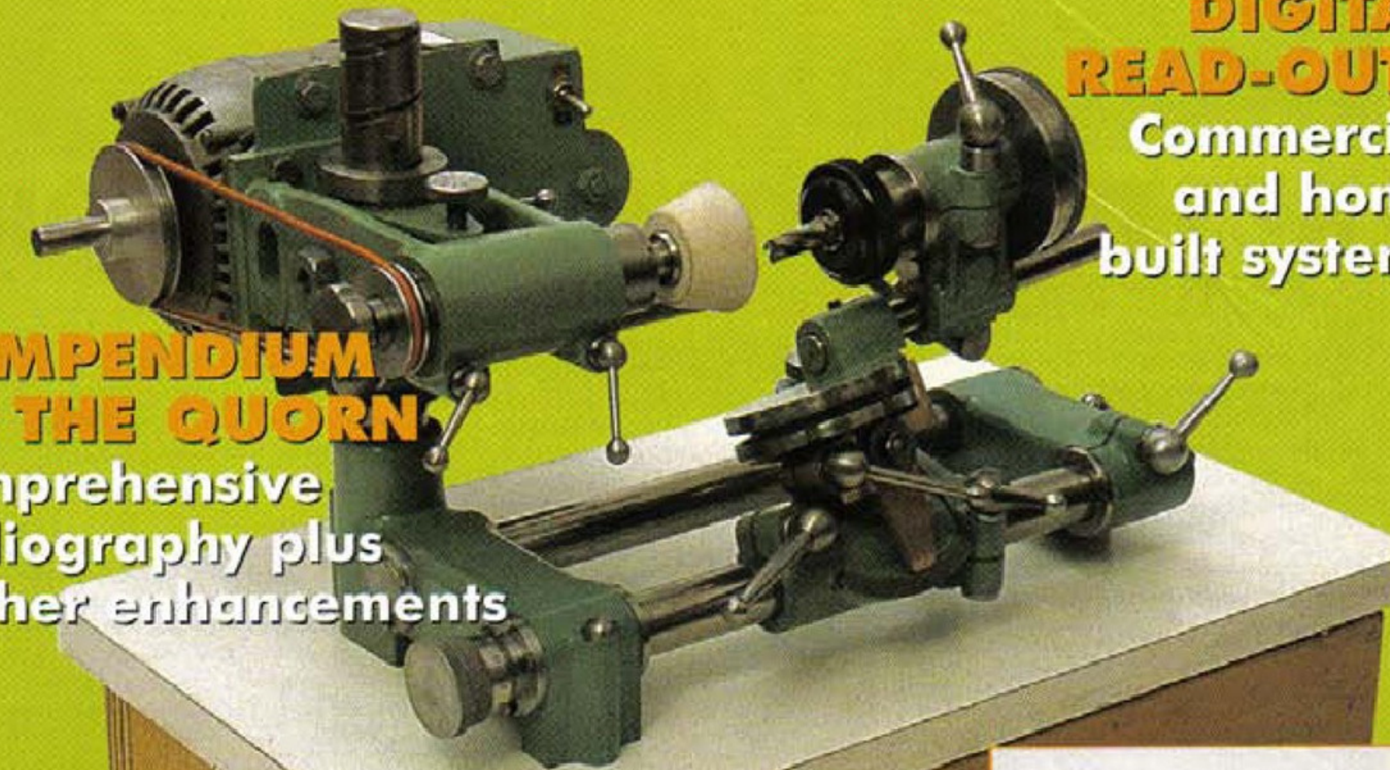
No.62

MODEL ENGINEERS' WORKSHOP

THE PRACTICAL HOBBY MAGAZINE



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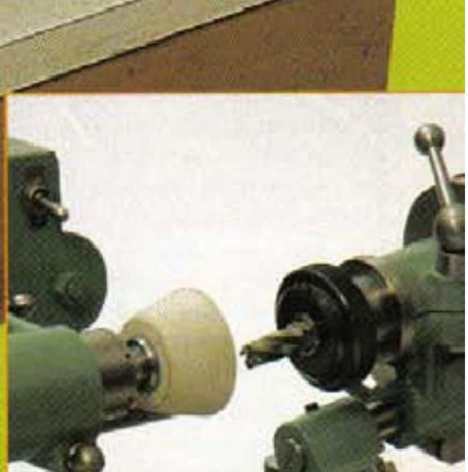

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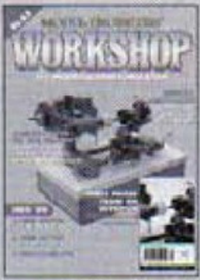

Published by
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SUBSCRIPTIONS

Nexus Subscription Services, Tower House, Sovereign Park, Lathkill Street, Market Harborough, Leicestershire, LE16 9EF.
8 issues UK £24.00, Europe & Eire £28.88, Sterling Overseas: £31.44 [surface mail] £34.48 [airmail], US$ overseas $47[surface mail] $52 [airmail] Cheques payable to Nexus Special Interests Ltd.
USA Subscription Agent: Wise Owl Worldwide Publications, 4314 West 238th Street, Torrance, CA 90505-4509 USA. For Visa/Mastercard orders in USA telephone (310) 375-6258. Fax (310) 375-0548. Pacific Time 9am-9pm Weekdays. 10am-6pm Weekends.
Postmaster send address corrections to: Model Engineers' Workshop c/o Mercury Airfreight International Limited
365 Blair Road
AVENEL, NJ 07001
USPS 010876

NEXUS

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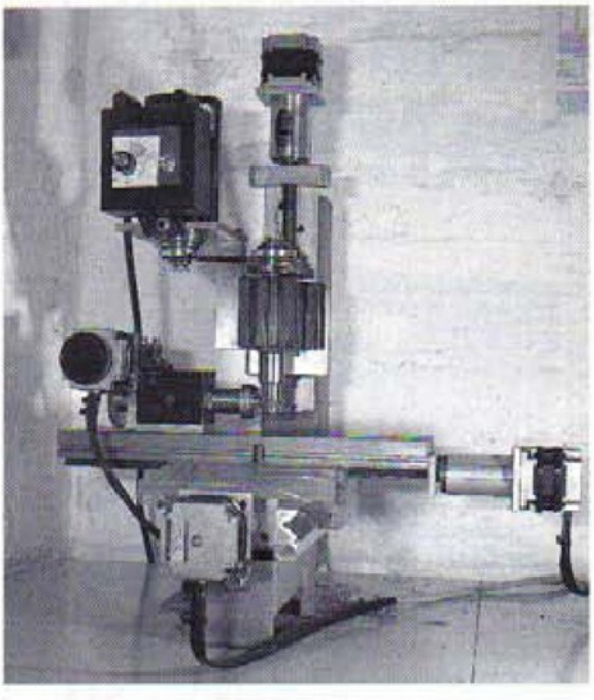
On the cover

Maurice Fagg's award winning version of the Quorn tool and cutter grinder.
Philip Amos looks back at the vast amount of literature published about this well-known machine and suggests that a few more changes could enhance it even further. His article starts on page 19.
(Photo. Elizabeth Shakeri I.I.P.)



Taig machines, marketed under the Peatol banner in the UK are popular with the owners of smaller workshops. Tony Jeffree has developed a number of useful accessories for both the lathe and mill. He describes some of these in an article starting on page 37

ON THE EDITOR'S BENCH

A couple of over-night frosts are a sure indication that the year's 'out and about' time is drawing to a close, with just a couple of weeks before attractions such as open air museums and National Trust properties close for the winter. Its therefore time to check the workshop draught proofing and heating systems and to plan the work schedule.

This summer's travels have taken us to some fascinating places and brought us into contact with some interesting people. Our involvement with the local brass mill restoration project has meant that we have become more aware of the many preserved water wheels around the country, so we have tried to seek out a few on our travels. The county of Devon still has quite a number, one of which remains in Coldharbour Mill at Uffculme. Describing itself as a working wool museum, this site also houses a beam engine and a 1910 drop valve horizontal cross compound engine by Pollitt and Wigzell Ltd of Sowerby Bridge. While the water wheel is still under restoration, the two steam engines are now in working condition and are demonstrated under steam on selected weekends through the visitor season. Essentially a spinning mill, Coldharbour retains much of its machinery which works on a regular basis, now powered by electricity. Hence, there are four 'generations' of motive power still on the site, something which I suspect few other facilities can match.

Not too many miles away, at Sticklepath is the renowned Finch Foundry, a water powered edge tool manufactory, now in the care of the National Trust. Here the machinery, consisting of a tilt hammer, shears and grindstone is driven from a number of water wheels and is demonstrated at regular intervals. The last mentioned of the three machines is of the 'prone position' type, with the operator working literally 'with his nose to the grindstone'! An upper room of the foundry is used to display some interesting artefacts, photographs and documents relating to the history of the site. It also contains some interesting models which clearly explain the operation of the machinery, something which is sometimes difficult to comprehend from the full-size installation.

It was at Finch Foundry that we made another discovery. For some while, my wife Gill has been seeking information on horse gins, because the grounds of our local National Trust house contain the remains of a cobbled 'turning circle' around which the horse walked. All the machinery has disappeared from the farm buildings, and she has had the task of explaining to groups of young visitors just what it was all about. As we entered the cafeteria at Sticklepath, we were intrigued to find that it is actually built around the remains of a gin, this one having powered the apple crusher of a cider mill, the remainder of which is in Oakhampton Museum. This gin is of the overhead transmission type, whereas our local one had the drive shaft to the building situated at low level. It was at a later event that we were told of a complete horse gin at an open air museum near Church Stretton. If the weather holds, we must try to arrange a visit while they are still open.

Just prior to our visit to Uffculme, I was invited to join Mike Chrisp and Anthony Watson for a trip on the River Thames steam launch Windsor Belle which had recently received a new boiler. Mike has described, in 'Model Engineer', the trials and tribulations suffered by Chief Engineer Frank Robinson at the hands of a variety of agencies, so I won't dwell upon them here. The pleasing result is, though, that an elegant Edwardian lady has been given a new lease of life and I consider it a privilege to have had the opportunity to spend a few hours, on a gloriously sunny May day, cruising the river and watching the preparations for the forthcoming Henley Regatta.

One of the highlights of the summer was a visit to the North East with our local model engineering society on their annual 'away' weekend. The focus of the trip was a visit to the open air museum at Beamish, a location which I had not visited for quite a few years. There was so much to interest us there that we were hard pressed to get a good look at everything there in a long day, and everyone agreed that it had been well worth the long coach journey. While in the area we were able to enjoy the beautiful City of Durham as our accommodation was in one of the University's halls of residence, where the facilities and catering were better than in many so-called up-market hotels in which I have stayed.

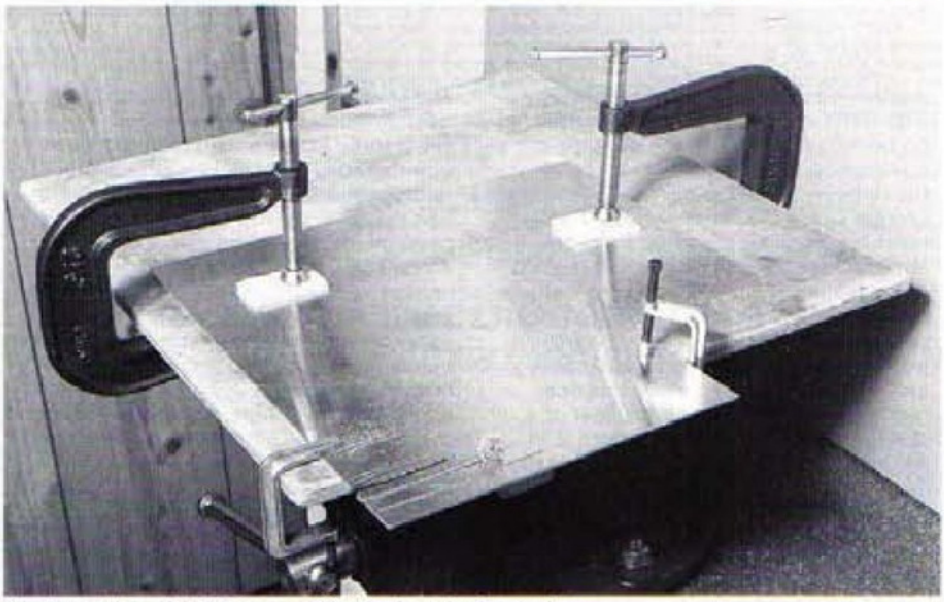
It was during the lunch stop on the way to Durham that we discovered another 'gem'. While looking for somewhere to eat in Chesterfield we passed the local Museum and Art Gallery and resolved to make enough time before returning to the coach to look in. Gill wanted to see the art collection, but unfortunately the gallery was closed for refurbishment. It didn't matter as there was plenty in the museum to interest us, particularly a complete garden shed, in which had been reconstructed the workshop of a now deceased retired miner from one of the local collieries. There was his lathe (apparently his only machine tool), all his hand tools and a compressor complete with reservoir made from an old fire extinguisher. On the benches and shelves were the models he had built, mainly small steam engines but also including a couple of sets of pit head gear plus railway lines and trucks. If I recall correctly, there were some thirty models in all, the result of some dedicated work by a keen craftsman. If you get the opportunity, go and have a look.

One model engineering rally we did get a chance to visit this year was that at Guildford, where we were made most welcome by the local club members. It was one of those blazing hot weekends when most of the visitors were seeking the shade and a cool drink, but the organisers made sure that there was plenty happening and much to see. The people manning the stands in the exhibition marquee were heroes as the temperature was such that I could spend only about ten minutes in there before seeking fresh air. Hopefully, we shall be able to visit again next year.

Another out-door event we managed to get to was the agricultural show at Usk, just over the River Severn. It is one of those delightful traditional shows, where the local farmers and their ladies gather to show off the results of their labours, either in the stock ring or in the various country craft marquees. We always marvel at the produce on show, particularly the mouth-watering fruit and vegetables. But this is an agricultural show with a difference, because it features an extensive model engineering section, organised by local doyen of the model traction engine world, John Haining. With engines in steam outside and a good display of engineering items in the tent, it is an extremely sociable gathering, at which a number of well-known faces from the hobby are seen regularly, some having travelled quite long distances to make a point of being there. Its another event to be recommended.

Its been an interesting summer and we have had the pleasure of meeting friends old and new. We look forward to the winter gatherings with anticipation.

CUTTING SHEET METAL



1. A small work table secured in the bench vice makes holding pieces of sheet metal for cutting an easy operation.

At first sight, cutting sheet metal would appear to be less difficult than working on heavier section material, but this often proves not to be so in practice, especially in the smaller workshop. Harold Hall considers some of the methods available and suggests ways of employing them

The ease with which most machine tool operations can be carried out in the home workshop competes quite favourably with the comparable operations in industry. Comparing like for like, say centre lathe with centre lathe, the industrial machines may be more robust and more accurate, in some cases producing the item a lot more speedily. Even so the difference is not that great. One area however where the difference is very marked is the cutting of sheet metal. In industry, place the sheet being cut in the guillotine, line up the blades with the cutting line, press the foot pedal, bang! and the job's done - and nigh perfect. If on the other hand it is a cut-out that is required or something with curved edges, then a computer-controlled punching machine will produce equally impressive results, albeit a little slower. There is no way that the home workshop owner can compete with these unless a large amount of money and space is available.

One possibility is the 'triple' (guillotine/bender/rolls) machine available from some of our suppliers. These can handle a 750mm wide cut, possibly more - adequate for most I would think - but only on material of around 1mm thick. Whilst 1mm will cover most modelling requirements, it is too thin for general applications. Of much more importance is, though, the high cost of this device (around £1000), which is likely to put it out of court for the majority of home workshop owners, especially in view of the limited use it is likely to get. Anyone wanting to know more regarding this machine should see the review by Philip Amos (Ref. 1).

A second-hand foot guillotine will probably cope with 1.5mm, perhaps even 2mm if you jump up and down on the foot pedal! Their main problem is that they take up a large amount of floor space, often a rare commodity in the home workshop environment, and they are not that easy to find in good condition.

In view of the above, less convenient methods have to be adopted but, before proceeding with this subject, I am going to describe an item which I made when attempting to cut some sheet metal and which has paid back the time and effort needed to make it (some five minutes), many, many times over. It has also been instrumental in making a range of jobs easier, much easier in some cases. The device is, for want of a better name, an auxiliary work table.

An auxiliary work table

Having said that it took just five minutes to make, I should own up to the fact that I had a piece of wood for the table top already of a suitable size. It was only necessary to cut a piece of 50mm square timber to length and nail this to the table top with a little adhesive so as to increase the ultimate strength.

In my workshop, most of the benches are fitted up to the workshop walls at their end, only the woodworking bench having a free end. However, when cutting sheet metal, perhaps using a jig saw, the only method of clamping the sheet to the bench was by means of sash cramps because of the thickness of the bench at the edges. These are very unwieldy and the bench always seemed to be covered with tools and other items which had to be removed.

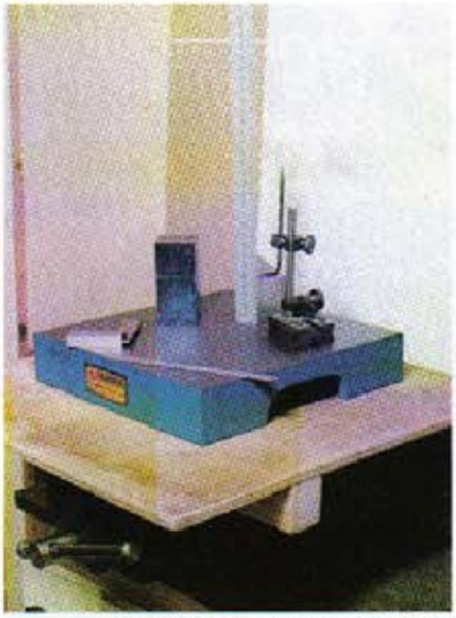
I figured that if a small bench were available with a thin edge on all four sides, it would be much easier to use G clamps at any suitable point around the edge. But, where was I to stand such a bench? Being small, it would be very unstable, so with this in mind, the idea of mounting a table top in the bench vice came to mind. It soon became apparent that an advantage of this was that, no matter how cluttered the bench was, I had immediate additional bench space, and uses for it flourished. I can safely say that no item I have ever made in so short a time has paid off so handsomely.

2. The bar on the back of the work table that permits it to be held in the bench vice.

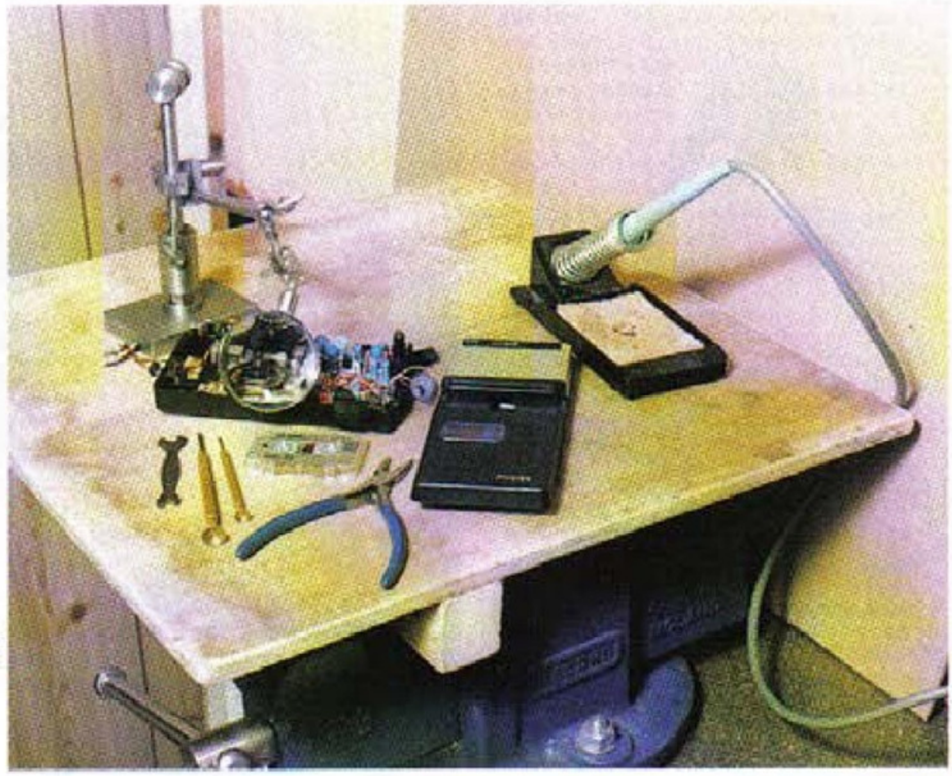
Uses for the table top

Photo. 1 shows the auxiliary table being used for its original purpose and ably illustrates the ease with which the piece of sheet metal can be clamped and ultimately cut. The bar on the back which enables the table to be mounted in the vice is shown in **Photo. 2**. The purpose of the bolt mounted through the bar, which was a subsequent addition, becomes apparent in a later photograph.

The raised working surface also made



3. and 4. The raised height makes delicate operations easier to see.



operations which need closer examination to be carried out more comfortably, as the work is raised nearer to eye level. **Photo. 3** shows it carrying a small surface plate and being used for marking out, a situation in which I find it particularly helpful. **Photo. 4** illustrates some delicate electronic repair work under way.

Benches covered with tools and parts for the work in progress often make workshop photography a chore as the clutter often has to be temporarily moved aside. Using the table top, as in **Photo. 5** eases the situation considerably.

We now come to the purpose of the bolt seen in **Photo. 2**; if this is gripped in the vice, the table top can be held at an angle and we have a ready made small drawing board **(Photo. 6)**. A small strip of wood clamped to the lower edge using small G clamps provides a ledge for pencils, spring bows and rubber etc. It also provides a simple stand for one's plans.

Cutting sheet metal

Having completed that diversion I now return to the subject of cutting sheet metal.

At the start of the article it was stated that the ideal method of using a guillotine will rarely be available, so we are left with numerous methods which are less expensive to establish, each having its pros and cons. The methods available can be divided into two groups, manually and power operated.

Hand tools

Photo. 7 shows some of the manual means. These are:- bench shears, hand shears, cold chisel and hacksaw. Very little needs to be said about the hand shears and the hacksaw, as most readers will fully appreciate their strengths and weaknesses. Hand shears are not that pleasant to use and are only suitable for the thinnest of materials, whilst the hacksaw is best suited to thicker items but will only be able to cope with a short cut. There are other types of saw that are not restricted by the frame and can, as a result, cut any length - typically the simple pad saw. Whilst these can be very useful in particular situations, they can no way be chosen as the major method of cutting sheet metal.

5. Making space on the bench for photography can be a chore. The work table makes it immediately available.

6. Using the bolt seen in Photo. 2, the table can be mounted at an angle providing a drawing board or a stand for ones plans.

The bench shear shown has a blade length of around 80mm, so it is quite small. Surprisingly, it is marked for use on material up to 2.5mm thick, and I have certainly used it at 2mm with comparative ease. This type of shear does tend to put a curve into the material, especially on the moving blade side. Because of this, cutting thicker materials is not always possible, even though the shear will happily cope with the thickness in some situations.

The problem is when the material on the moving blade side is too wide to bend as the method requires. This would occur when attempting to cut a part from a much larger sheet. The only way that such a pair of shears will cope with thicker materials is if it is being used to shear a thin strip which will curl as it is being sheared, allowing the material to be fed in to the shear blades for further cuts to be made. This assumes though that the thin strip is the waste and not the part required. A larger shear would cope better than the one illustrated, but would still have problems.

The final item shown in the photograph is the cold chisel and some will probably be surprised to see it included. Whilst its uses in cutting sheet metal are limited, there are cases where it comes into its own, **Photo. 8** showing just such a case. Here, a notch was required to be cut from the side of a piece of metal. Two saw cuts were made to the depth of the notch and the surplus metal between removed as shown. The operation is seen being

7. Manual tools for cutting sheet metal.

8. A cold chisel makes easy work of cutting out a notch on the side of a piece of metal. The sides of the notch having been cut using a saw.

performed in the bench vice, with two pieces of mild steel being used to raise the level of the cut above the vice jaws and to clamp the material over its full width. The method is a surprisingly quick and easy one, being best suited to smaller items, but it is not impossible to clamp a larger sheet between two much more substantial pieces of steel using toolmakers clamps or robust G clamps.

Another similar use is if a small piece of metal is required and a piece is available which is just too big. I this case, removing two edges to bring it to size will be much quicker than attempting to cut it using a saw or by filing. The method will comfortably deal with 2mm aluminium and 1.5mm sheet steel. The cold chisel must of course be very sharp and one kept specially for the purpose is a good idea, there is no point attempting to use the one last used to break up some concrete.

There are other manually operated shears, probably the best known and easiest to use is one which uses the same principle as the power tool shown, bottom right in **Photo. 9**. This will be described later. Also available are hand operated nibblers, though I would think that using one would prove to be a very tedious operation. The more specialised tools are eminently suitable for work on car bodies, though of course they are not limited to this application. For that reason one source of the more unusual sheet metal tooling is Frost Auto Restorations Techniques Ltd (2).

Power tools

Power operated tools have many advantages over the hand operated tools so far discussed, though they in no way make them totally obsolete. There are instances where the manual method is best, that shown in **Photo. 8** for example.

Photo. 9 shows three types of power tool. The jig saws are self-powered whilst the other two are attachments for a standard pistol drill. The two items at the bottom of the picture are a nibbler on the left and a Pencut attachment on the right. For those who do not

9. Power tools for cutting sheet metal.

10. The tools shown in Photo 9 having been put to work on a piece of 1mm aluminium. The tools can cut straighter and, had the cuts been made with a component in mind, I would have done better.

understand how a nibbler or the Pencut attachment works, **Figures 1 and 2** attempt to illustrate the principle. **Photo. 10** shows the result of using all four items to make cuts in the same piece of 1.5mm aluminium. I have to confess embarrassment at having to publish this photo as it shows that I made little attempt to make a straight cut. I would (of course) have done better if the cutting was being done with a component in mind.

The two outer cuts are those done with the jig saws, the smaller making the cut on the left. At 1mm (less in steel), the thickness is near the limit for this size of saw but with patience it is possible. **Photo. 11** shows a task with which it is more at home, this time cutting 0.5mm thick steel. The blades supplied with this saw are easily broken and quite expensive, so I use small lengths snapped from a junior hack saw blade. The wider blade means that it will only cut straight lines. It also needs to be narrowed at the end in order to fit into the saw, something I do on the off-hand grinder. If you attempt this, do ensure that the work table is very close to the wheel and that you are wearing safety glasses as it would be potentially very dangerous if the thin blade became wedged between work table and the wheel.

The larger jig saw copes easily with the 1mm material and will not object to even thicker work pieces. Of course, as the material gets thicker, progress becomes slower.

Keeping to a straight line with a jig saw is something which can be achieved, but care is needed. It is not helped by the small fragments of metal obscuring the line that one is attempting to follow. I have never tried it, but I suspect that if two pieces of steel were placed, one either side of the cut line and just wide enough apart to accept the saw blade then a straight line would result. The pieces would have to be wide enough to form a firm support for the jig saw and thick enough to discourage the saw cutting into it. One day I will attempt the method.

Front left of **Photo. 9** is the nibbling attachment which cut the widest and waviest cut in **Photo. 10**. This is unfortunately a very unfair representation of what can be achieved with such a device, that is assuming you require a straight cut. By using guide fences, perhaps one either side, perfectly straight lines will be possible. The nibbler

The extension on the Nibbler Punch limits the amount that the workpiece can be fed forward, as a result cutting only a segment at each stroke.

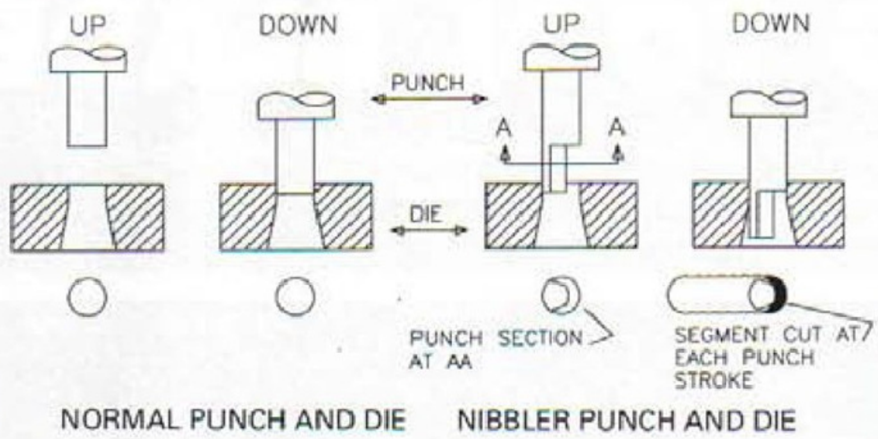


Figure 1. Nibbler Operation

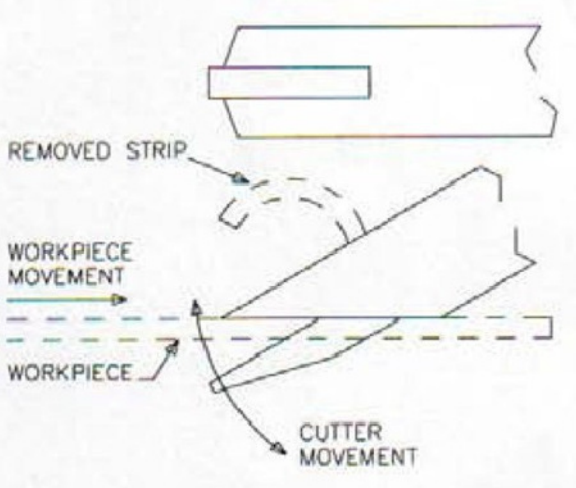


Figure 2. Pencut Tool

©

11. The small jig saw is more at home with thinner material, this time 0.5mm thick steel.

produces a cut edge that is quite jagged and which will need dressing with a file. The depth of the roughness is not that great, perhaps 0.1mm, so it is not a major task to remove it. The nibbler also produces a vast amount of very fine and quite sharp swarf, something which may be an inconvenience.

The Pencut attachment was reviewed (Ref. 3) in an earlier issue of Model Engineers' Workshop. If available this should be read because it gives more detail than I can include in this article. This device, like the nibbling attachment produces a cut width of 3mm, though that for the nibbling attachment shown in the photo would appear wider. I suspect that the vibration created by the oscillating action of the nibbler may make it move from side to side, thus producing the wider cut. Perhaps I need more practice!

As can be seen, the Pencut attachment produced a roll of metal as it cut. This needs to be discouraged by unwinding the roll from the outset as, after it gets to a certain size, it prevents the tool moving forward easily. If this phenomenon can be prevented, the device cuts with considerable ease and is a delight to use. The specified limits of capacity are 1mm thick steel and 1.2mm aluminium. This it achieves so easily that, for limited use in the home workshop, I suspect that a small increase on these values would not trouble the device.

The Pencut produces a very clean edge that is almost equal to that achieved by a guillotine, and whilst it removes metal, this is entirely in the form of a continuous strip, so there are no small fragments to clean up.

Quite by chance I attempted to demonstrate the action of both the nibbler and the Pencut attachment using a thin piece of card and turning the input spindle manually. The Pencut attachment tackled the task with ease, and would, no doubt have dealt with card of twice the thickness. The nibbler though I could not turn at all, even to make one notch. This illustrates that the shearing action of the Pencut places much less load on the drill than does the nibbling attachment with its punching action. This could well be a factor in why the Pencut appears to be a more pleasant tool to use.

Of all the workshop activities cutting sheet metal is probably the one I most resist. But, having completed my auxiliary work table and now thought through the process in order to write this article, I am sure that my next attempt at cutting sheet metal will be approached with much less apprehension. So, at least one person has been helped by this article! I do hope that many more readers will gain similar encouragement.

References

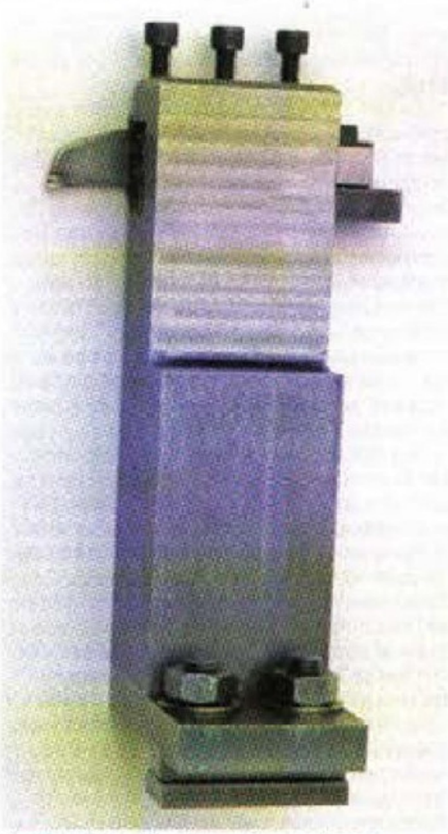
1. The Triple Machine, Model Engineers' Workshop Issue 51 page 39.

2. Frost Auto Restoration Ltd. Crawford Street, Rochdale, Lancashire, OL16 4NU. Tel 01706 658619 Fax 01706 860338.

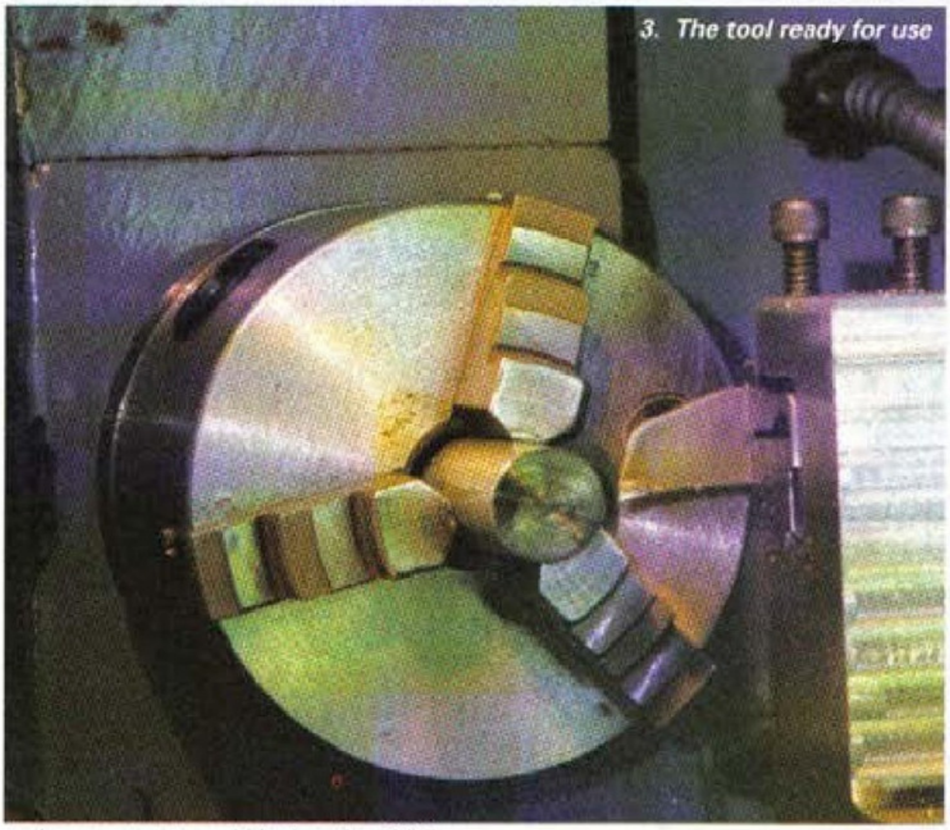
3. We review - The Pencut Attachment, Model Engineers' Workshop Issue 20 page 57.

A 'DISCOVERED' PARTING TOOL BLADE

Most home workshop enthusiasts are reluctant to waste anything which could possibly 'come in useful'. Mike Delaney of Oakville, Ontario has found just the use for those damaged carbide tipped circular saw blades



1. Fabricated back parting tool post



3. The tool ready for use

As I had just finished making a back toolpost for my lathe, I found the article on parting and parting tools by Mr. Sheppard in Issue 49 of Model Engineers' Workshop to be of particular interest. My toolpost **(Photo. 1)** is fabricated from steel bar stock and uses a commercial parting tool holder. The blade associated with this tool is solid HSS, nominally $^3/_{32}$in. wide x $^5/_8$in. deep. With it I was able to part mild steel up to $1^1/_2$in. dia. but I found, as did Mr. Sheppard, that if I put an angle on the front of the tool to remove the 'pip', the tool would bend and produce a cone face.

Shortly after this, to help out a neighbour, I undertook to clear up a pile of used lumber that had been acquired for firewood. A look at this material produced the impression that the original assembler must have had shares in the nail factory and delighted in never driving a nail straight! As the nails were well corroded, removal would have been very time consuming.

The least valuable blade that I had available for my portable electric saw was 24 tooth $7^1/_4$in. dia. carbide tipped. I decided to potentially sacrifice it, as the replacement cost would be less than $10 Cdn.. At the end of a full day's work the wood was all cut and stacked. The sacrifice was five carbide tips, four in a group and one singleton. I took the blade out of the saw and considered whether it was worth keeping for the steel disc which had been nicely ground flat. I had previously used the disc of an untipped blade as the blank for a multi-row dividing disc.

Then I saw it! A carbide tipped parting tool was hiding in the damaged saw blade **(Photo. 2)**. A few minutes work with a rule, a protractor and a fine tipped felt pen arranged that the tip would have a suitable top rake angle to the blade. I used about 10 deg.

