No.63

MODEL ENGINEERS' WORKSHOP

THE PRACTICAL HOBBY MAGAZINE

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Controlled power to your elbow

MODIFICATIONS TO THE HART GRINDING REST
Fine adjustment of the toolholder

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Issue No. 63

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On the cover

Tony Jeffree's Taig/Peatol mill is equipped for CNC machining. The description of his dividing system which can be operated either manually or under computer control concludes in this issue *(see page 36)*

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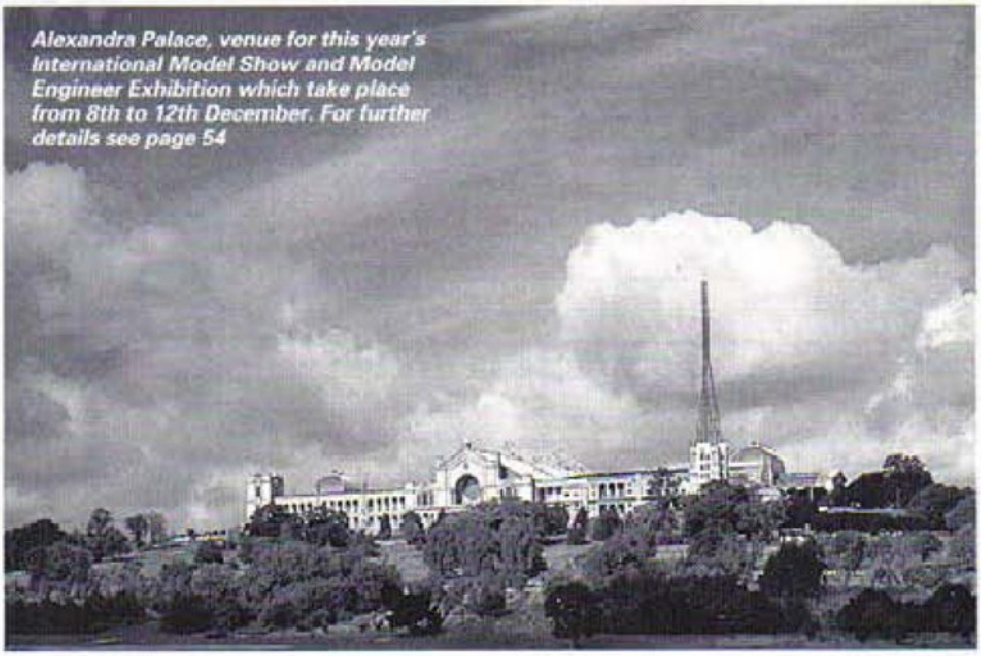


Alexandra Palace, venue for this year's International Model Show and Model Engineer Exhibition which take place from 8th to 12th December. For further details see page 54

ON THE EDITOR'S BENCH

I am aware that some readers may have had difficulty in obtaining a copy of Issue 57 of M.E.W. which was published in April of this year. The problems arose because of a misunderstanding between two of the subcontractors to Nexus who are involved in the production and distribution chain. This resulted in a number of copies being inadvertently destroyed instead of being sent to customers. Following lengthy negotiations, a batch has been reprinted and (hopefully) copies sent to all who were due to receive them. The knock-on effect was that their was a general scarcity of copies, so some readers were unable to find one when they went to make a purchase. Unfortunately, the issue in question contained a number of instalments of multi-part articles, so some readers may be short of some vital information. I am now told that our back issues agency in Market Harborough may still have some copies from the reprinted batch in stock, so any reader in desperate need should contact them at the number shown on the Contents page of this issue. If this supply becomes exhausted, our Reader Services Department have said that they will do their best to supply a photocopy of an individual article from that issue, The contact at Swanley is Jayne Hewish.

The Implanted Devices vacancy

Dr. Nick Donaldson of University College, London has been in contact to say that the response to their advertisement (Issue 60) for someone to join them in their work on implanted devices produced a much greater response than anticipated, with more than forty readers showing an interest. The vacancy has now been filled, the successful candidate having just started with them. Dr. Donaldson commented that it was a pleasure to meet such a wide variety of interesting and talented people, all of whom were able to demonstrate a range of skills. He thanks everyone who applied for their interest, the advertisement having produced a much more rewarding response than many placed in other publications.

The Data Book

Harold Hall, who has continued to generate the Data Book pages included in each issue feels that this project is now reaching the end of its natural life, and is planning to bring it to a close early in the new year, with a few 'tidying-up' pages.

It is interesting to reflect that, when the project started, there were many who questioned the need, feeling that there are quite enough reference works available in general circulation already. Gradually, however, the reaction changed as readers recognised that the content would be tailored toward the needs of the home workshop enthusiast rather than to a wider engineering audience. Many appreciative comments have been received but, in view of the fact that the material already published fills two of the folders to bursting point, Harold feels that 'enough is enough'.

I'm sure that, if readers could suggest a sufficient range of worthwhile additional topics, then it may be possible to persuade Harold to extend his researches in order to add them, but a degree of arm twisting would be necessary. He has put a lot of effort into the task and deserves our thanks.

There have been requests from a number of readers who have discovered M.E.W. since the series started if copies of earlier sheets can be obtained. I am investigating this with the powers-that-be and will report developments.

New projects for M.E.W.

I have written before of the challenge involved in finding new, interesting material for these pages. The history of model engineering and the home workshop covers a span of just about one hundred years. Over that period there has been an enormous change in the relationship between the techniques practised in our home workshops and those commonly used in industry. At the beginning of the century, the main differences were of scale, the technology levels still being very similar. Now, things have changed to such an extent that very few of the processes available to modern manufacturing industry are capable of being adapted for use in the home workshop environment. One or two pioneers such as Richard Bartlett and Peter Rawlinson have shown that there are some technological advances which can be tailored to our requirements, but at best, we are still some forty or fifty years behind the industrial world.

There has also been a distinct change in the nature of the projects which workshop owners feel the need to tackle. After the time when supplies of surplus material generated by World War II had been exhausted, tooling and accessories suitable for use in the home workshop were either not readily available or cost more than many felt able to spend on their hobby. The pages of 'Model Engineer' regularly contained drawings and instructions to assist the construction of such items and quite a few readers had sufficient time to construct them. Now the world has changed out of all recognition. There are so many more leisure activities in which we (and our families) are able to take part and greater personal mobility means that we can spend more time visiting places of interest, so that for many, workshop time is at a premium. The increased availability of very cheap tooling, much of it from Asia, makes spending time constructing similar items far less attractive, unless one is primarily interested in the exercise as an end in itself. In this case, it is not difficult to find a design for a suitable piece of tooling, an attachment or an accessory, just by looking in the pages of a back issue of a magazine or in one of the excellent books now widely available.

What many readers are seeking are projects which are innovative; something which brings a new approach to a problem or which increases the capability of the traditional home workshop, whether it be in ease or speed of manufacture or perhaps in the ability to handle a wider range of materials. Some of the working models now being produced in home workshops demand the use of materials which could have been termed 'exotic' just a few years ago and are not easy to work using old fashioned methods. The hobby is moving on, whether we like it or not. The magazines which support the hobby need to keep pace or they will soon become irrelevant.

At the other end of the spectrum, there will always be newcomers to our hobby or, I hope there will, otherwise it will die. They will always be seeking instruction in the basics, so the challenge is to make something available for them without alienating those who have 'seen it all before' (many times!). A reader based in South Africa and who has just returned to model engineering after a very long break feels in need of some basic instruction on lathework and has suggested that we should publish a series of projects which, if completed, would result in the maker having sampled all aspects of lathework and at least become familiar with the machine. I have asked Harold Hall to consider such a project and make some proposals.

A new Millennium

It has just occurred to me that this will be the last issue to be published before the end of the year. May I therefore take the opportunity of wishing all readers a Happy Christmas, a Prosperous New Year, a Successful Century and a Momentous Millennium? There, it's not often I have to do that, is it?

Seriously though, Best Wishes to all.

DEAD BLOW TOOLS

Simple to make but invaluable when the occasion demands, Robert Newman gives details of some unusual tools

Some forty or so years ago I watched a friend of mine who was a jobbing machinist, position a large vice on a drilling machine table. To finalise the position of the item gripped in the vice, he was giving the vice short sharp blows with something gripped in his hand. While he was working at the drill I examined the item with which he had struck the vice. It proved to be an egg shaped piece of lead.

An enquiry elicited the following. The weight of the vice was causing it to wring itself to the table, making it difficult to move by small amounts. If a normal metal hammer had been used to strike the vice, a lot of the force of the blow would have been lost due to the hammer bouncing. Remember what we were taught at school? - equal and opposite reaction to a blow. Getting the vice to move just that right amount using a steel hammer could prove to be a most frustrating exercise. The lead was heavy, dense and tended to mould itself to the item being hit, and it did not bounce away by any appreciable amount. Consequently there was a positive reaction to each blow, making it comparatively easy to judge the force needed for each strike. A demonstration reinforced the lesson which I was to remember some twenty or so years later. What I did not know then, but do now, was that my friend was describing a 'Dead Blow'.

