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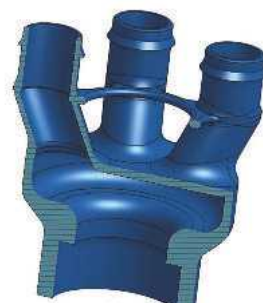
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On the Editor's Bench

On The Editor's Chair

Today, the Editor has a new chair!

Over Christmas, an occasionally niggling bad back decided to turn into a real problem. Sorting out the fit of my Mother-in-Law's back door finally finished me off. With more than thirty minutes in a chair locking me into an L-shape and requiring a longer period of rest, I had to do two things – first book a doctor's appointment, and second, order a proper 8-hour typing chair with lumbar support, instead of the rather droopy one I have been using. So I got one on next day delivery... it has just arrived! It's given me plenty of time to overcome the bad back and then lose a molar. I will spare the details, but back painkillers masked the toothache really well, so I only found out when my face ballooned...

So after wallowing in bathos, back to the chair. Like all the best flat pack things, it totally justifies the male imperative to throw away the instructions. I omitted this step and spent more time trying to figure out what the Coupling CPT was than actually building up the chair. Coupling CPT is easily identified as the only un-named object in the assembly diagram, being the bit that holds everything else together.

Perhaps the worst instruction was to 'take off the plastic sleeve from side



screw of the coupling CPT and then screw the adjustment screw A. This kept me going for several minutes, for after removing 'Adjustment Screw A' I couldn't see what the point was, so I put it back together. I was nervous on this point – failure of Adjustment Screw A is one reason why the old chair was so bad for my back.

Well, it's all together now, I just have to bear in mind the remarks. Fortunately, 'don't heat or take apart the gas lift' is simple enough to understand. I will try to avoid the places of high humidity level – usually only a problem when I spill my tea. I am concerned though about how to 'avoid the contact with the warmth spring'. Does this mean the chair can only be used in the chill of winter?

After 30 days of exploitation, I will not forget to strengthen the screws of the mechanism under seat.



Adjustment Screw A.

FUME FEVER

Bob Smith got in touch after reading my warnings about zinc fumes. He pointed out that the condition is cumulative and can be fatal, and supplied a link to an American website that reported the untimely death of a metalworking blogger who had died following an attempt to 'burn off' zinc from a batch of metal. Ironically he had made sure that colleagues were all kept away from the fumes. It is important to remember that any zinc containing metal, such as brass or galvanized steel, as well as materials with cadmium plating or containing lead etc. can all release potentially harmful levels of metals on heating whether by smelting, brazing, forging or welding. Please take care to reduce the risks by working in a well ventilated environment and using proper protective gear as appropriate when heating such materials.

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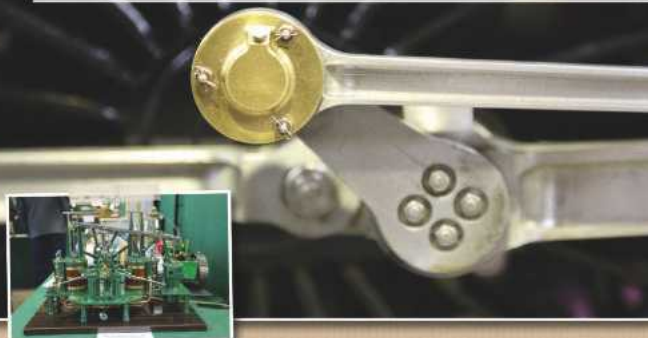
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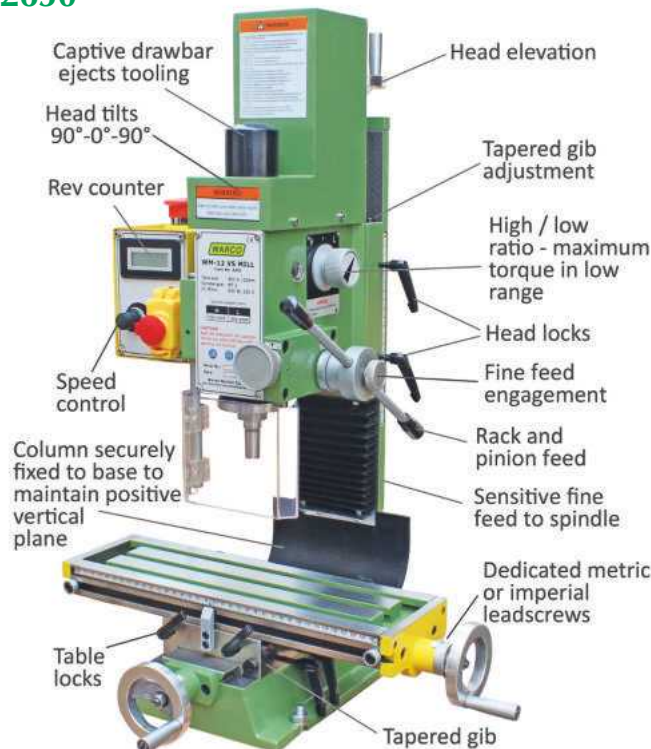
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Nick Farr made this sensitive pillar tool from an old drilling machine, see page 68 for the full story.



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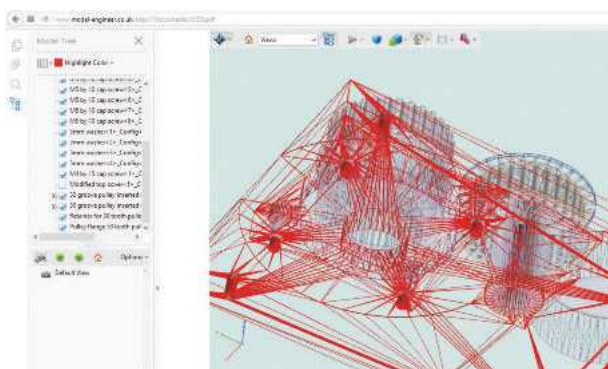
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RBelt Drive for an X3 Mill

In response to requests from forum members, a further updated 3D model has been added. It is worth taking a look just to see the incredible range of viewing options and features available within Adobe Acrobat viewer.

<http://www.model-engineer.co.uk/sites/7/documents/X3D3.pdf>



Other hot topics on the forum include:

- Hot Air and Stirling Engines
- Understanding the Square/Cube Law
- Workshop Radio - To DAB or Not To DAB?
- Recommendations for Neat Cutting Oil

AND:

- Do YOU finish every project before moving on?

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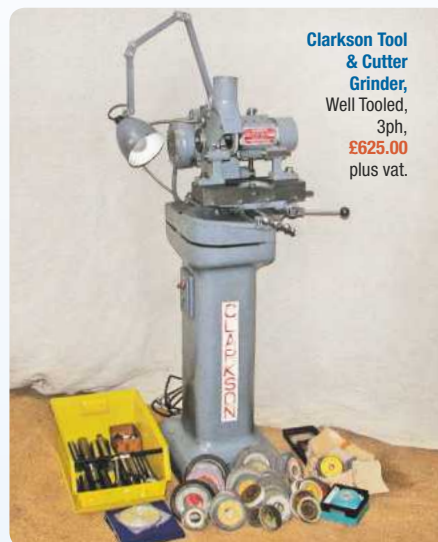
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Improvements to a Myford Super 7 Lathe



David Salter, a retired RN marine engineer officer and engineer/yacht surveyor describes some modifications to his machine.

I bought my Myford when I was approaching retirement and when I found some usable cash lying around not being used properly, such that I could start using my time properly building steam engines. For a couple of years before, I had been steadily studying available machines, comparing their capabilities and deciding what I wanted for myself. I realised that when I finally got the lathe, it was going to be almost 25 years since I was last at sea and so 25 years since I had done any turning at all. Worse, it was over 43 years since I finished my apprenticeship – time to be cautious.



Myford Super 7 in micro-workshop.

I decided on the Myford for several reasons, despite the much higher price tag. Simplicity of layout, availability of real low speeds - I always loved screwcutting and my sort of screwcutting

doesn't work at 200 rpm – the quality of construction and, yes, the old fashioned look of a real centre lathe. I finished up buying a good secondhand machine of 1991 vintage with a star/delta dual voltage 3 phase motor as I had the intention of powering from a 220 V single phase input 3 phase output inverter to give variable output speed. I managed to install the lathe safely in our 42nd floor 900 sq ft flat overlooking the airport in Hong Kong although sadly in a small spare room with no window rather than take over the sitting room and view from the balcony (see **photos 1 and 2**). Pity, I know, it would have been good to have a lathe with a view.

Electrical

The motor is rated at 2.3 A at 220 V 3 phase AC, giving just over 700 W power. I chose a TECO 7300 CV 1 hp inverter with a remote control pod. This offers good turn down to as low as 5 Hz without loss of torque. I mounted the inverter on a purpose made bracket on the left hand end of the stand (mine is the Myford industrial stand), **photo 3**. It is under the



The view over HK Airport that the Myford will never have.

overhang of the bench which protects against damage and I only need to access the display during setup. I installed the remote control pod for On/Off/Reverse and speed control on the front of the stand just under the lip with an emergency stop/double pole no-voltage-release switch immediately next to it for best access. Using the NVR switch enables me to isolate the lathe and inverter fully when not in use, rather than just the lathe with the inverter left live.

The lathe came with a 12V DC halogen work light. Rather than wiring this separately, I took AC power from the inverter input busbar and reused a redundant 12V printer PSU strapped to the back of the inverter to supply the light. This way it is also isolated when the NVR switch is put to off. Since installation, the inverter and motor have performed faultlessly. I set max frequency to 50 Hz as I have no need for step up speeds. I also did not wish to risk overstressing the motor by exceeding the rated output speed. Being able to turn down the speed is what is important. The standard range of belt combinations remain unchanged of course, giving 8 speeds from 210 to 2105 rpm ungeared and 27 to 270 rpm geared and I do use these as the baseline for any job because I want to keep the inverter and motor operating at as near to normal design conditions as possible for most of the time. However, having the ability to

reduce speed for short periods is absolutely invaluable, while facing a large cross feed surface for instance, checking a set up before starting a cut or eliminating a surface chatter on a cut. I have not bothered with fitting a frequency meter as I find I can gauge the speed turn down I need very satisfactorily by ear.

Headstock drive belt

When my lathe was delivered, the drive V-belts were aging and oil softened, particularly of course the headstock belt. Changing the primary drive belt was easy but I hesitated before starting dismantling the headstock to install a new one-piece drive belt. I tried a cheap set of link belting from an online supplier but found it unsatisfactory. It stretched once installed and became more of the consistency of a large elastic band. To achieve enough tension to eliminate slippage from the smooth plastic V-surface, the side loading on the countershaft bearings was so high that they complained, plus the links stretched further as they warmed up causing yet more slippage. Completely unacceptable ... and of course I had already cut off the old oily original belt. I was about to face the inevitable and start stripping the headstock when I found that RS Components in HK stock real Fenner PowerTwist Plus A/13/4L link belting (**photo 4**). This link belting

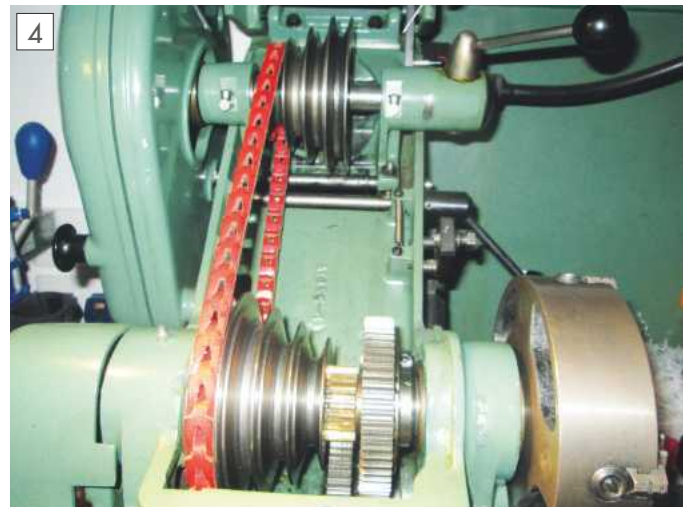
has established a very good reputation in the engineering industry. Fenner's specification indicates that the link belting at least equals the performance of conventional rubber V-belts and in adverse oil and dirt conditions usually outperforms it. Since I installed the new belt, it has proved to be totally successful, quick to install, with ample friction to avoid any overtensioning and almost silent in operation. Okay, it was more expensive than the standard belts at £36 but this was for a 2 m length which provides enough for 2 complete changes and spares besides. I fitted it while I was still working when my consultancy rate was enough that I can persuade myself that I probably saved myself around £400 by taking 5 minutes to fit the Fenner instead of 4 or 5 hours for the fixed length spare. For anyone else interested in this belting, I am confident that it should be readily available in UK from a wide number of sources.

Lathe tooling

Around the same time as I bought the lathe, I was given a box of assorted smallish lathe tools courtesy of a friend clearing an elderly relative's house. Included in this box were a number of brand new 10mm shank indexable tools with lots of spare CCMT 06 inserts; most of the remainder comprised HSS tools



Electrical installation on Myford stand – emergency stop/NVR, inverter and remote control pod.



Fenner PowerTwist Plus A/13/4L link belting for headstock drive.



$\frac{3}{8}$ " and 10mm tooling.



Quick change toolholders.

similarly of 10mm or $\frac{3}{8}$ inch (9.5mm) shank. Also in this treasure trove box were a rear parting toolpost with parting toolholder and several individual quick change toolholders which matched the Myford toolpost although they appeared to be from different manufacturers. The set of Myford's own HSS tools I had bought with the lathe were all $\frac{3}{8}$ inch shank with grooving for use with the scalloped adjustable base. A selection of these is shown in **photos 5 and 6**.

I wanted to use the $\frac{3}{8}$ inch and 10mm tools and in particular the 10mm right hand knife indexable tool:

- Because I had them.
- Because the extra tool stiffness compared to 8 and 6mm tools enables better finishes and also use of larger tool overhangs, important when working close to the tailstock to avoid contact between the top slide and the tailstock.
- Because I want the best tool stiffness when doing interrupted cuts such as facing castings and machining crankshafts.
- Because I have a bad habit of using the RH knife tool for universal turning and would spend an inordinate amount of time resharpening a HSS tool, whereas changing an indexable insert takes a few moments and I can reuse the worn insert in the roughing tool when I do remember to change tools

I also wanted to use the quick change toolholders on front and rear toolposts as my standard so as to avoid the endless routine of resetting height with shim packs at every tool change. The quick change toolholders all had space for tools with shanks of at least 12mm and some as large as 14mm, giving the impression that such tools may work. So I happily started installing the beautiful indexable tools in the toolholders, only to be totally set back in my tracks to discover that I could not get the tool cutting tips down to anywhere near centre height. Okay, time to put the steam engine plans aside and go back to some engineering.

Inspection and measurement of all the toolholders revealed quite large variations. It turned out I had a real mixed bag. There was the original equipment that came with my lathe, a Dickson toolpost with the Myford label on it and 3 Myford toolholders, 2 standard and 1 boring with the groove in the base for round tools. The rear parting toolpost and toolholder work really well and are easy to keep sharp and adjusted to centre height. The front parting toolholder was clearly of different manufacture but fitted well and could easily be adjusted to correct centre height (although more on that later). The Dickson-copy rear toolpost presented no problem and toolholders were interchangeable; however, it wasn't quite so easy with the remaining 7 toolholders. Most had sharp corners which made engagement with the toolpost cams difficult; okay, easily fixed with a lap and a bit of care. Much, much more problematical were the dimensions of the front toolpost toolholders. Full down height adjustment should give lowest tool tip position, with the base of the toolholder bottom flange touching the top slide top face, BUT:



Standard toolholder set full down on top slide.

- Except for the Myford toolholders, the height adjusting studs were all too short by some .250 inch. To allow adjustment full down, the studs need to be long enough to permit the adjusting screw bottom flange to extend to 0.700 inch above the toolholder top face. I renewed them with longer studs, after which they worked as designed.
- The bottom flanges of most of the toolholders were far too thick to permit the tool cutting tip to be adjusted down to centre height for 10mm and $\frac{3}{8}$ inch tooling unless the cutting tip has been dropped by grinding the top surface of the tool. Thicknesses varied from 0.24 inch for the original standard Myford holders up to 0.30 inch.

Any solution to the dilemma required quantitative knowledge. Accurate measurement on my lathe gave:

	Inches	mm
Height of cross slide table above lathe bed	1.432	36.37
Height of top slide top surface above cross slide table	1.443	36.65
Height of headstock spindle centreline above top slide surface	0.625	15.87

It was interesting to note that the centre height above the lathe bed = 3.500 inches exactly although I understand that on some lathes there is frequently slight variation in this centre height.

The last of these dimensions, the height of the headstock spindle centreline above the top slide top surface, is the crucial dimension for tool height setting since the lowest the tool tip can be adjusted to is when the toolholder is full down flush to the top surface of the top slide (see **photo 7**). Therefore, using standard or boring toolholders, limiting maximum tool height

measured from the cutting tip down to the base of the shank is:

(Height of headstock spindle above top slide) minus (toolholder bottom flange thickness)

For 0.24" flange, max tool height = $0.625 - 0.240 = 0.385"$ (9.78mm), ie will accept $\frac{5}{16}"$, 8mm and $\frac{3}{8}"$ tools but not 10mm

For 0.30" flange, max tool height = $0.625 - 0.300 = 0.325"$, ie will accept $\frac{5}{16}"$ or 8mm tool but not $\frac{3}{8}"$ or 10mm

There are a number of solutions:

- Use smaller tools. Sure, you can restrict your tooling to 8mm or less. This is the size that mini and micro lathes use. Using them on a Super 7 significantly reduces the cutting capability of the Myford. Tool overhang from the toolholder cannot be much over 0.5 inch for even quite moderate cuts and for any interrupted cut simply doesn't work as the tool bends. By comparison, I routinely use up to an inch overhang and sometimes more on 10mm tools, especially turning with tailstock or between centres as it keeps the top slide away from the tailstock. The Myford lathe with the correct size tooling is a big strong and stiff machine, capable of quite large cuts when required. Anyway, since I already had the 10mm tooling, restocking with smaller tooling wasn't an option for me.
- Selective installation. Obviously some tools like small boring bars and threading tools present no problem. Any tool where the cutting tip has been reduced in height above the shank base to 8mm or less can be installed and adjusted to centre height, even if the shank is $\frac{3}{8}$ inch, 10mm or even 12mm. Such tools include older many times reground HSS tooling and most boring tools where the cutting tip is mounted at around $\frac{1}{2}$ shank height. However,

all the full height tools including all indexable knife, rough cut and profiling tooling still cannot be used.

- c. Modify the underside of the toolholder by grinding a step such that it can overhang the edge of the top slide top surface (note that this feature is used on the standard front toolpost parting toolholder to enable use of a 0.5 inch depth parting blade), **photo 8**. This step gives much more freedom for tool height and indeed can allow use of larger tooling up to 12mm tool height with 12mm shank. However, such a stepped toolholder has the major disadvantage that the overhang prevents the toolpost from being rotated relative to the topslide and hence restricts use of the toolholder only at 90° or 180° to the top slide (**photo 9**). This creates a major restriction to accurate turning when using the tailstock centre as the topslide cannot be oriented parallel to the lathebed and hence cannot be used to set offsets. With the parting toolholder, the step is far enough away from the toolpost pivot to allow around 20° of adjustment (**photo 10**). Another factor against stepping the toolholders is that it is not easy to get the grinding of the step done on an existing standard toolholder because any self-respecting owner of a good quality surface grinder wheel would not permit it to be used for edge grinding into a corner. So these stepped toolholders will probably only work if one buys a new set already stepped (presently available from RDG Tools).

- d. I believe that the best final and definitive fix is to reduce the thickness of all the toolholder bottom flanges by surface grinding since it restores the ability to use any tooling up to 10mm shank thickness without any restriction. Even the 'copy-Dickson' holders are made of good quality steel and hardened; so there is still ample strength in the toolholder bottom flange to prevent any distortion as the tool setscrews are tightened. I simply stripped all the holders of studs and setscrews and found a friendly engineering works who surface ground the bottom faces of all the holders (including the original Myford standard ones and the 2 boring bar holders) to



Modified toolholder showing stepped bottom face and standard parting toolholder.

reduce the flanges to 0.228 inch (0.003 inch of flexibility included in this). £5 per holder that I hadn't planned for but well worth it. The result is that I now have 10 interchangeable toolholders which I can use for any size tooling up to 10mm. Even the 2 boring tool holders accept 10mm square shank tools completely satisfactorily as the tool spans the V-groove whereas smaller shank tools partially tip into the groove when secured losing the tool geometry.

Myford own spares on www.myford.co.uk
Flange 0.245 inch (6.22mm)

RDG Tools on www.rdgtools.co.uk
Flange 0.264 inch (6.71mm)

Chronos on www.chronos.ltd.uk
Flange 0.283 inch (7.19mm)

My calculation as above gives maximum tool tip heights for these as follows:

For 0.245" flange, max tool tip height = $0.625 - 0.240 = 0.385" = 9.78\text{mm}$, i.e. will accept $\frac{5}{16}"$, 8mm and $\frac{3}{8}"$ tools but not 10mm

For 0.264" flange, max tool tip height = $0.625 - 0.264 = 0.361" = 9.17\text{mm}$,
For 0.283" flange, max tool tip height = $0.625 - 0.283 = 0.342" = 8.67\text{mm}$, i.e. these last two will accept $\frac{5}{16}"$ or 8mm tools but not $\frac{3}{8}"$ or 10mm

By comparison, my modified toolholders all have bottom flange thickness of 0.228" (5.79mm). Maximum tool tip height = $0.625 - 0.228 = 0.397" = 10.08\text{mm}$ and will accept all $\frac{3}{8}"$ and 10mm tools. ■

New Toolholders

I have found new standard toolholders available online from 3 suppliers; there may be others I have not found or used. Some make claim to be usable with 10mm tooling. This is only half the truth. All the standard toolholders will accept 10mm shank tools, true, and 12mm also, but the cutting tip will be too high on all toolholders to be set correctly to headstock centre height.

I have checked the bottom flange thicknesses with the suppliers for toolholders being marketed at present, which are:



Modified toolholder on top slide showing restriction of positioning.



Standard parting toolholder on top slide showing stepped bottom face and limitation of positioning.

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Digital Scales for a South Bend 9A Lathe

Tony Hills fitted a low cost DRO to his lathe using Chinese scales and individual readouts.

I have owned a George Taylor vertical mill of considerable vintage for some time and after restoring it, I was never happy about the backlash in the X axis of the table. I was persuaded by the arguments of using digital readouts to overcome this (often referred to as 'Chinese scales') and I set about providing one for each axis. This taught me valuable lessons in designing their fixings to the machine.



First attempt at a DRO using individual read outs combined into one case.

Two particular aspects concerned me. I did not wish to keep switching on and off each scale every time they were used or keep peering closely at each scale while operating the handles. I like to watch what is going on rather than be distracted by bending over the machine to try and see the tiny readouts in the reading head of each scale.

So I decided to build a single unit readout using commercially available remote readouts which you can now purchase for around £30 each (the three axis readout was not available at the time). I took the electronics out of each remote unit and combined them into a large case, complete with its own mains driven 3v power supply. The controls were combined in a single keyboard and a further internal mains power supply of 1.5v was provided for the scales themselves. **Photograph 1** shows the result, which has worked satisfactorily for several years.

A DRO for the lathe

More recently I acquired a South Bend 9A lathe of wartime vintage which replaced a very old but faithful 5 inch IXL lathe. Being a 9A it has a gearbox for the lead screw and power cross feed which the IXL didn't. Unfortunately, it too was in need renovating and after a complete overhaul that included a lot of scraping, a repaint, new motor, stand, and a second hand bed that was in better condition than the

original, I am now pleased with the results I get. I have yet to replace the cross slide screw, which has excessive backlash but, learning from my mill experience, I decided to fit the machine with digital scales for the cross slide and saddle traverse.

Intrigued by how others have fitted scales to their machines I researched the many forums on the web and, came across Compucutters of Coventry who market an interface between scales and a computer. The interface is called CompUguide and this article was to include the building of this but, for reasons explained later, this was not to be and I reverted to using two independent readouts built into one unit with mains power supplied in a similar fashion to my mill. Building the readout is the subject of the second part of this article. The first part that follows is attaching the scales to the lathe.

The cross slide scale

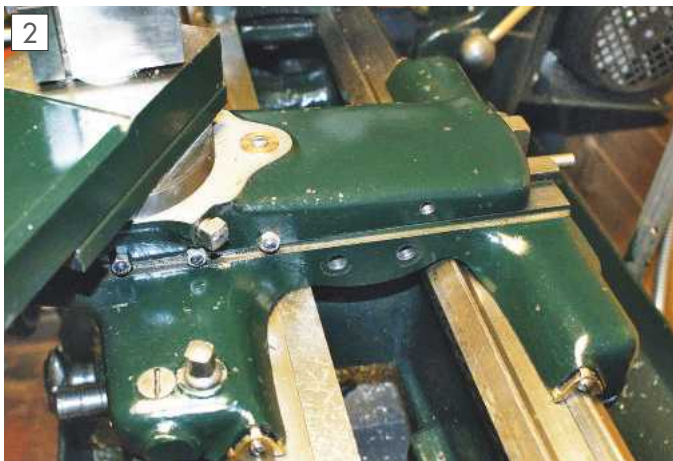
I toyed with many ideas of how to fit the cross slide scale. An early idea was to sling the scale under the bed and provide a link from the rear end of the cross slide such that when the cross slide moved, the scale underneath moved as well. The attraction was that it would leave the saddle uncluttered by the scale for operations involving close use of the tailstock. It would require some form of guidance and support at right angles

under the length of the bed to allow for the movement of the saddle as it traversed the bed and in the end I abandoned this as too complicated.

As I had seen other scales attached alongside the cross slide, I decided to follow this practice. An excellent article in *MEW* 87 and 88 adopts this configuration for a Myford. I also decided that, as the tailstock side of the saddle has two holes in the centre tapped $\frac{3}{8}$ BSW (**photo 2**), I would use these. They are for the travelling steady and other fitments.