Released from its confinement with a hacksaw and cleaned up parallel in the mill to $^5/_8$in. deep, the blade would fit in the commercial holder. I had selected a tooth tip with the tooth angle to produce the desired 'pipless' face on the parted piece. On trying the tool, even in aluminium, the tool coned. I have one of the, so called, 'diamond' files - I believe they are actually cubic boron nitride electro plated onto a steel backing. With this I was able to square up the end of the tip. With the square end I have used the parting blade on up to $1^1/_2$in. dia. free machining

2. The parting tool blade released from its captivity

steel with considerable success. The main advantage is that as the tip is considerably wider than the blade, relatively speaking, there is plenty of clearance and no tendency to jam. Also being used 'up-side down' the chips tend to fall out rather than wait to be pushed. I am sure that a more knowledgeable reader will be able to tell me that this tip is the wrong grade of carbide. But at the price!

HOW IT WAS
Part 3

Bob Loader returns with more reminiscences of his working and model making life

Regular readers may remember that the editor has occasionally let me indulge in nostalgia about things past. The last of these finished when I left Camberwell and went back to the government research establishment where I did my apprenticeship, picking up the threads from where I left off, with the exalted rank of Research and Development Mechanic (Special).

An interesting interlude

The high point of my time there in the late 1950's was about 18 months working on a ground radar installation. We were a small team of about six fitters and instrument makers in close touch with the draughtsmen and engineers responsible for the job, without the usual civil service layers of bureaucracy in between.

Most of the work was what we called 'plumbing' - making up lengths of waveguide with all the flanges to join it and the copper formed bends to turn it round corners. Soft soldering the bends and flanges had to be just right. Any obstruction to the smooth passage of the radar waves caused problems with the voltage standing wave ratio. The 'VSWR' was often heard muttered like an incantation and anything wrong with it was extremely undesirable. So, in spite of the work being a little repetitive, it was quite interesting and often taxing.

There were chances to exercise skills other than soft soldering and one particular chance came my way. A component was holding up progress, it was a main workshop job which was normally done by jig boring. As there was only one jig borer, there was a long wait. I suggested that it could be done by the old fashioned tool makers' method of 'boxing' the holes and making D bits for the non-standard holes. There were misgivings; engineers and draughtsmen of the high calibre involved don't know a lot about some of the lesser known methods. When it came to inspection time, it worked a treat and was a bit of a nine day wonder, especially when our foreman got a rocket for getting the job done without going through the proper channels: the civil service finds that unforgivable.

Reputation made

The bit of improvised jig boring made my reputation and very likely helped to get me short listed for a job I was interested in. It was for a Technical Class Grade 3, the lowest rung of the staff ladder, and the first big jump 'off the bench' and out of the industrial grades.

In at the deep end

I got the job, which was to set up a first year training workshop at the National Gas Turbine Establishment at Pyestock in Hampshire, whose business was the testing of gas turbines and components. The first year training had been done previously at the Royal Aircraft Establishment at Farnborough, a couple of stone throws away.

So there I was, with the usual new job self-doubt, and a week to organise all the small, and not so small, tools and the hundred and one other things I'd need. I was still ordering necessary items from the stores for weeks, as I found I needed them.

Good news and bad news

As usual, there was good news and bad. The worst of the bad was that for a couple of months I would be living in the hostel, until somewhere was found for my wife, children and me to lay our heads. Another bit of bad was that, although the workshop was very well equipped for the 12 apprentices expected, the machinery was unfamiliar; I hadn't operated any of the lathes or milling machines. It wasn't too big a problem. All machines have common features, different manufacturers just put knobs and dials in different places. I found an easy solution, but it would have been nice to have done a job on at least one.

Now the good news. For starters, the training workshop was at least 10 minutes walk from the main complex, so no-one bothered me much. The apprentice supervisor, my immediate boss, was a great bloke whose philosophy was, 'chuck him in at the deep end and let him get on with it'. It did wonders for my confidence, and he was always just a phone call away if I needed him.

The workshop had more milling machines than lathes and bags of bench space. For a year I ran the whole thing with a sheet metal worker for the things I couldn't do.

My boss, one of the old school, used to turn up from time to time, and stand in the doorway listening to the sound of filing, with a look of pure pleasure on his face.

I solved the problem of the unfamiliar machines. As I had a foot in both camps, staff position but working industrial hours, the solution was easy. Due to a change in the industrials' conditions of service, they knocked off half an hour before the staff. When it started, all us industrials solemnly put our heads round the door to the drawing office to bid them goodnight as we left. Thanks to the change, all I had to do to get to grips with all the machines was to catch the staff bus to the hostel instead of the workers' one. This won me half an hour a day, ample time to run through each machine. It took about three weeks.

Of the apprentices, three were engineering apprentices, very much A level types, three technician, and the rest craft. The three engineers at the top of the tree were nice people and mixed well with the others. In spite of finding out that you don't realise how little you know about your own subject, till you try to teach it, and occasionally wondering if I'd bitten off more than I could chew, that first few months was a fine introduction to the business of teaching people the rudiments.

Fun and games

During the first week or so, the apprentices played the usual game of 'let's see if we can catch him out', which every apprentice worth his salt will do. The most penetrating questions came from one of the A level ones and he had his opportunity on the first of the demonstrations I did to give them some idea of how the machinery worked. I chose the biggest lathe in the shop, a Canadian built Monarch which had a swing of about 8in. It was an impressive sight, twirling round at 1000 revs or so. The only snag was that it wouldn't twirl. The motor was running lovely but as soon as the clutch was engaged, everything stopped. I fiddled for a minute and the youth looked down from his 6 foot odd and suggested, politely and diplomatically, that I had no idea what was wrong. I thought quickly and said that I'd get the maintenance men to look at it and they'd say the same as me, that the clutch linkage had come adrift. He hovered conspicuously while they took a cover or two off and confirmed what I'd said. I uncrossed my fingers, the youth gave me a respectful look and I had passed the first big test. It was not the last.

Taking chances

It is vital that the instructor can do anything he asks the students to do. Not only just do it , but do it better and quicker. Thinking about this, I remembered how, when I was a senior apprentice, I couldn't understand how the instrument makers could measure something with a rule and give the size to within a couple of thousandths. Having worked on very small components when I was at Camberwell, I found that I could do the same, especially with the smaller dimensions. In those days my eyesight was pretty good and I was rarely far out. It became a favourite game, trying to catch me out, especially as the business became addictive and I took wilder and wilder chances. The apprentices could understand it as little as I could when I was in their position.

Eventually, one of them issued a direct challenge, so I offered to mark out a pair of hole centres in a piece of scrap. He could then drill and ream them, put dowels in and measure the centres. He chose some unlikely dimension - $7^{9}/_{64}$ths rings a bell. I marked out, centre punched and left him to do the rest, walking away with my fingers crossed. It came right, within the two thousandths the young man allowed me. 'All a matter of practice', I told him, 'and holding your mouth right'.

The affair of the phantom machinist

I got caught out from time to time, including the day I thought that someone had defied my instruction that all machines were to be isolated during tea breaks and at lunch time. I could hear one going while we were all waiting in the tea queue. "Which idiot left a machine running?", I asked. There was a lot of pointing and grinning and I had to own up. I'd been using a machine, got called away by someone wanting help and forgotten what I was doing.

Special jobs for special occasions

I had very little trouble with discipline and it was a pleasure to work with them. For the very few times when an apprentice was troublesome I had a special job which I kept ready. Pyestock, being concerned with jet engines, had a few special materials including several sorts of Nimonic alloys, used to make turbine blades and other heat resisting parts. I had a piece of particularly tough alloy, $^{3}/_{8}$in. diameter and about 6in. long. It looked very innocent, just like a length of cold drawn mild steel and could be cut, as long as it was treated right and sawn slowly. I would ask the transgressor to cut an inch off and leave him to it without the usual advice, like "the gentleman who made this blade put teeth all the way along it and he wants all of them used" and "no more than 40 strokes a minute". Lacking these bits of advice, the youth would wield the hacksaw like a scrubbing brush, using about 30 teeth in the middle of the blade. By the time he had worn out, overheated or broken about three blades with a pathetic little notch to show for it, he would get the message.

Five good years

When my wife and children joined me life was complete again. In the five years I was there I learned a lot about the teaching business.

One of the things I got involved in was examining for City and Guilds. That was in the good old days, when craft apprentices did a practical as well as a written exam, at the second and fourth year. A good result at the fourth year stage meant that they were competent craftsmen.

As well as marking the completed test pieces, examiners had to visit the centres where the exams were taken, usually colleges, to make sure that everything was done correctly. The lecturers at the colleges I went to were surprised at the hours I worked and the salary. They were of one mind, that I was a mug and could be on better pay, fewer hours and longer holidays.

I began to look at the adverts in the technical section of the 'Times Educational Supplement and applied for and was accepted at Harlow College to teach workshop practice and associated subjects. In those days it was called Harlow Technical College and had grounds instead of a 'campus'. It also had lots of apprentices from local companies and the workshops were busy: these days it is difficult to find a genuine workshop class. It is though, easy to find 'O' and 'A' level classes, especially the ubiquitous sociology.

Many things were different; discipline at college depended on co-operation from employers. In day-to-day classroom work, a lecturer has a personality and students have antennae. If the antennae detect any weakness the students behave accordingly; luckily my previous five years had taught me most of their tricks.

I spent nearly 20 years at Harlow, teaching mostly the unfortunates who, not having done too well at school, were pushed into engineering as a last resort. They couldn't be blamed for their resentment at being written off. It was a great achievement when I managed to get some of them to do some maths and science and extremely satisfying.

As always, in any job connected with engineering there were great people to work with and many laughs, like the evening class student who, having been criticised for not having a very academic attitude, turned up in an academic gown and mortar board, sitting there in solemn state all evening.

A start in model engineering

While at Harlow Tech, I made a pair of 2.5cc model aero engines for my son. They worked well and I designed a 1.5cc one instead of using a commercial design. I made two of those, with thoughts of perhaps making a control line Mosquito but my son's interest faded as he got older and the engines are still untried.

When my wife bought me a Unimat 3 at the 1985 M.E. Exhibition, things took off. I had retired early, the management having made me an offer I couldn't resist. One of the factors which helped me to make the decision was when I was interviewing a young man for a place on a course for which I was the tutor, and he said "My dad remembers you". I thought then, time to go.

Since I have had the Unimat I have had a lot of fun, mostly working out how to do things the machine was not really designed to do. The editors of 'Model Engineer' and 'Model Engineers' Workshop' have been kind enough to use my occasional contributions. They may, in future, be even more occasional because I have recently moved to a very small flat, where there is no room for any sort of workshop. My thanks to everyone who has written to me and to the readers, without whose encouragement the business would be meaningless.

QUICK TIPS

Eye protection

Spectacle wearers who find eyeshields uncomfortable should try a full face vizor. Although heavier, it gives greater protection. Take a tip from the motor racing world and apply a layer of cling film which can be renewed when dirty. Have a proper storage space for the vizor to prevent damage.

For heavy jobs use a full face arc welding mask fitted with two layers of transparent material. Using eye protection is cheaper than new spectacles and better than no sight at all.

H&MPE

Safe and clean

When handling liquids or wastes, wear disposable gloves. Latex gloves are readily available from chemists or drug stores and cost but a few pence - cheaper than hand cleaner and save having to scrub off ingrained residues. Less oily hand prints around the home will meet with your partner's approval.

Polyurethane gloves are more durable but not as snug fitting.

H&MPE

Painting the workshop

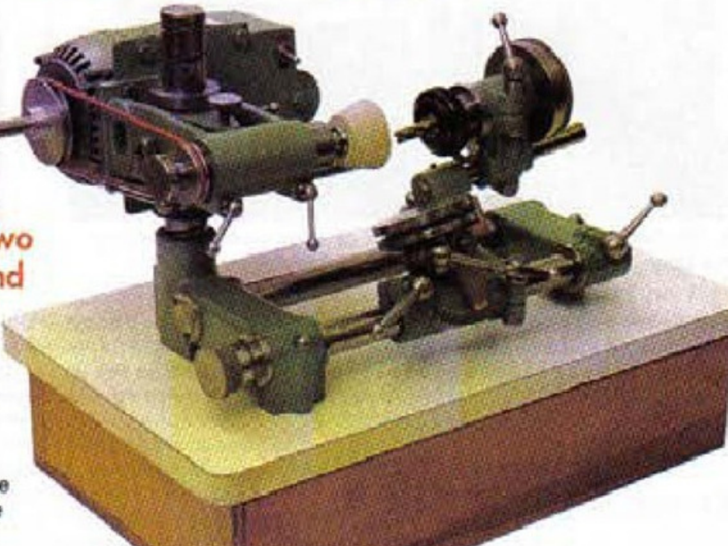
Use light colours to reflect light and improve efficiency of light sources. Have a large white surface somewhere, against which to view workpieces to check gaps.

When painting my workshop during the winter, I found that the emulsion paint was taking several days to dry properly. Running a small dehumidifier at night solved this problem.

H&MPE

COMPENDIUM OF THE QUORN

The popularity of the Quorn Tool and Cutter Grinder remains as high as ever, with casting sales continuing at a steady pace. Much has been written about the machine over the years, with suggestions regarding modifications and operating techniques. In this first part of a two part article, Philip Amos reviews the literature and adds a few enhancements of his own



Introduction

It gives great satisfaction to have available in the home workshop the Quorn Universal Tool and Cutter Grinder as designed by Professor D.H.Chaddock, and described in ME in 1974 and 1976 (References 2a to 2r) - later collected into an Argus book in 1984 (Reference 1).

Its simplicity and versatility are remarkable but, of course, like any other device it has problems both in relation to its manufacture and its use. These have been discussed in ME over the years by various contributors, some of whom have detailed useful alternative methods of construction or use, and various accessories to facilitate its employment to a wider range of activities. (See References 3a to 3i and 4a to 4x).

I purchased a copy of the book in 1985 and an Australian set of castings and materials a year later after studying the matter with some intensity. Manufacture was quite slow until my retirement in 1987 and did not really get going until 1988. Although some increase in pace then occurred, the machine did not reach the stage of first use until early 1994. Since that time improvements and reworking have been underway to overcome difficulties of various kinds. It seemed it might be helpful to others to record some of the problems encountered and the manner in which these were addressed - this is the purpose of the present article.

Goals

My goals at the outset of this project were threefold:-

- To construct a Quorn following the designer's methods and starting from the Australian kit of castings.
- To successfully use the machine for all the tool and cutter sharpening described by the author.
- To devise such additions and modifications as would improve the construction or facilitate the use of the machine.

Options & Elections

There were some choices to be made before proceeding with construction:-

1. The Australian kit of castings is for the Mark I Quorn, so this choice is pre-empted. Hence there are no castings for belt guard or wheel guard.

2. The motor available from the kit supplier is a 1/8 HP 240 volt 50 herz ventilated foot mounted split phase unit, so no capacitor is used - but see also Reference 4o.

3. It was decided to machine the coarse pitch thread on the vertical column.

4. The end face of the front bar was diamond lapped.

5. Threads used were BSW, NF, BA and Metric as appropriate. This lead to the micrometer thimble being calibrated with 60 divisions as the screw was M10 x 1.5; thus each division represented 0.025mm, which is the same as my lathe cross feed and my drill/mill down feed.

6. Dust covers for the main frame bars were spun over wooden forms from 22BG (0.79mm) black steel sheet.

7. Base casting holes were machined with a between-centres boring bar, as were the wheelhead bracket, wheelhead casting, toolholder, spiral head and tailstock.

8. Slitting was done with a 1/16in. wide slitting saw in the drill/mill.

9. Angular calibration was as recommended by the author, 0-40-40-0 and carried out in the drill/mill with components indexed by rotary table.

10. The rotating base was made to the alternative design with 20 off 2BA holes in lieu of a T slot.

11. The toolholder casting was made with a 1 1/8in. diameter bore, so as to accommodate No. 3 Morse taper mandrels, as recommended by the author, and other parts made to suit.

12. Two toolholders of the flanged pattern were made with respectively a square hole 15 x 15mm for most lathe tools, and a rectangular hole 21 x 10mm to use with an Eclipse parting off blade in its proprietary holder.

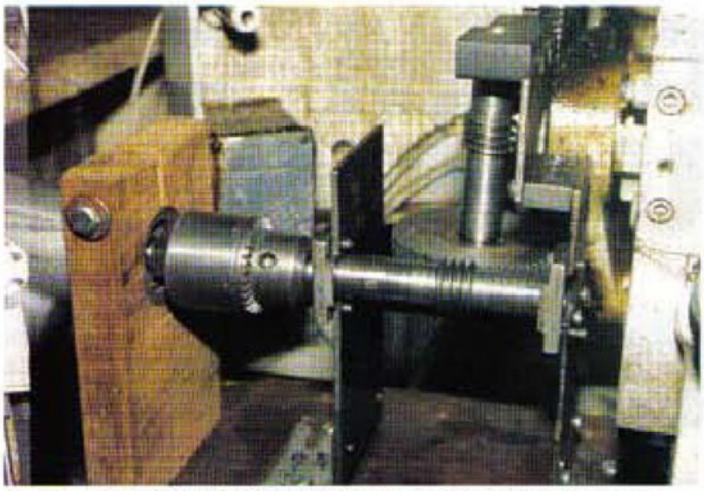
13. Dimensions of A13 magneto bearings are 30mm OD, 13mm ID, 7mm wide.

14. Two-switch wiring, as on page 61 of Reference 1, was used for safety sake (see also Reference 4o).

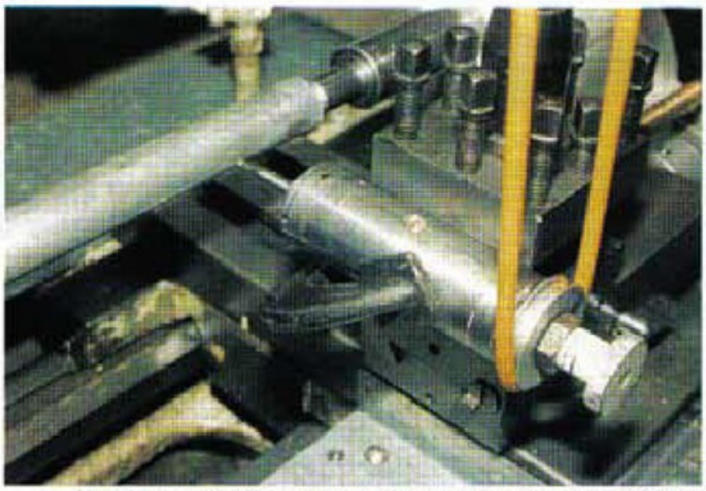
Selection of Construction Materials

Because I live near the ocean, almost any ferrous items in my workshop rust very quickly - probably due to moist salt particles in the air. So painting, plating, blacking and/or oiling are a requirement. However, because of the grinding effluent, oiling cannot be used with the working parts of the Quorn (except the spindle internals).

In these circumstances, and in retrospect, it would seem preferable to make the front, rear and vertical bars, the tooth rest bars, the bar beds, the micrometer thimble and other exposed bare parts from stainless steel. In this country, ground stainless steel grade T304 is available at a reasonable price, and it is not much more difficult to machine than mild steel. Other 'from stock' material might be made from bronze instead of cast iron.



1. Double reduction worm & wheel gearbox used to transmit the drive to the leadscrew from the Metabo drill



2. The Quorn spindle clamped to the lathe toolpost in order to mill the thread in the column

Very few suitable size grinding wheels are available in Australia to suit the Quorn application; hence most of mine have been obtained from the UK (in fact from regular advertiser Model Engineering Services of Eckington).

Errors & Omissions

Reference 1 does not show width dimensions on the base castings in Figure 3 on page 13. By scaling, the right hand base width is about 42mm (1.67in.). By cleaning up the Australian castings, the left hand base casting width is 50mm (1.98in.) and the right is 46mm (1.80in.).

On page 24, in Figure 15, the centre-to-centre distance of the two clamping screw holes is shown as $2^3/_8$in., but on the Australian castings this has to be $2^1/_8$in.

The drawing of the tilting bracket in Figure 25 on page 31 would be clearer if the top view depicted dotted both $^5/_{16}$in. diameter holes, as the centre line of the reamed one is otherwise left floating in mid-air.

The toolholder casting shown in Figure 35 on page 40 has two $^5/_{16}$in. diameter holes. One is used for the clamp bolt on the bar bed, but the other seems to have no use at all; it is not depicted on the original ME drawing (Reference 2e page 242), so can probably be omitted.

On page 54, in Figure 46, the spindle diameter of 13mm translates to 0.512in. (not 0.152 as shown).

Construction

Spindle

Professor Chaddock suggests in Reference 1 that if it is intended to machine the thread on the vertical column of the Quorn, it will be advantageous to make the spindle at an early stage, so that it can be used for this exercise. Thus I manufactured mine in accordance with his design and instructions. It is a very fiddly business with so many close tolerance dimensions, especially in the labyrinth seals. Measurement of some dimensions is not easily done after the parts are made, and it is difficult to determine whether there is any interference, and if so where. In fact, I had two goes at the spindle itself before I achieved a satisfactory result. The sliding spring box is another item which can cause trouble.

I was therefore very interested to later read about the design by D. Broadley in Reference 4g which employs Belleville style spring washers (obtainable from most bearing suppliers) to provide axial bearing loading. If I were repeating this task, I would probably modify the Quorn design to follow this other concept.

Before starting to build the spindle it is worthwhile reading References 4g, 4j and 10 as background information.

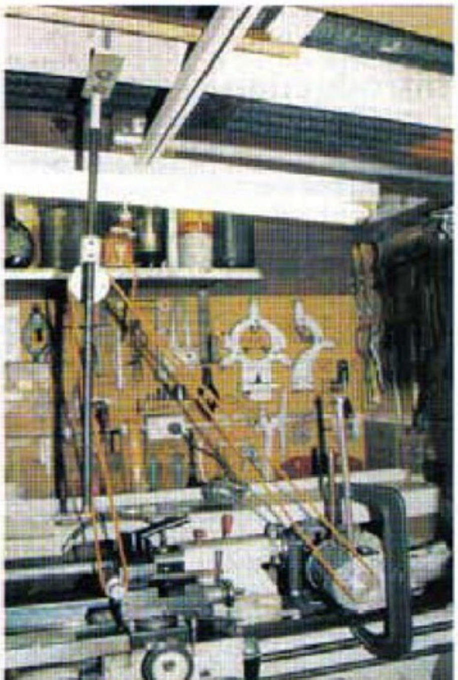
Professor Chaddock recommends packing the ball races themselves just level with molybdenum disulphide grease, and then filling sufficient light spindle oil (SAE 5 - known as 'fork oil' in the motor cycle trade in Australia) so that the lower balls just dip. So, how much oil is needed for this purpose? **Drawing 1** is a cross-section of the spindle with some geometry to arrive at a volume of about 2.6ml.

Vertical Column threading

The basic concept suggested by Professor Chaddock as to how to set about this task is well described in Reference 1. However, when your lathe has enclosed motor and countershaft and a Norton thread cutting gearbox it is less simple to arrange appropriate drives.

There are two requirements. Firstly, the ratio of the lathe spindle to the leadscrew rotations have to be such as to produce the required thread pitch. In its normal state my lathe has a gear train from spindle to gearbox of 40 teeth (idler 127 teeth) and 40 teeth, and this and the coarsest setting of the gearbox yields a $^1/_4$in. pitch thread. However, there is room to fit a 60 tooth gear at the spindle end and a 30 tooth one at the gearbox end (in lieu of the two 40 tooth ones), resulting in a $^1/_2$in. pitch thread. Because of the loading on the gear teeth it would be hazardous to try to cut a $^1/_4$in. pitch thread using the normal lathe motor power, and of course this is even more the case with the 60/30 combination, so an auxiliary drive from the leadscrew must be arranged. A 30 tooth gear was included in the lathe outfit, but a 60 tooth one (M1.25) had to be flycut in the drill/mill, indexing the blank on a rotary table. Also, the idler gear is a 127/120 tooth double and it was found more convenient to use the 120 tooth side in this instance.

The second requirement is how to drive



3. The overhead drive from the Quorn motor assembly which is clamped to the lathe bed

the lead screw and at a suitable speed for this thread milling operation. After much cogitation and unsuccessful experiments with Meccano pieces, the problem was finally resolved using a Metabo two speed (1600/600 rpm loaded) reversing pistol drill (360 watt output = $^1/_2$ HP approx.) as the power source and a double reduction worm and wheel arrangement as shown in **Photo. 1**. The lower speed was used. The worms engage with spur gears and are therefore angled to the gears for proper engagement (i.e. at the worm helix angle - in this case $3^1/_2$ deg.). By having one worm right handed and the other left, they are angled in opposite directions so that the input and output shafts become parallel - see **Drawing 2**.

The spur gears are of 62 teeth and the 30 teeth one mentioned above in the main lathe spindle to Norton gearbox train i. e. the one on the input to the Norton gearbox. Why 62 teeth? Well, I set out to make a 60 tooth one but messed up somehow and wound up with 62; but no matter, it suits this purpose adequately.

So, speed at the lathe spindle becomes:-

$600 \times {}^{1}/_{62} \times {}^{1}/_{30} \times {}^{30}/_{60} = 0.16$ rpm

For a vertical column of $1^{1}/_{4}$in. diameter, the circumference is 3.93in., so surface speed is $0.16 \times 3.93 = 0.63$in./min.

In Reference 8, Tubal Cain suggests the feed rate for slot drills of $^{1}/_{8}$in. diameter and below as:-

Tooth Load Factor x Cutter Diameter (in.) x RPM x Number of Flutes, which in this case becomes:-

$0.0007 \times 0.093 \times 4800 \times 2 = 0.62$in./min.

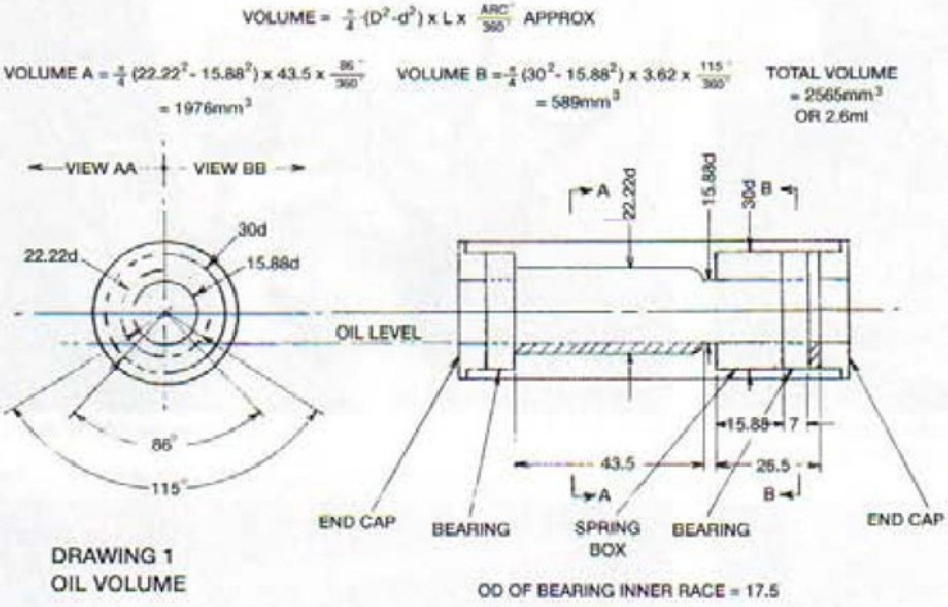
which looks a very neat fit - but note that the tool rpm at 4800 is on the high side. Tubal Cain's recommended rpm for slot drills is

RPM $= 3.8 \times 60 \times 1.1 / 0.093 = 2700$ approx.

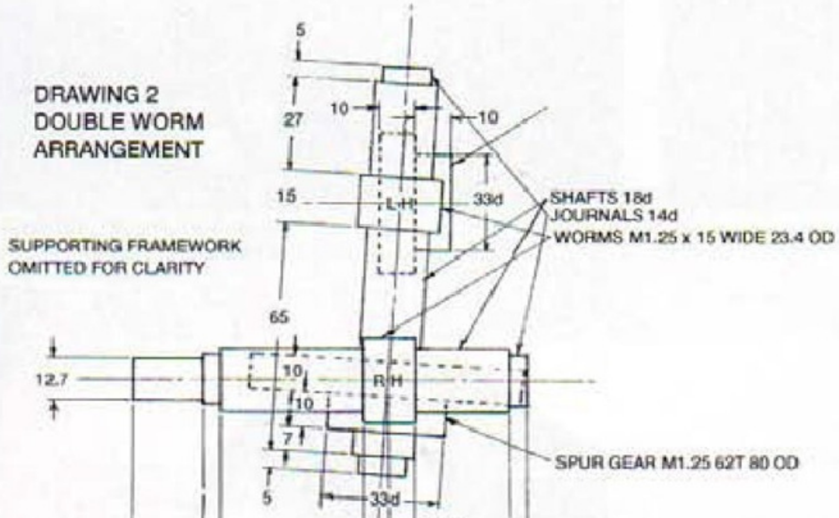
However I used 4800 rpm and it did the job - but I broke three slot drills in the process.

It is important when effecting the thread milling that the lathe split nut is left engaged and that the actual cutting is in the same direction (right to left) for both passes, lest backlash cause the tool to trace out a slightly different path and not produce a clean square thread.

The Quorn spindle is fitted with a $^{1}/_{4}$in. diameter collet, secured in place with its normal draw bar, to hold the $^{3}/_{32}$in. diameter slot drill. The spindle is held on to the side of the 4-way toolpost with a G clamp - see **Photo. 2**. The Quorn motor assembly is placed on the wooden lathe chuckboard at the tailstock end of the lathe bed and also secured in place with G clamps. The belt drive from motor to spindle uses an overhead arrangement as described by Tubal Cain in References 7 and 8. This is shown in **Photo. 3**. The overall arrangement is depicted in **Photo. 4**. Some may think it owes more to Heath Robinson or Rube Goldberg than to good engineering practice, but despite its eccentricity, it worked.

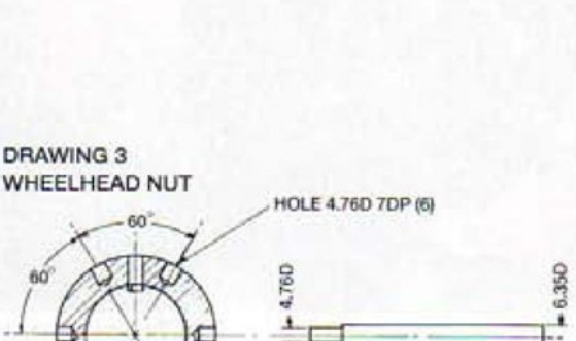


DRAWING 1
OIL VOLUME

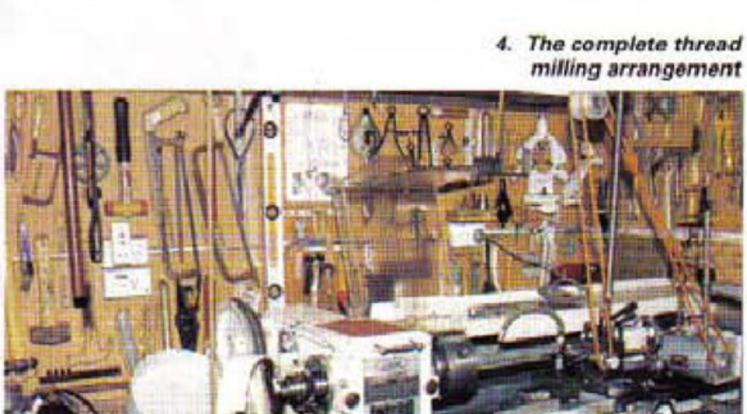


DRAWING 2
DOUBLE WORM
ARRANGEMENT

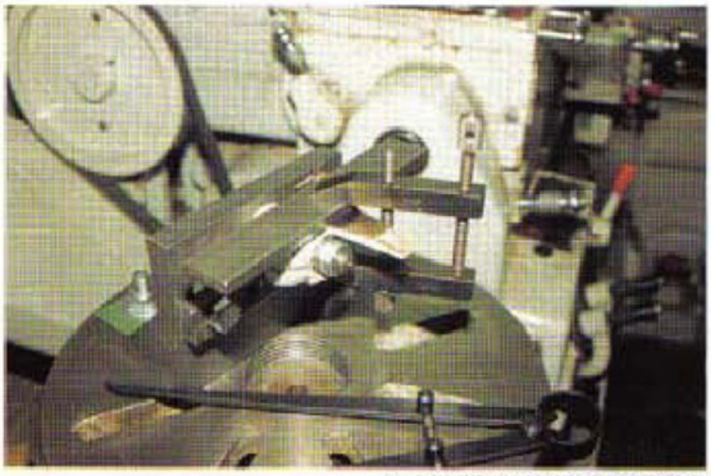
DRAWING 3
WHEELHEAD NUT



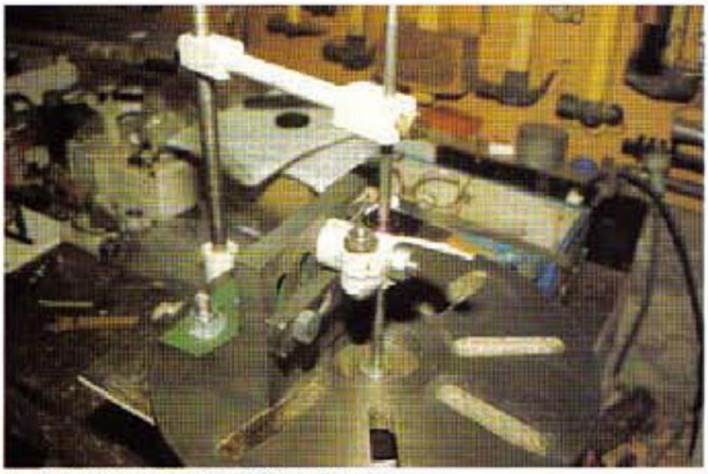
4. The complete thread milling arrangement



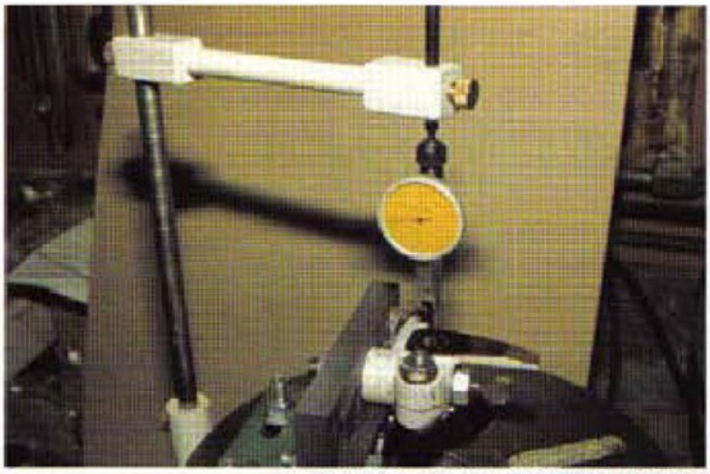
5. Modifying the Workhead Base. Careful packing and clamping is required when carrying out this operation



6. Levelling the Tilting Bracket



7. Rough centring the Tilting Bracket



8. Precision centring the Tilting Bracket. Note the prick punched location of the cone edge

In service it has been found that it is awkward to turn the wheelhead nut relying on its knurling alone. This nut has therefore been drilled with six equally spaced $^3/_{16}$in. diameter holes for use with a short tommy bar, which greatly improves the situation - see **Drawing 3**.

Clamping and Adjustment

(i) There are two distinct types of clamping and adjustment arrangements required:-

(a) Those that release to allow adjustment and then remain clamped during grinding operations.

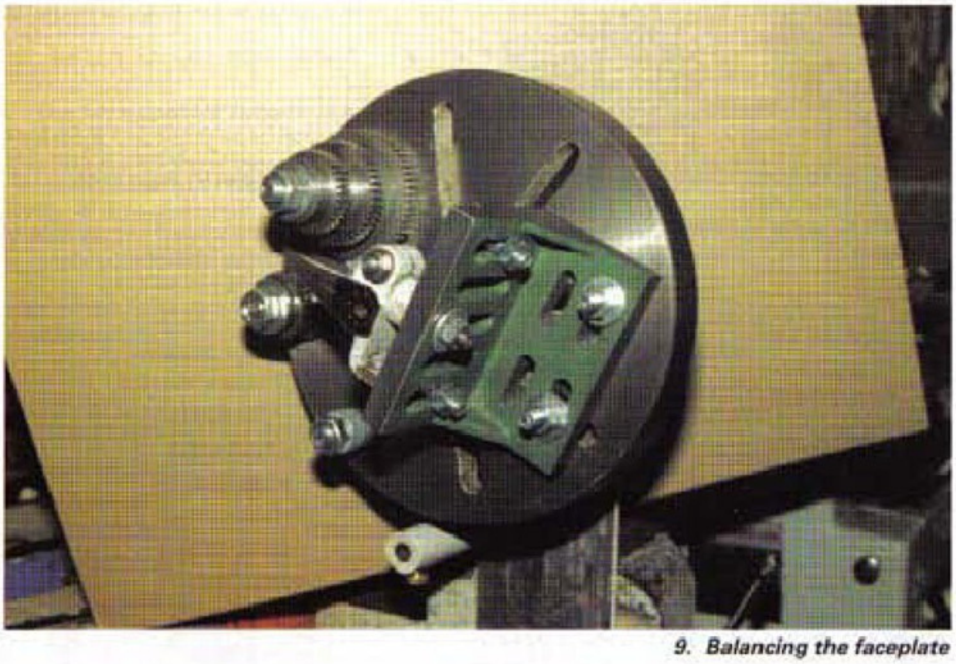
(b) Those that may or may not be required clamped or free during grinding operations.

(ii) It is imperative that all are quite firm when clamped and that excessive force is not required on the clamp handle to achieve this.

(iii) Likewise, movements required free for operations must be quite free and not jerky - i.e. easy sliding or rotating (must just about spin).

(iv) It is asking a lot of the flat/flat clamped joint between the tilting bracket and the workhead base to remain quite firm and not slip under load. The use of a paper washer between improves the grip but doesn't last long. A thin red fibre washer appears to provide an answer. An alternative construction by Professor Chaddock is given in Reference 4d - this matter is further addressed below.