Twenty years ago, when I was getting my home woodworking workshop together, I remembered that tool and made myself one. By that time I was also aware that lead is dangerous to health and that care should be used in its handling. The first 'Persuader' as I came to call it, was simply a four inch length of one inch copper tubing squashed flat at one end and then filled with lead.

It proved to be very handy, being able to quickly subdue a fence which was reluctant to assume its correct position; it had so many uses. With suitable covering for the lead, it was even used for wood assembly, though many times I wished it was a hammer with the same striking characteristics as the Persuader.

The tool has changed very little in the intervening years, construction is simple as I shall explain.

The 'Persuader' casing

This can be made from any suitable material. As I am able to obtain scrap ally tubing very cheaply, I use this. One end of the tube is closed by pressing into place a $\frac{1}{4}$in. thick ally washer.

Most of my 'Persuaders' are of one inch diameter, 16 to 18 gauge. At $2\frac{1}{2}$in. long, the weight of the lead-filled tool is approximately one half pound. A 3in. tube produces a tool of around three quarters of a pound. Two casings waiting to be filled with lead are shown in **Photo. 1**. Note the stand to ensure that the casings remain upright while being filled. Better safe than sorry.

The crucible

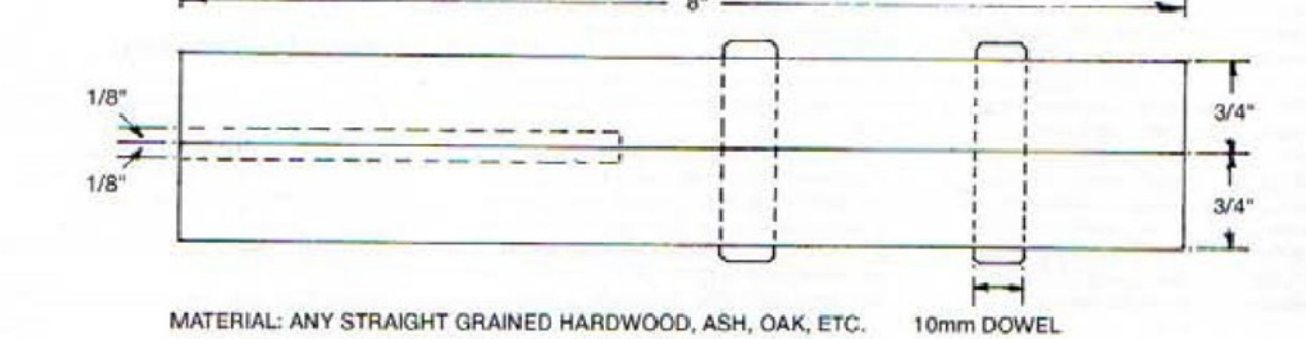
A container in which to melt the lead would not come amiss. The example shown in **Photo. 1** has given years of service in melting lead for fishing weights and is recommended. It is simple and quick to construct.

2in. box section tubing for the receptacle would have been nice but, not having any, I had to improvise. Angle iron, $1\frac{3}{4}$in. x $\frac{3}{32}$in. thick was the material used. Two pieces, $2\frac{1}{4}$in. long were welded together to form a box, and a piece of metal $1\frac{11}{16}$in. square was welded to one end to close it. When it was tested for leaks, a small bead of water appeared, so the weld in this area was ground away and rewelded. Tested again, all was well.

Suitable metal strap for the handle not being available, some right grotty $\frac{1}{4}$in. rod that a friend had purchased to repair a gate was used. The handle finished up 8in. long of which $3\frac{1}{2}$in. was buried in the wooden handle. General construction of the crucible is, I think, self evident if **Photo. 1** is studied.

Due to the heat generated in melting the lead, a wooden handle is the best bet in order to prevent heat being transferred to one's person. My handle is made from two pieces of scrap oak, $1\frac{1}{2}$in. wide, $\frac{3}{4}$in. thick and 8in. long. On the broad face of each piece, along the centre line, I routed a $\frac{1}{2}$in. wide x $\frac{1}{8}$in. deep slot, $3\frac{1}{2}$in. long. No router?, No sweat. Mill out the slots using metal working methods and tools. Glue

FIG. 1 BLANK FOR CRUCIBLE HANDLE BEFORE TURNING TO SHAPE



MATERIAL: ANY STRAIGHT GRAINED HARDWOOD, ASH, OAK, ETC.

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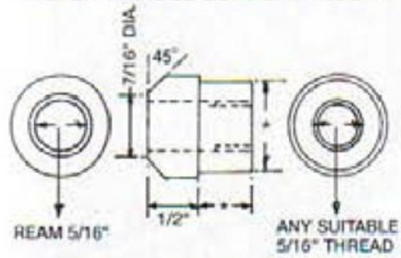
FIG. 2.1 HANDLE SUPPORT INSERT



* DENOTES DIM. TO SUIT SELECTED COPPER WATER PIPE TEE PIECE (SEE TEXT)

FIG. 2.2 HANDLE SHAFT

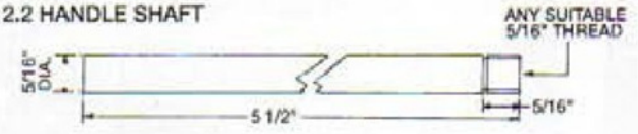
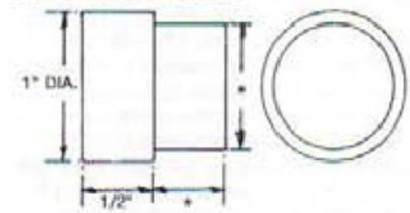


FIG. 2.3
SOLID FACE & INSERT



* DENOTES DIM. TO SUIT SELECTED COPPER WATER PIPE TEE PIECE (SEE TEXT)

FIG. 2.4 THREADED INSERT (BRASS)

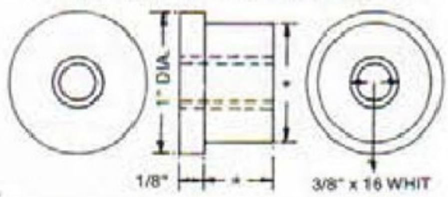


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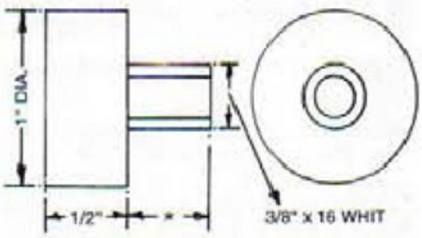
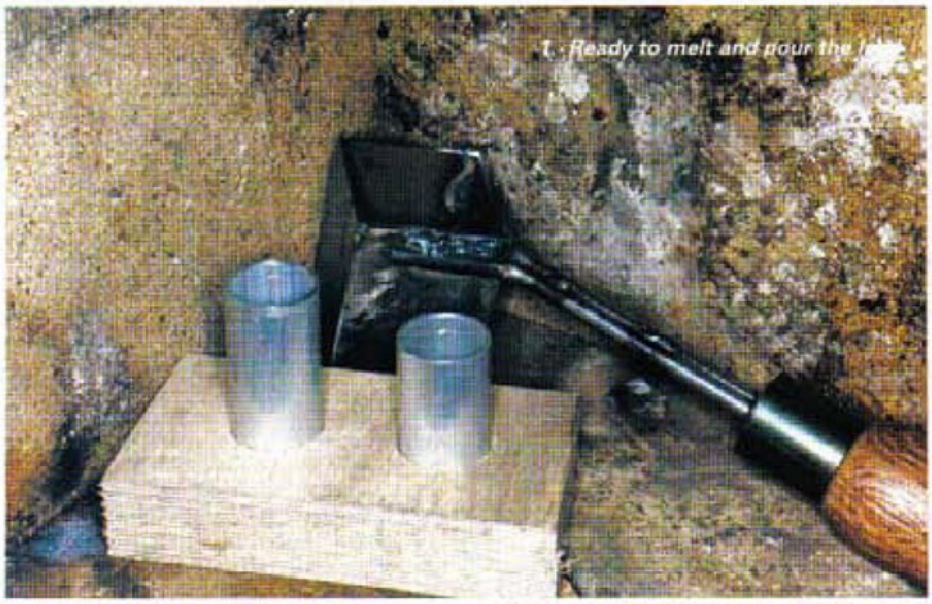
FIG. 2.5 THREADED SOLID FACES MATERIAL TO CHOICE (SEE TEXT)



* DENOTES DIM. TO SUIT SELECTED COPPER WATER PIPE TEE PIECE (SEE TEXT)

the two halves together using the metal handle to position the pieces correctly and clamp together. Remove the metal handle. Now drill for and insert two 10mm dowels, gluing them in position. All this is shown in **Fig. 1**. When the glue has cured, turn the handle to shape. Make the first priority the fitting of the ferrule. Do not put excessive pressure on the handle ends until this is done. The ferrule and dowels will then prevent the handle parting along the glue line.

Keep the diameter of the handle around $1\frac{1}{4}$in. to keep heat transfer down. The length is deliberate, two hands may be used to pour the metal if so desired or the extra length can be laid along the underside of the forearm to help support the weight.



Pouring the lead

THIS MUST BE SAID. Melting and handling molten lead can be a hazardous operation. Risks are minimised when care, common-sense and the correct precautions are taken.

