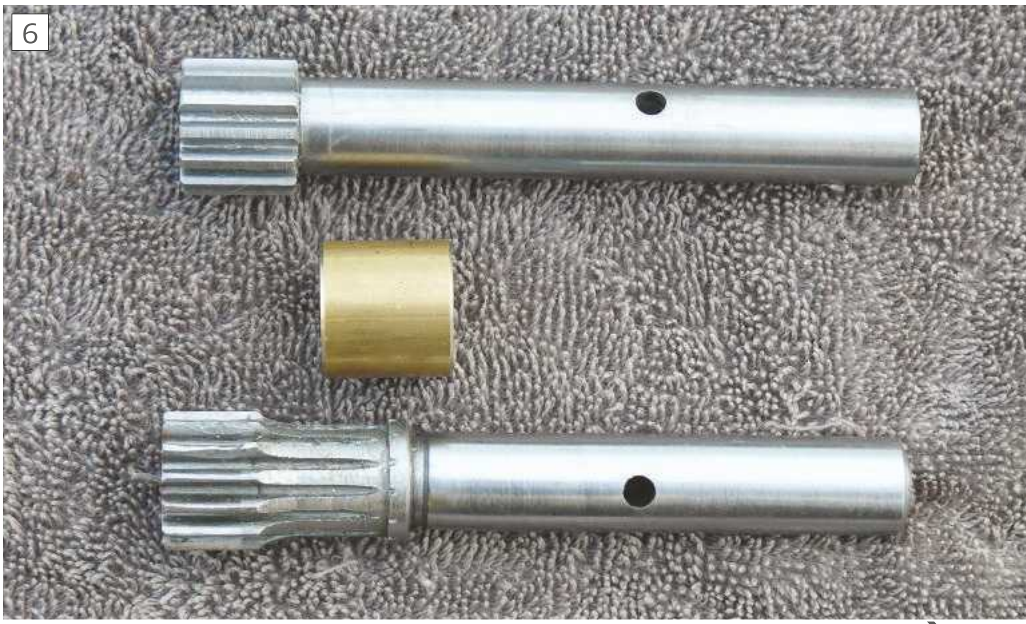
The upper gears in the apron appeared to be barely oiled, as the maximum oil level in the apron is limited by the hole through which the gear on the handwheel shaft passes during assembly.

A nylon plug was turned up, and tapped into this with a light hammer. Adding more oil to the apron, after the new shaft/gear had been fitted, showed that rotating the handwheel now brought oil up onto the gears which carry the power to the gears for either longitudinal or transverse feed.

I also noted, whilst rotating the worm to bring the key to the bottom, ready for reassembly, that the four capscrews for the worm housing were loose, so they were tightened. This later proved to be an error.

## Reassembly

After cleaning, the rack was refitted, and


6

*New gear and shaft (top) compare with the bent original* the pads, under the saddle, replaced in their original positions. The apron was refitted, but although the leadscrew went in without problems, it was clear that the feedshaft was badly out of line. The capscrews had been tightened with the worm housing out of place. I should have thought of that, at the time, in view of the movement possible.

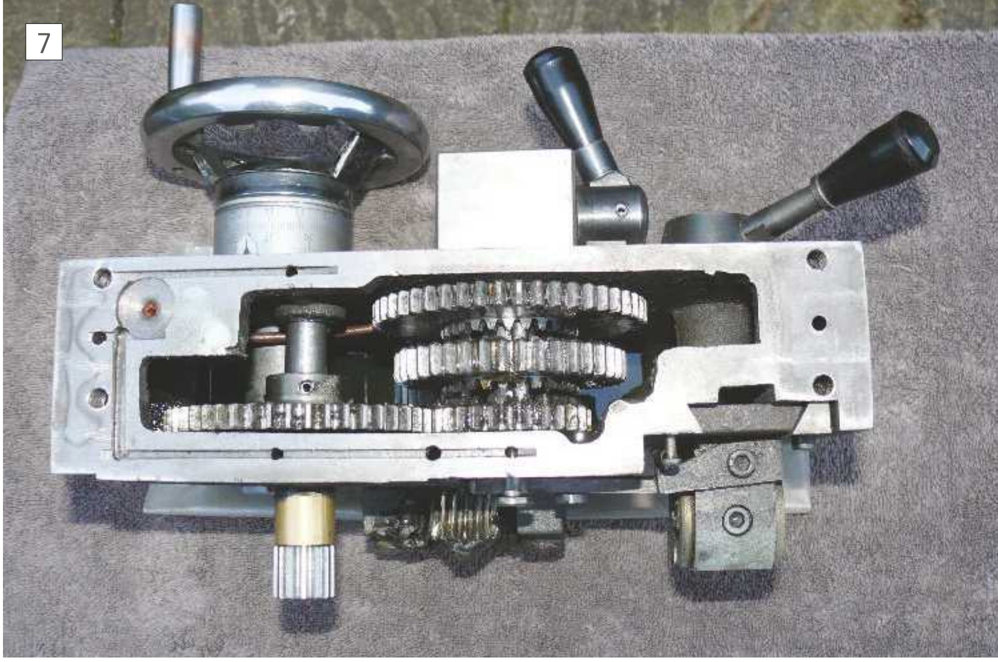
This necessitated removing the apron again, to gain access to the capscrews securing the worm housing.

Once these had been slackened slightly, the apron was refitted, using the M8 studding and nuts to pull the apron back onto the rollpins. The leadscrew was passed through the half nuts, not forgetting to replace the thrust bearing cover over it, before fitting the new brass shearpin. This time the feed shaft was replaced without problems, as was the tailstock end bearing block.

Both the rollpins for the feedshaft and leadscrew were replaced by 5mm brass pins, with a central 2.5mm drilling, to act as shearpins. The saddle lock was refitted and reassembly was almost complete.

To align the worm housing, the saddle was traversed to and fro along the bed a few times, ready for the capscrews to be tightened. The problem now was to access the four capscrews holding the worm housing, both to tighten the capscrews, and to see what I was doing!

The short arm of a normal 5mm allen key was too long to pass between the side of the lathe bed and the worm housing. A spare 5mm key was shortened by about 6 or 7mm. But the fingers holding the key prevented it being presented square on to the capscrews, so a 5.6mm hole was drilled into a short piece of 3/8 steel, and hammered onto the long arm of the key. This improved control, and enabled the key to be held without fingers fouling the lathe bed.



*Apron rebuilt and ready to replace.*

The job was still difficult because of the fact that vision was very limited, and before reassembly, the worm and wormwheel had been well lubricated with moly grease, which was not an aid to this particular activity. (Each time that I went into the house, I was told that my head was covered in grease; obviously from contact with the feedshaft). After nearly two rather trying hours, each capscrew had been turned, one flat at time, until as tight as reasonably possible.

The thread indicator dial was refitted, and the oilers in the bearing block given a shot of oil, until it could be seen oozing out of the side of the bearing. The saddle was now traversed up and down the bed by hand; it felt better than the original, being a little tighter, smoother, and had less backlash. The rack, despite being located by three rollpins is not completely level, as the movement is a little tighter at mid travel, but not excessively so.

With power feed applied, during longitudinal feed, the handwheel no longer displayed the slightly hesitant movement that had characterized it formerly. Whether this is due to a better pinion/rack fit, or a secure worm housing is not clear.

Removing the chuck, and traversing the saddle by hand showed that the pinion disengaged from the rack about 6mm before contact with the headstock.

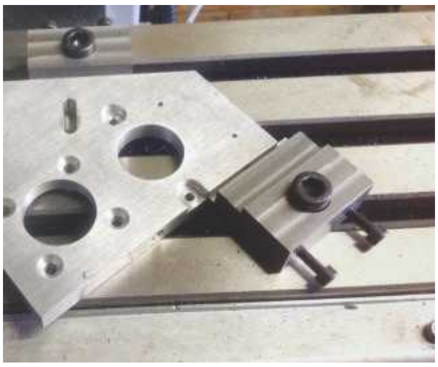
The main thing is that the damage has been repaired, is less likely to recur, and the machine feels better than before! Not to mention that I have learned to be a little more careful in future. ■

# In our Next Issue

**Coming up in issue 255**

On Sale 19th May 2017

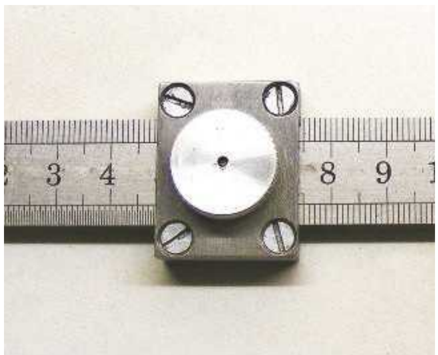
## In the next issue of Model Engineers' Workshop, number 255, there's more to help you get the most out of your hobby:



**John Hinkley** shows how to make some useful milling clamps.



**Richard Smith** returns with more details of his tooling system.



We go back to **Mike's Workshop** to discover handy marking gauge.

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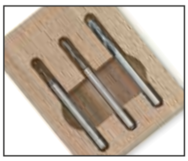

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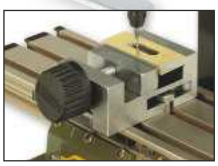

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# Useful Techniques for the Hobby Workshop

**Darren Conway demonstrates some model engineer's workshop nous by way of making a Poly-Vee Pulley - Part 2**

## Machining the Pulley

Long before I ordered the cast iron for the pulley, I designed the pulley using CAD. As part of the design process, I figured out the sequence of machining and the work holding. The pulley was designed to minimize the amount of metal to cut away. It was also designed to be easy to make and just fit within the limits of my lathe.

I began by facing and surfacing the cast iron pulley blank without adjusting the angle of the top slide. This provided two reference surfaces I used later for alignment for each setup. The first stage was to machine the tapered bore. With tight tolerances and plenty of opportunity to get it wrong, I wanted to minimize time invested if it turned into a failure. With the reference surfaces defined, I then set about making the tapered bore.

The top slide angle was accurately set so I could now drill then bore the cast iron blank for the pulley. The only remaining variable to set was the diameter of the bore. I did this using a telescoping gauge to transfer the measurement. Normally these are used to measure the diameter of a parallel bore. I set the gauge to a specific depth in the tapered bore of the prototype as shown in **photo 8**. The bore on the pulley was the right size when the taper gauge could be inserted to the same depth on the prototype and the pulley. So with both the angle and the diameter of the bore measurable, I was able to exactly duplicate the dimensions of the prototype. This ensured a precise fit between the shaft and the pulley. The bore was successfully completed and the prototype discarded.

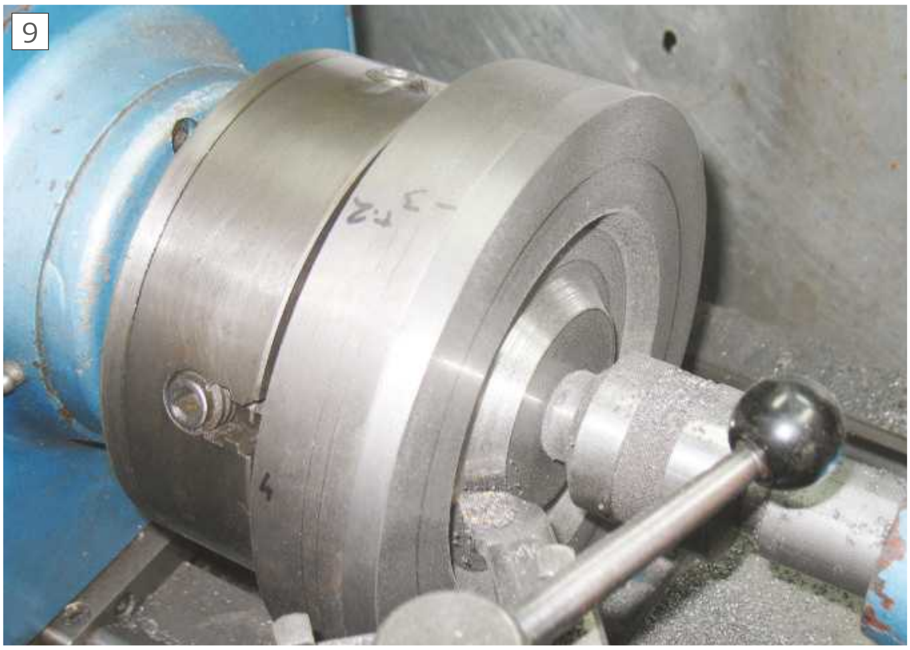
## Pulley Shape

The next stage was to cut recesses in each face of the pulley. This wasn't just to lighten the pulley or make it look better. What was to become the back recess was used for holding the pulley in the 4-jaw chuck. The jaws were expanded to press against the square shouldered recess cut into the pulley as seen in **photo 9**. The outward face (the one seen when fitted to the lathe) was cut with a bevel for purely aesthetic reasons. I used mostly carbide tooling to turn away the bulk of the cast iron. Carbide is hard but the cast iron wore out one insert. Cast iron is easy to machine but is very abrasive

8

*Using the Telescoping gauge to compare the prototype bore with the pulley bore diameter*

9

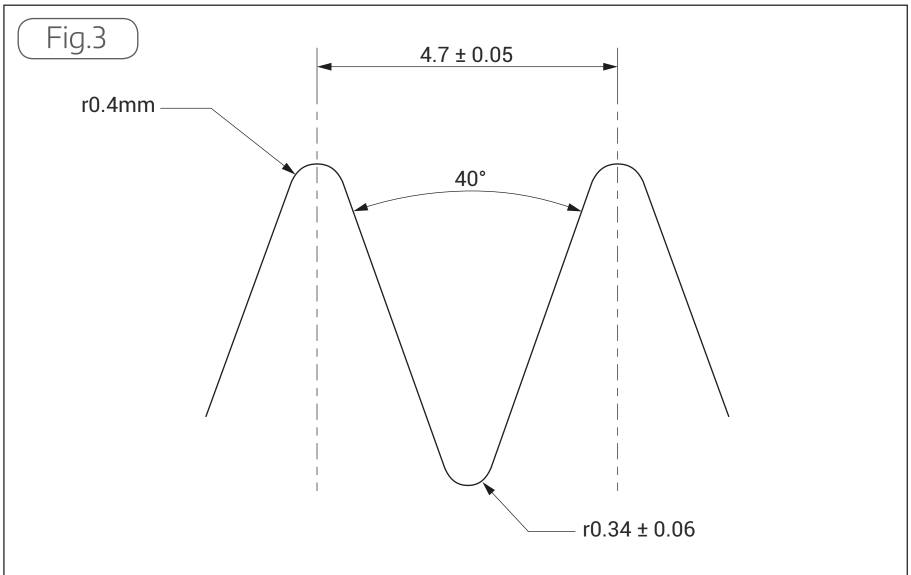


*The jaws of the 4-jaw chuck expand to clamp on a recess cut on the back of the pulley*

## Pulley Vees

The next stage was to cut the vees on the pulley circumference. This was not as simple


*Set up for cutting the vees on the pulley*




**Poly-Vee Pulley - L Type Groove Dimensions (mm) And Tolerances**

as it should have been due to the capacity limits on my lathe. At just over 175mm diameter, the pulley cleared the bed but not the carriage. In addition the tool holder only barely cleared the pulley. The vee form tool was ground so that the tool post was at a 20 degree angle. This allowed the tool to reach the full width of the pulley and provide some working space for the tool shown in **photo 10**.

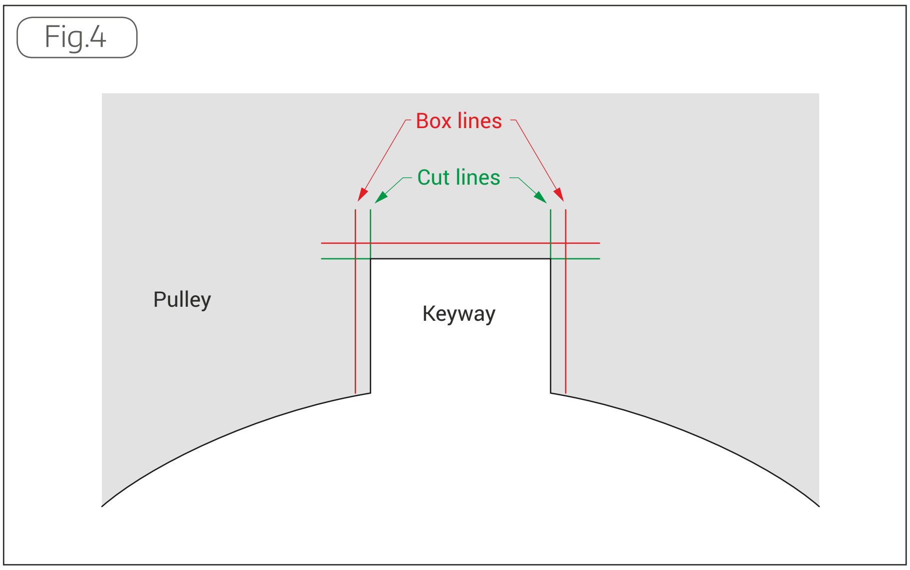
The specifications for pulley vees are surprisingly tight as shown in **fig. 3**. I spent a lot of time grinding the form tool and setting up to meet the specification. Once setup, the vees were machined with straight plunging vee cuts. A live centre was inserted into the pulley bore to provide added support and help prevent chatter.


*A cutting tool made from a bolt to round the tips of the pulley vees*

At near full depth, the tool did chatter. I modified the plunge cuts so only one side of the tool made a cut on each plunge. Some more trigonometry was applied to calculate the cuts effective depth.

The specification calls for a radius on the tip of each vee. I considered a range of options to achieve this. A form tool would provide consistent results but I didn't have the capability to grind a small concave radius on a HSS tool bit. Only a small amount of metal needed to be removed so I determined that old fashioned carbon steel would be sufficient to do the job. I don't have carbon steel tool bits and I doubt they are still available from anywhere. I looked around for a suitable alternative and decided that the metal of a high tensile socket head bolt would have the right properties.

I cut and filed a M6 bolt rather than grinding to avoid heat tempering the steel. The concave radius was formed with a miniature rat-tail file. The resulting tool shown in **photo 11** was as crude as it was effective. The tool easily cut the iron without any visible wear on the cutting edge. The pulley with all turning operations completed is shown in **photo 12**.




## Cutting a Key Slot

The Nardini lathe was factory fitted with a 7kW motor and electric brake so the driven pulley included a key to handle the power without slipping on the tapered shaft. I am only fitting a 4kW motor with VSD with electronic braking and the taper alone is probably sufficient to transmit the power without a key. I decided I would fit the new pulley with a keyway regardless. This would prevent any possibility of the pulley slipping on the shaft. I don't have a slotter, shaping machine or broaches for cutting the keyway in the pulley bore so I needed to use a different method.

Google revealed a number of slotting attachments made for a lathe. I chose to use the quill on my mill-drill to cut the keyway. Unlike other options, the mill is specifically designed to apply a strong plunging force with plenty of leverage. Conveniently, the mill includes a pin to lock


*The pulley finished turning and ready for the cutting of the keyway*


*The pulley rested on a Vee block while the keyway was marked*

the spindle rotation. Just what was needed to hold the tool in the right place. Making a tool for the mill offered the shortest route to successful completion of the job.