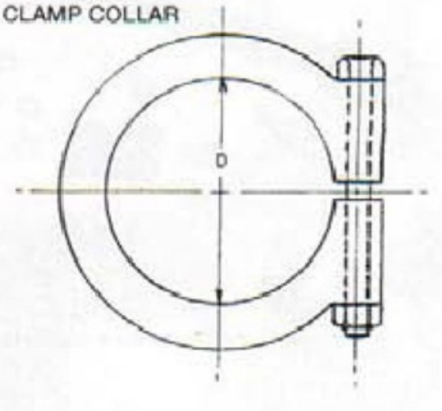
(v) It requires a nice judgement with clamping collars to provide firm clamping and easy running when unclamped.



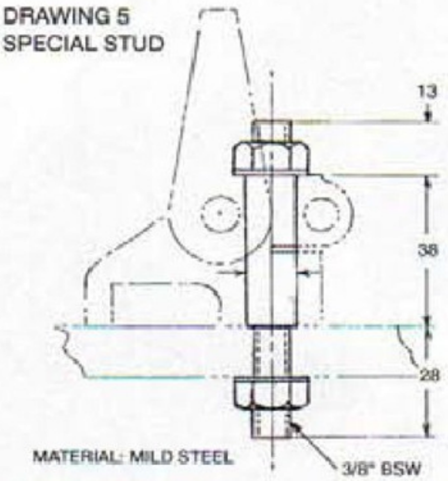
9. Balancing the faceplate

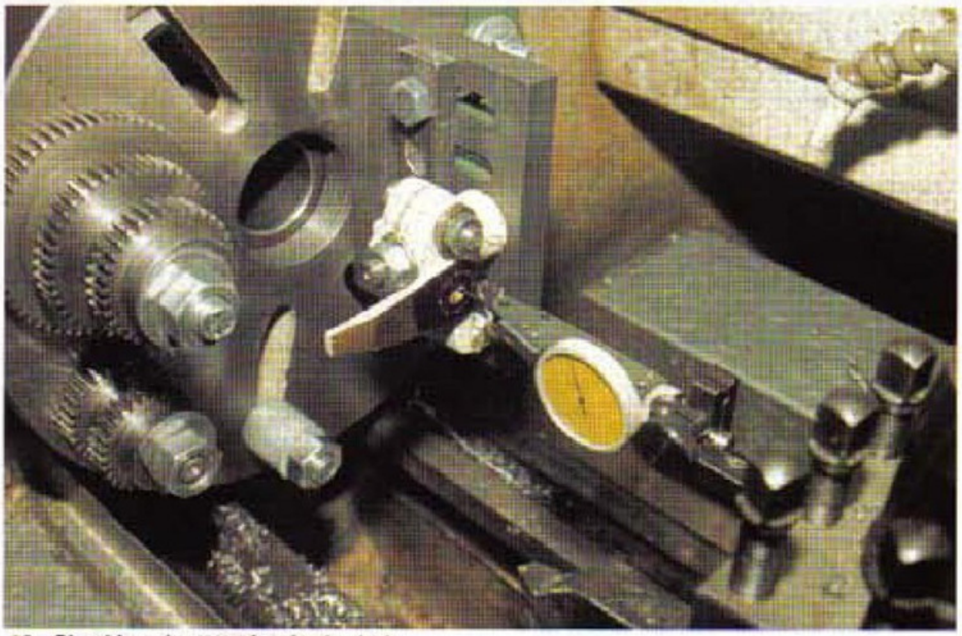
Reference 1 suggests "as neat a fit as possible for the front bar which must slide in them without play. If anything it is better to leave them on the tight side because they can always be lapped out afterwards." Just what constitutes "as neat as possible"? or "on the tight side"? After much fiddling around and trial and error, I

DRAWING 4
CLAMP COLLAR



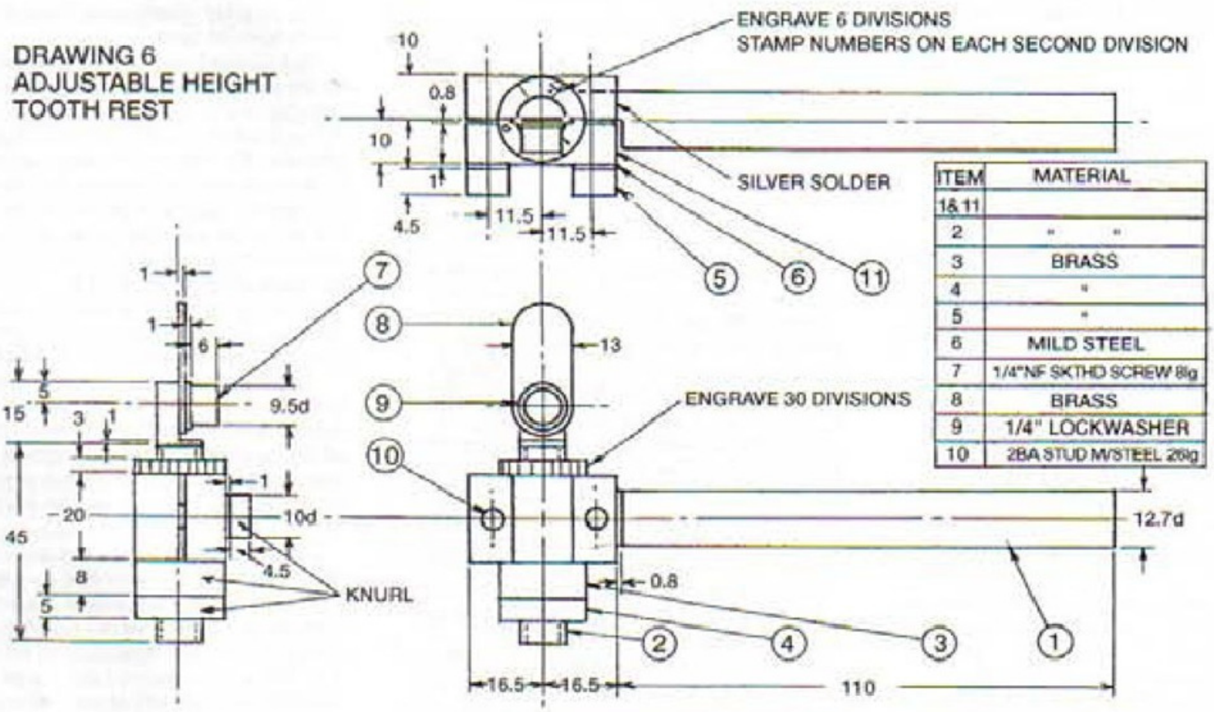
DRAWING 5
SPECIAL STUD





10. Checking the centring in the lathe

DRAWING 6
ADJUSTABLE HEIGHT
TOOTH REST



ITEM	MATERIAL
1& 11	
2	" "
3	BRASS
4	"
5	"
6	MILD STEEL
7	1/4"NF SKTHD SCREW 8lg
8	BRASS
9	1/4" LOCKWASHER
10	2BA STUD M/STEEL 20lg

have come to the view that Tubal Cain's figures given in Reference 6 can give a good starting point to define these terms. Referring to **Drawing 4**, measurement of change in diameter D, from free to clamped, of various main Quorn parts is about 0.04mm (say 0.0015in.). Hence, for firm clamping, shaft and hole dimensions cannot differ by more than about 0.025mm (say 0.001in.). For such Quorn parts of 25.4mm (1in.) diameter, this clearance corresponds to a Tubal Cain "Precision Run Fit". This matter is further addressed in Reference 41.

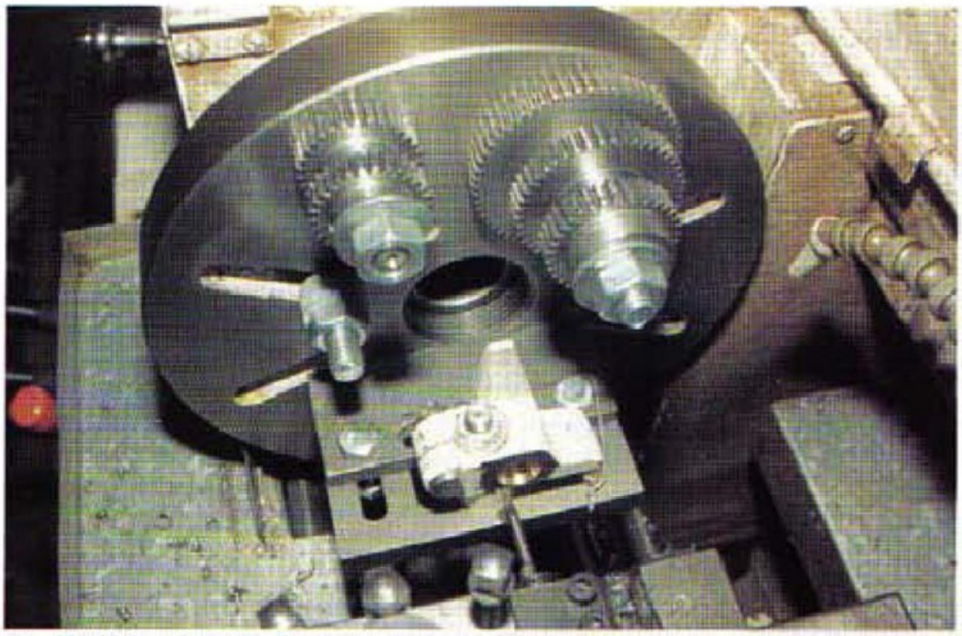
Because of irregularities in size and roundness in the various Quorn holes, the above clearance may be too tight and not allow easy movement when unclamped. It will therefore be necessary to engage in a 'lap and try' iteration until a balance is achieved where the parts can be easily clamped, yet provide easy movement (either axially, rotationally or both) when unclamped.

Tilting Bracket Clamping

Introduction

In Reference 4d, Professor Chaddock sets out an improved alternative method of clamping the tilting bracket to the workhead base. As he explains it is a "metal off" change, so that Quorns built to the original design can be modified to the new system. His drawings are reproduced here as **Drawing 5**.

Two existing components require further machining and a new clamp bolt arrangement has to be manufactured. This seems all quite straightforward but in fact there are some quite tricky bits.



11. Machining the second cone on the back of the bracket

12. The new adjustable height Tooth Rest

Clamping Bolt

This is a simple turned detail. It requires a milled or filed flat across the base of the cone. This part was held in the milling vice, supported on parallels (as described by George Thomas in Reference 5) and with a piece of card in the jaws to improve gripping. The diameter of the bolt was just below the top face of the vice jaws, so that the item could be firmly held, but the face could still be machined.

The hole for the locating pin was drilled with just the end of a BS 1 centre drill ($^3/_{64}$in. diameter) in the drill/mill after positioning it with a needle point centre finder; the hole was then opened out to $^3/_{32}$in. diameter for 5mm deep. The pin was Loctited in place (680).

The matching loose cone is quite a difficult part to produce. The procedure used here was to turn the cone on the end of a piece of $^5/_8$in. diameter steel bar and to drill and ream the $^5/_{16}$in. diameter hole through its centre. The part was then clamped in the milling vice between its end faces, again with a piece of card to improve grip. In this case the diameter was arranged $^1/_{16}$in. above the top of the vice jaw so that a $2^1/_2$in. diameter x $^3/_{32}$in. wide slitting saw could cut the axial slot with a $^1/_{64}$in. clearance to the top of the jaw. This slot was made sufficiently long to fully encompass the ultimate $^1/_4$in. axial length of the part. The item was then placed in the lathe 3-jaw chuck and its cone end bore was supported by a rotating centre. A parting-off tool was used to form a groove, not quite through to the centre hole and defining the $^1/_4$in. length of the part. It was cut off its stub with a hacksaw, and the end carefully filed down to conform to the groove face by rubbing the part along a second cut file on the bench. The part was rotated 90 deg. after each five strokes and this allowed the end face to gradually approach the groove face, until eventually these blended all round.

Workhead Base

There seem to be two possiblities here:-

(i) Hold the base clamped on a spigot with its own clamping arrangement. The spigot would have to held in a chuck on a vertical rotary table or on V blocks or some such similar device.

(ii) Clamping directly on the drill/mill table.

The second alternative was chosen as a more positive clamping arrangement. As shown in **Photo. 5**, the base is pushed against a fence at right angles to the table slots, and against a parallel in one slot of a clamping plate (as described in Reference 4h). The lug to be machined is supported on a pack of shims and two clamps hold the whole thing in place. The face of the lug (previously machined when the Quorn was built) was checked with a level and appropriate shims used to make it horizontal in both directions. A $^3/_4$in. diameter end mill was used to make the $^1/_8$in. deep rebate with 2.5mm side cut per pass. Although a 5mm side cut would have been allowable, the narrower cut was preferred as a cautionary measure.

When this operation was completed, the base was turned over and similarly clamped and checked. The $^3/_4$in. diameter spotface was effected with a slot drill.

13. The Tooth Rest dismantled

Tilting Bracket

The methods of holding this component for original manufacture did not seem likely to be sufficiently secure for its remachining, so another procedure was devised.

First the part was clamped to the drill/mill table with its $^5/_{16}$in. diameter hole vertical and the tongue uppermost. A skim cut was taken over the tongue to ensure it was parallel to the opposite face.

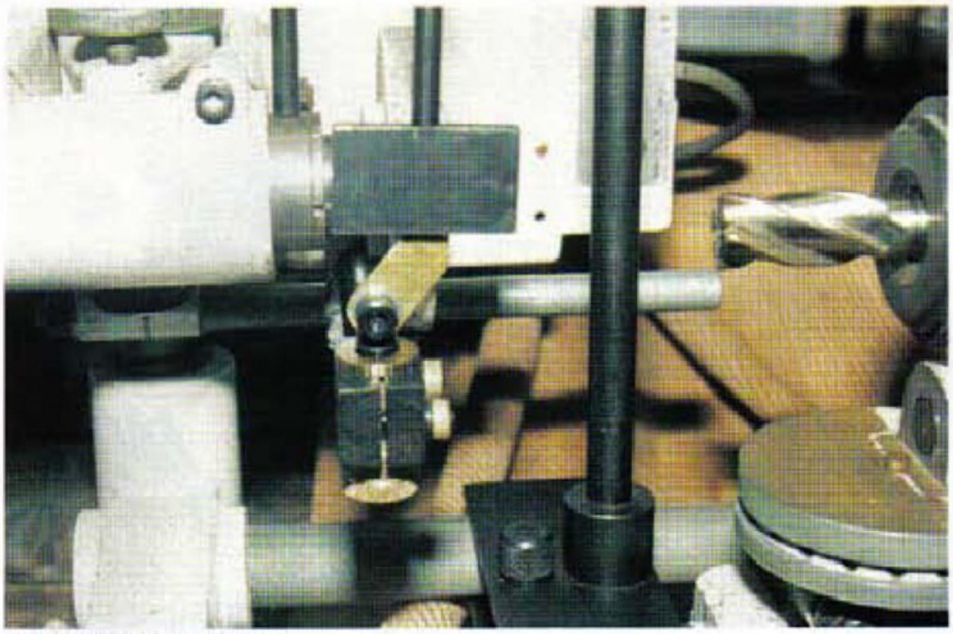
A special stud **(Drawing 6)** was made to attach the part to an angle plate mounted on the lathe faceplate.

Using a special dummy lathe spindle device (following Reference 4f), the part face to be machined was made parallel to the faceplate. This was done by clamping a parallel temporarily to the face and then checking each end of the parallel to faceplate gap with internal calipers **(see Photo. 6)**. When this process was completed, the nuts on the special stud were tightened and the rotating base clamp also tightened. Further, a bar was attached to the angle plate and tightened in contact with the underside of the tilting bracket and the latter was also wired to this bar - thus positively preventing the tilting bracket rotating in either direction on its special stud.

The tilting bracket was centred roughly using part of the kit of the lathe dummy spindle device **(see Photo. 7)** and then more accurately with a dial indicator **(Photo. 8)**. After tightening up the bolts holding the angle plate to the face plate, the spindle device was turned 90 deg. in the vice and its locking pin removed. This allowed the faceplate to rotate, and balance weights were fitted until the whole arrangement would remain in any angular position, thus demonstrating that static balance had been achieved **(Photo. 9)**.

The faceplate was then transferred to the lathe, checked for concentricity with a dial indicator **(Photo. 10)** and machining of the conical hole undertaken at lowest open speed (225 rpm) with a small boring tool (George Thomas design in Reference 5).

The central hole was not opened out to $^3/_8$in. diameter at this stage as the reamed $^5/_{16}$in. diameter hole would be used for setting up the part when reversed to machine the opposite conical hole **(Photo. 11)**. When this second cone was completed, the central hole was opened out to the required $^3/_8$in. diameter, which allows it to clear the key pin in the special clamping bolt.



14. Setting the Tooth Rest

Assembly

As with all other clamping handles in the Quorn, it is necessary to provide a washer of suitable thickness to ensure the clamping handle is in an appropriate angular position when clamped or free.

The assembly of the whole arrangement is much improved by the revised design. The sequence can be:-

(i) Workbase clamping bolt

(ii) Rotating base clamping bolt in tilting bracket

(iii) Rotating base screw to retain it in the tilting bracket

(iv) Tilting bracket clamping special bolt

(v) Secure tilting bracket to workbase

Calibration of the tilting bracket pointer is effected exactly as is described for the original design. It may be found necessary also to recalibrate the fiducial line on the rotating base.

So, in conclusion, the revised arrangement is not only easier to assemble, it is far more positive in its clamping action. The use of the revised arrangement at the outset is therefore recommended, despite the extra work involved.

Tooth Rest

The tooth rest clamping arrangement holds the blade quite solidly in position, but it is hard to make fine adjustments to its height. Furthermore, the blade shape required for use when grinding the sides of helical end milling cutters is different to that shown in Reference 1 and better arranged as shown in Reference 11. From consideration of the tooth rest designs in Reference 11 and what could be incorporated in the Quorn, an alternative tooth rest has been devised as shown in **Drawing 7 and Photos. 12 and 13.** It is intended to provide a screw height adjuster in a small space. It comprises a steel screw M10 x 1.5 running in a knurled brass nut (or reel) which is held in a split clamp on the end of a support bar. The screw also carries a knurled brass locknut. The dimensions drawn allow 10mm of vertical movement, although 5mm may well be sufficient for most purposes. The top edge of the reel is divided into 30 and its flat face into six, with each second line numbered. Thus each division on the edge represents 0.05mm height movement. The edge of the fixed part of the clamp is radial; and the blacking on the corner has been removed with a stroke of a Swiss file to provide a fiduciary line. In actual use this calibration is not necessary as the tooth rest is merely raised to touch the appropriate distance piece of the setting device described in Reference 4p. However, it was felt it might come in handy for some as yet uncontemplated use in the future.

The sequence of manufacture of the clamp is firstly to drill and ream the axial hole for the support bar and Loctite (680) that in place. When it is set, drill and ream the seat for the reel and drill tapping size for the clamp studs.

Next use a 1/32in. thick slitting saw to transversely half separate the block from the support rod and then, at right angles to this, to axially half separate the block, ensuring that one side of the saw cuts along the centreline and that the kerf is in the moveable part of the clamp. Tap the fixed part 2BA and open out the holes in the moveable part to 5mm diameter. Loctite (680) the studs in position. Dot punch both halves so that they can always be assembled the same way round.

It is important that there is no shake or wobble in this device. The reel is tap threaded and the screw is lathe cut with frequent trials of the reel until it will just freely engage the screw. Similarly, the part of the reel to be clamped is machined to diameter but slightly narrow between its cheeks which are then cautiously opened out until it will just fit the clamp body width. Nothing hard about this - just take it slowly.

In operation the tooth rest is positioned roughly about 2mm below its required height as shown by the distance piece. The locknut is released and the clamp nuts loosened so that the reel can be turned. The tooth rest is held so that it does not rotate, and the reel is rotated until the tooth touches the distance piece The clamp nuts are tightened and then the locknut **(see Photos 14 and 15)**.

References.

1. The Quorn Universal Tool & Cutter Grinder - Professor D. H. Chaddock.

2. 'Model Engineer' articles which, with some differences, together more or less equate to the above:-

a. 4 Jan 74 pp 19-22
b. 18 Jan 74 pp 68-71
c. 1 Feb 74 pp 121-124, 128
d. 15 Feb 74 pp 185-189
e. 1 Mar 74 pp 242-252
f. 15 Mar 74 pp 289-292
g. 5 Apr 74 pp 343-345
h. 19 Apr 74 pp 385-388
i. 3 May 74 pp 433-435
j. 17 May 74 pp 484-487
k. 7 Jun 74 pp 535-538
l. 21 Jun 74 pp 580-583
m. 5 Jul 74 pp 632-633, 659
n. 19 Jul 74 pp 684-688
o. 2 Aug 74 pp 736-740
p. 16 Aug 74 pp 822-823
q. 3 Dec 76 pp 1186-1190
r. 17 Dec 76 pp 1288-1289

3. Model Engineer articles and correspondence in support of or criticising the Quorn:-

a. 4 Oct 74M.	W. Thomas	pp 965-968
b. 21 Feb 75	"	pp 196-198
c. 7 Mar 75	"	pp 227-229
d. 21 Mar 75	"	pp 303-304
e. 4 Apr 75	"	pp 348-351
f. 20 Jun 75	"	pp 617-618
g. "	A. E. Case	p 618
h. 15 Aug 75	D. H. Chaddock	pp823-824
i. "	C. A. Schofield	pp 824-825

4. 'Model Engineer' and 'Model Engineers' Workshop' articles on modifications, additions to and uses of the Quorn and related matters:-

a. Drill Grinding on the Quorn - I. Strugnell ME 4 Jul 78 pp 781-784.

b. Collets for the Quorn - Bill Farmer ME 4 Jun 82 pp 682-685.

c. Comment on 4b - M. G. Satow ME 1 Oct 82 p 422.

d. Modifications to the Quorn - D. H. Chaddock ME 5 Sep 86 pp 272-273.

e. Constructing a Quorn - J. L. Ridgers ME 20 Nov 87 pp 610-611.

f. Faceplate Setups - R. Eldridge ME 1 Jul 88 pp 22-23.

g. A Grinding Spindle - D. Broadley ME 19 Jun 92 pp 722-724, 17 Jul 92 pp 84-85, 21 Aug 92 pp 224-225.

h. Small Workholding Clamps - R.

Fletcher MEW Issue 3 (Winter 90/91) pp 28-29.

i. An Elegant Ball Turning Tool - G. W. H. Swallow MEW Issue 11 (Jun/Jul 92) pp 44-46.

j. Milling/ Drilling Spindle - T. Skinner MEW Issue 17 (Jun/Jul 93) pp 14-20

k. Another Quorn - Theo Gooden MEW Issue 32 (Nov/Dec 95) pp 17-19.

l. Clamping Collars - Philip Amos MEW Issue 33 (Jan/Feb 96) p 69.

m. Cylindrical Grinding in the Lathe - Philip Amos MEW Issue 40 (Jan/Feb 97) pp 36-37.

n. Not Collets Again - Philip Amos MEW Issue 41 (Mar/Apr 97) pp 21-23.

o. Driving & Guarding the Quorn - Philip Amos MEW Issue 43 (Jul/Aug 97) pp 34-40.

p. Sharpening End Milling Cutters - Philip Amos MEW Issue 44 (Aug/Sep 97) pp 42-50.

q. Sharpening Slitting Saws - Philip Amos MEW Issue 45 (Oct/Nov 97) pp 28-33.

r. Sharpening Taps - Philip Amos MEW Issue 46 (Nov 97) pp 57-62.

s. Internal Grinding - Philip Amos MEW Issue 47 (Dec 97) pp 47-50.

t. Sharpening Reamers - Philip Amos MEW Issue 48 (Jan 98) pp 54-60.

u. Surface Grinding with the Quorn - Philip Amos MEW Issue 49 (Mar 98) pp 12-16.

v. Drills and Drill Sharpening - Philip Amos MEW Issue 50 (May 98) pp 44-50.

w. Turning Parallel - Philip Amos MEW Issue 61 (Oct 99) pp 17-18.

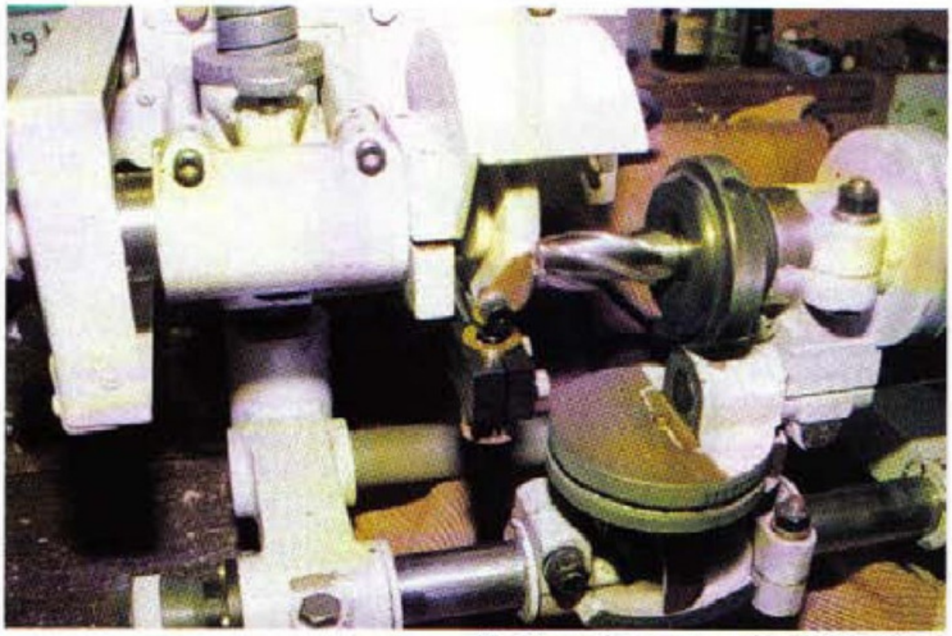
x. Some Boring Information - Philip Amos MEW Issue 53 (Oct 98) pp 60-61.

5. Model Engineers Workshop Manual - G.H.Thomas.

6. Model Engineers Handbook - Tubal Cain.

7. Simple Workshop Devices - Tubal Cain.

8. Milling Operations in the Lathe - Tubal Cain WPS 5.



15. Sharpening a cutter using the Tooth Rest

9. Workholding in the Lathe - Tubal Cain WPS 15.

10. Spindles - H.Sandhu WPS 27.

11. Precision Grinding Techniques - Jones & Shipman.

Supplier

Castings for the Quorn may be obtained from Model Engineering Services, Pipworth Farm, Pipworth Lane, Eckington, Sheffield S21 4EY Tel. 01246 433218

This article will be concluded Issue 63

MODEL ENGINEERING COURSES

Further to the information given in Issue 60, we have been sent details of two establishments in the Midlands which are offering courses which may interest readers.

Wulfrun College, Paget Road, Wolverhampton WV6 0DU
Tel. 01902 317700
Fax. 01902 423070
offers a full range of theoretical and practical courses during both day and evening. Their Course Directory lists, on Tuesdays 6.00pm to 9.00pm, 'Operatives Engineering, Years 1 and 2, (Incorporating Model Making)'.

Dudley College, The Broadway, Dudley, West Midlands
organises a course on 'Practical Engineering' on Wednesdays from 6.30pm to 9.00pm. The Course Tutor is Alan James, who can be contacted on
01384 455 433

LINK UP

Would readers wishing to make use of this facility please note that the maximum total value of items accepted for a 'For Sale' entry is £50.
To advertise goods of a greater value, please contact our Classified Advertisement Department.
Please indicate clearly if an item is intended for Link Up.

FOR SALE

- BOC Portapack gas welding set complete with trolley, 3 nozzles, cutting torch, all accessories, manual etc. No bottles. £50 buyer collects.
Tel. 01282 435843 (Burnley)

- 'Model Engineering' by Peter Wright. New, duplicate gift. £10.
Tel. 01420 477257 (Hants)

- Quick Change Tool Post Adapter with three tool holders to fit small four-way toolpost with gap to take $\frac{3}{4}$in. tool. £25
Tel. 01555 751740 (Lanarkshire)

WANTED

- Booklet 'Practical Notes for Clockmakers' by Eliot Isaacs.
A. Craven, Stanmore, Myrtle Lane, Penymaes, Holywell, Flintshire CH8 7BS Tel. 01352 711512

- Can anyone help me to obtain copies of Robin Dyer's series on construction of the Clayton Undertype steam Wagon? I have articles i, iii, iv, v and xiv. I require to complete the series before commencing construction.
Tel. 01274 882398 after 6pm

- Information on the 'Amolco' vertical milling machine or attachment, particularly regarding elimination of circumferential movement of head on column.
W. Walsome Tel. 0181 941 5304 (Hampton, Middlesex)

OPERATING A THREE PHASE MACHINE ON SINGLE PHASE SUPPLY

Shelley Curtis bought himself a lathe equipped with a three phase motor. With advice and support from a number of our advertisers he overcame some initial problems and now has it operating from a domestic single phase supply

1. The Eurotherm drive is mounted behind the headstock. The aluminium shield allows adequate ventilation whilst guarding against the ingress of swarf

"What I know about that I could write on the back of a postage stamp - in BLOCK CAPITALS"...!!

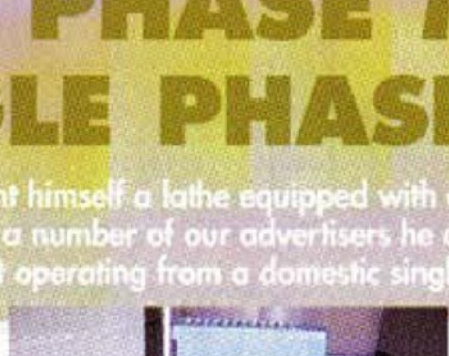
So ran an expression used by my father and which I recall from childhood days. It pretty well sums up my position vis-à-vis matters electrical today or rather, until I embarked on the adventure of running a recently purchased second-hand Harrison M250 (three phase) on domestic single phase supply.

First I tried a static converter. This proved unsatisfactory - the most horrendous thrashing of gears occurred as the spindle reached running speed. This was exchanged for a rotary converter as this - I am told - provides a more stable three phase supply. Again, this proved unsatisfactory. Although the headstock gears were quieter, at other than the higher speeds an uneven and very noisy rattle was superimposed over the normal gear whine.

The motor itself ran with what I can best describe as a 'hard' vibration, which could be felt through the lathe bed and saddle. Finish obtained on the workpiece appeared to be good. However, when viewed at different angles (rather as one looks at a hologram) there was evidence of faint diagonal patterning. None of these symptoms was present when I tried out the machine at the dealer's premises - running on mains three phase.

One evening, discussing this problem at our weekly gathering of model engineers at the local Tech, a much younger chap than I expressed the view that "converters are old technology. What you need is an inverter".

A further telephone call to the suppliers and they kindly agreed to exchange the rotary converter for a 601 Eurotherm Inverter.



2. The unit is secured to a bracket mounted on the rear of the headstock. If preferred it can be wall mounted

Unlike a converter, this unit embodies all operating controls and is connected directly to the motor - bypassing the lathe's switching and wiring circuitry. (It has provision for 24 volt remote control - more on that later).

Therefore you can strip out all the original wiring harness and switches - but retain the wiring to the emergency foot switch.

Rewiring the motor

The motor must be dual voltage (its plate will read 220-240/380-415) and you must change the motor wiring from 'star' to 'delta' connection. If your motor has a six terminal block you merely change two links. Mine has a four terminal block (enter Murphy, stage left!) with three winding leads attached to one terminal, one each to the other three ('star' connection).

By checking continuity with a meter, I paired up the leads and identified them with coloured tags. I then re-connected them to three terminals in series ('delta').

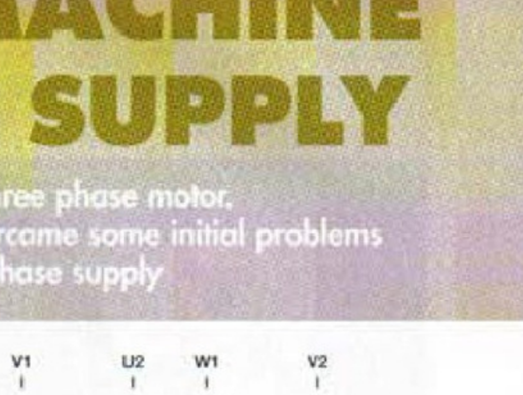


FIG. 1 'DELTA' CONNECTION 4 TERMINAL BLOCK

Having devised a suitable mounting arrangement for the 601 **(Photos. 1 & 2)**, I then connected it to the single phase supply and thence to the motor - and switched on. The motor was being energised but would not turn. I had apparently done everything correctly but had reached an impasse. Was the motor unsuitable for use with an inverter? I wondered. (Murphy again?)

This lathe is over ten years old and the motor was made by GEC Small Machines. I telephoned GEC at Rugby and they told me that the Small Machines business was acquired by Electrodrives of Birmingham some ten years ago and gave me their telephone number.

A call to Electrodrive's Technical department and all became clear! The windings are designated U, V & W and the leads are numbered U1, U2, V1 & so on. Identify these and connect as shown in the wiring diagram **(Fig 1)**. (With a six terminal block, just change the links to the positions shown in **Fig 2**).

This done, the unit worked perfectly.

Control settings

The second operation is to set the User Adjustable Parameters. Reference to the Instruction Manual supplied shows the

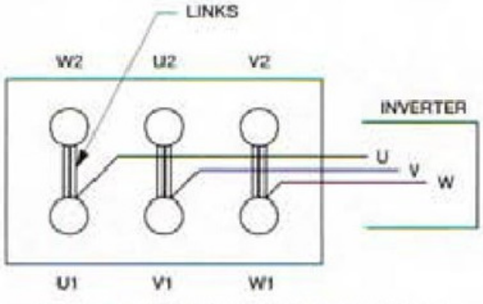
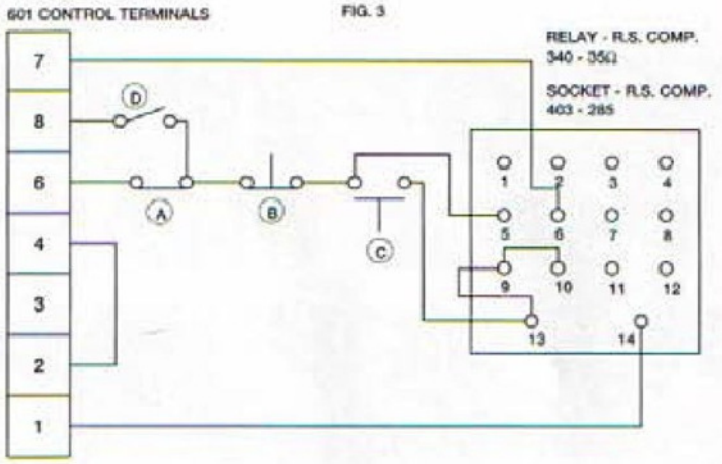


FIG. 2 'DELTA' CONNECTION 6 TERMINAL BLOCK



KEY:

(A) MUSHROOM HEAD EMERGENCY SWITCH LATCHING NORMAL CLOSED

(B) PUSH BUTTON STOP SWITCH NORMAL CLOSED

(C) PUSH BUTTON START SWITCH NORMAL OPEN

(D) FWD/REVERSE SWITCH ON/OFF

NOTE: JUXTAPOSITION OF 601 TERMINALS 7 & 8 PROVIDE CLARITY IN CIRCUIT DIAGRAM

3. The new control panel which allows 'Remote' operation

4. The panel has been incorporated into the lathe structure, bringing all controls conveniently to hand

factory defaults. If, as I do, you wish to run the motor at fixed speed (50Hz) and use the gearbox to change spindle speed, you will need to change some parameters. **(See Table 1)**. In most cases involving electronics and computers you cannot understand the instructions until you know how the equipment works. This is no exception!

However, further conversations with Eurotherm's Technical Department at Littlehampton enlightened me and I soon had the drive working on 'Local' - that is to say controlling the lathe was carried out by using the button switches on the 601 unit. This is not acceptable for everyday use as the switches are very small and a precision aim is not the ideal requirement when an emergency stop is called for! So the third and last operation is to set up 'Remote' switching using the 601's 24V control circuit.

The new control panel

For this it is best to start with a new aluminium panel and drill it to suit your new switches **(Photo. 3)**. I used the original mains isolator for the single phase supply to the 601. For the 24V circuit I purchased an emergency latching push button switch (contacts normally closed), an on/off rotary switch for the reverse circuit, green and red push button switch unit (Green/start - contacts normally open. Red/stop - contacts normally closed) and - to provide the essential no-volt release in the event of power failure - a 24V Relay, Part No 340-358, together with surface mounting socket, Part No 403-285, from R.S. Components Ltd., Corby. Connect up as in **Fig. 3**. The new control panel fits neatly below the headstock, with the switches conveniently to hand.

For those for whom a fixed 'Remote' panel is not convenient, I understand that Transwave can supply a pendant unit, the 3 metre flying lead of which permits control to be exercised from a position well away from the 601 unit.

A smoother start

An advantage of this system is the adjustable ramp-up time facility provided by the 601. I have set mine to take 3.5 seconds from pressing the start button to reaching full motor speed. Believe me, this gentle start is a revelation compared to the conventional violent full power shock transmitted through the headstock gears when no clutch is fitted. Headstock gear whine is now normal, no vibration is present and there is no patterning on the work.

Because an inverter is connected directly to an individual motor, it means that the coolant pump cannot be used unless an additional inverter is utilised. The simplest and cheapest way round that is to buy a single phase pump unit. But most model engineers don't need 'suds' on tap.

Support from the trade

I hope I will have enabled others to achieve a similar end, should they so desire, without incurring considerable expenditure of time and money on telephone calls. My thanks go to the staff of the companies I contacted for help. There's a mine of technical expertise out there which they are very willing to share.