1. Fumes from molten lead are poisonous. Work in a well ventilated area and wear a fume mask.

2. Observe fire precautions.

3. Use a face shield, minimum should be goggles.

4. Use leather gloves and if possible a leather apron.

5. Stout leather shoes are a must.

Get all the pieces together before you start, include among them a short length of wood, (6in. x $\frac{1}{2}$in. square) and a pair of grips with which to move the tube casings around. Position the casings, out of their stand, close to the crucible while the lead is being melted. These need to be hot when the lead is poured. Remember that the melting point of aluminium, if that is what you are using, is quite low.

Pour one casing at a time. When the lead has melted you will probably have a quantity of scum (dross) on the surface. Tilt the crucible and, with the piece of wood, remove the dross. Using the grips, position a hot casing in the stand and commence the pour. This should be continuous and fairly rapid; allow to overflow just a mite. If you stop pouring and then start again, you will be wasting your time. The second pour will not unite with the first and will part from the main pour when you attempt to use the tool. If making more than one tool (recommended), reheat the lead and the next casing before attempting to pour again. The square shape of the crucible assists in the pouring operation, which is why it was chosen in preference to round material.

When the tool is cool, mount in the lathe and remove approx. $\frac{1}{8}$in. of the casing, so that the lead can deform under blows. Two 'Persuaders' are shown in **Photo. 2**. The one on the left has been in use for some time, as evidenced by its shiny casing and deformed top. It is due for another haircut. The one on the right was made for this article.

The quest

I mentioned earlier that I wished that I had a Dead Blow tool as a hammer, as I thought that it would be easier to use in my woodworking than the 'Persuader'. Not having unearthed a tool in any catalogue, I decided to make my own. It just did not work, I was never able to get the same feel that the 'Persuader' gave to a blow. However, using gas and air piping cast 'T' pieces, I was able to make a couple of small hammers with brass faces, these being particularly useful. There the matter

2. A variety of 'Dead Blow' tools

3. Component parts of the nylon faced hammer

was allowed to rest, there being many other interesting things to do.

The whole idea was resurrected about five years ago when, in a tool merchants, I saw a tool described as a 'Dead Blow Hammer'. Its head was hollow and filled with lead shot. I could have cheerfully kicked myself down our High Street. For a considerable number of years I had been aware of the principle being used, but never thought of applying it to making the tool I had been seeking, nor of calling it or the 'Persuader' a 'Dead Blow Tool'.

The 'Dead Blow' Hammers

The following day I made the first hammer, using 22mm x 15mm pre-soldered copper water pipe tee pieces for the head. Two brass hammer faces and a handle support piece were secured in position by the simple process of melting the solder. As I am, (or was) an angler, lead shot was no problem. Sixteen grams were loaded in the head, leaving about $^{1}/_{8}$in. free room for it to rattle about in. A handle was quickly fitted and the first blow taken, and it worked. That feel to the blow I was seeking was there. A copper faced hammer quickly followed, as did a mini version using a 15mm x 15mm tee piece. Again, very pleased with the results.

So why did these hammers work and give a dead blow when the faces were not made of lead? The secret is in the lead shot which is free to rattle around some. Imagine that you wish to strike an object located on your left side. As you swing the hammer to your left the lead shot will set back to the right and remain there as you swing to the left. As the hammer face contacts the target, the shot will set forward, i.e. be thrown to the left and strike the inner surface of the face, preventing it from bouncing, which it was just about to do. Hence a dead blow. Again a bald description, but that is the sum of it.

Such is the effectiveness of the hammers that a swinging blow is not required, simple wrist action being all that is needed. It was never intended that it would be otherwise.

Shortly before all this happened I had joined the ranks of the home machinist. It quickly became apparent that the tools were more useful in this environment than in my wood shop. Further, with a metal lathe I could be more adventurous in the components made. The first two hammers used solid faces and insert, but this was to change as, with the materials I now proposed using, it would be better if the faces could be replaced by simply unscrewing the old and screwing in the new. In short order I made faces from Nylon, lignum vitae (ex bowling wood) and boxwood. The threads for the wood faces were hand chased, using a die to achieve final size. As the woods mentioned above machine well with metal turning tools, I see no reason why the threads cannot be cut with a die as we would metal. The threading equipment of a lathe can be used to form the thread; just ensure that freshly honed tools are used. Other woods that perform well are beech and most of our native fruit woods.

The only snag with wood is that it can absorb water and swell. To prevent this, soak the completed faces in Danish Oil or give them at least five coats of the finish. Diluted polyurethane varnish, using the same treatment, will accomplish the task. Then, be patient, and place the heads aside for about a week to thoroughly dry out.

The Nylon hammer was intended for woodworking but, such was its usefulness that it was often employed in metal working. It was decided that another would not come amiss, so one was made to illustrate this article. It differs only in having a longer handle, a feature which I have found desirable for woodwork.

Photo. 2 shows the first hammer I made, the nylon faced hammer is on the left with the 'mini' in the centre. **Fig. 2** gives details of parts and measurements where possible. The necks of the Tees are swaged to size during manufacturing, with the sizes varying slightly with different makes. The length of the swage also varies. Therefore, machine the faces/insert so that a nice sliding fit is obtained, remembering that the capillary action of the solder is required to work in our favour. The length of the part inserted in the Tee should be such that it will extend only about $^{1}/_{8}$in. past the solder line, this being to maximise the space in the head. In the same vein, note that the original hammer in **Photo. 2** has a decided central waist while the nylon hammer has not. Try to obtain the latter type to maximise the space.

The necks of all the Tees inspected had very rough edges and were most uneven, but a touch up on the disc sander soon rectified matters.

The handle support insert should have an external length and diameter equal to or slightly proud of the 15mm diameter and be about $^{1}/_{2}$in. long. The insert length should be as long as possible without encroaching on the main chamber.

The metal shaft for the handle needs to be about $5^{1}/_{2}$in. long of which $2^{1}/_{2}$in. is inserted in the wooden handle. I tried $^{3}/_{8}$in. diameter shafting in the nylon hammer and wished I had stayed with the $^{5}/_{16}$in. You do not have to thread the handle if you do not wish to do so. One of my hammers has its shaft glued in position - it gets much use and no problems so far. Use Araldite to secure the metal shaft to the wooden handle.

The wooden handle is $^{7}/_{8}$in. to 1in. diameter. Length is $5^{1}/_{2}$in. including ferrule length, but another 1in. will not come amiss. The ferrule is any suitable thin walled tubing, $^{3}/_{4}$in. long and $^{3}/_{4}$ to $^{7}/_{8}$in. diameter. I should explain that the nylon hammer is deliberately longer as it is intended for woodworking and that little extra length is needed.

All components should be thoroughly degreased. Apply flux to the inside of the Tee up to the solder line and to all components being inserted in the Tee. If you have one, a heat gun is the ideal tool for melting the solder. Apply heat in such a fashion that all soldering is accomplished at the same time. That fusion has occurred is indicated by the appearance of solder at the joints.

A word about the lead shot; diameter should not be much larger than $^{1}/_{16}$in. It does not have to be fishing shot - bird shot, the stuff in shot gun shells, would do just as well. Now that lead is being outlawed for such outdoor pursuits, there should be plenty available. Someone is going to figure that a solid slug of lead would do the same job as shot. I went that way. The idea works fine at first until the lead deforms and jams itself in the head. You then have only a heavy hammer. There are possibilities in solid, free to move internal anti-bounce bodies that I might explore at a later date.

A couple of points about the threads on screw in faces. The length of thread should be such that it just stops short of the inner face, this to prevent burring over the end of the thread. All threads should be given a couple of coats of silicon.

These tools have been easy and cheap to make. The only new items were the Tees, the nylon and shaft for the handle, all obtained from G.L.R. Distributors. The lead shot I have had for donkey's years. All else came from my oddments bin or was gratis.

MODIFICATIONS TO THE HART GRINDING REST

Harold Hall decided that a simple modification could enhance the performance of this useful grinding rest. An hour's work was all that was needed

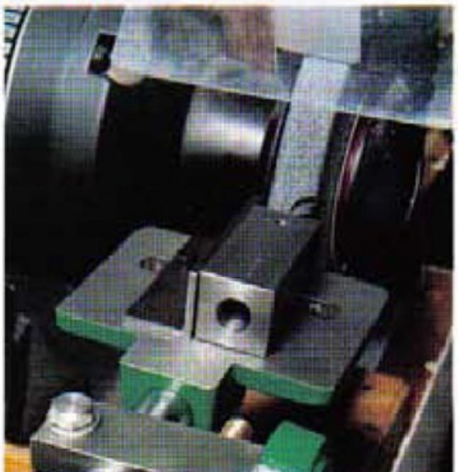
Some five years back I made the Hart grinding rest (**Photo. 1**) which was, as a result, featured in M.E.W., (Ref. 1). Since then I have found it to be a very useful aid to tool grinding. Whilst it cannot compete with the well known tool and cutter grinders that are available for use in the home workshop, it raises the capability of the basic off-hand grinder appreciably. It is therefore well worth considering for those who cannot go so far as making the Quorn or other such machine.