Before I cut any metal, I took a lot of time to accurately mark out the keyway on the pulley. I used a granite surface plate and Mitutoyo vernier height gauge to achieve accurate marking out seen in **photo 13**. Key tolerances are tight to avoid the key tilting in the slot so good marking out was important.

In addition to marking the boundaries of the slot, I also added lines 0.25mm lines parallel to box the marked cutting lines as illustrated in **Diagram 4**. When cutting to a marked line, it should virtually disappear and becomes unusable as a reference. The additional lines maintain clear reference lines. These provided confidence that the target dimension has been reached.

On completion of marking out the keyway, I then marked up a horizontal line for the centres of the two threaded holes used to pull the pulley off the shaft taper. Earlier while still mounted on the lathe, I had marked arcs on the pulley with the lathe tool. The combination of the scribed radial and arc lines accurately marked the centres of the M10 threaded holes. Such precision was applied to ensure the position of the holes didn't cause any imbalance.

I now needed to make a tool bit holder. I started with an 18mm diameter round bar that would fit both in my ER collet chuck and the pulley bore. The tool bit holder in **photo 14** looks a lot like other shop made boring bars I have produced. A round piece of HSS is fitted into a radially drilled hole in a steel bar. The bit is held in place by a single grub screw. The round bit has a flat ground along one side to ensure the bit is properly aligned and to prevent rotation. The tool bit was carefully ground so that the cutting edge was dead square. The tool bit was slightly narrower than the finished width of the keyway. The ER32 chuck had plenty of grip to prevent any slippage of the tool bit holder.

I spent a lot of time setting up the tool on the mill to ensure it was correctly aligned. The same rear recess used to hold the pulley on the lathe was used to hold the pulley on the 3-jaw chuck mounted on the mill. It took much more time to make the tool and setup than to actually cut the slot.

The tool was easy to use. I simply advanced the work towards the tool in small increments, and extended the quill each time to make a cut. At the end of each cutting stroke, I moved the mill table to separate the tool from the work on the upward stroke. This emulated the action of a clapper box on a shaping machine. The tool was narrower than the finish keyway so I simply cut the slot to width using several cutting cycles to reach the target width and depth. For finishing, I left the cutter in position and made about 10 strokes until the tool dragged evenly on the downward cut. The end result was an accurate keyway with a good finish.


*The keyway cutting tool in action*

## Lathe Cleanup

I don't machine cast iron very often, but after completing a project, I strip down the lathe and clean away all the iron dust. The dust is full of fine particles that include hard carbides. When mixed with oil, it makes a good grinding compound. The dust tends to cover everything in the vicinity. I removed the carriage and stripped it down to individual components, **photo 15**. Everything was cleaned and oiled before reassembly. It's not that big a job and is a good opportunity to complete maintenance. The apron on the Viceroy is double-walled with an oil reservoir. This catches chips and dirt falling from the feed shaft. I aim to clean the apron and change the oil about once per year.

## Balancing

The final task was to check the balance of the pulley. The various rotating parts of the Nardini lathe are fully balanced. I didn't want to add a heavy unbalanced pulley that would add vibration that wasn't there before. The density of iron can vary over a wide range but the continuously cast iron used to make the pulley should be homogeneous. Checking the balance confirmed this.

I don't have a balancer and I don't really need one so I took the shortest possible path to making one. I turned a simple arbor and then setup a couple of steel rules to act as a razor edge type balancer as shown in **photo 16**. This is not the way to make a precision balancer but it was sensitive enough to detect the imbalance due to the keyway cut in the bore of the pulley. I calculated the weight of the removed metal and used a couple nails to compensate for the cut away metal. The balancer confirmed that the pulley was balanced.

With balancing completed, the only thing left to do was paint the pulley red to match the factory colour scheme, and fit the pulley to the lathe seen in **photo 17**. That completed the mini-project. The next phase in the lathe conversion is modify or build a new motor mount for the new 4kW motor.

15

*On completion, the lathe was stripped down to clean away iron dust*

16

*A couple of rulers used to improvise a crude but effective balancer*

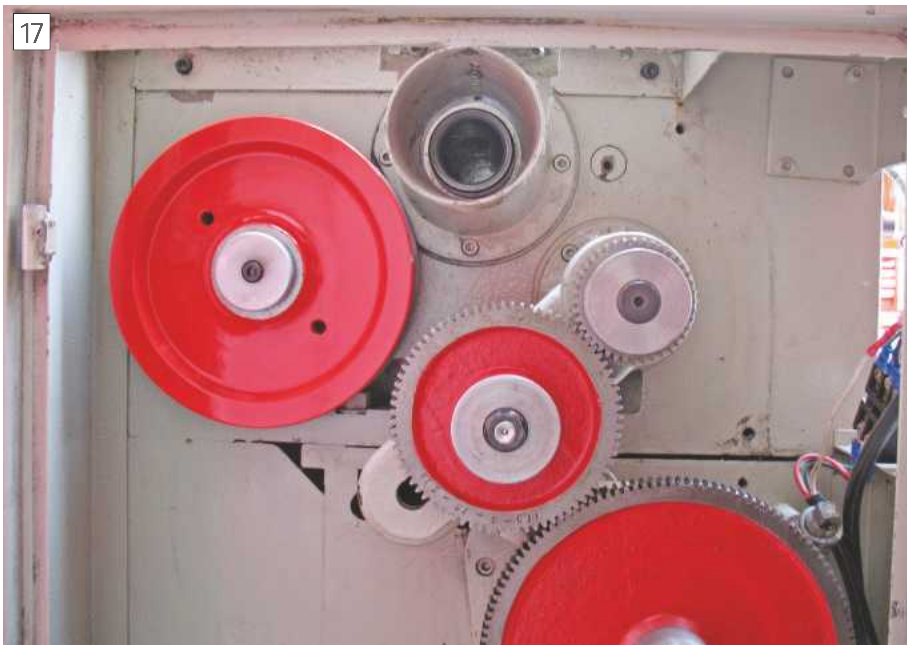
## Conclusion

The task of making and fitting a new pulley to accurately match an existing taper required the application of a collection of skills and methods including to:

- craft the design to make the pulley easier to manufacture,
- measure with reasonable accuracy an existing taper using calipers and trigonometry,
- measure and set the precise angle of the top slide using two diameters machined on the lathe,
- finely adjust the angle of the top slide by clamping on a bar and a piece of wood,
- apply binary division to efficiently home in to match an unknown taper,
- use of a prototype piece to set up the lathe to match a taper,
- measure the diameter of a tapered bore by comparison with the prototype and use of a telescopic gauge,
- apply box marks to guide the final cuts of the keyway,
- cut a keyway with a mill used as a slotter and,
- use a makeshift static blade balancer.

These techniques have application in the wider field of model engineering. They provide practical solutions using equipment commonly found in home work shops. ■

17



*The new pulley installed on the lathe*

On the

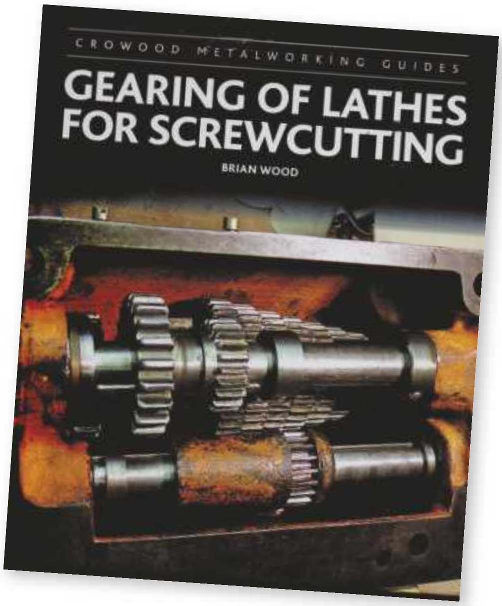
# Wire NEWS from the World of Hobby Engineering


## New Machine Mart Catalogue

It must be Spring! The Machine Mart catalogue is as reliable as the daffodils! This edition proudly announces over 500 new products and price cuts, and with a new store opening in Blackpool there are now sixty-six branches across England, Scotland and Wales. As well as the products featured in the catalogue are also over 14,000 extra products only available online from machinemart.co.uk.

If you don't receive a copy by post, you can request one from the Machine Mart website or pick one up from your local branch.

## Gearing of Lathes for Screwcutting




Members of the model-engineer.co.uk forum will be familiar with Brian Wood who has been collecting detailed data, and sharing useful advice, on the gearboxes, changewheels and leadscrews and other features of all the most popular hobby lathes for some time. Now retired engineer Brian's work has culminated in the publication of this new book in the Crowood Metalworking Guides series, Gearing of Lathes for Screwcutting.

Although this book is tackling a specialist subject in great detail it also has much of wider interest along the way. The introduction itself is a fascinating in-depth insight into the development of screwcutting lathes.

The main part of the book is a review of many different gearbox lathes, starting with Myford lathes (including those with Machin gearboxes), South Bend 'and its many clones' – including the Boxford, Smart and Brown, Raglan, Holbrook and Covmac. What could be dry tables of gearbox settings and changewheel tables are spiced up with many excellent and informative photographs, and some fascinating discussion. For example, did you know hat Smart and Brown's geared approximation for PI gave an error equivalent to just an inch in two miles!

This section is concluded with an exploration of choosing gears to approximate different pitches – and of what constitutes acceptable level of accuracy and the significance of errors. This is information invaluable for any lathe user.

The second, shorter, section looks at lathes without gearboxes, using as its example the imported Mini Lathe. Brian concludes with a discussion of future trends, notably digital control of screwcutting and machining centres.

I know that Brian has put huge effort not just into checking the theoretical ratios, but also into ensuring that the gear combinations and settings are actually physically possible -there's no point giving a gear combination that won't fit or uses an esoteric gear that isn't available!

If you have one of the lathes covered by this book, or just have a fascination with lathework and its history take a look at Gearing fo Lathes for Screwcutting. I suspect that as we move into an ever more digital world, this may turn out to be the definitive last word on a subject that has exercised the minds of engineers since Henry Maudsley perfected his screwcutting change-gear lathe in 1800.

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# Spark Erosion

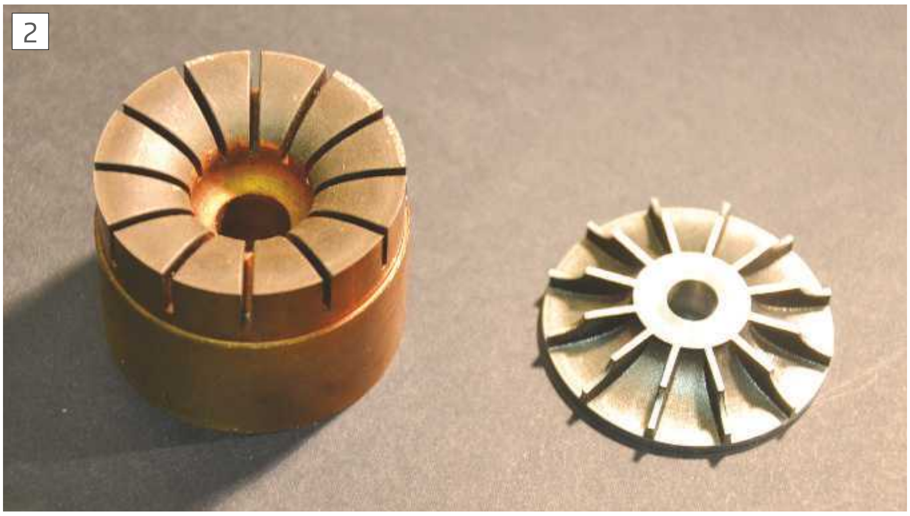
## Ben Tubbing, in Brussels, describes a home-built Electrical Discharge Machine and making gas-turbine components out of Inconel

Electrical Discharge Machining (EDM) - or Spark Erosion - has great potential for creating complicated shapes and for machining super-hard materials. However, it is not a common technique amongst model-engineers. The purchase of a commercial EDM machine is hardly ever an attractive proposition. At the same time, home-building one requires both mechanical and electronics development. The combination turns many hobbyists away.

I dedicate this article to my father. He is a radio-amateur and electronics enthusiast, and he exposed me to both mechanical engineering and electronics at a very young age. I was never able to choose between the two hobbies, and so EDM is an ideal playground.

This article describes first the home-building of an EDM machine, and secondly how it was used to manufacture some initial components of a miniature gas-turbine out of super-alloy Inconel 718.

The work-piece, an exit-vane section of a turbine wheel in Inconel 718



An Inconel turbine wheel made in 1996

The EDM machine

**Photograph 1** shows the most recent piece I made. These are the exit-vanes of a turbine for a miniature gas-turbine, made from Inconel 718. It looks simple enough. However, because of all the techniques involved, it is by far the most difficult object I ever made.

I will describe the project in a spirit of "showing what can be done at home". Beyond the EDM itself, I will need to deal with the manufacture of 3-D curved shapes through computer-programming and CNC milling. Obviously, nothing will be covered in depth. But I hope the article may provide an inspiration for some to try something different, and in that case I will be happy to go into more detail.

Everything I describe was done with my own equipment. My lathe is a Myford Super 7B, and my mill is a home-refurbished EMCO F1 CNC. For the electronics, I have an old 10Mhz oscilloscope and a few multi-meters, nothing unusual.

The project started around 1994, when I decided to try building a miniature gas-turbine with all the key components home-made. Here, the most challenging component is the turbine. For a gas-turbine to be efficient, the turbine needs to sustain maximum stress at maximum temperature. Therefore, it should be made of a super-alloy, for example Inconel 718. However, having bought a piece of it, I quickly discovered that I could not even get a hack-saw into it. I could just-about turn it, but definitely not mill it. Not wanting to be defeated by a piece of steel, the idea of building an EDM was born.

## The Principle of EDM

The principle of EDM is simple enough. From welding or plasma-cutting we all know that metal can be molten and (re-) moved by an electrical arc, basically because the arc produces heat. In the case of EDM, heat comes from a small electrical spark. It melts and ablates microscopically small droplets of the work-piece, each spark leaving a tiny crater. In EDM, we expose the work-piece to small sparks at a very high rate (1 to 100kHz), at semi-random locations, while it is immersed in a suitable liquid. Slowly but surely, the work-piece is eroded, while the ablated material is carried away by the liquid as a powder.

My machine is a so-called die-sinker. The sparks are created by applying electrical pulses across a narrow gap (of the order of microns / tens of microns) between the work-piece and an electrode, usually made of Copper or Carbon. The electrode has the precise "negative shape" of the work-piece one wants to make – quite like a casting-mould. During the process, the electrode slowly sinks down and the object is eroded to desired shape. When things are working well, the wear of the electrode is very much less than the erosion of the work-piece.

**Photograph 2** illustrates the concept. It shows the first meaningful piece I ever made, around 1996. It is the body of a turbine wheel. The Copper electrode was made by co-ordinate turning on the lathe, followed by slit-sawing. Soon after making this piece, the hobby went dormant for many years. I picked up the EDM again last year.

## More information about EDM

For a better description of the principles of EDM, I refer to the description in Wikipedia, ref. 1, for those unfamiliar, it may help understanding of the remainder of the article.

For those wanting to understand better the physics of the process, I refer to a brochure by the German company Oelheld, ref. 2. This is the company that

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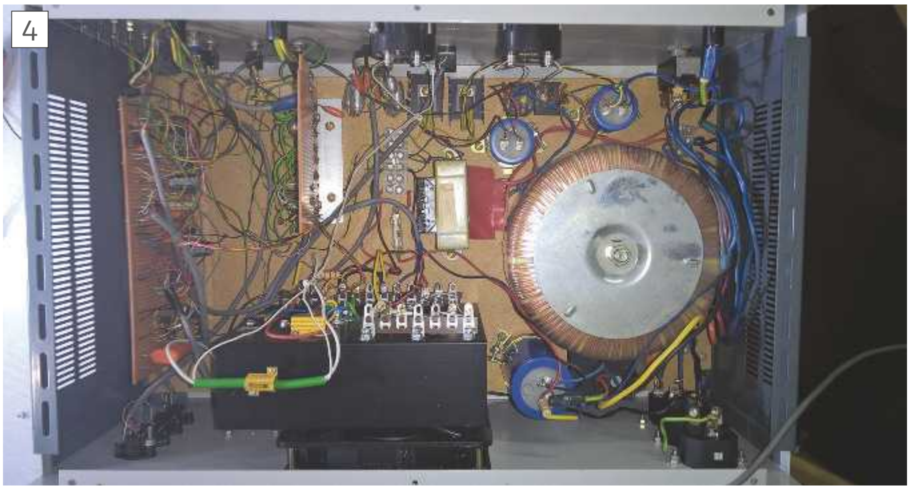

*The inside of the 140V, 3A pilot stage electronics box*

supplied the dielectric liquid that I use now. Various other liquids can be used (and I have some experience), but investing in a good dielectric makes sense: it made a big difference for me. Dedicated liquids not only optimise the EDM process itself, but very importantly also have better flammability and less toxicity and allergenic properties.

As I said, this article will not provide a prescription for building an EDM. My machine is the product of a lot of experimentation and trial and error. I am currently designing a second-generation machine, which will be much more efficient, provide a broader EDM parameter range, and have a light mechanical frame. On request, I will be happy to share the designs and exchange ideas.

There is an excellent book by US author Ben Fleming, describing the build of a robust and proven machine with straightforward electronics. Ben, like me, has been working on home EDM for many years. For those wishing to build a machine, Ben's book is by far the best place to start. In addition, he can provide circuit boards, ref. 3.

## The EDM machine – overview

**Photograph 3** shows my entire machine. It was built on the frame of an old milling machine. From the perspective of stiffness, this is entirely unnecessary because in EDM there are no machining forces. But for me it was convenient, as it saved me building a frame.

In the place of the mill-head is mounted the EDM head, consisting of a linear slide with stepper motor drive, end-switches and depth-gauge. The slide supports the Copper electrodes, which are held on an MC2 taper.

The EDM action takes place in the saucepan. There we have the dielectric liquid, in which the work-piece will be immersed. I included a rotary table in the set-up because it is useful to have some way of rotating and indexing the work-piece. Most pieces I make have symmetry and indexing helps to compensate for any non-symmetric electrode wear. Work-pieces are supported on an MC2 taper fitting into the MC2 bore of the rotary.

Underneath and to the side, there are two big electronics boxes and a small one. **Photograph 4** shows the inside of one of the boxes. It clearly shows that the electronics construction doesn't have to be very sophisticated – the wired boards are good for experimenting. However, one needs to be careful to avoid interference of the high-current switching with the lower-powered control electronics – which partly explains why multiple boxes.