And finally - so as to avoid giving the impression that I have become some sort of an expert - what I **really** know about this might now fill the back of **two** postage stamps - but still in **BLOCK CAPITALS!!!**

TABLE 1

Parameter	Function	Setting
P1	Minimum speed	50Hz
P3	Ramp-up time	3.5sec
P8	Jog speed	50Hz
P11	Stopping mode	1

If you wish to control the spindle deceleration when stopping, set P11 to 0 and P4 to the desired ramp-down time

ACKNOWLEDGEMENTS

Eurotherm Drives, Littlehampton.
(Wayne Jackson)
Circuitry and programming the 601.

Electrodrives, Birmingham.
(Chris Timmington-Taylor)
Advice on Delta connection of GEC Motor.

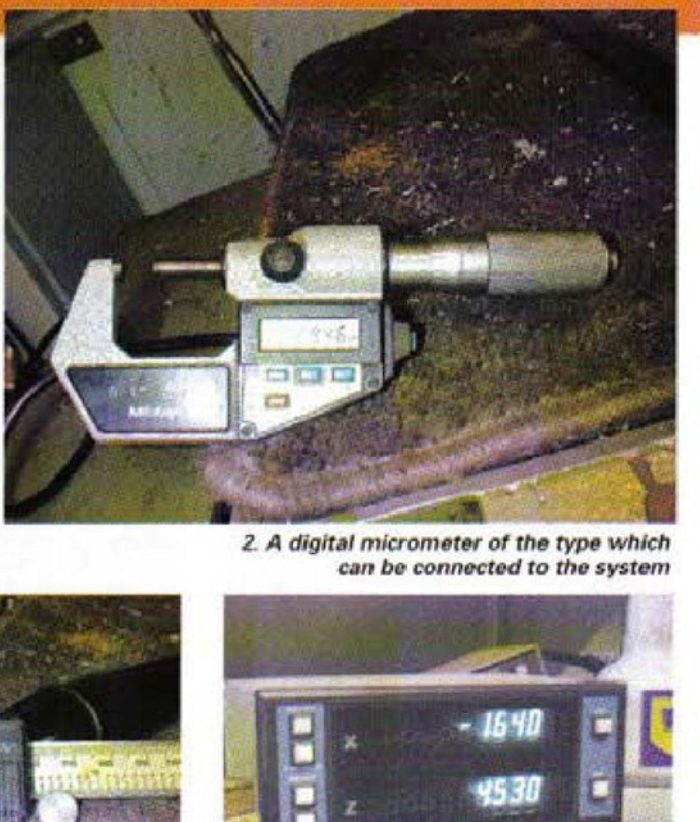
Power Capacitors, Birmingham.
(Matt Robbins)
Eurotherm 601 Drive. Circuitry for No-Volt Release in remote control panel.

Exhall Machine Tools, Coventry.
(Gavin) Control switches.

DIGITAL READ-OUTS FOR THE HOME WORKSHOP

Peter Rawlinson describes his experiences with commercial and home-made Digital Read-Out systems and suggests that it would not be difficult for the experienced amateur to construct his own

1. The 2 axis read-out of the system fitted to the author's lathe

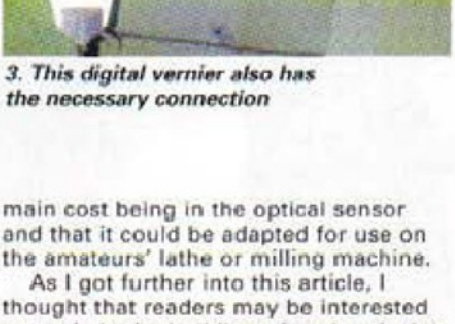


2. A digital micrometer of the type which can be connected to the system

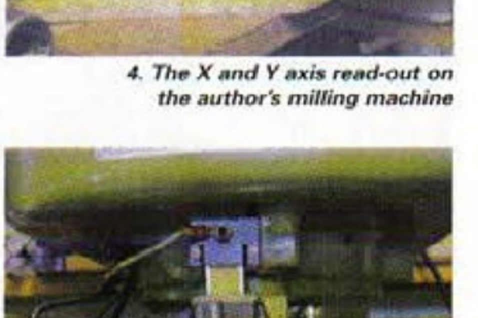
This article originated because, after completion of my CNC Mill, I found that it was awkward to re-set the Turret to the same height whenever it had been disturbed. It was therefore decided that some form of position marker such as a Digital Read-Out (DRO) was needed. Information was obtained from suppliers, but because the size of the Mill would not allow the fixing of a large unit, a small simple device, preferably of very low cost was required.

The next step was to investigate the possibility of building such a system, and while talking this over with a friend that I had met during discussions on the Band Saw blade Butt Welder, it was pointed out that Harold Hall, just at the time he became Editor of M.E.W. wrote an article on this very subject (Reference 1). This was duly read and it appeared that his solution could be ideal for my requirements, but it was suggested that, to eliminate the effects of backlash in the leadscrew, a wire could be wound round a pulley which would then turn an encoder, the wire being held taught by a spring. My friend had been using a similar system for a long time.

Having directed my researches in this direction, I now believe that it is possible to build an accurate and simple DRO for a single axis for about £120, the main cost being in the optical sensor and that it could be adapted for use on the amateurs' lathe or milling machine.

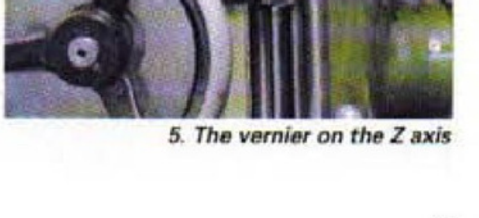


3. This digital vernier also has the necessary connection



4. The X and Y axis read-out on the author's milling machine

As I got further into this article, I thought that readers may be interested not only in the building of such a device, but also in the purchase and installation of commercial systems. I therefore decided to broaden the scope and to give some guidance as to the types which are available, together with some suggestions on interconnecting commercial and home-built equipment, a process which can, of course, save time, money and perhaps temper.



5. The vernier on the Z axis

6. The Z axis read-out

Background

I have had a DRO in my workshop for some 10 years and have, over that period, found it to be invaluable. It makes operations more accurate and it certainly saves considerable time, as it is not necessary to keep stopping to take measurements because the information is constantly up in front of the machinist in boldly lit numbers.

The DRO on my lathe **(Photo. 1)** is the more complex of the two as it can be 'programmed' - that is it can have diameter or a length requirement data fed into it. Alternatively, if a digital micrometer or digital vernier (with the appropriate output connections) **(Photos. 2 & 3)** is available, a measurement can be taken and simply by pressing two buttons this information can be fed into the DRO, thus allowing tool settings to be quickly known. It also allows the settings of a number of different tools to be stored in its memory and I believe that some of the more modern units have many additional features, such as the ability to calculate Pitch Circle Diameters and hole positions for flanges.

By comparison the DRO on my milling machine is much simpler and in fact consists of two separate systems, the first for the X and Y axis **(Photo. 4)** and a second for the Z axis. The X & Y axis unit could be used on a lathe as it is switchable for both radius and diameter but the read-out can not be programmed, only being capable of being reset to a zero reading, but I have not found this to cause any problems on the mill. The second unit (Z axis) is a capacitance type of read-out, similar to the digital vernier measuring gauges available from many suppliers **(Photo. 5)**. It feeds into a separate large size display **(Photo. 6)** as it has been equipped with the appropriate socket, only available when specified before purchase.

Both types are switchable to give both metric and Imperial measurements and, by slight alteration, can indicate movement in either direction, but I believe that this is now old fashioned because this feature is also switchable on later versions.

7. Components of the B. W. Electronics system

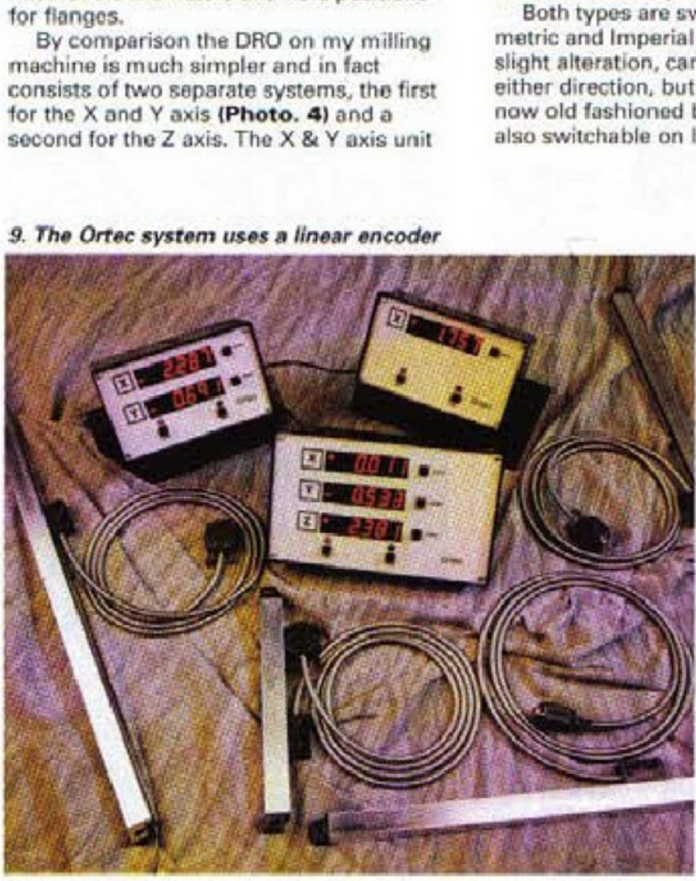
8. The B. W. system can also be adapted for use on a rotary table

Commercially available equipment

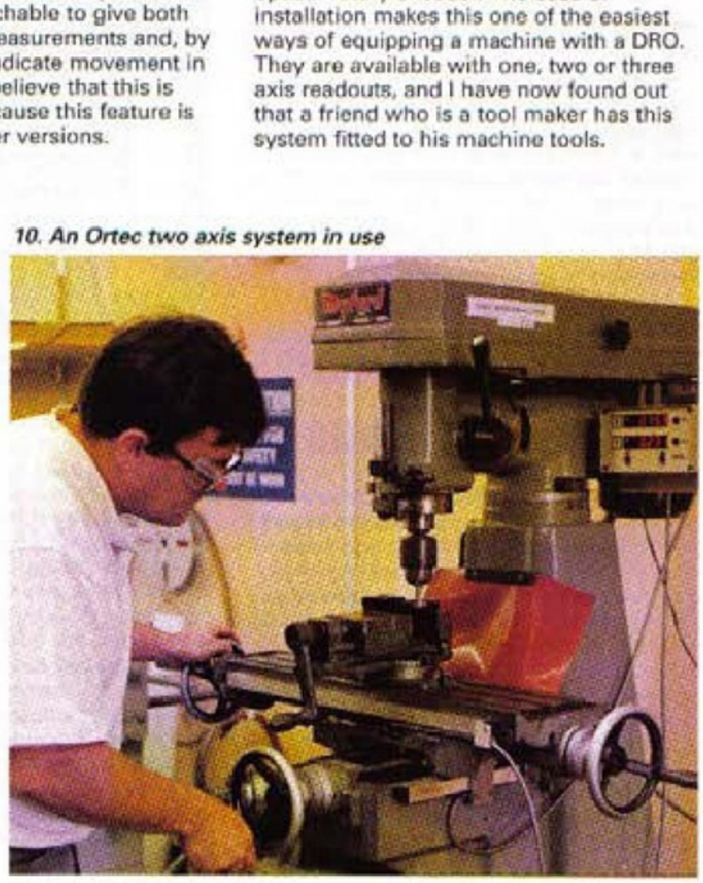
There are many manufacturers and suppliers in the market, a number of which are listed at the end of the article. Apologies in advance to those not mentioned. My own equipment is made by Mitutoyo but many of the points mentioned are equally applicable to the products from other manufacturers. All will have different specifications and, of course prices which, I understand, for the more standard packages start at around £700 and can go as high as £1300. Sets are available with very advanced features, with prices in the region of £3500. Some suppliers are more into the CNC side and theirs tend to be the higher priced set-ups.

One or two cater more for the amateur, one of these being B W. Electronics who produce a reasonably priced unit which uses sensors which can be moved from one machine to another without trouble **(Photo. 7)**. These units use a stretched stainless steel wire, held taught by a constant tension spring, which operates an optical rotary encoder. The ease of installation makes this one of the easiest ways of equipping a machine with a DRO. They are available with one, two or three axis readouts, and I have now found out that a friend who is a tool maker has this system fitted to his machine tools.

9. The Ortec system uses a linear encoder



10. An Ortec two axis system in use



Although of an older design than the current types available, he is most enthusiastic about the system, has had no problems and relies on its accuracy on both the mill and the lathes in his workshop. When he acquired his, the sensor was supplied as a self-assembly kit, whereas now it is supplied complete.

This system is well worth very close investigation as it can be purchased as sets of parts and therefore added to as and when required. It is also small enough to fit on the smaller machines which most of us use.

The added advantage of this system of wire encoders is that the wire, being so fine and flexible, can be taken round pulleys or even wrapped around the outside of a rotary table **(Photo. 8)**. This first arrangement allows access to difficult positions and the second, by the use of a calculator, can, in many situations, replace a dividing head. The manufacturer's literature gives details of this application. The measuring error to be expected from any sensor, as quoted by the manufacturer, is ± 0.002in. (0.05mm) which, due to the nature of the sensor, is cyclic and should be considered as a band 0.004in. (0.1mm) wide over the whole measuring range of the sensor. This range can be as great as 48in. (1200mm) depending upon the model selected.

There are other types of wire encoders on the market, but these are usually more expensive and will require a dedicated readout system to make them work. One is marketed under the name of Siko Ltd, a company which also makes a mechanical digital system and another very interesting system which uses a magnetic tape fixed to a stainless steel strip which can be fitted in place on the machine tool by the use of double sided sticky tape. The sensor moves along this tape counting the north and south poles as it travels. Again it requires a dedicated readout system, but the tolerance on the distance from the sensor to the tape is very wide (of the order of 1mm), making this a very easy system to set up.

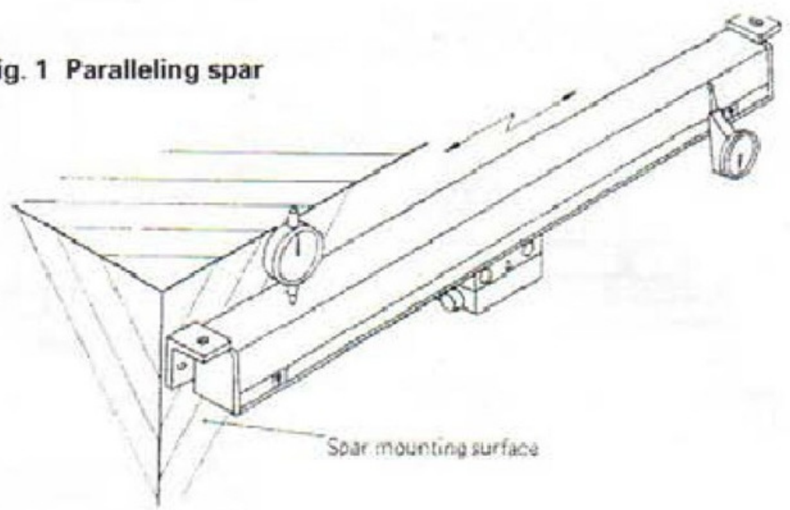
If the pocket is deeper, then the Accu-Rite, Mitutoyo or Heidenhain makes which use linear scales would certainly be a worthwhile consideration. Do however make sure that the resolution of the type considered is adequate especially the Y axis of a lathe cross-slide.

One linear scale system which is priced to suit the home workshop enthusiast is that from Ortec Limited of Guernsey **(Photos. 9 & 10)**. Covering a measurement range of 4in. to 18 in., it has a quoted system resolution of 0.001in. (0.02mm) and a maximum error of ± 0.001in. (0.03mm).

Mounting Linear Scales

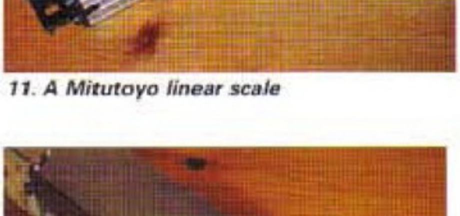
Mounting these scales **(Photos. 11 & 12)** is quite within the capabilities of the serious amateur engineer and requires only patience and a good dial indicator, plus of course a little 'nouse'. As the mounting positions do not always have flat machined surfaces it will be necessary to make the required brackets and to create suitable attachment surfaces or perhaps to use jack screws to give adequate alignment at the mounting points.

Fig. 1 Paralleling spar

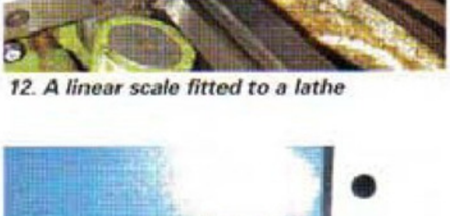


11. A Mitutoyo linear scale

12. A linear scale fitted to a lathe



13. Transit blocks which protect the components until they are secured in position



14. The graticule strip found in the Lexmark printer

It is unlikely that the tolerances I am about to quote are constant for all makes, but all manufacturers will supply their own manual with recommendations for mounting their particular scales.

My own scales are specified as accommodating a maximum out-of-alignment of 0.2mm over the full travel of the sensor, this in both directions (vertical & horizontal). This is achieved by locating the scale and lightly bolting it into place, but at this stage the sensor is not fitted and remains screwed to the spar with its 'in transit positioning blocks' **(Photo. 13)** which hold the sensor anchored to the spar until all mounting is finished. The dial gauge is then mounted on the cross-slide and wound by hand over the full travel **(Figure 1)**, adjusting the alignment of the spar until the requisite tolerance has been achieved. This will take a little time and patience to achieve, but must be done thoroughly or damage may be done to the scale.

The sensor is then fitted and must be shimmed such that there is no movement when the bolts are tightened. The positioning block screws are then removed and, if all is well, these blocks should just fall away. If they are tight then things have not been fitted correctly and a reverse procedure should be used, the whole assembly being rechecked carefully.

Of course, this procedure will vary in detail from supplier to supplier and the instructions given in the manual should be adhered to, thus reducing the chance of damage to the scale. It may of help, as well as using jack screws, to maintain the alignment by also mount the scale on a flat steel bar.

Just a point to note - the sensor has a limited movement in the longitudinal direction, so the unit should be purchased with a greater length of movement than the axis to which it is to be fitted. It should then be located such that the sensor can not pass the point of maximum travel in either direction. I am afraid I was guilty of making this error, but did not find out until some six or seven years later when the set-up required the X axis to be wound right back. 'OUCH'!

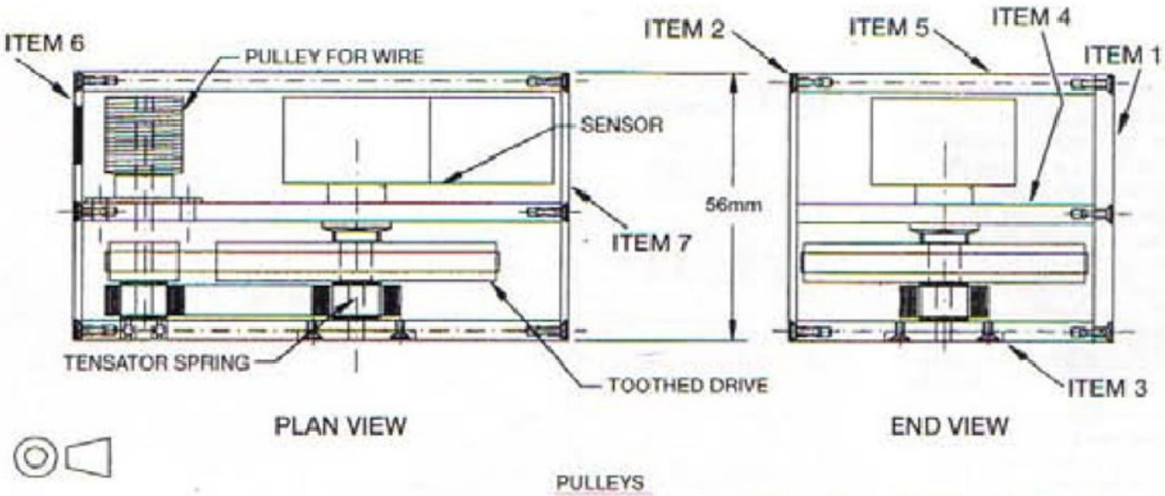
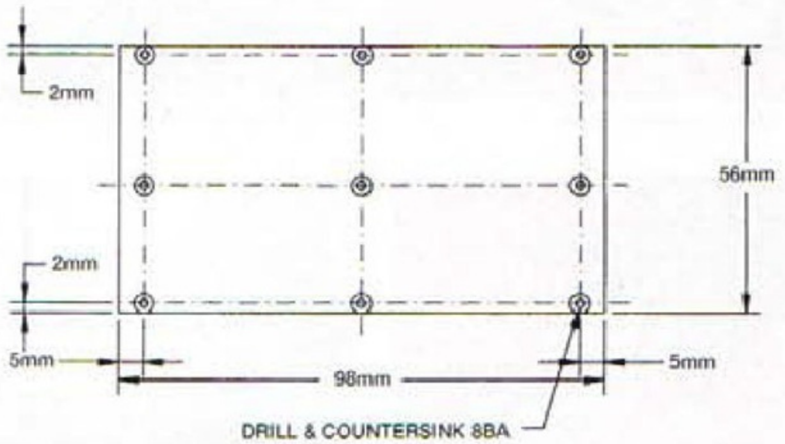
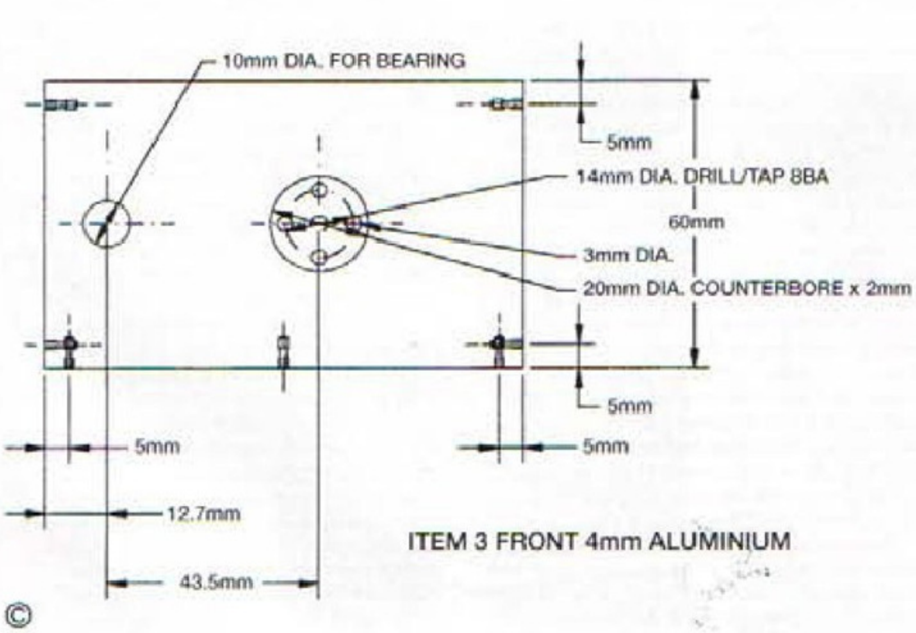


FIG. 2.
GENERAL ARRANGEMENT

PULLEYS
1 OFF 18 TOOTH 8mm WIDE, 4mm BORE HPC No. 18T2.5-8
PCD 14.32mm FLANGE OD 18mm
1 OFF 72 TOOTH 8mm WIDE 6mm BORE HPC No. 72YT2.5-8
PCD 57.3mm FLANGE OD 66.68mm
BELT
1 OFF 4mm WIDE x 2.5mm PITCH SYNCHROFLEX No. T2.5/210
OPTICAL SENSOR
FARNELL No. 730-944 (500 PULSES/REV.)
BEARINGS
2 OFF 3.0mm BORE x 10mm OD x 4.0mm WIDE



ITEM 1 BASE 4mm THICK ALUMINIUM
ITEM 2 TOP 1.6mm ALUMINIUM



ITEM 3 FRONT 4mm ALUMINIUM

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Build your own

For anyone keen to have a go at building their own system, it is probably sensible to consider the problem in two parts, firstly the position sensing or encoding element and secondly the electronics which convert the signals from that element into a form which will provide an intelligible display.

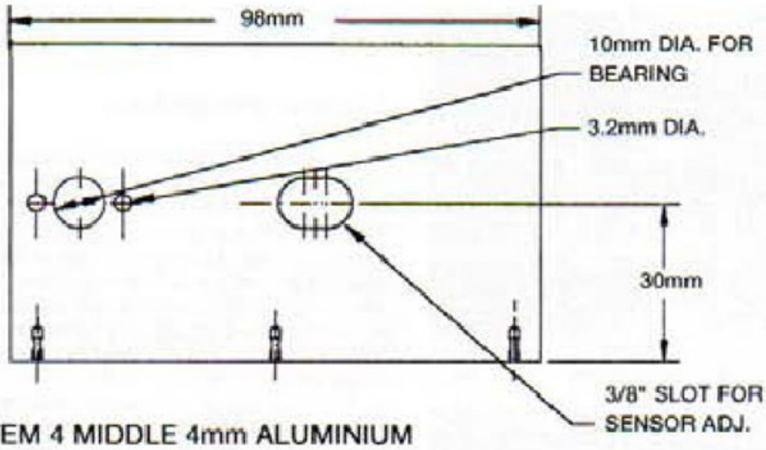
On checking Harold Hall's article, it was found that the main parts required are no longer available and further investigation suggested that there are no suitable equivalents. It was therefore necessary to get the books out and, after contacting the larger component suppliers, I have found a component which not only incorporates an eight digit display, but also has the rest of the control built in, thus providing a much simpler solution. This new component does not give the same overall characteristics as the previous design, but does entail considerably less work..

It is still necessary to build the 'Pulse and Direction Shaping Circuits' and, having contacted Harold, I am indebted to him for letting me use the design originally depicted in the original articles. I would recommend that these articles be read if they are available, as they deal with the subject more than adequately.

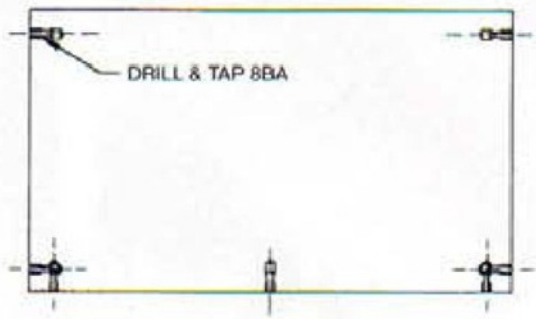
The remainder of this part of this article will look more closely at the subject of the sensors, while the electronics will be dealt with next time.

I will first describe some experiments which have provided one approach to the sensor problem.

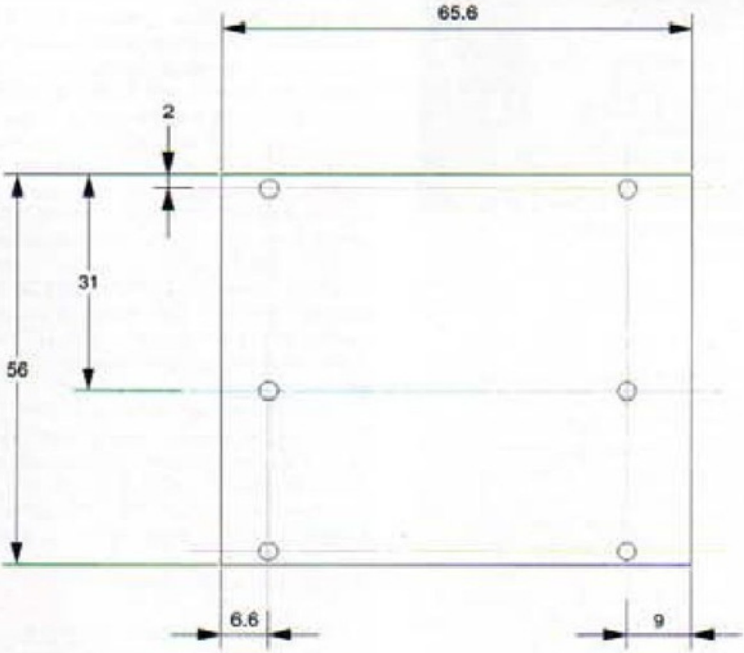
A short time ago, I was given a computer printer which had stopped working. Although it was only four years old, the 'big' store told my colleague that they did not repair them and to buy a new one. I expected to gain a couple of motors and a few bits, but was surprised to find a 5 volt stabilised power supply and some shafting. Incidentally, I found out that the power supply, if left connected to the mains, is live even when the unit is switched off, so be warned and turn off at the mains.



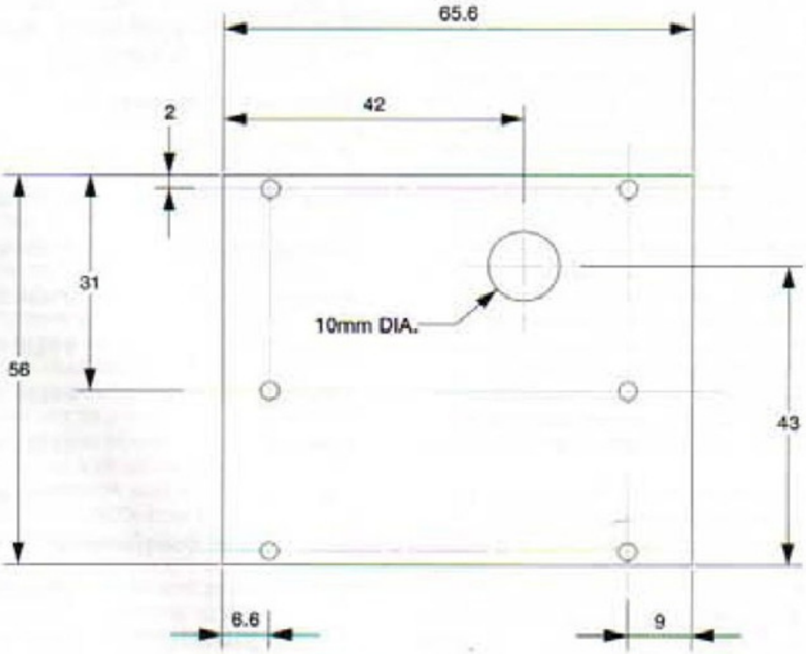
ITEM 4 MIDDLE 4mm ALUMINIUM



ITEM 5 BACK 4mm ALUMINIUM



ITEM 7 END PLATE
1 OFF 1.6mm ALUMINIUM



ITEM 6 END PLATE
1 OFF 1.6mm ALUMINIUM

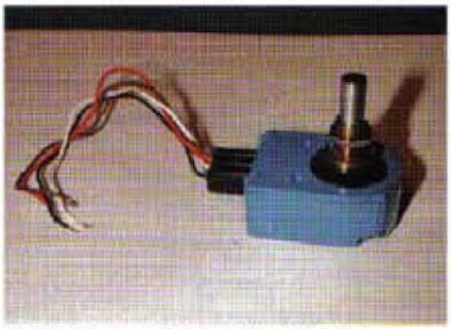
When stripping this unit, I noticed that there was a strip of what looked like Mylar running across the back, inside the printer and behind the ink carriage **(Photo. 14)**. This was under tension and kept this way by a plastic spring. On closer inspection under a magnifying glass, it was found to have on one side a grid of fine lines at regular intervals. These lines are, I believe, plated on to the base material and my rough measurements showed that they are at approximately 0.006in. or 0.015mm centres. I then found, on the back of the ink carriage, an optical sensor which ran along this strip and would then count the stripes as it moved along. Now, I don't say that this is ideal, as the sensitivity may not be suitable for most people, but a complete single axis DRO could be made for £20 - £25. A calculator must be used to give the correct measurement against the reading shown, but I don't think that this should be too detrimental as the accuracy and ease of use are still there. This is certainly very much experimental but it has been proved, so a single axis PCB is included with the electronics. You will still require a failed printer. Remember that the sensor and graticule must come from the same printer as I understand that the spacings on sensor and graticule must be compatible.

For those who would like to experiment, the printer was a Lexmark V. I have checked a Canon, but this seems to use a different system (I could only check externally as it is still working!). I do however have and use a Hewlett Packard Deskjet 690 and this has the same system fitted - it is clearly visible behind the ink cartridge housing. Actually, the Lexmark optical sensor has initials 'HP' moulded into it, which I believe stands for 'Hewlett Packard'.

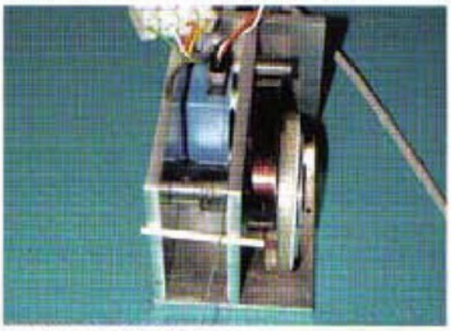
How accurate this system is likely to be over a long period is not possible to know, but I believe that Mylar is very stable. Different makes will possibly use different bar spacings, so this must be watched.

The accuracy can be checked by using a dial gauge, comparing the reading against the DRO indication.

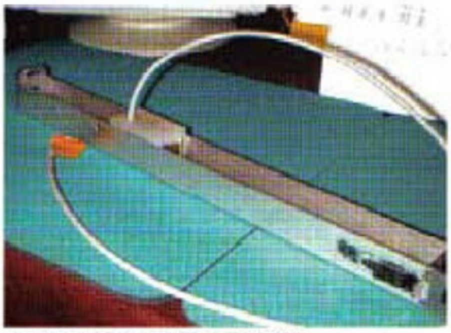
The original unit was tested using a standard Mitutoyo linear scale as it was easy to use and I knew that it was working correctly, although I was not sure at the time if it was going to work with my other circuitry.



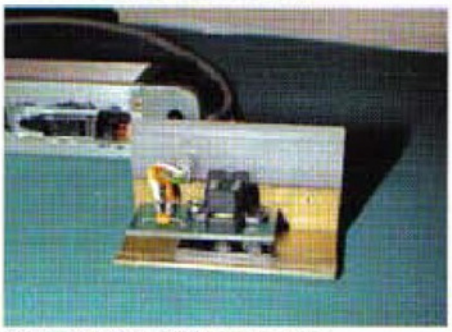
15. An inexpensive rotary encoder



16. The author's prototype 'stretched wire' rotary sensor



17. The home-made spar for the Lexmark linear sensor



18. The Lexmark linear sensor on its bracket

Sensor options

To take the sensor question a little further, I feel that we can consider the following possibilities:-

1. Commercially made linear scales are, of course, the best option as they are fitted in a way which provides a direct reading of slide movement, thus obviating any errors due to backlash which may be present in leadscrew systems. Their disadvantage lies in their relatively high cost.

2. Precision rotary encoders are even more expensive and although they may be fitted to a leadscrew without much difficulty, they then suffer from the backlash problem.

3. Low cost rotary encoders are likely to be less accurate, will probably have a shorter life and also be affected by backlash.

4. The 'Inkjet' system (if one can be located) is very cheap but will not necessarily give the ideal increments. It can be used with a little calculation - at the least you would know where you are to within a couple of thousands of an inch.

5. A 'stretched wire' system. This will give a reasonable cost unit which is easily detached and fitted to another machine. It is not affected by backlash and the signal can be taken from either a low cost rotary encoder or from the Harold Hall design made in the home workshop.

My 'stretched wire' system

This consists of a thin stainless steel wire which is wound round a drum of exact known diameter. This drum is, in turn, connected to the optical sensor **(Photo. 15)** by means of a toothed belt drive. A coil spring keeps the wire in tension, winding it in as the slide to which it is attached is moved back. The components are mounted in a small box which can be equipped with a quick release mechanism for attachment to lathe or milling machine. A General Arrangement of the device is shown in **Figure 2**, and my prototype is seen in **Photo. 16**

The easiest way of obtaining the wire is to use the 'Laystrate' type which many of us have used to tether control-line model aircraft. It has a diameter of 0.45mm (0.01771in.).

Let us assume that the encoder to be used has an output of 2000 pulses per revolution and that we require a resolution of $^1/_{1000}$in. Taking a mean spool circumference of 2in. as being reasonable, we will require a mean spool diameter of $\frac{2}{3.1417}$ = 0.636598in. If we then reduce this by the diameter of the wire, it results in a drum diameter of 0.621888in. (say 0.6219in.). If we specify a longitudinal movement of 20in., the barrel must accommodate 10 turns, so allowing for say three extra turns results in a barrel length of approximately 0.25in. Flanges will be essential, but even so, a total length of less than 0.5in. would be ample, a length which should not present too huge a problem to hand finish to the correct size. Ideally it would be best to 'thread' the barrel so that the wire will lay itself down and not form a 'birds nest' which would ruin the operation of the device. Obtaining the correct mean spool diameter would, however, be a little more difficult.

The resolution provided by components of the dimensions quoted will be compatible with the Readout which will be described in the next article.

My prototype unit had one shortcoming in that the spring which I used (taken from a 3M measuring tape) was not strong enough to retract the wire at a fast enough speed for my liking. The unit will accommodate a much larger spring and the Tensator component specified should be adequate.

Linear encoders

Considering linear encoders, it is possible to obtain the components to make your own, and a number of companies list a range of standard types, on either glass or plastic. The glass ones are, of course, the best as the plastic units are less accurate, but the cost is also lower. I have found that the suppliers sometimes seem reluctant to quote prices, but they all mention a one-off up front cost to make the masters.