The next consideration was the length of travel. With the cross slide fully extended outwards, I measured the travel to a point where the tool tip under normal conditions would be beyond the centre and this was approximately 4.5 inches. Knowing that a scale actually travels a little further than the stated length, I decided to use a 4.0 inch scale and purchased one at a show from an excellent retailer of these devices (**ref.1**).

As in all the other scales on the mill, I thought of using the bracket which comes with the scale and dreamed up difficult ways of connecting the reading head to the cross slide, with equally complicated ways of fixing the bar to the saddle. After many trials, it suddenly dawned on me that it would be much simpler to fix the head and move the bar! It makes no difference to the reading as this comes from the relationship of the two parts - not which bit is moving. This allowed the head to sink into the web space of the bed and



Existing tapped holes in saddle for travelling steady.



Parts for attaching scale to cross slide.



Cross slide scale assembly.



Drilling pillar holes in cross slide.

with only one end of the bar attached to the cross slide, lining up the scale was almost automatic. This meant that the head was lower than the top surface of the cross slide even when a guard was fitted. Also, by not using the end fixing brackets which come with the scale, a further $\frac{3}{4}$ inch was gained on travel. Several problems solved in one!

Fitting a scale using the existing holes would render them unusable unless the scale is temporarily removed - which then makes the scale unusable. So I decided to provide support pillars for the scale, but instead of using bolts to secure the scale, additional pillars would extend beyond the scale and provide new $\frac{3}{8}$ tapped holes. Although this allows the fixed steady to be used, it would be a further two inches towards the tailstock, but I was prepared to live with this. The tailstock would also not be able to come as close to the chuck unless the saddle is moved further towards the headstock but to date I have not found this a problem.

The parts which make up the fixing are shown in **photo 3** and assembled in **photo 4** with the front splash guard removed to show the reading head. I have not attempted to provide drawings or dimensions as these will vary according to your own lathe and the parts are very straightforward. Note that the forward extension pillar has been turned down for most of its length to accommodate the battery compartment in the reading head, thereby allowing the head to sit as low as possible. Also note the extension pillars each have an additional part that uses the

I thought of using the bracket which comes with the scale and dreamed up difficult ways of connecting the reading head to the cross slide, with equally complicated ways of fixing the bar to the saddle. After many trials, it suddenly dawned on me that it would be much simpler to fix the head and move the bar!

replacement hole with a rubber stop screwed to these. This is to prevent the tailstock from colliding with the scale, but the stops can quickly be removed if the holes are required.

A guard has been provided which prevents swarf and cutting fluid from getting on the scale. It has a separate front splash guard which can be removed quickly if access to the reading head is required.

There is also a steel tube which carries the cable from the head to the rear of the saddle. This is to protect the cable from damage and the tube was simply a piece of rusty brake pipe, de-rusted and buffed! It terminates in a right angle gas pipe fitting which I found in the scrap box as the tube was not long enough to bend at a right angle. A copper tube would also suffice and if long enough, could be carried directly into the connection box. To attach the bar and the guard a $\frac{3}{16}$ BSF was drilled and tapped at each end of the

cross slide, being careful to limit the depth of the holes to avoid breaking through to the slide way (**photo 5**). Pillars then provide support for both ends of the guard but only one end of the bar.

The Saddle scale

I decided to mount the scale along the rear of the bed, tucked well under the slide way overhang which, when combined with a guard, should provide protection from swarf and fluid.

The general arrangement is very simple, this time fixing the bar and moving the reading head by direct attachment to the saddle. With the saddle at the headstock end, the scale was positioned beneath such that the reading head was directly under the connection box at the rear of the saddle and to the extreme right of the bar. The fixing holes were then marked. Unfortunately, I cannot get access easily to the rear of the lathe, so this meant

completely dismantling it and turning the bed around. I drilled and tapped two $\frac{5}{16}$ th BSF holes through the bed (one of which is shown in **photo 6**) and then remounted the saddle to complete the installation of the transfer plate.

A new U shaped bracket was created to link the reading head with the transfer plate. I did not use the bracket supplied with the scale even though this would conveniently have been closer to the top of the transfer plate, as I wanted to have the bracket underneath the head and not above it. This way a continuous guard can cover the scale without the need for a slot to accommodate the bracket.

A further steel pipe carries the cable from the reading head to the connection box in much the same way as the cross slide. This has a small bracket with grommet to give support from the transfer plate. All the parts can be seen separately in **photo 7** and assembled in **photo 8** with the front splash guard omitted for clarity.

The rear mount and connection box

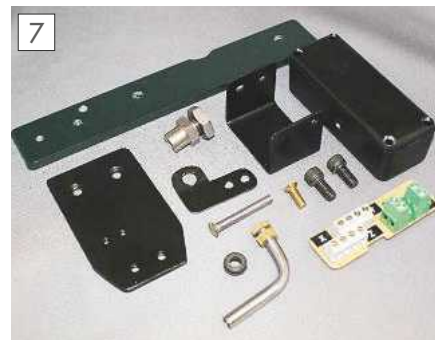
The rear mount is simply a solid bar (9 x 1.25 x 0.25 inch BMS) that is fixed to the saddle by two $\frac{1}{4}$ BSF cap screws, utilising an existing tapped hole in the tailstock rear wing and one which I drilled and tapped in a matching position in the headstock rear wing. The bar provides support for the connection box and transfer plate and requires a radius filed out of it along the top edge for cross slide lead screw clearance.

I could repeat the concept of providing further pillars with matching tapped holes to the original but as at present I have no attachments that will use these holes I have not done so. I can always make these later if, for example, I was lucky enough to acquire a taper turning attachment that uses these holes. Finding such luxuries for a South Bend is high impossible in the UK and although they do occasionally appear for sale in the US, the cost of shipping usually rules them out. I have downloaded an article for making one, so this may well go on my 'to do' list if I have a project that requires one! If so, it would be necessary to relocate the connection box further down, with the cross slide steel tube extended to avoid the attachment.

The connection box is die-cast aluminium and serves simply to provide a break in the cables between the reading heads and interface for easy maintenance



Hole drilled in rear of bed for saddle scale support.



Parts for attaching saddle scale to rear of bed.



Saddle scale assembly.

and dismantling. It is dealt with in more detail in the second part of this article. The box uses one of the rear bolts and an extended transfer plate bolt for securing to the rear mount.

Finally, the cables between the connection box and readout need protection and I looked to flexible conduit as the answer. Investigation of this proved that it was very expensive as it was usually sold only in long lengths. However, by chance my wife asked me to replace the shower hose as it was getting grubby and she was fed up trying to keep it clean. A replacement was purchased from B&Q at around £5.50 and as I was about to throw the old one away I realised

it was in essence a flexible steel conduit! Cut the ends off, pull out the inner plastic tube and it is ready. It is perhaps not as oil proof as purpose made conduit, but if that will be a problem then the inner plastic tube can be left in and used.

A connection was required and I machined this out of hexagon steel, providing a $\frac{5}{16}$ BSF on one end and a smooth extension on the other that allowed the conduit to slide over and be secured with a jubilee clip.

Photograph 9 shows the overall arrangement, with the lid removed to show the connection panel in place.

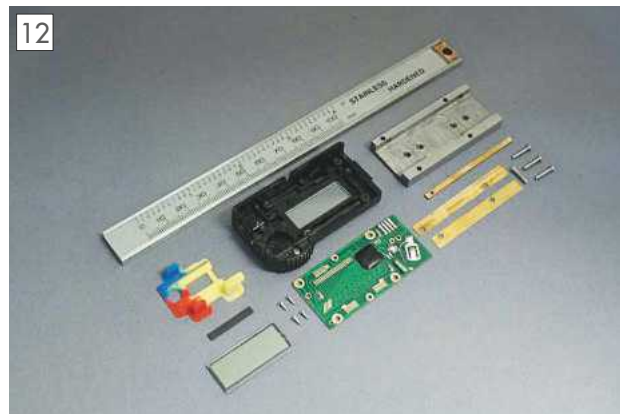
Although the scales have perfectly good LCD read outs, in their positions and



Hardware connections to connection box.



The completed readout.



Soldering leads to reading head pcb.

Components of a reading head showing the four pcb tracks.

covered as they are by guards, they are totally impractical to read while machining. A remote read out was my solution, shown in **photo 10**.

I intended to use a CompuGuide interface between the scales and a computer but despite two attempts at this (one built by myself and one supplied ready built) I could not get it to work with linear scales. The interface would work correctly with vertical scales, but these are bigger and would not fit the X axis in the way I wanted. Consequently, I abandoned the CompuGuide and reverted to using independent readouts. I would caution anyone contemplating using the CompuGuide to avoid linear scales and only use vertical scales.

The attraction of the CompuGuide was that it provided many additional facilities, including compensating for diametric cutting (i.e. twice that of the scale output) which is not available directly from the linear scale. So that I could quickly calculate any diameter reduction I decided to add a calculator for convenience and purchased one for £5.50 in the high street. Adding this saves having to find a calculator, often buried under a pile of clutter!

Connecting the reading heads to the connection box

The cable used to make the connection is four core shielded and sufficient length for two reading heads can be obtained when cropping the attached cables to the independent readouts (see later), including the special plugs.

Each reading head is provided with a removal cover to expose access for a four-way plug. The plug matches corresponding tracks on the printed circuit. Personally I do not like these plugs. They do not mate properly and all seem to be different sizes to the guides in the head, some being tight and others being loose. The last thing that is wanted is for one to come loose and lose connection. It will mean removing the guard and refixing, probably only to come off again at some stage. This is no mean feat if it is the Z axis reading head and will require leaning over the lathe to do so.

The solution is to solder the leads directly to the printed circuit. This will require dismantling the reading head to give access to the board which is a

delicate but relatively easy process. However, if the scales are new, you should be aware that such action will invalidate the warranty, so you may care to stick with the plugs however unsatisfactory they may be.

Before starting, remove the battery if this is still in place. Lay the scale face down on some cloth and, with a watchmaker's screwdriver, remove the four screws securing the back. One screw next to the battery compartment is a machine screw whilst the others are self tappers. Its position should be noted. Place a small piece of plastic over the back to hold the screws in position and then turn the whole scale over. Hold the bar in position and gently remove the front. Note that there is a very thin gib strip and top and bottom shims and try to keep these in position. Set the back and bar to one side.

crucial moment and I find the block most useful for steadying.

Which way up the wires lead out does not really matter. What does is that the correct colours are noted for each track on the board. **Photograph 12** shows the tracks and, reading from left to right, their purpose is: 1.5v Neg; Data; Clock; 1.5v Pos. I do not know if there is a convention but I connect black to -ve, red to Data, blue to Clock and white to +ve. Clearly, colours have no meaning other than to ensure that the correct connections are made at the other end in the connection box.

Check that the tracks are isolated from each other and no solder has 'crossed over'. A gentle scrape with the point of a scalpel may clean the board between the tracks that have been soldered and any flux should be cleaned off with mentholated spirit or a proprietary pcb

Each reading head is provided with a removal cover to expose access for a four-way plug. The plug matches corresponding tracks on the printed circuit. Personally I do not like these plugs. They do not mate properly and all seem to be different sizes to the guides in the head, some being tight and others being loose. The last thing that is wanted is for one to come loose and lose connection.

Turn the front unit over and remove the screws securing the printed circuit board. Lift out the board but note that it has to go back the same way, otherwise the LCD connections will not match those on a small bar embedded in the rubber push button moulding. Set the front casing, LCD display and rubber moulding aside.

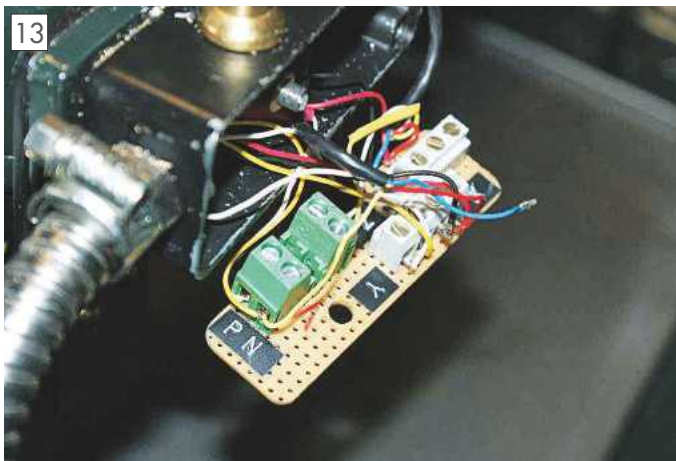
Soldering the wires to the tracks is tricky but not difficult. I use a 15 watt soldering iron and grind the tip to a very fine point. I tin the wires and tracks separately before finally soldering them together which gives a much faster solder and therefore less heat transfer on the board.

Photograph 11 shows the set up. Note the wooden block which I use to give support to my hand. The slightest tremble can move the fine wires too much at a

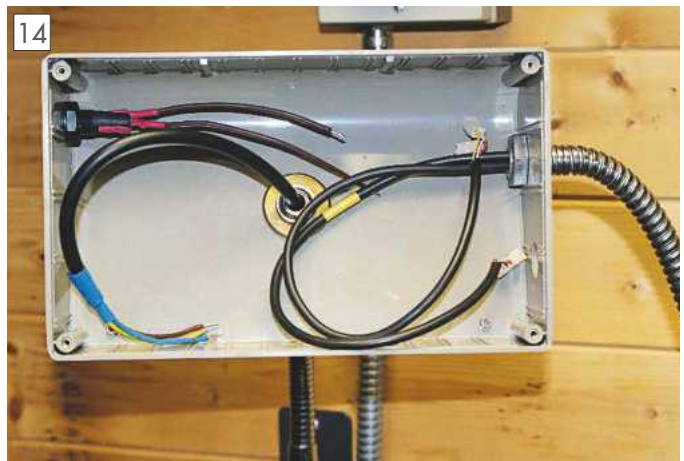
cleaner. Then feed the cable through the cover hole and reassemble the board in the front casing.

If you have left the back and bar complete with shims in place, reassembling the complete reading head is a reverse of the above. The reading scale on the bar must be facing up and vertically the right way as well. After wasting a lot of time I learnt that you could not put it facing the right way but upside down as it simply will not read! Lower on the front assembly and turn the whole unit over pressed against a board or card. It is only then a matter of tightening the screws.

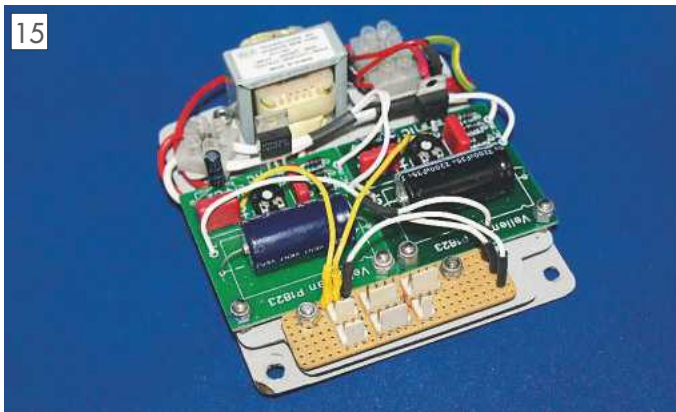
Make sure that the other end of the wires to those soldered to the board are separated and not in contact with each other. Then temporarily place the button



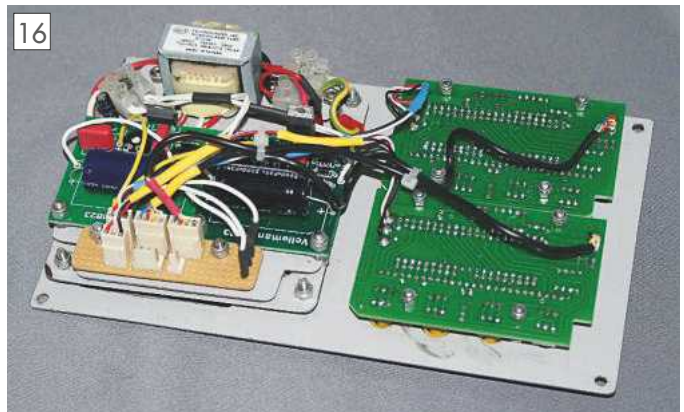
The rear connection panel.



The readout case with incoming cables.



The power supply sub panel and connections.



The individual readouts mounted and connected to the power supply.

**Please note that 230v AC mains is involved
and all safety precautions should be observed.
Never take mains for granted - it really can be lethal!**

battery in the holder and check that everything is working correctly. I then used a small amount of Araldite to keep the wires in place on the head.

The connection panel

A small piece of strip board was cut to fit inside the box and secured by means of the extended screw from the transfer plate that comes through the back of the connection box. Two 2BA nuts are used to set the correct height of this strip board.

The board has four two-pole connection blocks together with a further single two-pole block that is slightly larger, all purchased from Maplin (**ref. 2**). The smaller four blocks allow connection for the Data and Clock lines of each reading head (only two of these are connected at the moment but there is provision for more connections if required in the future). The larger block is for connection of +ve and -ve lines to all reading heads as it does not matter that they are connected together.

As the wire from the reading heads is very thin, I solder a pcb pin to each before it is inserted into the connection block. This gives a more secure fitting and less likely for the wire to be severed whilst screwing down. **Photograph 13** shows

the arrangement, but one wire has not been connected to show the pin soldered to the wire. A good length of cable (up to 75mm) is left within the box to allow the board to be removed and worked upon with relative ease.

Connection between connection box and readout

Six cores will be required for cabling between the connection box and the readout, only two of which carry the reading head power. The power is then distributed to the both heads within the connection box.

Any configuration of cable can be used. Termination at the readout end will depend on how it is connected to the board. I prefer four or two-way header connections obtained from Maplin.

Building the Readout

The readout is built in a plastic instrument case purchased from RS Components (**ref. 3**) which has an aluminium front plate. The plate is machined on the mill to provide all the necessary holes and cut outs but is fairly thin and therefore was not good for countersunk screws. To avoid

damaging the card cover I machined a piece of Perspex which when placed in front of the plate allowed the bolt heads to be below the Perspex surface.

I experimented with various fixings for this readout and initially tried a 13 inch gooseneck for microphones from Maplin. This was anchored to a plate on the wall using an old speaker wall mounting that I no longer required.. However, the weight of the readout proved too much for this and it sank slowly into an unreadable position. In the end, I had one six inch gooseneck which was too stiff on its own, so I bought a second one and put the two together. This was perfect, giving the right flexibility but also being stiff enough to support the readout in any chosen position. Finally, I added a fuse holder to the case and the completed case is shown (**photo 14**).

Power supplies

Please note that AC mains is involved and all safety precautions should be observed. Never take mains for granted - it really can be lethal!

The mains input is reduced to 12v by a miniature transformer I purchased from Maplin. In fact, this has two 12v outputs, so only one lead and the central tap are used, the other simply being terminated in a insulated terminal. Two voltages are required - one at 3v DC for the readouts and one at 1.5v DC for the scales. I used two Velleman kits from Maplin because I had them, but the power supplies are fairly simple affairs, using a standard circuit for the LM317 voltage controller. The small number of components is

inexpensive and further savings can be made by using the rectifier diodes and smoothing capacitors only once, feeding two LM317s with their associated resistors and capacitors. A circuit diagram can be sourced by looking for an LM317 data sheet on the internet.

The kits as supplied have a claimed range of 1.5v to 35v, this being set by a 4.5k ohm trimmer. This value does not give good results at the 1.5v or even 3v level, so it is better to use a 220 ohm trimmer for the 3v and a 100 ohm for the 1.5v. With these, the voltages can be set very accurately, usually in the centre of the trimmer rotation.

The completed supplies and connection board on their sub panel can be seen in **photo 15**.

The readouts

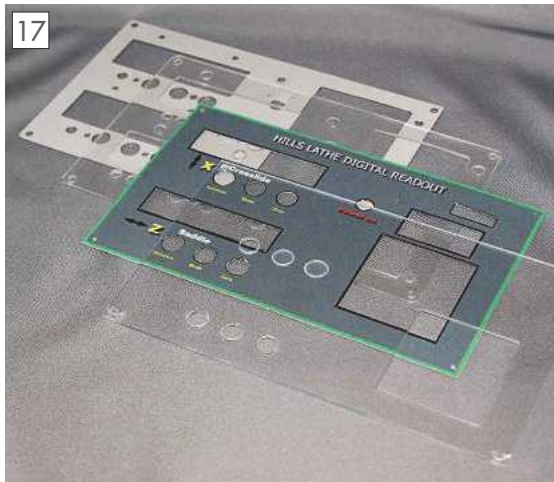
I have used two single readouts which I purchased from Warco (**ref. 4**). These are very good quality and I removed the boards from the cases. The only alteration was to remove the battery container leads and solder longer ones in their place, with headers at the other end. It was also necessary to crop the output leads to about eight inches and solder header plugs to these. Again - be aware that doing so will invalidate any warranty, so it may be better to check that they work before doing this. The leads with their plugs can be used at the reading head end (see earlier).

The readouts were then mounted on the main panel, but with only three push buttons instead of the usual four. I omitted the on/off button and left these permanently on as the power would be switched elsewhere.

I connected the readouts (always checking that the wires were correctly oriented) and the incoming leads from the reading heads to the connection board. The complete set up can be seen in **photo 16**.

The front panel

I created a front cover on my computer using a desk top publishing programme, but it could be created using the drawing facility in Microsoft Word or similar. This was then printed on thin card and cut out using a craft knife. A final Perspex cover was milled to allow the buttons to come through and an area to operate the calculator. All the milled parts making up the front panel can be seen in **photo 17**.



Front cover and other machined layers forming the front panel.

Power panel

A separate panel with an on/off switch was constructed (**photo 18**) for the front of the lathe stand. I chose a double pole double throw rocker switch to IP65 standard as this will switch 230v mains and with the possibility of suds flying around at some time, I preferred this additional protection. The power is connected through the contactor above, effectively using the no volt drop out should power fail for any reason. All internal wiring in the stand is contained in 20mm plastic conduit and, of course, earth connections abound.

The smaller rocker switch to the right is for a low cost suds system I have in mind, but this will use 12v for switching and does not, therefore, need the added protection.

Final assembly and use

It only remained to test the completed readout. This is always nerve racking where mains is concerned, but the only fault was that, despite careful checking along the way, one readout had its data and clock lines reversed, so it gave gibberish displays. After a while I discovered the error and it then worked perfectly.

The complete assembly can be seen in **photo 19**. In use it is excellent, allowing me to turn diameters down with confidence until very near the required

size without the need to constantly check the diameter with a micrometer. Whilst I accept to some degree David Clark's assertion that a readout for the Z axis is not necessary (*MEW 152*), I have found the ability to return to a particular place without the need to set or reset the carriage stop a boon. The batteries in both the reading heads and readouts are no longer required and therefore never need replacing.

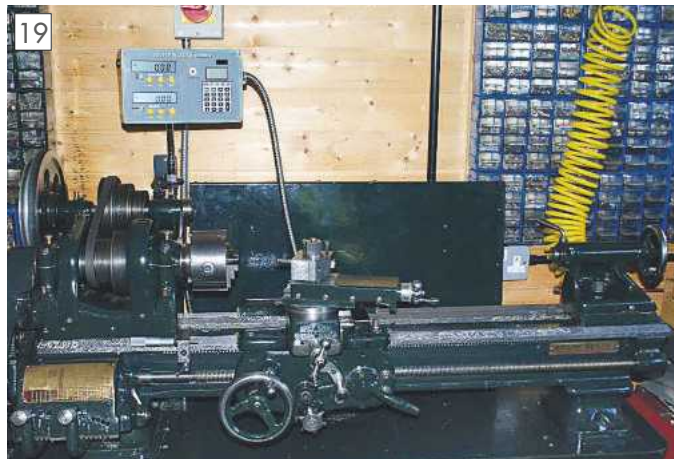
Was it worth the effort? Well, the whole project cost about £130 - including the scales and calculator. Each Warco readout comes in a magnetic case and can simply be placed on a metal plate fixing in much the same position as my readout. However, I enjoyed the challenges this project threw up and improved some of my skills along the way, whilst now being more confident in my turning - and I don't have to worry about batteries! ■

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1. Allendale Electronics Ltd 01992 450780 www.machine-dro.co.uk
2. Maplin Electronics 0844 557 6000 www.maplin.co.uk
3. RS Components www.uk.rs-online.com
4. Warren Machine Tools (Guildford) Ltd. 01428 682929 www.warco.co.uk



Switch assembly on lathe stand.



The completed readout.

Stub Mandrel's Short End Improvements to a Bandsaw



Stub Mandrel adds a few creature comforts to a workshop companion.

Ask which piece of shop equipment saves the most effort, and many will reply 'my bandsaw'. In a survey of *MEW* readers over 50% had bandsaws and 29% had power hacksaws. Does this mean the rest have over-developed biceps? The best thing about a bandsaw, is it stops you putting off bigger jobs, just because you can't face sawing through a big chunk of bar by hand.

With so many bandsaws out there, and the cheaper ones having the sort of limitations that come from being built to a price, several people have found ways to modify them for better performance.

Although every owner has their own favourite 'tweaks', here are a few of my own ideas, most aimed at increasing usability. As supplied my bandsaw made a pretty accurate cut out of the box; keeping a chunk of metal in the right place to cut it was the biggest problem!

The first, and simplest modification has been done by others – but perhaps that's because it works and surely as good a reason as any to repeat it? The moving jaw pivots, and this means you can't hold short work without something to balance the force on the jaw. Tap an M10 or M12 hole towards the far side of the moving jaw, but clear of the reinforcing web. Pop in a lengthy bolt (**photo 2**). No more hunting for an exact



The modified bandsaw.



A large bolt used to help balance jaw forces on short workpieces.

sized spacer when you want to hold a short end to one side of the jaw.

Second, get an offcut of hefty 2 inch angle iron and use it to make a proper work support (**photo 3**). Cut one side of the 'L' down to about 1¼ inches. Using a plate on top of the vice to align the angle, spot a 5mm through the short leg to set a hole just up and to the left of the hole in the vice for the length stop that you never use. Thread the hole M6 and open the angle in the angle enough so you can fix it accurately (**photo 4**). Perhaps it sounds a bit hit and miss? Maybe, but it's better than a pile of packing to support that offcut that just keeps slipping half way through a cut. But, you may ask, what happens when the blade finishes cutting through the work?