In total, the electronics has the following functions:

1. Create short and high voltage / low

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*The EDM slide with stepper drive and electrode holder*

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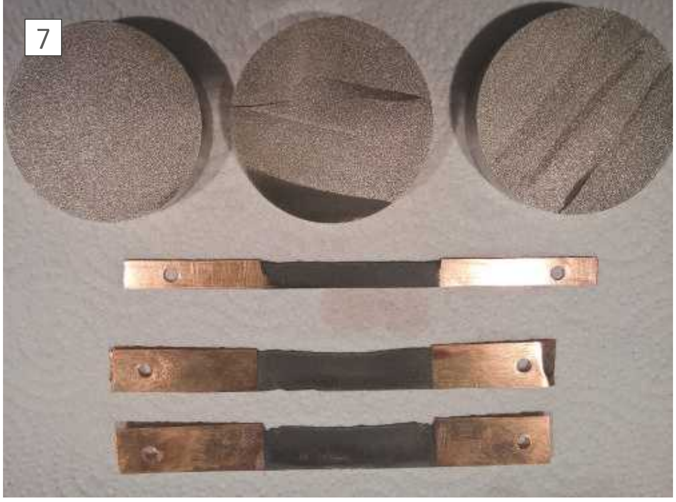
*The electrode for parting-off, on the machine, liquid partly drained*




*Three Inconel blanks, diameter 50mm, with electrodes*


*The electrode and blank, for reduction of diameter*

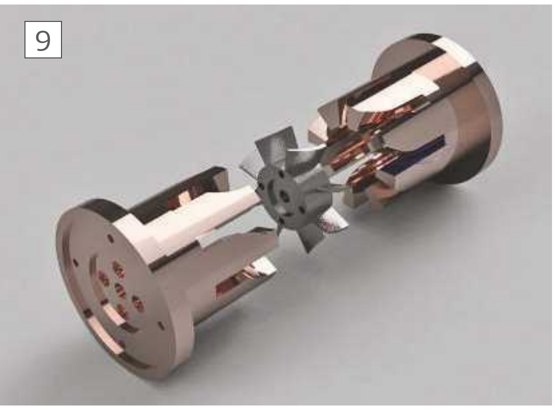
current (140V, up to 3A) pilot pulses that create the sparks by electrical breakdown of the liquid across the electrode / work-piece gap. Once the spark exists, the voltage across the gap drops to about 20V. The spark creation behaviour is quite equivalent to that of striking an arc in welding. The sustained voltage across the arc is in the 20V range.

2. Sustain the spark – now at 20V - with a low-voltage / high current (up to 10A) pulse. Pulse duration here is between some 10 milliseconds and 50 microseconds (but in my next generation I intend to bring pulse-times down to about 5 micro-seconds).

3. Fast-interrupt the power-supply when short-circuits arise. This happens either due to build-up of debris in the gap, or because work-piece and electrode touch.

4. Provide a dead-time between sparks. In my case the duty-cycle is 50% (but that is not optimum).

5. Control the size of the gap between work-piece and electrode. This is done by the stepper-motor on the slide. If the gap is too large, then there is no spark and the gap will be reduced. If it is too small or if the gap is clogged up with debris, there is a short-circuit and the gap will be increased.




*A CAD model of the EDM process, showing the work-piece and two electrodes*

The separation between pilot and sustaining pulses adds considerable complexity to the system, hence the two larger electronics boxes. However, it pays off because it allows optimising the two pulse supplies for their respective functions. One can buy high-voltage components with low current ratings and high-current components with low voltage ratings, which is much cheaper than buying components that can sustain both high currents and high voltages. In addition, it pays off greatly in overall power consumption. I would say that, in terms of complexity and component choice, the schematics of the pulse supplies are similar to those of audio amplifiers, but with some digital logic added.

Obviously, there are safety issues around the use of high voltages, so a project like this clearly requires a degree of knowledge about the precautions to be taken so be prepared to consult someone with relevant experience if you are at all unsure.

For the power-stages I used bipolar junction transistors (BJT's) throughout. Alternatively, one can use power Field Effect Transistors (MosFET's). FET's have many attractions in power-switching applications. On the other hand, I find that BJT-based output-stages offer advantages in handling the inevitable fast current transients that occur when the spark strikes, or when the gap is suddenly shorted.

The smaller electronics box - next to the machine - contains the new, recently built, gap-controller electronics. It is critical to the process to have a good and fast control of the gap. The electronics here uses measurements of gap-voltage and gap-current. If the voltage is around 20V, the motor doesn't move. If it is less than about 15V, the gap is too small, and the motor moves the electrode up. If it is more than about 50V, the gap is too large, and the motor moves the electrode down. The movements are very small; they can be of order a few micro-meters. And they are fast. I use the stepper motor with a commercial micro-step driver (Leadshine DM422) at its maximum current of 2.2A, and it is jigging back and forth as fast as the power rating allows. The speed of the gap control is a key factor in determining the overall process speed. In addition, this box handles the end-switches and the manual override of the spindle movement.

**Photograph 5** shows a close-up of the slide. I bought a linear ball-slide in order to have low-friction combined with a reasonable reach. You can see the small aluminum frame, which holds an MC3 – MC2 taper converter in insulating nylon bushes to isolate the electrode voltage from the frame. Any electrodes are mounted on an MC2 taper, which is then held in the converter. The slide is driven by a standard stepper motor and an M3x0.5 thread running in a nylon nut. I have no specific measures against backlash, basically gravity does the job.

Finally, on the right are the fluid filters that keep the dielectric clean. I use a dual oil-filter of a medium-size Diesel engine, and I use standard car petrol pump – by the way, of an MG-B.

## The EDM machine at work – parting off Inconel blanks

To make the vane-set of photo 1, an Inconel blank of diameter 30mm and length 9mm was needed. However, as I have mentioned before, there was no way I could either hack-saw, or part-off, from my 50mm diameter bar. Furthermore, turning from 50mm to 30mm would take a lot of time on the lathe. Therefore, both parting-off and diameter-reduction were done with the EDM.

For the parting-off, I devised a kind of guillotine arrangement, consisting of a steel frame holding a 0.5 mm or 0.3 mm Copper-strip as a knife-electrode. **Photograph 6** shows what it looks like on the EDM machine – prior to filling with dielectric.

**Photograph 7** shows the results, together with some electrodes. They show that, as I got the hang of the job, the quality of the cut improved and the electrodes stayed cleaner. In the end, electrode wear was just a few percent. In reality, this step took a lot of experimentation and frustration: the cut is deep so gap flushing is not evident and the gap used to clog up. Major progress was made only when I started using a professional dielectric liquid, in my case IonoPlus from company Oelheld (already referenced above).

Subsequently, the diameter reduction was carried out. As for every EDM operation, a specialized electrode was machined, in this case a cylindrical Copper electrode with a wall thickness of about 0.5mm. **Photograph 8** shows the set-up used, prior to making the cut.

It is interesting to appreciate that very little material was consumed in these two operations. In the parting-off process, the width of the cut is less than 0.6mm. In the diameter-reduction, the loss is similarly small, and the remaining Inconel ring can easily be used for other purposes – just as well given the cost of Inconel.

The Inconel blank was finished on the lathe. With an HSS or Carbide tool I can make cuts of about 0.1 mm; that gives a nice surface finish. A 7 mm central hole was drilled with a VHM 3-fluted drill. Then, on the EMCO, two positioning holes of 2mm diameter, 2.5mm deep were made on each side. In these holes, I insert a 2mm dowel-pin for indexing.

## Preparations for the manufacture of the vane-set

Having made the blank, we turn our attention to the preparations for the EDM-cutting of the vanes (of the object shown in photo 1), and more in particular to the manufacture of the Copper dies.

**Photograph 9** shows the concept of the manufacture. This Photograph comes from a drawing I published on the AutoDesk Fusion 360 Gallery, ref. 4 which also contains some additional photographs. Also, it is actively being developed and maintained.

The geometry of the exit-vanes is not simple. In order to have the correct flow of turbine exit gases, the blade angle varies with the radius – it is like a screw with a pitch that varies with diameter. To complicate matters, it is not enough to know the shape of the blade: to produce CNC machining instructions (G-Code files) for the EMCO, one must calculate the path of the centre of the ball-nosed mill. This is like a 3-D tool-offset, given by a vector perpendicular to the vane-surface and with a length of a mill-radius.

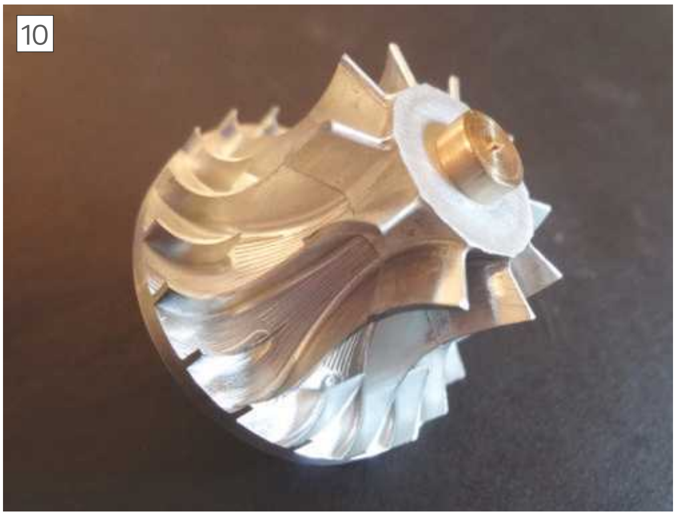
I spent some considerable time writing software in Microsoft Visual Studio Express C# to generate the G-Code files. This was a major investment of time, but I ended up with a rather general and powerful code-library that allows generating milling contours for almost arbitrary mathematical functions. Nice features of the software are that it can automatically avoid collisions with other surfaces. It also doesn't generate more contour-points than needed for the required accuracy, so it generates compact G-code files. I used a previous version of the software to mill the centrifugal compressor wheel in aluminium, shown in **photo 10**.

With complex shapes, it is obviously necessary to test the mill path prior to actual machining. Therefore, a small extension of the software was written to produce drawing-meshes. **Photograph 11** shows an example visualised with a free-software application for mesh-manipulation called MeshLab, ref. 6. You can see on the one hand the shapes of the die-surfaces to be machined. On the other hand, the "ribbon" shape which represents the milling contour. The width of the ribbon corresponds to the direction of the mill-axis. I typically used a mill inclination of 10°. The same drawing meshes can then be imported in drawing programmes to help create a model of the object: this is how the model of photo 9 was made.

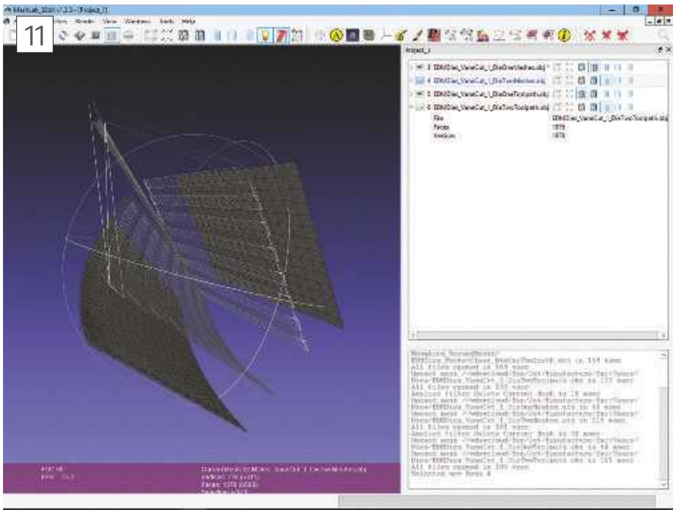
## Cutting the electrodes

Having finished the software, the next step was to define the precise milling operations for clearing the pockets and for final machining, and to produce the actual machining G-code files.

Turning the blanks for the Copper dies, out of 50mm copper, is perfectly straightforward. The dies are centred on a 7mm hole. A 2mm steel pin is inserted at a radius of 15mm to give a reference for




*An Aluminium compressor wheel made on the CNC mill*




*A visualisation of the electrode geometry, showing mill path of the mill*

As you can see, starting from the Inconel blank, the piece is made by two consecutive EDM operations, each with its own Copper die. After EDM'ing the front, the piece is turned upside-down and the rear is EDM'ed. Each die has eight surfaces matching the prospective blades, and eight straight surfaces. The two dies precisely inter-mesh, so that they remove all the material in between the blades. Assuming the EDM itself is now relatively straightforward, the main problem becomes: how to make the dies?

At this point, I need to point out the CNC capabilities I have available on the EMCO F1-CNC. I refurbished this machine a few years ago, with new stepper motors, micro-step drivers and all new electronics. I added a fourth axis by adding a stepper motor driven rotary table. I also added spray-mist cooling / lubrication.

The new motion-controller is an EdingCNC controller from Dutch company Eding CNC, PC-based CNC control, ref. 5. The user-interface is a standard Windows PC. The controller fully supports simultaneous 4-axes machining, and is genuinely perfect for this type of work.


*Machining of the electrodes*

precise angular location. The die-holders, both on the EMCO and on the EDM, have indexing slots.

**Photograph 12** shows the machining of the blade structure on one of the dies on the EMCO. Here, I use a 3mm ball-nose VHM mill, with spray mist lubrication. Chips are very fine, so I prefer to wrap the machine up in plastic bags.

In addition to the electrodes themselves, a couple of holders were produced to position the electrode and the work-piece. They all have slots to support indexing using the 2mm dowel-pins. The holders also allow alternating the electrode between the EDM machine and the EMCO, just in case the electrode would need touching up. **Photograph 13** shows the various bits together.

## Machining

At this point, all that remained was the actual EDM machining. **Photograph 14** shows the set-up, and **photo 15** shows what it looks like with the dielectric liquid.

The EDM process took a total of about 10 hours each side. As such, it would have been the least eventful of all steps, were it not for some alignment errors that needed correction during the process. During the EDM, the work-piece was rotated on its holder by 180° several times, to minimize any asymmetry. Electrode wear was very small, not more than a few percent. Material removal rate was in the range of 500 to 1000 cubic millimeters per hour.

Photograph 16 shows the final piece, posing in between its two electrodes. There are still some flaws, but the result is rather satisfactory for a first attempt.

## Where next?

The gas-turbine evidently is a very long-term project. As of today, I have made the necessary design calculations, and now the proofs of concept of the most important moving parts, i.e. the compressor and turbine wheels. However, other components remain even to be designed.

On the shorter-term, I am progressing on the design of a second generation of the EDM electronics. The new power supply will support regulation of pilot voltage (50 – 150V), spark current (1 – 10A), spark duration (1000 – 5 micro-seconds) and frequency (500Hz to 100KHz). It will be more energy-efficient than the current version, and thus use cheaper components. It will have several other nice features. The most annoying feature of the current machine is that I must install and align objects down in the sauce-pan; tricky. The future version will have a light and integrated mechanical structure, which can simply be lifted in and out of the liquid in its entirety.

For those contemplating to build an EDM: the mechanics is well within reach of any model-engineer. After all, all you need is a slide and a pump. The challenge lies in building the electronics. Here I repeat what I wrote in the beginning: Ben Fleming's book is the best starting point, either just to build or to develop upon; it doesn't get more accessible than that. At the same time, I will also be happy to share my new work, but it is going to be a bit more complex than Ben's.

For those interested in any aspect in this article: EDM, CNC, EMCO-refurbishing, C# coding for G-code, gas-turbine design: it was impossible to make a sensible choice about where to go into more detail and where not. Readers who are interested in any aspect are very welcome to make contact through Model Engineer Workshop

Readers, I hope this expedition to some of the fringes of the model engineers' hobby, has been of interest.

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*A collection of bits: electrodes and tool / work-piece holders*

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*The EDM set-up for vane-cutting, prior to filling with liquid*

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*The EDM in the middle of the job, immersed in the liquid*

## References


1. en.wikipedia.org/wiki/Electrical_discharge_machining
2. www.oelheld.com/fileadmin/content/pages/Prospekte_pdf/Prospekte_en/oh_Important_facts_about_spark_erosion_en.pdf
3. www.homebuiltedmmachines.com/
4. gallery.autodesk.com/fusion360/projects/copper-dies-for-spark-erosion-of-an-inconel-718-miniature-gas-turbine-vane-set.
5. www.edingcnc.com
6. http://meshlab.sourceforge.net ■


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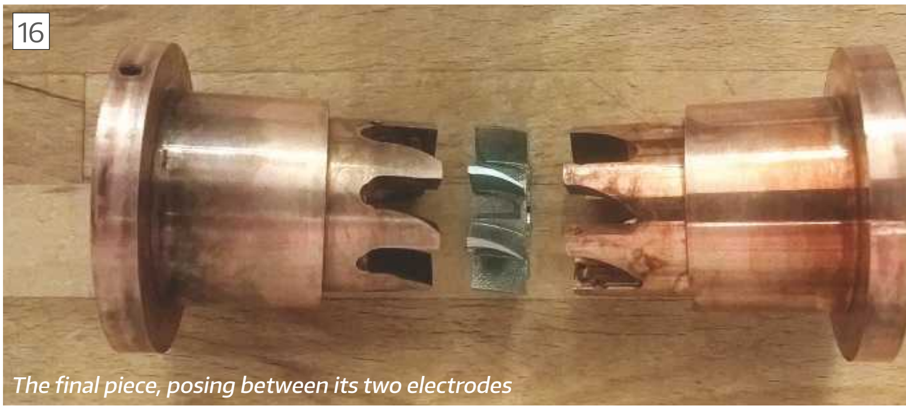


*The final piece, posing between its two electrodes*

# Workshop Diet

**Glenn Bunt discusses getting back those valuable inches!**


*The new layout.*

As with most model engineers my hobby and by that, I mean machine acquisition happened in stages. Initially I started off with a mini lathe, this would come in handy for making small repairs and replacement pieces on my clocks. Then I thought, why not engrave my own chapter rings and I purchased a Taig CNC mill. I then became more ambitious and purchased a Myford Super Seven lathe and the mini lathe was sold. Next, I purchased a Tom Senior Light Vertical milling machine and the Taig mill went. After purchasing a Startrite bandit 10 bandsaw and a CNC router my poor old garage was creaking at the seams!

The turning point came when I decided to upgrade and enlarge my CNC router/ engraver – there was just not enough room and head of the household said there was no way I would encroach further into the house!

In this article, I describe my workshop battle with room and some of the solutions I used to take back those valuable inches!

Formal negotiations started with the domestic management on plans for the way forward, the chancellor of the household exchequer reminded me that we were still in austerity and the bank account was in budget deficit. So extending the garage was out of the question!

## Front of the Garage.

I had a problem! Anything in the front area of the garage needed to be a less than bench height as the up and over garage door would do a fine job of decapitating equipment and people as it opened! It`s ferocity reminded me of Arkwright's till in Open All Hours!

Eventually after seeking domestic approval we opted to change the veteran garage door for a new electric insulated roller shutter door. Brilliant! now I could re-organise the space in the garage, **photo 1**. Winters in the workshop would be warmer due to the insulated properties of the door


*Old position of Milling machine*

Modified wall.

Lathe tray

and there should be a lot less draughts!

In my old layout, **photo 2**, my Tom Senior mill had to fit under the boiler which was purposely installed higher up the garage wall to allow to fit underneath it. The problem was every year it would have to be jacked up, placed on roller blocks and rolled out of the way ready for the boiler service and Gas Safe Check!