One of its benefits is that a much superior result can be obtained when shaping and sharpening lathe tools compared to attempting this on a standard off-hand grinder which usually has a very small work support table. Even more beneficial is its ability to put a new cutting edge on the end of end mills and slot drills, a task that is nigh impossible unaided on the off-hand grinder. **Photos. 2 and 3** show the rest being used to carry out this task. The screw on the side of the fence (**Photo. 3**) acts as an end stop, ensuring that each cutting edge is at the same level when the square holder for the end mill is turned over in order to grind each cutting edge in turn. **Photo. 2** shows that a feed screw is provided for feeding the table towards the grinding wheel so as to easily set the amount ground off. This should be a very small amount if tools are ground regularly, and as this is such an easy task there is no reason for this not to be so.

I have, though, when using the device for other tasks, felt a need for fine left to right adjustment of the fence. **Photo. 4** shows a typical need for this. The task being undertaken is to sharpen a tool for cutting a worm, the angle therefore being quite critical. The angle required is set entirely by positioning the tool on the small square plate to which it is clamped **(Figure 1)**. This plate is then slid along the fence, causing the side of the tool to be ground by the front corner of the grinding wheel. The fence is set round at a very slight angle, say 1 to 2 deg. maximum, relative to the side face of the wheel, thus ensuring that the tool contacts the grinding wheel only at its front corner. The reason for using just the front corner is that if the tool moved along the side face of the wheel, this would have to be dressed perfectly flat which, in itself is not easy to achieve. The fence would also need to be very accurately set.

If, having initially ground the side of the

1. The Hart Grinding Rest being used to sharpen a lathe tool. In this case it is a vee tool to be used for cutting a worm



2. The Hart being used for sharpening an end mill. The screw feed adjustment can be seen clearly

Fig. 1

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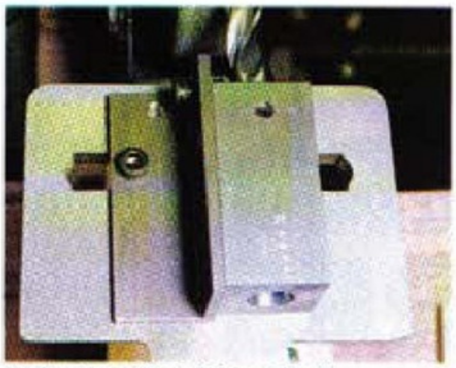
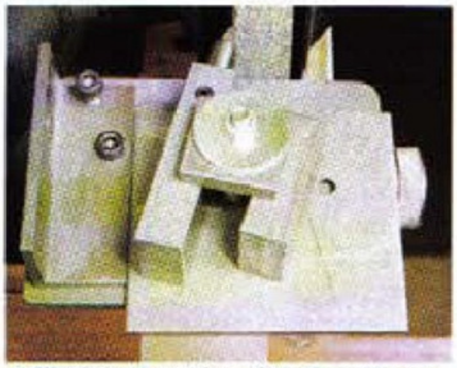
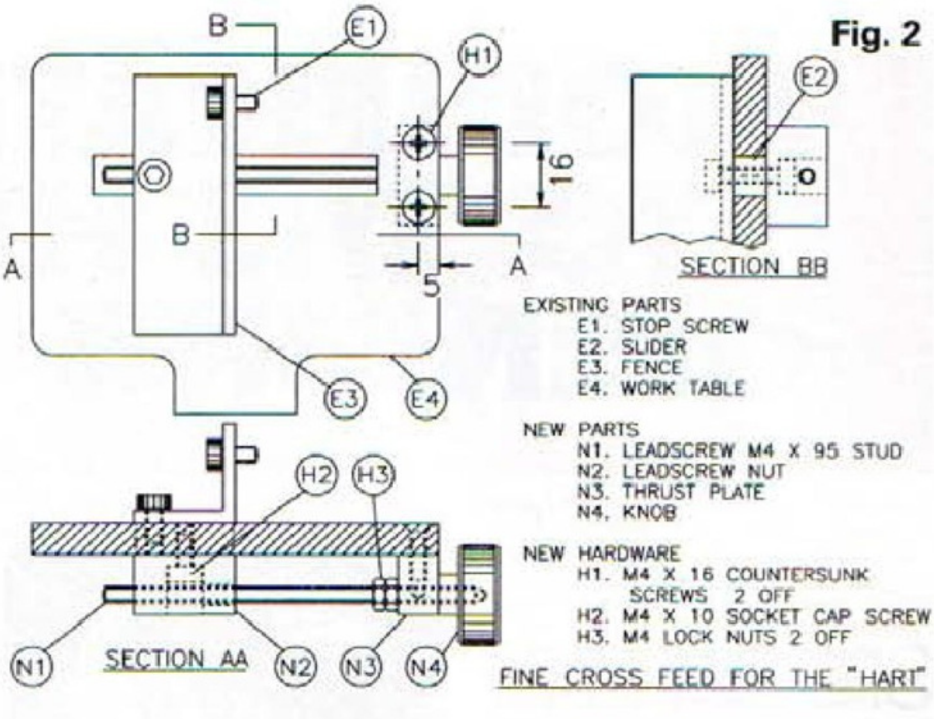


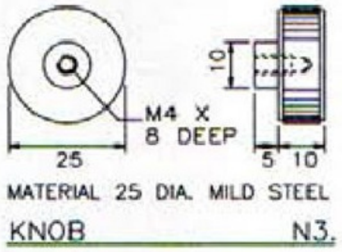
3. Another view of the end mill sharpening set-up. The slot in the table is used to guide the new leadscrew nut

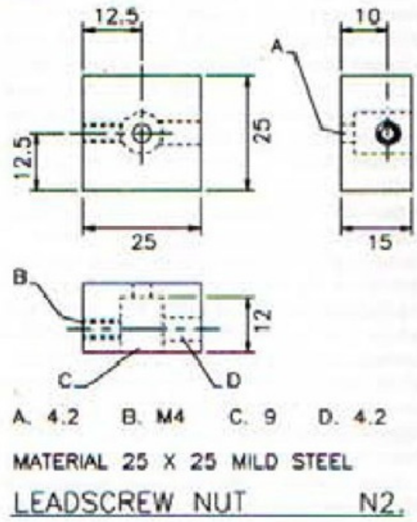


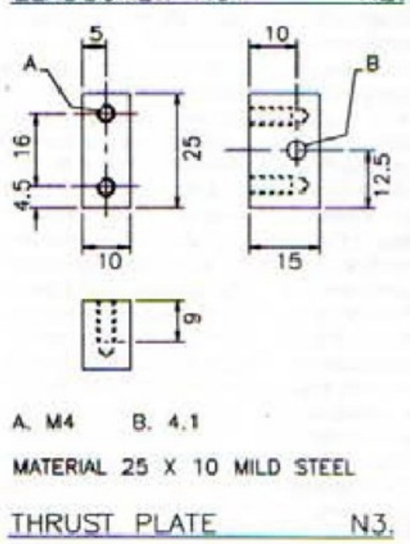
4. The lateral position of the fence is now controlled by the leadscrew, the knob of which can be seen to the right

Fig. 2









5. The lateral fine feed modification seen from below the work table.

tool, it is found necessary to take off a small amount more, a situation which is very likely to be encountered, then the fence will have to be moved very slightly to the right. While we have seen that there is fine adjustment for moving the table towards the front edge of the wheel, no such adjustment is provided left to right. The fence is allowed to move freely whilst attached to a small block sliding in a slot in the main table. It can though be locked in the required position by the screw that is positioned at the end of the fence (**Photo. 4**). The ends of the slot can be seen in **Photo. 3**.

A simple modification

I decided, as a result of attempting to shape the worm cutting tool, that the time had come to provide the much needed fine control over the fence position, so set about making the arrangement shown in **Figure 2**. The drawings should make the total picture clear regarding its construction so there is no need for any detail explanation. It is a simple modification, there being only three simple parts to make, plus the requirement for a length of studding and a few screws. The provision of two countersunk holes is the only modification to the original rest. The studding for the leadscrew is M4, which has a pitch of 0.7mm. There is no need to calibrate the feed, but at 0.7mm pitch this amounts to 28 increments of 0.025mm, (or 1 thou in Imperial terms) per turn, so it is a fine feed and therefore easy to control.

Having made the addition, which took about an hour and is seen from below the table in **Photo. 5**, the ability of the device has been enhanced, making it even more useful. One of these days I may find time to make a fully fledged tool and cutter grinder, but until that day the Hart, with its mods, performs most of the tasks I would like it to, producing adequate results and with relative ease.

References

1. The Hart multi purpose grinding rest. MEW issues 21 and 22. A Platform for the Hart. MEW issue 23.

Supplier

Castings for the rest can be obtained from Hart Engineering, Greenfield House, 19 Greenfield, Wrexham, LL11 2NR. Tel. 01978 359207

A MODIFIED INVOLUTE GEAR CUTTER METHOD

Norman Hurst used Don Unwin's 1997 gear cutting article for reference, but he felt that he could modify Don's system to suit his own needs.

On page 3 - the Contents page - of MEW issue 41, the editor stated "the aim is to remove some of the mystique from a straightforward mechanical exercise". He was referring to the article in that issue by Don Unwin on gear cutters. I have to admit that for a long time I had thought of the gear cutter making fraternity as not being 'one of us' and the subject of making gear cutters as not being very relevant as far as I was concerned. Needless to say, Don's article has worked its magic on me and removed the mystique.

