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

PRODUCTION
Designer: Andrew Tompkins
Illustrator: Grahame Chambers
Retouching: Andrew Tompkins
Ad Production: Andrew Tompkins

ADVERTISING
Business Development Manager: David Holden
Email: david.holden@mytimemedia.com

MARKETING & SUBSCRIPTIONS
Subscription Manager: Kate Hall

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

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On the Editor's Bench

A Meta-Index

I was rung up by a reader a few weeks ago with a request for an 'index of indexes' for Model Engineers' Workshop. After rather more digging than I expected, I have got what I think is the first definitive list of the issues where indexes appeared to be published in the magazine.

The index has an interesting story, it was initially produced by or second Editor, Harold Hall, who went on to develop a computerised version. This went on to be produced alongside the paper indexes. The indexing torch was passed on to Barry Chamberlain, but eventually due to the availability of other online indexes sales of the CDs dropped away and the CD version is no longer produced. Fortunately for readers, Barry does still produce the published indexes, the most recent of which appeared in issue 286.

One odd feature of the index is that from the third instalment each one covers 12 issues, despite MEW now appearing 13 times a year. This, combined with changes in publication frequency in the early days and the time required to compile and edit the index, means that its appearances in the magazine are not regular making them hard to track down.

Hence the value of a list; I hope readers find this useful –I hope it is accurate, but any errors are mine so please let me know if you find any. I will also make this list available on the forum at **https://www.model-engineer.co.uk/MEWindex**.

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Coming up...

in our next issue

Coming up in our February issue, number 290, another great read

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ON THE COVER

Our cover shows Martin Berry's Jones and Shipman surface grinder on board a six-wheeled truck journey-ng to his workshop. For the full story of its epic journey, see page 59.

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THIS MONTH'S BONUS CONTENT

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Visit our website to access extra downloads, tutorials, examples and links. Visit the links below to find more information on Jason Ballamy's shell end mill tests and the list of MEW Indexes.
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Plus even more at:
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Any questions? If you have any questions about our recent Alibre Atom3D or current Lathework for Beginners or Milling for Beginners series, or you would like to suggest ideas or topics for future instalments, head over to **www.model-engineer.co.uk** where there are Forum Topics specially to support these series.

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A Dore-Westbury Head on A Tom Senior M1 Mill

Alan Jackson brought together two well regarded machines to make this unique hybrid.

About 1976 I purchased a Dore Westbury vertical mill. It came as a kit of parts with the big bits that were beyond the average model engineer's capability, pre machined and a set of plans to complete the machine. For many years this machine suited all my requirements, but on one or two occasions I pushed it beyond its remit and messed up what I was making. It was never a fault of the machine; it was me expecting more than it could possibly deliver. In these instances, I had generally taken too heavy a cut, or pushed the feed rate too much, causing the head to rotate slightly without me realising it. Only to find, for example, that the tee slot I was cutting now had a slight joggle. Anyway some 30 years later (impetuous I know!. I managed to buy a Tom Senior M1 horizontal mill on eBay. I was totally surprised to see the price soar in the last bidding milliseconds from about £200 to just over £500, but it was mine, and with a further struggle delivered to me. It was sold off from a school workshop, it did not have a Tom Senior vertical head, I was told it just went missing before it was sold. Ah Ha? This would have been nice to have but I had a plan to use the Dore Westbury head on top of the mill anyway. As delivered on my driveway it looked quite sad, rusty and neglected. I had partially dismantled it and taken some parts beforehand, so the photo shows an incomplete machine. I found that the serial no. stated it was a 1967 model, **photo 1**.

As delivered

The motor for the horizontal spindle is mounted on the top of the vertical column, taking up nearly all the space I needed to mount the vertical milling head. My plan was to squeeze this motor into the bottom of the column to free up this space. Before doing this, I dismantled, cleaned up and painted the mill. It was not very worn but had a few dings in the table; as I suppose is to be expected with a school machine. These were filled with liquid metal and finished flush.

I was lucky in that it had an international 30 socket connection (INT30) for the horizontal arbour and I even found a couple of spacers for this arbour inside the coolant tank which is just below the chip tray. I can imagine some young schoolboy dropping them in there just to frustrate the teacher. Its easily done because the gauze covers for the coolant drain just lift off.

The cross feed for the table had a sheet rubber chip guard that folds as the table is moved towards and away from the column. This chip guard is supposed to prevent the ingress of metal cuttings from accumulating inside the knee casting, which is otherwise exposed due to the large rectangular slot required for the cross feed nut. When the knee was removed there was

Machining a recess for the slide plates

Recess completed & knee re-assembled

First attempt at slide plates

Second attempt slide plates - front view

a substantial amount of swarf inside the casting so clearly this chip guard did not work very well.

If you look at a Bridgeport mill you will see that the knee has a series of sliding plates that cover this slot over the full movement of the cross feed. This seems such a neat clean method that is was worth copying, besides, the rubber sheet restricted at least half an inch of the cross slide movement when fully compressed. Luckily, I still had the fully operational Dore Westbury. Cutting a central relief zone for these sliding plates was going to be its last job, its final epitaph. It was about as much as the machine can take but it did it well, **photos 2** & **3**.

My first arrangement of sliding plates was most complicated, involving connecting rods to the plates and fiddling set up procedures, **photo 4**. I finally came to my senses and replaced this with two sliding plates of set lengths with elongated rectangular slots that fitted over the cross feed nut. A shorter upper plate above the longer lower plate. The nut will push the plate or plates when it contacts the end of the slot or slots enabling the full slide movement without exposing the rectangular slot in the knee. This has been in operation for many years and works without it being noticed, **photos 5** & **6**.

Rear view of slide plates

Elongated lower slot for the motor spindle

Installing the horizontal drive motor

The existing three phase motor just about fits inside the base of the vertical column. The measurements said yes but until it is done there was a risk of failure. A slot was cut in the rear of the column casting for the motor spindle to project through, **photo 7**. The motor would have a new, shorter, vee belt with its drive upwards to the existing pulley. Belt adjustment is provided by slots cut into the motor mounting plate holes, with the upper bolts tapped into the column, accessible from inside the door opening and the lower bolts fitted with a tapped plate for both bolts accessible outside the column.

This has worked well; in fact, the belt has never needed any further adjustment. I was quite concerned about the motor overheating, but it is just not a problem. I have run the motor for extended periods both slow and fast in hot weather conditions and only gets just hand warm. The belt adjustment slot allows some air circulation. I did have a plan to make some air circulation holes in the door, but this is not required. I just have to be aware that if I drop something inside the column it will mean a lot of work to retrieve it, **photos 8**, **9** & **10**. The coolant pump and its drive have been removed. The coolant tank has been cleaned out and is not used. If needed I apply cutting fluid with a brush.

The original belt guard extended the full length of the column, and more, to suit the overhead motor. I cut this down so that it just cleared the horizontal overarm by riveting the top and lower sections together, then filler, sanding and painting to finish off, **photo 11**.

Side door view - motor at bottom

Looking down at motor

The Vertical head

I planned to mount the head on a 120mm square cast iron block bored to fit the existing (shortened. horizontal column. The bore is split above the bore and two M10 clamp bolts secure the column. There is provision for four M8 bolts to hold the block down in tapped holes in the top of the column. I squared up the block in the lathe using a large tipped tool in a 4 jaw chuck, **photo 12**.

I have also devised an eccentric clamp lever similar to a lathe tailstock clamp. This pulls the block down on to the column. The purpose of this clamp is to enable the head block to be rotated and locked for the milling head to cover the extreme limits of the table. The vertical hold down bolts are unscrewed and left in position when the block is rotated. This also allows the head to be rotated 90 degrees to clear the horizontal overarm when the horizontal mill is used. In practice I only use two diagonal bolts to secure the block down, in addition with the clamp, this seems very solid. (These bolts are not shown in the photos. I often leave the horizontal overarm in its retracted position and use the horizontal arbour on its own without the end support provided by the overarm. Enabling a quick change over from horizontal to vertical operations, **photo 13**.

To clear the top surface of the column the forward clamp bolt for the horizontal overarm was counterbored and replaced by a hex socket screw to provide a flush surface. One of the most difficult operations was boring a 40mm hole in the top surface of the column. This was cut with a circular hole saw, took ages. The underside surface of the hole was counterbored (I think I contrived a spring arrangement to pull the cutter up. to provide a smooth surface for the clamp). Luckily the top surface of the column was machined, so removing the paint locally was all that was required. There is very little vertical space between the top of the horizontal overarm and the underside of the column casting, so the clamp hub has minimum downwards projection, **photo 14**.

Motor pulley and upwards drive belt

A half HP three phase motor is mounted vertically upside down to drive the vertical head via a polyvee drive belt. Belt adjustment is provided by rotating the motor support column and clamping it in position, **photo 15**. The motor support tubular column is purpose made to fit the motor, this avoided using the motor mounting plate. The polyvee pulley diameters are arranged so that the belt can be moved without slackening this adjustment. However, in practice I rarely need to move the belt from the central position, because the range provided by the inverter covers a speed rotation between 200 to 2000 rpm at the mid setting for the polyvee belt, so there is

> One of the most difficult operations was boring a 40mm hole in the top surface of the column.

›

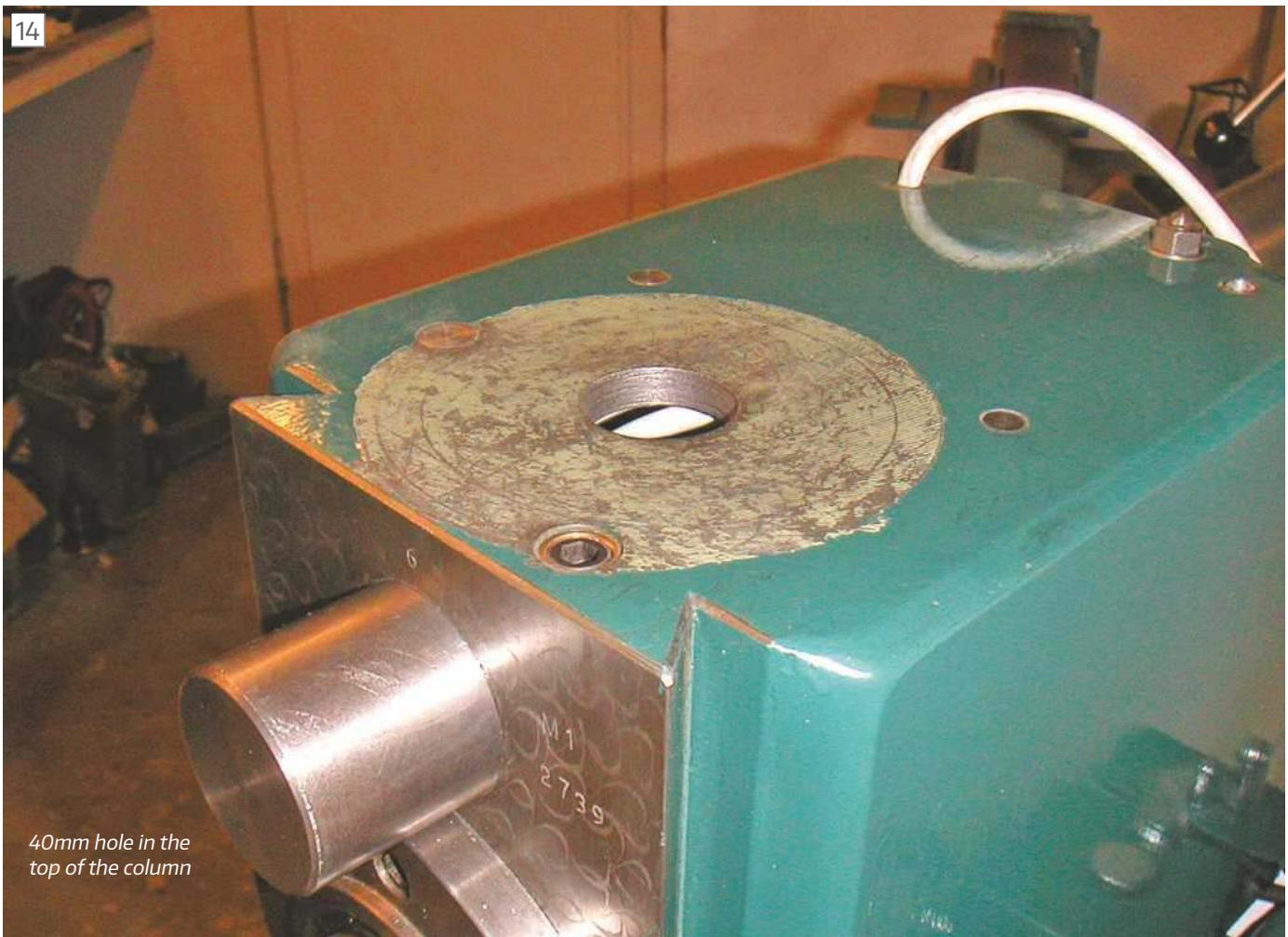
little need to change the belt for normal operations, **photo 16**.

Both the horizontal and vertical motors are inverter controlled and the power can be switched to either motor. I added a large ball bearing under the vertical spindle pulley which also runs on the existing plain bearing at the top. A shield is added to the lower face of this bearing to help in retaining some oil. The drawbar for the No 2 Morse taper spindle is retained by a left-hand threaded captive retainer nut screwed on to the top of the spindle, this avoids having to impact the drawbar to release the taper. The brass extension at the top of the spindle helps to reduce the slapping motion at the drive grooves when a milling cutter is used, by slightly clamping the drive pulley to the spindle, **photos 17** & **18**.

Belt cover shortened & ready for painting

Machining the Cast Iron block faces

Block fitted to column with milling head



40mm hole in the top of the column

Milling head vertical motor mounting

Polyvee pulley on milling head

Milling head pulley with brass damper

Overhead view of the brass damper

I use this vertical head as a drill as well as a mill and use homemade No2 Morse taper collets for the end mills. These, direct, collets enable a minimum distance for end mills from the lower head bearing.

The belt cover was fabricated from sheet steel with the front section removable for belt changes. The sheet steel parts were silver soldered together.

Photographs 19 & **20** show the left and right hand sides of the completed head with the belt cover fitted. **Photograph 21** shows the head rotated to enable the horizontal overarm to be extended.

Table drive

The M1 horizontal mill has the drive to the table in one direction, due to the cutter rotation, to avoid climb milling. Photo 10 showed the original table drive from the horizontal milling spindle. As this belt drive was driven by the horizontal spindle, it obviously would not be able to drive the table when using the vertical head. Now using an inverter drive and end milling etc. it became desirable to be able to drive in both directions. To do this I removed the original drive system and have mounted an old single phase motor, with

Left hand side view of finished milling head

Right hand side view

Milling head rotated to clear horizontal overarm

Milling Table drive motor

a start winding, to provide the drive. A change over switch has been fitted into the motor so that the start winding can be reversed when the motor is switched off. To reverse the table direction, the switch is flicked and on start up the motor will run in the opposite direction. I have attached a layshaft alongside the motor with small section vee pulleys (I should have used polyvee belts but for some weird reason did not! This reduces the motor speed to suit the table drive. The existing feed speed box gives three feed speeds, which works fine. This arrangement is attached by a bolted bracket to the column. It is relatively out of the way and it does the job admirably, **photo 22**.

I have routed the wiring for the drive motors inside the column. Holes were made in the swarf tray to route the cables down to the base of the stand. This keeps the outer column surfaces uncluttered and because the original coolant feed pipe has been removed, the cables can replace this route.

Conclusion

I am very happy with the finished machine. There is plenty of daylight between the milling head and the table and the table can be brought up close to the head if required. One plus is the ability to raise and lower the table without losing position, this was a

Front view of completed machine

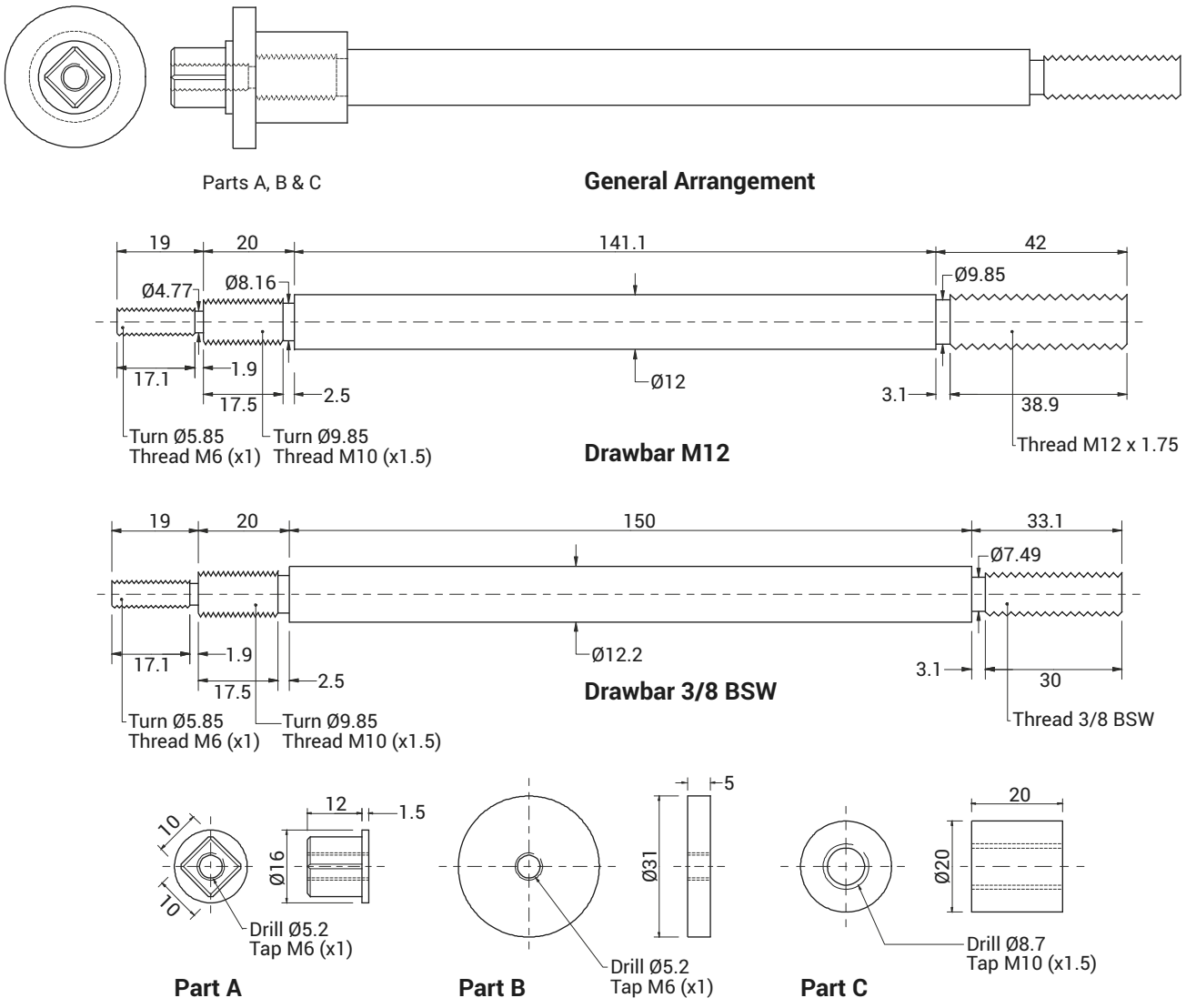
bugbear with the Dore Westbury. I have also made a simple taper conversion bush and adapted an international 30 hub to take Morse No 2 collets so end mills, drills etc. can also be used in the horizontal spindle. The finished machine is shown in **photo 23**.

There was of course some severe collateral damage to the leftover remains of the Dore Westbury. After all the good work it did for me, is this all it comes down to - the scrap heap? Actually, I do have a plan for you, said the Fat controller, we could call it a well-deserved promotion, a good service reward. You're going to become a very useful surface grinder! ∎

Two Hundred and Twenty drawbars and an Extractor

Peter Shaw makes some quality MT3 drawbars

Fig.1



Both my lathe, a Warco 220 (also known as the Mashtroy C210T) and my milling machine have MT3 tapers, for which I have bought a full set of metric direct collets. I find these items very useful for holding endmills and slot drills in either machine, and for holding short pieces of metric bar in the lathe. The milling machine came with a pair of drawbars (3/8 inch BSW and 12mm), but the lathe did not. **Figure 1** shows the drawings of a pair of drawbars suitable for the lathe. Incidentally, the collets I bought are a mixture of 3/8 inch BSW and 12mm, therefore two drawbars are required.

There is nothing special about the drawbars, **photo 1**, indeed I understand that some people use studding for the same purpose, however the following notes may be of interest.

The length of the 3/8 inch BSW thread and the 12mm thread was copied from the milling machine drawbars, hence the difference. On checking my collets, I did find that there was a discrepancy in the internal thread lengths with one of the 12mm collets in particular being very much shorter that the others. Fortunately, I had a 12mm tap so I managed to lengthen the thread.

The two drawbar shafts, as drawn, are slightly different diameters: this is because I used scrapbox material for one of them. In practice any bar with a minimum diameter of 12mm will be satisfactory.

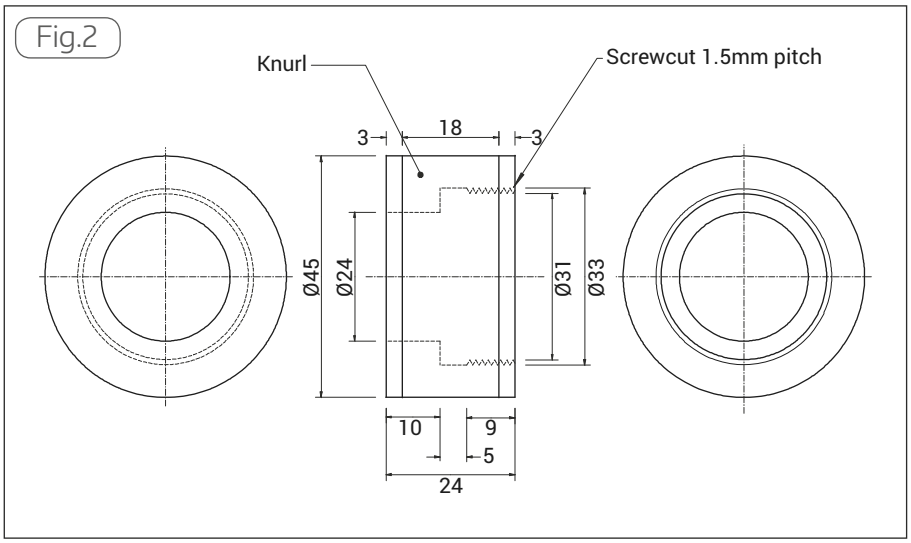
At the outer end, parts A, B, and C were made separately, screwed onto the shaft and fastened in place using an equivalent to Loctite 603 retainer. Part C is used to centralize the drawbar in the end of the mandrel; one side of Part B is used to bear against the end of the mandrel when drawing up the collet whilst the other side bears against the inside of the extractor when releasing the collet; Part A is used to both lock all three parts to the shaft and to provide a squared end such that the drawbar may be operated using the same spanner as is used for the four-way toolpost.

All three parts could be made from one piece of steel, and the parts soft or silver soldered together if desired. I used the retainer because it was 16 years old and I wanted to see if it was still active. So far, it has proved satisfactory.

Extractor

The problem with MT3 collets is that they are self-locking once inserted, but not self-releasing. Which means that it is necessary to have some means of removing them, most obviously by means of a hammer blow on the other end of the drawbar. I do not like this as it puts the pressure directly onto the mandrel bearings therefore a means of applying removal or unlocking pressure directly via the mandrel is highly desirable. As my lathe has 10mm of thread showing on the end of the mandrel, I therefore decided to produce the device shown in **fig. 2** which

The drawbars



screws onto the end of the mandrel.

The diameter over the mandrel thread was measured at 32.85mm, most probably a design value of 33mm, and the pitch was measured at 1.5mm. The appropriate calculations show that the minor diameter of the screw-on portion, i.e. nut, will be somewhere between 31.23mm for an OD of 32.85mm to 31.38mm for an OD of 33mm. In practice, I bored to 31.3mm diameter for a depth of 14mm, then with the boring tool set at the maximum depth inside the extractor, bored to 33mm thus providing a runout for the screwcutting tool. For screwcutting, I used a depth stop set to about 9mm, screwcut to a thread depth as measured by the cross-slide dial of 1.63mm and then tried the extractor for size. I then continued advancing, or perhaps I should say retracting, the cross-slide by small increments until the extractor screwed onto the mandrel. As usual, single point screwcutting throws up burrs: these were reduced by running the boring tool lightly over the tips of the formed threads followed by a cleaning run with the screwcutting tool.