Well, it cuts itself a groove in the angle, so next time it has somewhere to go. I adjusted the depth stop so the first cut was a bit deep, making a 1mm deep groove in the support. I then raised the depth stop so now the saw blade doesn't bottom out. The best bit of this is the unexpected side-effect that the saw groove now provides an excellent way to 'eyeball' where the cut will fall, rather than bouncing the blade on top of the work.

Third – widen the moving jaw by screwing a long, thick plate in front; ¾ inch or 5mm will do it, ¼ inch would be better. Rather than waiting for a suitable offcut to appear, what on earth is that thick chunk of metal doing screwed to the fixed jaw? A big chunk of cast iron jaw liner with a crude diamond pattern on it. All it does is make the fixed jaw thicker than it needs to be. Off it comes and – look it's just what we need to fix to the moving jaw (**photo 5**) to make it wide enough to match the fixed jaw and support work really close to the saw blade! Perhaps the factory fit the plates to the wrong jaw by mistake?

Fourth, look at the wasted space under the frame! I popped a rectangle of MDF underneath (**photo 6**). For some reason this has turned into a sort of elephant's graveyard for all my large imperial spanners. I have no idea why.

Fifth, check the gearbox (**photo 7**). This is a 'just in case' task, when I looked in mine it was full of a strange fluid like liquid gold. The worm and wheel weren't properly engaged and a lot of bronze had



The simple work supporting extension.



Held in place by a single M6 bolt.



Now why don't they fit the jaws together like this as standard?



The 7/8 Whitworth Spanner Graveyard.



If you are brave, remove this cover, but be prepared for oil spill!



Reinforced wheel mount.

been worn off the wheel. It's possible to remove the driving pulley and realign it. Doing this helped reduce blade throw-offs as well as, hopefully, extending the life of my pulley.

Sixth, the biggest problem with my bandsaw is where to put it. It demands a certain amount of space around it, is an awkward shape but is too heavy to lug around easily. I found some decent castors, two of them braked, from a big old computer desk – from the days when a computer, printer and CRT monitor

weighed about as much as a washing machine. One thought, most people fit both locking castors at one end – I fitted them at diagonal corners, so there's always one easily accessible.

These were rubber tyred ones, not cheap all-plastic ones, with hefty M8 mounting bolts. After opening the holes for the stand's feet to 8mm they fitted straight on, but as the frame is only 18-gauge steel the fixing points rapidly collapsed under the weight. Half an hour with the stick welder and a flat bar of black mild steel put a

hefty reinforcement across each corner (**photo 8**) and provided useful practice in sticking metal back on to thin air, where I blew holes in the thinner metal!

I was so impressed with the result I had to treat the finished stand to a coat of sage green Hammerite. Well, it had been looking a bit shabby since I spilt ferric chloride over it...

Final task – was to buy a really decent bi-metal blade, I get mine from tuff-saws, they hugely outlast plain carbon steel ones. ■

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3D Printing for Model Engineers



Simon Davies discovers that a 3D printer in the workshop isn't a white elephant.

I recently succumbed to a whim and purchased a second hand 3D printer from the usual auction site (**photo 1**) and then suffered a huge dose of 'what am I going to use it for'?

Mindful of a number of comments on the forum and elsewhere on the web, I suddenly saw an opportunity to while the hours away making parts for more 3D printers to make parts for more 3D printers in an endless cycle.... My next move was towards the web to examine a couple of sites which make available other people's designs ready to print (**refs 1** and **2**). One of the first prints I did was a (scaled) 3D drawing of a shoe to add to my wife's small collection of miniature shoes thus alleviating her pointed questions about it's use (**photo 2**). After that, there were a couple of known improvements to the printer, and then...? At this point I was convinced that either I had to head into 3D CAD to design my own parts or return the printer to the auction site.

I stumbled onto a program called OnShape thanks to a discussion on the ME forum and signed up to this web based 3D CAD. Unlike all other 3D systems I had tried in the past, I instantly found myself at one



My UP! 3D printer installed in the office.



Another shoe to the collection – height is about 60mm.

with OnShape (**ref 3**). It is still in beta-test and new functionality gets added almost every week but key advantages to me are the fact that it is free, that it generates files for the 3D printer to print immediately and that it is (to me) easy to use.

Once I had mastered the initial steps, I started making things – and so far in the space of 5 months I have consumed around about 5kg of print material. As each object probably weight between 5 and 50g, that gives you an idea of my output.

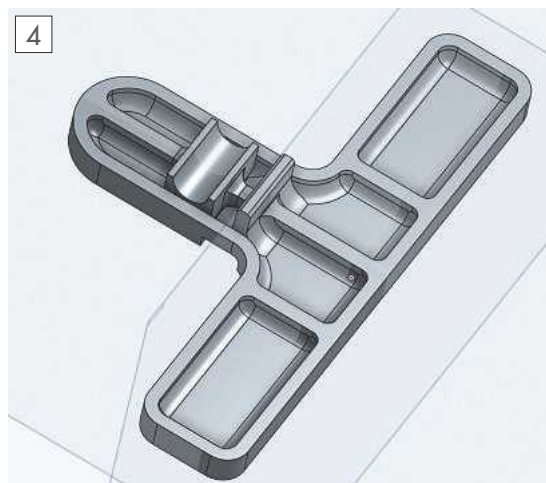
Presumably others are in a similar position so I thought I would share my own experience so far as well as some thoughts for the future.

The objects can be split into two categories – repairs and new objects.

The repairs are an easy topic and also the source of some domestic bliss and have ranged from a replacement part for a



Many brownie points earned fixing this clip (the orange part).



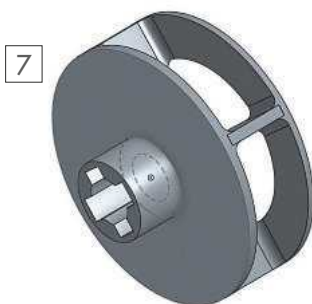
CAD view of the clip.



New cutlery trap replacing a gaping hole.



Headlamp bracket
CAD view.



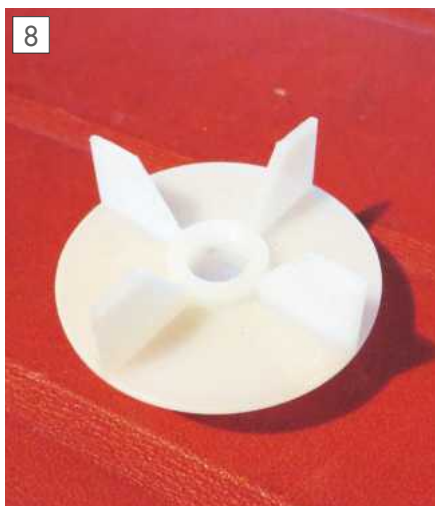
CAD view of the impellor.

plastic clip (**photos 3 and 4**) through a piece to fill the hole in the dishwasher cutlery holder (**photo 5**) a headlamp clip (**photo 6**) and a pump impeller (**photos 7 to 10**). None of them fall directly into the Model Engineering category but all help smooth the path of domestic harmony and allow funds to be allocated elsewhere – like new tools!

All have been drawn from scratch in OnShape with the aid of a pair of digital callipers and have been through maybe one prototype test stage and one finished part stage. The prototype stage is usually run at a lower definition than the finished object and is really aimed at the 'does it work' test – definition here in my case usually means each print layer of 0.25 or 0.30mm and the final version a much more defined 0.15 or 0.20mm. The basic rule is more layers = more time on a roughly linear rate. For instance, the clip printing at 0.25mm takes 24 minutes, the final version with 0.15mm layers took 50 minutes.

None of these objects were suitable for remanufacture in any other easy way and all the originals started life as plastic, albeit in several cases a very different sort.

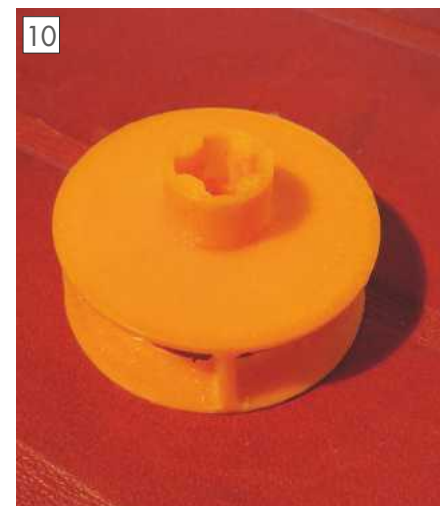
The next group of objects can be further



The broken impellor lacking the top disk.



Top view of the replacement showing top disk (this was the test piece so not completely cleaned of support material).

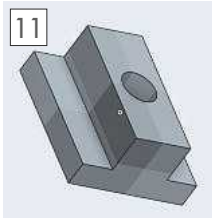


Bottom view showing the squared drive.

split into those that have a role to play as a final finished part and those that are simply being used as prototype parts, helping to prove a design or concept. This is much more focused towards the field of ME.

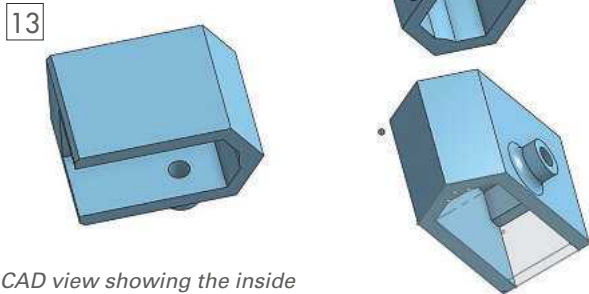
So far my stock of the former runs to:

- A set of T-Nuts for my shaper – I needed some T-nuts that were differently sized to all of my stock ones so I measured the dimensions, drew the section in CAD, extruded the section and inserted a tapping hole sized for M6 (**photo 11**). Once printed, I ran the tapping drill through to clean the hole (unnecessary as it turned out) and gently tapped them. The printing was carried out at a maximum density to ensure that it was as solid as possible. Do they work – yes, no issues although the forces involved don't exert a lot of stresses on the threaded part (**photo 12**).



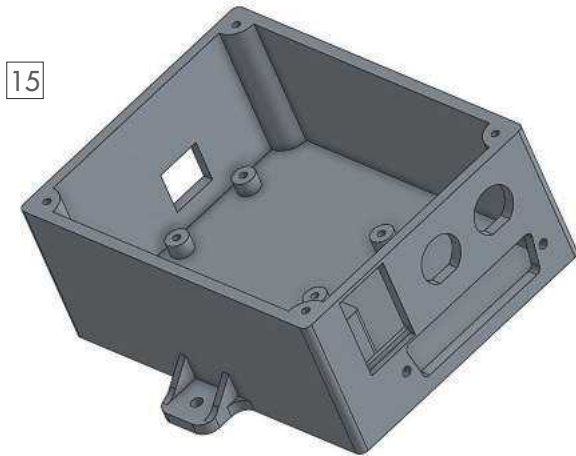
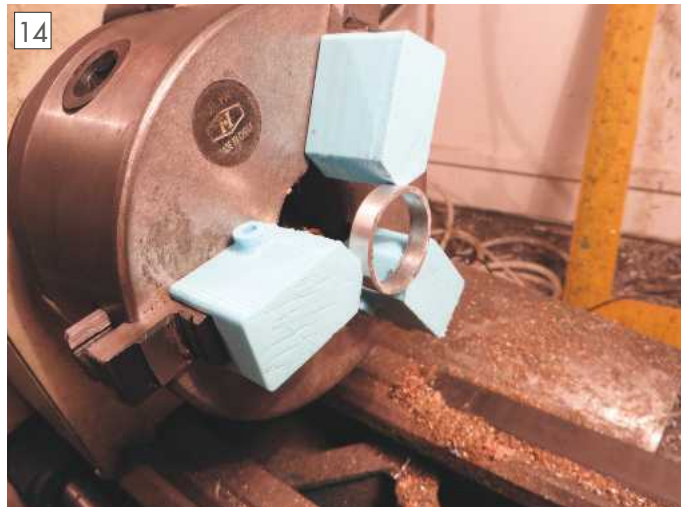
T-nut – very simple.

Almost hidden in that T-slot is a blue plastic T-nut.



CAD view showing the inside of the soft cover jaws.

In place with a ring (posed photo!).



CAD view of an electronics box showing cut outs, raised bosses inside and mounting lugs.

The real box wired and working.



- A set of soft jaw covers – these were made by measuring the jaws of my 3-jaw chuck and effectively wrapping them in a 3mm thick cover with additional material at the face and jaw sides (**photo 13**). They are held in place by a bolt tapped into a boss moulded on the side of each jaw (**photo 14**). They were inspired by a recent article in *ME/MEW* about making soft jaw substitutes (**ref 4**).
- Bespoke Electronics box for a PoKeys CNC interface board and associated connectors and a bespoke box for adding connectors to an aluminium box – nothing very special here in the

design of the boxes although it is nice to be able to mould in spacers for the electronics boards to sit upon shown in **photos 15 and 16**. It does however add a certain 'something' to a project to have a box that is designed for the contents with means of attaching it to the final destination as well.

- A 40mm plastic tube to multiple 15mm outlets – this is a design I tried to make last year solely in metal and failed miserably partly due to the effort required, partly to some unexpected design failures on my part. I drew this up and made the Mk1 which failed thanks to

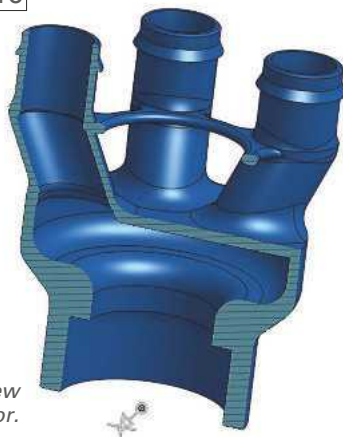
weakness in the outlet tubing – several iterations later and after various strength upgrades, I had the desired result. The whole design process of the Mk1 took a couple of hours plus another 2 hours for a high speed test piece. Each subsequent iteration probably consumed a couple of design hours and 3 hours print time per 'quality' test piece. To my mind, this is a fine example of the power of 3D over my original design – however it is fortunate that the temperature is limited to no more than about 40°C since much more would create problems for the plastics, **photos 17 to 19**.

17



CAD view of the multi connector exterior.

18



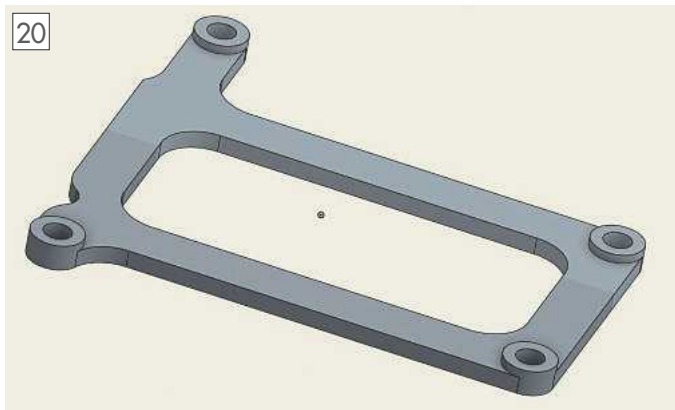
Sectioned CAD view showing the filleted interior.

19



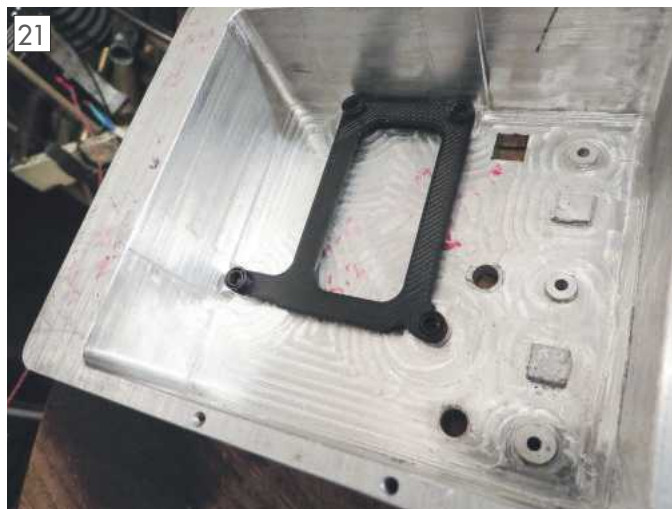
Plumbed in and working.

20



CAD view of a standoff showing the 4 washers joined by connecting arms.

21



Stand-off in its aluminium box – not much room to insert 4 washers here.

• A car headlight bracket – a friend had failed their 'contrôle technique' (French MOT) thanks to a wobbly headlight. The root cause turned out to be a missing plastic support bracket almost certainly broken when they had 'nerfed' something solid and dark green as evidenced by the remaining paint on the bodywork. The other headlight had a functioning bracket which I removed, measured and drew in 3D before printing, see photo 6. The look on my friends' face was something of a picture during this process! Result – a pass for the test and another 2 years motoring for their car.

• A stand-off for an Arduino controller board installed in an aluminium box – instead of struggling with plastic washers hidden under the board, this creates 4 washers and links them into one unit massively simplifying assembly (**photo 20 and 21**). Time taken to design – about 20 minutes and probably about the same to print.

• The plastic pipe that feeds the filter pump on our tiny pool is a square form, left-hand thread wrapped around a 40mm or so diameter nominal tube – to add an adaptor I drew the thread form as well as an inner support to the plastic. In this way, the pipe is both screwed into the threaded adaptor and supported on its inside as well – the

section shows this more clearly than my explanations I am sure (**photos 22 and 23**). A squirt of silicon towards the base of the connector and the pipe has happily screwed into it and has been leak free all summer. The other end fits into domestic 40mm waste pipe and is glued with pipe cement which seems to happily glue the 3D printed ABS plastic (**photo 24**).

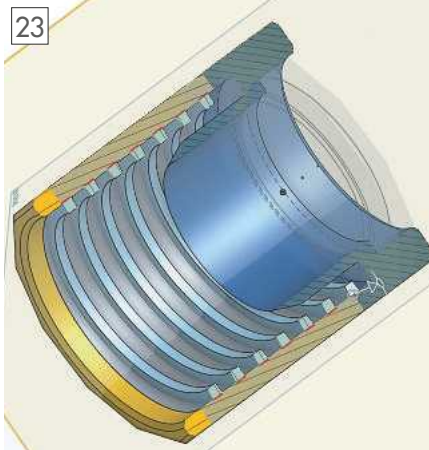
• I have not mentioned the support bracket adapter from pipe to box section, nor the DTI holder that slips into my QC toolpost, nor the pipe adaptors from obscure size to something else, nor the pool skimmer adapter (**photos 25 and 26**) or many other bits.

22



CAD view of the threaded inside of the connector.

23

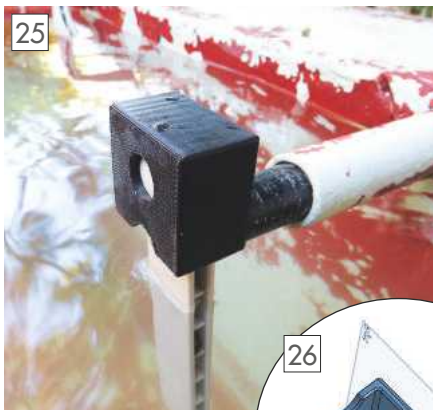


Sectioned CAD view showing the blue internal support 'tongue'.

24

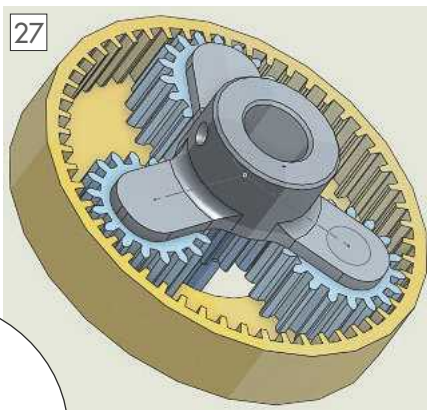


Printed version in place showing the bead of silicon ensuring a seal.



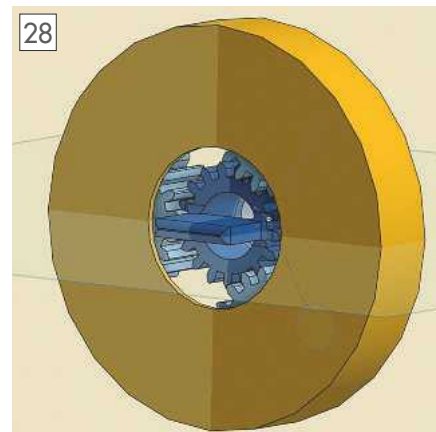
25
Pool skimmer support designed to fit into a convenient piece of plastic tube. INSET: The CAD version showing the structure.

In the prototype section, I have fewer items but the ease of creating gears for example is advantageous to check out operations and, as in the sun and planet unit, allowed me to test out a concept in a matter of hours that would have taken days with normal metalworking. As it happened the concept didn't work but the following step was going to be the subsequent



27
Sun and planet CAD view from the top.

manufacture of the gears in brass or steel. It also allowed me to merge gears together as a single homogenous block rather than having to screw or pin them in the case of metal ones. Printed in the densest format and to the finest detail, I strongly suspect that they would be adequate for light changewheel duty – not for taking several millimetres off in a single pass but maybe to supply the missing wheel for that obscure thread that needs to be cut (photos 27 and 28).



28
CAD view from the rear.

The sequence of photos shows the entire sun and planet gearset being printed simultaneously – this took just over 3 hours for this set (photos 29 to 34). It also shows one of the downsides of 3D printing which is the need to separate the base layer and support structure from the actual object – this consumed another 30 minutes at least. The holes were cleaned with a drill and the pinions had some fine sandpaper wrapped around them to remove any high spots. Then they just pushed together to



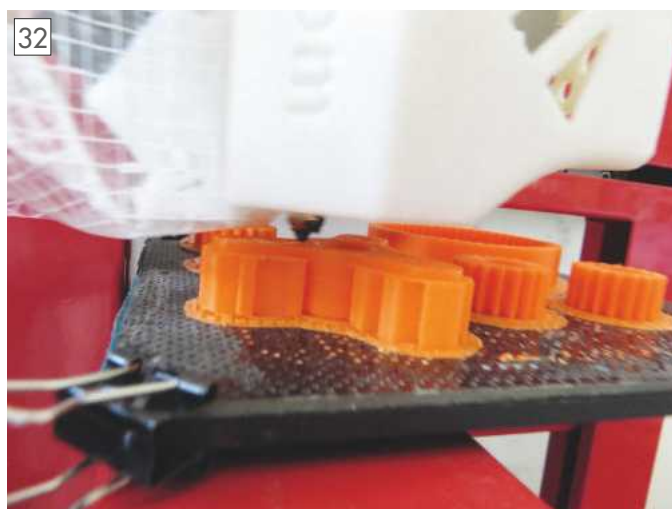
29
Bed (to ensure a good adhesion to the base plate) and initial layers are printed.



30
Support structure to the spider clearly visible (the wavy bit) as well as the hollow structure of one of the wheels (options exist to make this solid too).



31
Gears are now complete and the spider arms are part way through with the internal structure again visible.



32
Eye level view – the nozzle (a glorified glue gun) is the black blob in the centre.



Spider arms complete, just the 3 gear pivots to complete.



End result having just finished – caution required because the bed is still heated to 105°C. The eagle eyed will notice that the planet wheel is lacking the large centre hole – which had to be swiftly machined out!



Arty view of the end result.



Less arty and more detail in this shot where the effects of removing the support structure from under the spider arms can be seen.

prove (or rather, to disprove) my concept. Nice little object (**photos 35** and **36**), to pass around though!

One often mentioned comment refers to accuracy – I made the test box in the photo as a 24mm cube. It is actually 23.85mm high, 24.04mm on one side and 23.97mm on the other (**photo 37**). The wall thickness is 2.01mm at mid height and tapers slightly from 2.06mm to 1.96mm at the top. All within acceptable milling dimensions I suspect but with the advantage that the inner box corners are 90° - less easy to mill! Equally, anything above 150°C or exposure to any solvents and I will be wishing that I had milled it rather than printed it. However, it is now possible to get items 3D printed in metal, either from metallic resin powders or as a lost wax casting from external suppliers in the same manner as laser or water cut components.

My next stages will be to try printing some specific fixtures for my CNC mill since holding objects is always the bane of CNC milling. I also have several covers and brackets that will probably be better or easier constructed in plastic rather than tin bashing which I loath.

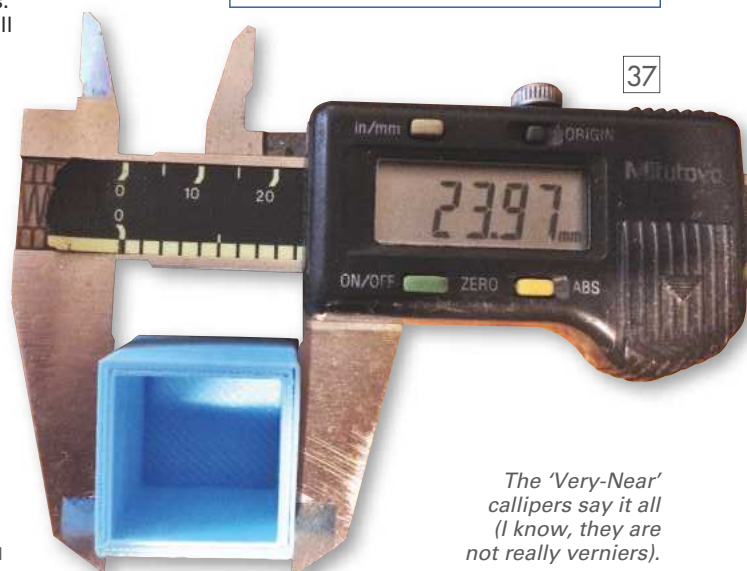
So what is my point to all of this display of plastic over metal – well rather like the

arrival of the microwave oven into the kitchen, there seems to be a feeling in some quarters that 3D printers are the answer to all problems. In my opinion, they are certainly not but they form a very useful secondary tool in a similar fashion to my shaper, MiG welder and a host of other tools. None are essential but all help arrive at an end result. If you can manage a limited proficiency at the CAD, there is no need to invest in the printer since there are a host of 3D printer networks mostly supported by people like myself and small businesses that are happy to print your object and post it to you – or have you come and collect it.

Do try them out, 3D printing has come a long way in the last few years and it is still changing almost daily. ■

REFERENCES

1. <http://www.thingiverse.com/>
2. www.grabcad.com
3. www.onshape.com
4. MEW No. 224



The 'Very-Near' callipers say it all (I know, they are not really verniers).