Now I could move my Myford Super Seven Lathe to the front of the garage. Not too close to the garage door as to stop access the leadscrew drive guard door and change wheels but close enough to easily access this area. Any long bars protruding out from the back of the headstock would be accessed with the garage door open.

Because I've fitted a DRO to my lathe, I have to leave enough room for the scale that protrudes from the back of the carriage. This means that lathe does protrude out from the wall a bit further. In my case, I had to modify part of a wall pillar to get full travel on the carriage, **photo 3**.

I made a tray out of aluminium, **photo 4**, which attaches to the wall and then slopes down to the Myford lathe tray. It has a lip to fit over the top. This allows any coolant or swarf to flow back into the lathe tray and reduces clean up time after machining. Ideally the tray would be made of stainless steel but I had aluminium available and it was easier to form. As a splash back, photo 5 , I purchased a stainless steel kitchen panel from IKEA (ref. 1) it wasn't expensive and again helps with cleaning up afterwards.

As a bonus, magnets can be attached to it to store lathe tools. I use a spring clip attached to a magnet to store my lathe backstop, **photo 6**.

Having a tray between the back wall and lathe serves another purpose – I can store items behind the lathe without getting them covered in coolant and swarf. I my case, I installed U-shaped wall brackets before moving the lathe into position. This has allowed me to store all my lathe bar stock safely behind the lathe, with a rack for different shape or material, **photo 7**.

You will notice that I painted the walls white before installing any of the equipment. This maximises the light in

Lathe splash back

Spring clip and magnet

Lathe bar stock

Tools mounted above lathe on improvised tool holders

The monitor mount.

Ipad mount

Rear of keyboard showing modified ipad mount.

the workshop by reflecting the light. It also makes the area look cleaner and more professional.

On the wall is mounted white melamine board for mounting lathe tools. I have two distributed on either side of the lathe. One behind the headstock and one at the tailstock end. One board holds my lathe tools. As they are all Dickson quick change tooling, I made brackets from aluminium angle so that the location slot on the tool holders slide onto the bracket and store on the wall, photo 8. This system makes it easy to change tools and store them out of the way. If you have another type of lathe or tooling system, it might be worth doing a search on the internet as there are a lot of good ideas out there for homemade tooling storage systems.

**Figure 1** shows the dimensions of the tool holder brackets for Myford Dickson quick change tooling

As my lathe has been modified to run in manual or CNC mode, it is necessary to have a Computer, keyboard, monitor and mouse to control it.

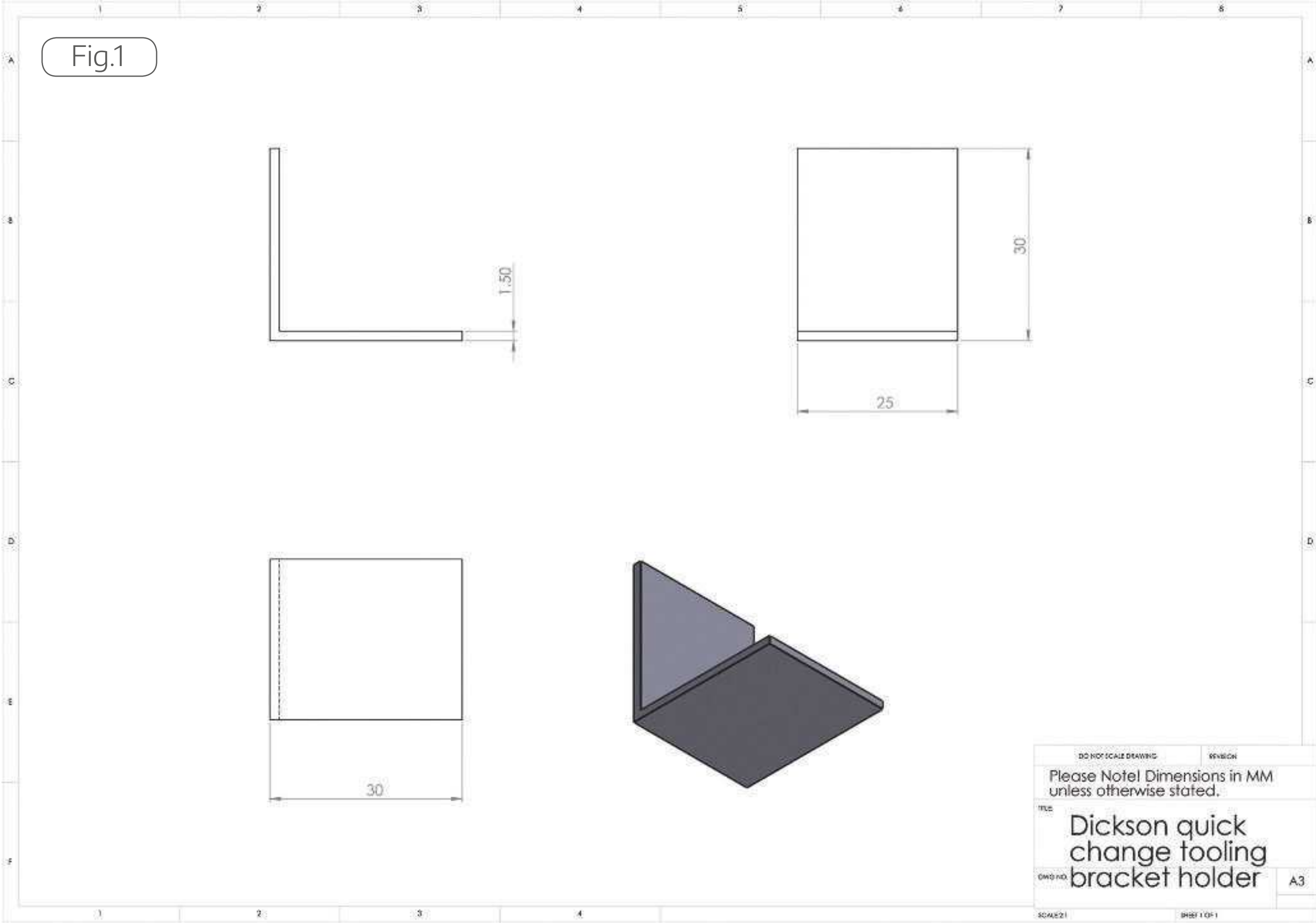
The PC is easily placed down on the floor beside the lathe but the other equipment is another matter. I initially used a monitor stand incorporating a keyboard and mouse plinth but I found this took up too much room.

The solution I now use is to mount the monitor onto the wall at a convenient position towards the tailstock of the lathe, **photo 9**.

A mini keyboard with integral trackerball was purchased to reduce the footprint of these components and I found an Ipad holder, ref. 2, for clamping it to the lathe, **photo 10**. The Ipad holder had to be modified a little, with an aluminium angle bracket screwed onto one of the clamps, **photo 11**. The bracket fixes onto the lathe base via three threaded holes and is pushed down flush with the lathe when not in use. When its required its simply erected and the keyboard, ref. 3, is clipped onto the mount, **photo 12**.

For clock arbors and small work, I tend to use an ER25 collet system on my lathe. The chuck screws onto the spindle nose via myford thread. When the collets arrived, they came in nice little cardboard boxes and shrink wrapped. For a while I diligently unfolded the flap of the boxes a removed the appropriate collet. Unfortunately, with the aid of oily hands and lack of patience the boxes ended up in the bin. Looking around for an alternative storage medium, I found an Ice cube tray ideal for keeping the collets together but I also wanted to protect them, **photo 13**. The real bonus of the tray is it makes them making them readily accessible.

I`m qualified as a six sigma green belt and one of the things that annoys me is clutter or having to search for tooling. Mounted opposite the milling machine is a shadow board loaded with spanners and other equipment that is used regularly. This is simply a white melamine board with tooling outlined carefully with a black marker pen, **photo 14**. Underneath the tool and within the outlined shape is the tool size. When




cleaning up I can now easily identify if a tool that is missing and go search for it.

The workbench is made up of a skeleton of 3x2 planed timber. It provides useful storage underneath for the items that are not used very often or very heavy – like my scrap box! The top is made from used kitchen worktop scrounged from neighbours and friends. Its an ideal thickness of 40mm. Kitchen worktop is very expensive to buy new and on my recent workshop revamp I didn't have enough of it to complete the workbench surface. I found the ideal solution in scaffold boards, **photo 15**. They are the right thickness , robust enough and above all cheap to buy. Yes, you are restricted to the width of the timber but when butted together they make a good work surface.

Underneath I purchased some extension ball bearing drawer slides and fabricated out of timber, three deep drawers for storing essential tooling like vices and mounting plates, **photo 16**. It pays to spend a little bit more for the runners to ensure they are rated for the expected load to be stored on them. You'd be surprised of the combined weight of your decent milling vice, angle plate, v-blocks and other equipment. Cheap ball bearing drawer slides will cope o.k. until you fully extend them and then they start falling apart. Don`t ask me how I know!

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*Keyboard in position ready for use with CNC controller on the lathe.*

My Tom Senior mill which is now located in the middle area of the workshop, is quite wasteful with the room it takes up. The splash guard on top of the base extends out by about four inches in all directions. This works fine for the front and sides. Stopping swarf and coolant from going on the floor but it makes the machine protrude out further from the wall. I did consider modifying the rear part of the guard to get the machine closer to the wall. In the end, I decided there was enough room in front of the machine and I could use the area behind it for shelving, putting the less often required items on them.

After installing the lathe, mill and router within the workshop and congratulating myself on the amount of space now available, I peered out of the garage and realised I hadn't found a place for my Startrite band saw! After a cup of tea and pondering the problem further. I decided to


*"Ice tray" collet holder.*


*Shadow board*

mount it on wheels and keep it mobile, after all, this flexibility will be ideal cutting long or short lengths of material. Being able to manoeuvre the band saw to ensure the cut material is unhindered by obstacles in the workshop is a real bonus.

One of the real fines when re-furbishing the workshop was installing led 20w strip lights. I still have one fluorescent light, as this tends to be more diffuse (LED tend to be more directional). The output from the led lights now bathe the workshop in 6000k white light. The light output is available instantly with the bonus of low power consumption. Several LED strip lights, ref. 4, have been installed around the workshop to illuminate all the corners and reflect off the white painted walls. I still have machine lights but there is now less need to have them.


*Work top made out of scaffold boards.*


*The fabricated drawers*

Hopefully this article will benefit those who like me found their workshop starting to get very cluttered and claustrophobic. It shows there are ways within reasonable budget to create those extra inches within the workshop to make it a more pleasant place to work and it also keeps the family exchequer happy into the bargain!

Ref. 1 Ikea - GREVSTA Cover panel, stainless steel, Article Number : 902.058.89
Ref. 2 Ebay - Extended arm wall mount bracket holder - Apple iPad 2 3 4 Air Mini Tablet 7" 10"
Ref. 3 Ebay - Accuratus black mini usb keyboard KYBAC5010-USBBLK
Ref. 4 Ebay - 1200mm T8 20W LED SMD integrated tube light fluorescent replacement 6000k ■

# Readers' Tips

TIP OF THE MONTH WINNER!

## Simple Deburring Tool

**This month, George Barczi wins this month's Chester Vouchers with a simple deburring tool!** There are occasions where it's difficult to debur small drilled holes with the 'normal' small countersinks available; what I have done is to utilise a small 5 mm glass drill. Having a carbide tip these drills, being of narrow profile, has made deburring tiny holes easier, I simply pressed the drill into a small file handle and 'voila' a neat small pocket size deburring tool.

Having a carbide tip this tool should never wear out, you would only need to dress the two cutting lips with a diamond stone for optimum sharpness.

My picture shows a cylinder cover for my S50 stationary engine I have just machined, the holes are only 2.5mm diameter and this tool deburred them so easily it will now stay in my warehouse coat pocket permanently.

## Toolholder Modification

**Runner up Mick Knights modified a quick change toolholder to take larger tooling. He wins a prize from the MEW lucky dip!** Its long been a problem to mount anything larger than a 12mm square tool in a standard quick change Myford tool post, as I've just acquired a Denford Novaturn cnc lathe, I bought a quantity of inexpensive inserted tooling. One was a 16mm square ER16 external screw cutting tool holder. As I had a T1 type quick change tool holder which came with the new machine I simply milled (using a carbide cutter) 6mm away from the tenon which enabled it to fit the Myford tool post. I've included a couple of photos of the process.

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

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

# Long Travel Threading Guide for the Lathe

**Martin Berry's useful accessory will let you make long threads by die cutting on the lathe. - Part Three**

Marking Guide Bush Holder Centre Line

Setting Guide Bush Holder Perpendicular

Then, after deducting the diameter of the guide holder, the gauge was re-set to give the centre height and a line scribed across the face, **photo 27**. The guide was then turned 90° and lined up using a square, **photo 28** and the perpendicular line added. The hole positions were measured 5 mm from the edge using the height gauge in much the same way as marking out the previous sets of lines. The hole locations are then centre punched.

The first drilling operation was to add the hole for the bush retaining screw, in the side of the guide holder. The set-up in the vertical mill, comprised a V-block centred in the vice using a backing plate to act as a register - as previously detailed, see photo 21. The hole position falls in the middle of a quadrant formed by the intersecting perpendicular lines. The position is not critical and was just eye-balled. The first guide was mounted and the edge found after which the x-axis is moved 7.5 mm to centre the spindle over the piece. The hole was drilled 4.2 mm and then tapped M5 using a taper tap in the drill chuck, followed by finishing the thread off-

Drilling Register Pin Holes

Drilling Through Register Pin Holes into Die Holder Body

*Drilling Through the Screw Holes*

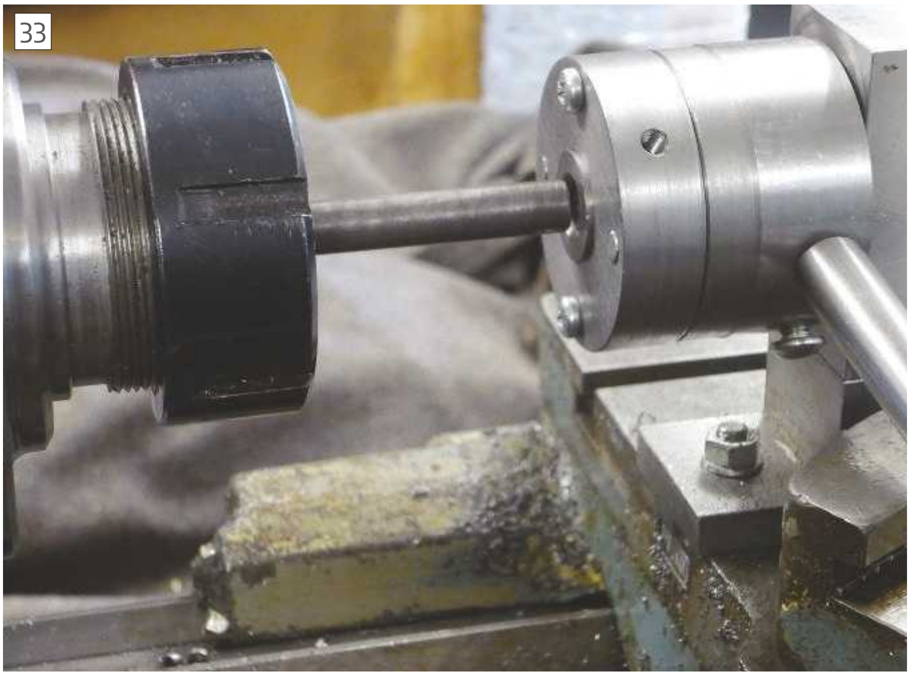
*The Completed Components*

machine using a tap-wrench and a second tap. The remaining two guides are drilled and tapped, at the same setting. Finally, the fourth guide was drilled 5 mm – this acts as the drilling jig for the guide bushes.

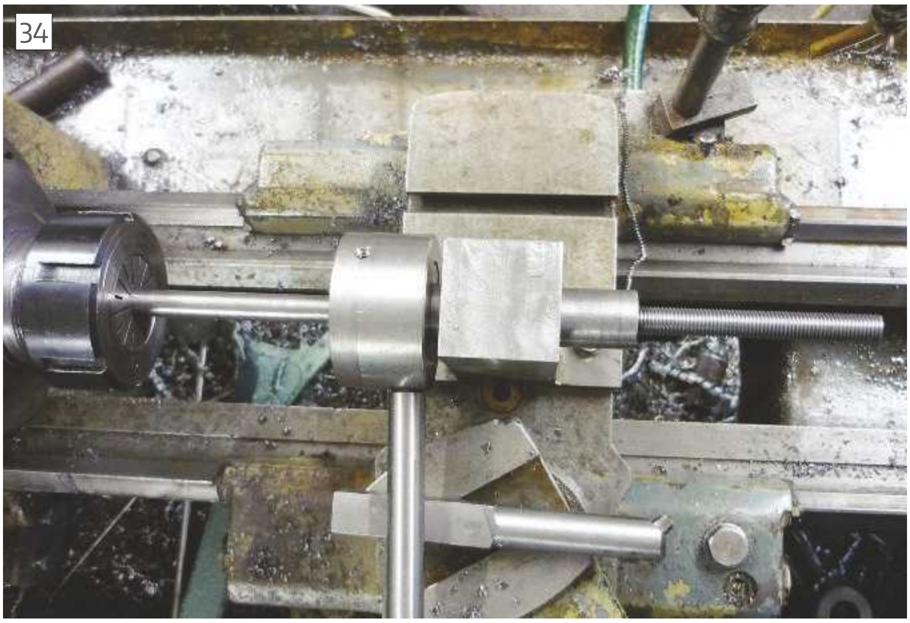
To drill the mounting holes in the guide holder, a narrow V-block laid on its side and positioned against the fixed jaw of the milling machine vice, centred and clamped down. The guide holder was sat on some parallels and positioned such that the drilling positions were parallel to the line of the table. After centring, the first hole was drilled 5.0 mm, **photo 29**, following which the guide holder was turned 180° and the second hole drilled and, thereafter, the exercise repeated for the other two guide holders.

The six, 5 mm diameter, steel pins were cut to 25 mm and the ends rounded using a fine file.

To ensure alignment between the guide bush and the die holder, three stepped set-up bushes were made having a 20.0 mm dia. portion and a diameter matched to the smallest bore in the individual die holders.



*Aligning Die Holder with Work*



*Threading Guide in Use*

The die holder and guide bush holder were assembled with the set-up bush and returned to the V-block within the vice on the mill. The table was then moved to bring one of the holes directly under the centre of the quill as gauged by the 5.0 mm drill passing easily into the hole. The drill was brought down to touch the surface of the die holder, the quill dial set to zero and then the hole drilled to a depth of 10 mm, **photo 30**. The first pin was inserted and lightly tapped in and the assembly rotated so the process could be repeated for the second hole.

Drilling of the screw holes was done in much the same way as for the pins, except that I drilled through the pinned guide bush holder and die holder 3.5 mm dia., **photo 31**, and then opened out the hole in the guide bush holder to 4 mm, before tapping the holes. The two items were then screwed together. To avoid any risks of minor errors in hole position which could lead to a misalignment, I marked the sides of the die holder and guide bush holder with a number of dots, a different number for each pair.