Principles

The mystique started to evaporate when I recently needed a gear cutting tool for a project that I was working on. The gear that I intended to cut was a non-standard and, as I did not have a cutter anything like the one I needed, it became evident that in order to cut this gear, a one-off tool would have to be made. To make the cutter I decided to use the recognised method of two hardened discs (otherwise known as buttons or pins), which would give a very good approximation to the involute form for the finished teeth. However, I had never been happy with the mystique of the design of the buttons or the method usually given to mount them onto their holder. I wondered if I could modify the system to give a more satisfactory result.

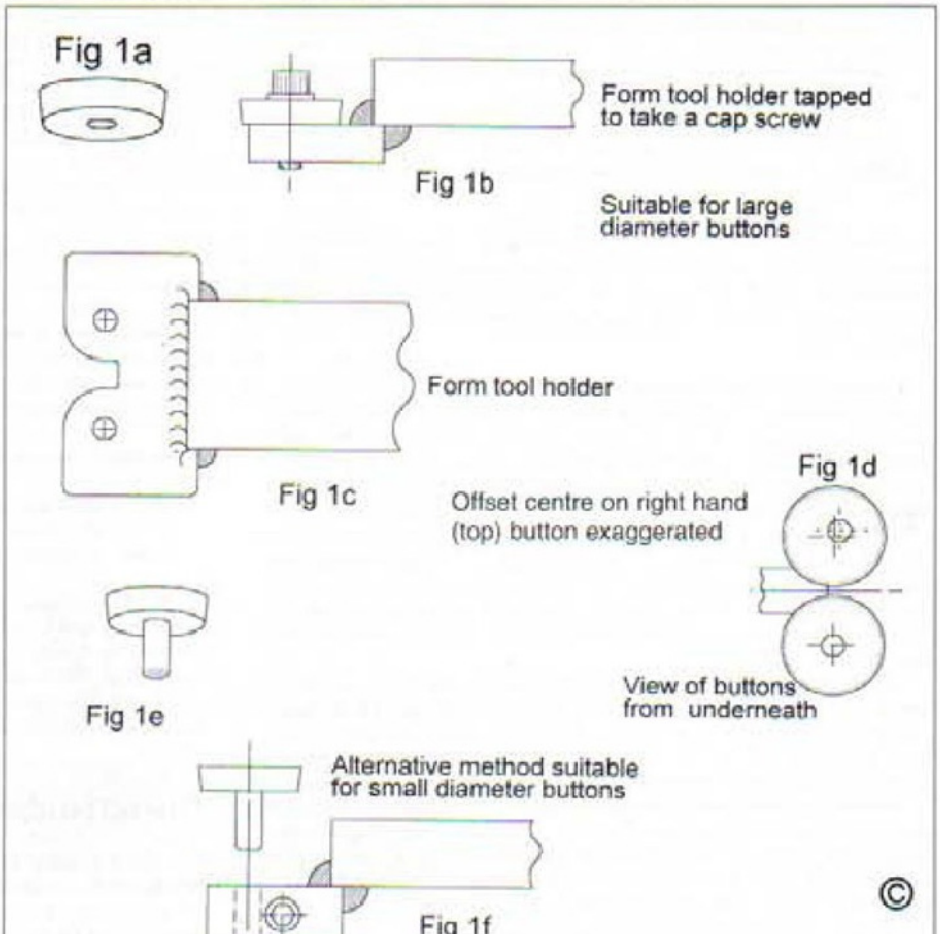
Usually, each button is made in a cylindrical form with the face cut back at an angle. It is then mounted sloping forward at the same angle to give a cutting edge. As far as I can see, the main advantage with this system is that the top sloping face of each button can be reground several times without losing its form.

The button system is used to make milling cutters or fly cutters and these are designed to be ground several times, and - over the course of their lives - cut hundreds of teeth.

With the buttons themselves however, their purpose is to do a one-off job, i.e. making one cutter. If they are correctly hardened, will we need to regrind? I don't think so.

The other problem that worried me was the amount of tool clearance. Towards the tip of the cutter being machined, the button cutting edge clearance is considerably reduced and I wondered how this could be resolved.

To overcome these difficulties, I decided that the buttons would be made in the form of a truncated cone, i.e. a cylinder with sloping sides, with the top face lying horizontally **(Fig. 1a)**. Each one would have an included angle of about 12 deg., giving a cutting edge clearance angle of 6 deg. Mine had a neutral rake, but a positive rake could be attained by 'dishing' the top face. There is always 'for and against' however, and the disadvantage with this method is that, if used with a standard type tool holder, the cutting edge is higher than with a sloping disc. I wanted a substantial shank to my holder and I found that the shank plus the thickness of the disc/button was too great when fitted into my lathe toolpost, the cutting edge being above the lathe centre line. Could this also have been a reason for sloping the discs? To overcome the height difficulty I made a 'staggered' tool holder **(Figs. 1b & c)** - but more of that later.



Don Unwin wrote an excellent article on gear cutting in 1997 (Ref. 1), where he rightly pointed out that the centre distance between the buttons must be accurate. I consider that this dimension is the most important one; a small deviation in the centre distance can result in a comparatively large error. Don gave an example for a No. 3 cutter with buttons of 0.239in. diameter, a centre distance of 0.253in., an in-feed of 0.062in., with a blank width of 0.080in.. I have used these figures to demonstrate the point that I am making. Using trigonometry, the tip width of the cutter calculates out at 0.01753in.. I give below three scenarios where I have reduced dimensions by 0.002in.

1. Each button diameter reduced by 0.002in.. Tip width becomes 0.01768in. i.e. an increase of 0.00015in.

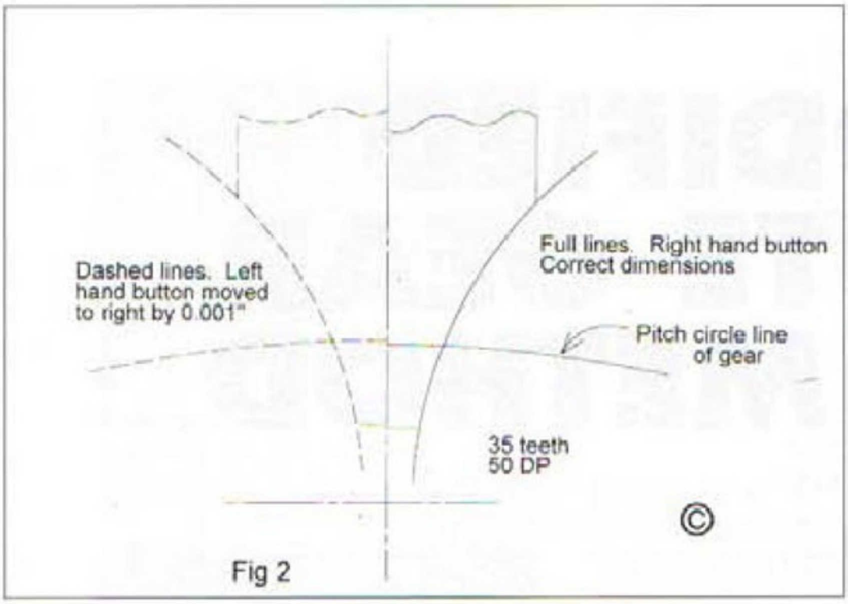


Fig 2

2. In-feed reduced by 0.002in.. Tip width becomes 0.01826in. i.e. an increase of 0.00073in.

3. Centre distance reduced by 0.002in. Tip width becomes 0.01590in. i.e. a decrease of 0.00163in., but an error of just over 10%.

I have shown this last condition in **Fig. 2**, drawn to a large scale. I have also drawn in (what will be) the pitch line. Measuring between two teeth along this line - which should be half of the circular pitch - it was noted that this also would be reduced by about a thou.

I believe that these results endorse my point that the correct centre dimension must be maintained. Jig drilling is very often quoted as being the best method of getting the correct centres. This could be done on a milling machine, or by clamping the work to a lathe top slide - as shown in Don's article - or by the traditional, but laborious, method of using toolmakers-buttons.

In my opinion, the tolerance on the correct centre dimension in the last example, should be ± 0.01mm (say ± ½ thou). With my equipment - and I suspect that this would be the case in many home workshops - I would not be confident to jig drill to this accuracy. So is there another method which is more suited to our equipment - and skill?