Readers' Tips

WIN
£30 worth of
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Tool Vouchers

Our winning tip from Matt Shaw is a useful bit of advice for anyone who runs a dehumidifier. He gets £30 of Chester vouchers.

Overflowing with Joy

Many people have started using a dehumidifier to help combat the dreaded rust problem. I myself have done the same for the last few years and it works very well, but one problem I have found, especially over the Christmas period, is that if you don't go into the workshop for a few days the dehumidifier is full and not doing its job. My solution has been to make it so it never needs emptying!

As you can see from the pictures I have added a pipe to the tank, using a toilet overflow fitting from my scrap box. Some models vary from mine that has a door which required a larger clearance hole, to some that have just a tank but I'm sure my fellow modellers can sort it out. I fitted the pipe just above half way up the tank on a nice flat bit so I have a good seal. Thanks to a length of pipe that runs out of the workshop through a hole drilled in the wall lower than the fitting added to the dehumidifier, it constantly drips water away from all the metal in my workshop. Don't worry if you get a blockage in the pipe as the auto cut off still works.

Hey presto one less job to do everyday and more time making.



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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 we will choose a selection for publication and the one chosen as **Tip of the Month** will **win £30** in gift vouchers from Chester Machine Tools. Visit **www.chestermachinetools.com** to plan how to spend yours!



No more than one prize with a value of £30 will be given each month. By entering you agree your entry can be freely published and republished MyTimeMedia on paper or electronically and may be edited before appearing. Unpublished tips may be carried forward to future months. You will be acknowledged as the author of the tip. There is no guarantee that any entry will be published and if no publishable tips are received a prize will not be awarded. The decision of the editor is final.

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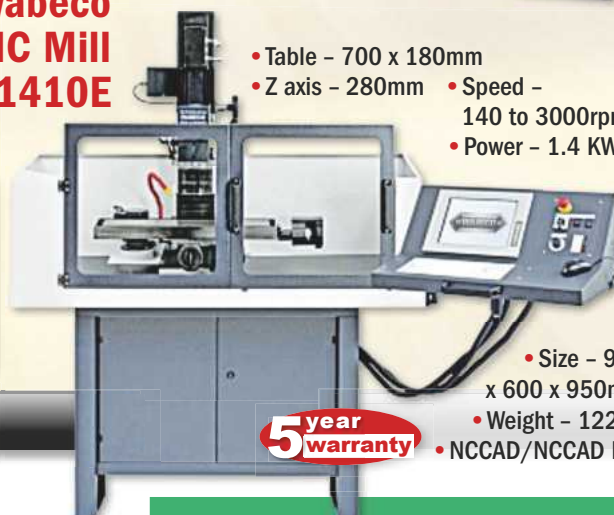
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CNC in the (Model Engineers') Workshop

Part 20



In this instalment, Marcus Bowman tackles a more ambitious 3-dimensional part.

This series of articles started from fundamentals and covers many aspects of CNC programming and machining. The series is not specific to one make or model of machine tool. There is a support website for the series at www.cncintheworkshop.com



Using 5mm deep finishing cuts produced a good finish.

Wizards

Mach3 has a set of external programs called wizards, which you can use to generate the G code for various tasks, including creating a circular pocket to a specified depth. Choosing Wizards > Choose Wizard > Circular Pocket starts a program which allows you to enter some values and generates G code to machine the specified pocket. Each wizard can post its G code into Mach3 and it can be run from there. The ADD-ONS package for Mach3 (a paid-for extra from Newfangled Solutions LLC) allows a substantial proportion of a G-code program to be assembled using several wizards in sequence. As far as I remember, the built-in Wizards will not post code back into the unlicensed demo version of Mach3.

Be aware, though, that each wizard will generate G code which moves the CP using a method determined by the author of the wizard. The Circular Pockets wizard used the basic method consisting of setting a Z height, positioning the CP above the centre of the pocket, plunging vertically into the work, then spiralling out to clear the whole circle at that Z height. In the end, I thought that method was a little brutal, and, with the settings I chose, took too long to machine the pockets, so I decided to create my own subroutine to do the job. That subroutine ramped the cutter more gently into the work, which I found less stressful both on the tool and my nerves. The wizard did work, though, and the use of wizards is a quick and effective way of creating programs, so it is

worth experimenting and becoming familiar with the set of wizards supplied with Mach3. If I had spent longer experimenting with the 'step-over' setting, I should have been able to reduce the time taken by the wizard.

The G code I used for the pockets is listed on the support website at www.cncintheworkshop.com

Machining the periphery

The periphery of the yoke should be a continuous path taking the CP right around the outside of the shape, taking account of the radius of the cutter. The thickness (depth) of the yoke demands special measures, though, and some care in finishing.

This is not the place for a blow-by-blow account of how I used a CAM program to create the G code to take the cutter around the periphery, using a profile cut, but it is worth saying that you do need to decide on a machining strategy before entering the various settings into the CAM program. I have found that the more pre-planning I do, the better the end result. Let the CAM program work out the co-ordinates of the various points on the path, but take human control of the way it uses the path to machine the work.

Two key questions are:

- What is the best way to deal with the Z depth of this workpiece?
- What machining strategy will produce a good finish?

For the Z depths, I decided to take a series of passes around the periphery, at 1mm depths. That would create a deep channel in some places, as the larger pieces of waste were separated from the emerging yoke. To achieve this without the cutter jamming requires continuously lubricating the cutter and clearing the waste. Liquid lubricant can be applied to the cutter and/or the channel using a brush or jet of cutting fluid or by applying a carnauba-rich wax; and the waste can be cleared by blowing, sucking or brushing.

I created a roughing path to cut the periphery 0.2mm oversize. Then I created a finishing pass to bring the periphery to size. I used climb milling throughout, because it gives a good finish, but there are danger points wherever the cutter emerges from a channel or enters a channel and that limits the feed rate. In the end, I used a speed of 3000 rpm and a feed rate of 100mm/min.

At that feed rate, this is a slow process, with 39 cuts (allowing the cutter to pass just below the bottom surface of the work on the final cut).

The final finishing cut was a bit of a trial. I had originally intended a single full-depth climb cut around the periphery, removing 0.2mm at 3000rpm and a slow feed rate, but the roughing cuts indicated that there was a tendency to snatch at top left and bottom right of the work, so I settled on cuts of 5mm depth, to produce an acceptable finish as shown in **photo 115** (where the slight blotchiness is wax residue, which will wipe off).



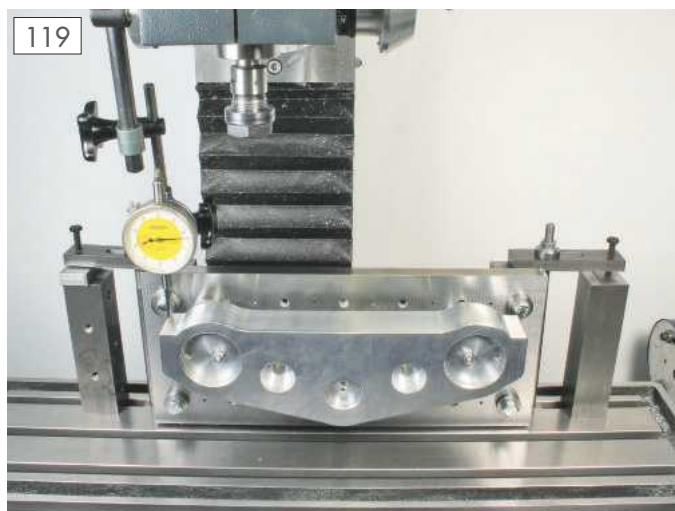
The best place for clamps is through the large holes for the fork legs. The third clamp uses an inverted top hat with a hole which is offset so that the bolt is aligned with one of the existing holes in the sub-table.



Plugs can be fixed to the sub-table to retain alignment of the yoke when it is flipped over.



The alignment plugs remain fixed, but allow additional clamps to be used to secure the yoke.



The yoke was turned on its side to machine the pinch bolt holes, and a DTI was used to compare the heights of the two flat faces for the pinch bolt holes.

Another work holding challenge

Holding the work on the table to allow the periphery to be machined provided an interesting challenge.

The side plates of the fixture plate must be removed to allow the periphery to be machined, but the holes through the work allow clamps to be secured to the fixture plate. Because the tapped holes in the fixture plate are at fixed centres, the best place for clamps is through the large holes for the fork legs (**photo 116**). To maintain alignment, the clamps were secured before the fixture end plates were removed.

A third clamp is used in the recess and hole for the yoke pivot and that takes the form of an inverted top hat with an offset hole. The clamp stud passes through the 6mm reamed hole in the centre of the fixture plate. Make the top hat first, then coat the end with marking blue. Make a short 6mm rod with a pointed end and place it in the reamed hole in the fixture plate. Then drop the top hat into the hole and rotate it against the pointer, to create a circle. Remove the top hat and drill a hole through any point which lies on the circumference of the circle. Remove the pointer and replace it with a stud or a

length of threaded rod, using nuts at either end to tighten the clamp.

Finally, remove the studs you used to hold the work (near the corners) while machining the holes earlier.

Now machine the periphery.

Creating the chamfered edge

The chamfered edge was created by using a 6mm diameter 45° chamfering cutter. The cutter path was created using the CAM program, but an offset was applied to the machining path (see MEW 234) and I found that offsetting the cutter by -2mm and using a depth of 1.9mm for roughing then 2mm for a climb cut gave a pleasing finish.

Dealing with the underside

The challenge in machining the underside is to maintain registration of the holes and the periphery, so that the additional pockets in the underside will be accurately aligned with the existing holes and the chamfer around the periphery will be aligned and look even all the way around.

Photograph 117 shows three additional alignment plugs which were turned to a close fit for three of the holes,

two of which would not require pockets on the underside. They were placed in position and tightened securely before the yoke was removed from the fixture plate. Flipping the yoke over and replacing on the plugs allowed the clamps to be replaced and tightened, ensuring accurate alignment (**photo 118**). These plugs were easy to turn to diameter, but awkward to fit because of the offset holes for the securing studs and for the longer studs passing through to operate the clamps. I used the same short punch as for the inverted top hat clamp, to mark stud hole positions. Once clamped in position, the smaller of the locating plugs was removed. Two plugs might have done the job equally well, but three seemed more likely to ensure accuracy.

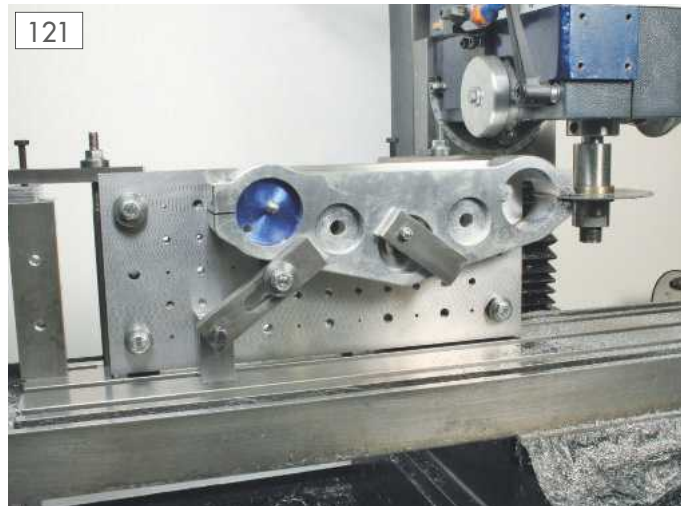
The proof that this method worked came when the chamfer was run around the bottom edge, as any discrepancy here would have been very obvious.

Creating the pinch bolt holes

The pinch bolt holes were a challenge of a different sort. These holes lie in a different plane, so the whole work holding setup was changed.



There is an attractive intersection between the edge of the pinch bolt holes and the curved face of the yoke.



The sub-table provides one way of setting up to cut the slits at the sides of the yoke.

The completed yoke is a lovely thing, and should generate a warm inner glow of satisfaction.

I resisted the temptation, but an item like this will polish to a chrome-like finish, if that's what you want.

Mine is destined for a gold plating bath.

Photograph 119 shows that the fixture plate was turned on its side. The ends of the square spacers attached to the 'underside' but not at the rear of the plate sit on parallels, to take the front of the plate clear of the mill table, and the table is held in position by clamps acting on the square spacers. It is important that the fronts of those spacer blocks are square to the face of the fixture plate, and that was arranged when they were originally made, by finishing the upper and lower long faces parallel, then turning the end faces square in the lathe.

The fixture plate securing bolts need washers and nuts at the rear, and the position of the plate can be adjusted so that the new reference 'front' face of the yoke clocks parallel to the X axis mill table. That is most easily done by using a lever-style DTI against the front face.

Use a plunger-style DTI as a comparator to check that the small flats at the ends of the yoke are at the same height above the table (photo 119). These are the locations for the holes for the pinch bolts. Take a reading from one face, then lift the plunger and move the table to site the DTI above the other face. Lower the plunger and compare the new reading with the first. There should be no appreciable difference. This is more a check than a necessity, because these faces were created as the profile was machined, and should be parallel to the front face of the sub-table. However, there is room for adjustment at this stage, if necessary.

Set the work origin at the centre of the upper face of the yoke, then use MDI mode or create a short program to centre drill then drill the four holes tapping size for M8 bolts. Then drill M8 clearance holes deep

enough to reach at least 1mm beyond the intended lower edge of the slits (to avoid a ragged start to the tapped section).

Finally, create a short program to use a 6mm end mill to create 14mm pockets for the heads of the bolts. There's a lovely intersection line between the curved edge of the pockets and the curved section of the periphery around the fork leg holes (photo 120).

Tap the holes. I did this by hand, using a sliding tapping chuck held in a collet, but the clearance holes provide a good enough guide that you could do this by hand, off the mill.

Slitting the clamps

Photograph 121 shows one way of slitting the clamps, and this is easily programmed, feeding in and across, repeatedly. Take care to calculate the spindle speed appropriate to the diameter of saw blade. Lubricate throughout.

Finishing

If absolutely necessary, deburr the holes carefully and gently using a hand-held carbide deburring tool, then clean the lubricant off the yoke. Polish with a soft cloth, and settle down to admire your work, preferably over a cup of tea and a digestive biscuit. The completed yoke is a lovely thing, and should generate a warm inner glow of satisfaction. I resisted the temptation, but an item like this will polish to a chrome-like finish, if that's what you want. Mine is destined for a gold plating bath, which seems entirely consistent with its status as an objet d'art.

I might even engrave something suitable on that large flat face before removing the yoke from the fixture plate. What artist can resist signing their work? ■

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for issues 225 to 236 of MEW



A computer based index is available for those with suitable equipment to run the software. Further information can be found on the last page of this index.

SUBJECT INDEX

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230	July	2015	236	December	2015

COMPUTERISED INDEX

Barry Chamberlain has compiled these indexes and will continue to do so, but sadly he has had to end the CAHW series of CD based indexes. These days many tablets and other devices simply can't access CDs, so it was sadly no longer viable to keep producing them.

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Peter Angus Locomotive Builder

Reviewed in *ME* No. 4522 - 27th November

Peter Angus's name and locomotives will be well known to the majority of 16mm NGA members; he is probably the most prolific builder in the world of hand-built small-scale, live steam, locomotives. Working with his colleague Mike Lax, over 300 locomotives have so far been constructed for the 16mm narrow gauge track widths of 32mm and 45mm, plus one Gauge 1 locomotive. All of these models share the common features of looking and behaving like the real thing, being very reliable and having good handling characteristics.

You will find photographs of the vast majority of Peter's locomotives within the pages of this book, but there is much more, including historical and technical details of the prototypes, how the models have been built, the ways he ensures their realistic performance, the different methods of firing, how he often fits unobtrusive radio controls, and so on, all whilst keeping a near scale appearance.

Whilst this book will have especial appeal to anyone lucky enough to own one of the locomotives Peter has built, it will also be a source of inspiration to anyone building their own smaller-scale live steam locomotive. It isn't a full-on 'how to build...' book, but it does show Peter's own unique techniques for building good engines for garden railways. For the model engineer, and the railway historian, the prototypes range from well known narrow gauge locomotives, through *Garratts*, *Kitson-Meyers*, *Sentinels*, *Shays* and *Avonside* locomotives to the very unusual. 221 pages, full of all sorts of delights, including archive B&W photos of prototypes and 100s of colour photos of models in various stages of assembly, plus some drawings. Hardbound.

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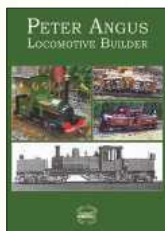
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Our associated business *ASH Models* is run by Alex Harris and offers a wide range of second-hand Gauge 1 and other smaller gauge locomotives & rolling stock. See their current selection at www.ashmodel.co.uk, or contact Alex at the phone number below for more details, or if you are considering selling such models.



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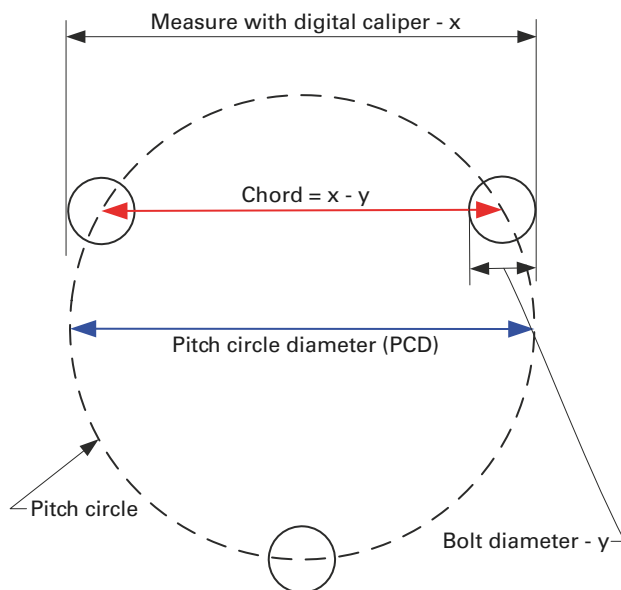


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For three equally spaced holes around a circle of diameter 1 unit the chord length will be 0.866025 in whatever units used

$$\text{PCD} = \text{chord length} / 0.866025$$

(Similarly for four equally spaced holes around a circle of diameter 1.0 the chord length will be 0.707107)

Ref. Machinery's Handbook
See also The Model Engineer's Handbook by Tubal Cain

Note On Finding PCDs

Life After Trigonometry

Dear Neil, I enjoyed reading the 'Three Jaw Chuck Mount' article by Henry Hicks (issue 237) as over the years I have mounted lots of chucks onto various back plates and in most cases having to find the relevant PCD. Henry has gone into some detail providing two good ways of determining the PCD for the fixing holes. However, there is a very quick and easy way of doing this that does not require either a drawing package or trig tables that I would like to share with other readers.

Start with two plugs that are a good fit in the holes and have identical diameters. Measure across the outside of the plugs with a digital calliper and subtract the diameter of one of the plugs, just as described by Henry, the result is the length of the chord across the pitch circle.

Then for 3 holes simply divide this measurement by 0.8660 to give the PCD. This works for any units metric or imperial. For 4 holes just divide the chord length by 0.7071.

Please see the sketch which gives full details.

Eric Clark, by email

Special Editions

Dear Neil, I have been reviewing my books and magazines, and I read in *Machining in the Workshop* published in 2010, that your predecessor hoped there would be 'many more over the coming years'.

Has any consideration been given to producing other issues of what I think was a great read, though a little heavy on Myford, there are other lathes in the world!

Undoubtedly many hours were spent in the preparation and photography of this magazine. At the time of its publication it cost \$12.99 in Australia, but I think it was worth every cent!

I am building the Blackgates Vee Twin and have found David's article of help.

I have been machining since the mid 60's but doing model engineering since about 2000, and is one of my great joys to immerse myself in my workshop since my retirement in 2010, after 41 years as an aircraft maintenance engineer. Keep on machining,

Ken B. by email

More such stand-alone specials (in the trade they go under the awful name of bookazines) are certainly possible, especially if there is a demand! If readers let me know or put their suggestions on the website I shall see what I can get to happen in 2016 - Neil.

More Bushcraft

Dear Neil, your recent correspondent John Woodgate in *MEW* No.237 asks about punching holes in sheet aluminium. I had a quick look in *Kempe's Engineers Year-book*, (92nd Edition, edited by J.P. Quayle, Morgan Grampian, 1987), which states that punching a 10mm diameter hole in 1mm thick soft aluminium with a shear strength of 11.81kgf/mm² will require a typical load of 928kgf. Hence I would expect that punching a 12mm hole in 0.5mm sheet should be possible with a 1 tonne arbor press. The force required can be significantly reduced by using a punch with a sloped or curved cutting edge.

However, I would suggest that he has a look in virtually any recognised mechanical engineering hand book (e.g. *Machinery's Handbook*, *Parrish's Mechanical Engineer's Reference Book*) to determine how to shape the punch - a simple straight punch will not be satisfactory. In fact there is a simple toggle punch described in Harold and Audrey Mason's book *Making the most of your lathe* (Patrick Stephens, 1992, ISBN

1-85260-304-6), specifically designed for punching holes in sheet material. I cannot remember just how big a hole can be punched, but it may be suitable as a guide to get him started. I hope that this is useful for John.

Graham Astbury, Skipton

Power of Youth

Dear Neil. Thanks for your reply to my query about printing from old *MEW* magazines. It's been a while, because I have only just managed to sort it out. My 14 year old grandson showed me how to do it! It only needed 4 or 5 clicks on the mouse to fix. What would we do without young technophiles?

John Yeoman, York

John had enquired about printing the archive issues that are accessible online with a digital subscription – Neil.

M-type Mandrel Bore.

Dear Neil, a long time ago I had an M type Myford and like Geoff Walker I was frustrated by the number 1 MT taper socket. I found that it was possible to make and fit a number 2 MT spindle provided that it had ML7 nose dimensions, i.e. a 1 ¼ inch register and a 1 ½ inch thread. The larger nose allowed a number 2 taper, but the bore had to be stepped as there wasn't room for a 1 ½ inch through bore, as on the ML7. I'm sure I didn't re-make the bearings. If I remember rightly I made the new spindle in EN8.

Jim Lugsden, Beckenham, Kent.



Spanish Castle Magic?

Dear Neil, I enjoyed the article on the Makers' Faire in New York State. It may be of interest to know that the item captioned as a 3D printed castle was in fact *Luna Park*, Coney Island as at the dawn of the Twentieth century. This was a very early theme park that grew out of *Sea Lion Park* with a live sea lion show. Further reference is to be found in *Amusement Parks* by Jim Hillman and published by Shire Publications. ISBN 978-0-74781-202-8.

Malcolm Tierney, by email



Captain Baxter

Dear Neil, your photo of *Captain Baxter* (Ed's Bench, *MEW* 236) reminds me of a visit I made in the summer of 1955, when two or three of us were taken to Dorking Greystone Lime Works by one of our school masters. Poor Captain Baxter was caked in mud as she struggled to haul a single wagon of coal up from the main line, looking very sorry for herself and only just managing to cope with even that small load. I remember that she had a couple of sisters, I think 3ft. 6ins. gauge, also built by Fletcher Jennings, one of which was in steam, working in the quarry. I believe one has also been preserved. It is nice to know that this fine locomotive has been preserved and is working once more.

Richard L. Hills, Mottram, Cheshire

We would love to hear your comments, questions and feedback about MEW
Write to The Editor, Neil Wyatt, Model Engineers' Workshop, MyTimeMedia Ltd., Enterprise House, Enterprise Way,
Edenbridge, Kent TN8 6HF. Alternatively, email: neil.wyatt@mytimemedia.com



The X1 mill as nature intended.



The Frankenstein arrangement.

Flat Belt Frankenstein

Gary Ayres details his custom Milling/Drilling workstation.



The call for short articles on customised 'Frankenstein' machines in On the Editor's Bench (*MEW* No. 231) was fortuitous for me because a few months ago I modified a Sieg X1 micromill (**photo 1**) enabling it to be used as a 'bolt-on' milling module mounted on – and powered by – my large drill press. Although (in my opinion) the result is too cute to be called a 'Frankenstein' (**photo 2**) the project appears to meet the brief!

Last year, while doing some work on the gearbox of my X1, I managed to accidentally destroy the PCB which controls the variable speed of the motor. To replace this would have been quite expensive, so I decided instead to think laterally and have some fun. I have a large floorstanding SIP drill press with a powerful motor, and it struck me that here I had a ready-made powerplant for the X1. The mill as purchased is designed in such a way that the entire gearbox and motor assembly moves up and down the z axis whenever the quill is raised or lowered. All I needed to do was figure out what kind of transmission I could set up between the spindle of the drill press and the spindle of the mill that would accommodate the up and down movement of the latter. Clearly, because of this vertical travel, v-belt pulleys would not do. A youtube video about a wonderful old-school lineshaft-driven machine shop gave me the idea of making a flat belt drive in which the drill press is fitted with a pulley which is long enough to accommodate the vertical travel of the mill. The belt would traverse this pulley when the quill

of the mill was raised and lowered. Gone would be the mill's original variable speed control, but in its stead would be the range of speeds offered by the usual belt changes inside the head of the drill press, and the RPM of the drill press would be transmitted unchanged to the mill as the two flat belt pulleys would be of the same diameter (**photo 3**). A bit of sizing up revealed that it would be possible – with the head of the drill press swung over to one side – to mount the mill on the table of the drill press. In effect, this would not only save bench space but would also create an integrated milling/drilling workstation which would allow various different configurations, as the mill – or alternatively, the column of the mill only – can be easily removed. Also, the flexible movement of the drill press table makes tensioning of the flat belt and adjustment of the working position easy. Drilling and milling operations at an angle are also possible, as in photo 2.

The supplier of the flat belt confirmed that inch wide three-ply balata belting would fit the bill, so I ordered a metre of it. It costs less to join the belting with an

'alligator' style metal clip than it does to have the supplier make a seamless join. I wanted to keep the project as economical as possible, so I opted for this solution (I also quite liked the idea of using a clip). However, he advised me that this would ideally require the pulleys to be made of steel rather than aluminium as the clip would be likely to erode the surface of the softer metal over time. I also learned that the pulleys would have to be a minimum of 3 inches in diameter as the sharper curves created by smaller pulleys would delaminate the belt.