## Guide Bush

The guide bushes were made from steel, by turning bar stock to 20 mm and parting off. The hole was then formed by mounting in the collet chuck and drilling and reaming to size, followed by countersinking. The depression for the clamping screw was jig drilled, using the drill's quill graduation, to 4 mm deep. I made about ten spare bush blanks for future use.

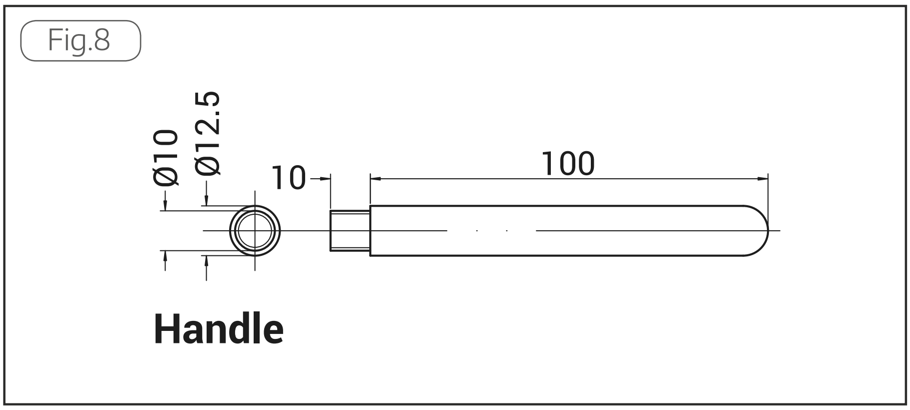
## Tail-stock Guide

To allow the die head to be used for producing short threads using the lathe tailstock, a parallel shank was made to fit into a drill chuck. This was a 100 length of 16 mm bar, with a 20 mm length turned down to a diameter of 12 mm and both ends chamfered.

## Handle, fig. 8

The handles are 100 mm lengths of 12 mm rod, threaded one end M10, using the lathe tail-stock die holder. The other end was chamfered and rounded off with a file. While one handle could be used for all three die holders, I decided to make one for each and use thread retainer to give them some degree of permanency.


*Pricking Out Swarf*




## In Use

That's all the parts complete, **photo 32**, you can now go ahead and make use of the device. The base assembly is clamped to the cross-slide and the die-head assembly inserted, with some grease on the guide tube. The cut end of the bar to be threaded is lightly cleaned up with a slight chamfer and mounted in the collet chuck with 50 mm or so protruding. The cross-slide is then adjusted to line up and give free movement of the bar inside the guide bush, as felt by moving the carriage back and forward, **photo 33**.

The die holder handle is rested on the compound slide, **photo 34**, and the lathe carriage fed into the work. Threading can be performed by hand, by turning the lathe chuck, which is quite tedious if there is a long length to be threaded, or under power, with the lathe set at its lowest speed in back-gear. Once the thread has been started, the guide bush is no longer needed as the die and work will remain in-line, and it needs to be removed to help with the clearance of chips.

As the die holder is pulled along its guide, the lathe carriage is advanced to keep up. For each 20-25 mm of thread the spindle is put in reverse and backed off a couple of threads. The build-up of chips in the die needs to be removed and for this a pricker was used, **photo 35**. This worked for 3-4 times before the build-up became too difficult to clear and the die head had to be fully removed from the thread and cleaned out. Failure to clean out the chips creates a jam which eventually drags on the cut thread and destroys it.

## The Result

As stated at the outset, the primary objective of this project was to create a longer cross-slide screw and this task has been truly successful, with a length of about 200 mm being threaded. The new screw is shown in **Photo 36** alongside the original screw. Not only is the new screw straight, but it is much closer fit in the lathe cross-slide nut, so reducing backlash. ■


*Finished Cross-Slide Screw with Original*

# A Rescue Job for a Covmac Lathe

## Brian Wood recounts a big salvage job using amateur size equipment


### Summary
There MEW forum has seen a lengthy discussion of the removal of a 1940's Covmac lathe to its new home in Somerset. **Photograph 1** shows the lathe as initially found. This article describes the recovery of the tailstock barrel from an accident that occurred in cleaning which had all the potential for scrapping this vital component and requiring a very expensive copy to be made.


### Introduction
The Covmac lathe was a 1930's design of heavy lathe made by the Coventry Machine Tool Company and without trying to steal any more of his thunder, I hope that Chris Mills, the new owner of this 1.5 tonne monster, will be writing an article on this adventure for publication under the 'One man and his Lathe' series.

Chris is an historian, not an engineer and he has bravely taken on the move and full restoration of this now very rare machine. There has been a lot of advice given to aid him in just moving it to the new location; in particular, some good, sound, practical information from Phil Whitley who is another owner of one of these lathes. In the process, I seem to have become mentor to Chris, a task I have accepted with some enthusiasm.

### The accident
To allow cleaning and repainting of the tailstock, Chris elected to remove the barrel and perhaps rather rashly used an old 3-2 Morse taper drill sleeve to help push it out of the tailstock bore.

Unfortunately, he then fumbled the handling and dropped all 10 pounds of it nose down onto a concrete floor. The drill sleeve was in effect hammered very hard indeed into place and refused to budge. All might still have been well, had he not then dropped a 6 inch length of bar, taken from his limited stock of material from the old owner, down the bore to then beat upon it using another length of bar to reach it.

Nothing moved and the short length of bar also become stuck in the bore; at this stage he asked for my help.

### Recovery plans
**Photograph 2** shows the barrel on receipt from Parcelforce, a week on from the incident. The sheer size of it is impressive;

1

*The Covmac lathe as found by Chris Mills.*

it looked much slimmer in photos when installed in the tailstock. Length is 461 mm (18 inches), diameter a hefty 45.45 mm (a shade over 1 ¾ inches) and the open bore at the threaded operating end is 20.24 mm. The outside square thread is 4 TPI and lathe cut into a run out, not machined by end mill as I had expected. The anti-rotation slot along the bottom is 8 mm (5/16 inches) wide. The nose has a 3 MT taper socket.

Until receipt I had not seen a detail view of the jammed socket, but there had been plenty of time to plan a recovery with ideas all based on the assumption that the drill sleeve was hardened (of which more later):

- Use the 50-tonne hydraulic press at my last place of work to push both bar and drill sleeve out. I was distinctly uncomfortable about this as there was a significant risk involved of sideways collapse from instability and turning the barrel, or something else into a projectile. I ruled this one out for the sake of my health.
- Exploit the inertia of the internal section of bar to try 'walking' it out of the barrel by belting the open end with a nylon faced hammer, after which send a full-length bar down to knock out the sleeve. Heating to expand the socket end if necessary was also part of that plan.
- If, as expected, the internal bar didn't move, use the coefficient of expansion in steel on cooling from ~ 1500 C to force the sleeve out against a screwed plug or bolt into the open end. The force involved would be very large with about 0.002 inches of shrinkage involved on the barrel length. This was the 'banker' plan.
- If all that failed, full transplant surgery become the final salvage alternative after cutting off the MT socket complete with the jammed sleeve and knocking out the jammed bar. That was to be followed by grafting in a section of new bar, joining it into a close fitting socket up the bore of the barrel.

The joint would then be loctited and cross pinned before machining a new 3 MT socket, turning the O/D to match the original size and completing the anti-rotation slot.

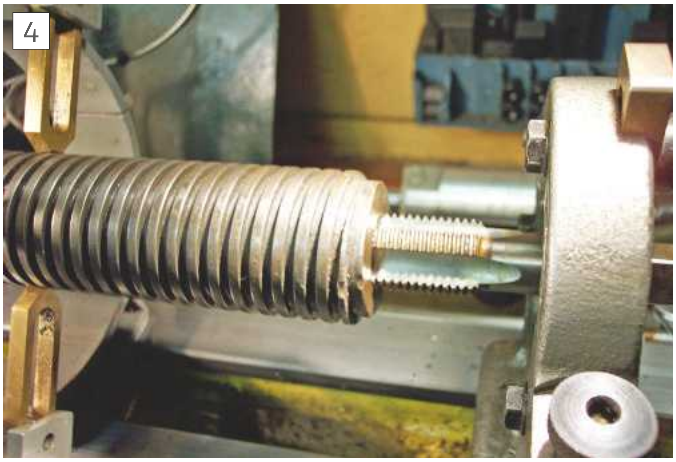
Tailstock barrel on receipt

Two steadies hold the barrel and threading tap in line

## Actions taken

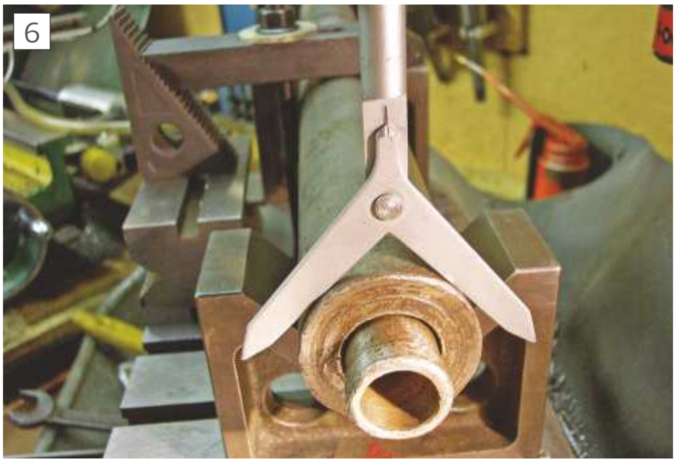
The first plan failed completely; there was no movement at all on the stuck bar. Now it was a case of threading the end of the barrel true and square, it was much too long to use the tailstock on my Myford lathe to help start the tap.

And what a tap too, the nearest I had to suit was 7/8 inch BSF of 11tpi which needs a tapping drill size of 19.75 mm diameter,



Close up view of the plug tap finishing the thread

An end view of the finished thread




*Barrel centred under the milling machine quill*


*Barrel clamped on Vee blocks on the mill table. Note the size and overhang*

0.5 mm down on the bore of this job. The next size in my box was 1 inch BSF with a tapping size of 22.8 mm which of course would mean opening up the bore. On a standard bed length Myford lathe that needed some ingenuity just to reach the end with tooling.

In the end, I elected to use the smaller diameter tap and cut at least 10 threads to offset the slightly inadequate degree of thread engagement.

**Photograph 3** shows how I held the barrel and tap in line with two steadies down the lathe central axis. The spindle was locked and the tap turned against it by a spanner on the square end. **Photograph 4** is a close up view of the plug tap while finishing the thread. Backing off the tap to free swarf between turns needed the chuck key as a lever to keep the chuck threaded onto the spindle nose. **Photograph 5** shows the finished thread.

It was only at this stage I looked more closely at the jammed drill sleeve, the outer shape was unusual with a shallow raised parallel section and I began to hope it was actually unhardened; I hadn't even considered that in my concerns in finding ways of supporting the barrel for threading on the lathe.


*Sleeve cross drilled*

To my great relief, it was made in unhardened steel. That immediately allowed a whole new approach to the job. **Photograph 6** shows the barrel being centred under the milling machine quill and **photo 7** the way it was clamped down to the table. The ruler shows how big it is compared to the mill.


*Bar inserted and opposed screwdriver blades in position*

**Photograph 8** is after drilling across the mouth of the drill sleeve and **photo 9** is with a short bar through and opposed flat blade screwdrivers being used to lever it out. After this treatment, it gave in without a whimper and **photo 10** shows the old sleeve in all its awful glory.

**Photograph 11** is a view into the MT socket with its many years of scarring from drill slippage and **photo 12** shows taper reaming by hand power to clean up the worst of the scars, after which a new hardened sleeve fitted with a satisfying ker-thunk.

**Photograph 13** illustrates how I supported the barrel to check the truth and alignment of the socket with a test bar. The result was spectacularly good with a run out of 1 thou at 5 inches from the socket mouth over about 300 degrees of rotation (to avoid the step effects of the anti-rotation slot)

The job was finished with some light

*Drill sleeve visible again*

*A look into the chewed up socket*

*Hand reaming with the 3 MT reamer to clean up the worst of the damage*

dressing here and there using a fine file to remove the minor bruises it had picked up in its 75-year history followed by a light polishing with a piece of well used Scotchbrite pad. All in all, this was a very satisfactory piece of work which took just under four hours from start to finish.

## Tailpiece

The short bar had to be hammered out back the way it came in and once it was free the reason for it jamming became obvious. The drilling down the bore of the barrel was in fact tapered and had been completed from both ends. At the meeting point there was, and still is, a step of less than 19 mm diameter, maybe one inch long, into which the short bar had become jammed solid.

The bar itself was a 6-inch length of fully hardened precision ground steel of 19.00 mm diameter and it had locked up without even reaching the drill sleeve.

So, it is just as well the old sleeve was soft and came out as it did. Without access from the MT end, there was absolutely no hope of drilling through the hard bar to knock out the sleeve with something of smaller diameter. The plan for differential movement on cooling would have failed without any apparent reason and become a worrying mystery since it had been assumed to be hard up against the drill sleeve.

That alone would have forced me to consider taking the surgical route as the only viable choice left open and I am glad it wasn't necessary.

Now, in hindsight, squeezing a pair of snug fitting folding wedges together below the raised section on the sleeve would have worked just as well. I was though concerned that time was important and the longer these tapers remained in such tight contact, the greater was the risk of cold welding which can bond wrung slip gauges together.

Post battle, I freely admit that possibility has only just occurred to me and is a method to remember for another situation.

I am though eternally grateful I didn't use the big press, who knows what further damage I might have inflicted. ■

*Checking socket truth and alignment*

# Scribe a line

## YOUR CHANCE TO TALK TO US!

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

### VFD Shielding – One Endian

Dear I strongly disagree with the views of " Electrical Engineers" re earthing of the shield of the motor cable. It should be at the VFD controller end with NO connection of the shield to the motor earth ( or any other earth for that matter). Connecting both ends of the shield causes earth loops, radiating noise in the earth return.

I have wired up many VFD's in industry and have had no trouble if I connected as above, BUT trouble if I did not!

If you wish I could send you a relevant page from one of the VFD installation manuals.

**John Chappell, by email**

### VFD Shielding – Both Endian

Dear Neil, I absolutely stand by my earlier comment that the shield of the cable from a VFD to its motor must be grounded at both ends to be effective.

I am a power industry engineer with some experience of VFD drive installations ranging from under 1 kW to about 50 kW from various major manufacturers including ABB, Siemens and Schneider Electric. I don't know where you found advice to only connect the shield at one end. That is not my experience.

**Keith Fisk, by email**

*I have had many passionate letters about the subject of shielding the wires between a VFD and a motor. As I stated last time, I have heard from professionals and read manufacturers' handbook advocating both the ground the screen at one end and ground at both ends approaches. There do seem to be slightly more voices in favour of the 'both endian' approach, on the grounds we are keeping electromagnetic interference in, not the 'one endian' solution, but the communications I have received are by no means unanimous. As the whole thing seems in danger of dividing the readership into Lilliputians and Blefuscudians, I must invoke editorial privilege and declare that this correspondence is now closed – Ed.*

### Oilstone Bodge

Dear Neil, With reference to Ted Joliffe's article A One Time Bodge. Wavy oilstones such as he describes can easily and quickly trued up by rubbing them on concrete.

**Victor Croasdale, Spring Valley, Illinois**

### Taper Setting

Dear Neil, another method for relatively easy and accurate setting for taper turning can be as follows.

For a taper from Diameter A to Diameter B over a distance of C, first machine a U shaped piece of metal such that the two limbs are sharply pointed, the points are N times C apart and are equal in height. Set a round bar between centres in the lathe, and at a distance NxC apart machine two lands on the bar with diameters of A and NxB.

Set the U shaped tool in the toolpost with the post pivot slack, clamp the gauge firmly in it, the gently wind the top slide until the tool contacts the two register lands. Firmly hold it contact with them and tighten the toolpost clamp. The topside is now set to the taper with an accuracy of N times your diametrical measurements.

**David E.Hockin, Portishead**

### Safety Advice

Dear Neil, I have to work machinery when I am on my own. Is there a safety device that will cut off the machine if I, for example, lean forward or get too near the revolving parts? Safety first!

**Mr. M. Lovell, New Waltham**

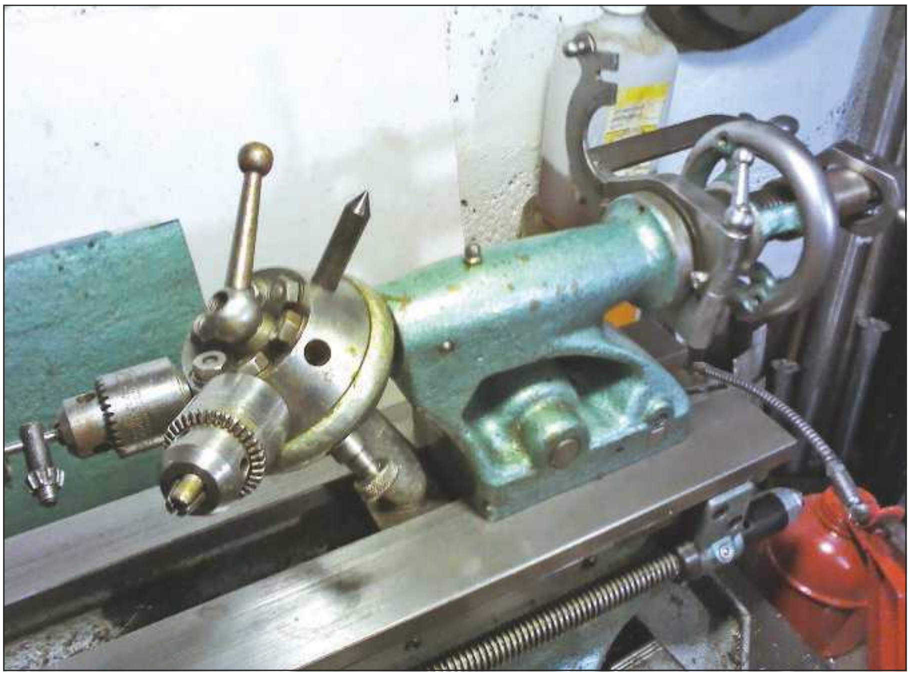
### Adams Drip Feed Oilers

Dear Neil, I recently read on one of the model engineering sites about Adams drip feed oilers being a good replacement for those on older Myford lathes and contacted Adams to see if I could purchase directly from them. They put me in touch with the New Zealand distributor who didn't have them in stock and proved less than helpful. The Adams UK sales manager then put me in touch with the Australian distributor and I've still had no luck at all. The UK sales manager (who I must say has been very prompt answering my emails) says the agreement Adams have with their distributors means he can't supply details of any UK distributors to me.

I wondered if you could possibly help please? The name of a distributor who is likely to stock the Adams range of drip feed oilers suitable for model engineering lathes would be ideal (rather than industrial units). I'm after 2 of part no. USF 7416.

I look forward to MEW arriving in the post each month. Yours is the only magazine I subscribe to. My other compulsory reads come via the local library, usually a month behind the UK!