In use, the drawbar is slightly slackened, the extractor screwed on to the threaded end of the mandrel, and then the end of the drawbar turned anti-clockwise until the collet becomes free. I find that it requires a fair pressure to release the collet, and that the release point is rather sudden.

I found that I could release the collet by holding the knurled portion of the extractor, however, if desired, suitably sized holes for a tommy bar could be drilled into the section with the 24mm diameter hole through it. ■

A Radio Amateur's Workshop

Shaun O'Sullivan recounts how his engineering workshop skills support another hobby.

My main hobby since I was a schoolboy has been Amateur Radio. I enjoy constructing my own equipment and the challenge of tackling a new frequency band or mode of operation. In truth, I probably spend more time planning and making my projects than using them when they are completed, but I suspect that it true of many amateur engineers!

By profession, I am a Chartered Mechanical Engineer and as part of my training, in 1979 I was sent off to Hackney College to do my Engineering Practice I. This was a basic, three month introduction to making things with metal. I really enjoyed using the lathes and milling machines, but my career was in the construction industry and so it went no further.

However, the idea remained in the back of my mind that one day, I would like to set up a small mechanical workshop at home. I used to visit some of the model engineering exhibitions because they are a great place to pick up tools and materials. Just over two years ago, having spent an hour or two looking at the new machines on display, I decided that the time had come to make a start.

A very mechanical aspect of radio – waveguide to conduct microwave signals.

An interdigital filter constructed in brass. This passes a selected band of frequencies and rejects everything else.

I acquired a small mill/drilling machine and a mini-lathe and positioned these on new benches in my workshop. I was warned that buying the machines is just the start and in the intervening two years, I have spent far more than the cost of the machines on the many accessories I decided I needed. In fact, setting up and equipping the workshop has been quite an interesting project by itself.

I am not a model engineer and the purpose of building the workshop was to enable me to fabricate the mechanical aspects of radio equipment. Many people might imagine that radio is very much an electronic business, but sound mechanical construction is very important for the stable and reliable operation of much electronic equipment. For example, microwave signals are often conducted along waveguide, which is a precision tube of rectangular or circular cross-section. A waveguide requires many fittings, bends, flanges etc. to form a complete system,

Starting to mill out the enclosure for the power amplifier from a piece of aluminium.

photo 1. Another example of mechanical radio equipment is the interdigital filter. **Photograph 2** shows one such filter that I have made. The filter is formed in a cavity with a series of tuned, resonant rods, which allow a selected band of frequencies to pass whilst rejecting others. The construction of aerials and steerable mounts for parabolic dish aerials also requires a great deal of mechanical engineering.

Perhaps the item that I have constructed

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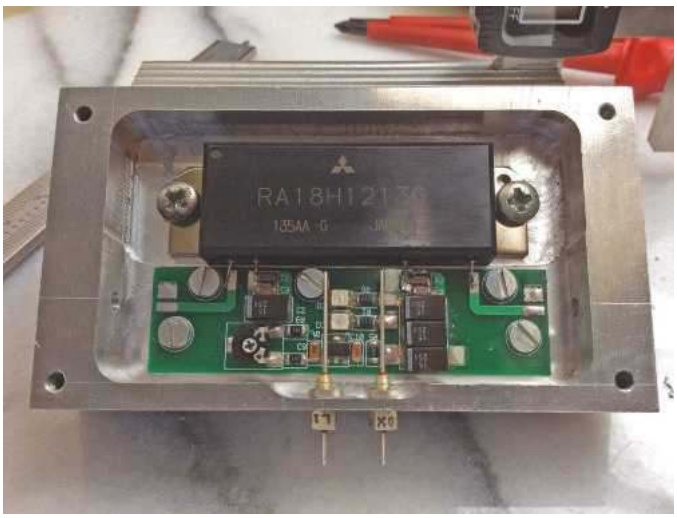


First fit of the amplifier module and circuit board into the enclosure.

The finished enclosure with lid removed showing final radio frequency and power connections and the use of some brass shim to earth bond the module fixing screws to the co-axial cable and circuit board.

most are enclosures for discrete pieces of radio equipment. I will describe one such project that was to house a radio frequency power amplifier. This was one of chain of three such amplifiers designed to amplify a very low level signal of about 1mW up to 30W or so.

The enclosure has a number of important functions. Firstly, it must hold all of the circuitry securely and rigidly, because movement can affect the stability and tuning of the circuit. Secondly, it must provide electrical screening to prevent the circuit either radiating stray signals or picking such signals up and amplifying them. Thirdly it is the first stage in the thermal management system of the amplifier. Ultra-linear Class A amplifiers of this type are not very efficient and about three quarters of the power applied to operate them ends up as heat. This must be conducted away efficiently or else the amplifier will overheat and fail.

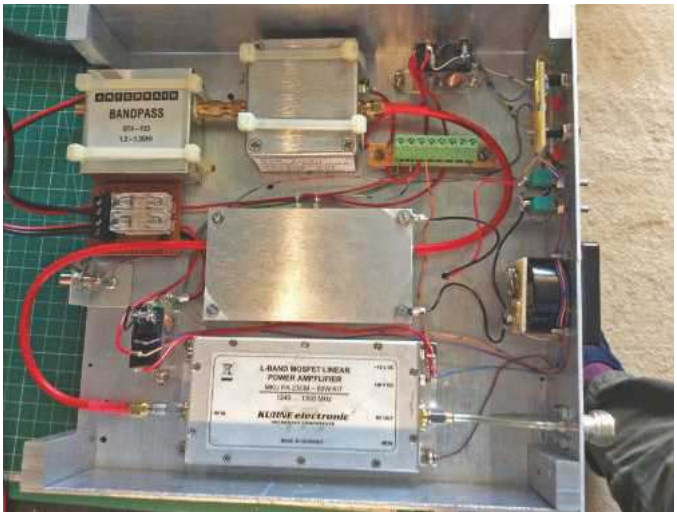
The amplifier consists of a factory made module, where all the really clever stuff happens. To interface this to the real world, there is a small printed circuit board whose function is to conduct the signals into and out of the amplifier and handle power supply arrangements. The module has a flat metal back that conducts heat away from the power transistors inside.

I formed the enclosure from a small piece of aluminium size approx. 105x55x20mm. I used a horizontal band saw to cut this and then faced off the ends square using the milling machine. The amplifier module and circuit board sit in a cavity that was milled out using a number of two flute cutters (slot drills). **Photograph 3** shows the start of this operation. The circuit board sits at a slightly higher level than the module so that the pins of the module lie directly on top of the circuit board tracks. A small section of the side wall of the enclosure was milled away to about 2mm thickness to allow a couple of bolt in feed through capacitors to be fitted, **photo 4**. These conduct the 12V direct current power feed into the amplifier.

Had this amplifier been intended as a loose piece of equipment for general use, co-axial sockets would have been fitted for the radio frequency input and output signals. Because it is an intermediate stage in a chain, the co-axial cable was brought in each side of the module and terminated directly onto the circuit board. Once the insulating jacket is stripped off the cable, it has a diameter of 3.58mm and so a 3.5mm hole provided a snug, interference fit that ensured the screen of the cable was securely earth bonded to the enclosure, **photo 5**.

A lid was formed from some 3mm thick aluminium sheet and this is fixed to the enclosure by screws drilled and tapped. The rear face of the enclosure was drilled and tapped and fixed to an extruded aluminium heat sink. This provided the chassis which the remainder of the amplifier was fixed to and the means to liberate the waste heat produced, photo 6. A small fan was fitted on top to assist this process. The mill was used to form four pillars 50mm tall, one in each corner. These hold the side panels and front fascia where control switches, indicator lamps and an output meter are provided, **photo 7**.

I cannot claim any great originality or precision for this project, but it is now working very well. Solid build means that the power output is very stable. It is one example of how a mechanical workshop can be very useful in a hobby where the average MEW reader might have thought there was no application for it. ■



A view of the completed amplifier chassis. The milled out enclosure is in the centre with its lid on.

The completed amplifier with extruded aluminium heatsink covering the top surface and fascia with control switches, indicator lamps, power meter and output socket.

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Myford tailstock bed ways refurbishment

Pete Barker uses a vertical slide to recast his Myford lathe as a shaper to machine its own worn-out bed ways which were allowing excessive tailstock movement

When the adjustable gib on the base of my ML7's tailstock was set to fit the unworn right-hand end of the bed, it had .005" of slop when slid to the working end of the bed nearer the chuck. With the tailstock barrel extended and a drill chuck in place, that five thou of movement became ten thou and more at the drill tip. A recent wide-guide conversion (see previous article) had brought the headstock spindle to saddle-movement alignment back to well under Myford's tolerance of .0006". How could the two worn inner bed shears that guide the tailstock now be brought back to the same high standard?

As with all machine tool reconditioning, the first step was to measure carefully. **photo 1** shows how the varying gap between tailstock base gib and the bed way was checked with feeler gauges along its length.

In **photo 2** a micrometer was used along both ways to confirm we had about two thou of wear on the rear shear and three thou on the front in the left to centre section of the bed. For the tailstock to slide freely but without shake between the vertical shears, labelled 2 and 3 in photo 2, we need to have the same gap between the pair all along, within half a thou or better.

The lathe as shaper

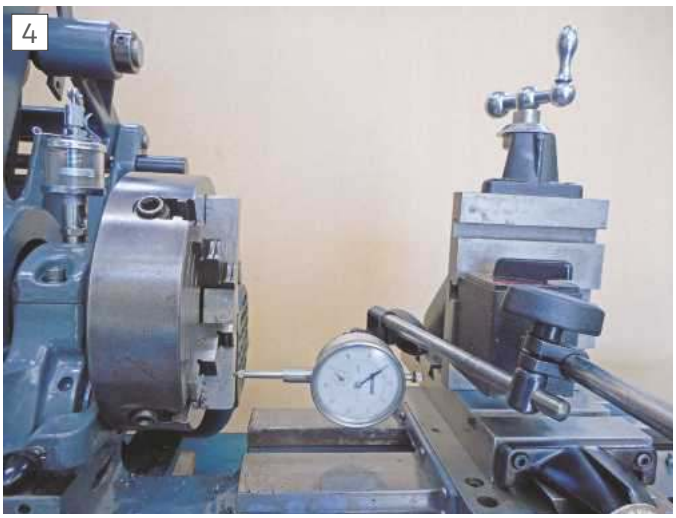
A method was devised to plane off the excess unworn cast iron and bring the two shears back to both straight and parallel to the longitudinal axis of the lathe. A vertical milling slide was mounted on the cross slide in the conventional manner but swivelled 180 degrees from the norm. A high speed steel tool bit was clamped to the bottom

> How could the two worn inner bed shears that guide the tailstock now be brought back to the same high standard?

Measuring gap between bed shear and tailstock guide block with feeler gauges.

Measuring width across bed ways with micrometer.

Vertical slide and cutting tool set up to recut No. 3 vertical shear using the saddle as a hand-powered shaper.



Setting the slide vertical using a parallel strip in the four-jaw chuck.

Sharpened tool bit is set on the most worn section of shear.

of the vertical slide and angled to bear on the vertical shear surface to be machined (**photo 3**). The chuck, apron and leadscrew were removed so the saddle could be run by hand up and down the full length of the bed unobstructed, like a hand-powered shaper in effect. Depth of cut was set by the cross slide and feed put on by the vertical slide at the start of each stroke of the "shaper".

As the saddle on this newly wide-guide-converted lathe was known to move parallel to the lathe axis, the newly planed or shaped shears would do likewise. This technique will not work on a lathe with a worn-out factory wide guide, i.e. rear vertical shear on the bed, or worn out front vertical shear. Of course, it can't be used on a standard narrow-guide (pre-1972) Myford where one shear we want to plane down is also the main guide for the saddle. But it is perfect for any pre-1972 ML7 or other flatbed lathe that has had the wide guide conversion.

Setting up the shaper

It's important to make sure the vertical side is moving truly vertical relative to the bed ways. This will ensure the newly machined shear surface is truly vertical and matches the tailstock gib and guide block surfaces. To do this, a parallel bar was placed in the four jaw-chuck as shown in **photo 4** and set so that each end of the bar returned a zero reading on the dial indicator as the chuck was rotated 180 degrees. Lift the indicator plunger gently out of the way as the bar is moved. With the dial indicator and slide mounted as shown in the picture, the slide's top swivel is adjusted until the indicator shows a zero-zero reading when the slide is wound up and down the length of the parallel bar. Don't make the mistake of plonking the indicator base on the bed and the indicator plunger on the side of the vertical slide and winding it up and down. This tells you nothing, but is an easily made miss-step.

Once set to travel vertically, the slide is swung around 90 degrees so the tool bit can be clamped on, reaching down to the bottom of the vertical shear. My son and I used a piece of half-inch square high-speed steel about four inches long, good and solid. I would not try carbide tooling because cutting speeds are too low, and you can't get a keen cutting edge on it like you can with HSS. The tool bit was first ground like a standard right-hand lathe turning tool, in the form of a traditional knife tool with about 10 degrees clearance on the cutting edge and 20 degrees rake on the top face. It's not textbook geometry for cast iron, but worked well for our purposes shaving just over one thou at a time under hand power. A small radius was put on the cutting point of the tool on the bench oil stone and the whole cutting edge brought to razor sharp on the same.

Hold both sides of the cross slide and pull the saddle toward the tailstock to take a cut.

The tool, clamped at an angle, was brought to just touch, or within a thou of, the most worn spot on the shear (**photo 5**). The cross slide was then locked. If you don't have a dedicated locking screw, just nip up one of the gib adjuster screws. The tool on the vertical slide was then wound up to the very top of the vertical shear surface ready for the first cut.

Taking cuts

The best position for the operator on our new "shaper" was to stand at the tailstock end and to pull the saddle towards himself. One hand grasps each end of the cross

Pull the saddle until the tool just passes the end of the bed.

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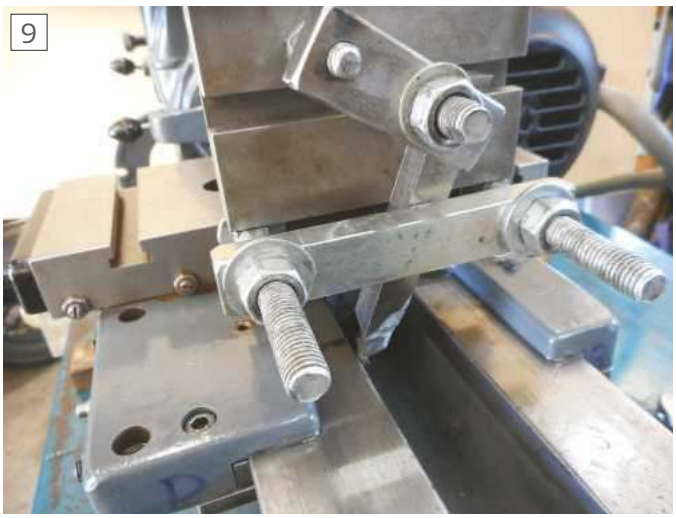
Cut progressing down No. 3 shear shows new and old surfaces.



Tool bit reground and swung over to cut No.2 shear.

slide, as shown in photo 6. You'll have to imagine the left hand, which was holding the camera at the time, grasping the left end of the cross slide. Gloves make the job more comfortable (my son reports).

Starting with the saddle up against the headstock, the feed is put on by winding the vertical slide down before the beginning of each stroke of the "shaper". Five thou per stroke for roughing and three thou for finishing feed was found to work well, and not take too long to make a full pass over the shear. The operator then pulls the saddle briskly toward himself, stopping when the tool clears the end of the bed as in **photo 7**. Although the saddle guides are partly off the bed ways at both ends of the stroke, pulling the cross slide evenly with two hands stops any swivelling under motion.

This action is kept up, adding the few thou of down-feed every time the saddle is returned to the headstock, thus cutting a new surface across the shear, photo 8. Although it looks bigger in the picture, the step is only about one thou, as evidenced by the fine iron powder swarf on the tool.

After the first cut is completed right down the shear depth, the cross slide is moved over one thou for a finishing cut and relocked. Feed of about three thou per stroke gives a good finish, seen in the foreground of **photo 8**. Again, it was smoother in real life than the picture shows.

The tool bit was then reground like a left-hand lathe tool and angled the opposite way before the procedure was repeated for the other vertical shear surface **photo 9**.

Final finish

Although this rather primitive yet effective method of cutting leaves a smooth finish, on par with the milled surfaces on the shears the lathe left the factory with, some fine finish was applied. A ten-inch flat file was run down each shear surface, using long strokes the full length of the bed. Then coarse and smooth slip stones followed it up. All burrs were filed or stoned off the top and bottom corners of the shears also. The result was very pleasing to the eye and touch and measured up showing no variation in gap between the two shears now.

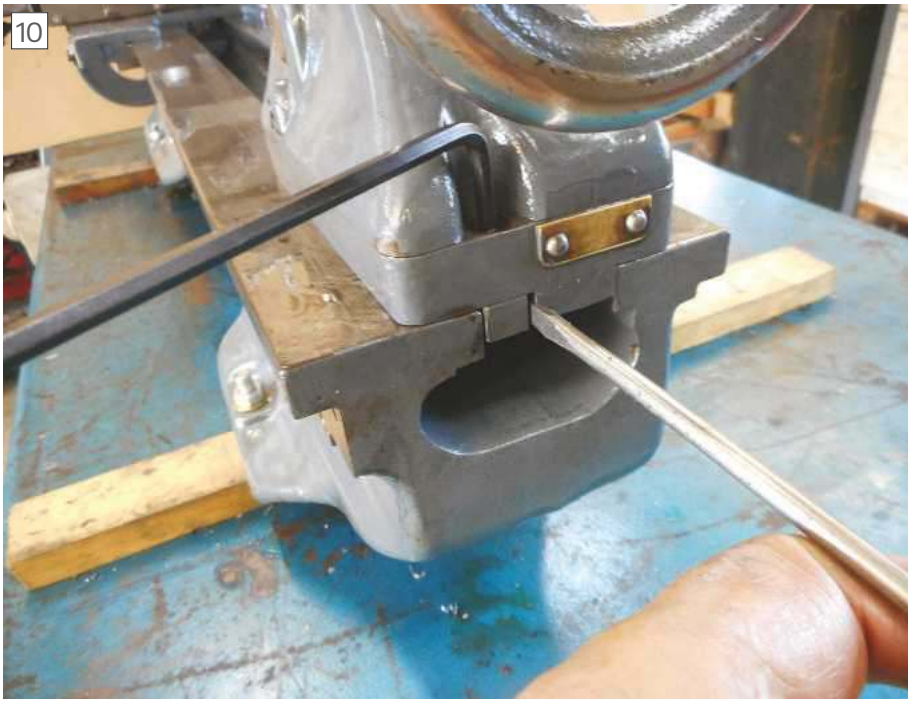
The joint between the old worn surface and the new surface where the tool bit's stroke started was smoothed over likewise, for appearance's sake. It is well past the point where the tailstock can possibly travel to, but visible to the world if not smoothed over.

The final "real world" test was to set the gib strip on the base of the tailstock, as shown in **photo 10**. By levering the gib strip over gently with a screwdriver and then nipping up the mounting Allen screw at each end, the base was set to have zero drag, zero movement at the tailstock end of the bed. The tailstock was then slid along the bed and checked at intervals, ending at the saddle up against the headstock. On our example, the tailstock now slid as if on rollers the whole way, with no perceptible side-to-side movement. Perfect. All that remains now is to adjust the tailstock itself for alignment, a simple matter to be covered in a further article.

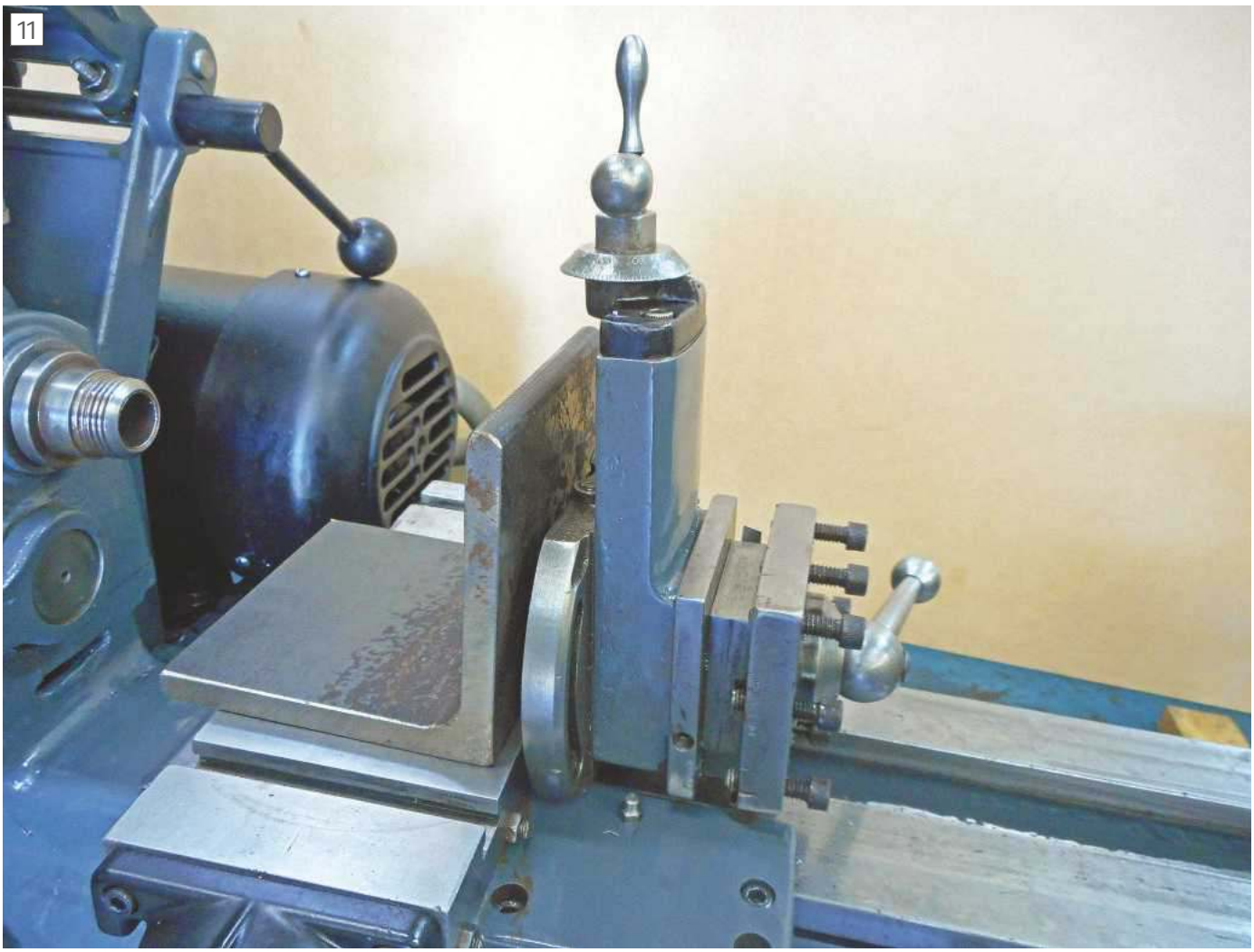
Conclusion: A great result

This simple method of planing a few thousandths of an inch off each inner vertical shear means the tailstock can now be used anywhere along the bed for precision drilling with very small bits and for turning between centres without unwanted taper, once final tailstock adjustment is done. The simple expedient of attaching the vertical slide and suitable cutting tool has provided a remarkably accurate result for very little outlay of time or money. Once the slide and tool bit were set up, first cut over each shear took 10 minutes and each finishing cut 20 minutes, thus a total of one hour "machining" time after set-up.

And if you don't have a vertical slide, you could even get by with the lathes' top slide mounted with an angle plate to the cross slide as shown mocked up in **photo 11**. ■



Setting tailstock gib for zero drag, zero shake.



Mock-up of top slide replacing the vertical slide to do the same job.

In our Next Issue

Coming up in issue 290
On Sale 24th January 2020
Content may be subject to change

Our February issue, number 290, will have plenty to read by the fireside this winter

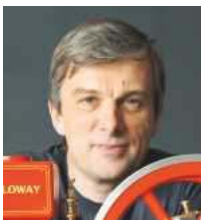
Will Doggett makes some tooling for his recently featured press.

Alex du Pre tackles a challenging repair.

Howard Lewis on his Adept Shaper.