When I found that the system from the old Lexmark printer worked so well, I switched my attention from the rotary system described above and constructed the linear encoder spar shown in **Photo. 17**. Made from aluminium channel, it houses the graticule from the printer and the existing plastic 'spring'. I have not included drawings as the components need to be made to suit the fixing system of the graticule which comes to hand, but as can be seen, the work entailed is simple enough.

The matching sensing unit **(Photo. 18)** uses the optical sensor from the same printer, mounted on a brass bracket which is fixed to a plastic slide. Although this is considerably simpler than the commercially available units, it seems to work adequately. Because the graticule is so thin, the tolerances are much greater, but care should be taken to keep the positioning and parallelism of the graticule and the sensor as close as possible.

Of course the unit as shown in the photographs has no means of keeping out the coolant and swarf. Some form of seal or enclosure must be used, or the sensor placed in a sheltered position. The arrangement will depend upon the details of the installation, but I am sure that potential builders will demonstrate their ingenuity.

If any reader is in need of help or advice I am happy to be contacted by phone on 01233-712158 (Charing, Kent).

References

1. 'Digital Readout' - Harold Hall - M.E.W. Issue 8 (Dec.'91/Jan.'92) pp 48-57, Issue 9 (Feb./Mar. '92) pp 51-59.

Suppliers of systems

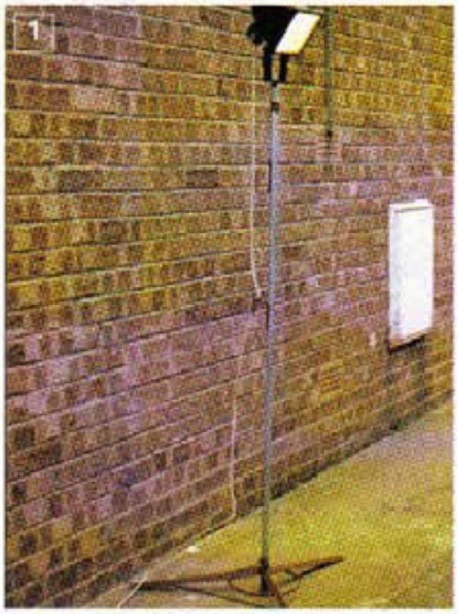
Acu-Rite (GB) Ltd.	01444 871101
B. W. Electronics	01476 550826
Control Transducers Ltd.	01234 217704
Heidenhain (GB) Ltd.	01444 247711
Litton	01628 486060
Mitutoyo (UK) Ltd.	01264 353123
Ortec Ltd.	01481 35708
Siko Ltd.	01845 578845

Suppliers of components

Farnell	0113 263 6311
Wren Engineering	0181 312 0413
Tensator	01908 271153

A COUPLE OF WORKSHOP QUICKIES

Its surprising how the simplest pieces of kit can add to workshop efficiency. Russell Kenyon of Bilton, East Yorkshire has devised a couple which, although they won't help to produce components for the next project, could make a real difference to the workshop environment



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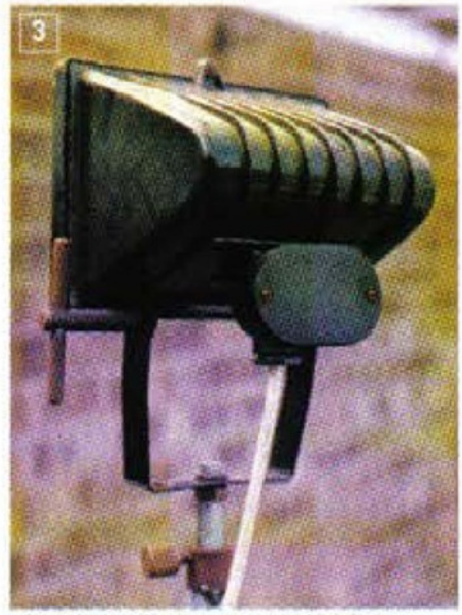


3

1. See The Light With A Fabricated Adjustable Halogen Lamp

Like most model engineers I am always scanning the pages of tool catalogues to see what's new and what I can fabricate to add to my expanding tool kit. It was one such catalogue that inspired what is to follow.

Light, or rather the lack of it, can often be a problem when working either inside or outside the workshop, particularly during the dark winter months. It was the need for a powerful portable light that prompted me to produce a very effective piece of lighting equipment without much capital outlay and using the simplest of designs. I am sure you would derive a good deal of satisfaction from producing your own version of what follows, bearing in mind there are no fine tolerances to work to and plenty room to add your own variations to the theme. The whole project **(Photo. 1)** can probably be completed in an evening. At this point I would like to add a special thanks to my old college buddy Dave Rogers for adding his skilful touch with the camera.

Now! On with the show:

Obtain the cheapest, no frills, basic halogen lamp available, either 150 Watt or 500 Watt (you choose). Wickes or Wilkinsons Stores are usually favourites.

Buy the cheapest adjustable metal clothes prop you can find. Mine was purchased from Skirlington Market for the princely sum of £1.99.

From the off-cut scrap bin (every reader of Model Engineers' Workshop has one), select a piece of tube, approximately 6in. long, which is a sliding fit over the bottom of the clothes prop **(see Photo. 2)**.

Saw three pieces of 3/4in. angle iron (or tube or even flat bar) 16in. long. These are going to be the legs of the tripod.

Set up for welding to the short piece of tube. The legs should be welded at 120 deg. with sufficient angle to form the tripod base. I rolled a ring from 8mm round bar and welded it in as an additional support; however short pieces of available flat bar would do just as well.

Now weld a suitable nut to the short piece of tube and drill through with the correct tapping drill for same. Run the relevant tap right through. This is so that you can clamp the base of the clothes prop to the tripod base). It also enables you to take the lamp apart if needs be **(see Photo. 2)**.

Next remove the hook part from the top of the prop.

Back to the scrap bin and select a suitable piece of mild steel and turn an insert approximately 2in. in length. Drill and tap either 8mm or 5/16 UNC (again you choose). This is going to be used to secure your halogen lamp to the top of the prop using the mounting bracket supplied with it. Fit the insert into the top of the prop. Drill through the side of the prop and the insert and pin in position. **(see Photo. 3)**.

Make up a couple of bent brackets (these are going to be used to wrap the flex round when the lamp is not in use) from suitable flat bar. Weld in position on the bottom half of the prop. **(see Photo. 3)**

Using a suitable length of round bar,

make up a tee bar. The tee bar will need to be about 3in. long in order to give your fingers sufficient clearance from the lamp when adjusting the beam angle (Halogen lamps get extremely hot in use). The tee bar will replace one of the side mounting bolts on the lamp-mounting bracket. Wire up the lamp using about 5 metres of flex. Make sure to follow the instructions supplied by the manufacturer. Fit a 3 Amp fuse to the plug.

Reach into the car glove compartment, fit your shades and plug in.

Bingo! A cheapo lamp. List price is £25.95 + VAT. You could even go mad and paint it if you like.

2. No More Excuses For An Untidy Workshop

Fabricate yourself a useful waste trolley from available stock.

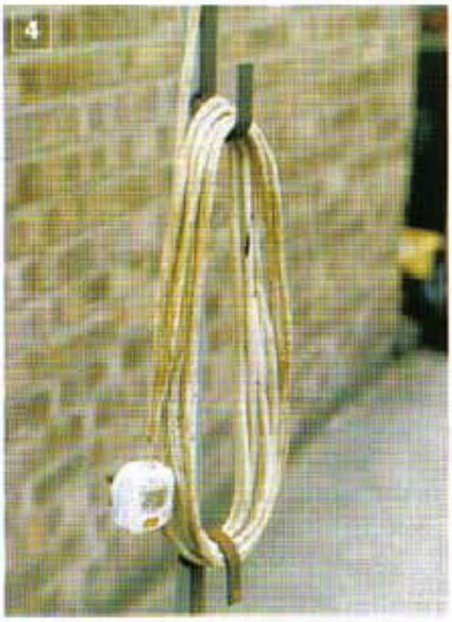
Most ideas are borne of a need and what follows was derived from one such situation. In February of this year, the flat felt roof on my garage finally got beyond the point of any feasible repair. Anyone who has stripped such a roof will fully appreciate just how much mess ensues. After years of expanding and contracting, the felt becomes brittle and hard. Trying to use conventional waste sacks proved useless as the sharp edges of the felt simply sliced through the sides. I scratched my head thinking of possible solutions to bag up the waste in order to ferry it to the local waste disposal site at Saltend. Woven nylon sacks are used in industry for transporting nuts and bolts and heavy metal parts; however the cost of these was very prohibitive. More head scratching ensued, followed by a trip to a local packaging firm (Tony Brittons, Holderness Road, Hull). The staff were extremely helpful and suggested the use of aggregate sacks (most builders merchants stock these sacks. Alternatively a quick scan through Yellow Pages should result in locating a suitable local supplier). The sacks I bought worked out at 15p each, a price well worth paying to rid myself of all that dreaded felt and grit.

Five trailer loads later and my backyard was clear of debris. It was at this point that the idea was born. These tough sacks would be ideal for transporting metal swarf and rough garden waste such as rose bush and hawthorn clippings and the like without the sack splitting and spilling the contents everywhere.

I already had a Black & Decker trolley, but the necks of the sacks were too small to go over the frame. A quick search amongst metal on my racking shelf and I had found enough material to fabricate a tailor-made trolley for use in the garage and around the garden. The constructional details follow (see **Photo. 5** for a view of the finished article).

Please Note: There are no hard and fast rules as to the specific materials to use and I am pretty sure that you will be able to find enough available stock to enable you to construct the trolley without having to dig into your wallet - I certainly didn't have to.

Measure the width of your sack and double it (mine was 22in. x 2 = 44in.).


4


5


6


7

Select some flat bar. I used 1in. x $^1/_4$in. and measure off 44in. Saw off neatly and file off any burrs. Mark out four sections 11in. each and, using nothing more sophisticated than your bench vise and a heavy hammer (taking care to allow for the bends), form a square and weld up. Using suitable tube (mine just happened to be $1^1/_8$in, but metal conduit or angle iron would do just as well), cut two pieces 35in. long (the up- rights), two pieces 14in. long (the base supports), and one piece $12^1/_2$in. long (the distance piece across the base).

Take the two longest pieces and, using the vise, squash one end of each of the tubes flat. Approximately $1^1/_4$in. flattened should do the trick.

Take the $12^1/_2$in. distance piece and a quick look at **Photo. 6** and it will soon become apparent how the pieces need laying out for welding.

Take your two remaining pieces (the base supports) and set up to weld at a right angle. Again a quick squint at **Photo. 6** will clarify.

Weld the formed square into place as per **Photo. 6** and allow to cool. Now try your sack which, if measurements have been made accurately, should fit perfectly without the use of any clips. If not, a couple of suitable bulldog clips could be used to secure the sack to the square frame.

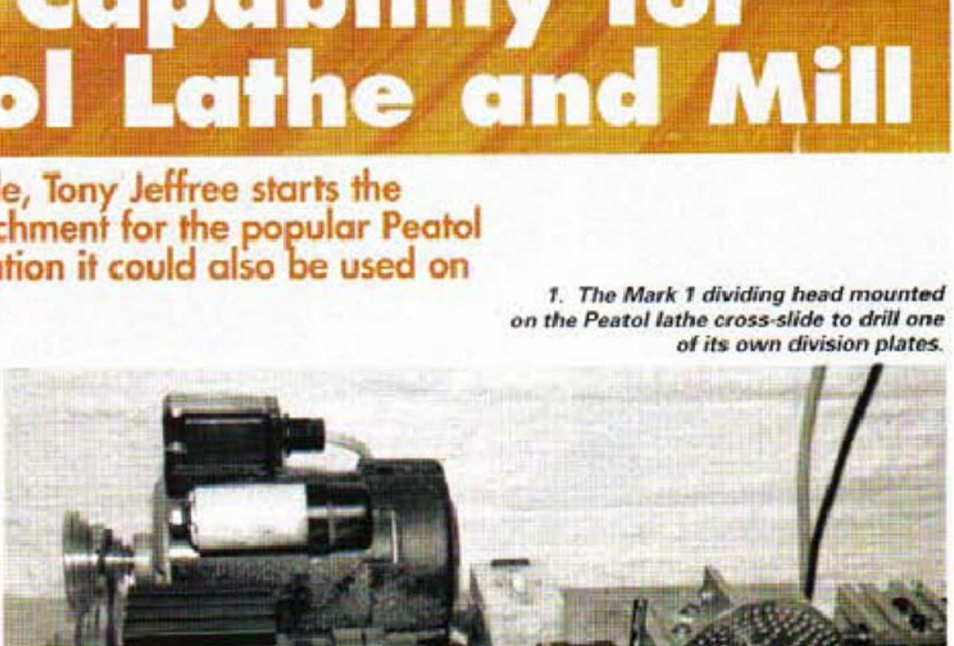
I fitted wheels to my version. The wheels started out in life as stabilisers on my first daughter bike. Danielle is now 12 - don't some people just hang onto stuff forever? Buggy wheels will do just as well.

Take a look at **Photo. 7** and with little more marking out and sawing, to suit the available wheel dimensions it will be ready for a few more sparks and a lick of paint. I used aluminium paint as it dries almost as soon as it is applied. This, as you might have guessed, is because I hate painting and therefore tend to use quick drying stuff for just about everything.

Very Important! Don't sit down to admire your handy work just yet! Walk over to the corner of the workshop, grab your dustpan and brush and have a jolly good sweep up. (or coax the wife in and get her to do it).

A Comprehensive Dividing Capability for the Peatol Lathe and Mill

In the first of a two part article, Tony Jeffree starts the description of a versatile attachment for the popular Peatol machines. With minor adaptation it could also be used on any machine of a similar size

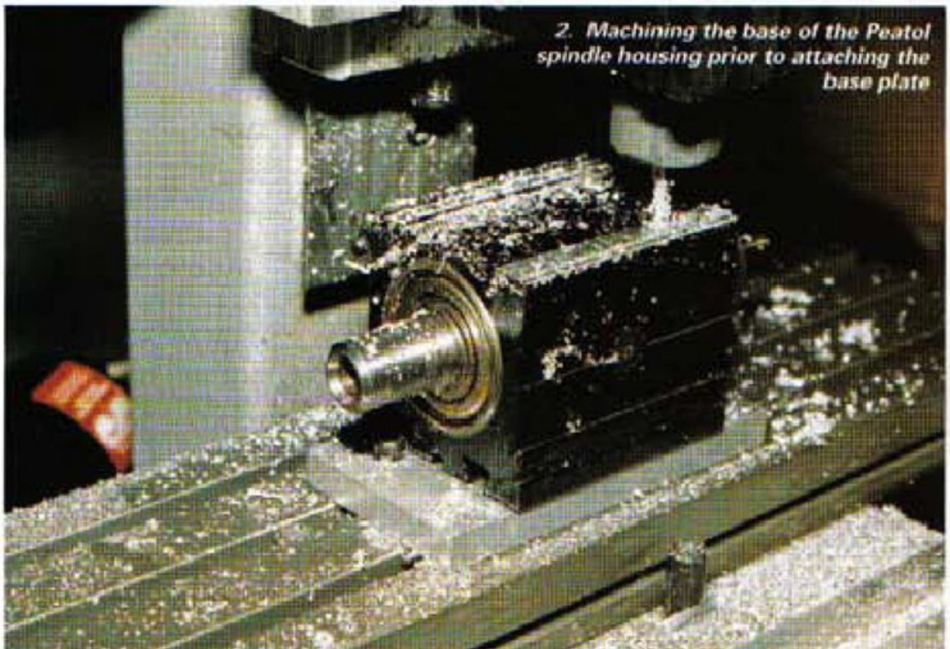


1. The Mark 1 dividing head mounted on the Peatol lathe cross-slide to drill one of its own division plates.

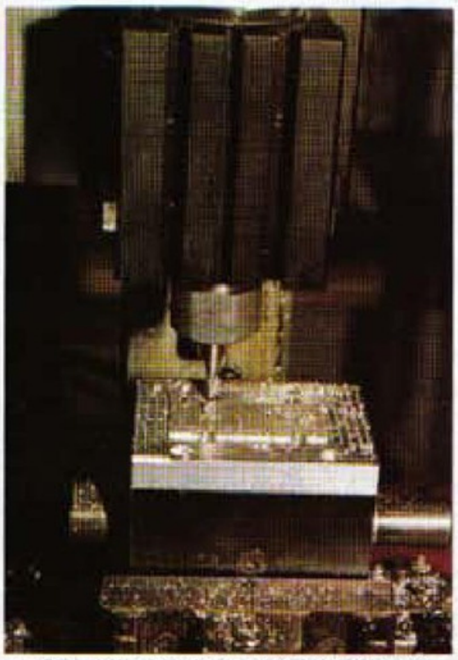
Introduction

The Peatol micro lathe (Ref. 1) (manufactured in the USA by Taig - Ref. 2) is a popular and versatile small machine, albeit with some limitations. Probably the two most significant amongst these are the absence of a leadscrew and change wheels for fine feed and threading, and the absence of dividing accessories. My articles in Issues 56 and 57 entitled "Peatol Plus" addressed the first of these, describing the addition of a leadscrew and associated equipment. This article addresses the second problem; how to add division capability to the lathe. As will be seen in the description that follows, the result is not just another dividing head or dividing attachment. Rather, it offers a comprehensive set of facilities for performing a wide range of dividing tasks in the Peatol lathe, or in conjunction with its big brother, the Peatol mill (Ref. 3) (also manufactured by Taig). The construction sequence described below also generates a useful milling spindle and a boring bar holder as accidental, added bonuses.

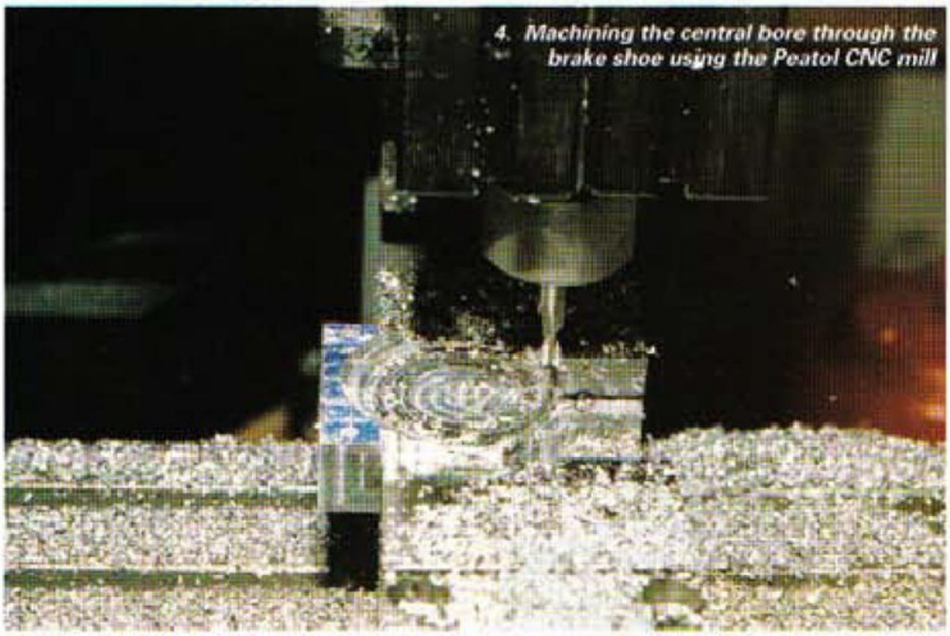
A few years ago, I built a simple dividing head (Ref. 4) for the Peatol lathe. This Mk I design was based on a 1MT drill chuck arbor that I had turned down to a plain shank, and mounted at centre height in a frame fabricated from 2in. aluminium angle. **Photo. 1** shows it in action, mounted on the Peatol cross-slide to drill one of its own division plates. The Mk I dividing head has proved to be a useful accessory since then; however, as it is limited to the use of a drill chuck as the workholding device, I had planned to develop a Mk II device that would provide a wider range of workholding options. I had originally intended the Mk II dividing head to be based around a No. 1 Morse taper spindle that would have provided the desired wide range of workholding options. However, while mulling over the possibilities, I was struck by the thought that ideally the head would allow the full range of standard Peatol workholding devices (collets, 3 and 4-jaw chucks, faceplate, drill chuck arbors, etc.) to be used. Clearly this would involve designing the dividing head spindle to have the same nose as the Peatol headstock, complete with through hole and internal taper; it



2. Machining the base of the Peatol spindle housing prior to attaching the base plate



3. Skimming the base plate to bring the spindle to lathe centre height



4. Machining the central bore through the brake shoe using the Peatol CNC mill

would then take all the standard Peatol tooling including any special arbors or attachments that might have been machined for it. This train of thought led naturally to the idea that I could simplify the construction considerably if I used a complete Peatol headstock as the basis of the design and modified it to suit the purpose. It turns out that Peatol will supply any of the components of the lathe individually, so a complete headstock was duly purchased for the project. (Actually, what I did was to treat my lathe to a new headstock and modify the old one, but that is a minor detail).

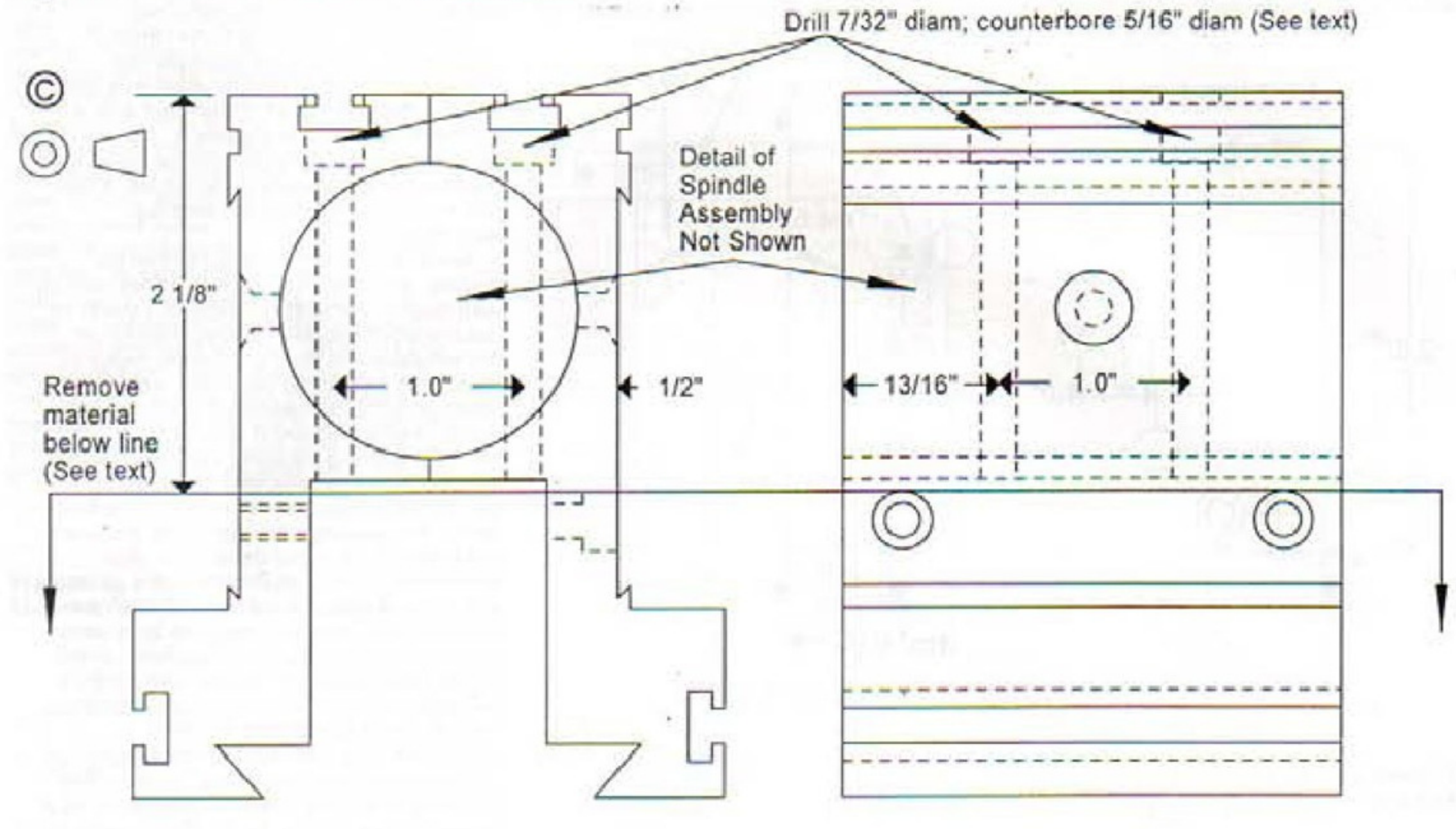
Other advantages of basing the design around a modified headstock also became apparent as I thought it through. In addition to its use as a dividing head, it would be possible to remove the worm drive, division plates, etc. and fit the standard Peatol drive pulley, thus allowing its use as a cross-slide or vertical-slide mounted milling spindle. Equally, any dividing attachments could readily be attached to the lathe headstock, having removed the lathe's drive pulley, giving the possibility of using the dividing capability directly in the lathe itself.

As with my previous design, I chose a 30:1 ratio for the main worm drive, using standard parts from HPC Gears (Ref. 5). This choice of ratio was largely dictated by the physical dimensions that I was working within; I wanted the head to be capable of cross-slide mounting in the lathe with its spindle at centre height, and there is approximately 1¼in. between the spindle and the surface of the cross-slide. Limiting the height of the dividing head was also desirable given that I wanted to be able to use the head in the Peatol CNC mill as well, as it is a bench-top mill with relatively limited Z-axis travel. The final choice was a 30T, 20DP phosphor bronze worm wheel and single-start steel worm (HPC part numbers M20-30 and W20-1 respectively) (Ref. 6). This seemed to provide a drive that fitted the space available, and was also substantial enough to take the ⅝in. bore required to fit it to the Peatol spindle. The choice of drive ratio was also affected by some of the considerations described in my previous article; with a 30:1 ratio, it is easy to cut a 12-hole circle, and from that, to cut a 360-degree protractor. Once you have a protractor fitted to the dividing head, it is then a simple matter to cut any of the other hole circles that you may decide are useful.

As I seemed to be 'on a roll' with the way the design was coming together, I decided that I might as well do the thing properly and add the option of compound indexing, in a similar manner to that offered by the celebrated George Thomas 'Versatile Dividing Head' design (Ref. 7). I felt that providing the compound head with a theoretical positioning resolution of 1/1000th of a degree (as is the case with the original VDH design) would be over-egging it just ever so slightly. Hence, I settled for an order of magnitude less on the positioning resolution, which should still be more than enough for most purposes, and is probably still rather better than my own machining ability would justify! Hence, my design for compound division uses a supplementary 30:1 worm drive to position the division plate, and 40 divisions on the graduated thimble fitted to the secondary worm shaft, giving positioning of the output shaft to a theoretical resolution of 1/100th of a degree. The ultimate positioning ability of a device built to this design will, in reality, be limited by the accuracy of the individual components and of the overall construction, so whether positioning to this accuracy is really possible is another matter altogether. As this secondary worm drive will never be required to take any load, I chose to use a Delrin worm drive from HPC's 32DP range (HPC part numbers ZPM32-30 and ZW32-1 respectively).

The dreaded 'feature creep' continued when I started to think about using the dividing head with my Taig CNC mill, which also makes use of the same headstock as the Peatol lathe. I realised that it would not be terribly hard to make an adapter that would allow a NEMA 23 stepper motor to be mounted on the dividing head, allowing its use as a 4th axis under CNC control. Visions of 'hands off' milling of clock gears made this a very

Figure 1. Peatol Headstock - Modifications



attractive proposition. However, for convenience in CNC operation with the Taig mill software, the worm drive ratio needs to be chosen such that it will render an integral number of motor steps per degree of rotation. A 30:1 ratio combined with a 400 steps/rev motor doesn't achieve this goal; 72:1 seems to be a more usual ratio for these devices (see Peter Rawlinson's design in Issue 56 of MEW; also, commercial rotary tables for small CNC mills appear to use this ratio). This results in 80 steps per degree - comparable to the performance of the compound division capability described above. For this option, I used a modified 32DP, 72 tooth phosphor bronze wheel and a steel single-start steel worm (HPC part numbers PM32-72 and W32-1 respectively).

Further features of this design include the ability to perform direct dividing by attaching division plates directly to the spindle in place of the worm drive. Although not described here, raising blocks could easily be added for machining diameters in excess of 2.5in. Similarly, tailstock support can be added for situations where it is necessary to machine long parts.

Finally, wherever possible, I have designed the components so that the head can be assembled with either 'handedness'. When working on the lathe cross-slide, it is often convenient to have the spindle nose pointing left with the division plate facing the operator. However, when using the components with the lathe headstock, it would be more natural to have the division plate facing you with the spindle nose pointing right. Converting between the two orientations can be achieved very rapidly.

So, in summary, the design as described offers a wide variety of interesting possibilities from which the reader can pick and mix to suit particular needs:

- 'Direct' dividing, using a simple division plate and detent;
- 'Simple' dividing, using a 30:1 worm drive and a division plate;
- 'Compound' dividing, using two 30:1 worm drives in tandem;
- CNC-controlled dividing, using a NEMA 23 stepper motor and 72:1 worm drive to provide a 4th axis for a CNC mill;
- Use of the simple, compound and CNC division components with either 'handedness';
- Using any of the above options either directly with the Peatol lathe headstock itself, or with the dividing spindle, comprising a second headstock modified for cross-slide mounting with its spindle at centre height;
- Use of the dividing spindle as a cross-slide or vertical-slide mounted milling spindle (with a pulley set and suitable drive motor attached);
- Use of any of the above with tailstock support. A by-product of the tailstock design described is that it will conveniently double as a boring bar holder for use on the Peatol lathe's cross-slide;
- When necessary, e.g., when using the head with the 3- or 4-jaw chuck for workholding in a mill, the dividing head and tailstock can be mounted on raising blocks, effectively raising both devices to 'normal' Peatol centre height.

Of course, the usual comments apply at this point; the materials, dimensions, etc., shown in this design are in many cases simply a reflection of the materials I had to hand, and can therefore be modified and substituted to suit the contents of your stock and scrap box. A major reason for the use of the Peatol headstock as a basis for this project was to maintain compatibility with the Peatol work holding attachments and to allow the division components to be attached to the headstock of a Peatol lathe. However, this design will no doubt be usable with other lathes and mills, perhaps with appropriate modifications to centre height and T-bolt spacing (within the constraints of the geometry of the headstock and its spindle assembly). As the chucks, drill chuck arbor, collet closer and collets for the Peatol lathe are all very reasonably priced, it would be relatively inexpensive to equip the head with a range of workholding accessories if it were to be used in conjunction with a different lathe or mill.

Modifying the headstock

The Peatol headstock consists of a pair of aluminium extrusions that hold a steel spindle carried in a pair of substantial 40mm OD ball races, with a steel spacer tube between the two races. The lower part of these extrusions form 'legs' that carry dovetail slots; these locate the headstock onto the lathe bed. Two 10-32 UNF countersunk screws hold the spindle in position between the two extrusions; a further two 10-32 UNF cap screws pinch

Figure 2. Base Plate
Material: 3/8" aluminium

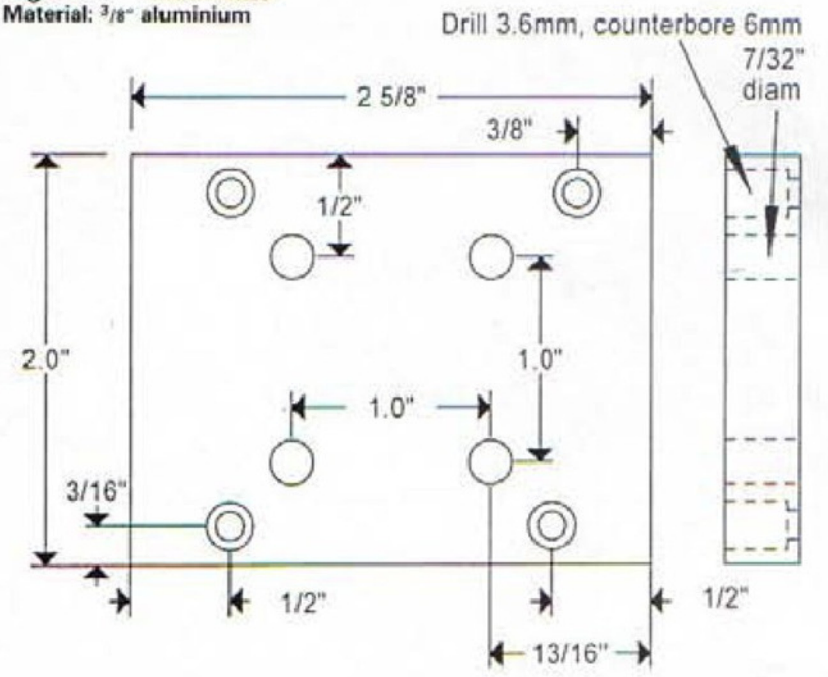


Figure 3. Brake Shoe
Material: 1/2" aluminium

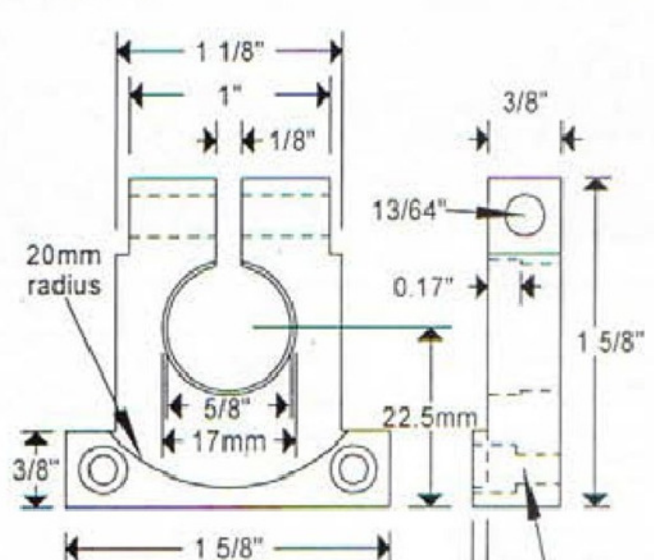
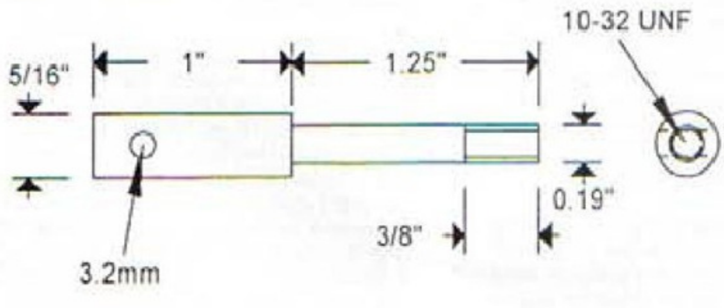


Figure 4. Pinch Bolt
Material: 5/16" Steel



the dovetail slots onto the lathe bed.

Taking your courage in both hands, remove the four screws, separate the extrusions from the spindle assembly, and remove the lower ends of the legs with a hacksaw, as shown in **Figure 1**. This will remove the dovetail slots and the holes for the cap screws, leaving a pair of feet a few millimetres long below the bearing housings.

Re-assemble the extrusions onto the spindle, ensuring that the two halves end up with their outer surfaces parallel. I chose to use a spot of Locktite bearing retainer on the extrusions to hold everything nicely in place; this was partly because I was modifying the old headstock from my lathe, and a certain amount of wear was visible in the front bearing housing. The two feet can now be milled to their final height, which should leave about a millimetre of the foot below the housing; this operation is shown in **Photo. 2**. The final dimension after machining is far from critical at this point, as you get a second bite at the problem later on when the base plate **(Figure 2)** is added and machined to give the right final centre height. The requirement here is to create a nice flat base onto which the base plate can be attached. I found that the most convenient way to mount the headstock for this operation was to use the T-slots in the top surface of the headstock extrusions as a means of attaching a 3in. by 2in. mounting plate with countersunk T-bolts. The assembly can then be fixed to milling table (or vertical slide) with further T-bolts through the mounting plate.

The base plate is made from a piece of 3/8in. by 2in. aluminium, 2 5/8in. long; it is fixed to the newly milled feet on the bottom of the headstock by four 4BA cap head screws. Ideally, the holes for these screws and the threaded holes in the feet should be drilled together. Clamp the base plate in position on the base of the spindle assembly and drill through both items with a 3.1mm (4BA tapping) drill. The holes in the base plate can then be opened out to 3.6mm (4BA clearance), and counterbored 6mm to bury the cap heads well below the surface. Tap the holes in the feet, then fix the base plate in position with the cap head screws. Note that the hole positions are not symmetrical; this is simply to ensure that should the base plate be removed for any reason, it will always go back the same way round, although there is not likely to be very much reason to do this.

The remaining four holes in the base plate are to allow T-bolts to pass through the base; these holes are arranged in a 1in. square to match the spacing of the T-slots on the Peatol lathe and mill. By now you will have spotted that these T-bolts must pass right through the body of the truncated headstock. The easiest way to drill these holes is by mounting the spindle/base plate assembly upside down, as it was for milling the feet, and to drill through from the base using a 7/32in. drill. Careful marking out is needed here; the objective is to have the T-bolt holes straddle the spindle, and to emerge in the middle of the T-slots in the upper surface of the headstock housing. In the process, the drill will partly pass through the steel spacer that separates the two bearings, as well as the aluminium extrusions, but will not penetrate into the bore or damage the spindle itself. This drilling operation provides ample opportunity for the drill to deflect, so gentle drilling and good lubrication is the rule. The assembly is then reversed, and the four holes counterbored $^5/_{16}$in. diameter to a sufficient depth to allow a 10-32 UNF cap screw head to sit below the bottom of the T-slot.