**John Proffitt, New Zealand**



## Lever Tailstock

Dear Neil, the photograph (page 43 of issue 253) of the tailstock attachment jogged my memory. I possess one! I dug it out from the back of a workshop drawer and took photos. It was made in around 1955 -1957. Geoff Walker is correct that it should be used with smallish drills. My one has excessive wear on the two pivot holes in the swing arm as the bearing surface is so narrow. I will drill ream and bush them and make the bearing surface area deeper if possible.

There is also a capstan attachment shown in the tailstock. This (I think) is a Westbury design (I'm sure have seen this design in MEW plans) where there is an arm and pad that fits between the lathe bed shears to take the reverse torque. Again, well old but thankfully not worn.

i hope this proves useful to fellow readers.

**Steve Middleyard**

## Long Threads

Dear Neil, The article by Martin Berry (Issue 251) stirred memories of thirty years ago. One of the repeat jobs was to produce batches of a thousand earth blocks to an IBM pattern. Each block contained two M10 grubscrews. At first these were subcontracted, but after checking out the cost of brass screwed rod, then 10mm dia brass bar, the decision was taken to start with round bar, thread it in metre lengths then form the 12mm long screws on an ancient Myford capstan lathe and finally slot on a Naerok mill/drill. The threading was accomplished on a Colchester lathe (initially Bantam later Chipmaster) by mounting an M10 die in holder in the lathe chuck. The tailstock was removed and a guide bush fitted to the toolpost. The length of bar was gripped with Molegrips and fed through the bush into the die. As it emerged beyond the spindle, the machine was stopped, the Molegrips were removed and a couple of M10 nuts fitted to the thread and locked. These were then gripped using two 17mm AF spanners (to keep the nuts locked), and the lathe restarted, and run until the rod was completed. The job was run with coolant and my vague recollection is that each metre length took around a minute, implying a speed of six to seven hundred r.p.m.

**Dave Fenner, by email**

## Fluxed Rods

Dear Neil,I hope this message does not conflict with the proposed article by David Banham and is sent with reference to the note on silver soldering by Chris Thorn in "Scribe a line" in issue 253.

I can thoroughly recommend an item that is obtainable from any BOC retail outlet and is produced by Johnson Mathey. The name to ask for is "Silverflow 55, flux coated rod". I have used this product many times and have found it to be the easiest most efficient silver soldering product on the market. It is expensive and retails on average at £66.60 inc VAT " for 5 X 500 mm rods 1.5mm diameter, approx 67 pence per inch.>

Unlike mixing one`s own flux for the immediate job at hand this silver solder is already fluxed on the outside of the rod. I can assure you that when optimum temperature is reached by the use of a gas torch, the flux on the rod will liquify and flow onto the workpiece, and the silver solder < at a slightly hotter temperature> will follow the flow of the flux with predictable ease. Furthermore, the flux does not set glass hard after it cools down if the object is quenched in water or dilute acid pickle after a few minutes of cooling, it is comparatively easy to remove any residue from the surface of the silver soldered item, by scrubbing under a hot tap with one of those green, synthetic pot scourers or fine emery/aluminium oxide abrasive fabric if any resistance is found.

To add to the comment made by Mr. Thorn, the combination of propane gas and pressurised air is a very satisfactory method of reaching optimum temperature for the purpose of silver soldering. I personally use MAP gas supplied by Rothenburger and is marketed in a bright yellow steel container. The main problem with silver soldering by the use of gas combinations, is the possibility of causing oxidation by overheating, to the surface of the object to be soldered and if anyone isn`t successful at first attempt it is a necessary and laborious task to clean the work piece of any oxidation or fire scale that has formed around the area to be joined. This problem does not arise readily with the use of JM Silverflow 55 fluxed rods.

I know this all sounds and reads like a commercial advertisement for J and M, but this product, although quite costly, is really good and easy to use.

**Stephen Bondfield, by email**


**LAL Taps and Dies**

Hello Neil, I too have a set, inherited from my father, on which is written 'Jan 50, 39/6 set nett'. A not inconsiderable sum of money at the time.

**Paul Murray, Herefordshire**

*Reader Eric Clarke has kindly sent me scans of some fascinating literature from LAL, which I hope to use in issue 255*

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*Content may be subject to change.*

**ON SALE 28 APRIL 2017**

# Time for a Lathe Bed Regrind?

**A regrind can give an old lathe a new lease of life, Laurie Leonard explains what was involved and how it went for him.**

1


*My Myford ML7 before work*

I purchased a second (or third or fourth...) hand Myford ML7 some twenty odd years ago and have used it for many projects. I would like to have a gearbox and it is getting rather old in the tooth but cannot really justify buying a new all singing and dancing lathe. Despite adjustment, the carriage bound at the tailstock end and I was having trouble with surface finish. Would having the lathe bed reground solve these problems? Would I be inviting trouble dismantling the lathe? How big a task is it anyway? I decided to have a go and make some notes on the way I did it.

## Making a Start

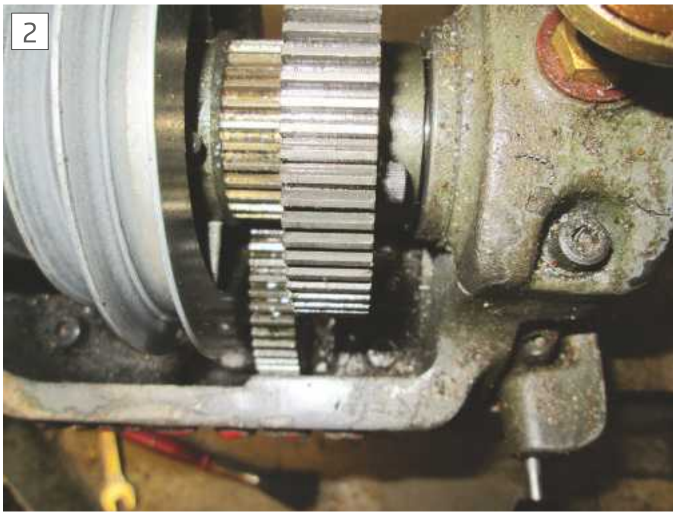
It is necessary to find someone to carry out the regrind and this really needs to be local for transport reasons. From a discussion on Model Engineer web site, ref. 1, I chose a couple of names and although the nearest was very busy he said he would see what he could do. I resigned myself to a double trip: take it there, leave it for work, return to collect it but in the event, was able to fit the whole operation into a short break in the area of the machine shop.

Nothing for it now but to start taking the lathe to pieces: one last look, **photo 1**.

Not being as young or strong as I was I reasoned that pieces of the lathe had to come off in relatively small chunks to enable handling so:

- the tailstock was removed
- the chuck was removed
- the top slide and cross slide were removed
- the apron assembly was removed
- the remainder of the saddle and mountings were dismantled
- the drive belt guards and gear train guards were removed
- the drive gear on the lead screw, the lead screw and the rack were removed
- the drive gear guard back plate was removed

It was now necessary to remove the main drive. The motor was removed from its support with difficulty which I later discovered was caused by a mixture of bolts that were not the same thread. In some cases, even the nut on the bolt was not compatible. Although the motor was on the lathe when purchased it was not original and its fitter had probably



View of headstock showing Allen screws with difficult access

Driving the piece of Allen key into hex bar using a vice

introduced the above trouble for me. The motor support plate was removed which turned out to be very unwieldy as it also carried the clutch assembly and the speed change belt tensioner.

Only the head now remained. This is held on by four large Allen screws. Although I had a key that would fit the screws, due to the depth inside the head only the short end was available for leverage. Despite utilising a piece of tube, I could not free them off and was concerned that the attempt would break the key. I had some hex keys with a ½ inch square socket driven but no way would they fit inside the head as access is tight, **photo 2**. The solution was to make a tool consisting of a piece of hex bar, to be driven by a ½ inch drive socket, with a piece of Allen key (7/32 inch), cut off utilising an angle grinder with cutting disc, fitted in the end. The simple tool is shown in **fig. 1**. I considered brazing the key in place but had concerns relating to the potential reduction in hardness caused by the heating process so instead opted for a simple three grub screw fitting with the screws bearing on flats on the key. A hole, approximately the diameter of the Allen key cross flats measurement (6mm), was drilled in the end of the hex bar and after drilling and tapping

Hex tool in use on the head Allen screw

for the grub screws the key was pressed in utilising the vice, **photo 3**. Although the grub screws protruded from the hex bar, there was enough clearance so their ends did not have to be ground off; grub screws are often hardened at the end. Photograph 4 shows the tool in use and illustrates the limited clearance available for it.

The keen-eyed reader, and the not so keen eyed reader, will have noticed the embarrassingly dirty state of the lathe. Whilst I regularly clear away swarf, religiously lubricate the lathe and spray liberally with WD40 to protect against rust formation, the painted areas can only be described as filthy. Have I let the lathe get into this state or did I inherit it? To give the grinding specialist a fighting chance I used a proprietary engine degreaser to clean the lathe prior to oiling the slideways pending carriage.

With the lathe bed now ready for transport to the machine shop, attention was given to the other parts that would need to go with the bed. These are the main saddle, the saddle gib strip, the two saddle strips (that clamp the saddle to the bed) and the bolts and screws that are used to secure them. I also included the shims, used to obtain the running clearance, as removed but the machinist ground the parts to fit and shimming was not required. This pack of parts was cleaned, oiled and protectively

Lathe bed removed showing state of paintwork on tray wrapped in rag for transport. The bed was oiled and protectively wrapped in rag and then overwrapped in corrugated cardboard for transport. The bed just fitted between the wheel arches in the back of a Ford Fusion (UK Version) which meant that the weight was over the rear axle and it could not move from side to side.

As a rough guide, to get to this point had taken about two hours' work. Not as much as I would have expected. It should also be noted that on the Myford most fastenings are old imperial, mostly BSF or BA. Correct spanners are really essential to prevent mangling nuts and making the rebuild difficult.

## Clean Up

As identified above, the lathe was in a dirty state so with it in pieces this was a good opportunity to clean everything up for the rebuild. With the lathe bed removed from the stand, the tray was in need of attention, photo 5. It can be seen in this photo that the paintwork is in a bad way and really would benefit from some attention but how far do you go. Complete stripping, sanding and filling or just a sand and repaint. A definition of quality is fit for purpose. I did not want the tray to rust and my bad experience with the use of filler in the past led me to sand and brush repaint. I did dismantle the mounting blocks so that the tray could be completely repainted and the height adjuster cleaned for easy adjustment on rebuild. The components and method of adjustment can be seen in **photos 6, 7** and **8**. Note the sealing washers on the underside of the blocks, to stop coolant leaks, and the ingress of paint on the lower surface of the block where it lands on the tray. This was cleaned off to promote a level bedding on the tray.

The lathe components had been laid out on the bench as taken off, **photo 9**. These were cleaned and checked in turn ready for rebuild. During this operation the reason why trouble had been experienced with the speed change guard jamming and twisting was discovered. One of the plates at the side was missing allowing the guard to skew when lifted, A new one, **photo 10**, was made.

The motor wiring was also tidied up and proper glands fitted to the motor terminal box.

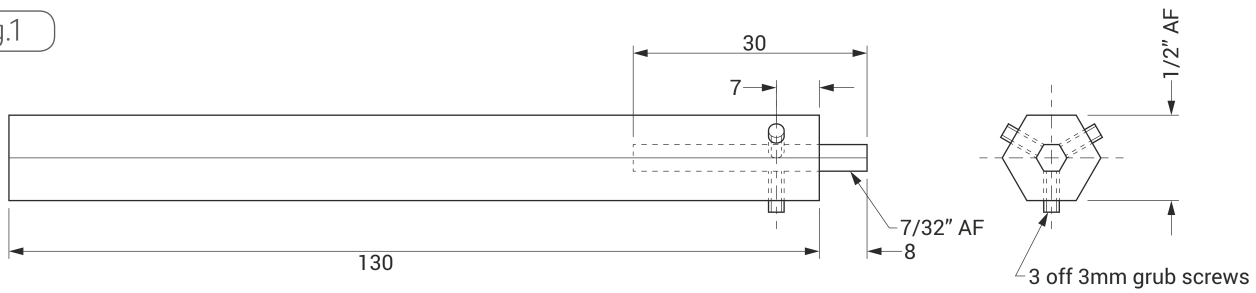


*Lathe bed mounting block adjustment components*


*Underside of mounting blocks showing "creeping" paint and tray sealing washer.*


*Lay down area on bench showing removed components*

Fig.1




**Myford Lathe Headstock Allen Key (Special)**
Dimensions in mm unless stated otherwise

## Opportunity Work

When handling the lathe bed off the stand it was noted that the stand rocked! I am sure it did not when installed but now it did. Not a great help in operation and levelling. Whilst the lathe bed was off the stand, a set of adjustable feet were purchased and fitted, **photo 11**, and the stand revelled. The previous installation was not level and the suds ran to the wrong end of the tray, ie away from the tray drain. When I had levelled the bed originally, and before the purchase of a suds system, I had borrowed a very accurate level and did not want to disturb the lathe bed alignment by moving the stand so I solved the drain problem by fitting a new drain, **photos 12** and **13**. This was now removed and the holes filled in as now that the lathe was off the bed any level and alignment had been lost so the tray could be reversed to put the proper drain hole above the suds' tank normal location. During painting it was suddenly found that the tray was not reversible as the mounting blocks were not mounted symmetrically. Plan B: site the suds tank at the opposite end of the lathe, **photo 14**, to its previous location and arrange a slight fall on the tray in this direction.

In a previous copy of MEW, ref. 2, a contributor had added a drawer to the stand to house tools. I have always felt that there was a lot of wasted space so I made the aperture as in the article ready to fit the drawer at a later date, **photo 15**, and I hope to use this in place of my improvised tool tray, **photo 16**, as this reminds me too much of the dentist's surgery.

## Rebuild

**Photograph 17** shows the lathe bed remounted on the stand ready to be bolted down and levelled. A lot of effort was put into making sure that there was no grinding dust left to score the newly ground surfaces. I thought it better to leave the levelling until all of the lathe was rebuilt as the motor assembly is very off centre and could put a twist into the alignment/levelling. The main lathe bed casting was repainted as it too had lost paint and looked really shabby against the newly painted tray.

The saddle assembly was rebuilt having first well oiled the bed and any contacting running surfaces. As mentioned above no shimming was necessary as the clearances had been set when machining was done but comment on shimming is available in a previous MEW article, ref. 7. The oil nipples were fitted and given a good dose from the oilcan. The gib strip was then adjusted to give free but snug movement.

The lead screw and remaining carriage parts were refitted but running the carriage down the bed resulted in a graunching noise. The lead screw guard is held by the locking nuts of the half nut gib strip adjusters and there is play in the mounting holes. I had left the protector too near the bed and it was fouling the protruding head of one of the rack strip bolts, **photo 18**.

A new felt wiper was fitted as a

10

*Replaced missing drive guard component*

11

*Fitted lathe stand adjustable foot*

12

*Holes in coolant tray for "new" drain*

13

*Position of coolant system*

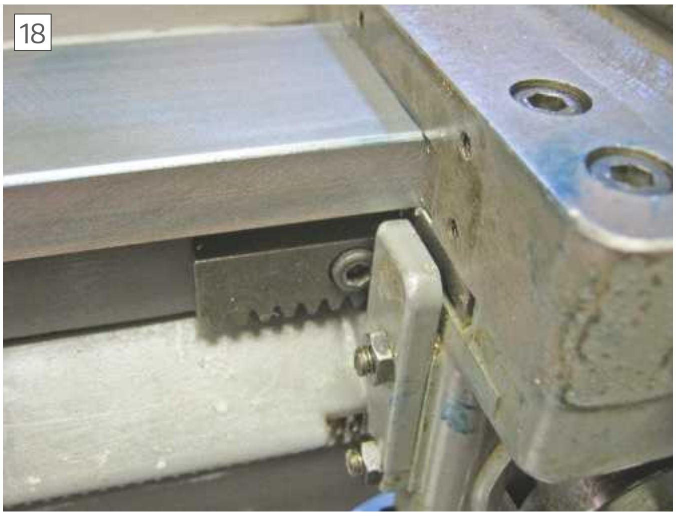
14

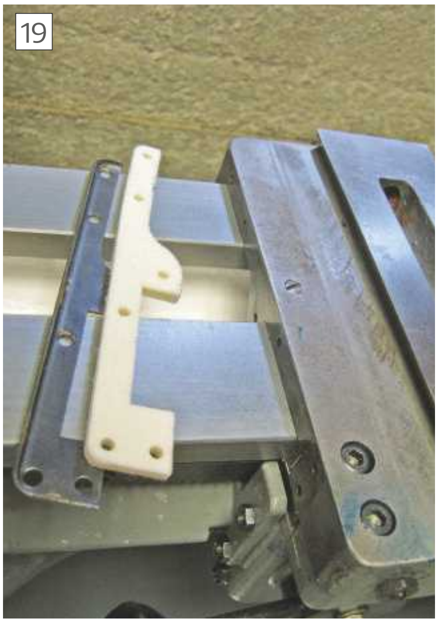
*Relocated coolant system*


15
Aperture in stand awaiting the fitting of a tool drawer


16
Improvised tool tray


17
Reground lathe bed back on the stand


18
Lead screw protector fouling on one of the rack securing screws


19
Lathe bed felt wiper awaiting fitting


20
Tailstock adjustable strip and securing bolt


*Position of adjusting screws on tailstock.*


*Swarf embedded in the tailstock clamp plate*


*Clearing swarf and cleaning up the tailstock clamp plate*


*Position of adjusting screws on the headstock*

precautionary step to help protect the new lathe bed finish, **photo 19**.

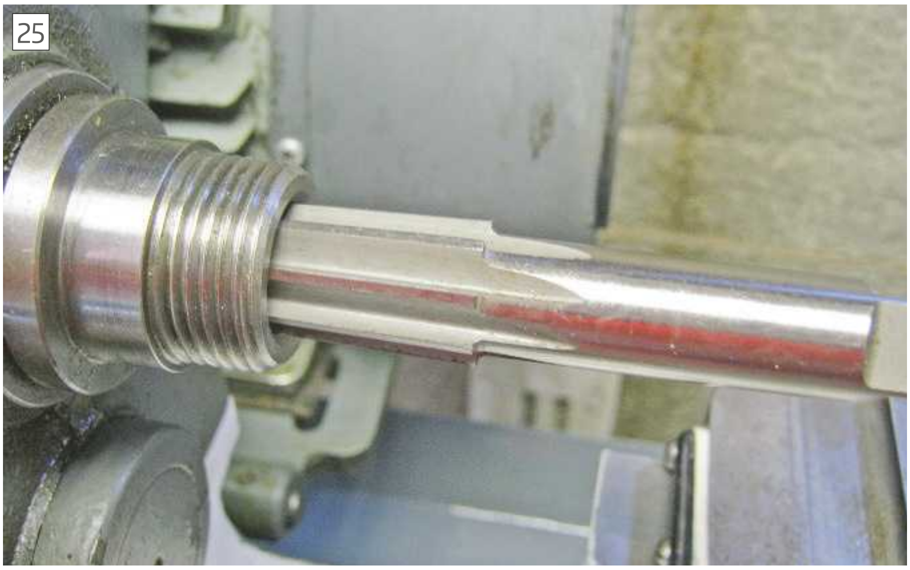
As the inner running faces of the slideways had been cleaned up, the fit of the tailstock needed to be reset. **Photograph 20** shows one of the bolts securing the adjustable strip and the strip end. **Photograph 21** (tailstock mounted on the bed backwards for the photo) shows the two adjusting screws which are angled down to adjust the strip. With the securing bolts nipped up, the adjustment screws were utilised to get a nice sliding fit for the tailstock and the securing bolts were then hardened down.