DON'T MISS THIS GREAT ISSUE - SEE PAGE 50 FOR OUR LATEST SUBSCRIPTION OFFER

A New Range of Inserted Tip Milling Cutters



Jason Ballamy looks at some new cutters from Arc Euro Trade

I was recently sent some samples from the new range of indexable shell mills from ARC Euro Trade for evaluation. The range consists of five different diameter cutters, the smallest 25mm ones have an integral shank to suit the popular spindle sizes of MT2, MT3, R8 and ISO 30 and on the typical bench top hobby machines would be suited to both facing and side cutting **Fig 1**.

The remaining four heads of 40, 50, 63 and 80mm diameters which I would expect to mostly get used as face mills but the 90degree inserts will also allow them to be used for side cutting or facing up to an edge. **Fig 2**. These shell mills will require a suitable sized arbor to fit the central hole which are again available in the same range of spindle fitments and additionally ISO40. The smaller size heads can be held with just the supplied cap head screw, but the larger ones are best used with a thick 5mm washer which can easily be made to suit. If your arbor comes with a washer head screw or separate washer that may need altering

Fig.1

For APKT1604 and APMT1604 Inserts

Code	Dia.	Shank	Drawbar Thread	Suitable Inserts
060-282-00252	25mm	MT2	M10	APKT 1604 PDFR or APMT1604 PDER
060-282-00253		MT3	M12	
060-282-00258		R8	7/16"UNF	
060-282-00260		ISO30	M12	

Fig.2

For APKT1604 and APMT1604 Inserts

Code	Type	Dia.	Bore	Height	Teeth
060-282-00440	BAP-400R-40-16-4T	40	16	44	4
060-282-00450	BAP-400R-50-22-5T	50	22	50	5
060-282-00463	BAP-400R-63-22-5T	63			5
060-282-00480	BAP-400R-80-27-6T	80	27		6

depending on the diameter/shell mill combination. **Fig 3**.

All cutters take the commonly available APMT 1604 and APKT 1604 style of inserts which are available individually or at a more attractive price in boxes of 10, there are two usable corners on each insert. As **fig 4** shows the APMT are suitable for steels and cast iron while the bright ground APKT ones are ideal for aluminium and other nonferrous metals much like the familiar **GT lathe inserts. Both these inserts allow for milling up to a right-angled edge and will leave a small fillet due to their 0.8mm tip radius.

Fig.3

R8 Shell Mill Arbors

Various sizes available in MT2, MT3, ISO30 & ISO40

Code	Spindle Taper	Arbor Dia. D	Length L_1	Length L_2	Drive Key W	Screw Thread	Drawbar Thread
060-281-10816	R8	16mm	21mm	17mm	8mm	M8	7/16" UNF
060-281-10822		22mm	24mm	19mm	10mm	M10	
060-281-10827		27mm	28mm	21mm	12mm	M12	

Cutters in action

The first combination that I tried was a 63mm shell mill which after cleaning off any protective oil/grease was fitted to a No. 3 Morse taper arbor to fit the Sieg X3, it was nice to find that the fit was a very close one which should result in little if any runout unlike some of the cheaper offerings where I have found a lot of play in the fit. The mill was secured to the arbor with the supplied cap head screw. This diameter mill required 5 inserts, and for the first cuts I fitted the APMT ones.

A piece of 40mm wide cast iron bar was put in the vice and some cuts taken at 120m/min which equates to 600rpm, 1mm deep and with a modest feed of 150mm/min. Straight away the cut sounded a lot better than I have previously achieved with cheap inserts and the resulting finish was very good. Some cuts with similar parameters were then taken on an odd bit of 38mm flat hot rolled steel and were quite acceptable given the unknown parentage of the steel.

Changing to the APKT inserts and a 50mm wide piece of aluminium the revs were increased to 1750rpm or 350m/min and a feed of 300mm/min gave a very good finish with fast removal rates. I also tried a 0.2mm deep finishing pass at 2000rpm and got a mirror finish. All the aluminium cuts were done with a small amount of paraffin applied to the work by brush.

I was also interested to see how the slightly smaller Sieg SX2.7 would handle these relatively large diameter cutters so mounted the 80mm one onto the 27mm R8 arbor, this required making up a simple 5mm thick steel washer to spread the holding of the supplied M12 Socket head screw.

This time six of the APMT inserts were fitted as the larger head can accommodate an additional insert, I also dropped the speed to 500rpm which still gave a similar cutting speed of 125/min and took the same sort of cuts from the cast iron and some EN3 steel all of which gave very good finishes. With a change to the APKT inserts and the variable speed wound up to 1750rpm giving a cutting speed of approximately 450m/min the cutter and machine sailed through the test material with the same good finishes. The final test of this combination was a 0.2mm deep finishing cut at 2000rpm which is the maximum spindle speed available giving a cutting speed at the insert of 500m/m to give a mirror finish.

Lastly, I tried the 25mm diameter, 2 insert, cutter on steel and cast iron at 1750rpm and got a good finish with the chips from the steel coming off blue. For a test on aluminium, I opted to use the Sieg KX3 mill and rather than doing just facing cuts I also tried some 6mm high adaptive clearing and finish contour cuts at 5000rpm with a modest 200mm/min feed which resulted in a very good finish.

2

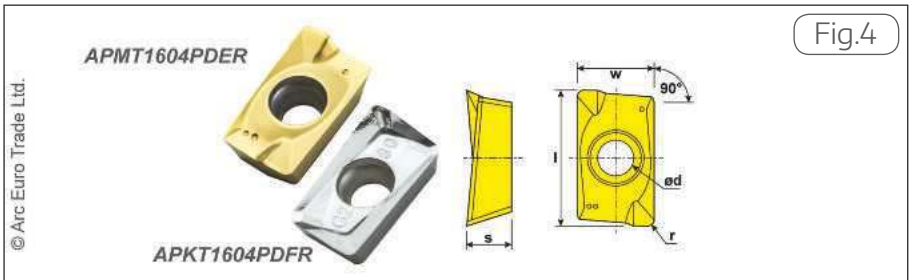
A selection of test pieces showing excellent surface finish.

Photograph 2 shows some of the test pieces, from left to right - Cast Iron, 6082 aluminium and EN3 steel. I will post some video and additional photos on the forum.

Conclusion

All the shell mills and arbors fitted well together and performed very well straight out of the box and would make a useful addition to any users tooling collection. They may look the same as some cheaper ones available on the net but from my own experience the ones from ARC are a far superior product. Prices and details from Arc Euro Trade's Website or latest catalogue. ■

Fig.4



Code	Type	l	w	s	ød	r	Qty
060-282-1604K	APKT1604PDFR Ground & Polished for non-ferrous	17mm	9.26mm	4.76mm	4.4mm	0.8mm	1
060-282-1604K10							10
060-282-1604M	APMT1604PDER TiN Coated for steel, stainless steel & cast iron	17.24mm	9.41mm	5.28mm			1
060-282-1604M10							10

ARC Euro Trade **https://www.arceurotrade.co.uk/**

Additional Content: **https://www.model-engineer.co.uk/shellmill**

On the Wire NEWS from the World of Hobby Engineering

London Model Engineering Exhibition: Alexandra Palace, London 17 - 19 January 2020

Now in its 24th year, the popular London Model Engineering Exhibition returns to the iconic Alexandra Palace, London from Friday 17th to Sunday 19th January 2020. Often regarded as one of the top model engineering shows in the UK, this leading exhibition for model engineers continues to enthral visitors and enthusiasts alike with thousands of scale models from the early age of steam engines right up to today's modern marvels.

The 2020 event will be packed with over 2,000 models built by individuals, clubs and societies, from traditional model engineering like locomotives, train layouts and traction engines to large collections of scale model ships, aircrafts, tanks and militaria to remote controlled trucks and even James Bond models and memorabilia!

Over 45 clubs and societies will be displaying their members work each vying to win the prestigious Society Shield. Plus, all the leading specialist suppliers will be on site providing an excellent opportunity to seek advice from industry experts and compare and purchase everything you need under one roof!

The London Model Engineering Exhibition is a 'must do' event for anyone interested in modelling and engineering. Come and marvel at a world of pure Imagination...

For further information or to book tickets, please visit: **www.londonmodelengineering.co.uk**

Festival of Model Railways 2019

Former MEW editor Stan Bray visits the PSME stand at the Festival of Model Railways.

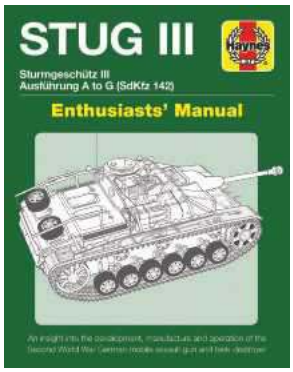
Peterborough Society of Model Engineers were again invited to exhibit at The Festival of Model Railways in The Peterborough Arena at the East of England Showground in Peterborough. We were especially pleased to have Stan Bray acting as a Steward as well as an Exhibitor, since he was the founding Editor of Model Engineers Workshop.

The frontispiece of the stand was the battery electric LNER A4 built by the late Roy Moseley and now owned by Brian Parker. Stan Bray also exhibited a Beam Engine and a German Wall Engine.

D A G Brown exhibited his Quorn Cutter Grinder, and on both days, used it to demonstrate four facet drill grinding. A range of Workshop Tooling was displayed by Howard Lewis, including an Adept No.2 hand powered shaper, together with a Machine Vice made for it.

The stand attracted a lot of interest, and it is hoped that some new members will result.

StuG Life



Fans of heavy armour will be delighted by Haynes new 'enthusiast's manual' for the StuG III assault gun. The relatively inexpensive and easy to produce Sturmgeschütz was one of the most prolific armoured vehicles used in WW2. With a focus on one of the last surviving StuG III Ausf Gs on display in the Tank Museum at Bovington, the manual charts the StuG's extensive use on all battlefronts. In the manual, author Mark Healy looks at the development, construction and fighting qualities of the StuG III. He also includes insights into what it was like to operate and maintain, shining a light on the lives of those who experienced it at first-hand. The StuG III Enthusiasts' Manual is available from **www.haynes.com** priced at £25.00.

WM16 Mill Spindle Hold Part 2

R. Finch describes a simple method of holding the spindle still on the Warco WM16 milling machine (and similar machines) when using a dial indicator

The switch actuator

This part is made from 1.6mm steel sheet to the dimensions shown in **fig. 6**. The 13 and 16mm dimensions are for folding after drilling and tapping. Bend the 16mm dimension first, making sure that the plain hole is in the 16mm long part. Now turn it round in the vice and bend to the 13mm dimension, **fig. 7**. Make sure that when the switch actuator has been bent, there is sufficient clearance between the underside of the horizontal part when mounted on the brake to clear the M3 cap head screws securing the tachometer ring to the spindle (the 16mm dimension). When fitted it should not exceed 30mm above the top of the milling head casting so as to miss the push fitted cap which allows access to the chuck draw-bar. The dimension between the two bent parts is not critical as there is an M3 screw fitted to adjust the action for the microswitch.

The spring

This is required to make sure that when the star knob is unscrewed to release the spindle hold, the microswitch is actuated to complete the circuit allowing the milling machine to start. I originally was intending to use 18 swg piano wire (spring steel to British Standard 5216 supplied in the fully hardened condition – available from model shops in 914mm lengths), as drawn in **fig. 8**, with the pin used to pivot the brake passing through the coil. One end presses onto the switch actuator and the other end bears on the other pin. It's not a precision item!

In the end I used some stainless steel flat spring of the type used in car windscreen wiper blades. This is 2.5mm wide and 0.9mm thick. It is drawn in **fig. 9**, but I think that it is best to use this drawing as a guide as it is best to bend it to suit. I ended up with a piece bent to the shape shown in **photo 12**. The part bent over on itself at the left hand end hooks onto the switch actuator plate and the other end sits against the remaining pivot pin. I found that an angle of about 100 degrees was about right for operating the microswitch. This is the last part and completes the metal parts to be made.

Assembly

The parts made are assembled as shown in **photo 13**. Do not adjust the microswitch at this stage as it needs to be fitted to the machine before adjustment. Make sure that the milling machine is disconnected from the power supply by pulling the plug out. The whole assembly is now fitted to the machine using the two M6 x 30 cap head screws which replace the original M6 x 20 screws used when it was built. You will need to undo the M4 hexagon socket cap head screw which holds down the motor connection block and slip the end of the baseplate underneath. Replace the screw making sure that the connector block is back in the same place, but just raised up by the thickness of the baseplate. There is enough thread on the M4 screw to allow this.

Fig.6

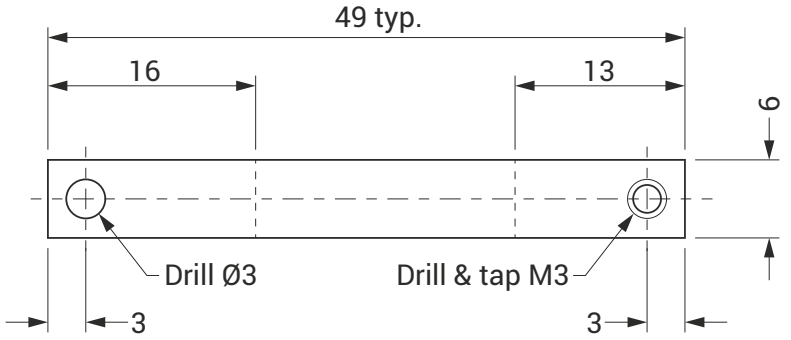


Fig.7

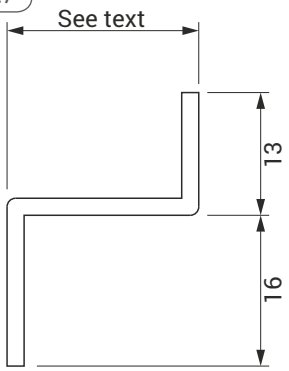
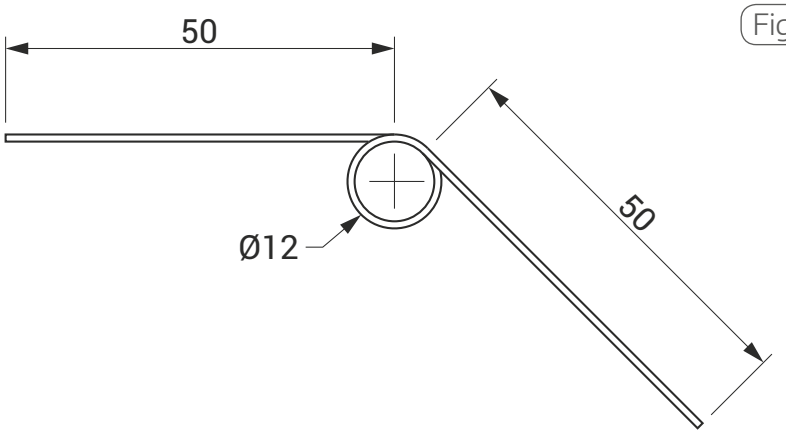
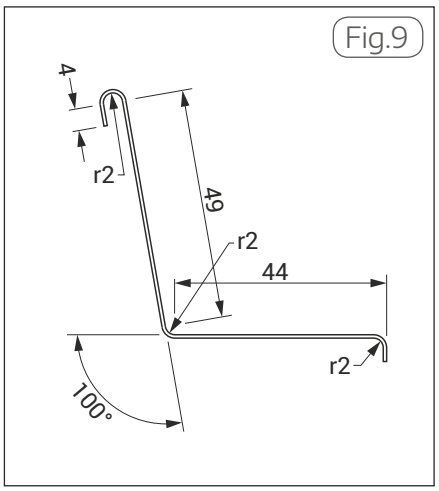


Fig.8





The spring made from stainless steel spring used in a windscreen wiper.

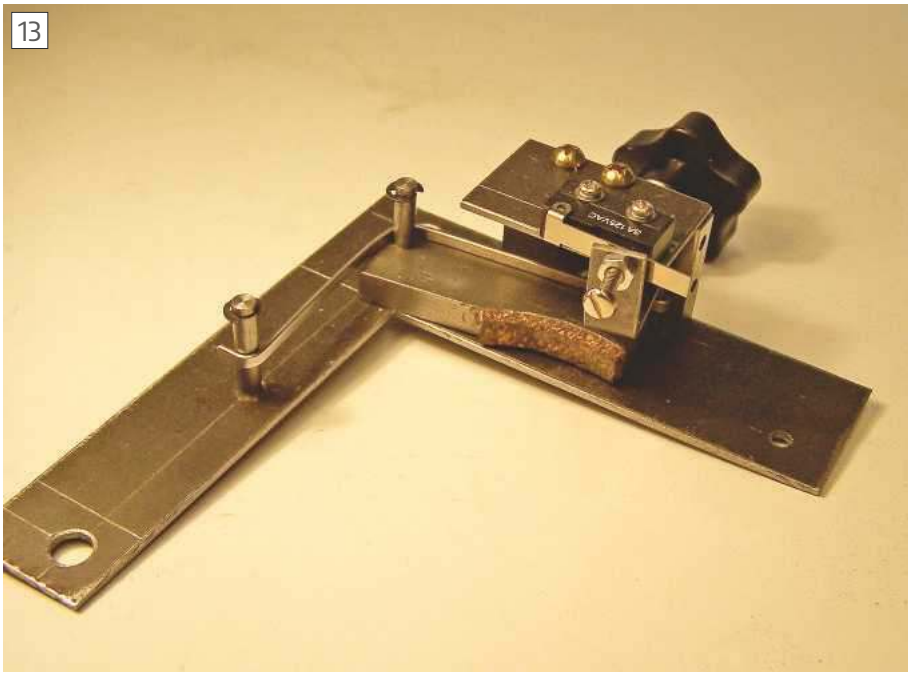
Hook to end of the spring over the switch actuator, around the pin for the brake and secure it behind the other pin. **Photograph 14** shows the finished assembly on the machine.

There are two ways to drill the hole in the motor cover, depending on how accurate your measurements are. If you are good, then just mark out where the hole should be and drill it 7mm. If, on the other hand you are like me, I drilled a 5mm hole from the marking out and then fitted the cover to see how near I was. As I had a rat-tail file of 5mm diameter, I could then draw the hole to the right place by careful filing on a cut and try basis. Once I had the centre lined up, I drilled it 7mm to clean up hole to make it look tidy, photo 2. You may have to trim a bit off the end of the star knob – I trimmed about 5mm off – to make sure that when unscrewed to release the spindle hold and allow the machine to be started, it does not foul the vertical arm of the guard. I used a star knob from Axminster, order code 953481 (usual disclaimer) which has a 30mm long thread, but any star knob could be used as long as it has a male thread at least 25mm long. You can search on the Internet for "M6 male star knob" and you will find all sorts of suppliers selling virtually the same thing. Leave the cover off for the time being as the microswitch and cable needs installing.

Interlock wiring

I wanted to make sure that the machine could not be started if the spindle hold were in use, so I decided to interlock it with the microswitch used for the guard interlock. This requires a minimal (reversible) modification to the machine. Firstly, use a 500mm length of two core sheathed cable with a conductor section of at least 0.5 sq.mm with an oval sheath. Do not use the round sheath type as used on pendant light fittings in the home as the diameter is too big to fit into the hole in the side of the milling machine head. Strip off around 80mm of the sheath and fit two crimp connectors to one end. You will need a piggy-back connector and a plain connector as shown in **photo 15**. These are standardised on colour for cable size, so you will need red sleeved ones. These crimp connectors have various names – commonly Lucar connectors; spade connectors; Faston connectors; or ¼ inch receptacles – you can take your pick what you call them, but make sure that they fit ¼ inch blades! These will fit onto the existing V3 microswitch. I crimped the piggyback connector to the brown wire and the straight one to the blue wire.

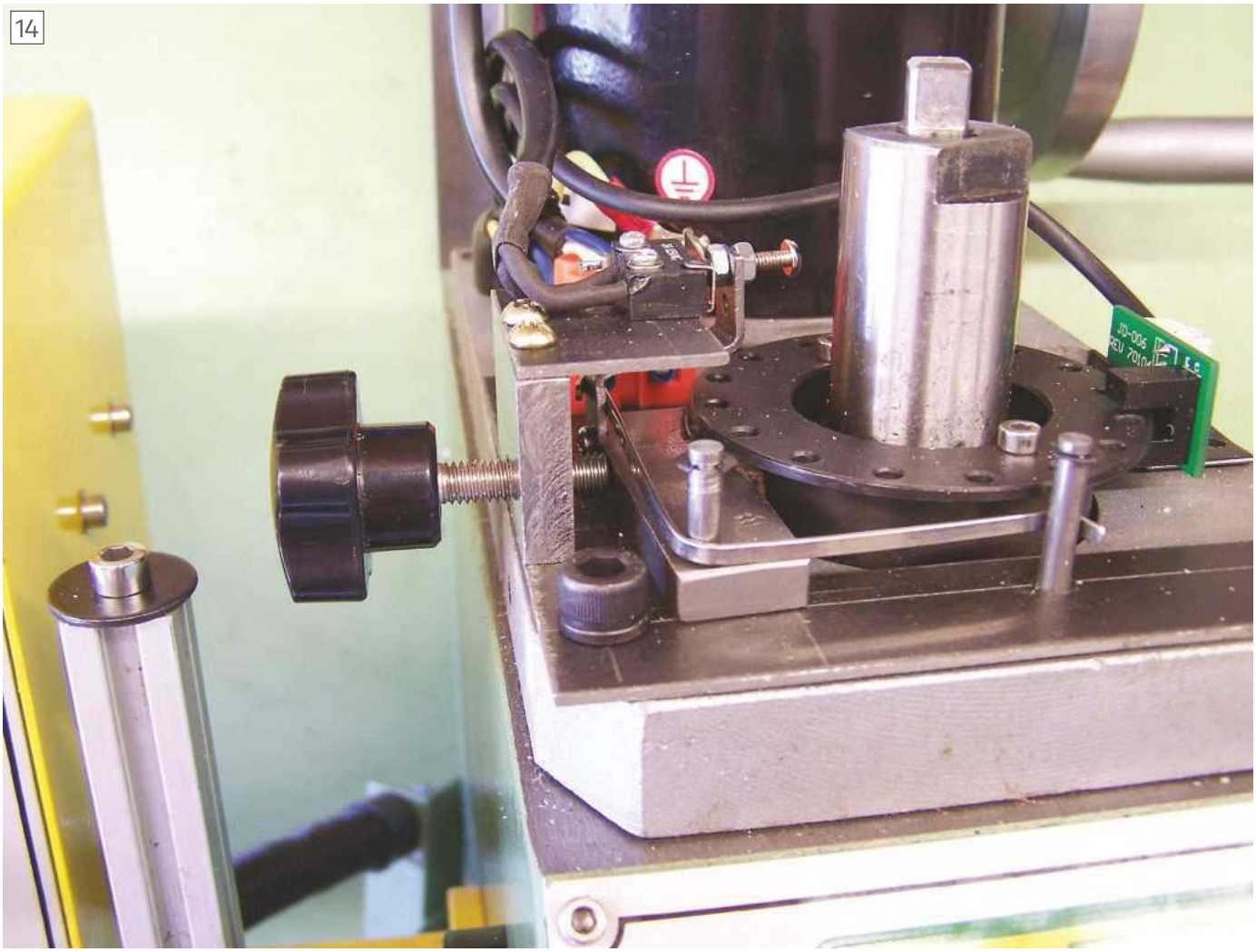
Remove the guard and microswitch assembly from the milling head and carefully pull the existing microswitch out of the assembly, without disconnecting any wires, **photo 16**. Note that this existing microswitch is a V3 type which is larger than the V4. Now thread the plain end of the length of two core cable through the angled hole in the side of the casting where the existing two-core cable goes, see photo 16. The end of the cable should now drop down under the head of the machine. Carefully push a piece of stiff wire down the slot beside the motor at the top of the head, **photo 17**, and tape the end of the new two core cable to it and pull it out next to the motor. You should now have three cables coming through the hole on the top plate – the motor supply; the tachometer cable; and the new interlock cable.



The assembled parts.