By the way, if the arrangement described and illustrated in **Photo. 2** is used to hold the spindle down while drilling these holes (i.e., using a clamping plate T-bolted onto the top surface of the spindle), be careful to ensure that the T-bolts used to hold the spindle onto the plate do not coincide with the expected points of emergence of the holes you are drilling. When I drilled these holes, I did not realise that these two T-bolts were precisely below two of the holes. In drilling the last two holes, the drill neatly took off the ends of the T-bolts, after which the spindle was no longer attached to the milling table. Thankfully I realised what was about to happen in time to switch off the mill, but it was a very close call!

Figure 5. Tommy Bar
Material: $^1/_8$" Silver steel and Brass

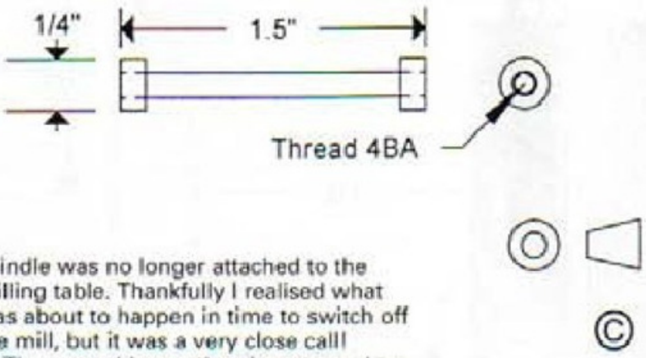
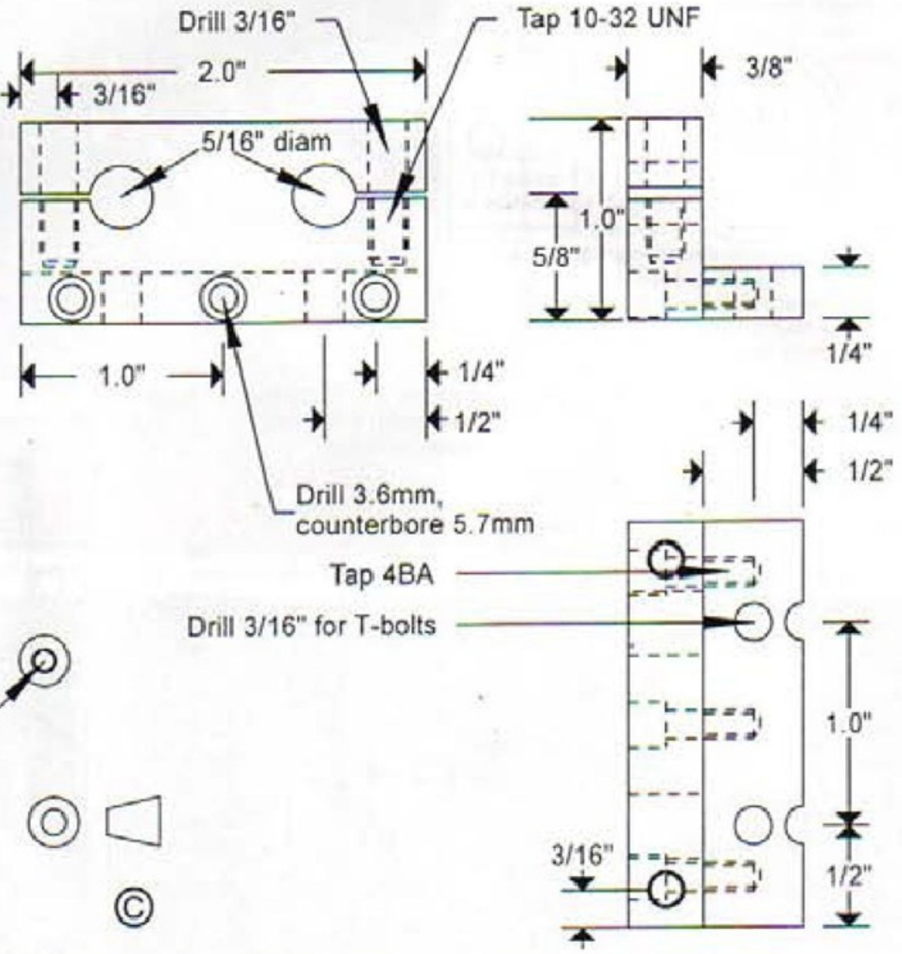


Figure 6. Dividing Assembly Mounting Plate
Material: Steel



The assembly can then be returned to the mill or vertical slide to skim the base plate. This can be seen in progress in **Photo. 3**. The plan here is to fix the spindle height of the dividing head such that it will be on centre height when fixed to the cross-slide. Nominally, centre height over the cross slide is $1^1/_4$in. However, it is worth doing some careful measuring to check the height on your own lathe. It is also worth taking care in the set-up to ensure that the final machined base is actually parallel to the axis of the spindle, and square to the sides of the spindle housing.

The T-bolt holes needed to secure the spindle to the cross-slide or milling table are rather long. You will need $2^1/_4$in. 10-32 UNF T-bolts to fix the spindle to the Peatol lathe cross-slide or $2^1/_2$in. bolts to fix it to the Peatol mill table (which has the same 1in. T-slot spacing as the lathe, but the slots are deeper.) I found that Emkay Supplies (Ref. 8) could source $2^1/_2$in. 10-32 bolts by special order, but unfortunately, at a special price, too. 2in. is the longest stocked length I could find elsewhere - of course this may be a lesser problem for readers in the USA.

The result thus far is the first usable product of this project - a milling spindle that can be mounted on the lathe cross slide or vertical slide (or indeed, on a milling table if you can dream up an application for this!). The Peatol lathe pulley sets and drive belts can be pressed into service for this purpose, along with a suitable fractional horsepower motor. I have not attempted to describe mounting arrangements for this application, as motor mountings and dimensions will vary. However, there is plenty of scope, given the availability of the two T-slots on the top of the spindle housing, to provide a mounting that can allow a motor to be rapidly attached and detached as needed. The short drive belts supplied for the Peatol Mill are probably the most appropriate for this application; using a Peatol pulley set, this combination gives approximately 3.8in. between the axes of the milling spindle and the motor shaft.

The Brake Shoe

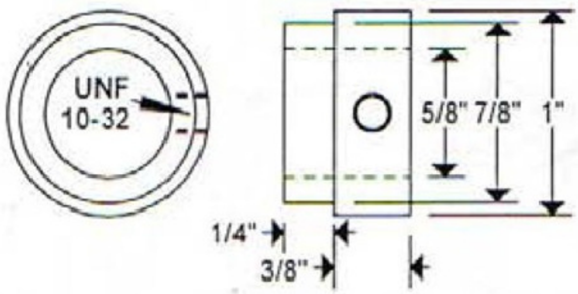
I pondered long and hard as to the best approach for providing a locking mechanism for the spindle. Clearly, if I was building the spindle and housing from scratch, the obvious approach would be to use some kind of clamp between the two bearings, as seen in the recent design by Harold Hall, published in MEW issues 53 and 54. However, as I did not relish the thought of dismantling the pre-loaded spindle assembly in order to modify its steel spacer, this was not a real option. Remaining options were to fit a brake shoe at the nose (turning down the 1in. AF hex. nut behind the nose thread to form a brake drum), or at the rear of the spindle, directly behind the rear bearing. I opted for the latter approach, as it is extremely useful to be able to use a spanner on the spindle when tightening the collet closer.

The rear end of the spindle poses problems of a different kind. There is a circlip that ensures that the spindle cannot escape the clutches of the bearings; this protrudes slightly less than 2mm proud of the aluminium housing. The rear bearing itself protrudes somewhat less than this also. So the brake shoe has to be offset from the rear surface of the housing by 2mm. The spindle itself is 17mm diameter at the point where the circlip retains it in the bearing; it then rapidly changes to $^5/_8$in. diameter for the remainder of its length. The brake shoe needs to be bored with both 17mm and $^5/_8$in. diameters, so that it can straddle the change in diameters of the spindle. This allows the available space at the rear of the spindle to be used to its best advantage, and in particular, also leaves sufficient room for the worm drive to be attached. These factors explain the rather curious shape of the brake shoe, shown in **Figure 3**.

The shoe is made from a piece of $^1/_2$in. thick aluminium, $1^5/_8$in. square. I had the luxury of being able to machine the shoe entirely using milling and drilling operations in the Taig CNC mill. Boring 17mm diameter holes with a $^5/_{32}$in. end mill is a lot of fun with such a machine. This operation can be seen in progress in **Photo. 4**. Needless to say, the lathe, vertical slide and 4-jaw chuck are equally appropriate tools for the operations required here.

The final shoe will be $^3/_8$in. thick, with an extra 2mm for the foot to offset it from the circlip and rear bearing. Having trued up the piece to $1^5/_8$in. square, it is necessary

Figure 7. Worm Wheel Boss
Material: Steel



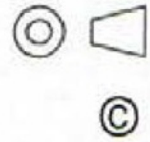


Figure 8. Stepper Motor Mounting Plate
Material: Steel

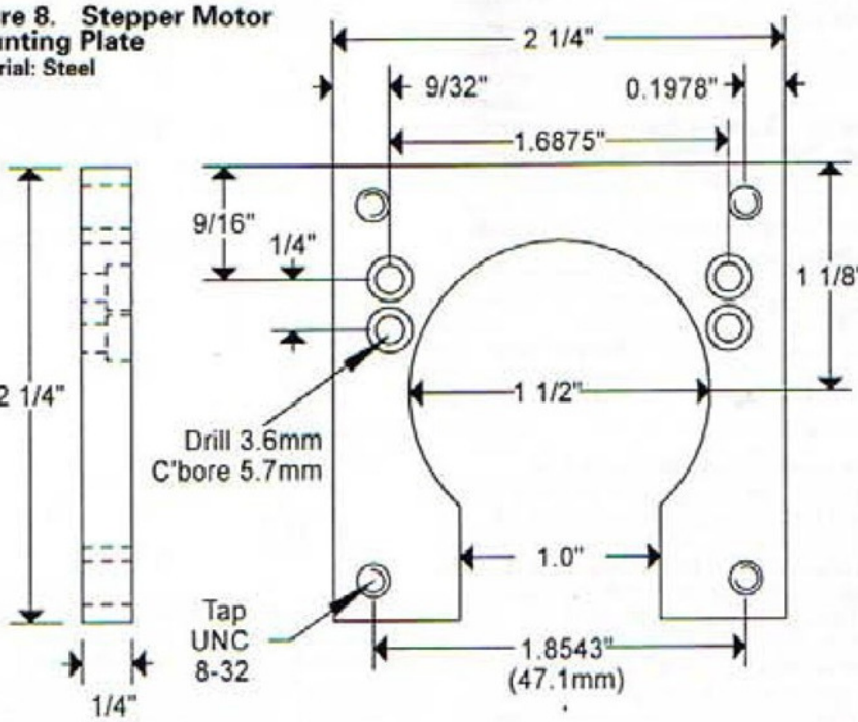


Figure 9. Motor Support Arms
Material: Steel Quantity; 2

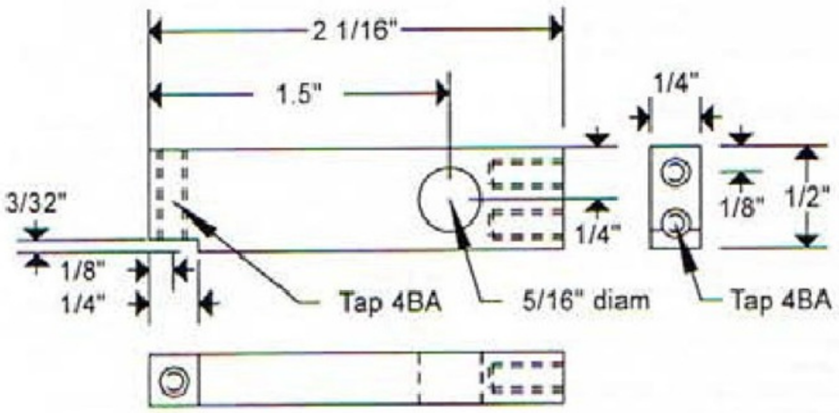
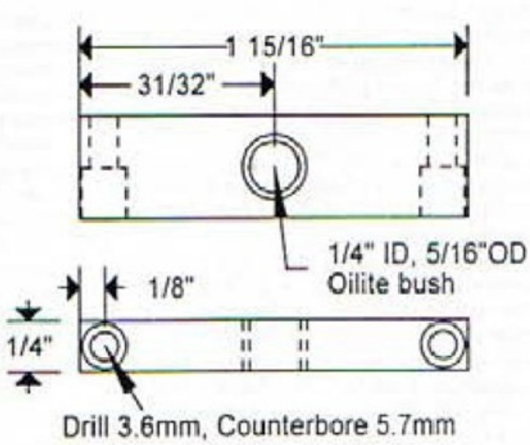
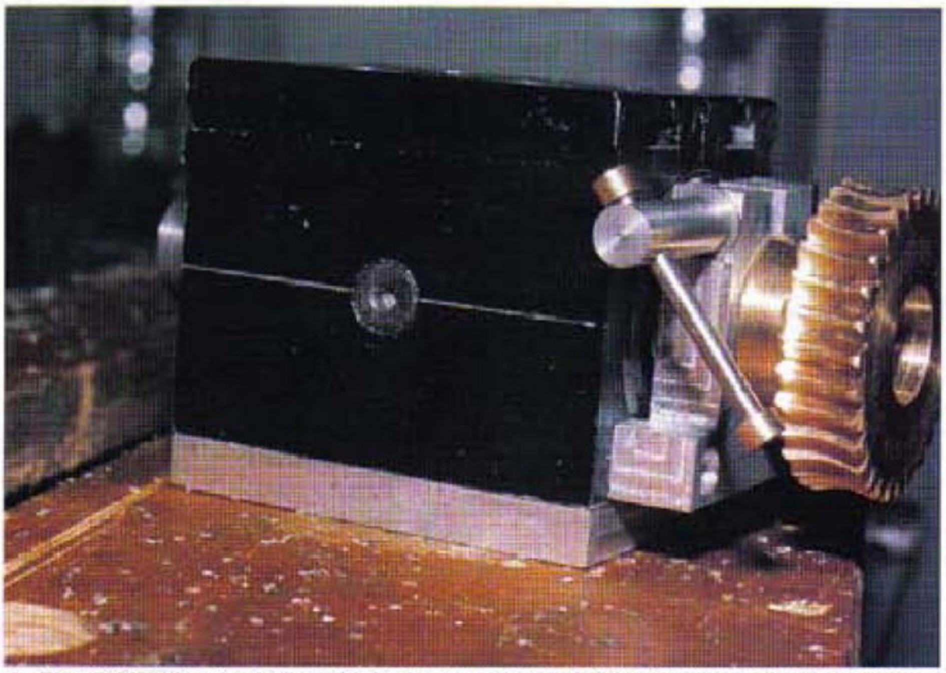


Figure 10. Bearing Support
Material: Steel





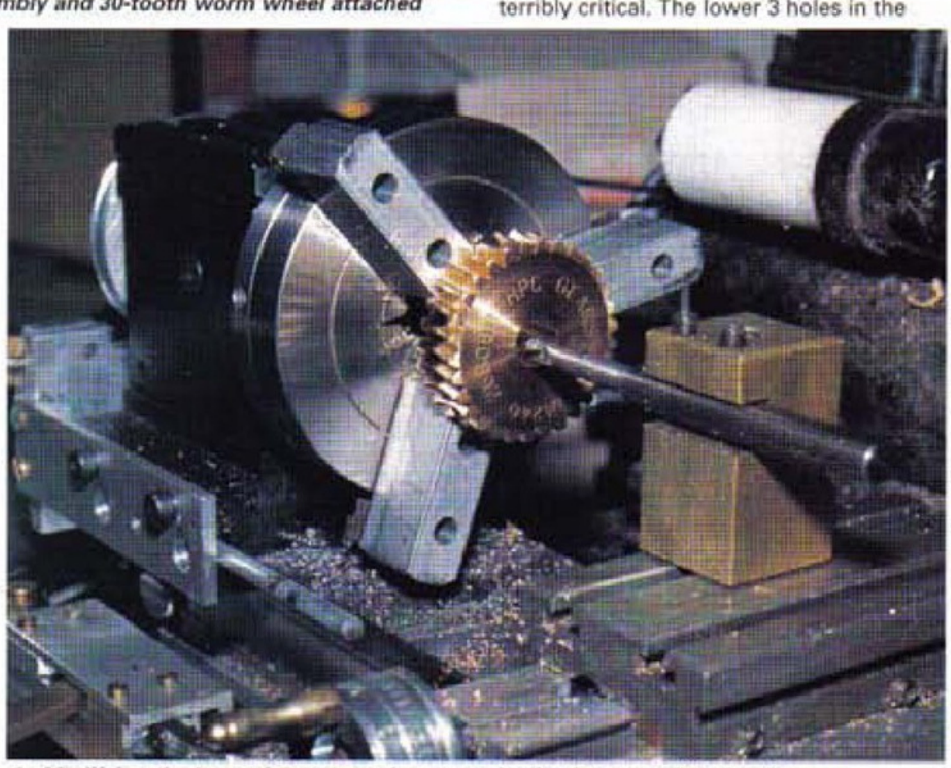
5. *The dividing head spindle, with brake assembly and 30-tooth worm wheel attached*

The Dividing Assembly Mounting Plate

This component is shown in **Figure 6**; it serves as a universal mount for the various dividing components. This plate is designed to fit at the tail end of the spindle, using the T-slots in the top of the aluminium shell - hence the two $^3/_{16}$in. holes in the base plate to take 10-32 UNF T-bolts. The two semicircular notches reduce the degree to which the plate obstructs the rear pair of T-bolts that pass through the headstock. If preferred, these could be elongated to merge with the $^3/_{16}$in. holes to form a slot; the only disadvantage with this alternative is that the T-bolts for the mounting plate are then no longer captive.

The mounting plate is fabricated from 2in. lengths of $^1/_2$in. x $^1/_4$in. and 1in. x $^3/_8$in. steel bar; these should preferably be clamped together while milled or filed to length in order to ensure that the lengths are exactly the same. However, this is only a cosmetic issue, as the length is not terribly critical. The lower 3 holes in the $^3/_8$in. thick vertical plate need to line up with the 4BA tapped holes in the $^1/_4$in. thick horizontal plate. The intent here is that the two plates are clamped together using 4BA socket head screws, and the counterboring allows the heads of the bolts to end up below the surface of the plate, leaving the rear surface of the plate unobstructed. The usual approach of careful marking out, spotting through holes etc., should be sufficient to ensure that these line up. Those of you that have a mill available (or even a cross vice with graduated leadscrews) will find this straightforward as the hole positions can be dialled in from a reference edge. Of course, one of the great advantages of CNC is that this kind of drilling operation can be performed simply, repeatably and

to mill or turn one face to reduce the overall thickness to 0.454in. ($^3/_8$in. plus 2mm). The foot is then formed by removing a further 2mm of material on a 20mm radius centred 22.5mm from one edge, and $1^3/_{16}$in. from the adjacent edges. The piece is then through bored $^5/_8$in. diameter, on the same centre, followed by boring 17mm diameter to 0.17in. below the surface. The profile of the piece is then cut as shown in **Figure 3**, and a hacksaw or slitting saw used to cut through to form the split clamp. Drill the mounting holes as shown, and counterbore them to allow the 4BA cap head mounting screws to be buried below the surface. Finally, drill the $^3/_{16}$in. hole for the pinch bolt. Note that the $^3/_8$in. square cut-outs allow the pinch bolt **(Figure 4)** to be inserted in either direction through the clamping hole; this is one of the 'ambidextrous' design features mentioned earlier. The cut-out serves to prevent the $^3/_8$in. square pinch nut from turning - use a standard Peatol lathe square T-nut for this purpose, or make one up from $^1/_8$in. x $^3/_8$in. flat stock.



6. *Modifying the bore of the 30-tooth worm wheel using a small boring bar*

The Pinch Bolt and Tommy Bar

The pinch bolt **(Figure 4)** is made from a 2.25in. length of $^5/_{16}$in. diameter mild steel. Turn down 1.25in. of its length to 0.19in. diameter and thread the last 3/8in. 10-32 UNF. Cross-drill $^1/_4$in. from the other end 3.2mm. The tommy bar **(Figure 5)** is a 1.5in. length of $^1/_8$in. diameter silver steel rod; thread each end with a 4BA die for about $^1/_8$in.. Strictly speaking, $^1/_8$in. is too small for 4BA threading, but it will take enough of a thread for this purpose. Fit a 4BA brass nut to each end and turn them down to remove the flats. Pass the tommy bar through the hole in the pinch bolt and fix the end caps in place with a drop of Superglue.

The pinch bolt can then be fitted through the hole in the brake shoe, with a steel washer under the shoulder and a square 10-32 UNF nut (the type used as T-nuts on the Peatol lathe) at the threaded end. As mentioned above, the bolt can be fitted from either direction, depending upon the desired handedness of the indexing components.

The shoe can now be fitted in place on the rear surface of the spindle housing, with its foot and mounting screws at the bottom. Clamp the shoe onto the shaft using the pinch bolt and nut. Spot through the mounting holes, drill 3.1mm (4BA tapping), and tap 4BA. The shoe can now be screwed into position. Note that if you plan to use the dividing components on the lathe headstock, this operation will need to be repeated on the rear of the lathe headstock. **Photo. 5** shows the completed brake shoe assembly, and the 30T worm wheel, fixed in position on the rear of the spindle assembly.

with great accuracy; despite drilling these two components independently using the Taig CNC mill, I found that they fitted together perfectly.

The two 5/16in. holes should be drilled undersize and reamed to size; these need to be a close fit with the 5/16in. steel bars that will be used to hold the various dividing components. The vertical holes for the 10-32 UNF pinch bolts are drilled last, after the horizontal saw slits have been cut. Drill to depth with a 10-32 UNF tapping drill (4.1mm) and then follow up with a 3/16in. drill to the level of the saw cut. The lower holes can then be tapped UNF 10-32. If you feel particularly energetic, the pinch bolts can be replaced by variants on the pinch bolt and tommy bar shown in **Figures 4 and 5**; however, as these bolts are likely to be used relatively infrequently, this may not be felt worth the additional effort involved.

Modifications to the Worm Wheels

The 20DP worm wheel as supplied by HPC Gears (see above) comes with a 3/8in. diameter bore. This needs to be increased to 5/8in. diameter to fit the end of the spindle. HPC will modify bore diameters for an additional fee, but this can also be achieved in the lathe. Grip the 1in. diameter boss in the 4-jaw and centre it carefully using a dial gauge. Alternatively, the boss can be held in the 3-jaw, if it is sufficiently accurate, or if you are prepared to bore out the Peatol chuck's soft jaws to hold the boss spot on. The bore can then be opened out using a suitable boring bar - this can be seen in progress in **Photo. 6**, using a 1/4in. boring bar fitted with a Sumitomo titanium carbide insert.

The wheel will need a grub screw; drill and tap the boss 10-32 UNF to take a 1/4in. long hex socket head set screw. The wheel is fitted 'boss first' onto the spindle and located with the grub screw. The wheel will overhang the end of the spindle by about 1/4in.; leave a small gap between the boss and the brake shoe so that there is no rubbing between these components. I chose to file a flat on the spindle to act as a pad for the grub screw to locate against; I have filed a similar flat on my lathe spindle. This simplifies fitting and removal of the wheel and drive pulley, as the inevitable burrs raised by the grub screw do not then foul the bores.

Modifying the 72-tooth worm is slightly more involved; it is supplied either with or without a boss, but the standard boss is less than 5/8in. diameter and is therefore of no use in this application. Again, no doubt HPC could make a non-standard wheel for a premium on the price. However, I chose to use the plain version of the gear as a starting point. A boss is cut from a piece of 1in. diameter round stock, as shown in **Figure 7**; a small shoulder is cut for 1/4in. of the length of the boss (the thickness of the worm wheel), leaving 3/8in. at the original diameter. Bore it through at the same setting, to ensure that the 5/8in. hole for the spindle bore is concentric. A radial hole is drilled/tapped 10-32 UNF to carry a grub screw as for the 30-tooth wheel. The worm wheel is then chucked, carefully centring its axial hole. I did this by machining a set of soft jaws to hold the wheel safely in the 3-jaw without damaging the teeth, but this could equally be done with a 4-jaw and careful packing of the jaws. Open out the bore in the wheel to give a press fit over the small diameter of the boss; press the wheel into place, using Loctite or Superglue to form a permanent joint.

As with the 20DP wheel, the 32DP wheel is mounted on the spindle with the boss facing the brake shoe. This wheel will also overhang the end of the spindle slightly when in place.

The Stepper Motor Mount

Figures 8, 9 and 10 show the components needed for this. The design is based around the NEMA 23 size of stepper motor (Ref. 10); this is a common stepper size for the various small CNC mills, and is the size suggested for Peter Rawlinson's dividing head design. The mounting plate shown in **Figure 8** is straightforward, although some of the dimensions are curious to say the least. I have shown the plate as 2.25in. square; this is actually slightly larger than the standard measurements for the NEMA 23 mount.

It seems a reasonable assumption that anyone building the stepper motor mount will be using the dividing head with a CNC mill. By far the easiest way to make the motor mount components is therefore to translate the drawings into CNC control files, and then let the machine do the hard part. Otherwise, some very careful marking out is needed to ensure that all fits together nicely. The 5/16in. holes carry 5/8in. long steel dowels (I used silver steel, but MS would be fine for this), held so that they can fit into the split clamps on the mounting plate, allowing adjustment for backlash and alignment of the worm drive. The provision of a dowel either side of the frame allows the motor to be mounted with either handedness. You may notice from the later photos that I had originally intended to use a pair of dowels on each arm and to arrange their positions so that the fit of worm and wheel was spot on. However, I concluded that this was not such a great idea as it is more difficult to mark out accurately and would not allow for any backlash adjustment. The dowels are Loctited into the support arms, and pinned through for additional strength.

Assembly is fairly obvious; the bearing support screws into the notches in the ends of the motor support arms, and the latter are screwed onto the motor mounting plate. If all is well, the axis of the 1/4in. bearing will be directly in line with the centre of the 1.5in. hole in the mounting plate. Adjustment of the notches in the side arms, or the addition of shim washers between them and the bearing support, can correct any misalignment that may be needed. Fit the worm to the motor shaft before fitting the motor to the mounting plate. A length of 1/4in. diameter silver steel forms a shaft extension, running in the Oilite bearing; cut this to length and Loctite it in place in the end of the worm once the final position of the worm on the motor shaft has been fixed.

The main purpose of the shaft extension and its bearing is to support the motor's own bearings. An additional use is to provide a means of adding a manual adjustment knob if the motor you are using is of the single-ended shaft variety. If this is needed, cut the extension over-length and add a manual control knob - the kind found on electrical equipment works just fine if you don't want to make one. My motor had a double-ended shaft and was already fitted with a manual control knob. The ability to position the worm drive by hand is very useful for setting up the initial position of a component prior to a milling operation, but this should always be done with no power to the motor. The motor can now be mounted on the dividing head with UNC 8-32 cap screws, and the position of the components finally adjusted and tightened. The stepper drive for the dividing head is now complete.

References

1. Peatol Machine Tools, 19 Knightlow Road, Harborne, Birmingham B17 8QS, UK. Tel/Fax: 0121 429 1015

2. Taig Tools, 12419 E. Nightingale Lane, Chandler, Arizona 85249, USA. Tel: (602) 895-6978

3. A recent addition to the Peatol product list (although it has been available in the USA from Taig for some time). I bought one of the first two of these machines to be imported into the UK, in October '98. Issue 59 of MEW carries my review of this machine in its CNC form; manual versions are also available.

4. The design for this dividing head was published in Issues 21 and 22 of MEW, Jan/Feb and March/April 1994.

5. HPC Gears, Foxwood Industrial Park, Chesterfield, S41 9RN, UK. Tel: 01246 260003 Fax: 01246 260003. Web page: http://www.hpc-gears.co.uk/

6. HPC also supply their worms and wheels in Delrin, at a reduced price and with somewhat lower torque capacity (2.75 Nm as opposed to 11.41). It may well be viable to make use of these parts in some applications, particularly if the spindle will always be locked prior to machining. A halfway house offering an intermediate torque capacity of 7 Nm is to use a steel worm with the Delrin wheel.

7. This design was originally published in Model Engineer; it is also described in the excellent book, 'Dividing and Graduating' by Geo. H. Thomas (ISBN 0-905100-85-9) and also in 'Workshop Techniques' (ISBN 1-85761-106-3), both published by Tee Publishing

8. Emkay Supplies, 74 Pepys Way, Rochester, Kent, ME2 3LL. Tel: 01634 717256.

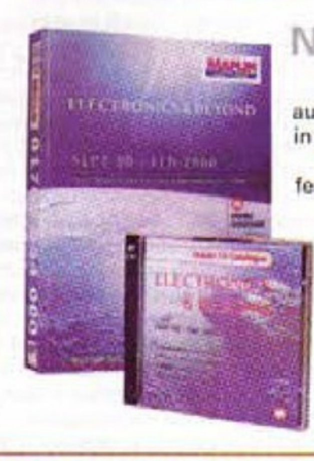
9. Sumitomo inserts and tools are obtainable from Penco, 3, Greenfield Close, Sheffield, S8 7RP, UK. Tel/Fax 0114 237 7716

10. Nema 23 stepper motors can be obtained from Model Motors Direct, Hillside House, Baltonsborough, Nr Glastonbury, Somerset BA6 8QJ. Tel: 01458 850061. Fax: 01458 851048.

To be concluded Issue 63

TRADE COUNTER

Please note that, unless otherwise stated, Trade Counter items have not necessarily been tested. We give news of products and services which have been brought to our attention and which we consider may be of interest to our readers



New Catalogue from Maplin Electronics

Maplin Electronics launched their new autumn/winter catalogue on 1st. September, in two formats.

The paper version contains 1600 pages and features over 1500 new products and 2000 price reductions. Also included are £60 worth of vouchers. The paper edition is complemented by an electronic version contained on a double CD ROM. This has comprehensive search facilities, pricing in sterling and euros, product pictures, technical specifications and over one thousand data sheets.

Either version is available by calling their order line on 01702 554000, the paper edition having the order code CA20 at £3.99. The code for the CD is CQ04 at £1.95. The catalogue is also available at Maplin's retail stores and it can be purchased at branches of W. H. Smith.

Maplin Electronics, P.O. Box 777, Rayleigh, Essex SS6 8LU Tel. 01702 554000 Fax. 01702 554001 email <recipient>@maplin.co.uk Web Site httpt://www.maplin.co.uk

COMPUCUT GOES 3-D

The appeal of the Version 1 Compucut system, consisting of software and electronics is limited to those for whom building or adapting a machine tool of conventional format is both a possible and an appealing proposition. For a wider range of people, CNC machining can offer a means to cut things that they would otherwise have to fabricate or buy. For them, the use of the end product is the sole motivation for making it, so it is possible to shed the constraints that fetter 'General Purpose' machine designs which may suffer through limited rigidity and/or power.

When one can predict the range of operations, materials to be handled and necessary working envelopes for up to 6-axes, then very effective machine configurations can be developed quickly, cheaply and most importantly, with modest levels of workshop equipment and skill. This approach is made possible by the vast range of cheap imported cast iron tooling now available.

Modular design, incorporating suitably modified and improved sub-assemblies brings the following benefits:-

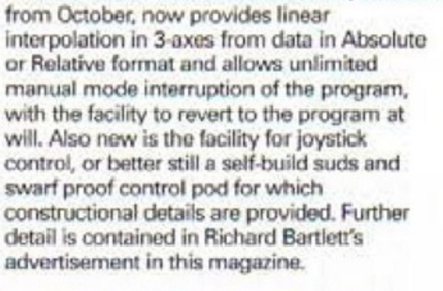
- Syndicates of friends could build rapid prototyping systems very quickly by dividing the workload.
- Interchange of critical assemblies becomes possible, facilitating changes of size, power and accuracy.
- Standard sub-assemblies may be re-used for their original purpose or in new configurations.

With these factors in mind, a new version of the Compucut system makes it possible to offer plans for COMPUCUTTER, a new DIY CNC machine which can turn, mill, drill and bore 'tricky' components for a number of applications. Typically, for model internal combustion engines (MICE), these would include turbine wheels, compressors, compressor casings, cams, rockers and connecting rods. For clocks, the cutting and crossing of cycloidal wheels, engraving of dials and turning of arbors and columns.

Compucutter will power a 6mm end mill 6mm deep through steel at 30mm/min (with lots of suds!). A more appropriate demonstration job is shown in the enclosed photograph, which is of a 20 blade turbine wheel milled using Compucutter from stainless steel containing 18% chromium, 14% nickel, 2% manganese and 2.5% molybdenum. The second photo shows the machine with a cheap resin blank loaded for test milling of a new blade profile.

COMPUCUT Version 2.0 software, available from October, now provides linear interpolation in 3-axes from data in Absolute or Relative format and allows unlimited manual mode interruption of the program, with the facility to revert to the program at will. Also new is the facility for joystick control, or better still a self-build suds and swarf proof control pod for which constructional details are provided. Further detail is contained in Richard Bartlett's advertisement in this magazine.

R. Bartlett, 17 Lime Tree Avenue, Tile Hill, Coventry CV4 9EY Tel. 01203 473851 email: compucutters@compuserve.com



A new Sensitive Bench Drill from Minicraft

Minicraft have recently introduced a new 12V Sensitive Bench Drill under the model number MB680. Of robust design and equipped with 4-jaw collets it is said to be the perfect tool for electronic, small DIY, hobby and creative craftwork where accuracy and precision are essential.

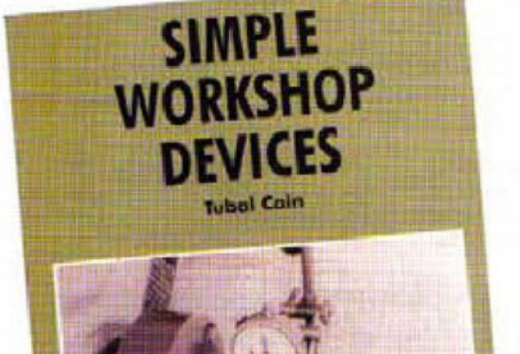
The drilling depth of up to 20mm is controlled by a calibrated lever which can be moved for left or right handed use. The 100W motor provides a speed range of 0 - 18,000 rpm with drills up to 3.2mm dia. The five collet system can be replaced by the 0.4 - 3.2mm keyless chuck (MB1932) for increased versatility. The base incorporates bench fixing holes and holes to accept the Machine Vice MB715.

The unit comes with the five collets and five HSS drill bits at a Recommended Retail Price of £99.99.

Minicraft, Macford Products Limited, 1 &2 Enterprise City, Meadowfield Avenue, Spennymoor, Co. Durham DL16 6JF Tel. 01388 420535 Fax. 01388 817182

FIRESIDE READING

With the rapid approach of Christmas, the Editor has been looking at some books which have come to his notice recently and which he feels would be welcomed as a 'stocking filler' by many home workshop enthusiasts. Perhaps a useful ploy would be to leave the magazine on the coffee table, open at these pages!



Simple Workshop Devices by Tubal Cain

It is now approaching 18 months since the death of T. D. Walshaw who wrote many of his books under the name 'Tubal Cain'. An acknowledged master in many fields, Tom Walshaw had the ability to express his thoughts with clarity, and a technical authority which came from his experience in industry followed by a long career as a university lecturer. His final book in the Workshop Practice Series consists of some topics previously covered in articles published in 'Model Engineer' plus some new material. It is significant because it includes the description of a number of tools, accessories and attachments for use in the workshop, whereas the majority of his writing in 'M.E.' dealt with model projects, engineering processes or standards.

The first few pages which form the Introduction include photographs of his workshop, one in fact showing Tom at work. They depict what many home workshop owners would consider to be a modestly equipped facility, but appearances are deceptive and this is one in which everything clearly resides in its appointed place.

The book is divided into 'Sections' rather than Chapters, and the first two deal mainly with workholding, the opening words being "A proper hold of the workpiece is fundamental to all manufacture". Section 1 "Getting Hold of the Job" deals not so much with chucks and bench vices but with ways of gripping the more difficult workpieces by using a thin piece vice (which is described in detail), Turner's cement and a variety of small devices made from wood. It closes with details of a simple soldering and brazing clamp.

Section 2 purports to deal with Jigs and Fixtures - workholding devices tailored to a particular work piece. In reality it has a much wider scope and contains a masterly exposition on how to use a lathe or a milling machine as a jig borer. Section 3 "Round and About the Lathe" includes some simple but useful accessories and also gives instruction on some more unusual tasks such as drilling and tapping a Morse taper arbor to accept a drawbar and turning fish-bellied rods. One useful sub-section explains the principles behind the use of tangential tooling and describes a practical adaptation of the principle, particularly useful for machining crank pins.

The final "Miscellaneous" section touches on a variety of topics ranging from a simple modification to a vertical milling machine to gain a more user-friendly speed range to the detailed description of an elegant micrometer scribing block. The final photograph is of "The author's favourite device - 'a little piece of wood'", of which he admits to having kept many to hand.

As is so often the case in a work of this type, there are many little 'gems' scattered through the text, such as the correct (and kindly) way to treat a milling machine vice when securing the workpiece.

Right at the end there is a paragraph which shows that even this great man was ever willing to learn. He had asked my colleague Mike Chrisp if he could find a suitable photograph to adorn the front cover. Mike chose one of a set-up of his own, showing a second lathe centre between the tailstock centre and the workpiece, together with a dial indicator, used to centre a casting in the four-jaw chuck. Tom's comment is "One look at it and I went into shock reflecting on all the time I had wasted over the last 60 years!".

This 140 page book is a small but fitting final tribute to a man who contributed much to the world of engineering, not just in the model making scene, and whose writings brought pleasure to many. It is a valued addition to my library.

Simple Workshop Devices by Tubal Cain is No. 28 in the Workshop Practice Series and is published by Nexus Special Interest Books at £6.95 plus p&p. (ISBN 1-85486-150-6).