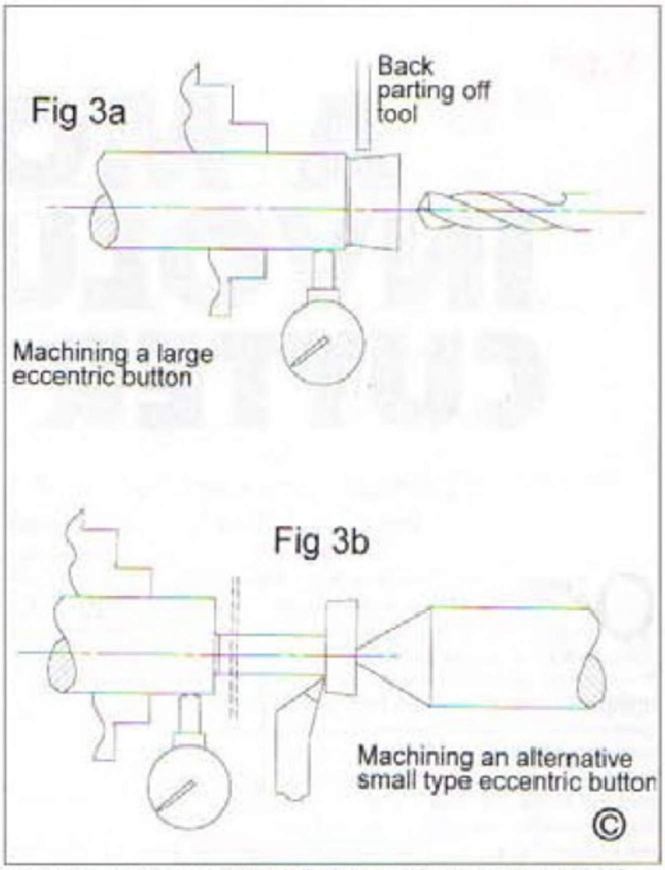
My answer to the accurate centre distance question was to make one of the buttons with an offset centre **(Figs. 1d & 3a)**. The principle is; with the holes drilled reasonably accurately (by eye), a correction can be made by twisting the eccentric button around to its correct position - which I will elaborate on later.

The reader will know how accurately he (or she) can mark out and drill holes and consequently how much the resulting error is likely to be. With the aid of a magnifying glass, I can usually mark out and drill to an accuracy of ½mm. Therefore, the offset dimension of the button centre could also be ½mm, giving a 'throw' of 1mm - well within my accuracy limits.

With the tool holder that I made, I secured each button through its centre hole with a cap screw **(Fig. 1b)**. With very small buttons however (similar to those in the previous example), this would not be possible. In this case an alternative type of button would be made. This type is similar to that shown in Don Unwin's article, with a reduced diameter locating pin or shank extending underneath, but with the top of the button in the truncated cone form **(Fig. 1e)**. One button would be machined concentrically but the other would be machined with its locating shank offset **(Fig. 3b)**. With both types of button, the method of centre setting will be the same; but first, a small hole, slot or nick needs to be made on the eccentric button in a position that is accessible, but does not interfere with the cutting edge or clamping system. The purpose of this nick/slot is to accept the end of a drift or pin punch.

The concentric button is fully tightened whilst the eccentric one is just 'nipped'. With the aid of a pin punch and small hammer, the disc is moved around by gently tapping against the nick/slot. When the button is in the correct position, it is fully tightened. How do we know where the correct position is? Simple - you just measure right across the two buttons with a micrometer.

If the lay-out **(Fig. 1d)** is considered, it is clear that the dimension of the overall width, looking from left to right, is:- half the left button, plus the centre distance, plus half the right button.



You will notice that we now have two half buttons, and that, of course, is equal to one whole button. Likewise, the dimension between the buttons, taken with a feeler gauge, would be the centre distance minus the button diameter.

Again using the previous example :-

Each button is 0.239in. diameter, centre distance is 0.253in.
Micrometer reading across buttons = 0.253in. + 0.239in. = 0.592in.
Feeler gauge between buttons = 0.253in. - 0.239in. = 0.014in.

Over the years, several tables of cutter proportions have been produced, but I suggest that the tables in Don's 1997 article should be consulted for this exercise. These tables give figures in inches for 1DP gears, which is equivalent to dimensions in millimetres for Mod 1 gears. It is then necessary to divide for DP gears, or multiply for module gears. All is explained in Don's article.

Construction of holder

As previously mentioned, the cutting edge of the button can be too high. I overcome this by making a staggered holder, in a 'T' shape, as shown in Figs 1b & c. I did this by welding, but a plate could be heated and 'joggled' (a double bend or Z shape) or a thick piece of material machined in a similar fashion. One advantage in having a T shaped holder, is that it gives plenty of space for the buttons and screw holes and to cut away the 'V' clearance area. On large systems, the T head could be offset to the right of its shank to bring the buttons in line with the toolpost screws and so distribute the cutting load more effectively.

Obviously the dimensions of the holder will depend on the size of the buttons and on the pitch of the final gear teeth, but generally speaking, for the type of work that most of us do, 10mm plate would be adequate, both for the shank and the T head.

Unlike the original holders with the sloping face, the button securing holes can be drilled on the drilling machine, which is more convenient and ensures drilling squarely to the holder. If you are making larger buttons, the holes would be tapped, but if you are making the small buttons with the circular locating shanks, then the holes (especially for an eccentric button) would be made to give a close sliding fit to these shanks **(Fig. 1f)**. With this latter type of holder, you may find it necessary to increase the thickness of the T head **(Fig. 1f)** to accommodate the clamping screw. Again, dimensions will vary according to the size of buttons, pitch etc., but M6 would normally be adequate. Don's article gives a good description of the button clamping method for this type of holder.

Construction of buttons

As in the case of the holder, the thickness of a button is arbitrary. I suggest however that the thickness be made about 20-25% of the diameter for larger buttons and about 30-40% for small ones.

Making the buttons themselves is straightforward. I didn't have any silver steel of a large enough diameter, so I machined them from mild steel, which I then case hardened. I gave them three 'dips' each and I probably had a hard skin of about 6-7 thou. It did the job that I intended it to do with no problem. Remember, we are making these items for a one-off job! This is not a new idea; 'Tubal Cain' claimed that a one-off, case hardened form tool would have a surface harder than tempered carbon steel (Ref. 2).

I suggest that the following method would be a suitable one to follow:-

Set up the bar of material in the four jaw chuck and square off the end face. Machine the bar down to the finished diameter plus a thou or so. Wipe engineers' blue lightly around the periphery; making sure that none gets onto the end. Any blue that goes on to this face will give a false indication when machining. Set the topslide of the lathe over by the correct amount to cut the clearance angle, then take small progressive cuts until the blue is just machined away. The diameter should then again be checked with a micrometer and, if necessary, another very light cut taken. The periphery should be polished with a fine emery cloth, making sure that it is kept flat to maintain the correct clearance angle and to keep a sharp edge. If it is to be a large concentric button, the work will be drilled and parted off in the normal manner. The button should now be laid flat on its face and polished with emery cloth. After it has been polished and the holes deburred, etc., it is ready for hardening. Before doing this however, check that the thickness of each of the buttons is the same. If they are not, remove metal (probably by grinding) from the underside, i.e. the small diameter. This is especially important if the buttons are to be case hardened as no grinding will be carried out afterwards. After hardening (or case hardening) the cutting edges should be lightly honed.

In the case of the eccentric buttons, the procedure is the same, except the work will be set over in the chuck immediately before drilling. The correct amount of offset should be obtained with the help of a dial indicator; the reading on the dial being twice that of the offset **(Fig. 3a)**. The button can then be parted off, but remember that the work is now swinging eccentrically, so for the first few revolutions the tool will be cutting intermittently.

I didn't make the small type of button, but the procedure will be similar. I would be inclined to do the machining, polishing etc., as stated above, but have the work further out from the chuck, as the length of the buttons is greater. After machining the angle, the work should be centre drilled, supported from the tailstock and the shank cut, generally as shown in **Fig. 3b**. Parting off work supported by a centre can be risky so in this instance, sawing would be preferable.

Aligning the buttons

After the discs have been secured in the holder and the holder secured in the toolpost, the assembly will need to be aligned with the lathe centre line. This can be done by squaring the cutters to a bar between the lathe centres, as shown in **Fig. 5** of Don's article. However, it is very often necessary to grind away the front edges of the buttons to make proper contact with the work piece **(Don's Fig 4)**. This grinding will usually be done before lining up, so there will be a problem in squaring the assembly when it is mounted in the toolpost. The way I overcame this difficulty was to hold a straight edge along the back of the buttons and align it parallel to the lathe centre line. The space behind the edges of the cutters and the holder shank was a bit cramped, but I managed it.

I am not a clock maker and my gears appear to be larger than Don's. My buttons and holder are of a heavier construction but the overall principle is the same. Whether you are a clock maker, a vehicle restorer, or whatever your interest, I hope that you now have enough knowledge - and confidence - to have a go.

References

1. Making gear cutters, an update. M.E.W. Issue 41, page 52.

2. Hardening, Tempering & Heat Treatment. 'Tubal Cain' - Workshop Practice Series. No. 1.

LINK UP

FOR SALE

● M.E.W. back numbers Nos. 1 to 57 complete, good condition (57 total).
Please call Mike Champion 01243 264685 (Bognor Regis) any time.

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Please call Jim Barrie Tel. 0141 775 1073 (evenings) or 0141 548 3257 (work) (Glsgow, Scotland)

● Tailstock assembly complete for Unimat SL twin bar lathe. Also 3 jaw chuck.
Please call Mike Champion Tel. 01243 264685 (Bognor Regis) any time.