Connecting to the new microswitch

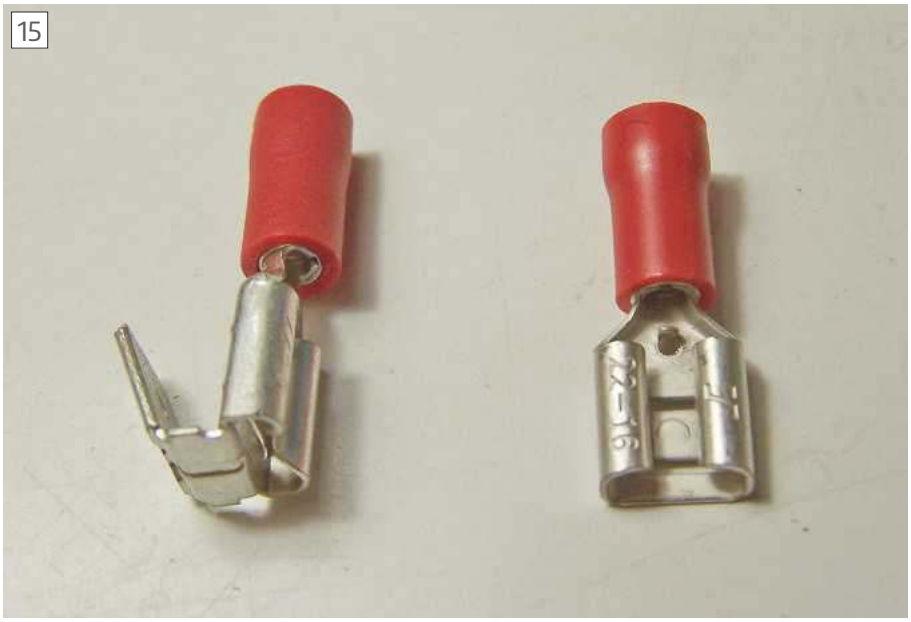
The new cable must now be wired to the V4 microswitch on the spindle hold. It



The assembly fitted on the machine.

cannot be wired before, as neither the switch itself nor the connectors will fit through the hole in the side of the milling head. Before soldering, slip a short piece of shrink fit sleeving over the individual wires before soldering the wires to the switch. Make sure that the wires go to the terminals marked 'COM' and 'NO'. Sometimes these terminals are marked '1' and '3' or 'COM' and 'N/O'. If there is any doubt, use a multimeter to check that you are connecting the wires to the two terminals which form a circuit when the lever is pressed down to actuate the switch. Once the wires are soldered onto the V4 microswitch, push the heat shrink tubing over the joint and warm it up using a suitable hot air source. Take care that you do not use a hot air gun set to the paint stripping or hot mode or you will damage the PVC insulation of the wires. You can, of course, send your wife out on a shopping spree and use her hair dryer on the 'hot' setting to do this. I accept no responsibility whatsoever for any marital disharmony resulting from taking up this suggestion. Finally make sure that the microswitch is fastened down.

The adjustment is best carried out now. Fit the M3 adjustment screw as visible in photo 13 but leave it just threaded



The crimp connectors – piggy-back (left) and straight (right).

into the switch actuator. Screw the star knob fully in until the spindle is hard to turn – don't go berserk and screw it down so hard that it bends something! Now unscrew it about 8 full turns or until the friction pad is obviously clear of the tachometer wheel. Once this is done, carefully screw the M3 screw in until the microswitch just operates. Lock it at this point using the lock nut. Now screw the star wheel in three turns and make sure that the microswitch operates again. If it

doesn't, unscrew the M3 adjusting screw slightly and try again. If you cannot hear the switch operate, then you can always use a multimeter on the resistance range to check when the switch operates. Once it is set, tighten up the locknut. Remove the star knob and re-fit the cover over the motor, replacing the star knob into the screw plate through the 7mm hole.

Connecting to the existing microswitch

This is where you have to pay attention and make sure that you wire it correctly! The piggyback connector on the new cable must be fitted to the spare blade on the V3 microswitch, which is marked 'NO', **photo 18**. Now pull the existing blue lead off the 'COM' terminal on V3 microswitch and put it onto the spare blade of the piggyback connector, **photo 19**. Finally, connect the straight connector on the new lead to the V3 'COM' terminal. Make sure that your connections look exactly as they do in **photo 20**. The new wiring that you will install have the red insulated connectors – the clear insulation on the other ones is the original wiring. When you are sure, refit the V3 microswitch into the guard interlock assembly and check that the switch 'clicks' when the guard is moved. If all is well, fasten the guard assembly back on to the side of the machine.

Now is the time to test it. The best way is to loosen the star knob and put the guard in its correct position. The machine should now start. If it doesn't, you have done something wrong and will need to check it out. If in doubt – don't do it! - get someone competent to do it for you. If you are not sure, there is bound to be some electrical guru in your club who will be able to help. If not, you can approach an electrician, but do make sure that he is from a reputable firm. In the U.K. the firm should be accredited by the National Inspection Council for Electrical Installation Contracting. The original and modified connections are shown in **fig. 10**.

Once the machine is able to start, move the guard and check that the machine stops. If all is well, reposition the guard and start the machine again. Now carefully screw in the star knob and the machine should stop before the friction pad contacts the tachometer ring at the top of the spindle. I made sure that all was clear by removing the motor cover and checking that the friction pad was clear and the microswitch was released before I started the machine up. Replace the cover before starting. If all is well, you now have a method of stopping the spindle from rotating when you have a dial indicator in the chuck.

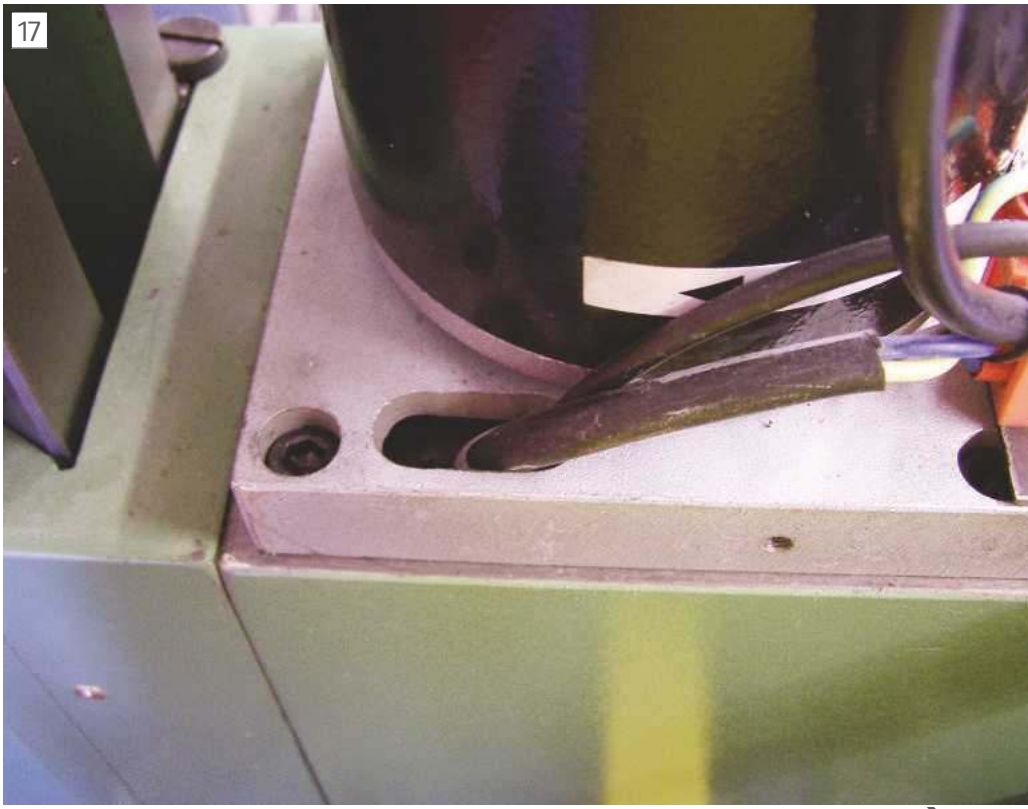
Final thoughts

This modification probably will require the purchase of the microswitch and maybe the screws, so I have added a list of all the separate parts that you will need (Table 1). Hopefully most these can be found in

16

The guard interlock microswitch and existing cable.

17



The hole for the cable, adjacent to the rear left hand side of the motor.

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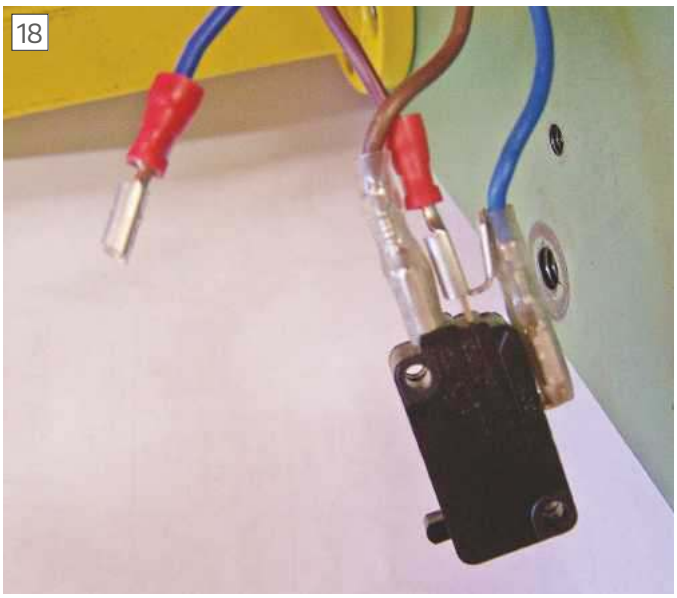
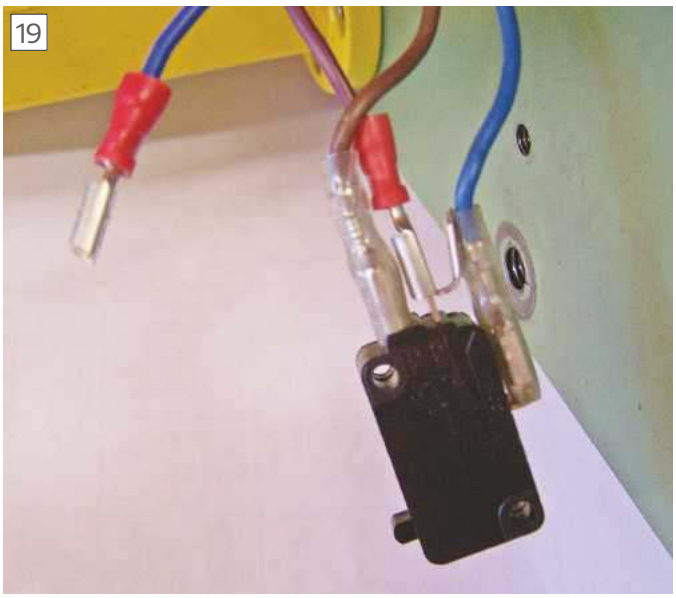
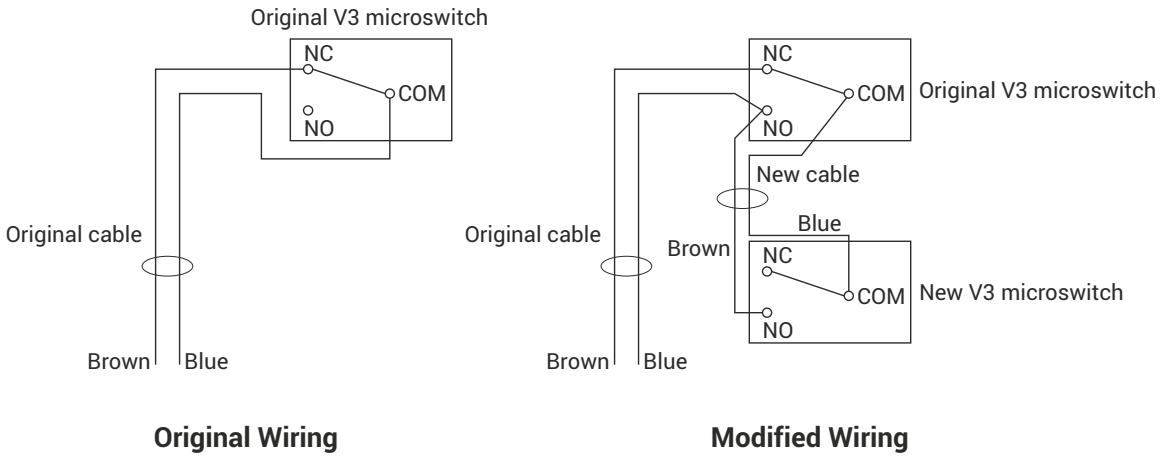


The piggyback connector is pushed onto the spare V3 switch terminal.



Move the existing blue wire to the spare piggyback blade.

Fig.10



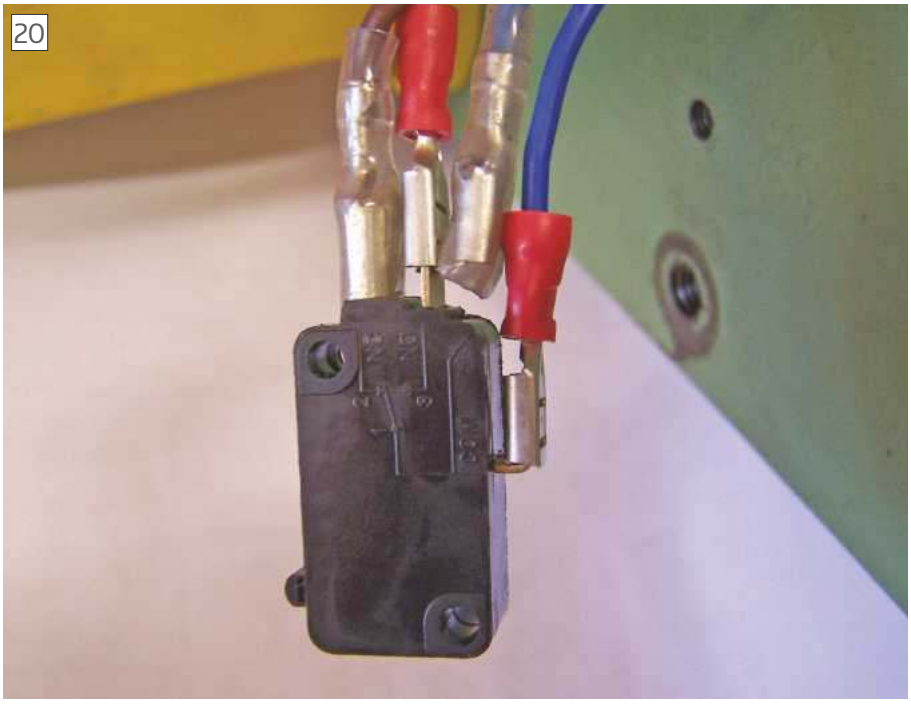
your 'Engineering Stores' and probably only the microswitch will be needed to be purchased. Make sure that you buy one with a plain lever as in photo 11.

This modification is fairly simple (it must be – I did it!) and limits the irreversible modifications to the machine to drilling a 7mm diameter hole in the side of the plastic cover over the motor.

If you wish to return the machine to its original condition (except for the hole in the motor cover), the original wiring must be returned to its original connections – this should be as photo 16 – but do make a note of how it is wired originally if it was not the same as photo 16. You can easily buy a blanking grommet to fill the hole in the motor cover.

It is not designed as a lock for the spindle, so don't expect to be able to loosen a collet chuck relying on the spindle hold.

Hopefully the instructions are straightforward to follow – so work safely! ■



Attach the new cable straight connector to the 'COM' terminal.

Readers' Tips

CHESTER MACHINE TOOLS

Get Your Parallels Organised!

TIP OF THE MONTH WINNER!

This month our lucky winner of £30 in Chester gift vouchers is Philip Hurst with a nice suggestion for the storage and indexing of parallels.

Here is an idea I had; I expect others do the same.

I hang the parallels on the inside of a cupboard door and label them with the distance between the top of the parallel and the top of the vice jaw. So, if I am machining a plate down to, say, 8mm I know to pick the 5.5 set.

I have no connection but a really good you tube channel is Joe Pieczynski. He does really good videos on machining and set ups on manual machines. Check out his workshop clock.

MEW is a good magazine. I have learnt lots from it over the years and been inspired to build many things.

Phil Hurst

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

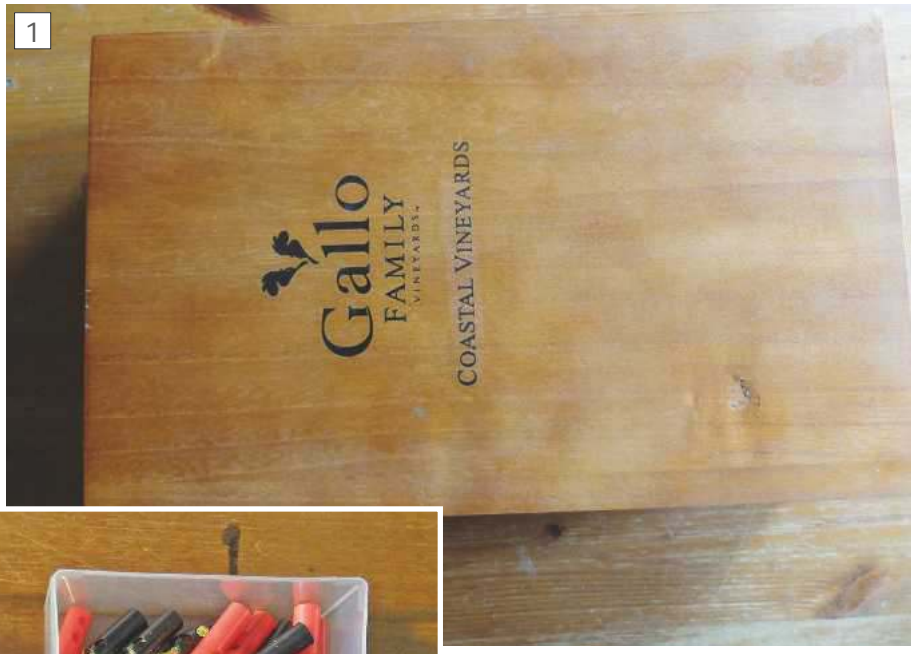
Please note that the first prize of Chester Vouchers is only available to UK readers. You can make multiple entries, but we reserve the right not to award repeat prizes to the same person in order to encourage new entrants. All prizes are at the discretion of the Editor.

Theasby's Wrinkles

Component Storage

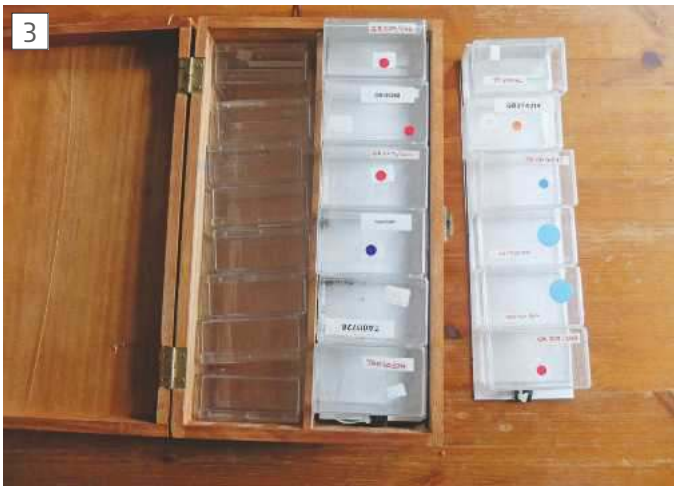
Geoff Theasby tidies up.

At a club open day, I bought a job lot of small plastic boxes, 80 x 50 x 35 mm, since I always need space for the myriad components that is a hobbyists lot. Thinking about how best to utilise them, I thought I might have a suitable wooden box or container, **photo 1**, and so it proved! The plastic boxes fitted neatly inside. Lacking these, Boyes stores sell a similar item, 100 x 65 x 40 mm, which can also be fitted in, **photo 2**. No doubt others too. The box concerned once held two bottles of rather nice wine, so it could be worth checking with your wine merchant for such items. (Wine merchant? Get him!) Noticing that there appeared to be room for a second layer even with the box closed, I found this was so. Debs asked how to deal with getting to the layer below, and in a serendipitous moment I said, "Removable trays, like a box of chocolates" A piece of heavy card, or Plastikard, with a Ty-Wrap loop at one end, has a bit of plastic angle glued on at the other, to stop them cascading all over the floor when lifted out, **photo 3**. These trays may be placed inside the open lid when accessing the lower boxes, **photo 4**. Suitably labelled, they keep my supplies in some semblance of order. ■



A little whine, sir?

Alternative container.



Lift out system.

Patent lid storage system.

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- Power – 250 W

Ceriani Lathe David 203

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- Speed – 100-1800 rpm • Power – 0.75 HP

Wabeco Mill F1210

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- Z axis – 280mm
- Speed – 140-3000 rpm
- Power – 1.4 KW

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The Modular Dividing Head

Ted Hansen makes a flexible system for dividing using standard change gears, including an explanation of its use with various popular lathes.

The basic indexing head with a threaded spindle for holding the work.

This version uses a four jaw chuck instead of threaded spindles, photo credit C.Peters)

"What!" You say, "Yet another indexing head project? Aren't there a lot of these already?"

Yes there are.

But this one really is different.

It is the simplest, easiest to construct and most versatile small indexing device available.

It is a unique design featuring interchangeable spindles, a versatile single bolt mounting, a spring index for direct indexing and an (optional) worm indexing attachment for more complex indexing operations. The spindles are removable and can also be used in the lathe so that work can be left on the same spindle for both turning and milling operations. It can be used for making cams, graduating dials and radiusing as well as dividing circular work.

It can be mounted on the lathe, milling machine or on the workbench and set to any desired angle. The head is basically a square block so it can easily be aligned to any available reference surface using a square or an alignment template.

With the worm drive attachment, it is capable of producing almost any desired division.

It is quick and easy to set up and use.

It costs very little. The basic "direct indexing" unit can be built in a couple of evenings from stock material.

It was inspired by a 1966 article in Model Engineer magazine by Martin Cleeve, one of the most ingenious designers to grace the pages of that magazine over its long history. The subject of the article was a new method of making gear cutters but, almost as an aside, it included a unique indexer with interchangeable spindles and indexing gears. Adapting this basic design to use stock materials and introducing the modular concept for the accessories produced the indexer shown here.

It consists of four components:

1. a rectangular body which has been bored to accept a work holding spindle.
2. a series of interchangeable work holding spindles.
3. an indexing device attached to one end of the spindle. This can be a protractor, a simple graduated disk, a gear and spring detent or a worm wheel with dividing plates.
4. mounting adapters to hold the assembly on a machine tool or on the workbench.

The outstanding feature of the design and the key to its versatility is that any of these four main components can be exchanged, developed or modified without

A Modular Dividing Head adapted to use 5C collets instead of interchangeable spindles, photo credit L.Hoy)

affecting the other components. For this reason, I have chosen to christen the design the 'Modular Dividing Head' or 'MDH', **photos 1** and **2**.

Its one limitation is that it is an indexing head only, not a rotary work head. It is not designed to be rotated as the cut is being made because it lacks any real bearings for the spindle. As a result, the spindle must be locked by the clamp screws while the cut is being made. This has not proven to be a significant limitation. The MDH is quite capable of performing jobs that would seem to require a rotary table (such as radiusing the end of a bracket) by milling a series of facets then smoothing with a file. The versatility made possible by the simple construction, modular design and interchangeable spindle feature more than compensates for this limitation. These features also enable the constructor to adapt the design to better suit their own needs, **photos 3**, **4** and **5**.

This article is divided into two parts. The first describes the basic indexing head set up for direct indexing using a gear or index plate. The second describes a worm module attachment which expands the range to enable indexing almost any reasonable number of divisions.

Part I: The Basic Head and Direct Indexing

The body of the indexer is a rectangular block which has been bored to accept a series of interchangeable spindles. It is split on one side of the bore and provided with clamp screws to lock the spindle. One end of the spindle is adapted as needed to hold various types of work pieces while the other holds a suitable indexing gear. A spring detent bears against the teeth of the gear to accurately index the work piece. The spring detent is easier to construct and use than the screw locking device often seen on other designs. It has no moving parts, no possibility of free play in the mechanism and it automatically takes up rotational backlash.

Two versions are shown. The larger version with 20mm diameter spindle bore is appropriately sized for lathes such as the Myford or the Boxford. The smaller unit with the 15mm diameter spindle is tailored especially for use on the imported 7" "Mini Lathe". The design could, of course, be scaled up or down to fit whatever equipment you have.

Standard bar stock is quite good enough for the spindles even though it may be very slightly undersized or out of round. These tolerances are on the order of only a thousandth of an inch or so and will not materially affect the accuracy of the indexing operation. Clearance due to under size shafting is taken up by tightening the spindle clamp screws before commencing the cut. Out of round tolerance will have the effect of very slightly offsetting the actual centre of rotation from

The parts for the 5C collet Dividing Head. Note the three shop-made interchangeable gears, photo credit L.Hoy)

All of the other features of the MDH design are retained in the 5C adaption, including the use of the worm module, photo credit L.Hoy)

The Basic Head and Direct Indexing

This figure is intended as a key to the figures for the basic dividing head which follow.