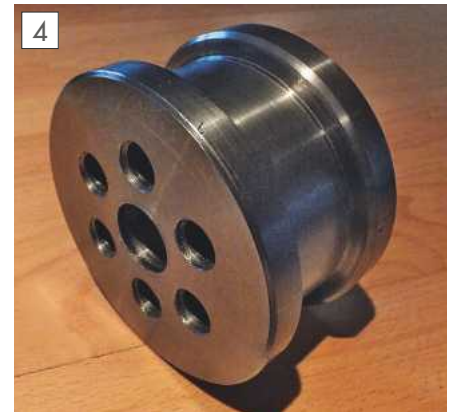
For the mill, a pulley of 3 inch diameter and 1 inch width was turned from bright mild steel (**photo 4**). Using a dividing setup on the drill press, six holes were drilled through it in order to reduce its weight, and a keyway was cut to accommodate the existing key. Making this pulley was quite a mission, but in terms of design it was fairly straightforward. The drive pulley on the drill press required a bit more thought. What I didn't want was to have the pulley fall out of the drill when in use as the consequences of that could be disastrous. After considering options, I decided to use what was already there – the drill chuck – as the core of the pulley. A piece of steel pipe was used to form an outer sleeve for the pulley. Due to a mismatch of diameters, it was necessary to make an inner sleeve as a spacer, for which I used a piece of aluminium pipe bored to size. Sliding fits were created between the chuck and the two sleeves. A collar was made to fit over the end of the quill of the drill press, again using steel pipe shimmed with aluminium. This was then drilled with three equidistant holes which were tapped M6 to accept stainless steel cap-head screws. When the pulley is in position these screws are tightened into three locating indentations which were spotted into the nose of the spindle of the drill press. The screws provide most of the drive which is transmitted from the rotating drill spindle, and they anchor the pulley to the spindle to hold it in position.

For the top end cap of the pulley, a circle was cut from steel plate and the centre of this was bored to the diameter of the collar. The outer sleeve, the top end cap and the collar were then silver soldered together to form the main assembly. The bottom end cap is not fixed to the pulley, enabling installation of the pulley into the drill press by sliding the drill chuck up through the pulley and inserting the shank into the drill in the normal way. A short piece of round steel bar with a threaded end – having already been secured in the chuck – protrudes down through a hole in the bottom end cap which is then locked in place with two nuts and a washer. A circular locating groove was milled in the upper side of the bottom end cap to ensure concentricity with the rest of the assembly. **Photograph 5** shows a cut-away view (created using Gimp open source image editing software) of the drive pulley assembly in situ on the drill. The completed drive delivers plenty of torque as transmitted from the drill press, and the flat belt grips the pulleys well.

The castings of the mill and the front part of the head of the drill press were originally red in colour. In order to put my own stamp on the workstation while



Flat belt pulleys and balata belt.



The hefty 3-inch driven pulley.



Cutaway showing how the drive pulley fits over a drill chuck.

ensuring that the two component machines remained visually integrated, I painted these parts white - not a particularly 'Frankenstein' colour, and arguably not a particularly practical colour either. I like it though!

One of my concerns about this project was the possibility that the table of the drill press – although heavy – would not provide a stable enough base for the mill and that this may result in excessive vibration. However, this is not as bad as I expected it to be, and I anticipate that the device will be able to perform a good range of useful operations. My sense is that what has been sacrificed in terms of a rock-solid setup will be compensated for by convenience, flexibility and space-saving. In any case, early indications are good.

The small example shown in **photo 6** illustrates a piece of work done with the milling table set at an angle (as in photo 2). This is a finial on one of the aluminium shelf support columns for a built-in TV and media unit. The angled cut at the top was made using a slitting saw in the mill with the workpiece held in a three-jaw chuck mounted on a locked rotary table fixed to the tilted table of the mill. In order to create

the effect of the column 'piercing' the hardwood shelf, the column was made longer than the height of the shelf. The top of the column was then turned down and threaded M6. The narrow threaded portion of the column was passed through a small hole in the shelf, and the finial – which was drilled and tapped – was screwed on to it.

I look forward to further exploration of the capabilities of my 'Frankenstein' milling/drilling workstation. ■



A shelf support finished on the Frankenstein Mill.

The mobile 'smart' phone as a workshop tool?



Howard Jennings has a play with new technology.

I rate tools on how often you find yourself using them. To my surprise I have found my mobile 'smart phone' becoming an integral part of my workshop activities, finding it in my hand more and more. I decided to pen this article (on my phone of course) to give readers a heads-up on how I am using my phone and where I think the technology is going. This is not a comprehensive round-up of the market or the technology. Writing such an article would be a massive task and the market for these devices moves so fast that the information would be out of date in a few months.



My wife's Samsung phone.

My Nokia phone showing apps and features in this article.

If you have got this far into this article and you are in the 'over my dead body' camp when it comes to digital technology I hope to entice you to read on. The smart phone is a really easy way in to all aspects of the internet. This is because the operating system has to be really intuitive to use since just about everything is done using the touch screen. Many smart phones can be instructed by voice or handwriting too, so there is no need to think you will be a slave to the keyboard. At this point I would like to mention that I use the term 'mobile phone' to mean smart phone or tablet. See **photos 1** and **2** for the phones mentioned in this article.

It is perhaps worth reflecting how far technology has moved in my working life. As I was entering my teens I watched the original Star Trek series with the communicator devices that allowed conversation between characters in different places, and then went to computer studies lessons where the machines we used were programmed with punched cards. It was a task to get such machines to add up and the communicator of Star Trek looked to be science fiction

that would never come to pass in my lifetime. How wrong I was! The smart phone is the embodiment of the Star Trek communicator, on steroids! It is a powerful computer with a camera and other sensor technology built into a package handy for your pocket: it can secrete its way easily into your workshop where the sensors can be made to work as instruments and tools for all sorts of tasks.

Where did it start?

About ten years ago I was looking for a new mobile phone. My daughter got involved and encouraged me to buy a phone with a camera. I was really skeptical about the use I would make of such a device built into the phone. Again I was wrong: soon I found myself using the camera as a powerful and accurate note-taking device, photographing tooling and materials at shows and in shops for later reference. Then the direct workshop applications started to creep in. Photographing an assembly before and during dismantling, particularly wiring inside machines can be a real time- and

possibly life saver when assembly time comes weeks/months later.

As time went on phones arrived with more and more powerful cameras. These were used to magnify photos of components to help me analyse problems. Has a tool tip frittered? No messing about trying to get a magnifier (and my head) into a position to inspect the tool - just photograph it and enlarge it on-screen. Looking inside a dark space anywhere inside a machine, even right at the back of the bench where you thought that part had dropped. Out comes the phone - 'click' - a few shots with the flash on and then scour the photos for your elusive quarry! No moving stuff around, contorting to get yourself in, banging head etc. All of the photographs for this article were taken on a mobile phone: if I am doing a job that could make a good article, out comes the phone to take some shots of the set-ups ready for a later write-up.

Much of my work these days involves making or repairing parts for vintage cars (c. 1930). Clearly it is not always practical to bring the part-assembled car to my workshop to machine the mating part. So

the next best thing is to photograph the mating assembly, sometimes with a rule positioned in the shot and or some accurate caliper measurements. This helps me to check or infer dimensions later, the zoom on the camera being particularly useful. This approach is nearly as good as a drawing and takes far less time. Plus the phone gives me direct access to the internet: I can look up technical information instantly and check shops for materials and tooling while I am involved in the job. And yes, I can phone suppliers or order directly online.

Yes, you can get the equivalent of a CAD system working on a mobile phone! Okay, it doesn't have the full functionality of a 2D CAD system but this isn't some kiddies' drawing plaything that puts coloured lines and shapes on the screen.

Apps

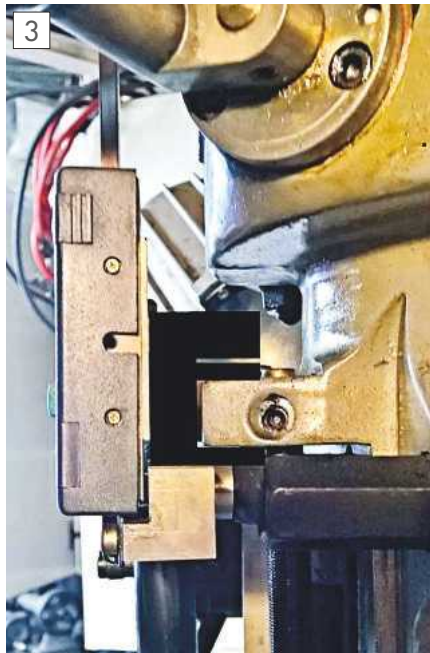
I am trying hard not to sound like a computer magazine. However, I cannot avoid this shortened form of the word application. So far I have looked at uses for the smart phone in the workshop using the 'out of the box' features. Things get more interesting when we start to look at the apps available for smart phones. Whilst there are millions of apps for mobile phones, only a small number have direct relevance to workshop activities.

Photo 1 shows the apps I use arranged separately on the screen. I use the photo light almost daily. For those unfamiliar with the possibilities offered by apps, this one allows the camera flash light to stay on continuously for illumination. I am forever finding the need to look into a dark recess inside a part I am making and it is invaluable when something drops on the floor and rolls into a dark area. I always have my phone on my person for communication so it is a torch ready to go, (usually) fully charged and perfectly to hand.

More recently I have found a magnifier app useful. I had to try out one or two options to get the right functionality but the best I've found feels very similar to using a magnifying glass with the added benefit of intuitive adjustable magnification. At the very least it is good for reading obscure text/small print/grubby two-year-old pencilled notes! And better still, so far all the apps I've mentioned are free!

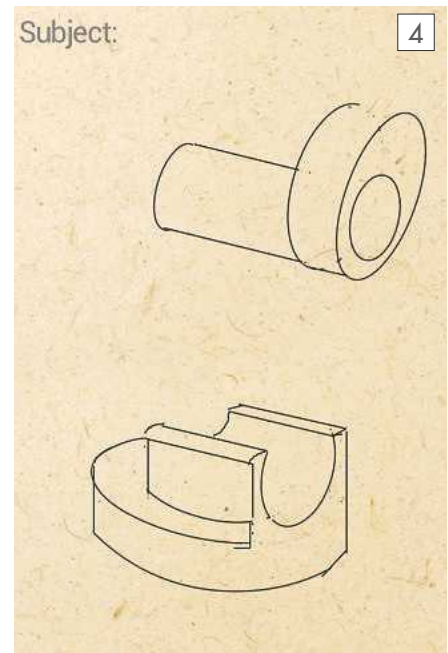
Drawing App

Yes, you can get the equivalent of a CAD system working on a mobile phone! Okay, it doesn't have the full functionality of a



Milling machine part sketch.

2D CAD system but this isn't some kiddies' drawing plaything that puts coloured lines and shapes on the screen. The one I use is called ArchiTech. All the drawing is done with the end of your finger, even if you have big fingers (as I have). You select the line type (solid, dashed etc) and then control the length, width and angle with your finger using the screen icons that appear around the line. All of the features work in a similar way to this. The app is designed for architectural plan drawing but can be persuaded to produce engineering drawings at a 'looks much more professional than hand sketching' level. And even better it will allow you to draw on an image - photograph a component and then draw on top of it to show how a modification or addition will look. This is like taking your workshop with you in your pocket! Sitting around on the bus or train, in any waiting room or on your mother-in-law's sofa out comes the phone



Sketch using the Samsung.

and the plan for the next job is on its way! **Photograph 3** is actually a screen shot from ArchiTech showing a part (blackened in) that I am pondering making for my milling machine. Note some phones like the Samsung (photo 2) have a built in drawing system using a separate hand stylus. **Photograph 4** shows a sketch done using the stylus-based sketching system built into a Samsung Galaxy Note phone.

Clinometer app

If you've handled a smart phone, you will know that they contain sensors that enable the screen image to be reoriented as you rotate it. These are utilised in a more sophisticated type of app to allow you to measure angles quickly and easily using a phone. You can get some idea of how accurate it is from **photo 5**. The phone (showing the clinometer app) and the decent, metre-long level are up against



Clinometer app.



Clinometer surface level.

each other on the same surface. There is an in-built calibration within the software that seems to work by 'splitting the difference' when the phone is rotated on a reasonable surface as instructed by the app. You will note that this app claims to be able to measure angles to within ± 0.1 degrees depending on the phone quality. As I write I have no reason to doubt this accuracy on my phone. This app also acts as a surface level (see **photo 6**), though since the camera lens stands proud of the rear of my phone, I have to be a little careful when using the app for this.

Market reality

At this point I must just throw a bit of cold water reality in to this article mainly due to the mobile phone market. In coming to write this article I took account of my own smart phone, which is a Nokia Lumia 1520 (photo 1) that uses the Microsoft Windows operating system: it has a large screen placing it halfway between being a phone and being a tablet (a 'phablet', yes I hate it too).

Those of you who remember the 'good old days' of the VHS/ Betamax video players will not be surprised to learn that there are competing smart phone operating systems, the two biggest kids in the playground being Apple's iOS and Google's Android. There are literally millions of apps available for both iOS and Android through their respective app stores, but it seems most of the engineering apps are built for Android. Darn it! I chose the wrong system for the right reasons! Let me explain - Nokia is now owned by Microsoft which is great for compatibility with the Windows operating system on my computer. However, Microsoft entered the smart phone market late and has therefore had to try to get a piece of the action from the other two giants. Unfortunately, it has fallen badly at the apps fence because there are not enough users for the app developers to be interested. It seems that something will have to change to open up the market and there is strong talk that Windows will eventually accept Android apps. This is the approach taken by BlackBerry, remember them? I had a BlackBerry myself up until a year ago. Five years ago BlackBerry would have featured strongly in an article like

this but no more, since their poor app showing (amongst other problems) caused big issues and their popularity took a nosedive. Things move fast in this market - I am conscious this article may well be out of date in under a year.

Samsung to the rescue

As luck would have it my wife also has a large screen mobile phone; a Samsung Galaxy note 2 (photo 2) that uses the Android operating system. She kindly allowed me to look around at some apps. I can therefore report that Android appears to have more engineering apps and there are more CAD drawing systems available. The engineering apps are mainly aimed at engineering students and feature a range of automatic computations but I can see some of you being able to pick out functions from apps like this to assist projects. As for the CAD drawing systems on Android most of them seem to be CAD viewers but some seem to be capable of modifying drawings that are saved as DXF files.

Unfortunately I haven't managed to lay hands on an Apple iPhone for this article. However, the competition with Android is so fierce that I would expect to find an equivalent of any of the apps I have mentioned on the Apple system. It may well be that the Apple system is better on some engineering apps as apple software is the 'standard' for graphics work.

Other handy apps

In preparing this article I did a bit more research to see what I could find that may be useful in the workshop. I haven't got a lot of experience with these apps but I feel they are worth a mention. You will see on photo 1 a tile button to start a unit converter. I have noticed quite a few apps like this. I am giving this one a try, I don't find myself doing a lot of unit conversion but my experience is that conversions often crop up out of nowhere. Another app you may notice on Photo 1 that took my eye is a decibel meter. I don't do a lot of really noisy stuff but handy just to check up on the noise level on jobs that may be a problem with the neighbours. I am sure you have spotted the fraction calculator on photo 1 as well, another app that is handy to have around in the imperial measuring system.

I was particularly interested in the app in **photo 7**. I was originally trained using SI units since my apprenticeship was with a firm that worked almost entirely in imperial. My subsequent career was all with companies using SI units. My business now involves cars from the 1930's, all imperial measurements. Switching between the two systems is a regular part of my workshop life. However, I like using metric measurements on some machining operations because of the appearance of the sizes. Compare 1.125 and 1.25 inches with 28.575 and 31.75 mm: the significant difference in the numbers and sequence between the sizes I find helps to prevent mistakes, particularly with an operation like coordinate drilling. This app could be a massive help. Note also the nifty feature of finding the nearest fractional inch size straight from a metric to imperial conversion. I do have a 'Zeus' book that this app does not replace - I see this app as a useful co-player.

The future

I see the apps improving and more being added. However, the addition of extra equipment to increase the functionality is starting to happen. You may have seen apps that analyse car electronic control systems, working through a device plugged into the car and a Bluetooth link. I see considerable possibilities here for the smart phone in the workshop.

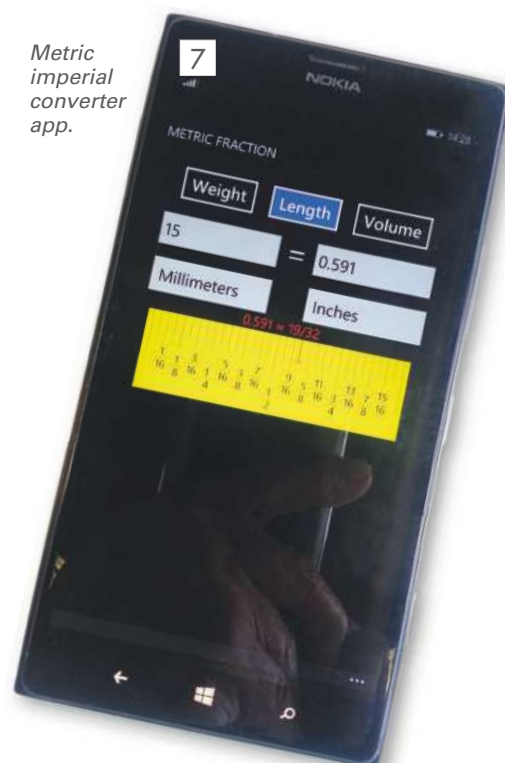
Buy a phone

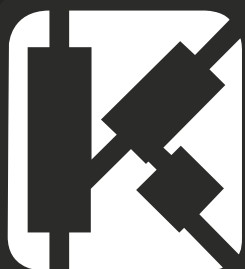
If you are looking to upgrade or may be enter the market don't buy on impulse. Take a long look, ask around, look online; if you can go in a shop at quiet time and see phones demonstrated so much the better. I notice a trend towards smart phones having better forward cameras (looking out of the screen for 'selfies') than the cameras for taking pictures away from the screen. In my view such a phone would be limited in the workshop. You will find the bigger the screen and more 'mega pixels' the cameras have the more you pay. Just because these devices are sold as phones there is no need to operate them as such - you could think of them as very small computers or even as semi-virtual multitools. If your phone or tablet will only get used in the house and workshop look at using WiFi only. If you are in luck it might be possible to hitch on to a free local WiFi if you live near one or do a deal with your neighbour to use theirs.

Finally

I hope you have found this quick look at the mobile smart phone in the workshop has opened up possibilities you were not aware of. I have deliberately not mentioned all the communication tools that such phones offer: SMS (texts), email, skype, facebook, twitter, and good old speech telephone! Surely even the most die-hard anti computer workshop hermit cannot ignore the potential these phone devices offer. ■

Metric imperial converter app.





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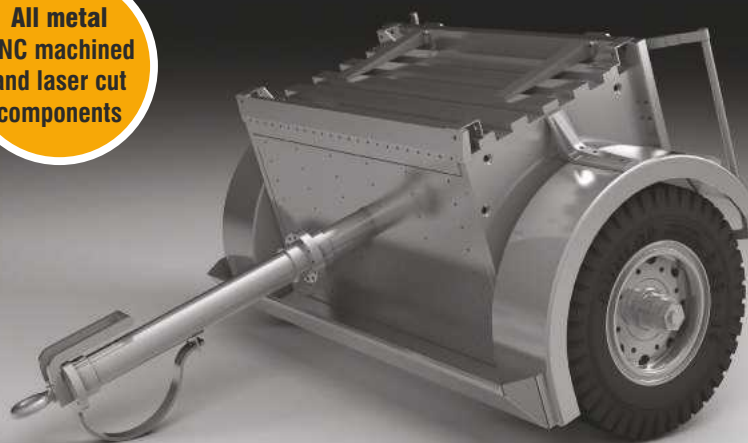


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Myford ML7R Power Cross Slide

Part 3



Keith Wraight answers a perennial question – can power cross feed be fitted to an ML7R?

Standing at the lathe, a Myford 7R, taking a few thou off the front of a face plate I was thinking how nice it would be to have a Myford super 7 machine with power cross feed.

There seemed no prospect of a mechanical modification as the Super 7's saddle and cross slide is completely different to that on the 7R and it would be a very expensive proposition. However, not wanting to be beaten I then turned to thinking about an electrically powered approach and this seemed to be a much more promising proposition.



The completed unit ready for painting.

Mechanical assembly

Please note, the electrical components in the body area need to be fitted before the mechanical assembly can take place, see the next section. Remove the cross slide handle and dial from the lathe. Remove the two retaining screws and remove the cross slide bracket from the slide. Unscrew the lead screw from the nut in the cross slide.

8



Wiring attached to the unit.

This is a good time to check the settings of the slide gib strip as it is only possible to set it up correctly when the lead screw is removed and the slide can be moved from end to end by hand, after cleaning and oiling.

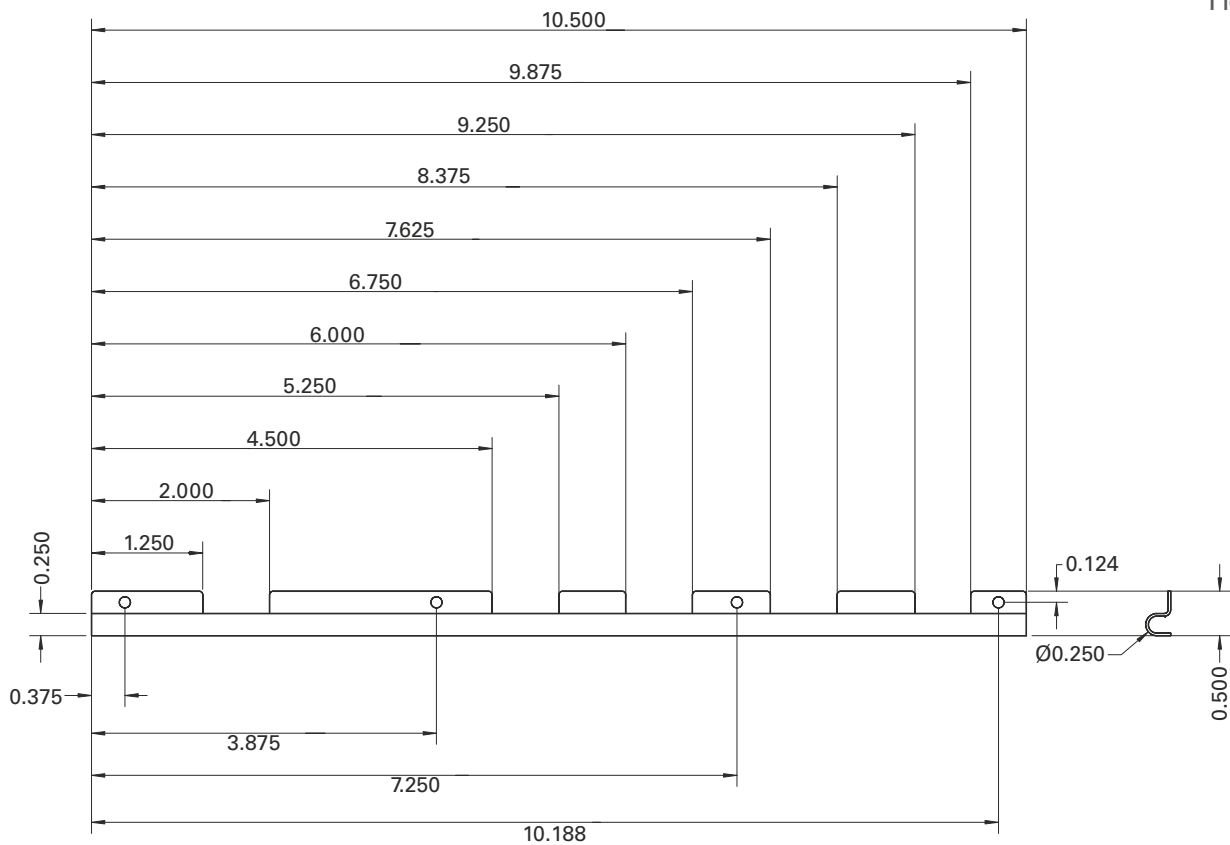
Slide the larger of the bevel gears, 32 teeth, onto the lead screw extension, ensuring it is the right way round, see fig. 1, and lightly lock in place over the flat cut out section of extension. Screw the $\frac{1}{4}$ inch BSF end of the lead screw fully into the $\frac{3}{8}$ inch end of the extension and, lightly gripping the lead screw (vice with soft jaws), and using the spanner flats tighten the extension fully. Lightly oil the extension and carefully feed the $\frac{1}{4}$ BSF end through the two bushes from the back of the front plate. Take care that the wires in the chassis area are not trapped and are directed well clear of mechanical components. Slacken the screws retaining the two bevel gears and when the gear lever is locked in the fully up position the gears can be adjusted for smooth running. The latch stop screw may also need adjusting at this time. Fit the case with four 6BA screws.

The unit can now be fitted to the lathe. Supporting the drive unit, screw the lead screw back into the cross slide nut. If the power unit is available the cleaned and lubricated lead screw can be driven in under power, much easier. Attach the drive unit to the cross slide with the two cap head screws removed above. The position for the limit stop cam can now be found and the cam fitted to the front of the saddle. All that remains is to attach the lead to the side of the cross slide with the conduit (**fig. 13** and **photo 8**). The details of the conduit are for the ML7R lathe and may be different for other models/lathes.