CAD for Model Engineers

When my predecessor investigated and reviewed the relative merits of a number of computer aided drawing (CAD) systems, his efforts received a somewhat mixed reception, with some readers questioning the relevance of computers in the home workshop environment. Gradually, contributions from such authors as Richard Bartlett, Peter Rawlinson and Tony Jeffree among others have shown that these devices can be used to carry out tasks appropriate to their capabilities in exactly the same way as can a lathe or milling machine. The traditional drawing board is becoming an increasingly rare item in the modern industrial drawing office and I am getting a firm impression that something similar is happening in the hobby scene among those who enjoy designing their own models and workshop equipment rather than constructing to someone else's design. Whenever a contributor mentions a particular CAD package, I receive letters and telephone calls asking if more information is available. This addition to the Workshop Practice Series, while only mentioning a few specific programs in passing, goes a long way to answering many of the more general questions asked by those thinking about acquiring the capability.

Author Derek Brown has become a familiar figure at model engineering exhibitions, demonstrating the use of his selected system, showing how easy it is to carry out the basic drawing tasks and how much time can be saved when it comes to dealing with repetitive actions. His book expands upon the material contained in his lectures and provides many useful tips for those who may be taking the first few hesitant steps, but perhaps more importantly, to those wishing to know a little more before investing in their first system.

The inspiration for the book came out of a discussion between the author and Tom Walshaw just a little while before his death. They were discussing a possible updating of the Tubal Cain book (No. 13 in the Series) on Workshop Drawing and a suggestion that any forthcoming edition should include something on CAD. Tom was of the opinion that Derek was far better qualified to produce such a work, and so it was agreed. It is my firm view that anyone setting out on the path of using CAD who has not already been trained in draughting techniques could do no better than become familiar with the practices expounded by Tom Walshaw before attempting to master CAD. Use of such a system can, in no way, guarantee the creation of a technically sound engineering drawing. What it can do is to speed the application of good practices and help to

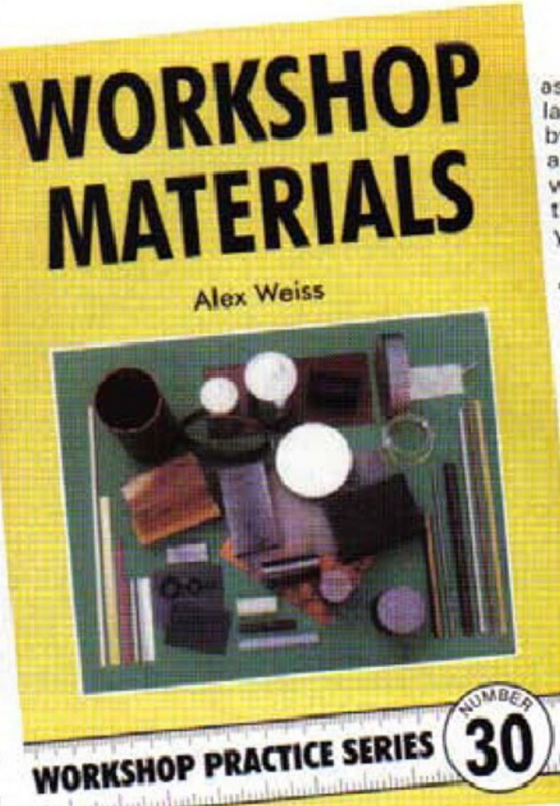
Workshop Materials by Alex Weiss

This book surveys the materials which could be encountered in the home workshop, either in the free-standing state or combined with others into a variety of forms. Because it looks not only at basic construction materials but also at processing compounds such as cleaning and plating agents and coatings, fuels and lubricants, the list is long. Indeed, the introductory chapter lists the chemical elements which may be encountered in one form or another, and these total some 48, and it would not be too difficult to argue for the inclusion of a few more.

A further reason for the comprehensive coverage is that the author has aimed the book at an audience wider than that regarded as being within the model engineering field, such as those working with full-size machinery, including vintage and veteran road transport (two and four wheeled), traction engines and railway locomotives. Thus, the majority of M.E.W. readers should find it of interest.

The first three chapters deal with metallic materials, Chapter 1 covering ferrous, Chapter 2 aluminium and copper and Chapter 3 other non-ferrous metals. Each looks at the nature of the material, sources and methods of production, properties and uses.

Iron and steel are dealt with at some length, the effects of varying carbon content being discussed in detail and illustrated by iron-carbon equilibrium diagrams. The impact of adding a variety of alloying elements are covered, with



material specifications, equivalents and applications being listed, together with mention of applicable heat treatments.

Again, the chapter on aluminium and copper is mainly concerned with the alloyed forms and their characteristics, though the suitability of high grade copper for model boiler work is highlighted.

The coverage of other non-ferrous metals is wide, ranging from lead and its alloys to the nickel-chromium alloys such as the Nimonics and to titanium. The latter are, of course, now being used by those home workshop owners who are developing the small gas turbines which have made such an impact on the model engineering world in recent years.

Chapter 4 deals with the selection of materials reviewing their characteristics, sources of supply and importantly, ways in which they may be identified, essential for those whose happy hunting ground is the local scrap yard or material suppliers off-cut bin.

Subsequent chapters cover wood, both as a material for inclusion in the finished project or as a tooling material for such things as casting patterns, plastics (of which more later), refractories and abrasives, joining materials and the processing and protective fluids. The final chapter is on Safety and this is followed by a series of Appendices containing a glossary of terms and abbreviations, conversion tables, lists of suppliers and a bibliography.

This 150 page book can be recommended to home workshop owners as a wide ranging review, covering the majority of the materials they are likely to encounter and giving sufficient information for most purposes.

Workshop Materials by Alex Weiss is No. 30 in the Workshop Practice Series and is published by Nexus Special Interest Books at £6. 95 plus p&p. (ISBN 1-85486-192-1)

(Details of the full range of books in the Workshop Practice Series can be found on pages 63 and 64 of this issue.)

generate a neat and well laid out drawing. Although I believe that the Walshaw book is currently out of print, I have heard of plans to revive it, but in the meantime, try to borrow a copy as it contains much wisdom.

'CAD For Model Engineers' firstly discusses the philosophy of CAD then goes on to deal with the equipment required. It points out that the enthusiasm of the younger generation for machines which will run the ever more sophisticated computer games means that there is much very reasonably priced second-hand equipment available, most of it quite capable of handling the sort of CAD packages we are likely to use. As far as programs are concerned, Derek wisely refrains from recommending any particular one, pointing out that new systems and revised versions of older systems are continually becoming available. What he does is to define the features which should be present in any package under consideration, emphasising particularly the differences between true CAD systems and the popular graphics packages.

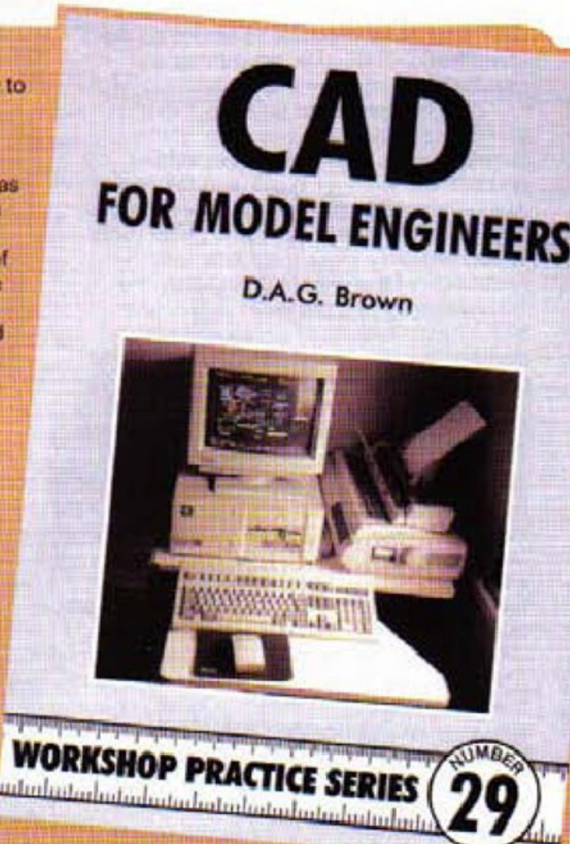
Subsequent chapters describe various aspects of the drawing process, showing how a CAD system can be used to generate the necessary elements which form the drawing, such as lines, figures, shapes, hatching and dimensions. The use of layers is explained as are the techniques of editing and copying, two of the facilities which really set CAD apart from the more traditional drawing methods. The ability to create libraries of the drawings of commonly used components and the facility of scaling from the dimensions shown on full size drawings are shown as tools which the model maker can use to advantage.

A chapter is devoted to the printing of the finished drawing, with advice on the selection of an appropriate computer printer and some of the actions required to ensure that the finished product reflects the intentions of the draughtsman.

Derek Brown's 90 page book is a valuable addition to the Workshop Practice Series as it extends the coverage to deal with more recently introduced techniques and a topic on which advice is being actively sought. The writing is factual, backed up with well illustrated examples and technically sound, as is to be expected from such a well qualified and experienced engineer.

Fittingly, the book is dedicated to the memory of Tom Walshaw.

CAD For Model Engineers by D.A.G. Brown is No. 29 in the Workshop Practice Series and is published by Nexus Special Interest Books at £6.95 plus p&p. (ISBN 1-85486-189-1)



A Treatise on Oiling Machine Tools by Guy Lautard

The writings of Canadian author Guy Lautard will be familiar to many readers of M.E.W., particularly from his three 'Bedside Readers' which have been made available in the UK through Camden Miniature Steam Services. Another of his efforts, now unfortunately out of print, was the source of the design of the file rack which forms the subject of Tony Birkinshaw's article which starts on page 53 of this issue.

Recently received from Adam Harris of Camden is this monograph on the topic of the lubrication of machine tools, written by Lautard, part of it arising from correspondence with Tim Smith of Toledo, Ohio and some based (with permission) on an article by Herbert Dyer published in a July 1936 issue of 'Model Engineer'.

In addition to a general article on the topic there is a more specific one on adding a centralised lubrication to a milling machine. Two articles deal with the manufacture of sight feed oil cups, the 'M.E.' based version being of a size suitable for use on machine tools while the other is proportioned for fitting to model engines.

The leading article is, however, entitled "A Myford Owner's Fondest Dream Come True - How to Make an Effective Substitute for the Myford Oil Gun!". This article arose from the writers' dissatisfaction with the item supplied with Myford 7 Series lathes and which lead to a lengthy correspondence in 'Model Engineer' in the early 1980s. The result was a modification to a lever type grease gun, and although the basis was a particular model available in North America, the same alterations could probably be applied to a number of similar types.

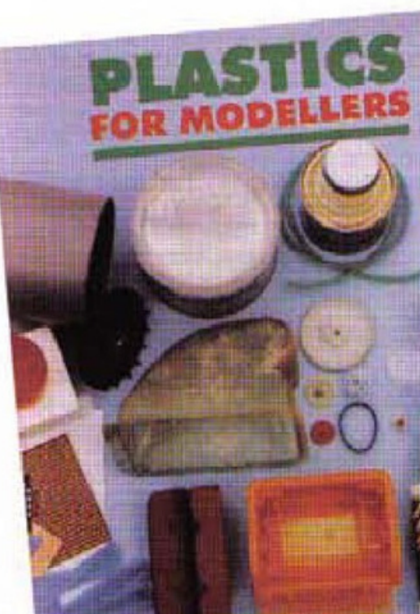
This publication is a simple but clearly printed A4 size booklet of 24 pages containing line drawings and sketches but no photographs. The version I have is printed in Great Britain by Camden Miniature Steam Services, under licence from Guy Lautard who is the copyright owner. It contains much useful information on the nominated subject and many interesting hints and tips on a variety of topics which just happen to arise along the way.

A Treatise on Oiling Machine Tools is available from Camden Miniature Steam Services, Barrow Farm, Rode nr. Bath, Somerset BA3 6PS (Tel. 01373 830151 Fax. 01373 830516) at £5.65 post paid in the UK.

Plastics for Modellers by Alex Weiss

While Alex Weiss' book on Workshop Materials contains just a chapter on plastics, this publication (not part of the Workshop Practice Series) deals with these materials in much greater depth.

Many model engineers are constrained in their choice of material by the range used in the prototype they are modelling. Those with wider home workshop interests are not handicapped in this way and now have a bewildering selection of raw materials from which to choose. This book will be invaluable to them as it gives much good advice on the identification, selection, machining and manipulation of these materials.



Although the author points out that plastic materials occur naturally, in the form of amber, bitumen, casein, rubber and shellac, the book deals with the man-made materials which first appeared in the 1860s, but which have become much more widely available since the 1930s with the expansion of the petroleum industry. He acknowledges that the word plastic has historic implications of cheap and nasty, perhaps the result of stories about some of the early applications of plastics which have become myths as materials technology has improved. Now, of course, plastics are highly valued engineering materials with a wide application, the modern motor car, for instance, containing a very high proportion of man-made materials as a result of the eternal search for weight reduction and hence fuel consumption. In our own workshops, the use of such things as plastic drive belting and engineering adhesives typified by the 'Loctite' products are just a few examples of the increasingly widespread application of these materials.

After a general description of the nature of plastics, the book goes into much more detail on the various thermoplastics and thermosetting plastics which may be encountered, listing their characteristics and possible applications. Some of the photographs used to illustrate this section feature a number of projects (and the occasional personality) which will be recognised by readers of M.E.W. and others familiar with the world of model engineering. Tables list a variety of tests which may be carried out in order to identify a particular type of material, and others define the physical properties of each, information which is essential when selecting a material for a particular application. The availability of the various forms and sizes which can be obtained are covered, as are possible sources of a wide selection of types.

Part 2 of the book deals with working with plastics, giving such information as suitable cutting tip angles for saws, drill bits, lathe tools and milling cutters. One chapter covers the important topic of joining plastics to themselves and other materials, providing information on suitable adhesives and processes.

A number of chapters describe methods of forming and manipulating these materials, of particular interest being the use of rubber moulds and components in the low temperature casting process which is quite capable of handling the lower melting point metal alloys.

The final part of the book illustrates the various applications of plastics in the modelling field, one chapter dealing specifically with model engineering. Examples quoted range from components for scientific instruments to the tyres for large steam road vehicles. One interesting point made by the author is that if a clock maker wishes to simulate ivory, plastic is now the only legal solution. The contribution of plastics to the development of modern electronics is acknowledged, with many instances being given of their use in the home construction scene, printed circuit boards being a prime example.

Many model engineers are still not comfortable with the use of these materials, feeling that they are not 'traditional', witness the 'Plastic Free Zone' depicted in one of the book's cartoons. However, where the choice of materials for a particular project is not restricted by considerations of 'fidelity to prototype', plastics are materials which have physical and mechanical properties which can make them the material of choice for a particular application. This 145 page book is an ideal introduction to those who may be unfamiliar with the range of materials available and their capabilities, and is therefore to be recommended.

Plastics for Modellers by Alex Weiss is published by Nexus Special Interest Books at £7.95 plus p&p. (ISBN 1-85486-170-0)

IMS UPDATE

A message from Ivan Law, the Chief Judge

As I sit to write these few words, with the sun high in the sky and the temperature in the top twenties, the Model Engineer Exhibition seems a long way off. However, preparation for the Exhibition starts very early and in my case, as Chief Judge, I have to arrange for every one of the 70 or so categories to be competently judged by at least two of 40 specialised judges that are required - and this takes time to arrange.

Being a member of the old brigade, I still refer to the International Model Show as it is now called as the Model Engineer Exhibition. The term model engineering can cover a wide field; many of the aircraft on show are examples of model aeronautical engineering; the boats are examples of model marine engineering, and so on. However, the IMS covers all aspects of model making.

Of all the categories on display, one is different from the others, and that is the one for Tools and Workshop Appliances (Class A5) - the section that readers of this magazine are likely to find particularly interesting. The models on display in the other classes are usually small scale replicas of some full-size prototype whereas the tools are pieces of equipment constructed to assist in the production of components of the models. The approach to tooling is therefore different to that taken to the actual model and so the method of judging the tools also differs.

There are a number of headings in which marks are awarded in the judging of a model. these I have outlined in the Competition Information Booklet, a copy of which is sent to every entrant. One heading is complexity; a highly complex model will gain more marks in this section than one where the quantity of work is far less. In tooling, it is not complexity the judges are looking for, but simplicity! A good tool or fixture is one that is simple in concept, easy to make and will perform its allotted task with complete satisfaction. It should also be a pleasure to use, with no sharp edges to cut the users fingers. The general surface finish should not be as high as that required on instruments as a highly polished finish does not improve a tool's performance. This does not mean that the finish should be crude - the general appearance should be pleasing to the eye and the touch, but no more. Chrome plating for the sake of appearance is not an attribute.

At exhibitions, we all like plenty to look at and admire on the display stands but it must be remembered that all the entries come from us, the model engineering public. If we do not send our entries then we should not be disappointed if other people do not do so.

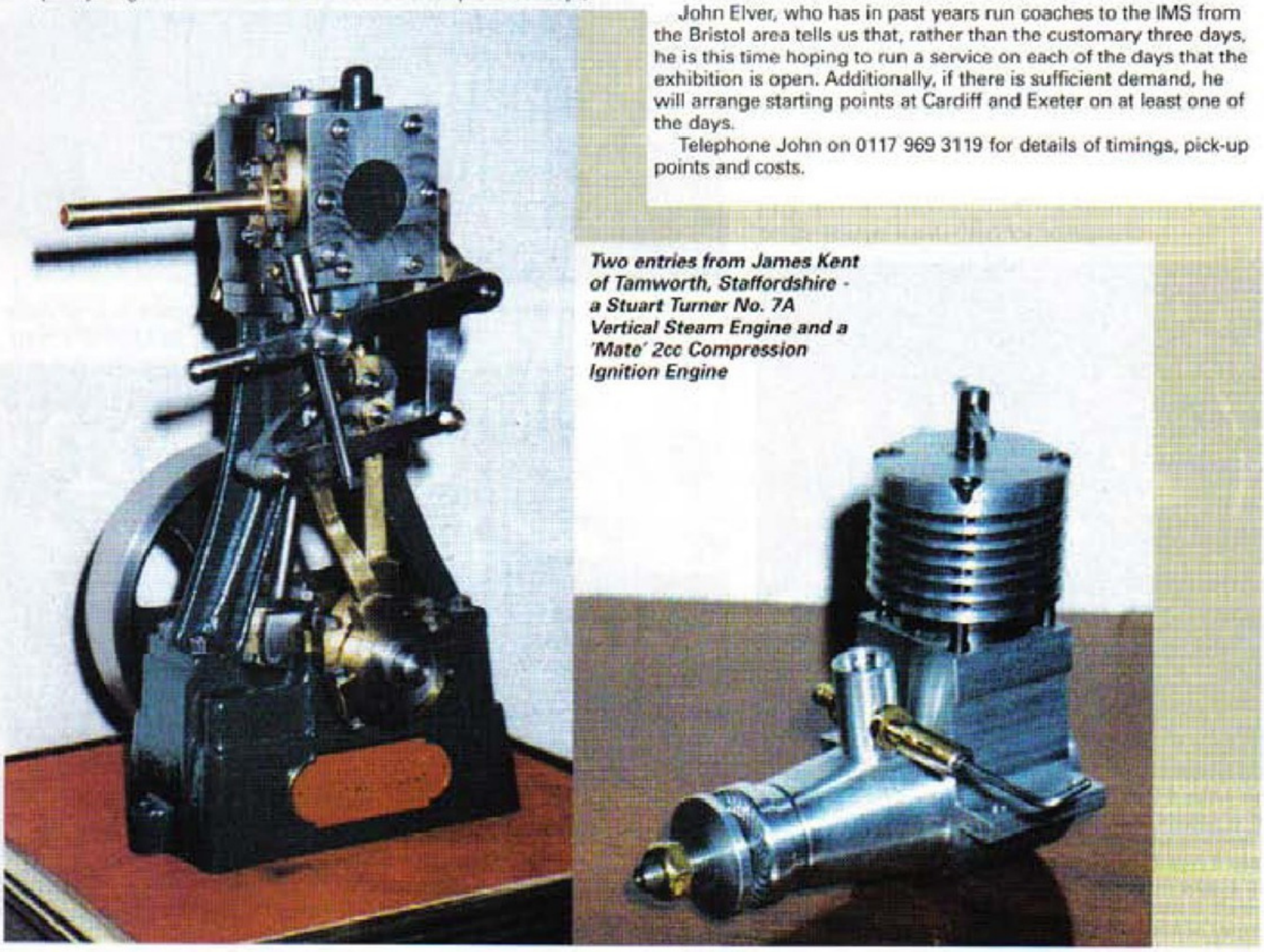
There are many changes in the Nexus organising team this year. They are, from my experience, a listening group who want to make the Exhibition and particularly, the competition part of it, a success. they are more than willing to understand what we, the exhibitors and the public have to say and to act on our suggestions.

This year, the venue is much easier to get to, particularly from the North. There is a vast free car parking area and transport can get directly into the hall on 'setting-up' days which eases the delivery of the larger models. Every effort is being made to get the exhibition back to its former status - it used to be known as 'OUR EXHIBITION'. It is now up to us, the modelling public, to give our support by entering many exhibits, so that after the event we can look back and say that a great step forward has been made in returning the Exhibition to its old glory.

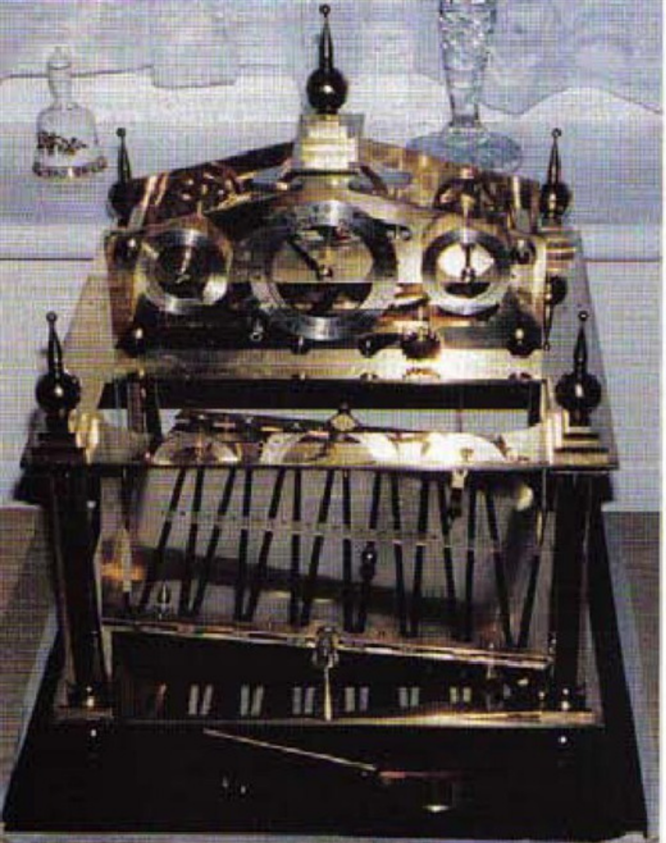
Getting to the IMS from Wales and the West of England

John Elver, who has in past years run coaches to the IMS from the Bristol area tells us that, rather than the customary three days, he is this time hoping to run a service on each of the days that the exhibition is open. Additionally, if there is sufficient demand, he will arrange starting points at Cardiff and Exeter on at least one of the days.

Telephone John on 0117 969 3119 for details of timings, pick-up points and costs.



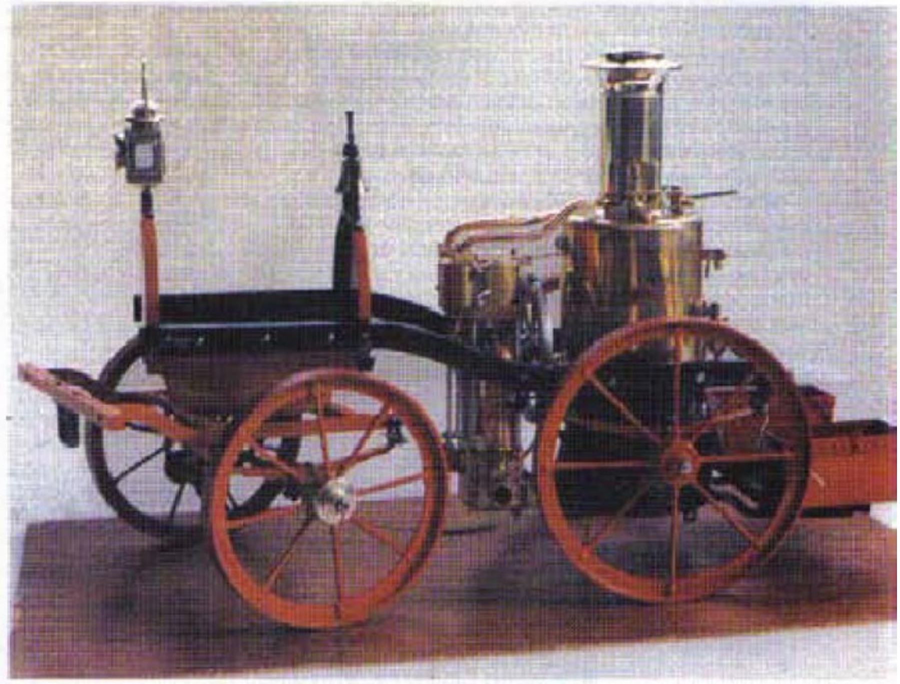
Two entries from James Kent of Tamworth, Staffordshire - a Stuart Turner No. 7A Vertical Steam Engine and a 'Mate' 2cc Compression Ignition Engine



George Pratt of Hunstanton, Norfolk has constructed this Congreve clock to John Wilding's design

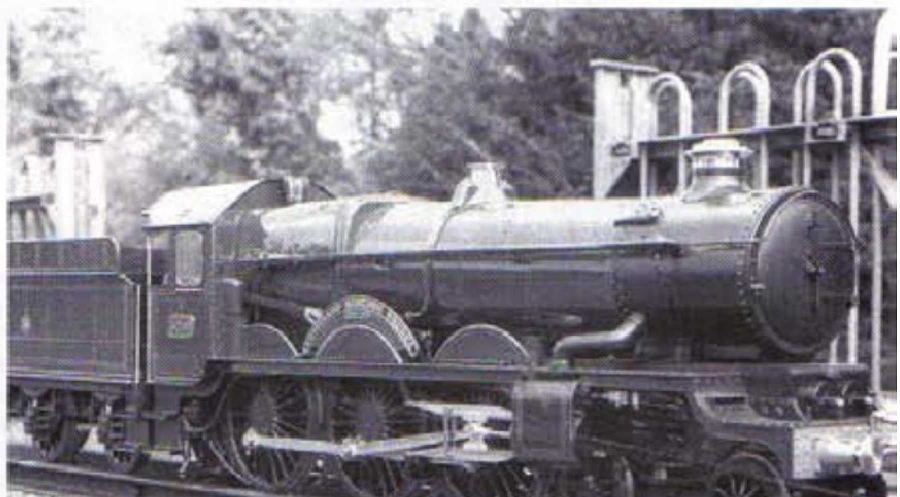
The blacksmith's shop at the Chiltern Open Air Museum inspired this model by Edward Lawrence of Northolt, Middlesex

Just a sample of the entries received in the engineering classes so far



A Shand Mason Hand Drawn Steam Fire Engine to 1/10th scale entered by Philip Pugh of Shrewsbury

This 130cc 9 Cylinder Radial Petrol Engine has had a number of features added in order to make it resemble the Lycoming 680 engine fitted to a Stearman aircraft. It was built by Bill Connor of Maidstone, Kent



Winner of a Gold Medal and The Charles Kennion Memorial Trophy two years ago, this 5in. gauge Castle Class locomotive 'Isambard Kingdom Brunel' by Graham Hawkins of Bristol is entered in the Duke of Edinburgh Trophy competition.

A PRECISION SPACING PUNCH

An evening in the workshop is all that is needed to complete this useful marking-out device described by Alan Jeeves

Here we have one of those workshop aids which is cheap and easy to make and is really handy to have around when the need arises. It is a device **(Fig. 1)** for marking out the centre positions of holes which have to be spaced with precision. The principle is similar to that of a trammel set except, instead of scribing a line, the hole centre is actually punch marked in the exact spot where it should be. Once one punch mark has been established, it is a simple matter to form another one at exactly the right centre distance and then as many holes as are required can be marked out using this simple device.

As the drawings are looked over it may be decided that the dimensions should be altered to suit the type of work most frequently carried out. What would look better than a set of, say, three or four, each of a different size, capable of dealing with any job which may be encountered? Carefully stowed away after use in a rust-free atmosphere, perhaps in a small fitted wooden box with some VPI paper, such tools would give a lifetime of service as well as a great deal of pleasure.

Starting with the main frame **(Item 1)**, this can be made out of any material to hand and bright drawn mild steel is as good as any. A good quality slot is machined into it, parallel to the edges and with a good surface finish to allow the centre pin **(Item 3)** to be smoothly adjusted. The hole for the punch is reamed for a good fit and a small drilled and tapped cross hole accommodates a grub screw to hold it in place. Sharp edges should be removed from the main frame and it should end up comfortable to handle. Perhaps here is an item on which to practice the methods of achieving a high quality finish advocated by Dr. Peter Clark in his article in Issue 60.

The punch **(Item 2)** is simply a length of silver steel of the correct diameter which has a 60 deg. point machined on exactly concentric with the o/d. It also has a small chamfer at the opposite end to prevent it from piening over when it is lightly tapped with a hammer. This is, in fact good practice where any form of punch or chisel is concerned as a deformed end can break away when next struck, with risk of injury from the flying fragment.

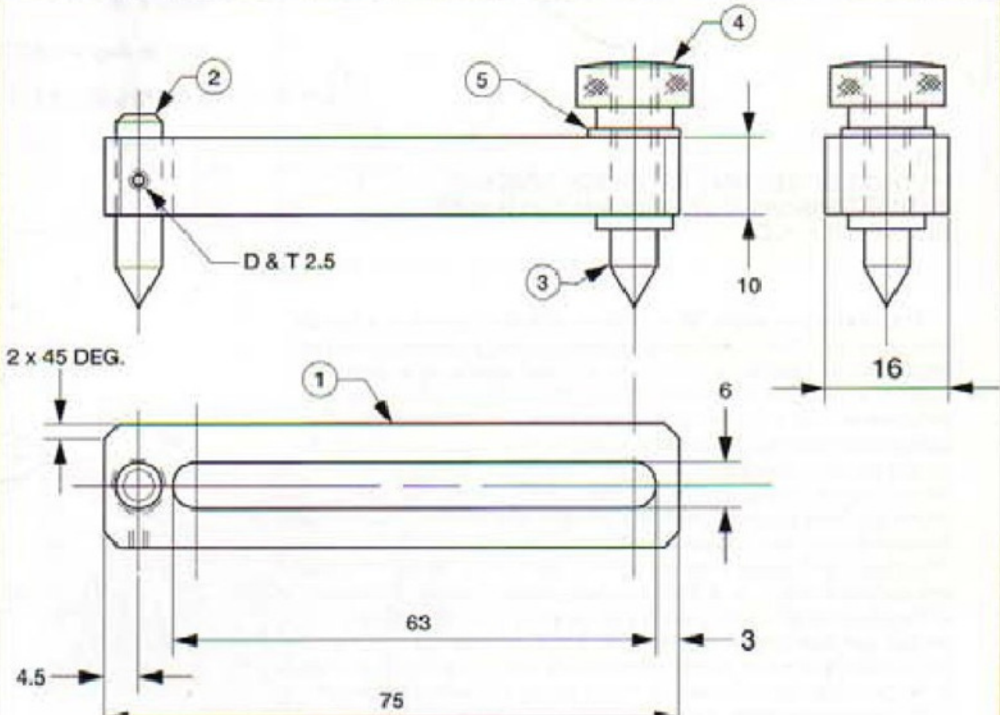


FIG. 1
PRECISION SPACING PUNCH

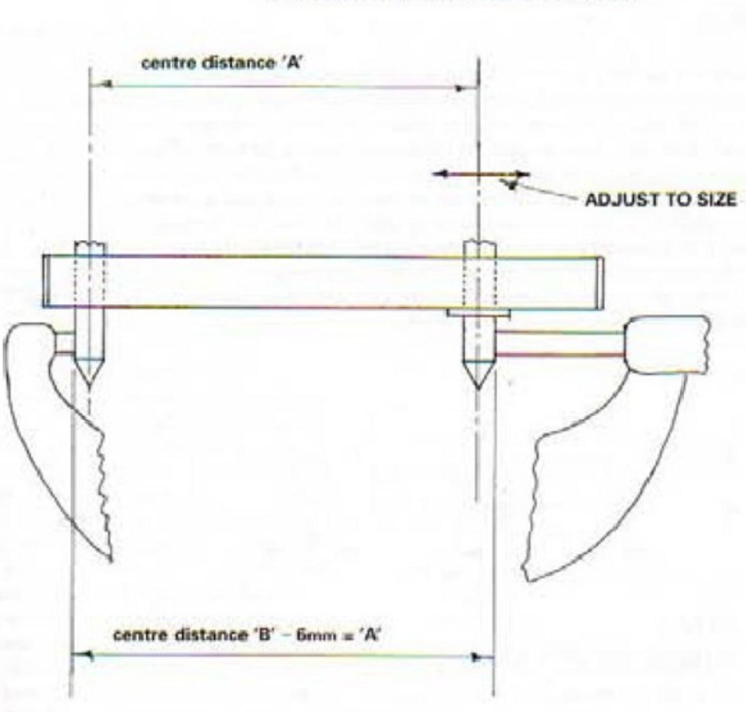


FIG. 2
SETTING THE PUNCH WITH MICROMETER

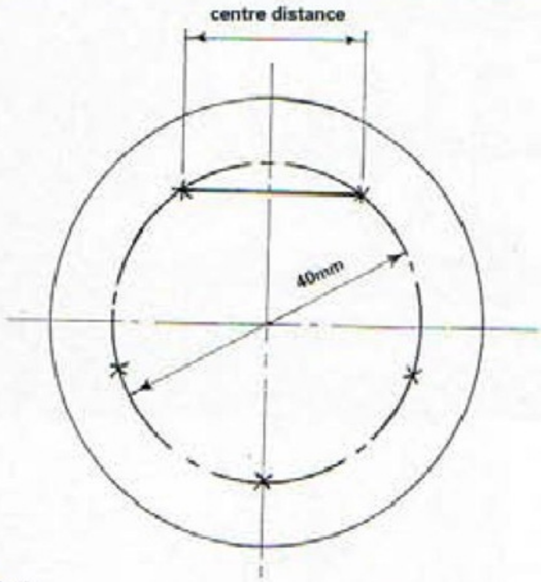


FIG. 3
METHOD OF SETTING PRECISION SPACING PUNCH TO MARK OUT EQUI-SPACED HOLES ON A GIVEN PCD.

Equi-spaced holes on a PCD

If the task is to set out a number of holes equally spaced on a pitch circle of a given diameter, then the following may help.

The centre distance to be set on the spacing punch **(Fig. 3)** can be determined by dividing 180 (deg.) by the total number of holes required and finding the sine of the resultant angle. This figure is then multiplied by the PCD to give the centre distance.

For example:-

Five equally spaced holes on a pitch circle of 40mm dia.

180/5 = 36

sine 36 deg. = 0.58778

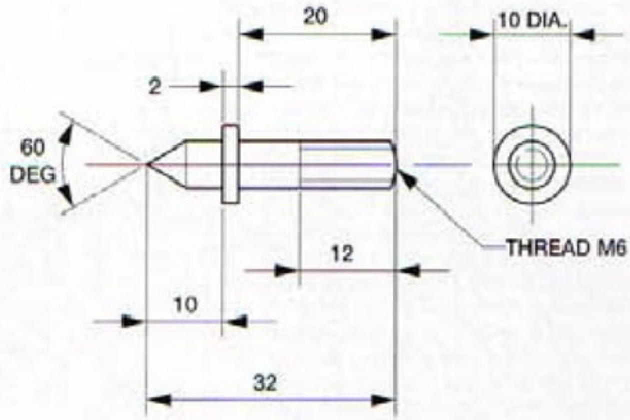
0.58778 x 40 = 23.51mm

The centre pin **(Item 3)** is slightly different as it has a flange machined on. It is a distinct advantage if the parallel section of the centre pin (between the point and the flange) is exactly the same diameter as the punch. This makes things easier if it is proposed to set the centre distance with a micrometer or a calliper (vernier or, these days, digital). The opposite end of the centre pin is threaded for enough of its length so as to ensure that it can be firmly clamped in the slotted frame. Both of these items are heat treated and it is a simple operation to harden and temper the points. They are heated to cherry red and plunged into clean cold water thus rendering them very hard. The points are polished bright and then carefully heated about midway along their length until the colours start to run. When light brown reaches the tip of the point it is an indication that the temperature there is about 2500 deg. C. and they are quenched in water. This should result in them being properly tempered.

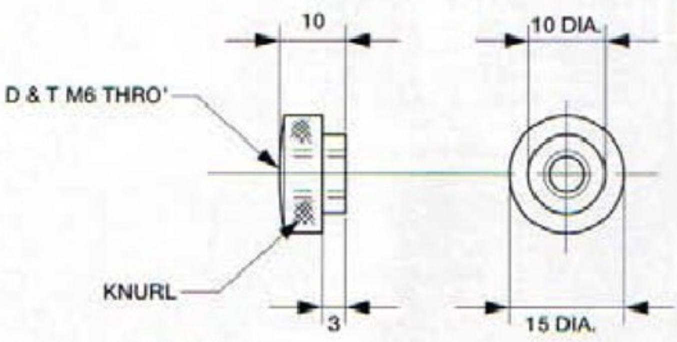
A thumb nut **(item 4)** is turned in the lathe and well knurled. A standard hexagon nut will do if you like, but is less convenient. The thread should be a nice easy fit because we do not want to move the centre pin unintentionally when tightening. **Item 5** is simply a standard washer.