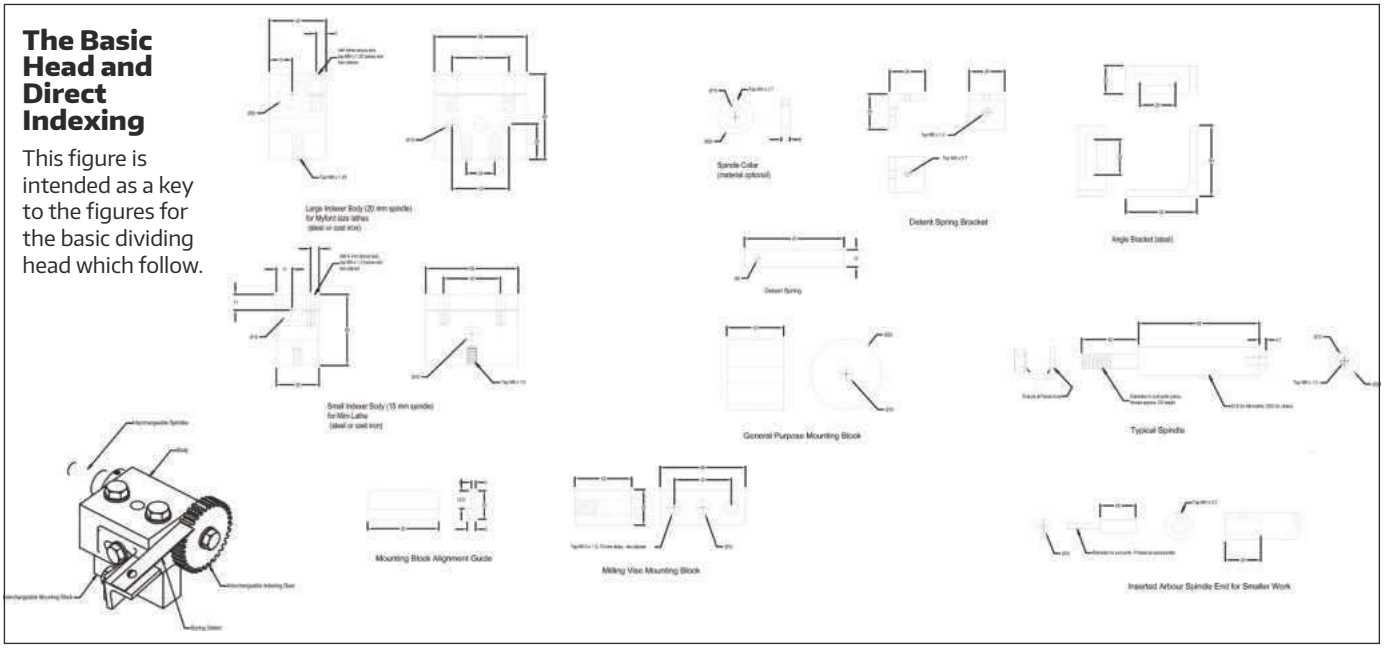


Fig.1

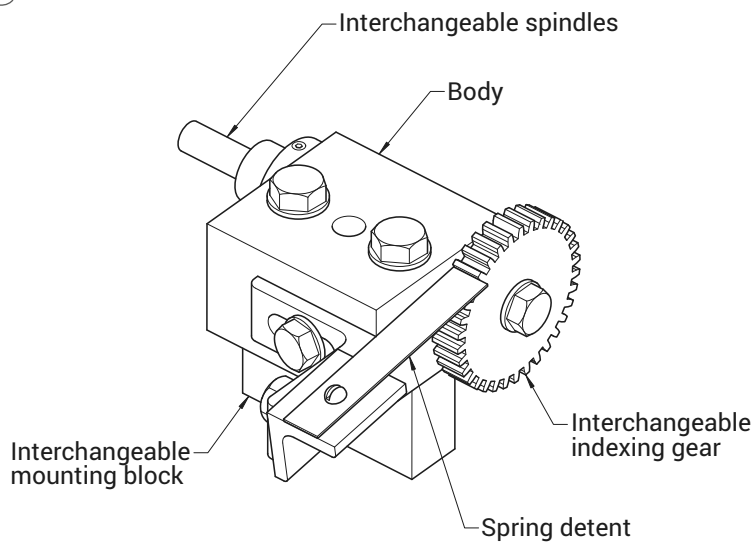
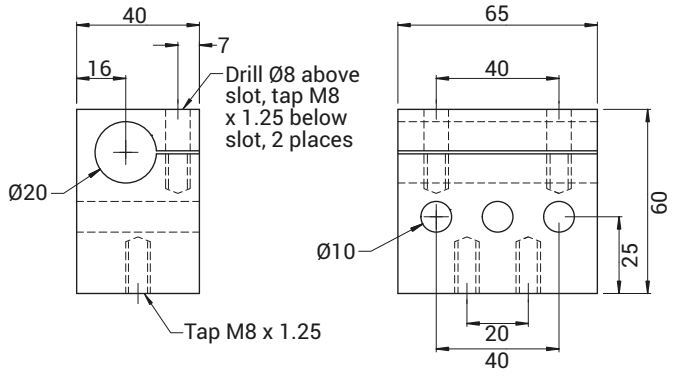
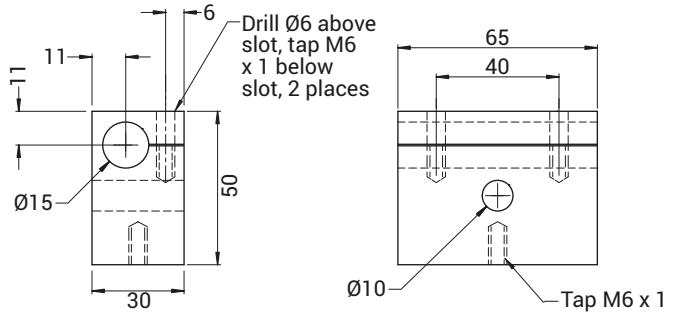


Fig.2



Large Indexer Body (20mm spindle)
For Myford Size Lathes
(steel or cast iron)



Small Indexer Body (15mm spindle)
For Mini Lathe
(steel or cast iron)

the nominal centre of the shaft. The actual offset will be only a fraction of the out of roundness in the shaft. Provided that the work holding end is concentric with the rest of the spindle, this will not affect the accuracy of the indexing operation.

Most indexing jobs can be held by a central hole, so the spindles are fitted with a threaded stub end in standard sizes for holding the work. Work that does not have a suitable hole can be mounted on a faceplate, a small chuck, on an angle plate attached to a faceplate, or perhaps to a sacrificial mounting piece.

The design provides for direct indexing using a spring detent and indexing single gear. A slotted arm for a compound gear train could also be added as another "module" which would extend the range of divisions available. For instance, to index 360 divisions with a 90 tooth gear, the 90 tooth gear would be set up as the lead gear in a compound gear train giving a 4:1 ratio with the spindle. One turn of the 90 tooth gear will give one quarter turn of the spindle, therefore one tooth of the 90 tooth gear will give one quarter of ninety thus achieving 360 divisions. Readers are encouraged to look up R. Finch's article "Mandrel Indexing With Non-Standard Change-wheels" in Model Engineer Workshop issue number 264, February 2018. for a thorough discussion of indexing using a compound gear train.

My preference, however, is to build the worm indexing module described in part II of this article to expand the range of indexes available.

Choice of index gear:

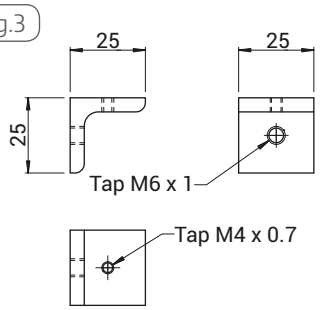
While there are valid considerations regarding the selection of the "best" gear for indexing, the real consideration with the MDH is obtaining a set of interchangeable indexing gears of useful size. Because one indexing gear is easily exchanged for another the choice of an individual gear is less important than having a good selection available for easy interchange i.e. a collection of gears with same hub bore size. Make your spindles to fit your lathe change gears if you have them otherwise choose a suitable hub size from your collection of gears for your standard. If you find that you have an 'odd' gear that you wish to use for indexing it can be bushed to match your standard bore.

In practice you are unlikely to need more than two or three gears to cover most of your indexing requirements. Choose a set of gears whose teeth count contains the maximum number of factors. These will be able to obtain the maximum number of divisions from a single gear. For example '36' contains the factors 2,2,3 and 3. Multiplying various combinations of these

Example of Factoring

To find the factors of a number divide by the smallest prime number until it will no longer divide evenly then move up to the next prime number and continue until you are left with only a prime number. Thus, to find the factors of 180, first divide by 2 (the smallest prime number) (yes, 1 is also a prime but it is rather silly to divide by 1). The result (90) is still divisible by 2,so divide again. This result (45) is not divisible by 2 so move up to the next prime number (3). 45/3 gives 15, which is still divisible by 3 so divide again. This time we are left with 5 which is a prime number so we can go no further and we have found the factors of 180 to be 2,2,3,3 and 5.

Fig.3



Detent Spring Bracket

factors together (2x2; 2x3; 2x3x3 etc.) gives the divisions which can be obtained using a gear with this number of teeth. For a 36 tooth gear the available divisions are: 2,3,4,6,9,12,18 and 36. Note that 5 and 8 (both potentially useful divisions) are missing, so next gear in the set should contains these missing factors. A 40 tooth gear will give these missing factors (5x8=40) and allow dividing 2,4,5,8,10,20 and 40 divisions. Add a 28 or 42 tooth gear so that the factor of 7 is included and 2,3,4,5,6,7,8,9,10,12,18,20,36 and 40 as well as either 14 or 21 can be obtained with only three gears. This range will probably cover over 90% of the divisions the average model engineer is likely to encounter.

For mini lathe and Myford users, using just the available 40 and 60 tooth gears included in the change gear set will provide most of the divisions likely to be encountered, **table 1**.

Division	Gear to use
2	either
3	60
4	either
5	either
6	60
8	40
10	either
12	60
15	60
20	40

A protractor or degree wheel could also be used instead of a gear if appropriate to the job.

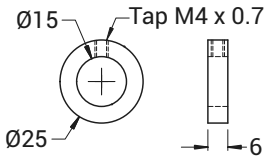
Construction
Main Block

Start construction with a steel or cast iron block for the body. True up all six faces of the block using the lathe with the block held in the four jaw chuck or on the faceplate, photo 6. Although squaring this block could be done on a milling machine, using the lathe allows the spindle hole to be bored at the same setting as the end truing cut which assures that the hole will be square with this face. The block does not need to be held to close dimensional limits but it is important that all six faces be flat and square to each other as accurately as possible. After machining, deburr all edges with a file.

Bore the hole for the spindle at the same setting as the final facing cut. Aim for a smooth finish slightly (.02mm or so) over the nominal dimension. Slight oversize is preferable to dead on size as the hole will probably close up a bit when the slot is cut and boring is preferred to reaming as it is less likely to produce an out of round hole.

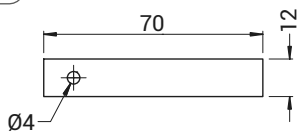
Mark out, drill and tap the other holes in the block as per the drawings. For the clamp screw holes, first drill tap size to full depth, then open out the hole to 5/16" for a depth of 1/2". Tap the threads then cut the slot, preferably with a slitting saw. It can be cut with a hacksaw but a slitting saw makes a much neater job. Deburr the edges of the cut with a triangular file not forgetting the edges inside the bore.

Fig.4



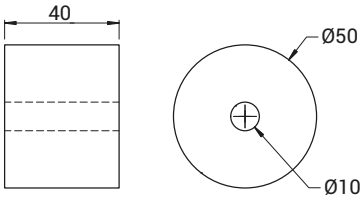
Spindle Collar
(material optional)

Fig.5



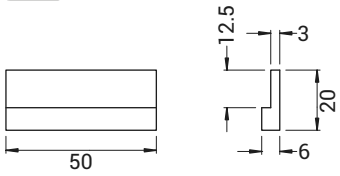
Detent Spring

Fig.6



General Purpose Mounting Block

Fig.7



Mounting Block Alignment Guide

Spindles

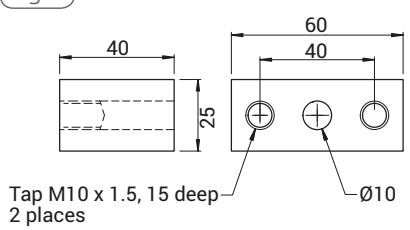
The interchangeable spindles are one of the features which makes the MDH so versatile. The spindles are made from 20mm diameter bar stock and you will want several. The most useful will probably be the ones with 6, 8, 10 and 12mm threaded stub ends. For smaller work, a spindle with a 12mm bored hole and a set screw can be used to hold small stub arbors. I recommend finishing at least these five at first construction plus three or four more blanks finished only on the indexing gear end.

Standard steel shafting is sufficiently accurate for the spindles, but it is important that the work holding ends be concentric with the rest of the spindle. If you have any doubts about the accuracy of your three jaw chuck use the four jaw and set the bar to run true with a dial indicator before cutting the work holding end. Perhaps even better would be using a collet to hold the shaft. The clamping action of the collet closely simulates the clamping action of the slotted hole in the indexing head body in adjusting to any slight out of roundness which may be present in the bar stock.

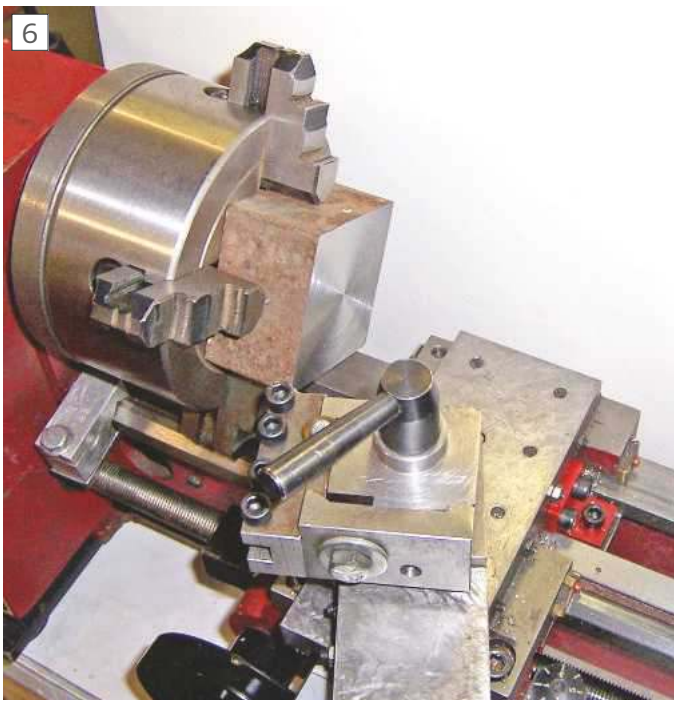
Alternatively, grip just the end of the stock piece in the chuck and support the outer end with a steady rest. The spindle will then be rotated by its own outside diameter, ensuring that the machined work holding surface will be concentric with the outside diameter of the spindle.

The threads should be lathe cut. 'Skewed' threads from a die not started square to the work may cause inaccuracy due to uneven clamping forces on the workpiece. If you have not yet cut threads on your lathe now is the time to learn as lathe cutting is the only way to insure accurate and parallel threads. This is not the place for a lesson on cutting threads, but it is not all that difficult especially with a quick change gearbox. The finicky part is achieving the correct finished size. A quick but perfectly satisfactory method to achieve this is to lathe cut the threads

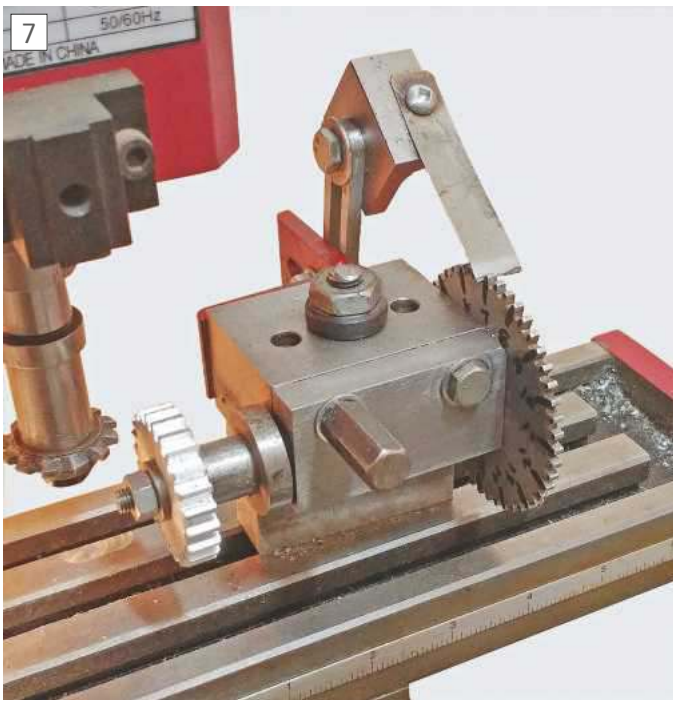
Fig.8



Milling Vice Mounting Block

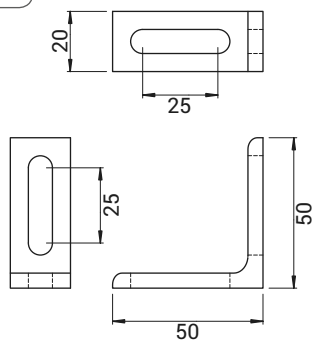


Facing the body of the indexer on a mini-lathe.



The basic head set up to cut a gear on a vertical mill.

Fig.9



Angle Bracket
(steel)

to about 75% of finished depth then finish the thread to size with a die.

Make at least three or four workpiece retaining washers for each arbor size. These are simply heavy washers parted off from bar stock. The faces must be flat and true; commercial washers will not do.

The workpiece retaining nuts are just commercial nuts with at least one end trued up. This is done by locking two nuts together on a threaded mandrel with the edge of the outer nut overhanging the end of the mandrel to allow a facing cut. The mandrel must be a true running shaft with accurate lathe cut threads not just an old bolt with the head cut off.

The other end of the spindle is just turned down for a short distance so that the change gears are an easy but not sloppy fit.

The Spindle Collars

Material choice for these is optional. Make several at first construction; one will be needed for each of the interchangeable spindles. Bore (or drill and ream) the inside diameter and part off, then drill & tap for the set screws. If you are not able to part off in the lathe, saw slightly oversize then mount in the lathe on a 20mm stub mandrel for facing the ends. Generously relieve the bore in the area beside the setscrews with a file to prevent seizing due to burrs on the shaft from the setscrews.

The Angle bracket and Detent Spring Bracket

Start from a piece of 50mm angle sawn to length. It is not absolutely necessary to true up the faces however you will get a better looking finished product and a more secure seating if you do. The easiest way to true the side edges is to just grip the piece in the three jaw chuck and face the overhanging edge. {include only if have a photo}

Drill and tap the holes in the required locations for the detent spring bracket. For the slots first remove the bulk of the waste by drilling then finish by milling. Drill bits remove metal faster and are much easier to sharpen than milling cutters.

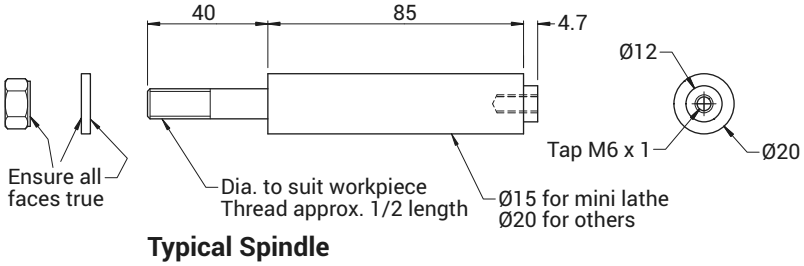
The Detent Spring

A suitable source for material is a piece of bandsaw blade. Grind off the teeth and cut to length by grinding a score mark at the cut line then breaking it off. Grind the edges square.

Use a short piece of steel rod in the drill

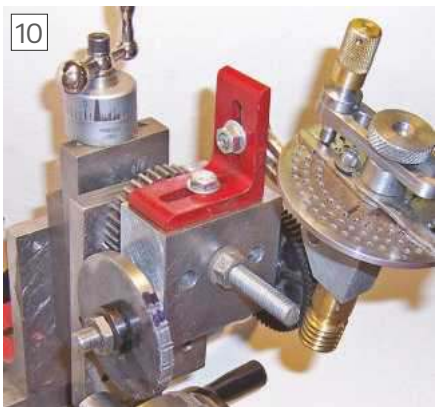
Cutting a spur gear with the MDH mounted on a vertical slide in the lathe.

Fig.10



Typical Spindle

Cutting a flute on a single tooth formed cutter.



Notching an indexing disk.

Profiling a radiused end by cutting a series of small facets.

press to friction heat the area around where the mounting hole will be drilled. This will soften the material enough to be able to drill through it.

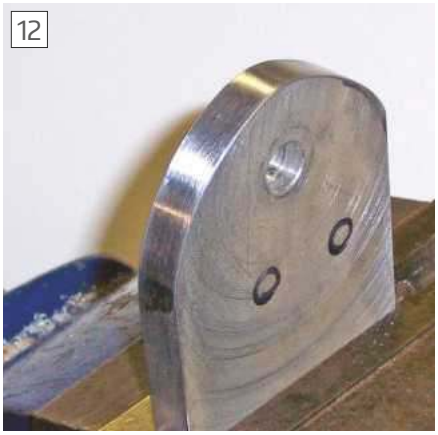
Mounting adapters

Mounting adapters usually consisting of nothing more than appropriately sized spacer blocks allow mounting on any flat surface such as the machine table, on an angle plate or in the milling machine vice.

If you are like me and leave the milling machine vice in place nearly all the time, you will find it convenient to be able to quickly mount the MDH in the vice. Two adapters are shown, one for clamping in a vice and one for 'general purpose' mounting on a flat surface.

It is important that the top, bottom and the two face sides of the milling machine vice adapter be flat and square to each other as any of these surfaces may be used as a register face for mounting the indexer. The base is attached to the main body using two bolts and can be aligned to the edge of the body using the alignment guide shown.

The 'general purpose' base is used to mount the indexing device to an angle plate, lathe cross slide or to any other flat surface. It is simply a parallel spacer made from 50mm diameter bar. A single bolt mounting is used so that the indexing head can be set at an angle where necessary.



The finished piece after a few strokes with a file to smooth out the stepped surface. This profile required three different radii from three different centres. The black circles show the approximate locations of the centres.

Direct Indexing with the MDH:

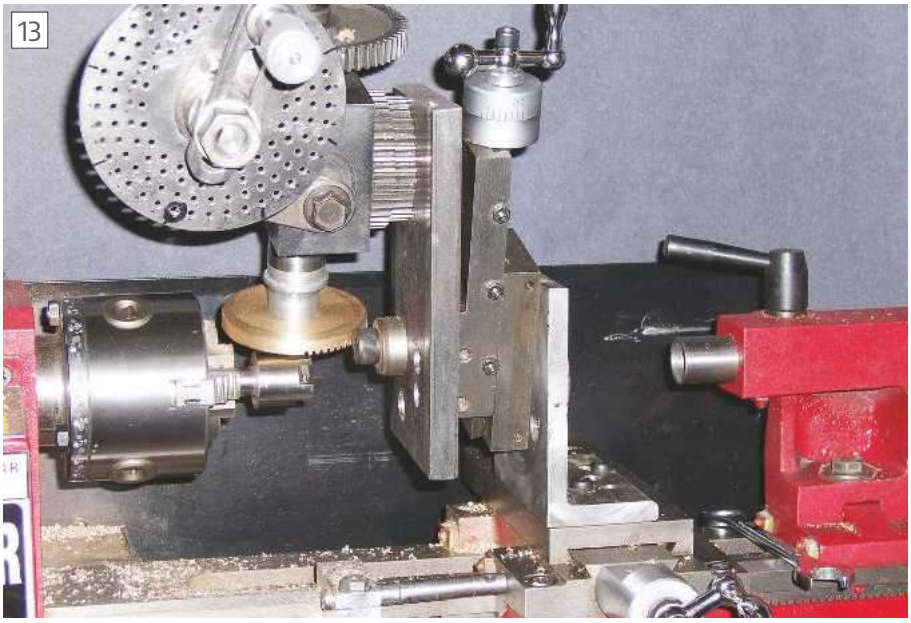
There is little to be said regarding use of the MDH except to be sure everything is tightened securely before commencing each cut. I am sure we have all had the experience of having the workpiece shift under a milling cutter. It is not a pretty sight.