Electrical components

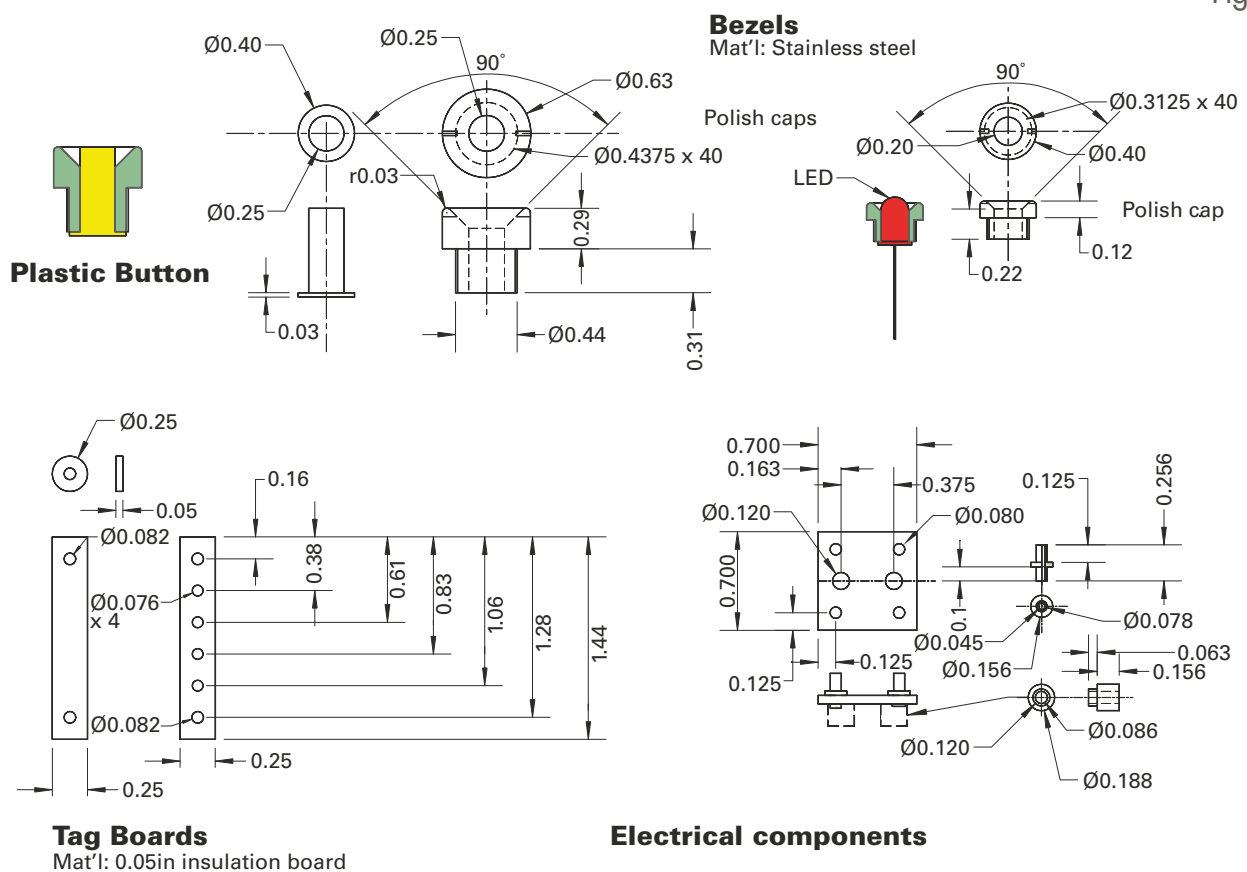
Refer to **fig. 14**. There are one or two electrical components for which no commercial equivalent could be found, so I finished up making them myself. For the two small tag boards I used some tags which are called 'Turret Lugs' which I had on hand. Again I could not find a supplier so I have included a drawing of a brass tag that will do and whilst rather fiddly is not too bad to make, and only eight are

Fig. 13



Conduit Cable

Fig. 14

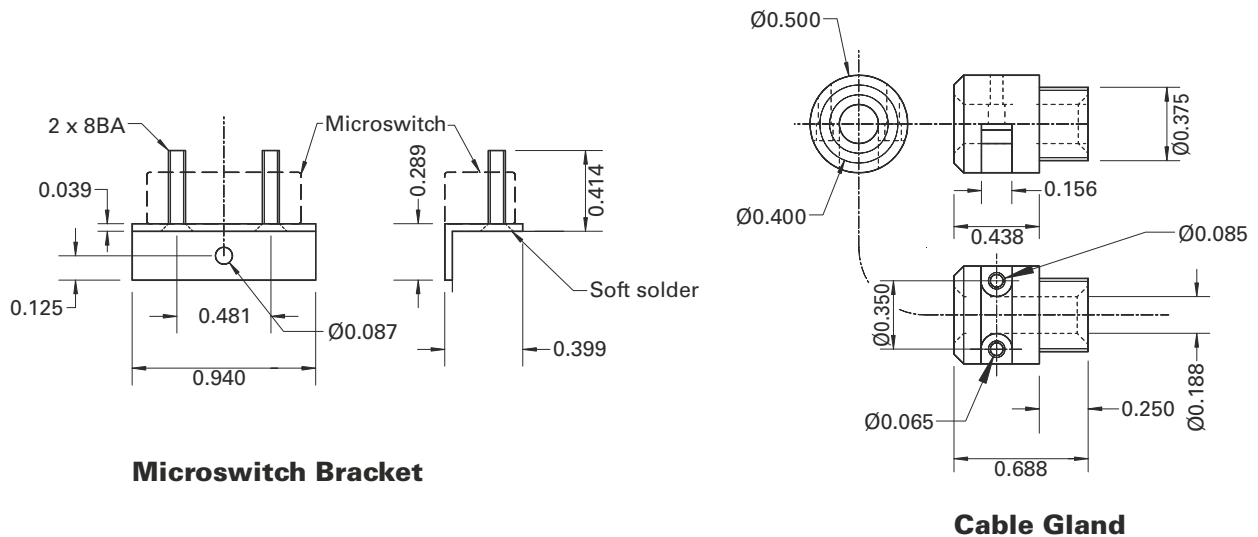


required for the two tag boards. The long tag strip is attached to the body by two 8BA screws with a plastic strip and two plastic washers to insulate and space the tag board from the body (**photo 9**). It will be found much easier when you come to assemble the small square tag board to the body if the spacers fitted behind the board are attached to it. The spacer drawing shows a tubular rivet formed on one end of the spacer for this purpose. The next item is a bracket used to mount the limit stop micro switch. The bracket

consists of a short length of brass angle with two captive 8BA countersunk screws (**fig.15** and **photo 10**). The two screw heads are soldered to the bracket, soft solder being plenty strong enough here. The two micro switches, one with a roller part no. 78-2474 and one with a lever part no. 78-2468, are both from 'Rapid electrical components', usual disclaimer. The switch with the roller is used as a limit switch and the one with the lever as the switch element of the stop switch fitted on the top of the unit.

The electrical components can now be mounted on the chassis. Screw the two stainless steel bezels (fig.14) into the body from the outside, tight. Place the switch button in the larger of the bezels from the inside and then screw the micro switch with the lever in place. Note: the lever may need adjusting (bending) slightly to make the button operate correctly. After soldering the components to the square tag board; see circuit diagram, **fig.16** and photo 10. Screw the tag board in place with two 8BA screws. Solder the link from

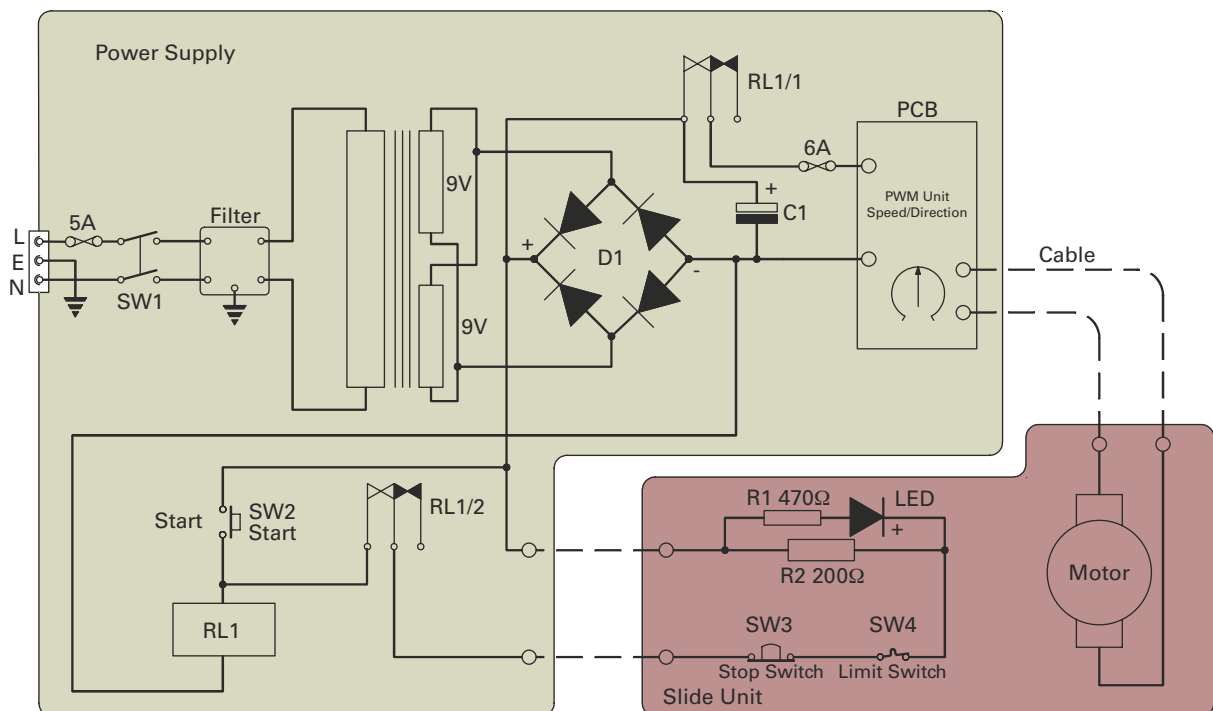
Fig. 15



Microswitch Bracket

Cable Gland

Fig. 16

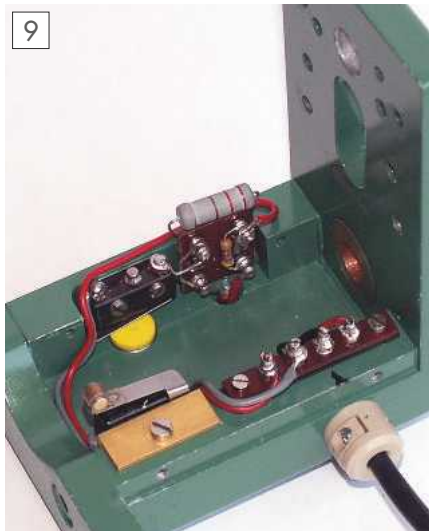


Circuit Diagram

I have found the unit very solid and extremely useful since I fitted the prototype to my machine. I recommend the drive to anyone wanting an interesting project with a useful addition to your lathe at the end.

the tag board to the micro switch. Connect a short length of insulated wire (red in photograph) to the tag board. Solder another short length of insulated wire (grey in photograph) to the other end and contact of the micro switch. Connect the two wires to the long tag board the grey one via the outside terminals of the micro switch with the roller which can now be mounted on the chassis as shown. The cable gland of your choice can now be fitted and the four way cable you have chosen can be feed through the gland and soldered to the long tag strip as shown. The plug can be attached to the cable to finish of the wiring of this unit. Please make sure the wires are tucked well down into the chassis as shown and will not interfere with the mechanical operation.

The linear cam which operates the limit switch is mounted on the front of the lathe saddle, is shown in **fig.18** (overleaf). With two 6BA/3mm screws. The location of the



Tag strips inside the body.

cam is best left until the unit is mounted on the lathe and the position of the cam can be ascertained, and the holes drilled and tapped for the screws in the front face of the saddle.

Electrical details

See circuit diagram, fig.16. When the power lead is connected to mains some components inside the power supply unit will have lethal voltages on them. Do not operate the unit with the cover removed. If the builder does not feel competent to construct electrical components, you are strongly recommended to seek assistance from someone who is.

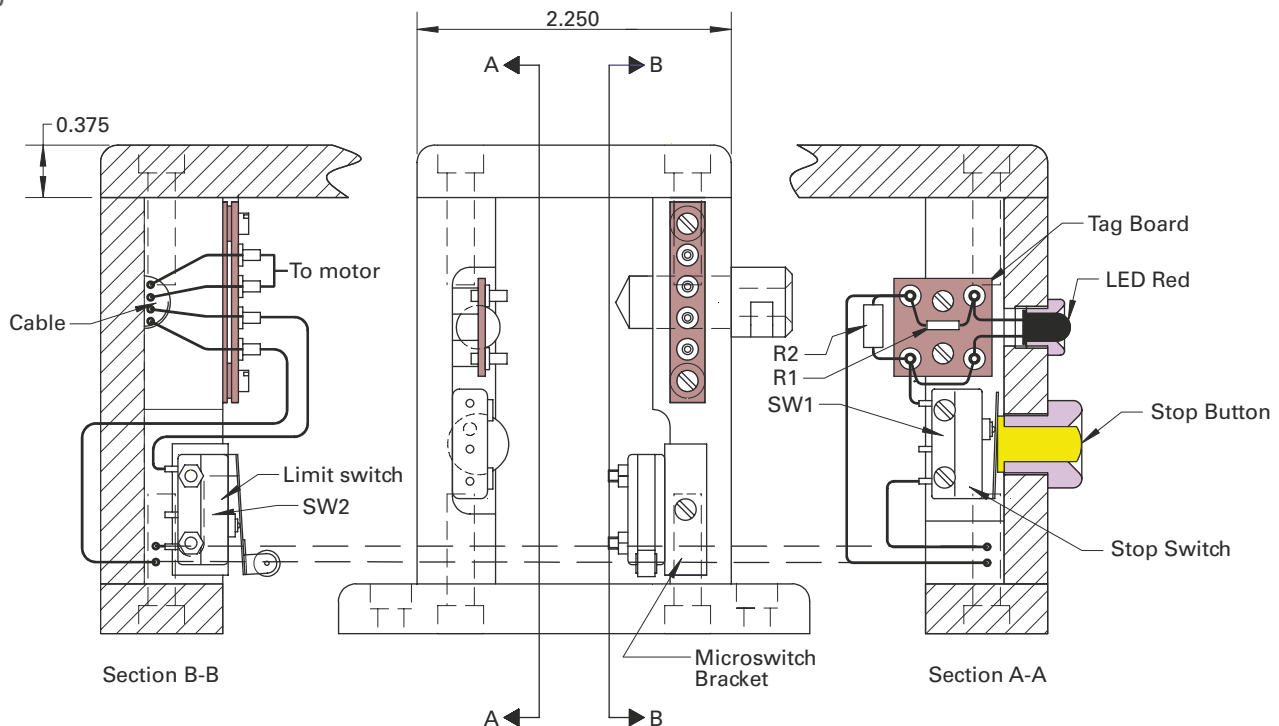
The circuit diagram is split into two parts. The first and simplest part is the



The microswitch can be seen at right.

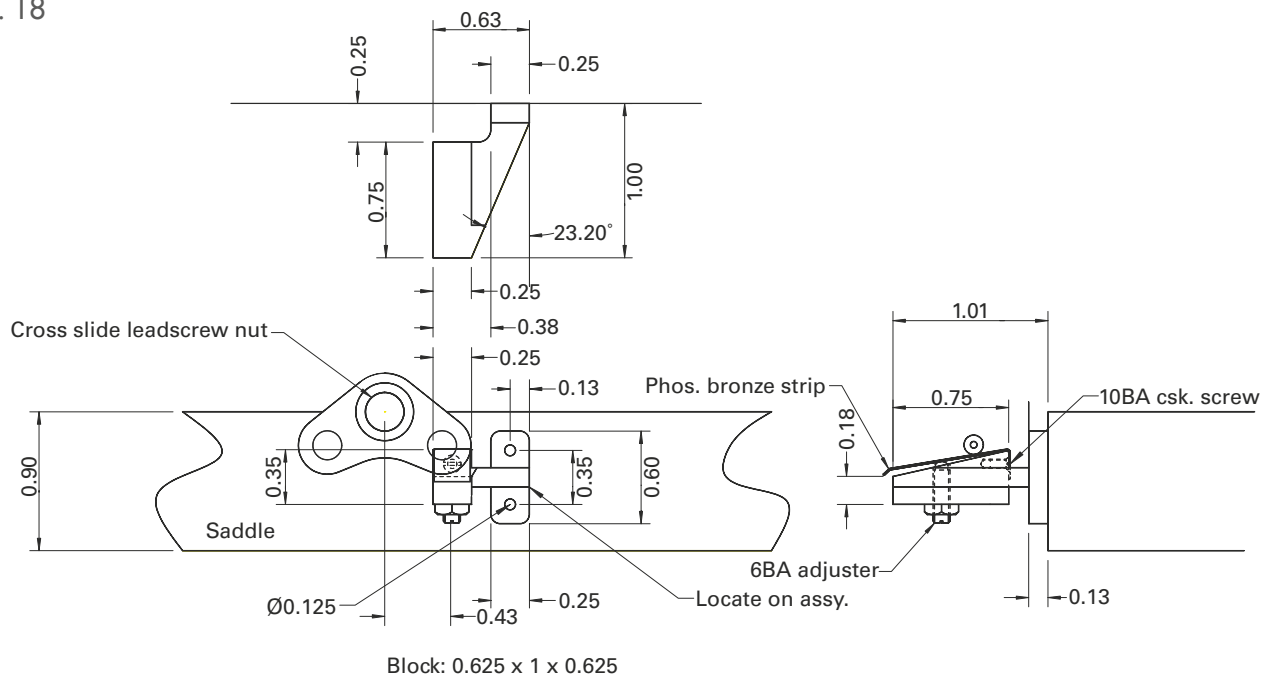
wiring and components fitted to the slide unit on the lathe which are connected to the power supply by a four way cable with a plug at the power supply end. The cable is fed through the cable gland and soldered to the four way tag strip mounted on the chassis see fig.7 and **photo 10**. From the tag strip two wires are connected direct too the motor and the remaining two wires connect the two micro switches. The two switches are connected as normally closed and are in series with the 200 ohm resistor R2. There is also an LED with its associated 470 ohm current limiting resistor connected across R2. Take care that the wires are routed as shown in the photograph as they have to avoid other components on assembly.

Fig. 17



Position Of Electrical Components

Fig. 18



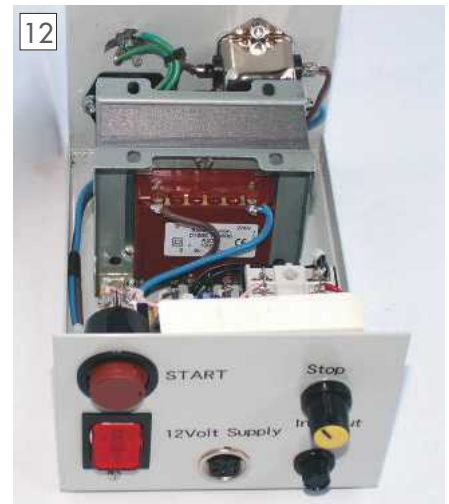
Limit Stop Face Cam
Mat'l: Aluminium

Power Supply Unit

See **photos 11, 12 and 13**. The unit needs to be housed in a metal case which must be earthed, for which I will not be supplying any mechanical drawings, as I used a commercially available case. There are many ready-made cases you can choose from one of the suppliers listed at the end of the article. I used one from Radiospares (*showing your age! They rebranded as RS Components in 1971! – Ed.*) which can be seen in the photographs. The power supply unit contains an ON/OFF switch SW1, a mains filter and a 9 volt transformer TR1 which with a bridge rectifier D1 and smoothing capacitor C1 producing a 12 volts supply at up to 5 amps DC for the motor. There is also a 5 amp fuse in the mains supply socket. The power supply unit also contains relay RL1 which has two changeover contacts, the pulse width modulation (PWM) module and a press button (press to break) switch. The PWM module is available from many suppliers and in many types. The speed control featured in a recent MEW could be used with a separate direction change switch. The one I chose controls both the speed and direction of the motor with one rotary control that has a stop position at the centre of its range, it is available from MFA/Como Drills part no. 919D2PR, as also is the motor which is part number 970D471LN and comes ready fitted with a 47:1 gear box, which combination I found to give a usable range of speeds at the lead screw via the 2:1 bevel gears. See **photo 14** for the complete assembled unit ready for mounting on the lathe.



Power Supply Unit.



Inside the unit.

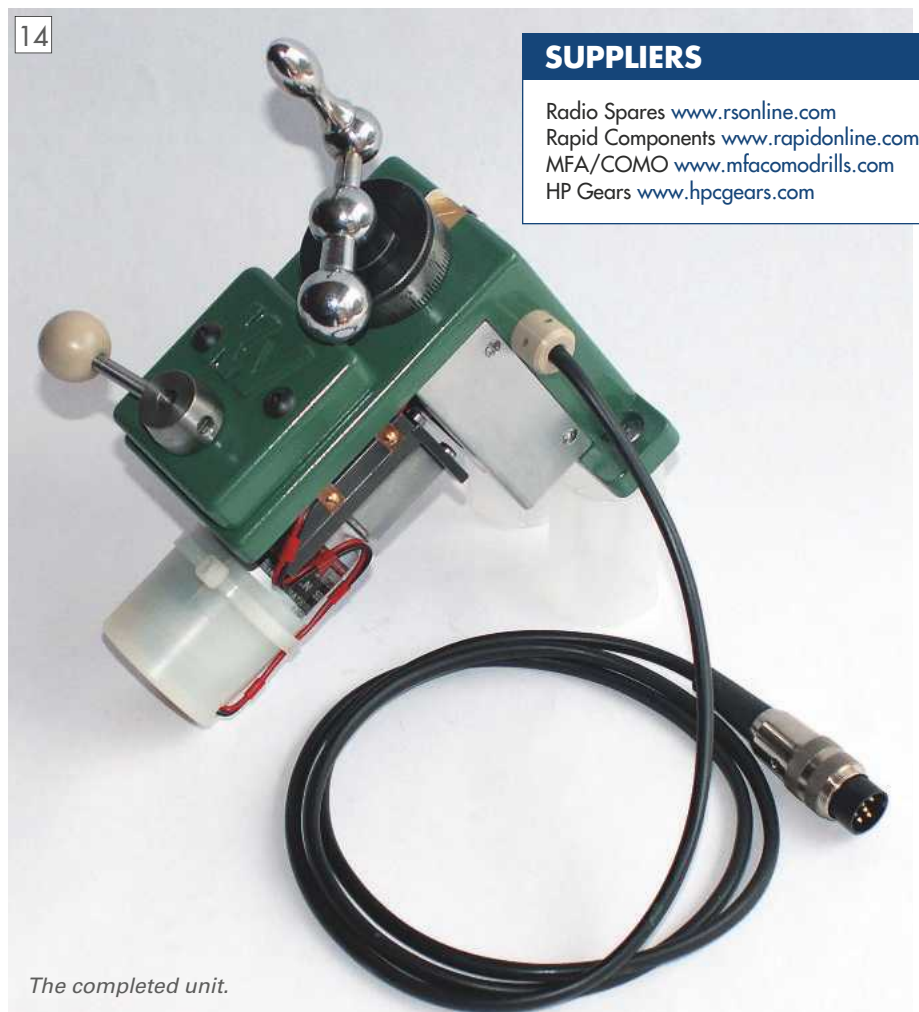


Transformer
and PWM
module.

Operation

With the mains power lead connected to the power supply and the cable from the cross slide unit connected. Turn the gear lever anticlockwise to disengage the drive from the lead screw. Switch ON the mains switch, the switch should light up. Press and release the start switch on the power supply. The relay RL1 will energise. Contacts RL1/2 will change over connecting 12 volts positive via. The two micro switches and R2 the 200ohm resistor in the slide unit holding RL1 ON. The voltage dropped across R2 is also applied to the LED and R1 and the LED will light. At the same time relay contacts RL1/1 close and connect 12volts to the P.W.M. unit and if the rotary control on the P.W.M. is set to run in either direction the motor will start, the lead screw will not turn as the bevel gears are not engaged. You can now check the operation of the P.W.M. unit. Turn the rotary control fully anticlockwise and the motor should run at full speed in one direction. Turn the control slowly clockwise and the motor will slow down and stop when the rotary control is centralised. Continue to turn the control clockwise and the motor will start to turn in the opposite direction slowly at first and at full speed when the control is at its stop. Check that both the micro switches stop the motor when operated. Check that if the lead screw is turned by hand the limit switch SW4 operates before the cross slide touches the saddle. Turn the rotary control back to the centre OFF position and the motor will stop. It does not matter which way the motor turns as you will soon get used to which way to turn the control. It is a simple job if you feel you would rather it was the other way, simply reverse the wires at the motor or the tag board. Now turn the gear lever slowly clockwise until it locks, the gears are now meshed and the rotary control can be used to check the

14



The completed unit.

lead screw turns freely in both directions. Check the limit switch again just to be sure. Turn OFF the switch on the power supply. Congratulations you now have a working unit.

SUPPLIERS

Radio Spares www.rsonline.com
 Rapid Components www.rapidonline.com
 MFA/COMO www.mfacomodrills.com
 HP Gears www.hpcgears.com

I have found the unit (**photo 14**) very solid and extremely useful since I fitted the prototype to my machine. I recommend the drive to anyone wanting an interesting project with a useful addition to your lathe at the end. Happy turning. ■

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An Old Bench Drill Adapted for Milling



Not being able to justify the expense of a 'proper' milling machine, Alan Wain took a cheaper but more rewarding route by adapting a sturdy piece of good old British engineering to take on the role.

I had a dream

In my (limited) experience, the Hobbymat lathe is capable of quite demanding turning operations for its size but is pretty hopeless when it comes to milling. The limited travel of the slides severely restricts the size of work piece and, more critically, the 'D' shaped bed is not sufficiently rigid to allow anything but very light cuts. I have been able to fly cut fairly large chunks of aluminium by resorting to some radical work-holding methods but machining has always been painfully slow. Consequently, a milling machine has been on my wish list since my very first attempt; however, I have never been able to justify the cost for the limited amount of use, continuing to struggle with the lathe. I've had various hare-brained ideas about building my own milling attachment for the lathe but when thought through, the answer always came down to 'not with the Hobbymat'. I know that drill presses have been converted for light milling by other home machinists but a machine of sufficient rigidity and quality of manufacture would probably also be an expensive route once the cost of the co-ordinate table is added. Nevertheless, this remained an option if the right drill came along at the right price.

A dream comes true?

The company I worked for until retirement had a policy of offering surplus equipment for sale to staff instead of just scrapping everything that had been replaced. Items were generally either obsolete or faulty and could range from office furniture, through computers, electronic test equipment to, very occasionally, mechanical workshop equipment. Sealed bids were required and, judging by the number of failed bids I submitted over the years, the 'rubbish' on offer could make quite high prices. One such sale included an ancient but very sturdy looking Pollard Corona bench drill with three phase motor. This intrigued me because the quill/spindle housing is supported by a cast bracket sliding on flat ways. A cursory examination revealed no apparent defects so I considered it to be worth a fiver to me and placed my bid.