● A full set of 0.8 module involute gear cutters.
Please call Derek on 01363 773 920 or write to 3 Prince of Wales Road, Crediton, Devon EX17 2AG

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● 1. A clean copy of M.E.W. No. 44 to complete my set (somebody nicked mine!). 2. A source of circular belt drive material ('Polycord'?). 3. Info about my Smart & Brown 'Sabel' lathe.
Bill Morle, Brook House, 9 Woodhill Avenue, Gerrards Cross, Bucks SL9 8DJ Tel. 01753 884360

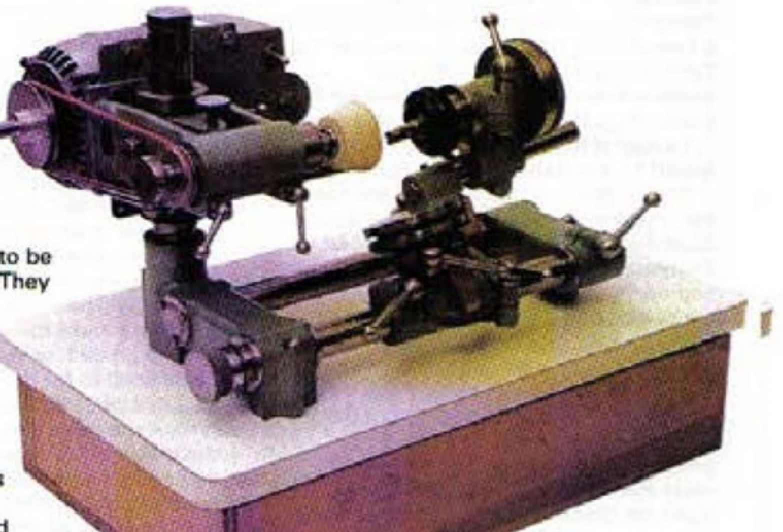
● 'Dividing and Graduating' by Geo. Thomas
Tel. 01625 576709

● Manual for Jones & Shipman Model 701 hand operated cylindrical grinder. I will pay for any photocopy etc. I would also like to talk to anyone who has experience of the machine.
S. Trendall, 15 Waterloo Road, Crowthorne, Berkshire RG45 7PB Tel. 01 344 774 886

COMPENDIUM OF THE QUORN

Part 2

Philip Amos concludes his review of the Quorn Tool and Cutter Grinder and its literature, suggests a few more modifications and gives some hints on wheel dressing



Quorn Clamping Handles

One of the first impressions of the Quorn is the number of ball ended handles for clamping the various actions. The numbers required stated in Reference 1 are incorrect and this is noted by Professor Chaddock on page 659 in Reference 2m. The correct numbers are ten large, six small and two straight small if that option is selected for the rotating base stops. He also there refers to the need for a special spacer, 13/16in. long, for the wheelhead casting column clamp.

There is really no mandatory reason why these handles have to be ball ended, but that is the way Professor Chaddock designed the machine. It will work quite satisfactorily with plain handles as shown in **Drawing 7a**. If preferred, a purchased bakelite knob can be screwed on the end as in **Drawing 7b**.

If there are to be ball handles, then it would seem that most Quorn builders do not favour the Chaddock method of broad form tools to produce the balls - there are frequent references in the literature to this view. Most use some form of spherical turning attachment on the lathe e.g. Reference 4k.

George Thomas suggests a variant where the smaller ball is made separately and attached with adhesive. However, with either ball handles or the plain ones referred to above, it is necessary to have spacer washers of fairly precise thickness so that the 'clamped' position of the handle is where the operator wants it. This need arises because the orientation of the screw threads in the handle and in the clamp bolt are more or less random.

Making such washers is difficult. They need to be a nominal 1/8in. thick, which makes them too thick to be easily cut from sheet. They can be parted off from bar after it has been drilled appropriately, but the axial accuracy of the parting off is difficult to control. I have tried Tubal Cain's 'turner's cement' technique as described in Reference 9, but must admit failure to get a result. From experience of these difficulties came a thought of using a selection of surface ground washers of four precise thicknesses which, in combination, could yield eight possible handle directions at 45 deg. intervals.

These thicknesses were derived as follows:-

For 2BA, the thread pitch is 0.81mm. Hence 1/2 turn is 0.41, 1/4 turn is 0.20 and 1/8 turn is 0.1 mm., so make washers 1 1/2 turn (1.22mm), 1 1/4 turn (1.01mm) and 1 1/8 turn (0.91mm). These, combined with the nominal 1/8in. thick washers (3.12mm) allow appropriate thicknesses to achieve 1/8 turn steps.

Similarly for 5/16in. NF thread, pitch is 1.06mm, and the special washers are:- 1 1/2 turn (1.59mm), 1 1/4 turn (1.32mm) and 1 1/8 turn (1.19mm).

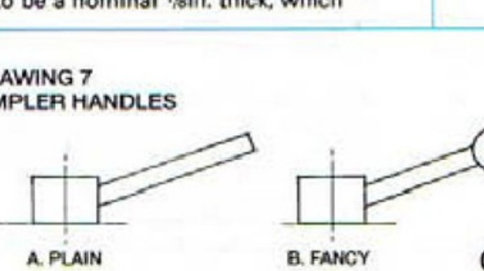
In Reference 4u it is mentioned that the holding power of a magnetic chuck is much diminished for thin pieces, so some special precautions are necessary.

(i) Position the washers across one of the magnetic insulation gaps.

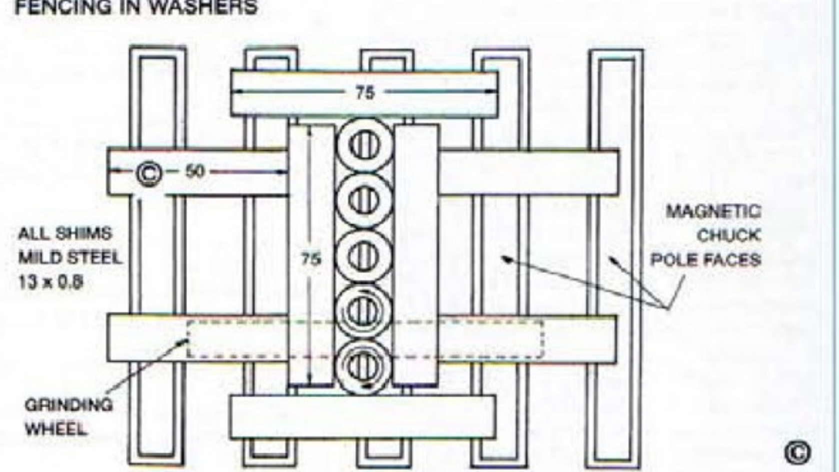
(ii) Surround them with thin pieces of steel - see **Photo. 16** and **Drawing 8**.

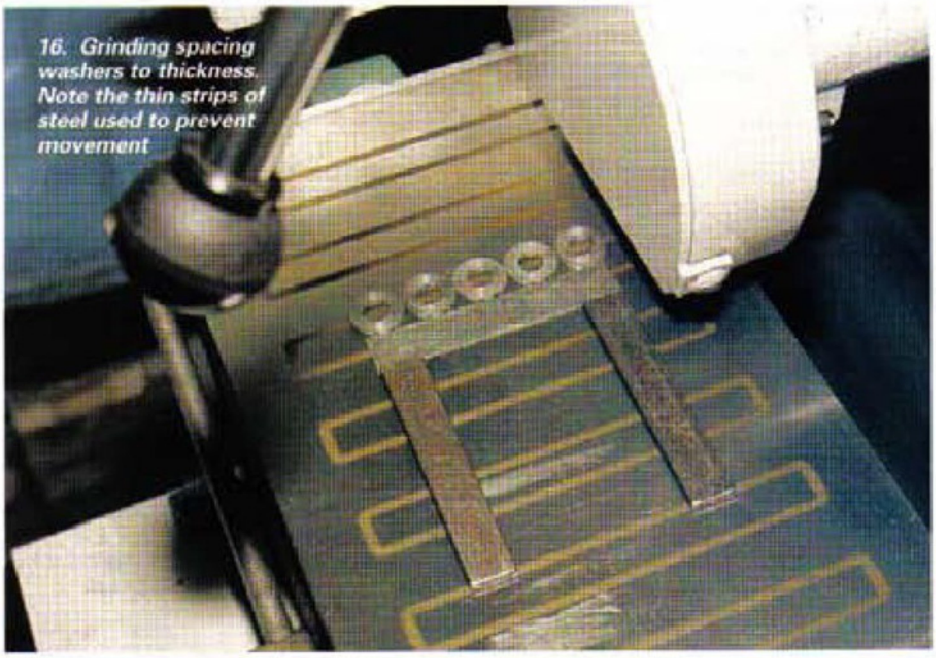
(iii) Move the table slowly and with care to avoid sudden engagement of the wheel with the work.