The detent spring will take up any backlash in the rotational direction but axially end play must be taken up manually before tightening the spindle clamp. I tried a coil spring behind the indexing gear to take up end play but found it was easier just to take up the play by hand. For many work pieces (cutting a spur gear for instance) axial location does not matter as the cut passes the full length of the workpiece.

Photographs 7 to **15** show a number of varied setups. Some of these show the worm indexing attachment. The setup would be the same if the number of teeth on the gear permitted direct indexing.

The MDH for the Mini Lathe:

For mini lathe users, a smaller version of the MDH is appropriate because little lathe will only accept 15 or 16mm through the hole in the chuck. The body is smaller,



Cutting a bevel gear. Each tooth required three passes as described in Ivan Law's book "Gears and Gear Cutting".

The setup to cut a pinion gear using the MDH mounted on a vertical slide in the lathe.

the spindles are 15mm diameter and the indexing end is 12mm to fit the mini lathe change gears. The work ends are threaded as above.

Construction procedure for most of the parts will be the same except for boring the hole in the main block. Because of the size of the piece it will be easiest to bore the hole by mounting it on the cross slide and using a rotating boring bar. This method has the advantage that it guarantees the hole will not be tapered. The setup is more rigid because the bar is supported on both ends instead of being overhung. There are various ways of setting the cutter but the easiest is to mount the driving end of the bar in the four jaw chuck and adjust the jaws to set the diameter of the hole.

Mark out the location of the bore on both ends of the block and rough drill the hole to about 12mm diameter by drilling in from each end. Clamp the block to an angle plate on the cross slide to bore the hole. To align the block, remove the jaws from the chuck and hold the block against the face of the chuck body with the tailstock while tightening the clamps and bolts holding it and the angle plate in place, **photos 16** and **17**.

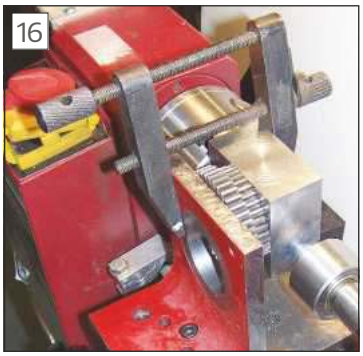
Lock the cross slide in place by tightening the gib screws. Insert the boring bar in the four jaw chuck gripping by just the very end of the bar (4mm or so). The jaws should be adjusted so that the bar is approximately centred, and the tool bit should be aligned with one of the jaws to make adjusting easier. Adjust the jaws so that the bar takes a small cut with each pass. Open out the hole using power feed to achieve a good finish. Aim for a finished diameter of 15.00 to 15.02mm – a bit oversize is acceptable, but it should not be under size. The tailstock can be pulled away to measure the diameter without affecting the boring bar setting.

Finish the block by drilling and tapping the holes and cutting the slot.

15

The completed gear and pinion set.

16



Clamping the block to the angle plate. The tailstock holds the block against the face of the chuck while the angle plate and clamps are aligned and tightened. The two gears are just spacers.

17

Boring the spindle hole using the between centres boring bar.

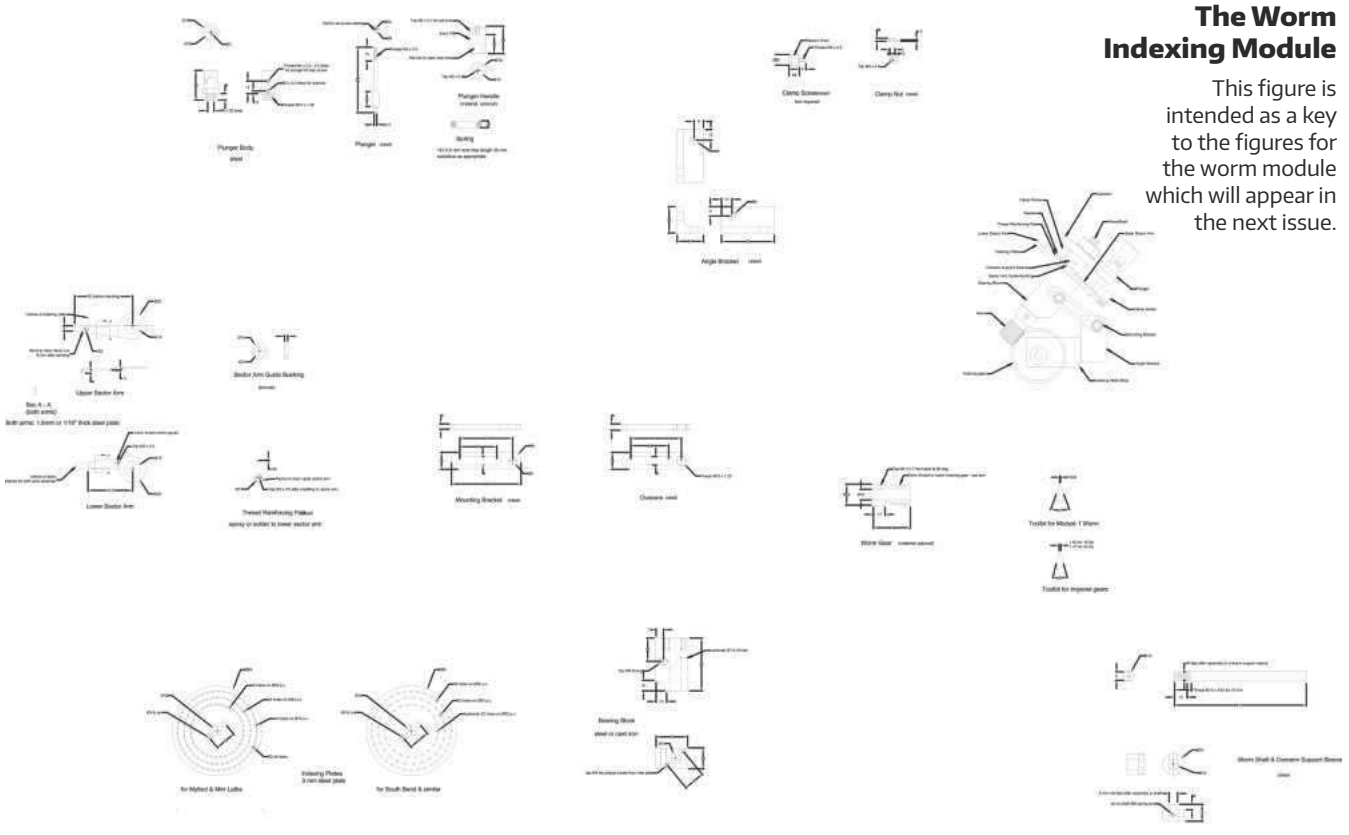
Part II – The Worm Indexing Module

The modular design of the MDH makes the worm unit just another accessory attached by a single bolt. It replaces the spring detent and will enable the user to index almost any desired division.

●To be continued

The Worm Indexing Module

This figure is intended as a key to the figures for the worm module which will appear in the next issue.



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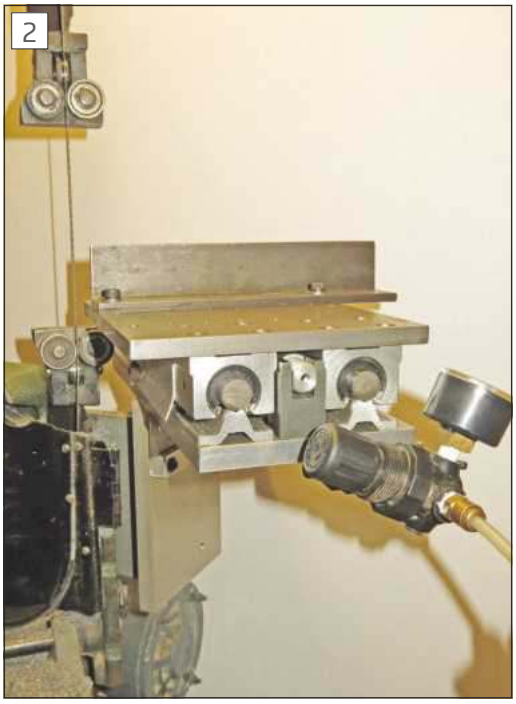
A guided power feed for a Warco bandsaw

Richard T. Smith makes a pneumatic accessory for a vertical bandsaw.

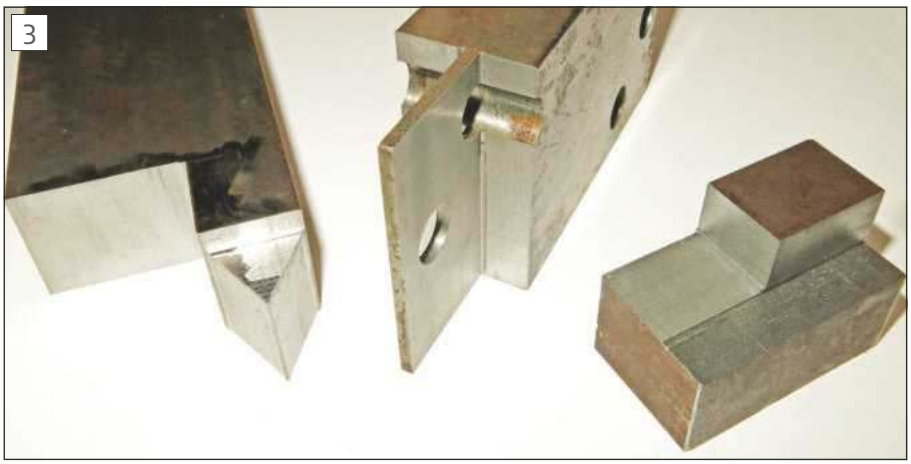


I have made the attachment shown in **photos 1** and **2** in order to be able to saw blanks such as **photo 3** which shows the ends of some scrap BMS sawn into different shapes. The left-hand one might be the starting point for an indexable insert carrier. The middle one is a thin tenon. Both of these from 25 x 50mm BMS scrap. The righthand one was cut from a small piece of scrap. All would be close to a final finished size saving machining, and all would have been difficult for me to cut without the attachment.

I have had my Warco 'Horizontal and Vertical Metal Cutting Bandsaw' for many years and in horizontal mode it works brilliantly cutting off right through leaving a clean and square edge. In vertical mode you fit a small pressed metal table and hand guide your work. I have used this to cut sheet material and I found it difficult to guide, hard on the fingers, and not helped by swarf getting under the work. I haven't had the patience and finger strength to cut thick material.

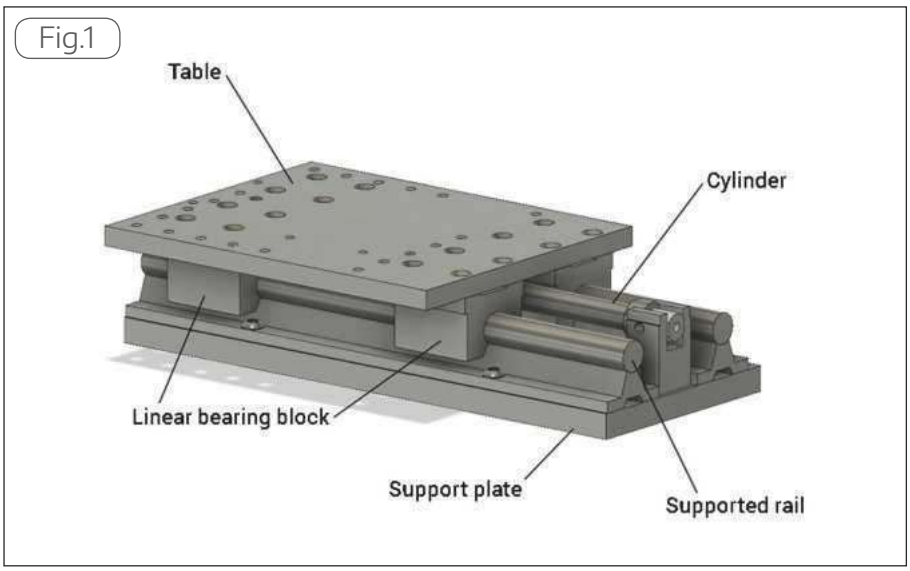
For my tooling system I need to make angled cuts and also cut out rectangular notches in 20 x 40 and 50 x 50mm BMS. I found myself using horizontal mode and clamping work at funny angles and still ending up using a hacksaw to finish the cuts. The object of sawing is to reduce the amount of metal to be milled away to the finished dimensions. Sawing should be a quicker and cheaper way of removing bulk waste material.

In horizontal mode the work is fixed, and the blade is guided accurately by the



pivoting action of the saw. The blade is under steady pressure and cuts straight. If you only cut part way through the cut finishes at an angle so two intersecting cuts don't join completely. In vertical mode the blade is square to the table so that cuts made part through and at an angle to each other will meet along the whole cut, no hacksawing. The work moves against the blade, so what I need to do is to cut in vertical mode guiding the work movement accurately and with a steady pressure. To do this I envisaged the work clamped to a guided table pushed by a steady force. I found that I could buy linear bearing blocks running on supported shafts very cheaply online. I had a small air cylinder in stock, and these items formed the basis of my attachment for the saw. The saw still needs to be usable in horizontal mode as a cutoff saw and has to be easily restored to that use.

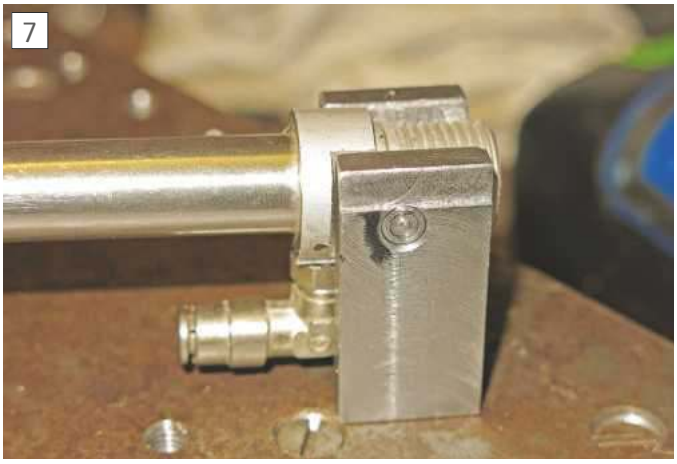
Manufacture fell into three parts, the sliding table subassembly, the first mounting bracket, and the final mounting bracket.

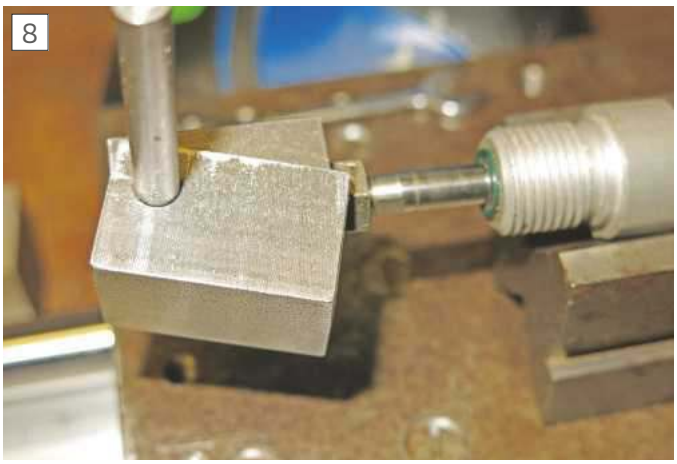


Sliding Table

I have started using Fusion 360 and this is the first project I have tackled with it. As I have mentioned I found 4 bearing blocks plus 2 off 300mm long16mm diameter supported shafts online. I couldn't find any drawings so had to measure up and draw my own. The cylinder I had was 12mm bore and 80mm stroke. I also had some 160 x 10mm flat and a piece of 1/2 ins thick aluminium plate that had been salvaged from a test rig. The design I arrived at is shown in **fig. 1**. For the tooling system most of the cuts will be in 40 x 20mm flat and either crosswise or lengthways so I wanted a fence that would suit these cuts. I had some 40 x 40 x 5mm angle for the fence, so I planned for the fence to be held by two screws through slots into tapped holes in the table. I laid out these holes first. Pairs of holes were positioned spaced so that the fence could be mounted crosswise partway down the length of the table, enough to locate 50mm wide material. A second set of identically spaced holes allow the fence to be located lengthways on the table. After this the countersunk holes for the screws to attach the bearing blocks were then drawn keeping the bearing blocks spaced as wide apart lengthways as possible without fouling the tapped holes. The table also needs to overhang on the side by the blade to clear the saw bottom blade guide.

To simplify machining squared plates, and then drilling and tapping in alignment I made a simple arrangement. I first made four tee-nuts tapped M8 and then used them to attach two pieces of flat in the Y

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direction on the mill bed. They were set with a square and then I milled a small recess in the top on each of their inner edges. The left-hand flat is not moved and serves as a reference location, and the righthand flat serves to support the other side of the plate and is moved appropriately. To square a plate, locate one edge in the fixed flat and support the opposite edge with the moveable one, and then pressing it against the fixed flat clamp it down. Mill the edge exposed above the flats and this now becomes the reference edge on the plate. Locate this edge against the fixed flat and machine the edge now above the flats. Turn the plate over still locating the reference edge against the fixed flat and machine again. Three edges are now square to each other so now locate the plate between the two flats and machine the fourth. **Photograph 4** shows the bearing block mounting holes being countersunk supported on the flats. This simple arrangement made machining edges square and drilling and tapping holes in line really easy and saved a lot of time.

I first cut off a piece of the 160 x 10 and


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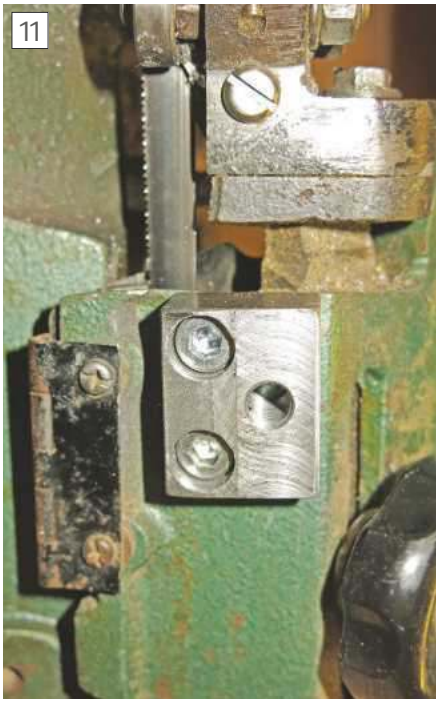
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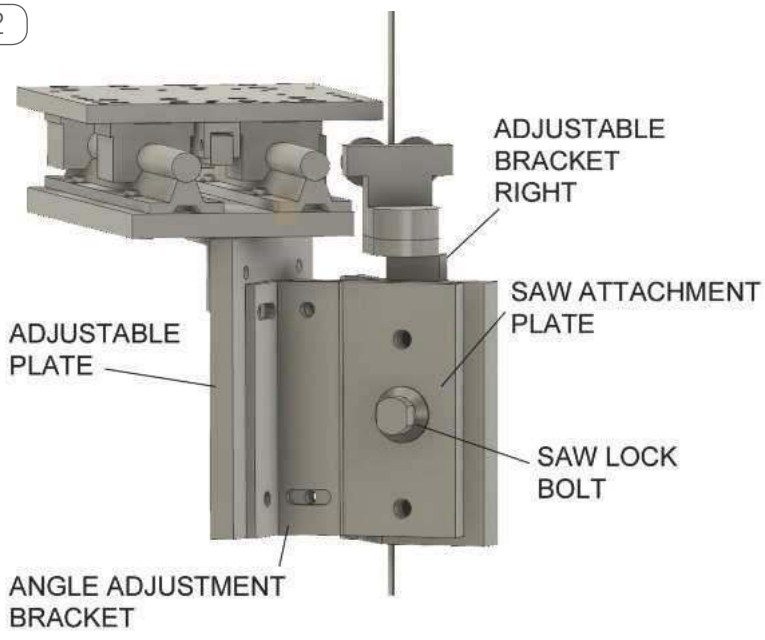
Fig.2

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milled the cut ends square and to 200 long. Then I drilled the bearing block mounting holes and did a trial assembly before drilling and tapping all the fence mounting holes. I am not really sure how it happened but I drilled a couple of holes in the wrong place and had to plug them. **Photograph 5** shows the underside of the table with the bearings mounted and the shafts run through. The support plate was cut from my scrap ½" aluminium, machined to size as described, and then holes tapped to attach the supported shafts. **Photograph 6** shows the assembly with the cylinder laid loosely between the bearings. I made a simple pivot block to mount the cylinder onto the support plate, **photo 7**, and then a clevis type mounting for the rod end to attach to the table, **photo 8**, The completed assembly is shown in **photo 9**. **Photograph 10** shows how the fence fits for cross cuts.


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First Mounting Bracket

I wanted to mount the table assembly on the saw so that I could try it out and see if the whole idea worked. To attach to the saw near the blade I made a block with two counterbored holes for M8 capheads and drilled and tapped two holes in the saw casting, **photo 11**. The block also had a machined face inline with the pivoting action with an M10 tapped hole in it. I made up a simple bracket out of some 80 x 10mm flat and the same angle that I used for the fence, **photo 12**, and clamped it under the saw base casting. I added a strap across to the block making a rigid assembly. With the aid of packing, I got the table square with the blade and drilled and tapped holes in the support plate to attach it to the top of the bracket, **photo 13**. I ran an airline to the cylinder through a valve and I was able to make the first cut under pressure, **photo 14**. It worked! A nice straight clean cut. I cut a notch out and it was really easy, and so I tried cutting at an angle clamping the scrap down onto the table. All fine.


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I found it best to start a cut using hand pressure then turn on the air. To finish a cut either turn off the air right at the end or turn off slightly before the end and use hand pressure. If cutting right through either use hand pressure to finish or position the fence so that the end of the cut occurs just as the cylinder reaches its end of stroke. Don't allow the cylinder to hurl the table down the slides!

Final Mounting Bracket

The bottom guide for the saw blade is called the 'adjustable bracket right' in the saw manual! This slides in a slot in the casting and is locked by a knob with a male thread. In practice I never adjust this. The saw casting has a flattish surface here and my first thought was to hold a plate on to it by screwing through into holes tapped in the casting. My second thought was to screw into the 'adjustable bracket right' which could be removed for modifying, and that the whole attachment could then be removed by unscrewing. However, the adjustable bracket right could move when the knob was unscrewed, and it would not necessarily go back in the same place potentially upsetting the blade to table alignment. I decided to replace the knob with a cylindrical bolt to both lock the adjustable bracket right permanently in place, and to provide a location over which a hole in the plate could fit tightly. To complete the location two screws would go through the plate into new tapped holes in the adjustable bracket right. Just to be sure, I also drilled two pilot holes in the plate through which I could drill into the casting for locating pins, I haven't had to do this, bit excessive really.

Fig.3

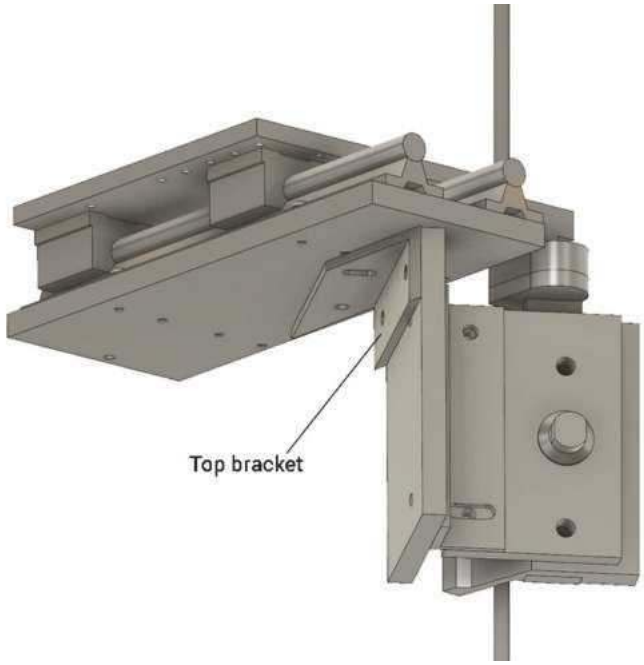

Figure 2 shows the arrangement I came up with. The saw attachment plate is mounted as described above. The adjustable plate is joined to the saw attachment plate with the angle adjustment bracket which allows limited adjustment in two directions at right angles to each other. The saw casting is rough hence the need for adjustment. The table subassembly is bracketed off the adjustable plate with a top bracket which also has some

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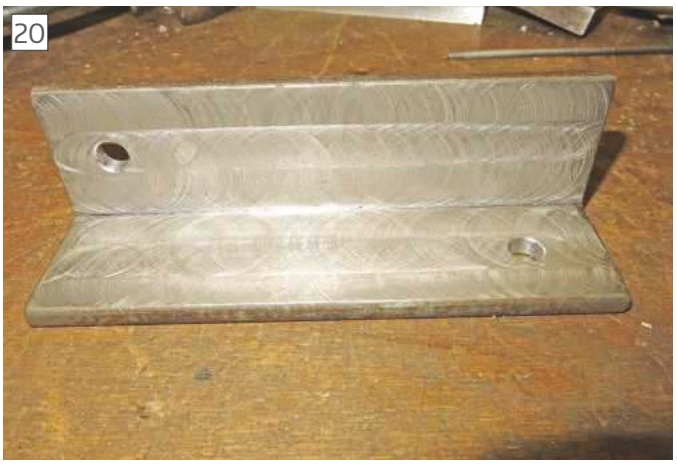
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adjustment capability, **fig. 3**.