My bid was successful because, apparently, it was the only one; I can only

presume that other bidders had been deterred by the three phase motor, or the weight, or the age, or something else that I hadn't noticed. I had to dismantle my prize in order to move it but it easily broke down into three (just) manageable pieces. The internet didn't reveal much useful information other than praise for a good old piece of British engineering. The company, of course, has long since gone, having been set up in 1920 by Frederick Pollard when he left Jones and Shipman (a company which he also co founded). The company made high-speed drilling machines, often ganged together to provide up to six spindles. The high-speed drilling capability is borne out by the maximum speed of my example, of 6,050rpm, and the very small chuck ($\frac{1}{8}$ inch) for the size of the machine. The machine, as acquired, is shown in **photo 2**.



Bench drill as acquired.



The adapted bench drill.

A closer look

My purchase remained in its disassembled state in a corner of the garage for a long time before I found the time to investigate it properly. From the limited information I had gleaned from internet forums, I expected the spindle to be hollow with a Morse taper; what I found came as something of a disappointment and shattered my dream of using it for milling. There was no sign of a draw bar or any other retaining arrangement at the top of the spindle and the solid shaft seemed quite slender. Removing the chuck revealed a Jacobs taper, subsequently measured and determined to be a '2'. At this early stage, I conceded defeat but decided to replace the $\frac{1}{2}$ hp motor with a single phase type anyway, so that I would at least have a bench drill at last.

A search on ebay found an abundance of motors of all sizes and ages, but I settled on a used Brook $\frac{3}{4}$ hp at the 'buy it now' price of £25. Lack of time intervened again and the motor gathered dust alongside its new home for a considerable time before I managed even to check that it worked. I did notice a few minor problems that would need to be resolved: The replacement motor shaft was smaller in diameter than the original; the new motor was larger in diameter and length than the original and



Machining the additional motor foot.



Setup for milling pockets and drilling mounting holes in the second foot.

the mounting holes were spaced differently. These differences were not entirely surprising and I had anticipated making an adapter from 12mm aluminium plate that I had put aside for the purpose. Oh well, perhaps another day?

Making a start

Retirement brought the time needed to catch up on long forgotten (or ignored) projects and I had really become tired of tripping over, or having to move, this pile of cast iron. First of all, I prepared a pedestal for the machine. This is actually a four-drawer cabinet, in solid mahogany, that originally supported one end of a laboratory bench where I worked (yes, obtained in an earlier 'staff sale'). My lathe is mounted on 40mm kitchen worktop across two of these, well screwed together and fitted with adjustable feet for levelling. A similar arrangement was prepared for the Pollard but also with castors beneath that can be jacked clear of the floor by the adjustable feet. There isn't much ground clearance but it does make the machine moveable without having to be dismantled. The Pollard was assembled onto this pedestal, minus the motor, so that it could be moved for all round access.

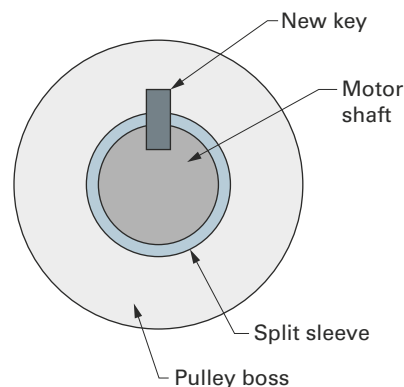
After some careful measurement, it became clear that simply using an adapter plate would not work, so I resorted to turning around the motor mounting 'foot', leaving room for a second but narrower foot with just two mounting holes. Making the extra foot, and drilling and tapping two extra holes in the motor casing didn't seem too onerous a task; or was it?

The additional foot was made from a length of 25 x 50mm aluminium of unknown grade. With not a little difficulty, the work was marked out and attention turned to removing metal. Believing that hand working was my only option for this 200mm long part, I set to with the hacksaw, cutting down almost to the marked arc near the centre and then breaking out the pieces with a chisel until enough metal had been removed to allow cutting sideways with the saw. I thought the sawing was hard work but when I started filing, my heart sank! Filing out this profile across 50mm was going to take a long, long time. Time for some further thought.

One of the accessories with the Hobbymat lathe is an angle plate for mounting the top slide vertically for milling operations. By fitting a rectangle of aluminium plate to this, to vastly increase the height, a pivot point could be positioned above lathe centre height by the radius of the motor case, plus allowance for half the milling cutter diameter. I hoped, then, to be able to swing the work piece on a bracket from this pivot and hence machine the radius; alright in theory but would it work safely in practice? Various bits of metal were duly drilled, tapped and screwed together to form a swinging milling table. A fresh chunk of 25 x 50 was screwed to this from below, at the points which would eventually become the mounting holes. Having previously marked out the radius again and also set out equal divisions above it, the bulk of the material was removed fairly easily by chain drilling. The work was swung to each hole position in turn, before tightening up the pivot bolt and clamping with an engineer's clamp; the cross slide being locked throughout the exercise. The work had to be removed from the setup for final separation with a hacksaw but the task was accomplished far quicker, and with much neater results than sawing and chiselling produced on the first attempt. To finish, rather than attempting to swing the work around a milling cutter, I used the same method as for the chain drilling but only moving the work about 0.5mm or less each time before plunging the cutter across the work. The method produced a finish with very small ridges but that was a small price to pay for the physical effort saved! The only problem encountered during the machining was the cutter pulling out of the taper when withdrawing the work after a pass. I have a selection of imperial drills and milling cutters with no. 1 Morse taper shanks. The drills work well in the lathe using a 2 - to - 1 sleeve but the milling cutters have no means of being locked into the taper and tend to shake out. I overcame this problem by very carefully holding the cutter shank into the headstock during every withdrawal. I stress 'very carefully' because I am attached to my fingers; fortunately, there is quite a long shank down to the sharp bits. The final stages of milling the curved seat can be seen in **photo 3**.

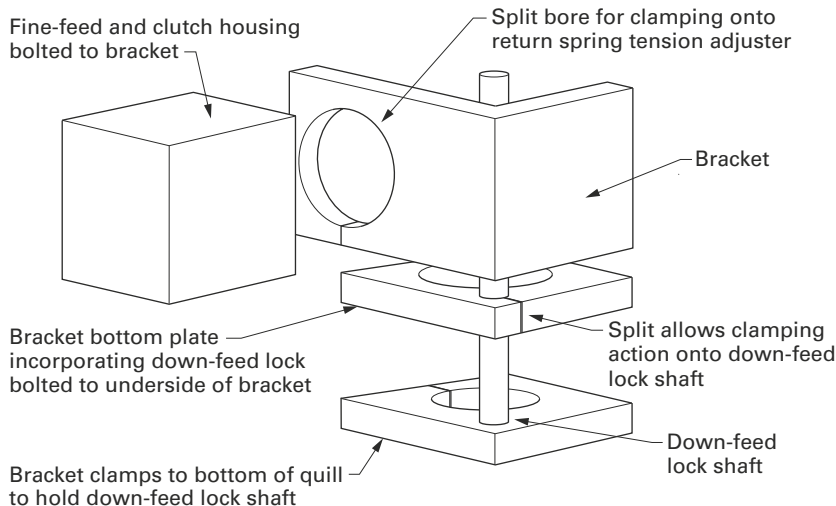
The rest of the foot was completed by saw and file apart from milling and drilling the angled pockets and holes for attaching to the motor case. This was accomplished by clamping to a bracket on the swivelled top slide to achieve the correct angle, as shown in **photo 4**. When offered up to the motor casing, it became evident that the foot had a slight taper, not obvious until checked with a square. I believe this was caused by lack of rigidity, allowing the whole setup to be 'pushed over' by the plunge cutting method. I corrected the error by taping decorators' aluminium oxide paper to the motor casing and rotating the foot around it with pressure biased towards the high side. This solved the initial problem but left the foot slightly lower than the existing one; a strip of thin sheet steel between the motor foot and the mounting bracket on assembly made up the difference, resulting in the drive belt tracking well on the pulleys. The remaining work to fit the motor was fairly straight forward. A sleeve turned to fit the drive pulley and bored to suit the smaller motor shaft diameter was split lengthwise to the width of the key, and a deeper key made from Gauge plate (**fig. 1**). I replaced the internal three phase wiring and fitted a no-volt release switch from Farnell on a

Fig. 1



Pulley bore modification

Fig. 2



Note: Clamping screws omitted for clarity

Exploded GA of down-feed lock, fine-feed housing and attachment bracket

plate made to fit the existing switch housing. First trials were encouraging and, by fitting the single phase motor, the three spindle speeds had reduced to calculated speeds of approximately 950, 1200 and 3000rpm. At this stage I felt quite pleased with my purchase, and with myself, for having acquired an excellent bench drill for a total outlay of around £40. The cost increased to around £60 after painting!

That dream again

The machine entered regular use immediately and I often wonder how I ever managed without a bench drill. The more I used it, the more my thoughts returned to my original idea; I felt sure it would be sturdy enough for light milling, if only a milling chuck could be persuaded to stay on that short taper. It occurred to me that an axial screw through a chuck and into the spindle may be sufficient; it would be self-tightening and should prevent the chuck being shaken free from the taper. It would all depend on how hard it would be to drill the spindle. With a drill chuck rigidly mounted vertically under the quill, I fed the arbour down onto a small drill and, to my delight, it drilled very easily. This was so encouraging that I enlarged the drilled hole and tapped it for an M5 countersunk socket screw. Now, what to fix onto it? I considered making a milling chuck to Harold Hall's design but discounted the idea on the grounds of having to cut internal threads (I still haven't plucked up the courage to try). Instead, I opted to buy a flange-mounted ER32 collet chuck that I could use on the lathe and also, via an adapter, on the Pollard. If the project failed for any other reason, then at least I could still use the chuck on the lathe, therefore it would not be wasted.

With the chuck problem solved, in principle, it was time to assess the other essential requirements for milling, these being:

- A fine down-feed of the quill, preferably retaining use of the coarse feed handle when required;
- Some means of locking the quill in any position;
- A means of measuring down-feed;
- A co-ordinate table;
- Raising the column to compensate for the 125mm lost to the height of the co-ordinate table.

Although fundamental to milling, the co-ordinate table was deliberately left near the bottom of the list because this would be a major purchase and, thus far, none of my hard-earned cash had been badly-spent.

The first three requirements would need some means of attaching them firmly to the machine. This seemed implausible because the castings have no flat surfaces. The only area that seemed suitable was the large knurled housing at the left end of the down-feed spindle (**photo 5**). This is for adjusting the quill return spring tension and is locked by a screw from below. When tried, this didn't seem as if it would move readily, so became a possible structure for attachment to.

Visible in the photo, at the end of the knurled housing, is a round plate covering the down feed return spring, pegged to rotate with the spindle and retained by a single screw in the centre. This, I decided, could be modified or replaced to effect drive to the spindle from the left side, leaving the existing down-feed handle undisturbed. A fine feed could be applied to the modified or replaced plate via a clutch of some type.

The first consideration of a down-feed lock was to use a clamp and pinch bolt on the quill itself; however, such an arrangement would reduce the amount of quill travel, and the affect on alignment of clamping direct to the quill was unknown but could possibly impart sideways pressure when clamping. The second idea and the method adopted,



Attachment site for fine-feed bracket.

comprised a silver steel shaft parallel with and firmly attached to the bottom of the quill, with provision for clamping the shaft at the bracket.

I wanted to avoid the complication of working out gear ratios for a calibrated down-feed, because a single turn of the down-feed handle didn't seem to produce a logical travel of the quill. Instead, I opted for the simpler solution of bolting on one of the low-cost digital readouts readily available. The bottom end of this would attach to the quill bracket holding the lock shaft.

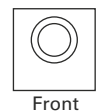
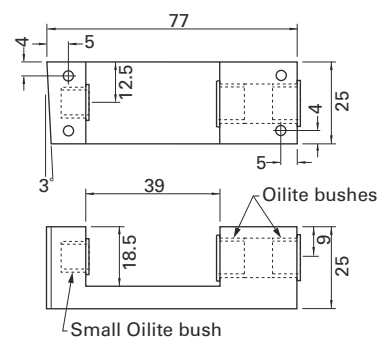
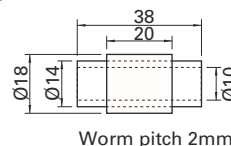
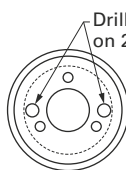
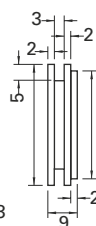
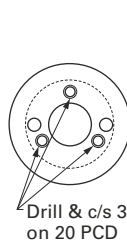
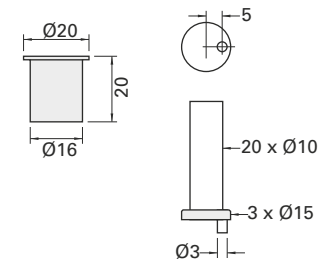
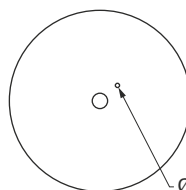
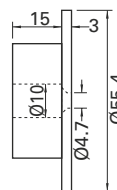
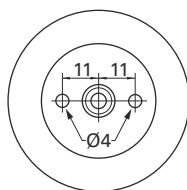
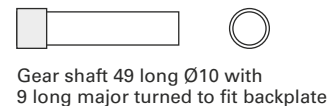
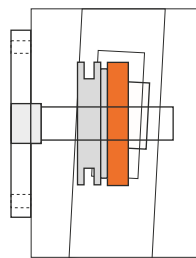
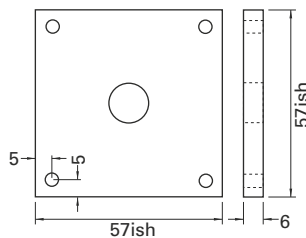
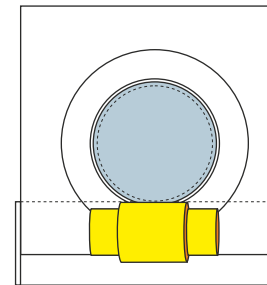
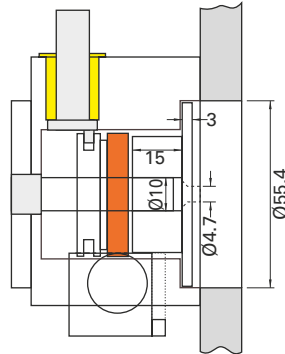
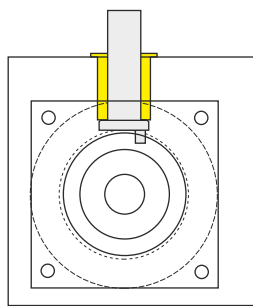
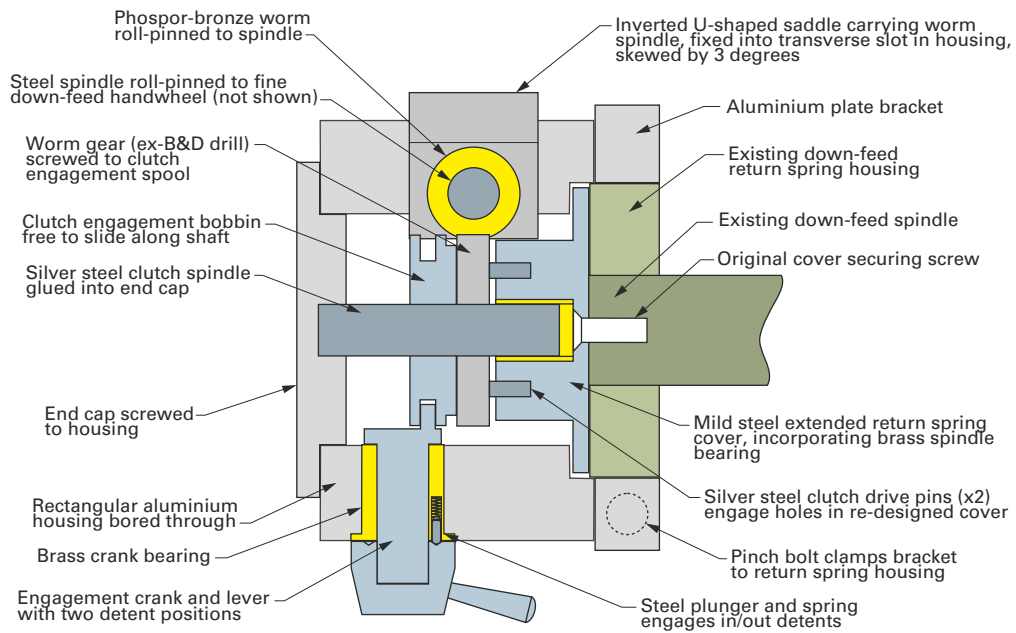
I didn't envisage problems in fitting a co-ordinate table and raising the column, so the only real show-stoppers would be the chuck, fine-feed or down-feed lock; if I could make these aspects work satisfactorily, then the dream could become reality.

Design

Measurements were duly taken and a drawing produced to test and juggle ideas. The general arrangement devised for attaching the bracket, fine-feed assembly and down-feed lock is shown in **fig. 2**.

After a rummage through my 'come in useful one day' collection, I found a couple of two-speed gearboxes from Black & Decker hand-drills. When stripped, these provided a collection of gears and what I believe are sintered phosphor bronze bushes. One of the gears, straight cut rather than helical, seemed the right physical size to use as a worm gear for the fine-feed and mated reasonably snugly with the thread of a 20 x 2mm pitch bolt skewed by approximately three degrees. The fine-feed design evolved around this match and is shown as a longitudinal section in **fig. 3**. The worm gear, screwed to a bobbin, is free to slide along a spindle aligned with the machine down-feed spindle, and is moved by the pin of a crank running in the bobbin groove. Two drive pins in the machine side of the worm gear engage corresponding holes in a top hat-shaped replacement for the return spring cover, which also incorporates a bearing for the clutch/worm gear spindle. This arrangement not only engages/disengages the fine-feed with the down-feed spindle, but also brings the worm gear into and out of mesh with the worm. For this to work smoothly, the worm carrier is

Fig. 3



Longitudinal section of fine-feed mechanism and clutch, shown engaged

attached to the top of the housing at three degrees so that the worm spiral is in line with the straight cut worm gear teeth. The worm spindle runs in three of the ex-B&D sintered bronze bearings. The engagement crank spindle, operating from below, runs in a thick-walled brass bearing; the bearing wall is drilled parallel to the spindle for a detent plunger that engages in either of two detents drilled into the body of the actuating lever. The crank gives a throw of 10mm, sufficient to completely disengage the worm gear and drive pins.

My design seemed to work on paper but the success of the project still relied on solving the cutter-holding problem, hence this part gained top priority.

Cutting metal

I purchased a flange-mount ER32 collet chuck at a model engineering exhibition with the intention of screwing this to a home-made adapter. However, I soon realised that it would not be too difficult to make a chuck body to fit directly onto the Jacobs taper of the drill spindle, leaving the purchased chuck body for the lathe. If this worked out, I could then buy a dedicated collet nut to make up the pair. The chuck design is dictated by the dimensions of the Jacobs taper and the ER32 specification; no innovation here.

At the first attempt, I machined a female Jacobs taper in one end of the work, after first making a gauge by trial and error fit to the original chuck. I then made a Jacobs no. 2 mandrel out of a MT1 blank-end arbour and mounted the work piece on this to machine the collet taper and thread for the closing nut. The threading went well whilst supported by the tailstock centre but without that support when boring the collet taper, the job rapidly went down the pan! I ended the exercise with a good paper weight and some invaluable practice at cutting threads.

After a protracted re-think, I decided on the following course for the second attempt: a) I would need a fixed steady to support the weight of the work piece whilst boring the tapers; b) complete the collet end of the chuck first, so that it could be used to clamp the work onto a parallel mandrel to turn the Jacobs taper; c) buy a Jacobs taper mandrel to use as a gauge, to maximise accuracy. Item 'a' on the list proved to be the only real challenge, resulting in my having to make a fixed steady for the Hobbymat, which subsequently became the subject of an article in *MEW* (issues 216 and 217).

My second attempt at making a chuck proved to be something of an anti-climax. I turned a parallel mandrel, supported by a tailstock centre, 40mm long to exactly 20mm diameter to mount a 20-19mm collet bought specifically for the purpose. I used this arrangement to set the top slide angle, using a dial gauge mounted at centre height in the tool post, by traversing back and forth along lands of the collet to achieve minimum total indicator reading (TIR). I say lands because once the angle seemed correct, I rotated the collet on the mandrel and repeated the exercise on several lands to obtain the best setting. During all measurements, the collet was kept firmly pressed against the rebate at the chuck end of the mandrel; a locking collar would have been a good idea but I



Setting top slide for boring the collet taper.

am inherently lazy and didn't bother. Although tedious, I devoted a long time to this operation, rewarded by a TIR of pretty well zero everywhere, except that I found my budget priced collet is actually slightly barrel-shaped, albeit by only 0.0005mm. The setting operation is shown in **photo 6**.

With the work piece chucked and supported by the tailstock, the external diameters were turned and the thread cut for the closing ring. With the work supported by my new fixed steady, I drilled and bored the collet taper, first parallel to 22mm diameter and full depth, then tapered until the correct size was reached. ER32 collet chuck manufacture is widely covered on the internet and I used a method described on one such site to ascertain the correct fit and finished size to the tapered bore, using engineer's blue. The size is correct when a collet; inserted gently into the well-cleaned bore, will enter until the protruding diameter of the collet measures 31mm at the face of the work. I used a 10-9 collet with the 10mm shank of an end mill inserted to prevent inadvertent compression. With the work still chucked and supported, I drilled and countersunk for the M5 fixing screw.

With the collet end completed, I set up the top slide to turn the Jacobs taper, using the same method as before but with a MT1/J2 mandrel between centres (yes, I bought one). I then re-chucked the 20mm mandrel used to set up the collet taper, and skimmed it true before mounting the work onto this mandrel using the closing ring and 20-19 collet. The work was also supported with the fixed steady whilst boring the Jacobs taper, checking the



Finished collet chuck, minus closing ring.

MT1/J2 mandrel for fit with engineer's blue. With the taper finished, I marked the positions of three equally-spaced tommy bar holes before removing the work from the chuck and drilling them on the Pollard. The finished chuck, minus closing ring is shown in **photo 7**.

With the collet chuck fitted to the Pollard spindle, I checked it for run-out and felt very smug at this being negligible. The only down-side I could see was the length of the chuck but I felt, at this stage, that continuing with the fine-feed and down-feed lock would be worth the effort.

The bracket for the down-feed lock shaft I made from half-inch steel plate but the fine-feed housing and main bracket are aluminium block and 12mm plate screwed together. The edges of plates forming the bracket were machined square in the four-jaw on the lathe; a lot of care and patience was exercised here because of the large overhang. The sizes of both steel and aluminium plates prevented them from being chucked to bore the internal diameters for clamping to quill and return spring housing. Instead, these holes were trepanned and then bored to size using cutters ground from round tool steel mounted in a steel block held in the four-jaw as a makeshift boring head; tedious, but with care this arrangement did the job; **photo 8** shows the down-feed lock bottom bracket being bored to size. The sacrificial plate that the work is mounted onto shows where the cutter has passed through. Note also in this photograph, that the work has already been drilled and reamed 1/2 inch for the silver steel down-feed lock shaft at bottom right.



Method of boring brackets for clamping.



Fine-feed and mounting components.

The bracket, comprising side, front and bottom plates are assembled with socket cap screws with their heads in counter-bores. The fine-feed housing is also secured to the bracket using socket cap screws from inside the bracket. To ensure that the fine-feed housing bore aligned correctly with the down-feed spindle, a piece of steel turned to a close fit inside the housing and bracket bores held the parts in alignment when drilling for these screws.

The fine-feed housing just fitted into the four-jaw chuck, allowing all faces and the bore to be machined. Although an intimidating sight when turning, this also proved to be trouble free. The slot for the worm carrier was roughed out by hand and then milled to size in the lathe by clamping onto the angle plate. The worm carrier itself was also machined square all round in the four-jaw before roughing out the 'U' by hand. The internal faces of the 'U' I then finished by milling in the lathe. Returned to the four-jaw, end-on, the worm carrier was next drilled and bored for the sintered worm spindle bearings.

Except for the worm, the remainder of the fine-feed/clutch components were fairly straightforward turning, drilling and boring tasks. With the worm spindle finished to slop-free fits in the bearings, the latter were Loctited into place using the spindle to ensure alignment.

I pondered long and hard over the choice of material for the worm. I discovered that worm and gear combinations were almost always specified in different materials, the worm invariably made from steel and the worm gear often phosphor bronze. This is at odds with my chosen worm gear, which is steel. Despite the consensus, I was stuck with a steel worm gear, so decided that, for the relatively low stresses involved, reversing the normal material selection would have to do. Although the thread of the 2mm pitch bolt mated fairly well with the worm gear, I determined a best fit pressure angle for the worm by trial and error; not ideal but it works.

The down-feed lock screw has a left-hand thread so that, when locked, the lever points upwards out of the way. I bought the M6 LH tap but cut the locking screw in the lathe, using my home-made change-gear bracket extender, which increases the range of threads that can be cut and provides lead-screw reversing.

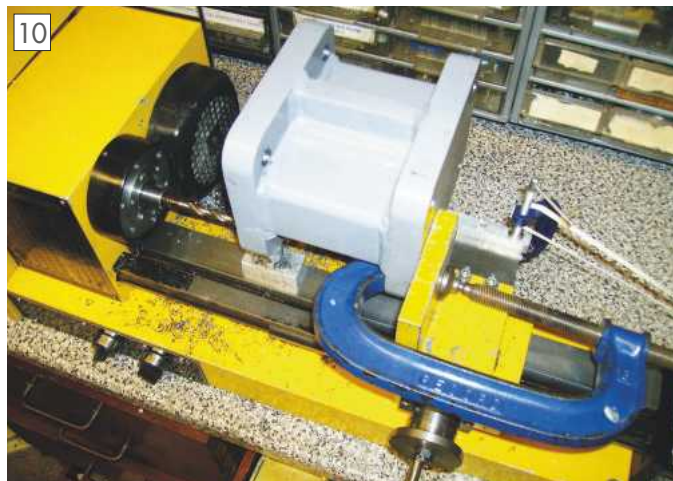
The finished components for the fine-feed/clutch are shown in **photo 9**,

which gives a better idea of the construction.