The tailstock clamp plate was removed and examined and found to have swarf embedded on the running surfaces, **photo 22**. This was cleaned up and the running surfaces cleaned up with a file **photo 23**. Whilst not as important as the slideways it was thought that the effort would assist positioning the tailstock in use and this seems to be the case in practice.

The headstock was remounted on the lathe bed and the socket head bolts were inserted and nipped up. The adjustment screws on the bed, shown in **photo 24** at an early state of rebuild, were then used to force the head onto the datum face and the socket headed bolts were then hardened down.

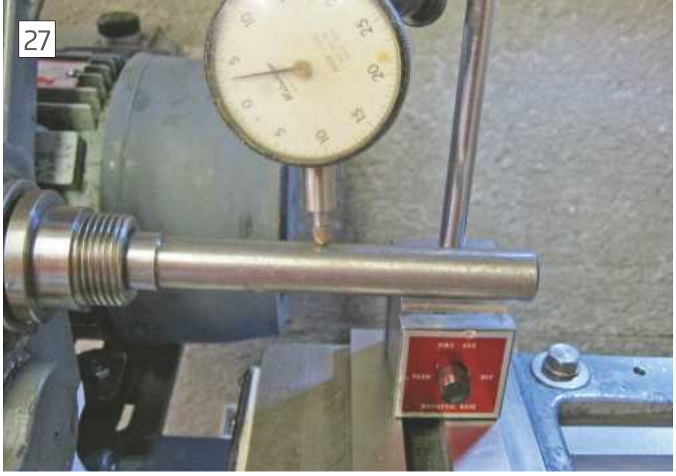
## Alignment Checks

Having carried out such major work on the lathe it is necessary to check the alignment and cutting accuracy. The lathe bed was levelled with the best equipment I had to hand but this was not really accurate and consideration is being given to making a sensitive level for this purpose (refs 3 & 4). To be able to use the lathe for everyday jobs and get a level of confidence in its turning capability, a couple of checks were made with a clock gauge and a test bar. The latter has a Morse taper and an accurately ground section although this has suffered from storage in the workshop despite WD40 and polythene wrapping. The bar is mounted in the headstock taper so it is important that the latter is clean. A number




*Using a No 2 Morse taper reamer to clean headstock bore*

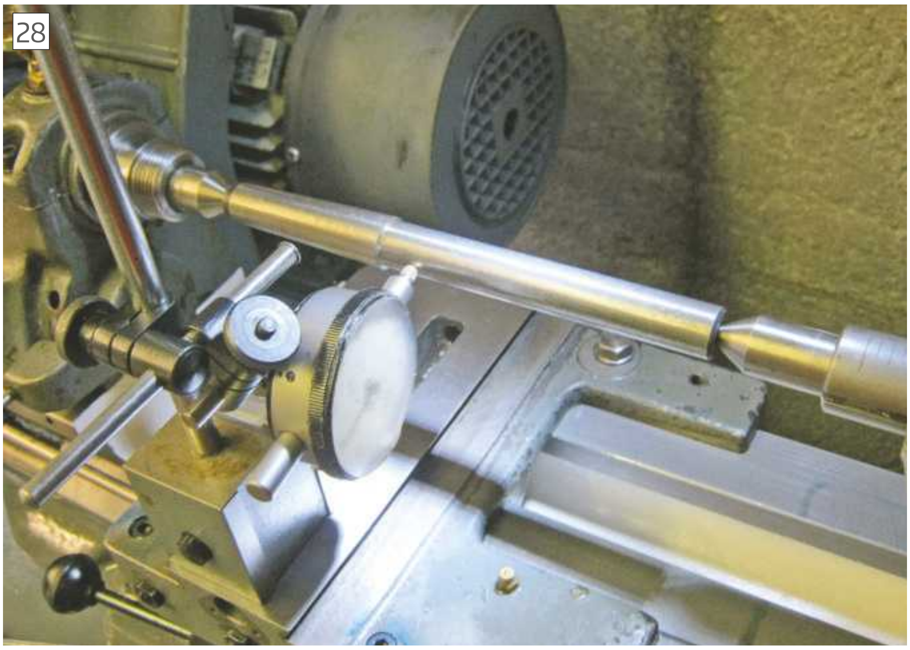
*Debris removed by reamer from headstock bore*



*Alignment checks*

2 Morse taper hand reamer was used to clean the bore, **photo 25**, and the resulting swarf/debris is shown in **photo 26**. A clock gauge was mounted on the carriage and set vertically, **photos 27**, and horizontally in turn and the carriage run along the bed for the range of the bar noting the change in reading. About a thou was noted, but a concentricity check of the test bar indicated that it was not running concentric to the headstock bore so a test cut was made on a stock bar as described in an MEW article (ref. 5). This gave an error of 0.0018 inch on diameter measured with a micrometer over a distance of about 90 mm. Whilst correction can be made as in the article I will be making an accurate level to set the bed and will then proceed from there to get a final alignment.

The test bar was also mounted between centres, **photo 28**, and similar checks made to verify tailstock alignment.



*Alignment checks*

## Conclusion

The reground bed looks great, **photo 29**. When I queried the original condition it was pronounced as "not bad" by the machinist who carried out the work who said he had removed 6 thou.

The carriage is very smooth with no binding or perceptible play and the tailstock, which used to bind and dig in now also moves smoothly.

The actual job was far easier than anticipated although basic precautions such as putting parts for each stage of the dismantling process into separate containers, e.g. mounting block work, photo 9, greatly helped in the rebuild. Reference was also made to the parts lists in the Handbook to confirm the correct selection of fasteners for each stage of the rebuild and to assist when there is slight lapse of memory. Parts lists as in the manual are available on the Myford web site (ref. 6).

Although the above work is specific to a Myford ML7, the basic stages will be common to other lathes although each make will have its specific details.

The tricky bit is the final alignment and an accurate level would appear to be the best way forward for this aspect of the work.

## References


1 MEW web site - www.model-engineer.co.uk/

2 "A Drawer for a Lathe Cabinet", Sid Reid. MEW 28 March/April 1995

3 "A Very Sensitive Level", Peter Peters. MEW 36 July/August 1996

4 "On the Level", Bill Morris. MEW 77 October 2001

5 "Lathe Projects for Beginners (4) - Turning Parallel", Harold Hall. MEW 70 December 2000

6 Myford web site - www.myford.co.uk

7 "Rebuilding the Myford Super Seven Lathe", "Richmond". MEW137 April 2008 ■



*Rebuilt lathe after the bed regrind.*

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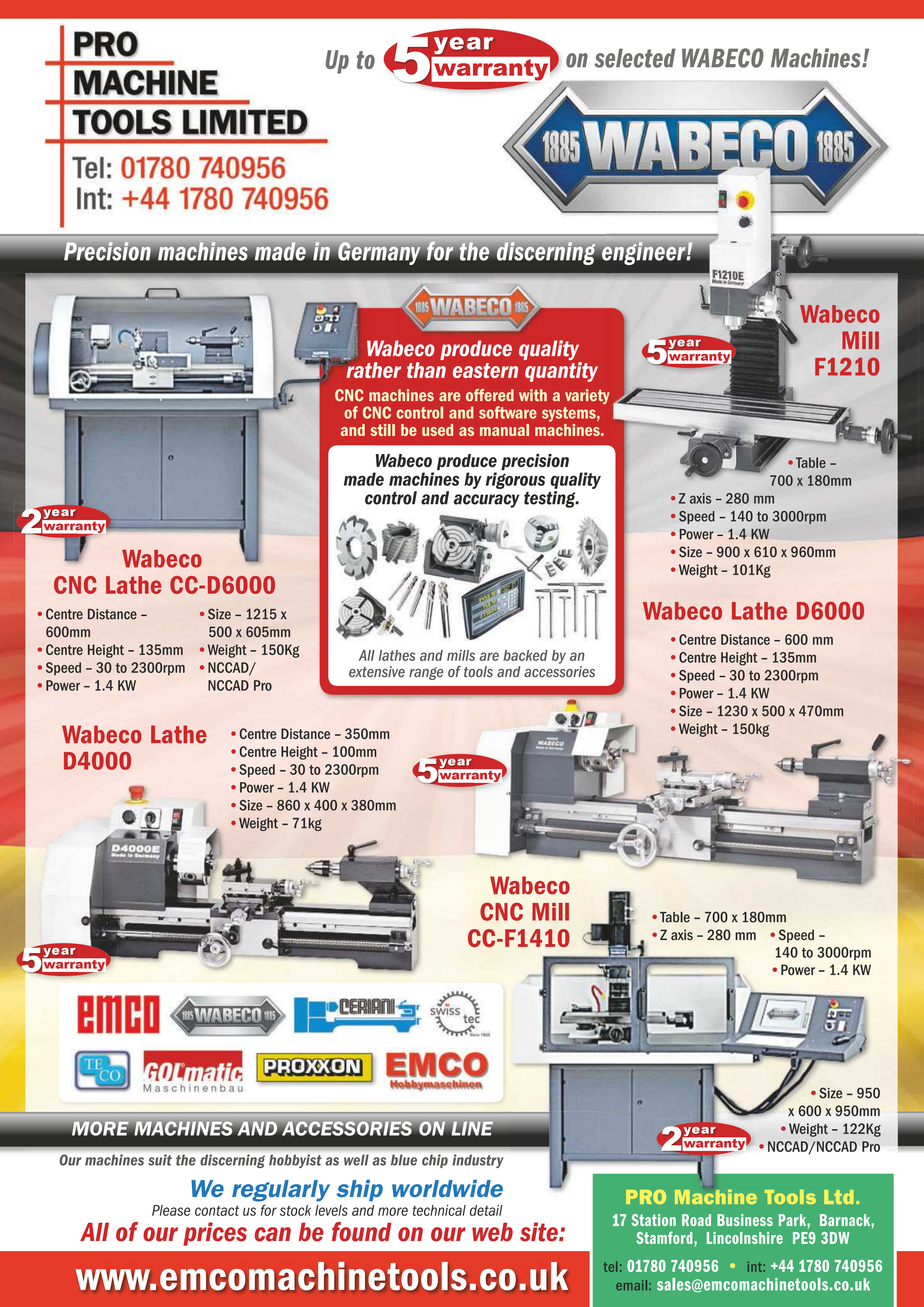

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# Extending the capabilities of the Jacobs Gear Hobber.

## Differential indexing, worm gears and more. By Chris Robinson – Part 2

### Hobbing wheels to mesh with a left-handed worm

Ideally to do this you need a left-handed hob but these are hard to come by. However, a reasonable approximation can be achieved with a right-handed hob by turning the cross slide anticlockwise, as for a LH helical gear, to twice the lead angle of the hob. The worm wheel in photo 8 is actually a 39T Mod 0.8 wheel being hobbed with a right-handed hob to mesh with a Mod 0.8 left handed worm. The lead angle of the hob is 2° 3' so the cross slide is set over at an angle of 4° 6' in the sense of hobbing a LH helical gear, otherwise the process is just the same as described above. The finished gear pair is shown in **photo 10**. Comparison with photo 9 will reveal the RH and LH helices.

10

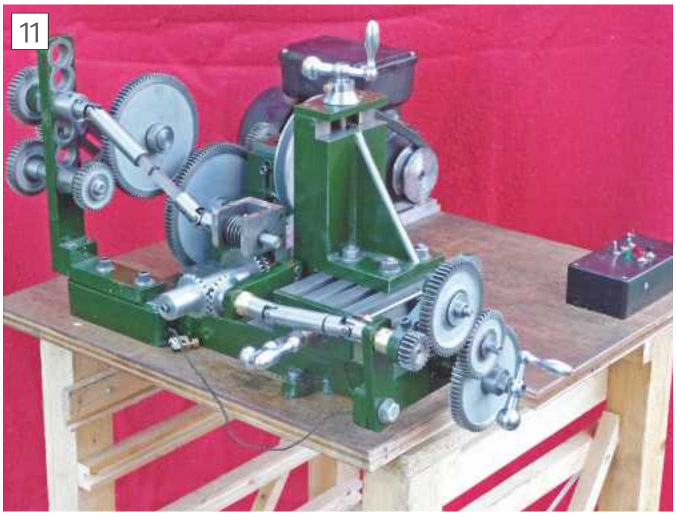
*Finished Mod 0.8 LH worm and 39 tooth wormwheel*

### Using taps as hobs.

It is quite possible to use an ordinary thread cutting tap as a hob. However, because taps are designed to cut in an axial direction then to use them, a means must be found to feed the work parallel to the tap axis. The relief on a tap to allow it to cut is only on the lead in, unlike a true hob where all teeth are relieved allowing it to cut anywhere along its length. In the context of gear hobbing, this is generally referred to as a "tangential feed", because it is in the direction of a tangent to the workpiece.

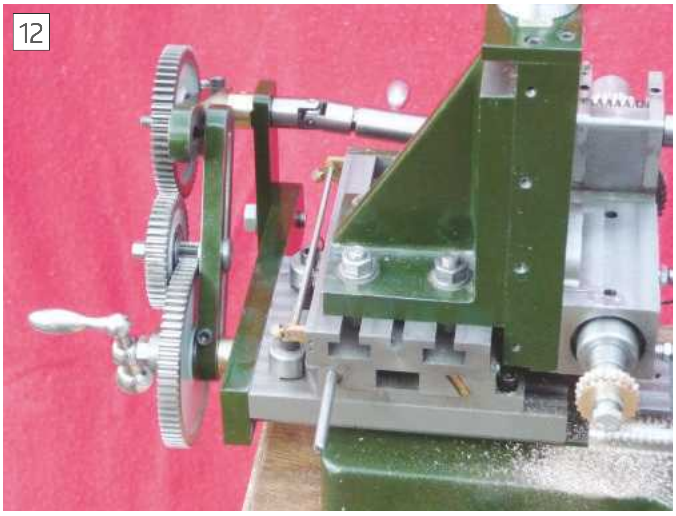
The longitudinal slide of the Jacobs machine is not strictly necessary for making spur and helical gears, but for using a tap as a hob requiring a tangential feed it is most useful. By taking a bevel drive from the workpiece arbor this can be linked to the longitudinal feedscrew through a set of gears as shown in **photos 11** and **12**, thus

11



*Set up for tangential feed*

12



*Gear train for tangential feed*

making it a powered feed. It will be noticed from photo 12 that two banjo arms are used to bridge the necessary gap. The existing ones can be used. The additional parts are shown in **photo 13**. The largest piece (top, centre) replaces the longitudinal slide thrust plate and supports a banjo arm, a stub shaft and another bracket (bottom, right). This in turn supports the second banjo arm and a stub shaft (these are shown but were already made) to carry an extra 2 gear cluster. This allows a set of 6 compound gears to be used for the feed allowing a much richer choice of feed ratio. A third bracket (bottom, left) fixes to the workpiece arbor housing and carries a second stub shaft (bottom, left) to which is fixed a bevel gear which meshes with a second bevel gear (also bottom, left) keyed to the workpiece arbor. The two stub shafts and the universal joints connecting them via a sliding coupling are shown on the bottom row. Finally, a leadscrew on which gears can be mounted is required. The elongated leadscrew (top, left) made for plunge feed (photo 7, right) can be used. Photos 11 and 12 just show a single idler between the first two shafts of the feed train so in this case there are only 4 compound gear plus the idler. As for the differential, the bevel gears for this drive are parallel depth bevel gears as per ref. 3, pages 104 – 111.

In addition, a means must also be found to mount the tap. Here a new mainshaft was made and bored to accept ER20 collets and threaded 25 x 1.5mm pitch to take the collet nut. ER20 collets can accept taps with shank diameters up to 13 mm. This can be seen in **photo 14**.

*Additional parts for tangential feed*

*Cutting a 22 tooth wormwheel with a 5/8" x 8 tpi RH ACME tap*

## Workpiece motion correction

Because we now have a feed motion parallel to the hob axis, the index gears must be corrected in just the same way as in making helical gears though the calculation is slightly simpler. To calculate the index ratio "I" between hob and workpiece we need the following data referring to **fig. 5**:
T = number of teeth on gear to be cut, Mod = module of gear to be cut, M = Machine constant, S = Number of starts on the hob

p = Pitch of the feed screw, R = Gear ratio workpiece : feed screw (feed ratio), Ps = Profile shift ratio

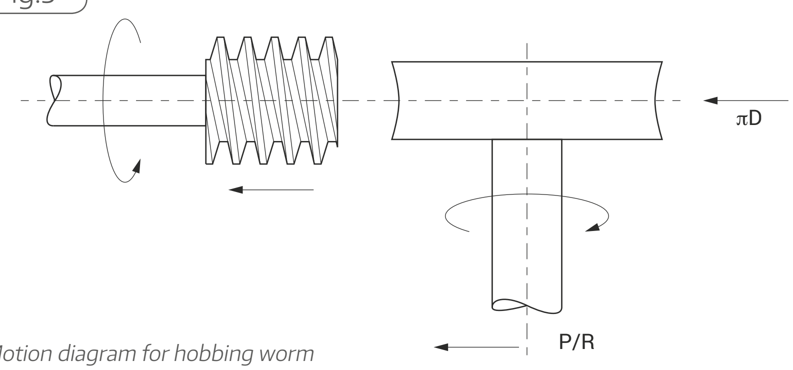
Note that an additional variable S, the number of starts on the hob, has been introduced here. This is because multi-start hobs are often used when hobbing worm wheels whereas there are generally no advantages in using them for spur and helical gears. For our purposes two-start ACME taps are available and can make useful hobs.

The feed ratio R is defined as: Number of turns of the workpiece for one turn of the feed screw. Normally the profile shift ratio Ps = 1. For an explanation of profile shift ratio, see the paragraph at the end of the last section prior to conclusions.