The first part to make was the saw attachment plate which needed a blank cutting from the scrap aluminium. I marked out the blank oversize and fastened the aluminium to the table with toolmakers clamps, **photo 15**, and cut the full stroke of the cylinder. Stopped the saw and moved the table back, then moved the aluminium forward to the end of cut, clamped it and made a second cut. I couldn't get right through as the work would foul the saw, so I turned the aluminium over and cut in from the other side. The resulting cut was a little uneven being three joined cuts, but I had allowed extra for machining anyway. Similar procedure for the second cut. The plate was machined to size on the flat strips as already described, **photo 16**, and drilled and tapped, **photo 17**. Note the two pilot holes for pins on the right. A centre for the lockbolt hole was also drilled, **photo 18**. I mounted the plate in the 4 jaw chuck using the centre drilling to locate it, then drilled and bored the hole, **photo 19**.

Next up was the adjustable angle bracket. I used the saw to cut the angle and cleaned and squared it up on the mill before drilling the two pivot holes, **photo 20**. To be able to pivot this to cut the two curved slots I turned down some scrap and threaded it M8 male one end and M8 female the other, **photo 21**. This was fastened to a piece of scrap that had previously been machined parallel,


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which was then clamped to the mill table, **photo 22**. The spindle was centred on the pivot body before the angle was fitted and fastened with a couple of nuts and a washer so that it was firmly held but swingable. The DRO was used to set the arc radius. The outward end was G clamped to a small angle plate lying loose on the table to provide support, and a couple of stops were clamped to the table to define the arc swing. Taking small cuts and swinging between the stops using the G clamp as a handle it was easy to mill the slot. The second slot was done the same way.

Then I made the adjustable plate, cutting the blank on the saw and machining and drilling on the flat strips, **photo 23**. The top bracket to connect to the support plate was cut on the saw, **photo 24** and it was then cleaned up and drilled and slotted in the same way as before.

●To be continued


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Milling for Beginners

PART 15 - DEALING WITH CASTINGS

This month Jason Ballamy wraps up the series by looking at ways to hold and machine castings and odd shaped parts

RMC Type-B Casting set (Photo N. A. Rowland)

Turning the feel flat

It does not seem like two and a half years ago that I started to write this series and am now putting together what will be the last instalment, though the thread on the Forum will remain open for anyone with queries or questions. I hope the series has been useful to both those new to milling and others thinking about buying their first one.

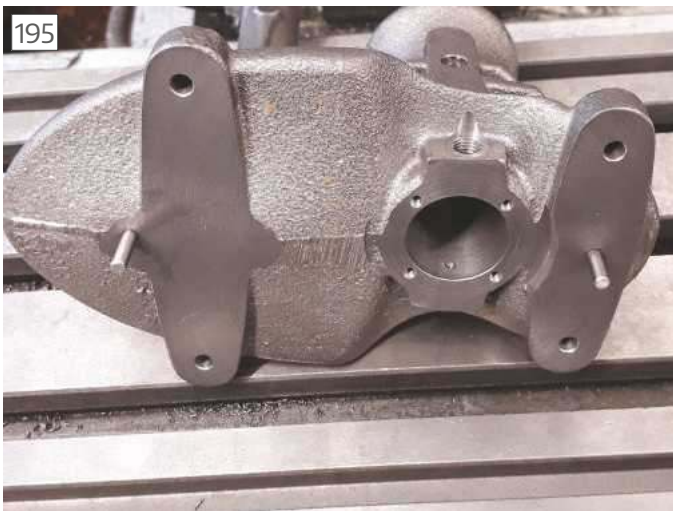
Up until now most of the items I have described how to machine have been easy to hold and had flat faces that can be used to reference from, this time some of the methods which can be employed when dealing with odd shaped items and in particular castings will be covered.

Those that follow the Forum may have seen some recent progress on an RMC Type B engine that I have been working on which like most of Nick Rowland's designs has a very flowing organic form in an Art Nouveau Style. **Photograph 192** shows the set of castings supplied and it will be the large main frame that will be use as an example. As you can see a very generous chucking piece is provided and this can be used to hold the casting in the lathe's 4-jaw chuck allowing the small spigot on the bottom to be lightly faced and then centre drilled. A revolving centre in the tailstock is then used to help support the work while the undersides of the feet are faced flat, **photo 193**. You can also see that I have used a pair of Vee blocks and a 15-30-60 block lashed to the side of the casting to counteract the unbalanced shape so that the work can be turned at a reasonable speed to bore the cylinder without the lathe jumping down the workshop!

Drilling mounting and dowel holes

I left the work in the 4-jaw and transferred that to the mill, located the cylinder bore and checking that the casting was lined up as true as possible to the X&Y axis. The four mounting holes were then drilled, **photo 194** which could then be used in subsequent setups to line the casting up in one axis but as they were in two pairs at different spacings they could not be used to line up the casting at right angles so I added two 3mm holes to take short pins which would then allow the casting to be lined up in the other axis, **photo 195**.

The instructions suggest that the next operation is to machine the elliptical surface for the name plate on the top of the casting which carries the crankshaft bearings and also the end of the crankshaft hole. To do this the two pins were placed into the extra holes and pushed back against the edge of one of the tee slots in the mill's table as the casting was clamped down which set it in



Locating dowels in place (completed casting)

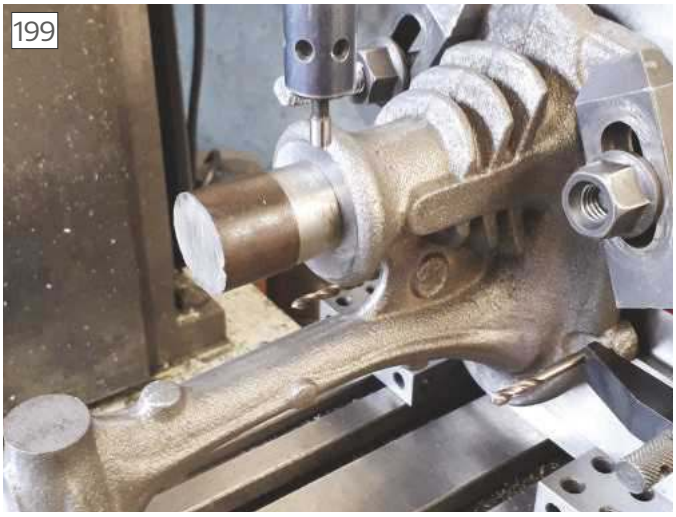
Setup for machining top of casting

Milling the top of the cylinder to height with indexable shell mill

Chamfering cylinder edge with boring head

line with the x-axis. As the surfaces to be machined are a long way from the table and on a quite slender upright I also arranged two angle plates to offer some support to resist the direction of the cutter and also held the casting to the angle plate with a toolmakers clamp to stop any chatter, **photo 196**. I used one of the new shell mills from ARC for these cuts as they can do both flat facing cuts as well as side cuts and the carbide inserts will handle any hard skin or chilled edges that can be found on some castings, luckily these castings were very good and a joy to machine.

With the casting still held in this position I also cleaned up the top of the cylinder where the chucking spigot had been sawn off, the large diameter of the shell mill also helped here allowing the spindle to easily clear the top of the casting, had say a 12mm cutter been used then it would have had to be a very long series one or used in an extension, **photo 197**. I did not have a large enough countersink bit to add a chamfer



Using edge finder to locate cylinder centre line

Reaming main bearing hole

›

Machining features on side of casting

Drilling angled hole for grub screw

Setting machining plate to lathe axis

Machining plate set across lathe axis to bore bearings

to the edge of the 22.2mm (7/8") bore but just managed to get a 50mm boring head in with a 45 degree cutter to do the job, **photo 198**.

The next operation was to drill and ream for the crankshaft bearings. To hold the casting for this an angle plate was first clocked true to the Y-axis across the table, then two drill bits placed into one pair of the mounting holes were supported on a combination of 15-30-60 blocks and a parallel resting on those and the casting clamped to the angle plate. The height of the hole could be established by locating the edge of the angle plate but in order to locate the cylinder centre line a close fitting plug had to be machined and it was then easy to touch off each side of this and then half the reading to give the centre, photo 199. With the hole being about 170mm from the angle plate there is a risk of the work flexing under drill pressure so some aluminium packers were added for support before spotting, drilling and then reaming the hole 12.7mm (½"), **photo 200**.

Part screwed to a square machining block

The holes in the side of the cylinder for Exhaust and spark plug electrode need to be machined at right angles to the previously machined crankshaft hole so this time the two extra holes I had drilled were fitted with short pins that again rested on a parallel stood against an angle plate. Due to needing access to the small electrode hole I swapped the Arc tee slotted angle plate to a smaller one that I had which did not protrude too far above the casting, **photo 201**.

The final operation was to drill and tap for a grub screw to retain the exhaust silencer which had to be drilled upwards at an angle to fit between two of the cooling fins. I opted to use a pair of angle plates, one bolted to the mill table and the second one to that which can be set to any angle needed. It was then just a case of passing a long stud through the cylinder to hold the flat bottom of the casting against the second angle plate and then drilling and tapping the hole, **photo 202**. This can be a handy method even on machines with tilting heads as it is often quicker and easier than tilting the head and then getting it back in tram.

Another option that can be used to locate a casting is to mount it onto a machining plate which is simply a heavy metal plate approximately 10-12mm thick that has been machined all round to ensure that the opposite sides are parallel and the sides are at right angles to each other. Just like the previous example the casting needs a face to be machined flat and mounting holes drilled to a close fit on the fixings being used. It is then just a case of accurately drilling and tapping a matching set of holes into the plate and securing the casting to that.

Ideally all machining operations should be carried out without removing the part from the plate which avoids any error should the part not go back onto the plate in the same position, this is one reason for making any mounting holes a close fit to

Well used machining plate and blocks

Casting in ER collet block

Part being cut from solid in %c Spin Indexer

Casting held in makeshift metal block

the fixings rather than what would be a usual clearance size. If there will be a need to separate the two then some additional dowels or even stop blocks can be added to accurately relocate the two. A bit of forward thinking helps by running through what machining will be needed in advance so that any tapped or clearance holes can be put into the plate to aid bolting it down to the mill table, lathe cross slide, angle plate, etc.

In use one edge of the plate is clocked true to the machines axis and the required machining carried out, in this instance the long edge of the plate has been set true to the lathes axis so that the casting can be bored and faced to accept the cylinder casting, **photo 203**. When complete the plate and casting can be repositioned for the next operation setting the same edge true to another axis, **photo 204** shows the plate now set at right angles to the lathe axis so that the bearing holes can be bored exactly 90 degrees to the cylinder bore.

From the above you can see that the lathe can be pressed into service for milling and boring when you run out of room on your actual mill, even if you do have room it can be useful to take advantage of the powered feed on a lathe if you don't have it on the mill for jobs like boring cylinders where a gentle steady feed will give the best finish to the bore. It is also worth accurately measuring the lathes centre height above the cross slide which will make it easy to work out what packing is needed under the machining plate or work piece to bring it up to the correct height.

Smaller items can be handled in a similar way but rather than fixing to a plate a square block of metal will be found to be more useful, **photo 205** shows such a block in use, it has been rotated four times in the vice to machine the rectangular end, then stood with the work pointing up so the slot could be milled with a long series end mill and finally back down on it's side to drill and ream the pivot hole, note the use of a simple jack to support the overhanging end while drilling. Just like the machining plate these blocks can be kept and used again and again so although it may seem a bit of an expense to drill and tap holes into a useful piece of pristine metal for the first time you will feel less guilty each time you reuse it. **Photograph 206** shows that I have got plenty of use out of mine. The large M10 and 10mm clearance holes have been used to mount the plate as that suits my Tee slot size and the jumble of smaller holes have been the mounting holes for various items of work.

A small casting may also be provided with a chucking spigot much like the larger one shown earlier which is best cleaned up on the lathe to give a clean surface to hold preferably to a common size. This makes it easy to hold the casting for subsequent machining in an ER or 5C collet block that can easily be orientated to any of the X, Y or Z planes on the mill as the machining operation requires, **photo 207**. In the same way items being cut from the solid bar can be held in a collet block or Spin indexer for ease of further machining, **photo 208**. Don't worry if you do not have any collet blocks (yet) or even the correct size collet to hold the chucking spigot a simple hole drilled centrally into a squared block can be use and the part retained by a cross drilled and tapped hole for a grub screw or with a dab of Loctite that can be heated to break the bond once the machining has been completed, **photo 209**. ∎

The items featured in this series are available from Arc Euro Trade, **http://www.arceurotrade.co.uk**, who also sell the X series of mills.

See the accompanying thread on Model Engineer Forum **https://www.model-engineer.co.uk/forums/postings.asp?th=131318&p=1** for more discussions about this series.

Damage to Myford Super 7 back gear.

Brian Wood finds the consequences of grease in the wrong place.

This is what I discovered when I had to replace the back gear cluster for a broken tooth. The bore damage within the old gear where pick up off the spindle has taken place is very obvious in **photo 1**. Traces of matching binding on the spindle can be seen in **photo 2** as a witness at the right hand end after dressing the high spots away.

I ran a 1/8 inch diameter end mill along the spindle to help carry oil over the whole bore of the replacement gear from Myford spares. The depth is only 0.5mm but that should be quite sufficient to act as a reservoir for the future.

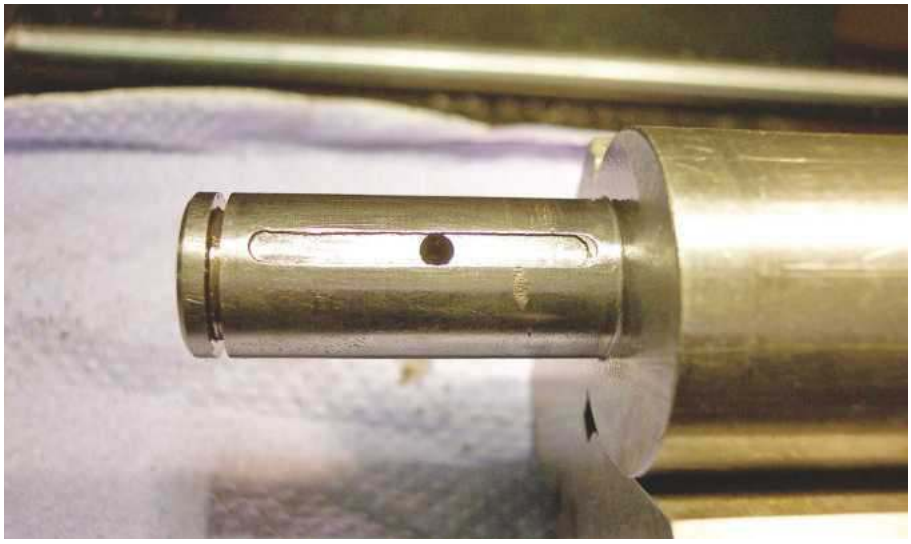
Why did the gear bind on the spindle?

There were traces of grease in the undercut between the two gears on the old cluster but the real culprit was choking by old grease in the oiling passage up the spindle which explains why trying to pump oil down the spindle was such hard work.

I put that down to a very good fit between the components; it was actually only getting lubrication from run off with oiling the gear teeth from time to time.

I had found other places on this lathe where a grease gun has been used incorrectly in the past and I thought I had found them all by now. ■

Binding damage in the bore of the old cluster.



Milled out groove to spread oil over the cluster bore.

Moving a Jones & Shipman Surface Grinder

Martin Berry manages a major machine moving challenge.

I've long had a small Herbert Junior surface grinder, which is rather limited in its capability and capacity although it had been a good introduction to the peculiarities of surface grinding. For some time, I'd dreamt of something a little bigger with a bit more sophistication and the ubiquitous Jones & Shipman 540 seemed to be the obvious next step, but surface grinders do not come cheap and, unlike my lathe which has certainly earned its keep, a surface grinder is somewhat a luxury, so the dream remained just that until one day I spied upon an advert for one going for an advantageous price not more than 50 miles away. Initial enquiries concluded that it was an earlier model and not quite so powerful as the later models; this suited me as it would not stretch my 3 HP 3 phase converter.

Cutting a long story short, a satisfactory demonstration proved it produced good results and purchase was agreed on the basis that delivery could be procured at a reasonable cost. The machine's owner fortunately had contacts in the trade and, for a sum no more than it would have cost me to hire a van and collect it, it was delivered a few weeks later as a cash-in-hand "part load" looking quite small on the back of a large flat-bed truck. I'd once bought a Harrison milling machine and collected it using a pallet truck and a tail-lift van. For reasons I will not go into here, it was not an exercise I would not to repeat; so the aforementioned delivery was a pleasant experience.

When I originally moved the contents of my workshop from the garage at the side of the house to a purpose built building at the bottom of the garden, I constructed a trolley using a salvaged plasterboard pallet reinforced at the side with some steel box section and fitted it with six wheels. **Photograph 2** shows the trolley with modifications as detailed below. I thought the unmodified trolley would be adequate to move the surface grinder just reinforced a little by adding some 3 mm steel sheet to the top to help spread the load.

The surface grinder was craned from the lorry and carefully positioned about four metres away on my trolley, ready for pushing into the garage in preparation for the ultimate trip to the workshop at the bottom of the garden. I had noticed that the surface grinder was heavier than anything I'd moved before and was visibly flexing the trolley cross-spars and splaying the wheels. In fact, it was about double the weight of anything I'd moved previously with the machine's manual indicating a weight range of between 770 and 975 kg and the effort of getting the loaded trolley up a relatively short incline into the garage was already giving me serious concern.


1

The trolley is roughly the height of the floor slab of my workshop and previously machines were either slid off or rolled off using a pallet truck. Sliding it off the trolley and into the workshop was not an option and the pallet truck would have to be used. The only problem was lifting the machine up sufficiently to get the pallet truck under it, and this is the primary focus of this article. A secondary, although hugely important, consideration, was the strain the trolley was under; the splaying wheels was

The Modified Trolley

Tie Bar Brackets

an immediate sign of the trolley bending in the middle. There became a need to reinforce the trolley to minimise the risk of it breaking while being trundled down the, not so even, back garden. The third issue was moving the considerable mass down the garden to its new home.

Reinforcing the Trolley

With the machine already sitting on the trolley, there was no way that I could add steel members to reinforce it. So the only option was to use tie-bars, which are mounted below the two centre cross-members. These take up the tension and prevent the cross-member bending any further. 20 mm threaded bar was used, this being available in 1,000 mm lengths, which was not quite long enough to span the width of the trolley so a further 200 mm was added with the two pieces connected using a threaded socket. Two "L" shaped brackets were welded up from some 50 mm x 10 mm bar and initially held down with screws. A single 12 mm bolt was then added to clamp the bracket to the cross-member, **photo 3**. The tie bar passes through an approximately 22 mm dia. hole in each bracket, **photo 4**. The eerie creaking of the trolley as the nuts were tightened was worrying, but the wheels started to gain a more vertical appearance and the trolley looked less distorted, so this fix seemed to have worked.

Further reinforcement of the front and rear spars was made using some "U" form channel welded together in the form of a box and bolted on using 12 mm threaded bar. The added advantage of these bars was to provide a stronger support when jacking the trolley or using a bar to move its position (see later).

Lifting the Machine

As indicated above, the objective was to lift the machine sufficiently to get a pallet truck underneath. The normal practice for moving these machines is by lifting using the cast lugs and eye-bolts fitted. I do not have a crane or lifting tackle of any kind and a low-cost workshop crane having a 1,000 kg capacity, at a minimum reach of 1 m, would cost almost as much as the machine itself. Therefore, the only option was to lift the machine by its base.

Tie Bars Beneath Trolley

Void Between Surface Grinder Feet

The machine has a cast iron base which sits directly on the floor. There are recesses on the ends and sides about 12 mm high, **photo 5**, and these are the only points a lifting device can be inserted. I decided to use the side slots, with an option to consider the front and rear slots if necessary.

The basis of the lifting device is a pair of 100 mm x 50 mm (4" x 2") rolled steel channels, one either side and held in place by braces across the back and front of the machine. Part of one side of the channel was cut away to form a lifting foot, which needed to be cut at an angle one end, photo 6. On the other face, four 22 mm holes were drilled, two either end of the channel, and on either side of the holes a nut was welded. As the inside face of the channel is tapered, this had to be partially milled flat, so the pairs of nuts sit parallel. A piece of 20 mm threaded rod was used to hold the two nuts to the channel for tack welding, although removed for final welding. Afterwards a tap was run through the nuts to clean out welding spatter and remove alignment errors. The inner pair of screws are located are just further apart than the width of the pallet truck fingers.

Eight 330 mm long legs were cut from 20 mm threaded rod and a nut was welded to the top of each. To prevent zinc fume

Frame Lifting Lug

Lifting Frame Components

from the BZP nuts and threaded rod, these were soaked in acid until all trace of the zinc was removed; furthermore, all welding was performed outside.

The side braces were made from 50 mm x 32 mm (2" x 1.25") box section into which inserted blocks having two 8 mm threaded holes to which the end frames are bolted. The side braces do nothing more than hold the end frames in place. The inserted blocks stop the tube crushing at the bolting points. The component parts of the lifting frame are shown in **photo 7**.

In use, the side frames are positioned and the front and rear braces bolted on. The four pairs of legs are then screwed in, with an ample application of grease, and steel or hardwood block used for the legs to bear down on. Using a socket wrench, the legs are screwed down a few turns each, going around several times to raise the machine up relatively evenly. In practice, the unevenness of the trolley caused the machine to slide and several attempts were made to get it supported correctly. As the machine was raised, wood blocks were placed below it to provide support just in case a jacking point gave way. For transport the machine was supported by wood blocks.

Transporting & Placing

Previously, I'd moved the trolley over dry ground carrying a maximum weight of about 500 kg and this required two strong bodies, one pulling and one pushing. With the greater weight of the surface grinder and running over now softer ground, I decided to reduce the effort by making a pulley block set. One end was anchored to the workshop floor using Rawlbolts, **photo 8**, with the other pulling a rope connected to the trolley.

To reduce the risk of the trolley sinking into the lawn, which was getting soft from the persistent rain (early March), thin steel sheet was used on top of hard rubber matting. For some areas, dips in the ground were roughly filled with strips of wood under the steel sheet to reduce the undulation.

The route from garage to workshop is not straight, **fig. 1**, and two changes in direction were required, each at approximately 15°. Pulleys were used to guide the trolley in a set direction, one at the end of the garage to ensure the trolley pulled down the garage in a straight line, and one at an oak tree to bring the trolley to its turning point where it would align with the workshop door. The garage pulley was mounted in the middle of a wooden bar spanning the width of the door and held in place using a couple

Pulley Block & Floor Anchor

Ready for the Off

›

Guide Pulley at Rear of Garage

Rear of Garage Removed

of 10mm threaded rods, photo 10. The second pulley was mounted on an A-frame pressed against the tree and wedged in place, photo 15. I only had two pulley wheels, although the main rope between pulley block and trolley, was doubled up. Once the trolley reached the end of the garage, the garage pulley was relocated to the tree location to provide a pulley for each half of the rope.

To get the trolley to change direction, boards were placed under the centre pair of wheels which provided a fulcrum, with the front and rear wheels either off the ground or more lightly loaded. A bar was then used to twist the trolley towards its new direction of travel, **photo 12**.