After assembly, operation of the fine-feed/clutch and down-feed lock was sufficiently successful to warrant purchase of a co-ordinate table. I had looked at the offerings of two suppliers but chose a 400 x 145mm table from Arc Eurotrade (usual disclaimer) that I was able to collect on the return journey from visiting a relative. I had already noted the dimensions and determined that, to give sufficient space between chuck and table, the Pollard column would need raising by 150mm. I asked a neighbour who co-owns an engineering company, making a variety of fabricated products and agricultural machinery, if he could spare me some scraps of thick steel plate. The intention was to build up a spacer in layers and have it surface-ground parallel. The response was a very kind offer to design and manufacture a spacer for the column (for free). The resulting spacer comprises two 30mm steel plates welded to the ends of short lengths of very heavy box section, the two faces then ground parallel on a Lumsden grinder; to give some idea of how sturdy this is, it weighs in at 12kg! This was a very magnanimous gesture, so I hadn't the cheek to ask him to drill it for me as well, hence the set-up in **photo 10**. Because of the weight, the spacer had to be well supported from the cross slide, lathe bed and base, not all visible in the photograph. In fact, the drilling was another of those anti-climaxes. I bought longer ½ inch Whitworth bolts to replace the originals into the Pollard base and also to use with nuts to bolt the column onto the spacer.

The down-feed measurement, as previously stated, is a digital read out (DRO). This was screwed to a rectangle of 3mm steel plate and mounted by holes in the corners to the front of the main bracket. The bottom end of the linear scale required shims under the attachment bracket where it is screwed to the down-feed stop shaft bracket, to ensure that it runs parallel with the quill.

To tidy things up, I wrapped the spacer with thin steel sheet screwed to the top and bottom plates. The fine-feed bracket also has a welded steel sheet cover with a rectangle cut into the front for the DRO mounting plate. The fine-feed wheel fitted in the heading photograph is a larger diameter aluminium version that I made to



Drilling holes in the column spacer.

replace the original plastic one shown in the components photograph; this is also roll-pinned to the worm shaft instead of the original grub screw fixing. Also visible in the heading photograph is the single point oiling cup on top of the worm carrier. This delivers oil through drillings to two points above the clutch shaft and to all three worm shaft bearings; the engagement crankshaft also receives a share of oil courtesy of gravity. The focus of most of the work involved is shown in **photo 11** and the complete machine in the heading photograph (**photo 1**).

Does it work?

Yes, it does, so long as I remain patient and don't expect to take massive cuts. Roughing out by hand is still the quickest way but at least it is fairly accurate and able to machine much larger work than the Hobbymat. Engaging the fine-feed requires positive pressure on the engagement lever whilst turning the coarse down-feed handle, owing to the two-pin clutch. Although it will never be as capable as a purposely-made mill/drill, milling with my adapted bench drill is infinitely better than with the Hobbymat. Improvements are required, one already implemented and another under way, which the Pollard is being used to manufacture. ■



Down-feed modifications.



16-18 September 2016
Brooklands Museum, Weybridge, Surrey

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Email: post@michaellaw.co.uk

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PERSONAL DETAILS (Please print)

Surname _____ Forename(s) _____ Age _____

Address _____

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Home Tel No _____ Daytime Tel No _____

Model Club or Association _____

How many years have you been a modeller? _____

MODEL DETAILS - PLEASE TICK BOX IF MODEL IS FOR LOAN ☐

Entry Class (competition entries only) _____

Model Title (to be used for catalogue and display card) _____

Model Description (to be used for catalogue and display card) _____

Model Scale _____ Length _____ Width _____ Height _____ Weight _____

Type of construction _____

Parts not made by you and commercial items _____

Please supply a photograph of the finished model for insurance purposes. (Please note: It may not be possible to provide insurance for models entered later than 19th August 2016.)

Are you supplying Judges Notes? Yes ☐ No ☐

Value of Model (MyTimeMedia Ltd will not insure the model unless a realistic value is entered) £ _____

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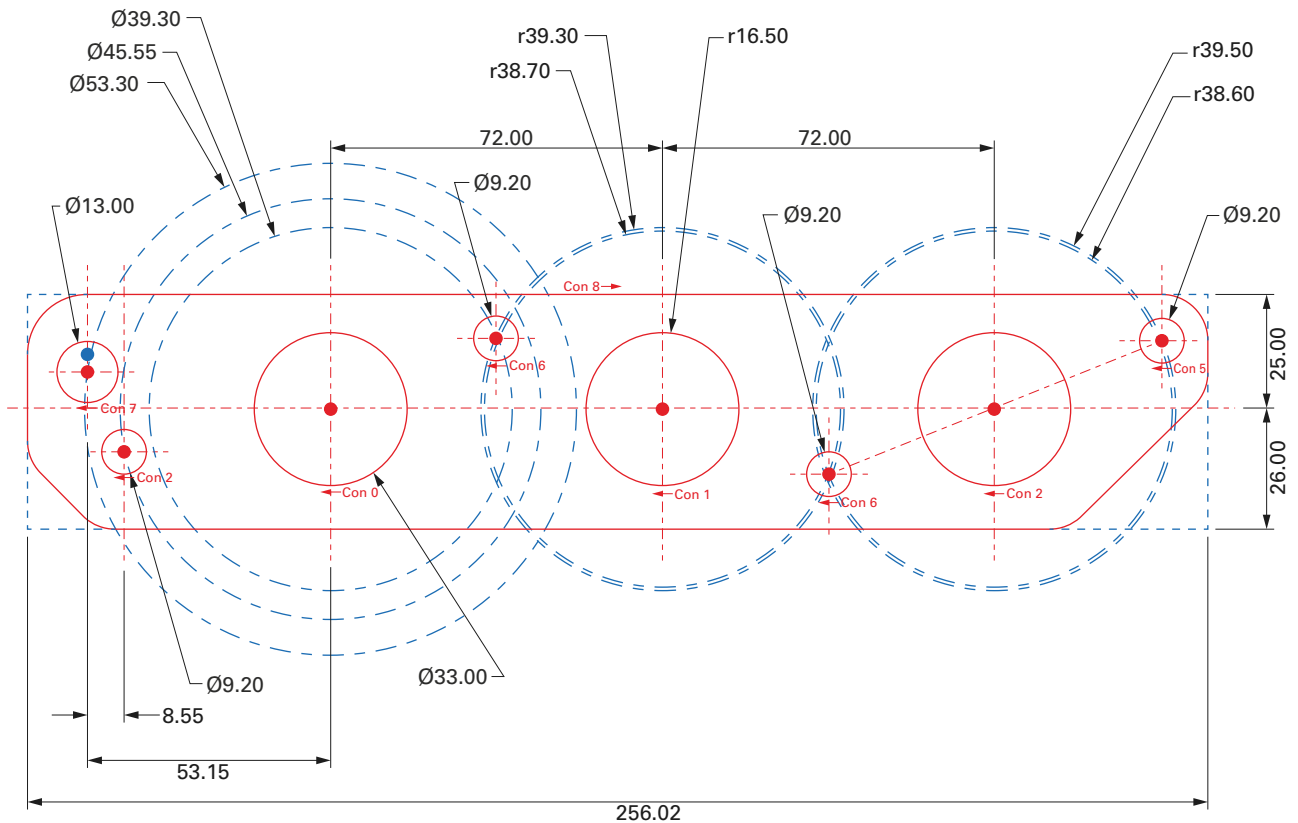
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Fig. 1



Carols, Cappuccinos and Lofted Solids: Postscript



A few months after finishing my original article (*MEW* 235/236) there was a further request from Nephew No. 3B. The inlet manifold adaptor fitted as it should, but when it came to connecting the exhaust manifold there was a problem. Due to the slightly different position of the turbocharger the exhaust manifold would not line up. It seemed that my wish for a quiet existence was to be postponed.

Bob Reeve adds a brief postscript to his recent adventures in CNC.

What was required was a simple 17mm thick flat-plate spacer with circular ports and no fancy machining. I pointed out that it would need to be in cast iron rather than an aluminium alloy because of the temperatures likely to be reached but it was within the capacity of my CNC X3. I was slightly surprised that it was cheaper to buy standard square bar rather than have it cut closer to the size required. As things turned out, that proved to a lucky piece of serendipity.

The now familiar process was followed:-

- 1) Design in Dolphin Partmaster 2D Cad (**fig 1**).
- 2) Convert to G-code with Dolphin Partmaster CAM.

- 3) Manually mill a blank to the correct thickness but sufficiently oversize to allow for profiling.
- 4) Transfer the blank to the X3 (using jig & sacrificial MDF as for inlet adaptor) and CNC machine:-
 - a. The fixing holes
 - b. The circular ports
 - c. Profile
 - d. Chamfer profile
- 5) Engrave as necessary.

All went well and the completed exhaust adaptor was shipped off to be fitted

Things again went quiet for a while until a telephone call to the effect that all was not well. The adaptor fitted the engine perfectly and it also fitted the exhaust

manifold perfectly. Unfortunately, not at the same time!

It turned out that the problem was the bespoke stainless steel exhaust pipe was just a few millimetres too short and no amount of pipe wrestling would make it meet up with the engine.

I was reminded that similar problems were identified at aero engine maker Rolls Royce many years ago. The essence of the problem is that long lengths of pipe, twisting and flexing in three dimensions, are difficult to measure and too often the result is that the pipe doesn't fit. At Rolls Royce the problem was solved by two clever engineers who developed a high precision measuring probe with a low contact force that didn't distort the pipe. The engineers concerned went on to found Renishaw which now has worldwide sales of these probes.

Without such a device, the easiest way to fix this problem was to make a thicker exhaust adaptor. It was here that the element of serendipity arose because the remaining piece of cast iron was just big enough to clean up and give the required 33mm thickness.

So, with minimal alteration to the CNC code, it was back to the X3 for the Mk2. However it did look to be a very much more substantial piece of metal that was bolted to the table and the ports and profiling were now at nearly twice the original depth. Extra -long series slot drills (**photo 1**) were available that would do the job.

But, as I found, they were a lot more flexible than I would have wished. The ports were less of a problem than the profile. The problem being that at the radiused corners the cutter was prone to flexing and trying to snatch at the feather edges created. The 4 flute cutter only had three flutes by the third corner! Slower feed rates cured the problem, but it took a while (**photo 2**).

Photograph 3 shows the finished adaptor. This time it fitted as it should and the rebuild continued without any further assistance from me.

Emily re-upholstered the interior in a striking black and orange scheme (**photo 4**) which was continued in the engine bay by using orange flexible pipes, where possible, to contrast with black engine components (**photo 5**).

As expected, the inlet manifold adaptor is not visible, but the exhaust adaptor is - if you look very carefully (**photo 6**).



Extra-long series end-mill.



Profiling nearing completion.



The completed adaptor.

Things again went quiet for a while until a telephone call to the effect that all was not well. The adaptor fitted the engine perfectly and it also fitted the exhaust manifold perfectly. Unfortunately, not at the same time!



Re-upholstered interior.



Engine bay.



The exhaust adaptor in situ.



Carol up and running.



Interest in Carol.



Groomobile.

The engine runs, the car is drivable and passed its MOT test, but there are still a few minor leaks and adjustments to be attended to.

The exterior has not received as much attention as the mechanical parts, apart from some smart new wheels (**photo 7**). It still has some of the scars inflicted while lying under a hedge in a ditch.

The current matt black finish was intended as a temporary measure to get it to a Kei Car Club meeting (on a trailer) where it received more attention than expected (**photo 8**).

In parallel with all of this, No. 3B Nephew had proposed to, been accepted by and was about to be married to his Emily. The Carol had a quick makeover to deliver the groom (**photo 9**).

It then appeared in the wedding photographs along with the Kei car (Daihatsu Copen) that delivered the bride (**photo 10**).

Readers might expect this to constitute a happy ending to the story, but at the back of the newlywed's garage, I espied a much modified Honda Beat about to receive a Honda Accord, Type R engine. That quiet existence I was seeking may be a long time coming... ■



Kei Cars at a wedding.



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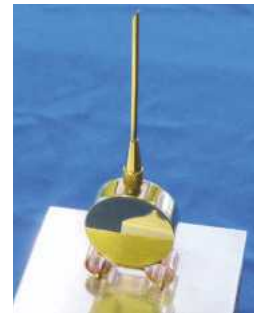
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A Bench Drilling and Tapping Machine



Nick Farr's Pillar Tool was a loan exhibit at MEX 2014, he also exhibited this neat oil can to Mogen Kilde's design, published in MEW.

Nick Farr tells the story of an interesting machine many readers will remember as a loan exhibit at the 2014 Model Engineer Exhibition.



The finished machine, note the simple belt guard.

This project was largely experimental but was also intended to be a useable piece of workshop equipment (**photo 1**). No plans were drawn up and I made it as I went along. Some changes were made during the process.

I bought this drill, as shown in **photo 2**, from a trade stand at the Weeting Steam Engine Rally at Fengate Farm, Weeting Norfolk in July 2001. I dismantled and cleaned it at the time with the intention of restoring it to its original condition, but never did find any illustrations of one. During the spring of 2014 when having a bit of a tidy up in my garage, I came across it in a box all in pieces and decided to review its worth. At about this time, mention of Universal Pillar Tools was a subject of one of the threads on the Model Engineer website forum.



The pillar drill as purchased.



Raising spring in the pillar.

From reading the posts I hit on the idea of making a thread tapping machine for the smaller taps used in fine modelling work, so after some thought I had a basic plan in my head. The first thing to consider was the arrangement of the drilling spindle and the way it was held by the mechanism, which consists of an inverted 'L' shaped tube affair. This was held up in the pillar by a spring inside the pillar (**photo 3**) and where it slides up and down in the pillar is a rack formed in the back of it, which a cog engages into, which in turn is rotated by the operating spindle, which is turned by the drill press lever. This was not ideal at all, because the spring is much too strong for the very small taps without keeping one hand on the drill press lever at all times which in turn would lead to a bit of fatigue in one's hand during the process of tapping small and delicate taps and parts. I decided to remove the spring and make a counterbalanced system instead. This system required a weight that would balance the weight of the drilling spindle, the chuck and its raising and lowering 'L' shaped tube. A nylon operating pulley was made and pressed onto the operating spindle that rotates the cog that in turn raises and lowers the tube and drilling spindle. A cord is wrapped around this pulley and strung over another freely rotating pulley and is then attached to the counterbalance weight. A small bracket was made to hold the rotating pulley above and behind the pillar, which is fitted into a hole at the top of the pillar.

Construction

The nylon pulley was made to be a reasonably tight fit onto the operating spindle and the operating spindle was knurled with straight knurling wheels. When the operating spindle was pressed into the nylon pulley, the knurling cut into the nylon and gave a better grip (**photo 4**). The freely rotating pulley, which is also made from nylon, has a bearing pressed into it which was salvaged from the pickup arm of a scrapped computer hard drive. The pulley on the operating spindle has a channel cut into it, which keeps the cord captive and the rotating pulley has a half round groove for the same purpose, both

were cut using my rotary table on my milling machine, using a slot drill for the channel and a bullnose end mill for the half round groove. The counterbalance weight was made from a section of an old car engine camshaft and an odd bit of BMS drilled and bored for a press on the bottom section; any spare piece of metal could have been used, but this didn't need too much machining as only the cams were machined down to give it the shape that I wanted. I did need to grind down the cams though, as they were quite hard as you might expect! The bearing was only skimmed to tidy it up. I made it this shape so extra horseshoe shaped weights could be stacked onto it as and when required. The top end of the counterbalance weight was drilled and tapped and a section of a brass spindle from a scrap gate valve was turned up, threaded part way on the outside and knurled at the top and a hole drilled through its length just big enough for the cord to pass through.

The pulley which originally drove the drilling spindle was removed and a new pulley was made (**photo 5**). The bottom half was knurled so that it could be used for turning the drilling spindle by hand when using small taps. The top half was turned to a smaller diameter and, using an index plate on a rotary table, set up on my milling machine. Six equispaced blind holes were cross drilled for using a tommy bar if needed and then a half round groove was cut into it using a bullnose end mill again using the rotary table and milling machine. The groove is for a round belt drive when used for drilling. The pulley was then bored and reamed for a sliding fit on the spindle and a keyway was cut with a broach using a fly press. The drilling spindle had a taper bore in the bottom end where drill bits or a chuck would have been fitted, I bored it parallel and tapped it 1/2 inch UNF (**photo 6**). About the first 4mm was bored slightly larger for a register so that different drill chucks could be fitted to run true. Adapter pieces were made and fitted and were

then turned and threaded to fit the drill chucks (**photo 7**). The components were all assembled onto the pillar and a trial hole was tapped with success.

The next step was to figure out how to drive the spindle for drilling and after looking at different ways to mount an electric motor at the back of the pillar proved fruitless, I decided to build a separate pillar from some scrap aluminium channel that I salvaged from some roller conveyors that I had to repair in the early part of 2014. This was fabricated from suitable sections using 3/4 x 3/4 x 1/8 inch aluminium angle and two offcuts of 2 x 2 x 1/8 inch angle for the feet, placed forward of the pillar and all pop riveted together. The pillar was made to fit an electric motor that I'd salvaged from an old electric typewriter I scrapped many years ago but I had to make a couple of brackets for the motor first, as the original ones were integral to the typewriter base. These brackets were made from an off cut of 6mm thick aluminium plate and are held onto the rubber mountings of the motor with three lengths of 3mm threaded rod and nuts. The brackets were first bent to an 'L' shape, so as to form mounting feet and then clamped back to back and three holes drilled through both, for the threaded rods, concentric to the centre position of the holes which are for mounting the anti-vibrating rubbers of the motor. These were cut using a hole saw and then set up on my mini mill for boring to size. Two holes were drilled in the feet of each bracket to attach the motor to the pillar's adjusting slots which were milled with the pillar temporary bolted together to get the correct positions.

A panel mounting NVR start/stop switch was mounted into a small piece of 3mm thick aluminium plate, after cutting out an aperture for it on my mini milling machine. Four 3.2mm fixing holes were also drilled close to the corners. This was then mounted onto a short off cut of rectangular aluminium rain water downpipe with two pieces of brass angle



Knurled operating spindle.



New driven pulley.



Threaded bottom end of drilling spindle.



Chuck adapter.

and the downpipe is attached to a short piece of aluminium channel that also holds the motor capacitor, a mains euro chassis plug, the mains wiring and a bottom cover plate, which formed a sub assembly (**photo 8**). This sub assembly is bolted to the back of the motor pillar with two distance pieces of 1 inch aluminium rod, the depth of the inside of the channel, to prevent the channel from being crushed. A pulley for the motor was then made from the centre part of the cooling fan from a large scrapped industrial electric motor (**photo 9**). After tidying it up a bit and the centre hole bored out to remove the keyway, an offcut of brass bar was turned in the lathe for a press fit, knurled with straight knurling wheels and it was then pressed in using a little Loctite 638ure. Once the Loctite had cured it was returned to the lathe held by the end of the brass bar which was sticking out of the back of the pulley and was turned to size, a groove cut for the round drive belt with a form tool and bored to fit the motor shaft. Two small holes were cross drilled and tapped for grub screws 90 degrees to each other. It was then parted off from the surplus bit of bar. The pulley was then mounted onto the motor shaft. A cover plate was made to fit between the motor brackets and the pillar so that the electrical connections are made inaccessible and a small cover plate was made for the back of the motor pillar, the whole assembly including the NVR start/stop sub assembly was fitted together and then clamped to the mounting board behind the pillar drill and an 'O' ring was used as a drive belt. A 3mm test hole was drilled in a small piece of 3mm scrap aluminium with success.

I had to make an anti-deflection strut to fit between the top of the motor pillar and the back of the pillar drill, to stop the drive belt going to slack while drilling. I therefore made a clevis for the pillar drill from an off cut of a 25 mm thick bar, the two holes opposing each other are fitted to the rod that is part of the bracket that holds the rotating pulley. A piece of 12mm threaded rod was turned down to fit in the vertical hole behind the pillar at the top (**photo 10**). The other end was turned down and threaded 8 mm. The 12mm portion screws into the top of the clevis with the plain part protruding through. A 12mm nut was then thinned down to a half nut and is used to lock the pin into the clevis (**photo 11**) and the 8mm portion fits through one end of the strut. A piece of 10mm threaded rod was also turned down and threaded 8mm and was screwed into a pin made from a short length of 1 inch aluminium rod, which is



Sub assembly.



Holes for clevis and freely rotating pulley bracket.

bolted on the top of the motor pillar and the other end of the strut fits onto the 8 mm portion of the rod. The strut is made from a piece of 19 x 4mm black flat steel bar. Wing nuts are used to hold the strut onto the threaded rod ends, which makes the strut easy to remove so that the drive belt can be taken off out of the way when not needed during tapping operations and when it needs replacing with a new one.

Finishing

The machine and the mounting board were painted and the aluminium channels were cleaned and polished. The machine and the motor pillar were then finally assembled and bolted to the mounting board using 'T' nuts. The machine works very well for both tapping and drilling within its scope. A suitable small weight with a small knurled screw is used on the operating



Motor pulley blank.



Anti-deflection strut clevis.

lever while tapping to give the required starting pressure for the tap (**photo 12**) leaving both hands free to hold the part to be tapped while turning the spindle using the knurled part of the spindle drive pulley. Drilling is achieved using the operating lever in the conventional way, but horseshoe weights (**photo 13**) can be used on the counterbalance weight when using very small drills to give a little more resistance on the lever to help prevent accidentally breaking them by applying too much pressure. I didn't consider a full guard over the drive belt a necessity, but I did make a simple one which could easily be attached and removed onto a pin fitted into a vertical hole in front of the spindle pulley during drilling operations (**photo 14**) to reduce the risk of the hair on my head being drawn into the belt drive, but I do recommend everyone doing a similar project to consider carefully if their belt drive design needs a full guard or not. A



Operating lever weight when tapping.



Horseshoe weight.



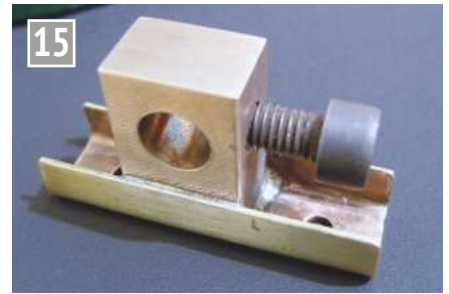
Simple guard location pin.

piece of aluminium from the cover of the scrapped computer hard drive was used for the guard, pop riveted to a bracket made from an odd bit of brass and an off cut of brass sheet pressed into a channel shape and soft soldered together (**photo 15**).

Materials, nuts and bolts etc.

With exception of nuts and bolts, all materials used are either off cuts or salvaged from other jobs, or scrap parts that I've collected over many years.

The NVR start/stop was purchased new from Axminster Tools & Machinery and the nuts and bolts from a selection of eBay and local traders the pop rivets were obtained from Screwfix and a new capacitor for the electric motor was obtained from Maplin electronic suppliers, new thrust bearings for the drilling spindle were obtained from Arc Euro Trade. I have no connection with any of the retailers mentioned above, and the same or suitable parts are obtainable elsewhere. ■



Simple guard bracket.

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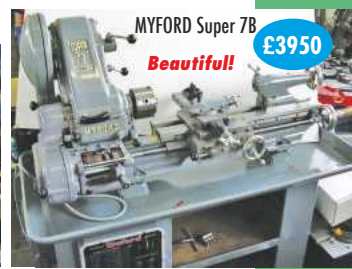


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MYFORD Super 7B
Beautiful!

£3950



Colchester Triumph lathe

£5750



New 18"x 6"
ground compound table

£125



£425 Jenny Lind 3 1/2" + plans
& boiler tube



**Reduction
NOW only
£245 to Clear**



£1250



J & S 540P
surface grinder

£4950



£1650
Harrison
vertical mill



Wadkin
AGS 10" saw
bench

£950

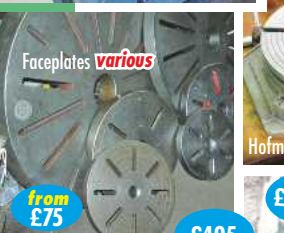


£3250
Tom Senior
ELT 36" x 8"
table

£3250



£325
Meddings Drilliru
500 4000rpm



Faceplates **various**
from £75

£495



Hofmann 12" thin rotary table

£1850



Burnerd collets
(both types) + chuck

£20
each
WD-40



Elliot Junior
Omnimill + inverter
28" x 7"

£3250



Q and S 6" hacksaw

£40



Sylvac
1 metre vernier **boxed!**

£495



BRL mower
grinding machine



Warco 1327GH
6 1/2" x 27" lathe (Taiwan)

£1950



Myford
Speed 10 lathe

£845



J & S arbor press
8" x 1 1/2" height

£425



Myford
ML7 lathe
late model

£1225



Colchester
Triumph Fixed Steady

£425



Prince 6075
grinder

£12000



Baileigh
APS 5Ton
press

£1275



Myford
fixed steadies

£75
each



Precision Stanier 55mm machine
vice from New Zealand

£15
each



Boxford AUD MK111
5" x 22" lathe

£1500



Various!
Micrometers
0-16"/
300mm



Wadkin 12" x 7"
planer
thicknesser

Special only £725



Myford Super 7B
+ Sino DRO & Tesla

£3950



DP/MDG gears **Just arrived!**

£15
each



Steel EN3B
(mild steel)

£7
each



Various!
Angle plates +
surface plates

£145
each



£245
Viceroy buffer

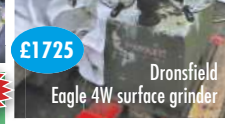


Harrison M300 lathe

£3950

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&
Sunday 28th February (10.00-16.00)
@ Middleton Arena
M24 1AG



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325mm Between Centres
180mm Swing Over Bed
£399 inc vat



DB10 Super Lathe
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250mm Swing Over Bed
£1,225 inc vat



Super Lux Mill
470mm Spindle to Table
240x820mm Table Size
£1,997 inc vat



Conquest Super Mill
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470x120mm Table Size
£547 inc vat



Model B 3 in 1 Machine
520mm Between Centres
130mm Swing Over Cross Slide
£989 inc vat



DB7VS Lathe
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180mm Swing Over Bed
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