The Index ratio for making a spur gear I = M/(S x T). The PCD of the gear D = T x Mod x Ps

Referring again to fig. 5 which represents hobbing a worm gear with a right handed hob using tangential feed. For each revolution of the workpiece the distance parallel to the hob axis travelled by a point

Fig.5



*Motion diagram for hobbing worm wheels with tangential feed*

*Data for ACME taps suitable for use as hobs*

Table 1

| Nom Dia | Dia Inch | Dia mm | TPI | Pitch | Equ DP | Equ Mod | OD/pitch |
|---|---|---|---|---|---|---|---|
| 5/16 | 0.3125 | 7.9 | 16 | 0.0625 | 49.8 | 0.51 | 5 |
| 3/8 | 0.375 | 9.5 | 10 | 0.10 | 31.4 | 0.81 | 3.75 |
| 7/16 | 0.4375 | 11.1 | 10 | 0.10 | 31.4 | 0.81 | 4.375 |
| 1/2 | 0.5 | 12.7 | 10 | 0.10 | 31.4 | 0.81 | 5 |
| 5/8 | 0.625 | 15.9 | 8 | 0.13 | 25.1 | 1.01 | 5 |
| 3/4 | 0.75 | 19.1 | 6 | 0.17 | 18.8 | 1.35 | 4.52 |

*Spreadsheet output for hobbing worm wheels with ACME taps*

Table 2

Input Field
Output field

**WORM GEAR WITH TANGENTIAL FEED**

| | | | |
|---|---|---|---|
| No teeth of gear to be cut | | 22 | |
| TPI of hob | | 8 | |
| Linear pitch mm | | 3.175 | |
| Module | | 1.01063388 | |
| Cross feed pitch | | 1 | mm |
| Width of gear | | 8 | mm |
| Trial Cross feed ratio | | 16 | |
| Corrective ratio for trial feed | | 0.99910603 | |
| Depth of cut ACME | | 1.588 | mm |
| Cross feed ratio | | 16.1344537 | |
| Pitch diameter of gear | | 22.23 | mm |
| Pitch circumference of gear | | 69.85 | mm |
| OD of gear | | 24.26 | mm |
| ID of gear | | 19.90 | mm |
| Corrective ratio exact | | 0.999113469 | |
| Corrective ratio used | 47 | 0.999113475 | |
| Feed ratio/input red'n | | 16.134574 | |
| Feed to traverse gear (2 x width) | | 16.0 | mm |
| Cross feed per rev of wk arbor | | 0.0620 | mm |
| No revs of wk arbor to cut gear | | 225.88 | |
| Pitch circumference of gear | | 69.8500000 | mm |
| Cicum dist/rev exact | | 69.7880758 | mm |
| Cicum dist/rev used | | 69.7880762 | |
| Tooth thickness error/rev | | 0.000000461 | mm |
| Tooth thickness error total | | 0.000119091 | mm |
| Thickness of tooth | | 1.59 | mm |
| Thickness reduction | | 75.02 | ppm |

| Tangential feed gears | | Ratio | 16.13445378 | Total |
|---|---|---|---|---|
| Driver 1 | Driven 1 | Driver 2 | Driven 2 | teeth |
| 17 | 48 | 14 | 80 | 159 |

| Corrective gears | | Ratio | 0.999113475 |
|---|---|---|---|
| Driver 1 | Driven 1 | Driver 2 | Driven 2 |
| 49 | 48 | 46 | 47 |

| Index gears | | Ratio | 0.55000000 | Total |
|---|---|---|---|---|
| Driver 1 | Driven 1 | Driver 2 | Driven 2 | teeth |
| 40 | 1 | 1 | 22 | 210 |

Input Field
Output field

**WORM GEAR WITH TANGENTIAL FEED**

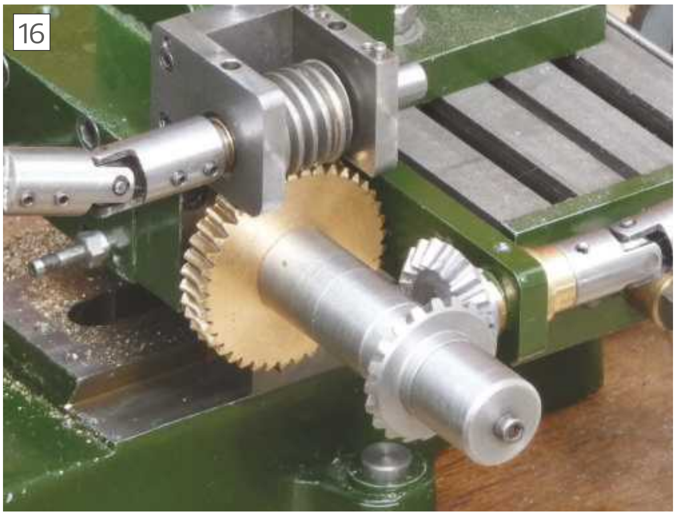
| | | | |
|---|---|---|---|
| No teeth of gear to be cut | | 27 | |
| TPI of hob | | 10 | |
| Linear pitch mm | | 2.54 | |
| Module | | 0.80850711 | |
| Cross feed pitch | | 1 | mm |
| Width of gear | | 7 | mm |
| Trial Cross feed ratio | | 16 | |
| Corrective ratio for trial feed | | 0.99908949 | |
| Depth of cut ACME | | 1.270 | mm |
| Cross feed ratio | | 16.4335664 | |
| Pitch diameter of gear | | 21.83 | mm |
| Pitch circumference of gear | | 68.58 | mm |
| OD of gear | | 23.45 | mm |
| ID of gear | | 19.96 | mm |
| Corrective ratio exact | | 0.999113486 | |
| Corrective ratio used | 47 | 0.999113475 | |
| Feed ratio/input red'n | | 16.433362 | |
| Feed to traverse gear (2 x width) | | 14.0 | mm |
| Cross feed per rev of wk arbor | | 0.0609 | mm |
| No revs of wk arbor to cut gear | | 230.07 | |
| Pitch circumference of gear | | 68.5800000 | mm |
| Cicum dist/rev exact | | 68.5192029 | mm |
| Cicum dist/rev used | | 68.5192021 | |
| Tooth thickness error/rev | | 0.000000754 | mm |
| Tooth thickness error total | | 0.000173431 | mm |
| Thickness of tooth | | 1.27 | mm |
| Thickness reduction | | 136.56 | ppm |

| Tangential feed gears | | Ratio | 16.43356643 | Total |
|---|---|---|---|---|
| Driver 1 | Driven 1 | Driver 2 | Driven 2 | teeth |
| 22 | 47 | 13 | 100 | 182 |

| Corrective gears | | Ratio | 0.999113475 |
|---|---|---|---|
| Driver 1 | Driven 1 | Driver 2 | Driven 2 |
| 49 | 48 | 46 | 47 |

| Index gears | | Ratio | 0.67500000 | Total |
|---|---|---|---|---|
| Driver 1 | Driven 1 | Driver 2 | Driven 2 | teeth |
| 40 | 1 | 1 | 27 | 210 |


*Completed 22T x 8 tpi RH and 27T x 10 tpi LH worms and wheels*

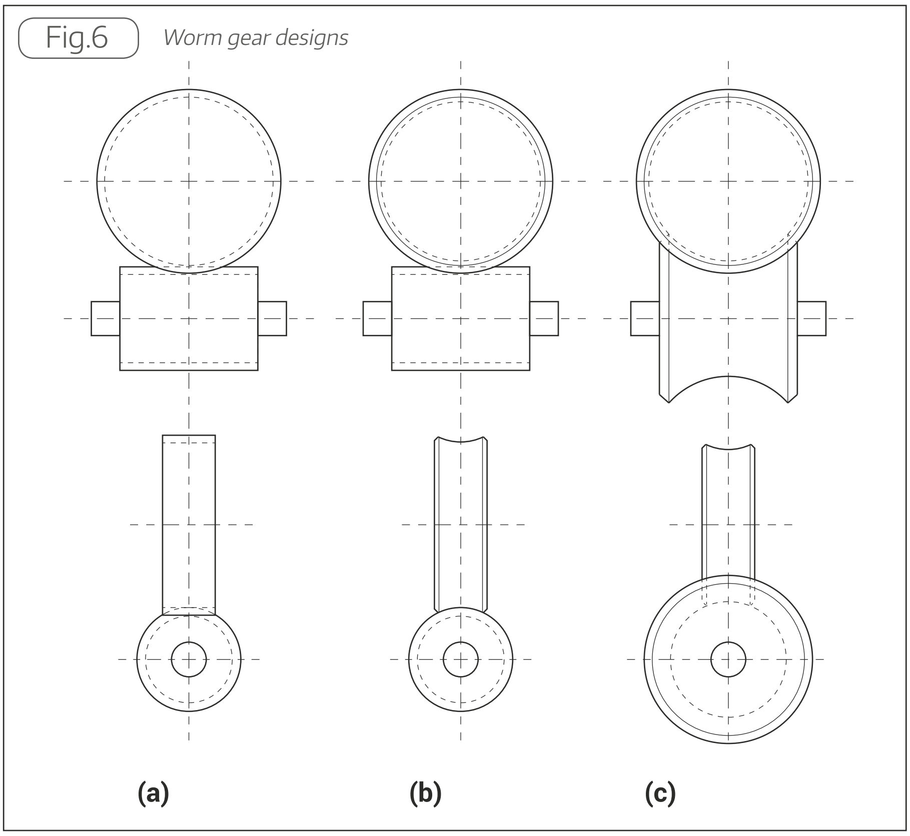



*20DP right handed worm and wheel for the index drive*

on the PCD of the gear being cut, relative to the cross slide = π D. However, the cross slide itself will have moved a distance = p/R in the same direction, so the motion relative to the hob is a little more and equal to π D + p/R. To correct for this the motion must be slowed down by a ratio which can be expressed as :

π D/(π D + p/R) = 1/(1+ p/ π RD), so the modified index ratio becomes I = M/{S x T(1+ p/π RD)}

The spreadsheet already designed for helical gears has been modified to find compatible combinations of index and feed gears.




## ACME taps as hobs

ACME taps are a good choice for a hob because they have a profile quite similar to a standard tooth profile with a 141/2-degree pressure angle. The thread form will give a tooth depth somewhat less than that of an equivalent standard rack (about 78%) but this will be adequate for most uses. ACME taps are typically available from 5/16" to 3/4" in both RH and LH form, and are compared in **Table 1**.

Regular fastening thread taps could also be used but will be equivalent to a pressure angle of 30° for Unified and metric, 27.5° for Whitworth, which is generally higher than ideal though gears of 30° PA are used in the aircraft industry. BA taps offer the equivalent of a 23° 45' pressure angle which would be suitable except the largest size being 6mm, they are too small to be of much use.

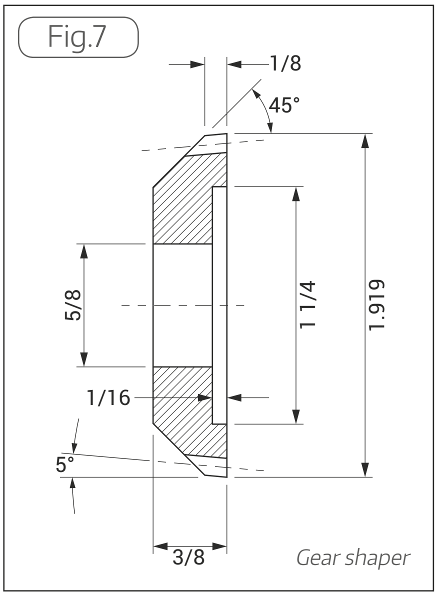
## Cutting a 22T wormwheel using a 5/8" 8 tpi RH ACME tap

**Table 2** (left hand column) shows the spreadsheet calculation for the index and feed gears for cutting this wormwheel. Note that the OD and ID of the blank are different from a regular involute gear since the tooth depth is ½ pitch as opposed to 2/DP in inches or 2xMod in mm which is equivalent to (2/ π) x circular pitch = 0.637 x circular pitch. The blank thickness was chosen as 8mm, otherwise the blank dimensions are calculated as in the previous example. It was decided to cut the wheel in one pass so a slower feed ratio of about 1:16 was chosen. Since the "hob" is of smaller diameter (5/8") it was driven at a higher speed using 30T/100T drive gears to give a similar cutting speed to the purpose made hobs.

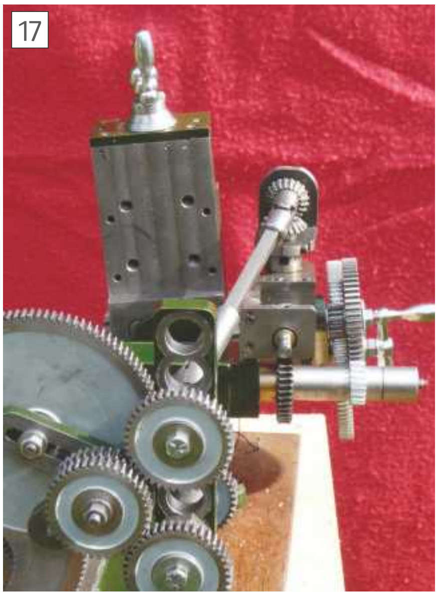
**Photograph 14** shows cutting in progress and **photo 15** shows the completed worm and wheel combination (the larger of the two), to give some idea of scale, the worm is mounted on a 5/16" shaft and the wheel bore is 3/8".

## Cutting a 27T worm wheel with a 1/2" 10 tpi LH ACME tap to mesh with a LH worm

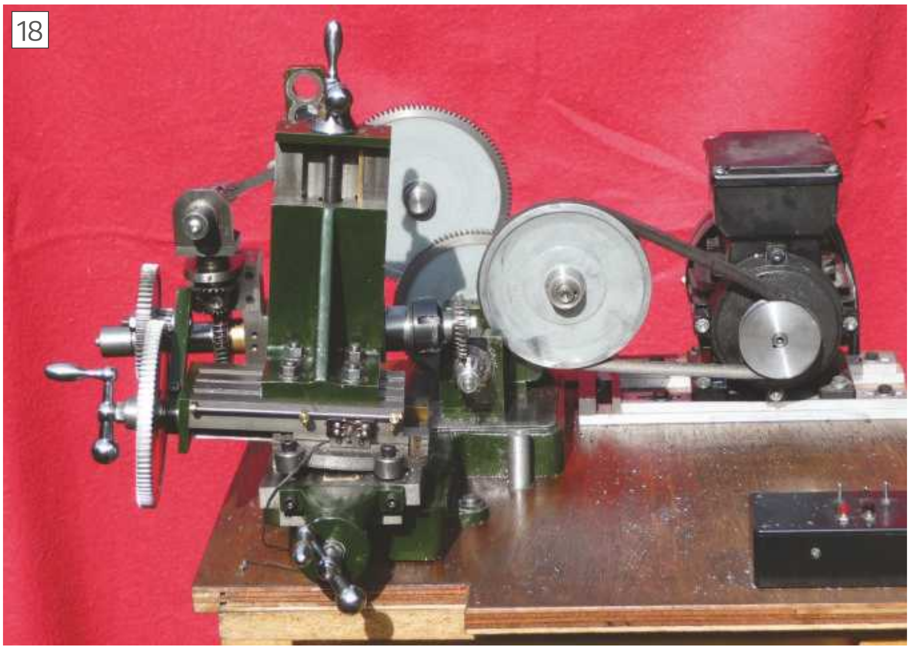
Since Left Hand ACME taps are readily available, it is fairly straightforward to hob a worm wheel to mesh with a LH worm. In this case the hob must be driven in the opposite direction but since the index motion for the workpiece must remain the same, the LH worm and wheel in the index drive must be replaced by a RH pair, **photo 16**. The 40T RH wheel for this is easily made on the machine by the method already described above provided you have the necessary hob. I had a 25mm diameter Mod 1.25 hob which is very close to the 1" diameter 20DP worm specified by the CES drawings. The Mod 1.25 40T worm wheel was made slightly oversize to keep the centre distance the same as the CES pair. A 27T worm wheel to mesh with a ½" diameter 10 TPI left hand worm was made in this way. The spreadsheet calculation for the index and feed gears is shown in table 2 (right hand column). The resulting worm




Gear shaper



Work arbor motion inclined at 50



Hobbing the 37T gear shaper

and worm wheel pair are shown in photo 15 (the smaller of the two), here the worm is mounted on a ¼" shaft.

## Making a double enveloping worm and wheel

**Figure 6** shows three designs of worm and wheel pairs. 6(a) is a worm mating with a standard helical gear and the two will have point contact only. 6(b) is a worm mating with a throated wheel such as those described above and the two will have a greater load capacity than 6(a) because they will have line contact. 6(c) is a design where the worm is also throated and in effect wraps itself around the wheel resulting in multiple line contacts and giving further load capacity. This design is referred to as a double enveloping (or double throated) worm and wheel pair.

Of all the gear hobs in my possession the one closest to a worm gear hob is the one of Mod 1.25 with an outside diameter of a shade under 25mm, the same one used to make the RH index wormwheel in the last section. This gives it an OD/pitch ratio close to 7 compared to 5 which is typical for industrial worm gear hobs, so this was selected for making a double enveloping worm and wheel.

To make an enveloping worm requires a cutting tool to move in a circular arc the same as the teeth of the worm wheel with which it must mesh. This could be a single point tool as used to cut cylindrical worms on the lathe but in this case, not only must the cutter describe a circular arc, but its rotation must be indexed to the worm blank rotation with the correct ratio. While this would involve much complexity on a workshop lathe, the hobbing machine itself already possesses this capability. If a straight cut spur gear is made to the correct dimensions in hardened steel with the teeth relieved so they will cut, we can simply turn the machining process around and have the gear cut the worm. The tool required is shown in **fig. 7** and is effectively a disc type gear shaper similar to that pioneered by the Fellows Company in the USA early last century for cutting internal gears.

This shaper can be hobbed as any spur gear on the machine but the need to relieve the teeth introduces an additional requirement. The rear of the cross slide was packed to incline it downwards at the appropriate clearance angle, 5° was chosen in this case. The workpiece arbor housing was mounted on the vertical slide via a packing piece inclined at 5° upwards thus returning the axis of the workpiece arbor to horizontal. This can be seen in **photo 17**. Also shown in photo 17 is the 20T helical gear made to drive the cross feed. This has a helix angle of 5° right handed to allow for the inclination of the feed gears on the cross slide. This arrangement allows the teeth of the shaper to be cut with the correct profile while still having a relief angle for cutting. The machine setup is shown in **photo 18**. A 37T gear was chosen having an OD a little under 2". Any hardenable steel such as silver steel would suffice but in this case EN24 was used.

Having made the blank as per fig. 7, the shaper was hobbed in the usual way, see photo 18. After hardening, the front face was ground on a Quorn tool and cutter grinder to ensure sharp edges. The worm blank was a simple turning job. It was made from 1 1/8" diameter mild steel with a width of 7/8". The bore was 10mm to match an existing hob spindle. The OD profile needs to be a radius to match the ID of the gear which is (35 x 1.25)/2 = 21.88mm. A simple circular arc turning fixture was made up as shown in **photo 19**, and the blank finished to diameter equal to the OD of the hob at the "neck".

**To be continued**

Turning the throated worm blank

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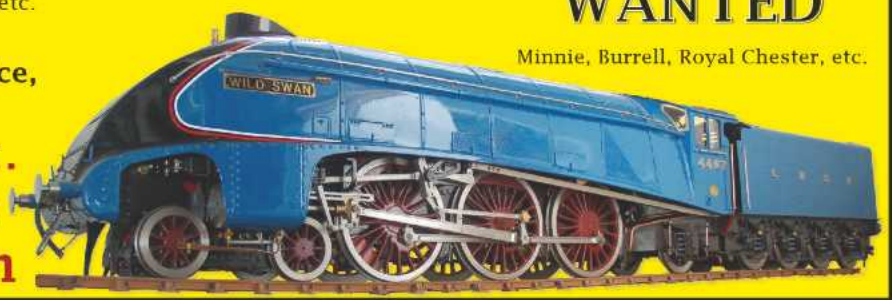


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