In use

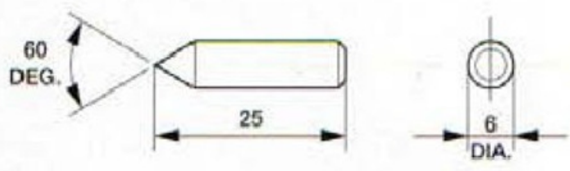
To use the gadget, a punch dot is made at the starting point with a good sharp centre punch and thereafter, all equi-spaced holes can be laid out by locating the centre pin in the previous punch dot and then lightly tapping the punch with a hammer. This applies to holes on a circular pitch as well as in a straight line. For very precise marking out, the points can be measured across with a micrometer or calliper and set exactly **(Fig. 2)**. The micrometer will read the required centre distance plus the diameter of one of the centres as long as they are of the same diameter, as mentioned previously. If they are not, its a matter of allowing for the radius of each.



ITEM 3
CENTRE PIN (SILVER STEEL)



ITEM 4
THUMB NUT (MILD STEEL)



ITEM 2
PUNCH (SILVER STEEL)

A LAZY SUSAN FOR A FILE RACK

Or how to make what cannot be bought

Tony Birkinshaw of Telford, Shropshire had difficulty in locating materials for a popular workshop project designed in Vancouver. This description of his modified version may help readers who have experienced similar problems

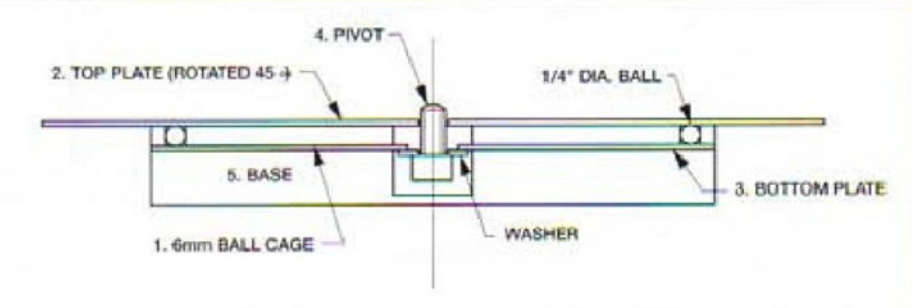
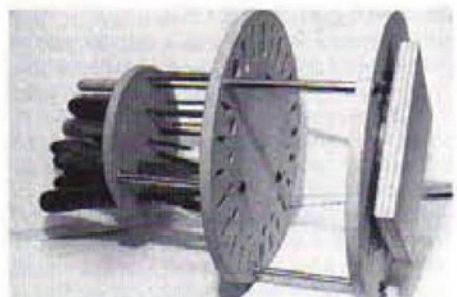


FIG. 1. LAZY SUSAN THRUST RACE (CROSS SECTION)

Half a dozen assorted files have been adequate for constructional projects in radio and electronics during a lifetime of interest. Upon retirement I converted the inbuilt garage to a workshop, installed lathe and milling machine and started a collection of cutting tools. It was about this time that large quantities of new and second hand tools appeared on market stalls and at steam rallies. Much was at a fraction of manufacturing cost and famous Sheffield and American brands not to be found in local shops. One purchase, at fifty pence apiece, was three large and very thick files that had lain boxed and unused in a brass foundry since the turn of the century. A friend in Sheffield tells me that the change in thickness is due to improvements in steel specifications. OK, but the old thick ones seem to handle better.

As my collection of files, from Swiss types to big ones grew, storage became a problem, first in cardboard tubes from kitchen foil and clingfilm rolls, standing up in boxes with big 'uns in a bucket. This is fine for protecting cutting edges but a pain, as one could only see the handle. Much time was wasted lifting each up in turn to select the file needed and, according to Murphy's Law, one went through the lot on each occasion. Something better was needed. Then I discovered Guy Lautard's Strokeagenius File Rack.

I had made four of Guy's projects before; they enabled me to cut my teeth, so to speak, in newly acquired skills - very entertaining and the products are useful additions to the workshop. What follows is an alternative approach in producing the file rack because sourcing of materials is different here in Telford from that in Vancouver. The design calls for three large discs of medium density fibre board and Guy gives advice on how to trepan these on the milling table while warning of the hazard involved, not to mention the dust arising. Now I have recently discovered that when I need sheets of wood-like material cut to a specific rectangle, instead of erecting the Workmate it is easier and quicker to hop on the local bus (armed with my bus pass) to visit our local woodyard cum DIY store that has some pretty accurate machines.



The file rack laid on its side to show the 'lazy susan' bearing assembly

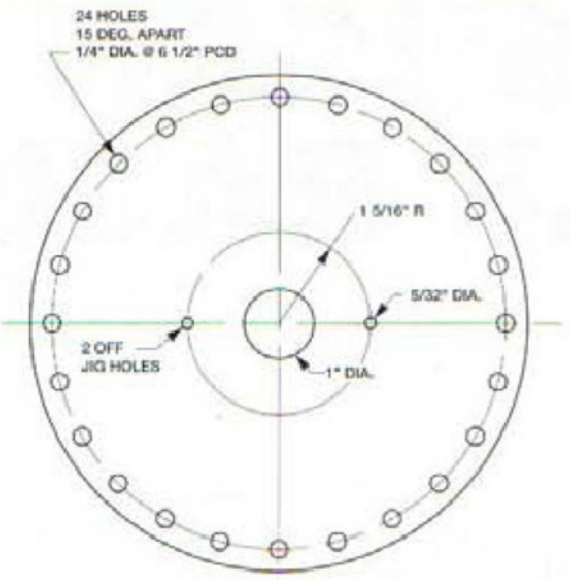
For a few extra pence per cut and a ten minute wait you leave with just the piece(s) you need. So I asked "can you cut circles?" - "Circles, triangles, ovals. No problem sir" was the reply, so I was back home in a trice with three precision cut circles of MDF and a square of three-quarter ply, all in a bag, ready to get on with the clever bit. Having completed the main structure of the file rack I hit on a real problem because I was unable to source the component that converts it to carousel mode so vital to user friendliness.

6in./400 lb capacity 'lazy susan' bearings specified in the Canadian design are not recognised locally - a lady in a department store, being a veteran of many Tupperware parties, knew what a party susan was and said they were popular in Chinese restaurants and they had a nice hardwood version for twenty pounds. The man in the wedding cake shop had a mushroom-shaped contraption in white plastic for icing cakes at thirty pounds. The technician in the ball and roller bearing agents said there wasn't much call for thrust bearings and one of the size I required would need balls about 25mm diameter. I didn't tell him that mine would rotate once a fortnight with bursts of twice in ten minutes and I was not building a crane because body language told me that he didn't like discussing lazy susans. I don't know why - there wasn't another customer within 100 yards of the place. Maybe he's missing out on a line of business. A friend, knowing my need, obtained a plastic Turntable Organizer made in China from a market stall in Wales for 99 pence. This had the right overall dimensions but alas, only six plastic balls that wouldn't roll because they turned out to be nylon beads. Perhaps they also make toy necklaces.

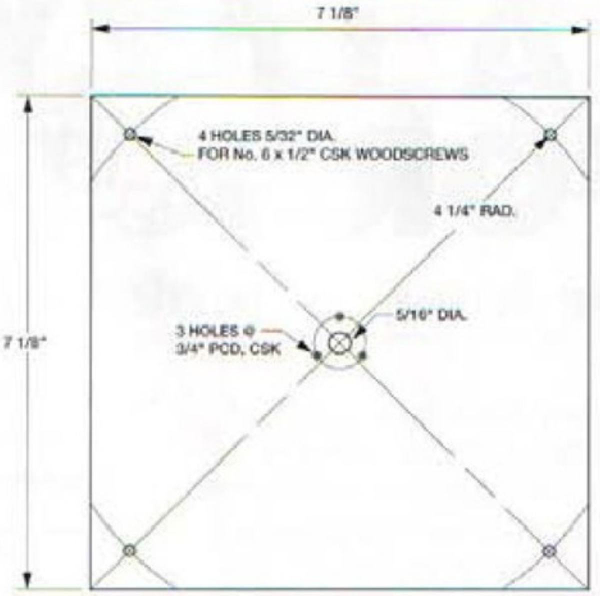
I replaced the beads with quarter inch diameter bottom bearing balls sold for the repair of bicycles, and the surplus beads, threaded on piano wire, were just the thing needed for a scoutcub project involving wind measurement for my grandson. Although the plastic version now worked smoothly, it was too flimsy for the task in hand and was put aside for possible use as a rotating table whilst paint spraying a model. It gave me an idea that I could easily produce. Call this the development phase.

Foraging for materials to make what couldn't be bought

The balls I had used were left over from a cycle repair project by my son who had flown the nest pre metrication/decimalisation. Enquiry at the local cycle shop revealed, rather surprisingly, that packets of the same Imperial balls were still sold containing the same quantity (22) and for the same



ITEM 1 BALL CAGE
6mm POLYCARBONATE, 7 1/8" DIA.
FOR 24 OFF 1/4" DIA. STEEL BALL BEARINGS



ITEM 2 TOP PLATE
3/64" OR 1/16" THICK MILD STEEL

purpose, but the shilling was now a pound (a dime to two dollars if Guy's reading this). Metrication has not arrived in that quarter! I wonder if continental bicycles use metric ball races?

The multiple giant retail store sells a similar packet of 22 x 0.25in. balls, but with a dab of grease which increased the price to two pounds.

Now we come to the clever bit - I had some offcuts of 6mm polycarbonate sheet, used by our allotment club to deter vandals from smashing their windows and, since the smashed windows of local bus shelters and telephone boxes were replaced by this material, no further replacement has taken place. It proves to be a pretty tough substance. Now, 6mm is a nice clearance size below quarter of an inch and fine for producing a ball cage for the lazy susan. A square sheet of 6mm polycarbonate (Makrolon or Lexan trade names) was first sawn to an octagon, mounted on the faceplate via two jigging holes to chipboard, and skimmed to a circle. 24 equi-spaced 0.25in. holes were drilled on a pitch circle of 6.5in. with angular displacement of 15 deg. Two square thrust plates of 3/64in. mild steel plate, chosen for its flatness and availability, were sawn rather than sheared, in order to preserve that flatness. Fortunately I have stock of sheets with corners cut out, a failed project by a chap who started to make a set of steel drawers but didn't have the bending tackle (neither have I). The square shape facilitates assembly via corner holes. A bar end of brass was used to make the centre pivot, the function of which is to centralize the loose ball-cage. The assembly is shown in **Figure 1**.

My file rack is two years old now and, when full with 57 files on board it is quite heavy at 32lb, but rotates at the touch of a fingertip. Selection of any file is achieved in seconds rather than minutes by the old method and easy to pop back in the right place when tidying-up. I can see what I've got - handy for one with a short memory!

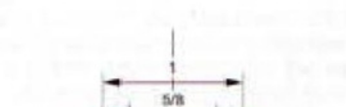
Method and order of fabricating the lazy susan thrust race

1. Do not proceed until you have obtained a sheet of 6mm thick polycarbonate and two dozen quarter inch ball bearings which are the critical items.

2. Both faces of the plastic sheet are protected with adherent paper. Do not remove the paper until all marking and drilling operations are completed.

Mark out the ball cage dimensions (Item 1) and first drill three M4 or 5/32in. holes centred in a row 1 5/16in. apart. Cut the square slightly over 7 1/8in. then cut corners to octagon shape. Using a woodscrew as a pivot through the centre hole, mount the rough octagon on a sheet of chipboard which should then be clamped to the table of the mill/drill. I always use white faced chipboard under all things that I drill through. One thing, it's nice and flat, reflects the light. White chippings and wood fragments come up the drill flutes on penetration and the slight scouring action of both seems to minimize burrs. Also you can write memos to yourself on the surface. When it becomes overused and grotty just chuck it in the bin and get a fresh piece; offcuts are easily come by. Position the drill at 6 1/2in. PCD and drill the twenty-four 1/4in. holes, rotating the octagon on its temporary centre pivot.. Use a stub drill for preference. I always centre pop with an automatic centre punch and use a smaller drill first, then enlarge to full size to give a cleaner hole. Test that balls are a rolling fit; if not parallel ream or finish with a M6.4 drill.

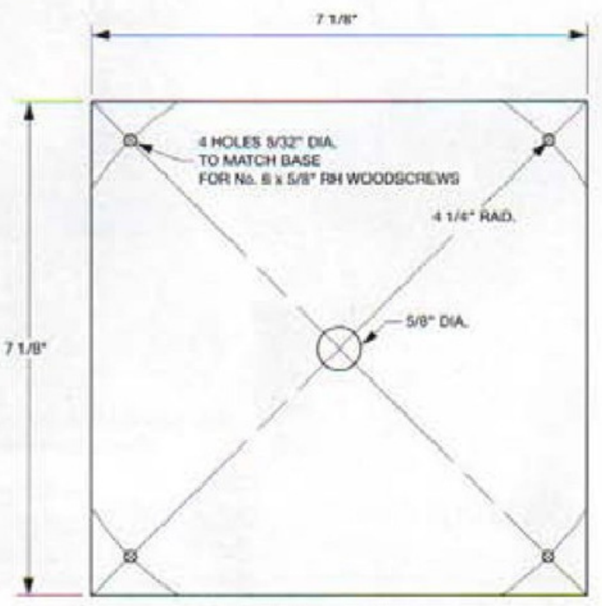
3. Separate, hold the chipboard against the lathe faceplate, using the tailstock centre in the centre hole, and screw a couple of short No.10 woodscrews, with penny washers, from the back of the faceplate. Retract the tailstock and reposition the plastic sheet, again holding centrally by means of the centre whilst fixing, via the two jig holes, using short countersunk No.8 Posidrive woodscrews.



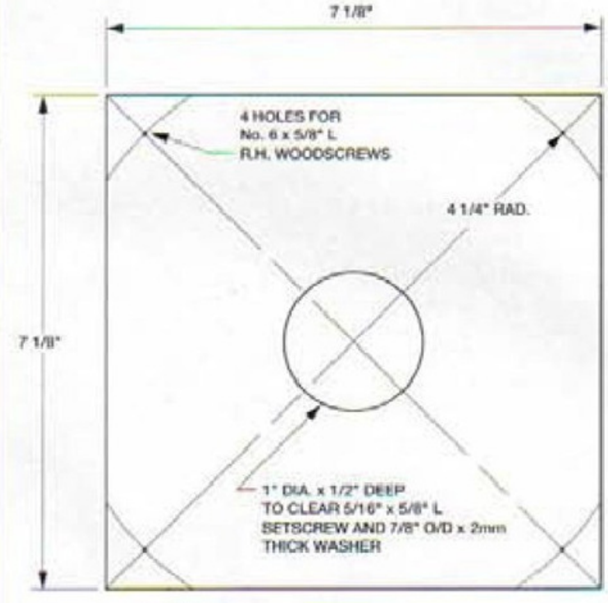
ITEM 4 PIVOT
ALUMINIUM/BRONZE

Drill and bore the centre hole of the plastic, which should be a loose fit on the centre pivot of approximately 1in. diameter. If you are using smooth drawn bar for the pivot, this can be used as a gauge. Sizes over 1in. can be used if that is more convenient; leave the bar as drawn - do not machine down to 1in. Now, with a LH facing tool (that's the one that curves round to the right) parallel to lathe axis skim to an overall diameter of 7 1/8in. and set aside.

4. Saw out two squares of BMS or similar plate using a fine tooth hacksaw. A guillotine or shears may impair the flatness, which should be checked using a steel rule. Smooth and deburr the edges. Use marking blue and scriber (or self-adhesive paper labels and a well sharpened pencil) to mark out hole centres as per drawings of the top and bottom plates **(Items 2 and 3)**. Mark one 'TOP' and the other 'BOTTOM' to avoid confusion.



ITEM 3 BOTTOM PLATE
3/64" OR 1/16" THICK MILD STEEL



ITEM 5 BASE
7-PLY, 18mm THICK

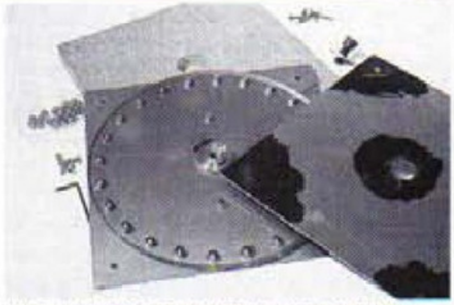
5. Form the centre hole in the bottom plate. I used a 5/8in. valve radio chassis punch for this operation. Being a screw operated punch this requires a pilot hole for the screw and leaves a rounded edge on one side and a burr on the other. The smooth side should face the pivot on final assembly. Try to co-ordinate all corner holes so they can be orientated in either of four positions, not critical but tidy. Drill the centre 5/16in. hole and three small countersunk holes to suit your screws in the top plate. The countersink tool will be 90 deg. for BA screws or 82 deg. for Unified. I made my own D-bit countersink tool when I came up against UNC/UNF socket head countersunk screws several projects ago. It's well worth making one and saves a lot of Esperanto if you are in the habit of purchasing bags of miscellaneous screws. I describe my method of making these countersinks later in the article.

6. I used aluminium bronze for the pivot **(Item 4)** because I have stock purchased from either the aforementioned market stall, or was it the much lamented Whistons Cat? Any smooth drawn metal will do. Chuck, face, drill and tap 5/8in. or M8 according to preference. Turn a step to fit the 5/8in. hole in the bottom plate. Part off oversize and face to drawing dimensions.

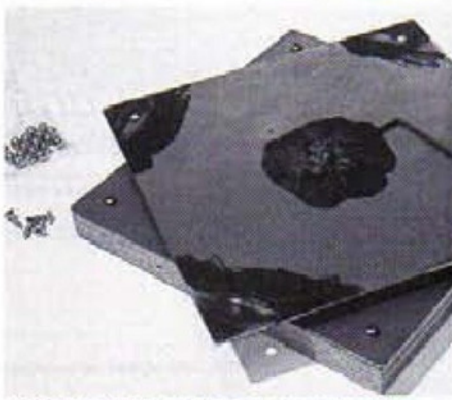
7. Mount the pivot on the top plate using a 5/16/M8 set screw through the plate into the threaded pivot hole. Drill and tap for the three countersunk screws through the guide holes in the top plate and assemble.

8. The components can now be assembled. Place the cage over the pivot, insert 24 balls with just a trace of light grease, fit the bottom plate on the step of the pivot and secure with a set screw and a large thick washer.

9. Drill a 1in. blind hole in the centre of the seven ply base **(Item 5)** to clear the head of the set screw and washer. Place the race assembly, bottom plate down, on the base. Awl and drive four No.6 RH x 5/8in. screws. The whole is now ready to mount beneath the file rack. You may need to drill a shallow 3/8in. blind hole to clear the threaded end of the setscrew.



The components during assembly. The bottom plate (right) locates over the spigot of the central pivot and is retained by the cap head screw and large washer



With the bottom plate screwed to the base board, the assembly is ready to be fitted to the bottom disc of the file rack

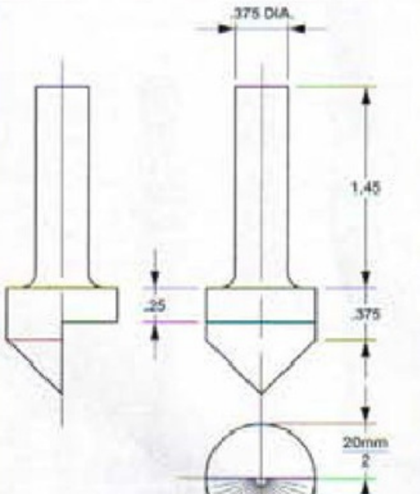


FIG. 2. D - BIT 82° COUNTERSINK TOOL. SILVER STEEL

D-bit countersink tool for Unified screws up to 3/8in. shank

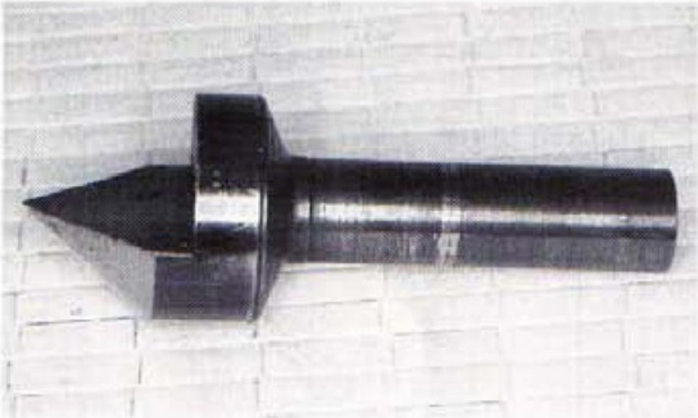
Some years ago, my first attempt at making a D-bit was a total disaster. Carefully I filed out a perfect Dee shape to make a parallel 1/4in. reamer. When it came to hardening I couldn't get the heat right, so I took it to evening class. The instructor lit an enormous fierce flame on a gas torch and proceeded to heat and dunk my effort. As a result I took home a perfectly hardened and tempered, but useless, banana-shaped tool which put me off the whole idea, vowing the exercise should not be repeated. On this particular effort I first made a rather fancy one, copied from an illustration in a tool catalogue. Instead of being D-shaped it had a large hole drilled through the cone. This looked great until I dunked it. There was an expensive sounding CLICK as it fractured either side of the hole. Hence the present design **(Figure 2)**, which worked out fine and has done many countersinks to date. The tool is made from a short length of 20mm silver steel. First turn the shank to 3/8in. x 1 1/2in. or to suit your drill chuck, reverse and with the top-slide set to 49 deg., turn the cone to produce an included angle of 82 deg., leaving a 3/8in. length of unturned bar. File the cone to a few thou. over half the bar diameter, which will be stoned to size after hardening. There are two other sizes that could be made and may be useful to some, but the size I have made here covers all my needs. A small one from 15mm bar would cover Unified sizes to 1/4in. shank and a larger one from 30mm bar up to 5/8in. shank.

Hardening & tempering

Being partially colour blind, I no longer guess at the colour of cherries but use an old loudspeaker magnet laying on my firebrick heat treatment tray. I heat the tool (using a Taymar propane/butane mix gas supplied in a handy cylinder), until it no longer pulls to the magnet (look up Curie point), then quickly dunk. Tempering is easier because I can see when different shades run to the tip.

Sources :-

1/4in. balls	Any bicycle shop, sold in packs of 22 (at approx. £1.25) for replacement of bottom bracket & rear wheel bearings.
BMS Sheet	Mindon Engineering.
Polycarbonate Sheet	Refer Model Engineer magazine Vol. 165 No. 3879 dated 17 Aug. 1990 pp 228 & 249. Trade names ICI Makrolon or GEC Lexan
Original Drawing	G. Lautard "Hey Tim I Gotta Tell Ya" ISBN 0-9690980-4-9 published 1990, Mail order from Camden Miniature Steam Services. (Currently out of print)



The home-made 82 deg. D-bit countersink

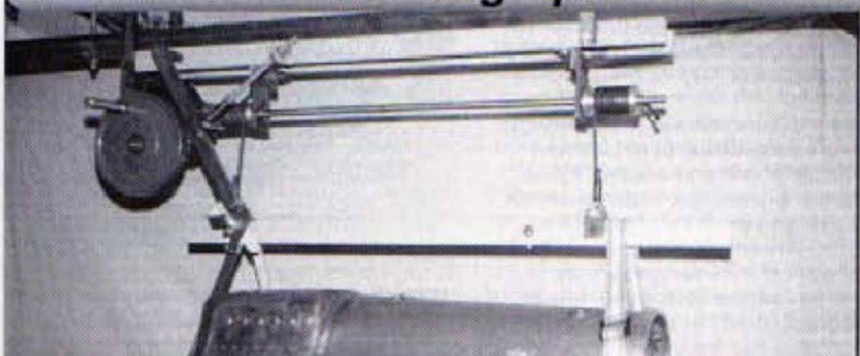
Acknowledgements

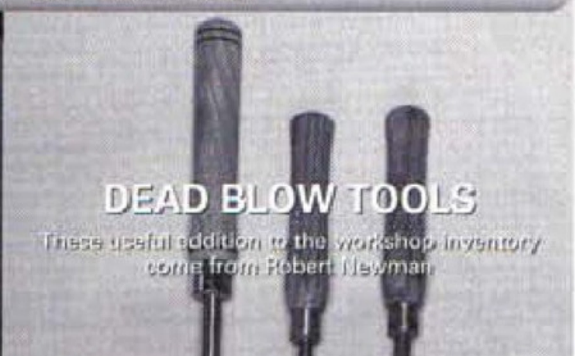
The groundwork done by others is not always apparent in one's own work, therefore I would like to acknowledge inspiration gained from previous writers in M.E.W., namely Richard Bartlett (MEW41) who gently introduced computers and how they could do something useful, Bob Loader (MEW52) laid down guidelines for workshop photography and Ivan Trobe (MEW55) who sparked the idea of making a modelling lamp.

FOOTNOTE :- I used the 5/16-18 UNC cap screws specified in the original article, so the whole of my assembly is a mix of Imperial, Unified and metric dimensions. Unusual? I think not - metric domestic power supply tails are clamped in fuse-box main switches with 1/4in. Whitworth screws, even on new tackle and the new regulation earth bus to common water, gas & electric also appears to be sold with Whitworth screws (or maybe they are Unified - I can't tell).

IN OUR NEXT ISSUE

Coming up in Issue No. 63 will be





MAKING INVOLUTE GEAR CUTTERS
A MODIFIED METHOD

Norman Hurst suggests that the method previously described by Don Unwin could be simplified.

Issue on sale 26th November 1999

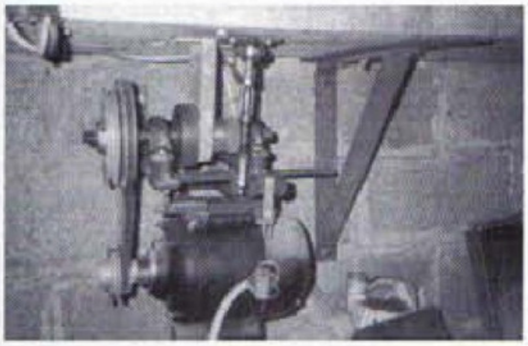
(Contents may be changed)

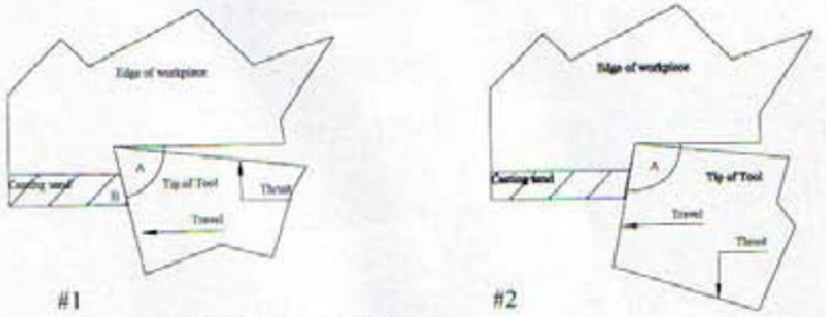
South Bend lathes

From R. Sharples, Barnoldswick, Lancs

In Issue 61 Mr. Bert Martin of Dorset asks for information concerning the conversion from a rear-mounted countershaft drive to an under-bench type drive for his South Bend lathe. I carried out a similar modification in 1990 to achieve the same arrangement and I thought that the photographs included here may help.

Also, he asks which Boxford accessories fit this type of lathe. I have fitted a modern Boxford tool holder and it works perfectly. Which other items fit, I am not quite sure, perhaps they all do.





Top view of cutting action.

Machining cast iron

From Ted Wale, Porters Lake, Nova Scotia

There are many references to machining cast iron and all that I have seen say something like:-

" High speed steel tools are fine for cast iron, it cuts easily and needs no lubrication as the graphite in the iron is its own lubricant. The only thing to be careful about is the surface of a casting where sand from the mould is occluded. This can wreck the tool edge quickly. To overcome this, the first cut should be deep enough to get under the surface sandy layer to break it away from underneath, where the tool is cutting into the cast iron and not the sand."

I have seen some places where a sixteenth of an inch is suggested as a minimum for the first cut. This all appears to make good sense and anyway, who am I to question the accumulated wisdom of the industrial revolution?

Personally, I have taken the warning to heart and avoided the problem by always using carbide tools and tool tips for the first cut, but then I am lucky in coming to cutting problems after the arrival of carbide. However, recently being involved in machining some castings, it occurred to me that I did not really understand how this 'wisdom of the ages' works. It would appear to be saying that the set-up should be as in Sketch 1, where the sandy iron in the area B will break away with little force as the underlying iron has already been cut away by the tip of the tool BUT this would mean that the angle A will be less than a right angle, and in many other places, particularly in sections dealing with grinding and setting up cutting tools, it is emphasized that angle A should always be at least a right angle and normally a little more, as in Sketch 2. In Sketch 1 the cutting action produces an inward thrust on the tool which takes up all the backlash and flexibility it can find and drives the tool deeper and deeper into the work (it does too). All accuracy is lost and damage can occur. If the set-up is as in Sketch 2 the thrust is outwards and all is well EXCEPT that now the tool edge just outboard of the tip is cutting into the sand and, in fact, is taking the main load of the cutting action (in my sketches at least 50%) and the shallower the cut the greater the sandy load vs the clean load. It would appear that the tool would very quickly be blunted in this area and the complete cutting action of the whole set-up spoiled.

Other readers may have similar worries, so perhaps someone will enlighten us on this problem as one day I am going to be caught without my faithful carbide and would like to know what to do when this happens (for I hate giving Mr Murphy best if I can avoid it).

Motor speed control

From Harold G. Cohon, Morton Grove, Illinois, USA

The excellent article about speed measurement (MEW 60) by Mr. Tony Jeffree was quite timely. Having a Sherline mill, I had been thinking for some time about the inability to set approximate speeds. The calibration disks finally got me going.

I copied these disks, trimmed them slightly to avoid rubbing, and attached them, one at a time of course, to the pulley. Problem No. 1 was that I could not see them well enough to determine speed. Incandescent light was useless and my fluorescent bench light was not much better. Solution was to buy a neon pilot light from Radio Shack and use that as the light source. It worked pretty well, but got me thinking its time for any eye examination.

In any event, I checked the speed with a Starrett No. 104 revolution counter. Belt and suspenders! When satisfied, I marked the speeds on a piece of cardboard put behind the knob. I then took off the cardboard, fastened it to a large piece of paper and measured the angles vs. the rpm. Also, wrote out the numbers on my computer; so I could paste them on at the correct location.

From the above, I made a double size drawing of what I wanted and used the copy machine at work to reduce the copy to the correct size. Correct size is $1\frac{3}{4}$in. from border line to border line. The enclosed copy is the correct size. It can be copied and glued to a piece of light cardboard. Then, a piece of clear 2in. wrapping tape can be put over it for protection. The hole in the middle should be cut out (Xacto knife) to a diameter of $\frac{9}{16}$in. to clear the nut holding the potentiometer.

Also, I substituted a knob I bought at Radio Shack. The new knob has the white indicator line all the way down the side to

Isolating an 'artificial' three-phase

From Ged Whitney (G8RSI), Sale, Cheshire

Concerning the use of RCD (or RCCD) units with 'artificial' three-phase supplies (letter from Alan Tudor - Issue 61).

Firstly, any outside workshop, or supply that is to be used outside of the household 'equi-potential earthing zone' (that is outside of the main house) should be equipped with an RCD. For new installations, these are a requirement of the 16th edition regulations BS7671 (amd2-1997). These devices are available in a variety of enclosures and switching ratings, for 'retro-fit' and as a permanent part of a household consumer unit (fuse-box). For domestic use, these are specified as having a tripping time of no greater than 40mS at five times its rated tripping current; for devices to BS EN61008, this is 30mA (not 35mA, as stated by A.N. Claridge) or if you prefer, 0.03A.

The application of half the rated tripping current (15mA) should not result in operation, and the application of 30mA (rated current) should result in a trip within a maximum of 300mS, unless it is to BS4293 when it should trip within 200mS.

Right, now we are clear on that, here is my practical advice from 26 years in the electrical industry. I think that Mr Tudor's RCD will trip, despite the three-phase supply being from a transformer source. This is because the device protects from leakage currents on both poles of the incoming supply, reference to earth. An RCD detects leakage by measuring the imbalance between the live and neutral conductors of the supply. It does this by passing the two conductors through the core of a toroidal transformer (imagine passing two wires through the middle of a doughnut). If the current passing down the live wire and coming back up the neutral wire are the same, then the magnetic fields so created around the wires is cancelled out, and nothing happens. If however, either the live or neutral has an alternative path (your body etc.), then one of the fields will increase, and the balance will be lost. The error field is detected by a coil wound on the body of the toroid, and used to operate a trip mechanism.

From experience with phase converters of many different types, I am surmising that Mr Tudor's unit does not use a 'true' double-wound transformer, but in fact uses an 'auto-wound' device in which the common point of the windings is connected back to neutral. Because of this, any imbalance due to a fault current should be sufficient to operate an RCD. In fact, I have double wound (but not split bobbin) isolating transformer in my workshop. I can trip a conventional RCD using this due to 'leakage' between primary and secondary, despite there being a screen between the windings, which is at earth. This is probably due to the size of the transformer (2.2kVA). I think that nuisance tripping is more likely to prove a problem, due to the phase variations between the voltage and current waveforms as a result of the transformer, motor and capacitors present across the supply. This is most likely during starting-up.

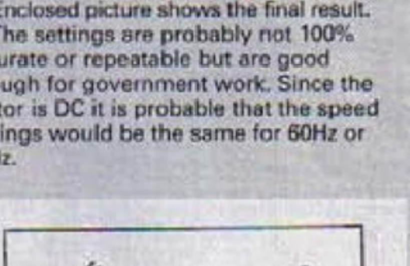
I have found in practice, that grounding the neutral to earth at a normal socket outlet is sufficient to trip a domestic RCD. This has happened when I have been working on a supply where the breaker has been switched off or removed only (fuses and breakers only appear in the live conductor) and the corresponding neutral has not been lifted from the bus-bar to prevent this. I have done this deliberately on occasion, when my RCD test set has not been to hand, and I have wanted a rough check (you will understand, of course, that in most cases earth and neutral are at the same general potential), having of course verified the polarity of the supply first! I would not suggest this method in Mr Tudor's case, as the neutral on the unit he has may not in fact be 'true' neutral. The best bet would be to seek out a properly equipped electrician (an NICEIC contractor perhaps), and have them put an RCD test set on the out-going three phase terminals. It should be possible to do this with the motor connected.

One last point, concerning the correspondence about transformers. I have found that the main weakness of home-made transformers is damage to the insulation of the copper wire used during winding, this causing premature failure (usual flash-bang!) of the primary winding, failures on the secondary normally causing terrific over-heating first. Modern enamelled wire, being protected by a resin plastic type coating, should not have this problem. Therefore, do not re-use old wire! The other weakness is insufficient turns on the primary causing overheating, but fortunately you have to be out by quite a bit, say 100 turns or so in 1500 turns, so this should not be that much of a problem if you are careful (I say this from personnel experience). My usual approach, is to find a modern transformer with a split bobbin construction (primary mounted physically above or below the secondary) and remove (with a saw) the secondary from its bobbin. The space can then be filled with whatever turns you require. To find the amount required by rule of thumb, simply wind on say 10 turns of any wire, and apply to an AC voltmeter. The turns required will be V/10 turns per volt. For example, if 10 turns gives 10 volts then it is one-turn-per-volt! This crude suck-it-and-see technique is very common in the electronics industry, as it cuts out the maths quite a bit! For the low energy requirements we have, this is a very effective way of getting an 'odd' transformer. What about current you say? Well take a good look at the quantity and thickness of the stuff you cut off. Simply put; lots of thin wire = high voltage/ low current; not many turns but quite thick = low voltage/ high current. If the core of the transformer is of large cross section and the primary wire looks quite stout, you should be on to a winner. I have successfully converted transformers from scrap VCRs and other equipment in this way, including that spot-welding transformer from the HV unit used in a microwave cooker.

Oh! and by the way, in my opinion, clamping yourself to earth during tests on this stuff is unnecessary and pretty stupid. I have never done this except when working on sensitive CMOS based electronics, and then via a ten megohm resistor. Take care!

make speed setting easier. Used the lathe to shorten the knob up about 1/16in. for a better fit. Enclosed picture shows the final result.

The settings are probably not 100% accurate or repeatable but are good enough for government work. Since the motor is DC it is probable that the speed settings would be the same for 60Hz or 50Hz.



Differential for a 'Trike'

From P.J. Jago, Thornton-Cleveleys, Lancs.

In response to the letter from Mr. Walsh in Issue 61, I have a trike which is propelled by one wheel only, but I think that he is mistaken when he says that this is the only option available in the UK. If he gets in touch with the Tricycle Association, I am sure that they will be only too pleased to advise him of the various models and the conversion axles available. Their club magazine usually contains information on second-hand models for sale.

Their secretary is D. Heighway, 24 Manston Lane, Crossgates, Leeds LS15 8HZ.

Blades for the Rapidor hacksaw

From John Buckley, Norton-Canes, Cannock

Very often reference is seen in M.E.W. to the Manchester Rapidor Hacksaw. The blades for these old machines are quite expensive, about £6 or more. Some years ago, I was in a shop where they make up bandsaw blades, and they had lots of short ends of 1in. wide metal cutting blade material. I was given about six pieces of various lengths which I ground off to match the old blade in the hacksaw and drilled them through with a tungsten carbide countersinking rose from either side.

I have been using these blades ever since and I have often cut 6 x 1/2in. plate and 3in. bar steel without ever a problem. They have to stand up to a lot of hard work in a bandsaw, so I suppose the slow 140 strokes a minute in the old Manchester is quite kind to them.