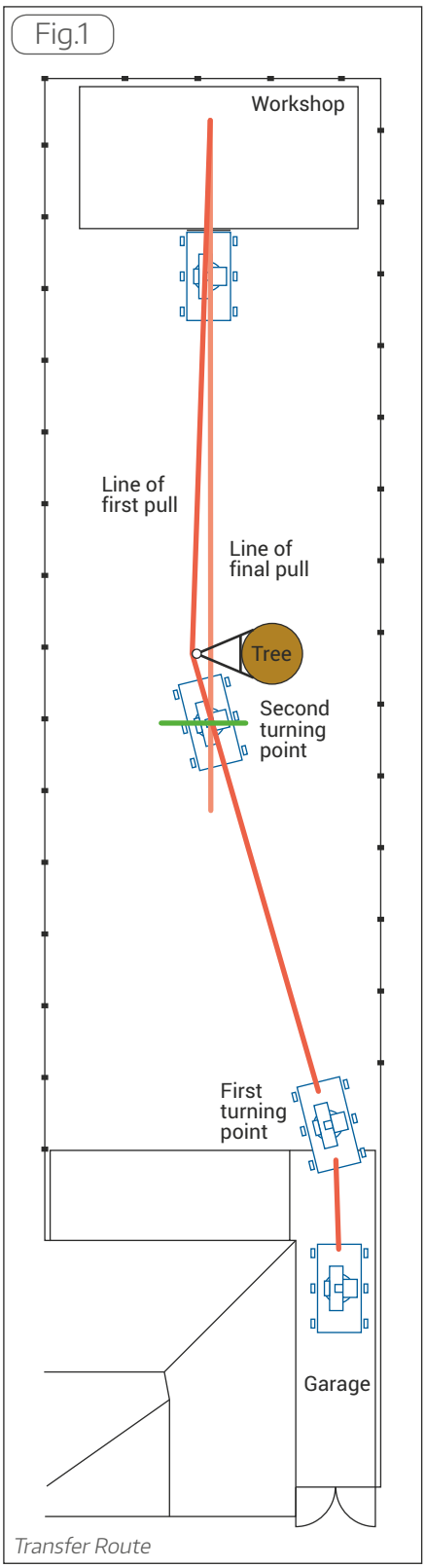
Photographs 13 to **17** give a further pictorial impression of the move from inside the garage up to the workshop and the reader will gain more information from these than I can detail in words.

Unfortunately, the rear opening of my garage was narrower than the trolley axles, so in the words of Bernard Cribbins in his rendition of "Right Said Fred", we had to take the wall down! This was not a problem as two weeks thereafter the builders were moving in to do the very same thing.

The rope on the pulley block was 30 m long, which provided just under 7.5 m of travel (4:1 ratio). The practical pulling range was about 3 – 4 m as I did not want to keep stepping into the workshop. So, the main towing rope connecting the pulley block to the trolley had to be shortened quite a number of times.

As a proportion of the distance to be covered was slightly downhill, chocks of wood were laid about 600 mm ahead of the front trolley wheels to prevent any possible run-away. This meant having to regularly move the chocks and do relatively small bursts of pulling.

On reaching its final destination, at the workshop door, the wheels of the trolley were heavily chocked to prevent it moving during the machine transfer process and



Transfer Route

the rear of the trolley jacked up on timber blocks to make it level. The surface grinder was then lifted by the frame's legs, as described above, a long board which bridged from under the machine to inside the workshop was inserted and then the pallet truck inserted. The machine was lifted and pulled off the trolley and into the workshop, wheeled into position and the pallet track lowered to just a few mm short of its lowest position, while gradually

Some Effort Required to Turn Trolley

On Tracks Down The Garden

What a Drag!

Guide Pulley Against Oak Tree

screwing up the legs.

The pallet truck was removed and the four legs each progressively screwed up, while keeping the machine roughly level, until the surface grinder sat itself on the floor - job done!

Photographs 18 and **19** show a rope around the machine; it was thought that a little extra pull may be required when the machine was on the pallet truck, but this proved unnecessary.

Conclusion

While I was pleased with the lifting frame and resultant soundness of the trolley, I was particularly delighted with the impact the pulley block had on moving the trolley and its contents as the physical effort of moving the machine was solely accomplished by myself, gratefully assisted by my wife who provided guidance where I could not see, helped move mats and the steel sheets, took pictures of the day's events and frequently reminded me to be careful.

Not having bodies digging their heels in to the soft lawn while trying to pull or push the trolley meant that the ground did not get churned up. This combined with the load spreading of the steel sheet, which was about 1.0 mm thick (some old office shelving), and rubber matting meant that no obvious damage was done to the lawn – not even a wheel track!

It took about six hours to complete the move, rather longer than I'd anticipated. But this did include an interlude to demolish the rear of the garage and a pit-stop for a quick mug of coffee and a toasted tea-cake. Taking it slowly meant there were no incidents or accidents and the satisfaction of seeing a new toy in the workshop makes the trepidation of what seemed to be an almost impossible task and the hours of preparation all worth while. The next project is to get my new acquisition cleaned up and operating.

Final Thoughts on Construction

You may ask why eight jacking points or why two nuts at each jacking point. Not being an engineer by profession, I prefer to apply Battleship Engineering to such activities, rather than risk under sizing

Getting Close

Lifted and Pallet Truck Inserted

In You Come!

something or rely on my poor (seriously lacking in practice!) standard of welding. The last thing I wanted was a failure resulting in an expensive one tonne garden ornament spoiling my wife's Feng Shui - it would not have been the first time! As it was, while lifting the machine to off-load, one of the jacking points slipped off the steel plate it was bearing on and smashed through the top of the trolley, causing the machine to tilt over.

After I'd fitted the tie-bars to the trolley, I realised I could just get my car jack under the frame. Rather than make support brackets for the tie-bars, it would have been possible to jack up each side on blocks and remove the bottom steel box section to which the wheels are mounted and drill this for the tie-bars. The advantage being that a) it prevents clutter of the trolley's top and b) it increases the clearance below the trolley. Hindsight is a wonderful thing! ∎

Editor's note: Moving heavy machinery is always a challenge and potentially dangerous. Plan carefully, always have someone else on hand, in case of an accident and if you have any concerns, get an expert in to do the job.

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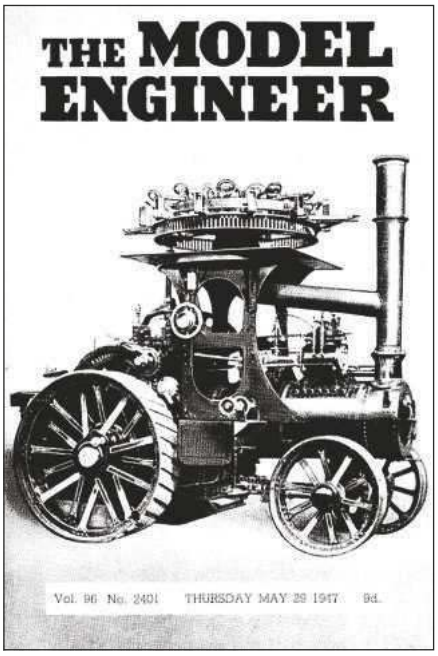

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Line Boring

John Olsen explains a way to make accurate holes in awkward castings

Every so often, a job comes along that just won't quite fit into the available machines. This seems to be true even if you have quite big machines, presumably because of a variant of Parkinson's law. Just as work expands to fill the time available, jobs expand to fill the machines available.

As an example, lately I have been machining up the set of castings for a PM Research water cooled "Red Wing" hit and miss engine. All was good until I started to look at setups for machining the cylinder bore. The suggested arrangement was to set up the casting on the cross slide and bore with a boring bar either between centres or held in a collet chuck. Unfortunately, my biggest lathe is an ML7, which does not have enough clearance over the cross slide to accommodate the Red Wing casting. I had anticipated this and had in mind an arrangement with the main casting mounted vertically in the milling machine and using a boring head to do the bore. On looking at this, I found that the travel on the quill was not sufficient. The cylinder bore is nominally 4 and 7/16 inches long, while the travel on the quill is only four inches. The head of the mill, an RF45 clone, is on dovetails, but I didn't fancy my chances of doing a bore while traversing the head up and down, especially since there is no sort of fine feed on the head movement.

So, after some thought, I concluded that my best bet would be to line bore the cylinder using the table of the mill to traverse the job back and forth. I have previously done this to line bore the main bearings of my steam launch engine, a Leak 3" + 5" by 3" stroke unit. For that job, I drove the boring bar by means of an electric hand drill mounted on a nearby bench and connected up by a length of shaft with rubber hose serving as flexible couplings. The shaft stayed in one place and the job was traversed along it by the milling table. The mill column and head played no part in proceedings.

The current job was a little smaller and offered the possibility of driving the bar from the milling machine head. I dug out a little right angle drill unit and tried setting the job up. The setup looked very promising, except that the plastic housing of the right-angle unit was obviously not up to the job. I bought a better unit with a metal casing and tried it. **Photograph 1** shows the setup I came up with.

For this setup to work, the two plummer blocks must be set up at the correct height to put the bore where needed in the casting, and the boring bar must be aligned along the table. The job itself must also be aligned along the table, and when connecting the right angle attachment, the shaft must be aligned with the centerline of the quill. This can be done using the cross feed and a normal centre finder. Once everything is aligned, the only adjustment needed is the depth of cut on the boring bar. For this set up, there was little room available to set this, which lead to the job bore ending up a few thou over the nominal size. This is of no real consequence, since the piston will be made to suit and the error is within tolerance for the rings. Checking the bore size is a bit of a mission, since it involves withdrawing the boring bar through the bearings to clear the bore, and then using a bore gauge from one end. It would be better to use a boring bar with a micrometer feed, and I really should make one sometime.

The job clamped down and ready to machine.

The plummer blocks I used are actually nearly 100 years old. They came from an old rotary telephone exchange and were used to support self-aligning bearings for the drive shafts used in those exchanges. They had plain bushes fitted for the last line boring exercise, since for this setup to work, the boring bar must traverse axially through the bushes. The boring bar remains in a fixed position while the job and the bearings traverse along it. The end location of the boring bar is only fixed by the angle attachment, but this worked well. I guess not everyone would have plummer blocks like these lying around, but in fact you could use simple blocks of metal with holes bored in them to suit the boring bar.

It sometimes pays when you do have one of these oversize jobs to think about how it would have been tackled on the original job in full size. They quite often did not have machinery big enough to tackle the job directly, particularly when it comes to things like large flywheels. These were sometimes turned by mounting them on a stub shaft in two plummer blocks either side of a slot in the floor. Rotate the flywheel by any available means and mount a compound slide where needed. I did the final trueing up of the disc flywheel for my Leak engine by bolting the engine down on a suitable bench, clamping a compound table next to it, and clamping a piece of tool steel on the table. This allowed me to take cuts on the side and face while running the engine on compressed air. ∎

Scribe a line

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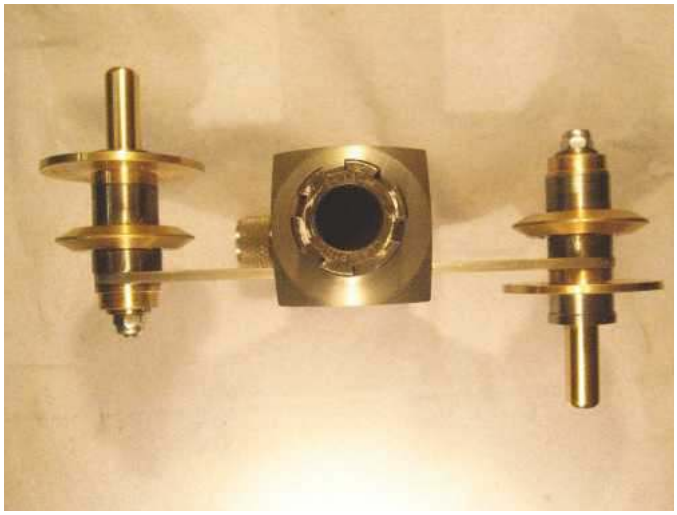
Drop us a line and share your advice, questions and opinions with other readers.

Pointmaster



Dear Neil, having made a version of Keith Johnson's excellent Pointmaster drill sharpener, it eventually dawned on me that it can also be used to sharpen LEFT handed drills by exchanging the angle wheels and their spacers 'end for end', this is actually shown on the GA (Fig 2 in the article, Oct. 2019) on the left hand sketch, where the wheel angles are given. However, this view is of the non-collet end but if this point is ignored, the geometry is correct.

The Pointmaster's range fits neatly between my DAG Brown micro drill sharpener and the Quorn and has already had a lot of use!

Attached, for clarification, are some pics of the set up and of sharpened left & right hand drills. As I have arthritic hands,I added the spindle extensions to the wheel sets to give me better grip and control.

Many thanks to Keith!

I was once told, in all seriousness, that left handed drills were developed for use in the Southern Hemisphere so that they would rotate in harmony with the Coriolis Effect, which is opposite to that in the Northern Hemisphere.

Sadly, such elevated theory is incorrect and they are, of course, used in multi-spindle drilling machines to give more compact gearheads without the use of transposing gears.

Peter Sanderson, by email.

Digital Readouts

Dear Neil, please could you ask one of the many gurus in our hobby to write an article on digital read outs (DROs)? Many of us have now fitted them as great improvements to accuracy and a corresponding decrease in wasted materials and time, but the small handbooks that come with them are bye and large incomprehensible and full of complicated maths.

I, like many, am not an engineer by training and am experiencing difficulty understanding mine. So, if someone could write an article in simple language it would be much appreciated.

Jim Lake

Hi Jim, it's true that most articles describe fitting DROs rather than more advanced ways of using them. I have consulted one of our gurus, and hopefully an article will be forthcoming not too far into the future – Neil.

Spotting Drills

Dear Neil, I am also a great fan of spotting drills but am baffled because I use them completely differently to recent contributors. I only use them in coordinate drilling (in the mill) to start holes which I subsequently drill to depth with a normal drill. To me the whole point (pun intended) is to make an accurate starting hole for the drill. If for instance you use a drill or centre punch on a rough surface the point will wander and not go in the right place. A spotting drill is quite rigid and sharp so will not wander especially if fed slowly. It can even be used on a slight incline. I think of a spotting drill as a pointed milling bit.

Unfortunately, I also get many breakages but only because of my carelessness. If you traverse the table while the point touches the work-piece then the tip will break, and the bit is scrap. Even the slightest chip makes it unusable and regrinding to the required accuracy seems very difficult.

Eckart Hartmann, by email

Pictures and Cutting Oil

Dear Neil, thank you very much for your continued service to all of the model engineers and tinkerers over the world. We love your magazines and appreciate the variety and depth in the articles.

One of my "pet peeves" is that it is sometimes difficult to understand the purpose of a tool or project from the photos in the article. A good example of this is issue 288, page 13. Howard Lewis describes a roller box and shows photos [1] of ball bearings on knurled shafts. These photos give the reader no indication of the intended purpose of the device. The reader must read and digest many paragraphs to figure out what is intended. It would be very helpful if you could lead off with a photo of the tool in use. Photo [10] on page 16 would have been more helpful as a lead, rather than photo [1]. Alternately, perhaps you could request an additional photo.

On another topic, I noticed a minor error in issue 288, page 44. It's not important and certainly not going to cause problems. You show Maxsyn SLF and caption it as a neat cutting oil. I had never heard of this product, so researched it to find out if I should get some for my shop. According to this website, it is not a neat oil, but instead a cutting fluid intended to be dissolved in water:

Bob Neidoff, Bedford, New Hampshire, USA

Hi Bob, I'm afraid you are right, some of our articles could be improved with a good overall view or general arrangement. I do sometimes 'rejig' the order of photos or figures. Our guidelines do ask authors to supply one, but I need to be more persistent when these are missing. As for the cutting fluid, you are right, but the label doesn't make it clear it's for SUDS. That said, it's worked very well neat! I shall put it to one side until I have my CNC mill set up and revert to using my old neat cutting oil – Neil.

Spindle Hold Errata

Dear Neil, Thanks for printing the article. I have found two errors (oops!). The last sentence of the article has the wrong tapping size as M2.5. It should read M2 (my fault!). Also the drawing (Fig 5) shows the tapped hole as M3 and it should be M2. Could you put a small correction in please? The parts list shows the correct screw size as M2 x 10mm.

R. Finch, Skipton.

Ring Lights

Dear Neil, please pass on to Michael Cox my thanks for his article (MEW 287) on the Ring Lights. I have made two following his detailed and helpful instructions.

I purchased a variable voltage stabiliser off EBay from a Chinese supplier. It came as a kit with full instructions. Beautifully made and it works. I also have a Multi-Fix system tool holder for my ML7 that again is well made and again is Chinese. It is a pity that so many people voice only derogatory remarks about the quality of Chinese products when my experience is that they are high quality and inexpensive.

Peter Alcock, by email

CNC Machines in Australia

Dear Neil, just a brief introduction; I'm a nearly retired Industrial Electronics Engineer and company owner for 25 yrs. I have dabbled in hobby engineering since the early eighties, have been an avid reader of MEW for many years (BTW there is not one other mag available in Australia that even comes remotely close to being aimed at this hobby). Keep up the good work please.

I have owned a lathe since the beginning of the eighties and later a milling machine and another lathe. The latter 2 I converted to NC control with MACH3 software. The second lathe has just been upgraded to MACH4. I also have a mini milling machine and a laser cutter which have suffered the same ordeal. (MACH3)

Currently am building a mini CNC lathe with 4 axes, from scratch which is of my own design. A project I hope to complete within the next few months.

Also, the renowned Quorn has been built and is a very useful part of the workshop arsenal.

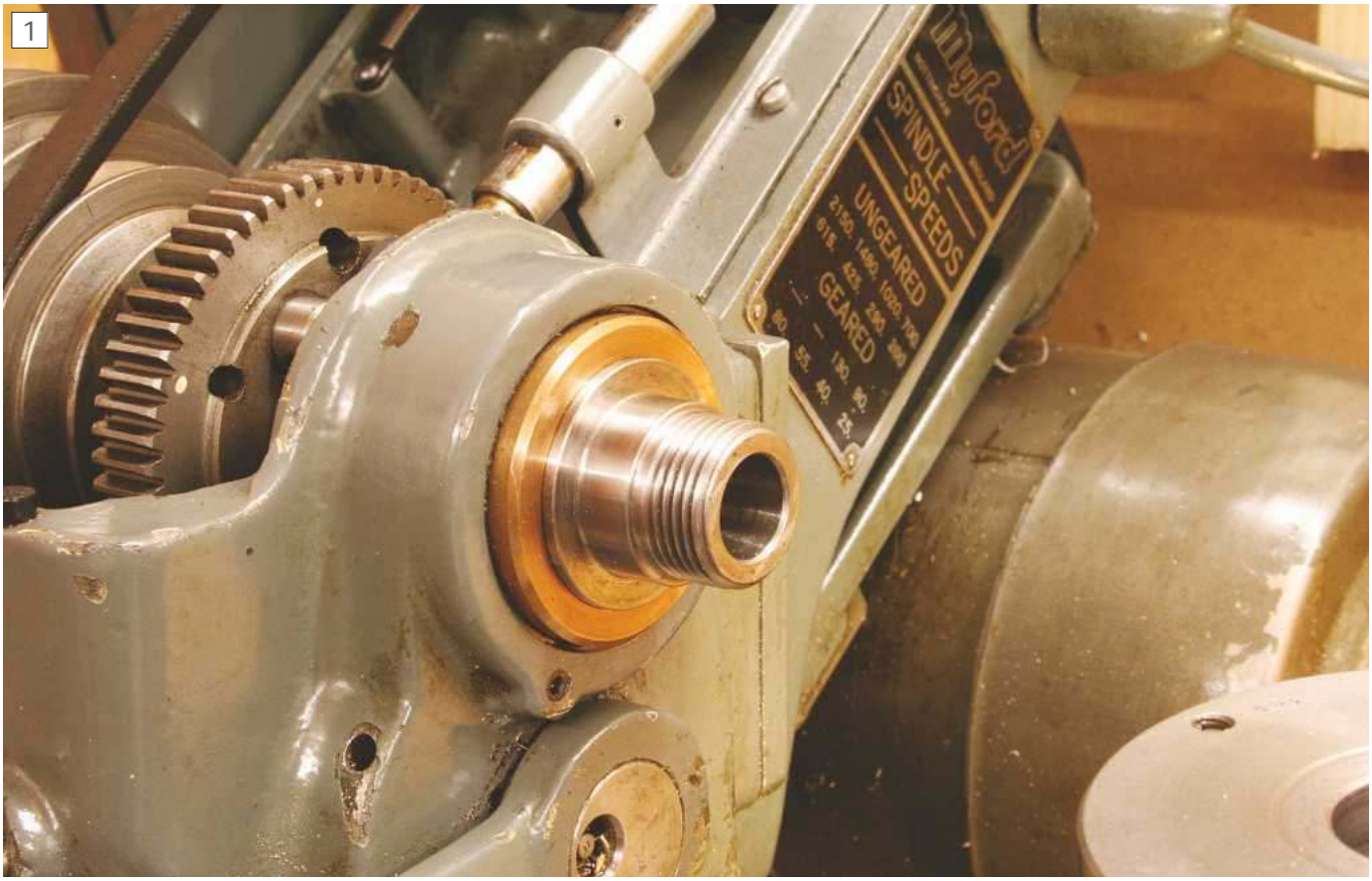
I read the MEW and admire a lot of the projects and designs and think should I try to offer something that may be of interest to anyone or is mine just old hat. I will attach some pictures for your info and would be happy to share any info if of any value.

Rudi Broekhuizen, Melbourne (Geelong), Australia.

We've included a few of Rudi's photos, hopefully he will be writing up some of his projects for us in the future - Neil.

Tooling: A System Approach

Stewart Hart offers some advice on making things interchangeable.



Myford Type screwed head stock fitting

When anyone takes their first steps into setting up a small model engineering workshop, they face a bewildering number of logistical problems Where and how to build the workshop; how big; how to power; light and heat; how to equip it. When I built my own workshop, I simply utilised the small concrete standing at the back of my garage, the space I had available controlled the size of my workshop. This governs the size and range of machine tools I could fit into it, stretching my ingenuity to its limits but in the end, I managed to shoe horn everything in. I think using the available space to the best possible advantage is what most model engineers do. All this takes time and money. Starting with a lathe and perhaps a pillar drill, and some basic equipment, you start making models or equipment for your workshop. Then gradually your workshop evolves and allows you to pursue your particular modelling interest to the best of your ability.

The process will be helped by having a long term plan and vision of what you want to achieve. Armed with this plan and vision you can apply a systematic approach to your acquisitions. By treating your workshop as a system each element of it will complement each other, the lathe and its equipment will compliment the mill and its equipment. Each piece of equipment will have a dual purpose and flexibility of use, this will keep down duplication and cost and make your workshop more space efficient and productive.

The lathe is the foundation of any workshop, and the singular most important piece of equipment you will purchase, so it's worth taking your time over. I don't want to rake up old arguments over a used Western manufactured lathe against a new cheap far Eastern lathe or the choice between Imperial or Metric, these argument has been done to death many times, but I do want to point out lathe features that will have an effect on your tooling systems. The first and most obvious thing is to choose between the Imperial and Metric system, the choice boils down to one fact, it's your workshop, so choose the system you are most comfortable with. You can build wonderful models in inches or mm. However, there is one thing that I would like to point out in favour of the metric system, it is the industrial standard throughout the majority of the world; this has an effect on costs and availability of equipment. I am of an age to have been raised on the imperial system, and gone through the change to the metric system,(I can still convert the cost of an item into old money (£ s d)), but I must admit I prefer the metric system.

The next important features are the attachment interfaces particularly the

Flanged back plate

Range of different tooling back plates

head stock and tail stock. Tail stocks almost universally use a Morse taper and for a small home shop machine this is usually M2 or M3. My own lathe and milling machine are standardised on M3 so all of my drill chucks, collet holders, boring heads etc are interchangeable.

With the head stock there are quite a number of different fixing systems, the two most commonly found systems used on home workshop lathes are the nose thread system as used on Myford, Boxford and Viceroy lathes, **photo 1**, and the flanged back plate system with three fixing screws that is most favoured by the far Eastern manufacturers, **photo 2**. Now chucks, face plates and collets are not only used on lathes, you use them on the mill, rotary tables, spin indexers etc. This is where a system approach comes in, with a little ingenuity you can make adaptors so that your chucks, face plates, and collets can be used with these bits of kit. From **photo 3**, clockwise from bottom left: ER32 collet holder for the lathe: Spin indexer adaptor plate: Rotary table adaptor plate.

These adaptor plates give you the flexibility to ring the changes: for example, you can remove your chuck from the lathe with the work piece still in place, locate it on the adaptor plate of your spin indexer or rotary table, and it will automatically line up true and the part can be accurately machined. So, by treating your workshop and equipment as a system you can avoid expensive duplication of equipment, improve your productivity and your quality of work. ■

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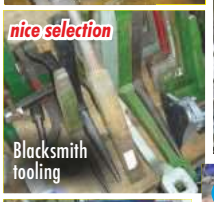
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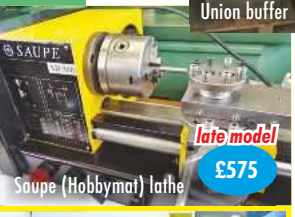
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