DRAWING 7
SIMPLER HANDLES



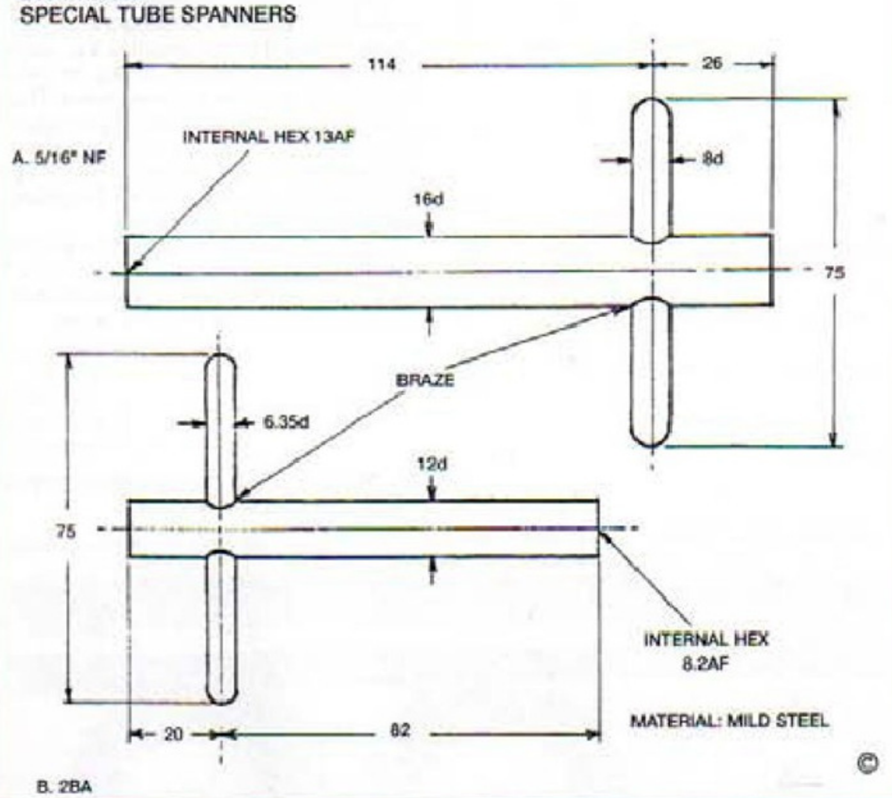
DRAWING 8
FENCING IN WASHERS





16. *Grinding spacing washers to thickness. Note the thin strips of steel used to prevent movement*

DRAWING 9
SPECIAL TUBE SPANNERS



Although boxing in the washers can prevent their horizontal translation, they can still rotate in that plane, and do so - see **Drawing 8**. However, this does not seem to be much of a problem in practice.

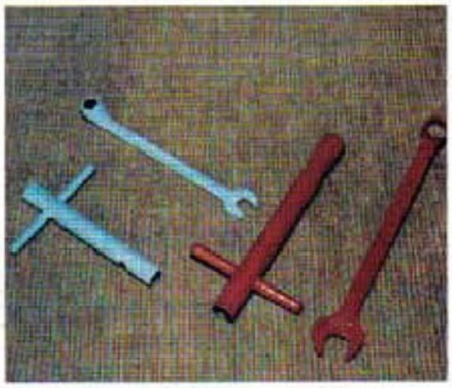
In my case, five washers of one nominal thickness were parted off about 0.2mm oversize in thickness. They were deburred by rubbing on coarse emery paper on a flat plate, then measured for thickness, and the thickest one noted. They were then placed side by side on the magnetic chuck, with enclosing shims, and clamped in place.

The grinding wheel was turned on and lowered over the thickest washer until it sparked. The height was locked and the table traversed back and forth, removing 0.025mm per pass, until all washers had cleaned up.

The washers were removed and their thickness measured. They were replaced on the table, ground side down, and reclamped. The table was again traversed back and forth at the same height setting - there was some metal removal here and there.

The washers were unclamped, measured and reclamped. The grinding continued and this cycle repeated until the washers reached the desired thickness. They were deburred inside and out and were ready for use.

However, even with ball handles fitted in quite precise orientations, there always seems to be some circumstance when they foul something else or can't be operated without doing so. In fact there is usually no need to operate more than one handle at once, so there is a good case for replacing the handles with nuts and having a tube spanner with a cross tommy bar welded in to operate them and/or a combination open/ring spanner - see **Drawing 9**.



17. *Colour coded clamp spanners*

Spanners for 5/16in. NF (1/2in. AF) seem to be readily available everywhere, but this may not be the case for 2BA which requires 8.2mm AF. To overcome a possible problem, one can start with 8mm. AF spanners and ease them with Swiss files until they fit the 2 BA nuts. In my case, to facilitate easy recognition, the 2 BA spanners are painted lime green and the 5/16in. NF are painted pillar box red - see **Photo. 17**.

So, despite making ball handles and special spacing washers, I have now reverted to nuts, and find this much more convenient.

Access

General

The physical arrangement of the Quorn design inherently creates some limitations on configuration of work and wheel which can be achieved. Sometimes a bit of lateral thinking can overcome the problem; in other cases some compromise must be adopted.

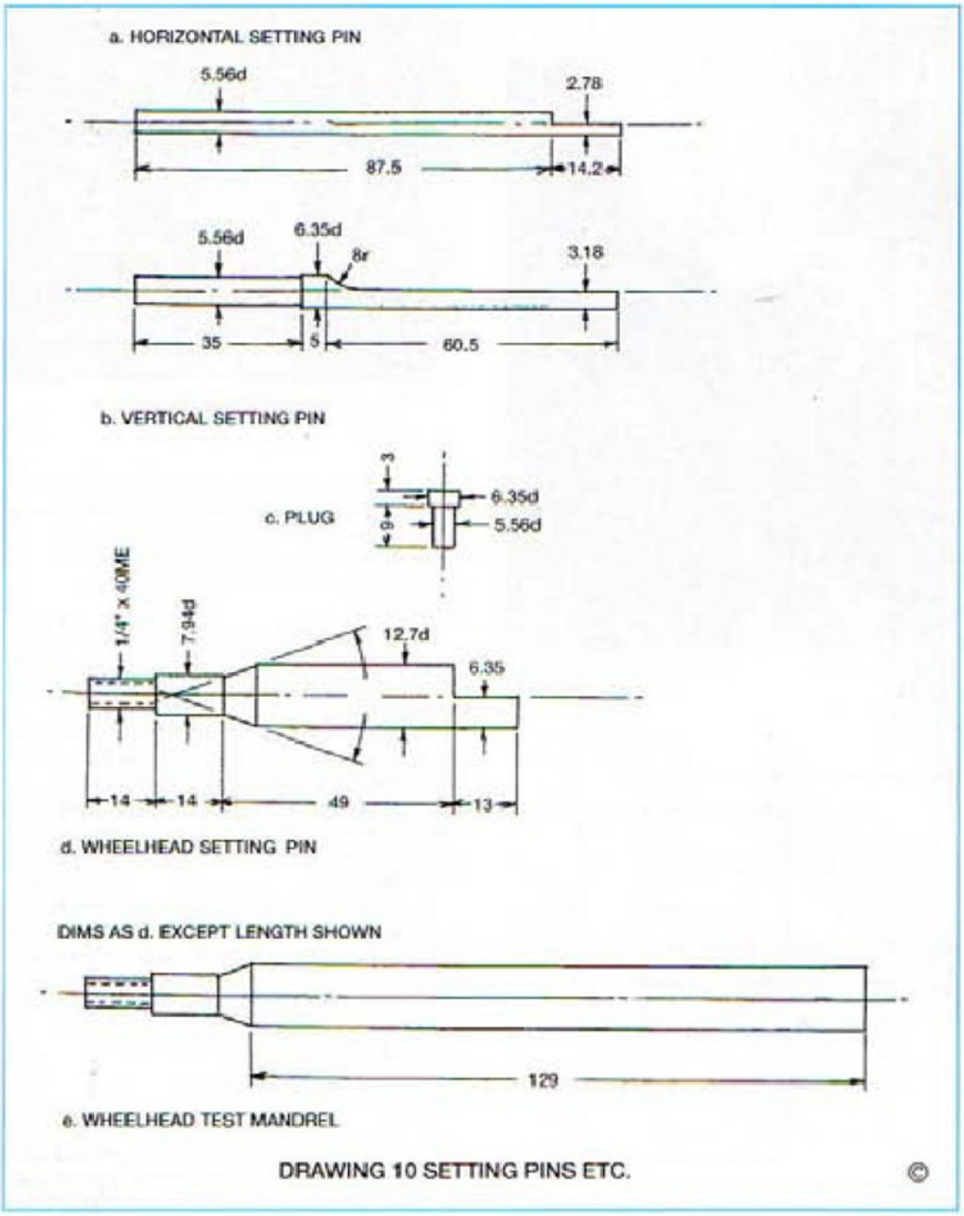
Rotating Base

On occasions, when the workhead is mounted on a short bar bed, it tends to prevent viewing the fiducial line which relates to the rotating base scale. It is worthwhile checking where the edges of the tilting bracket cross the scale of the rotating base and recording these numbers, as they can be used as an auxiliary datum.

Setting Pins

The use of the height setting device described in Reference 4p eliminates much of the need to use setting pins, but they still have some applications. The vertical setting pin **(Drawing 10b)** locates in the centre hole of the rotating base, but if the horizontal setting pin **(Drawing 10a)** is held in a collet in the workhead, then it can be backed off out of the way, allowing the vertical pin to be removed; but this cannot be done with the wheelhead pin.

To overcome this difficulty the vertical setting pin is machined to half its thickness



DRAWING 10 SETTING PINS ETC.

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for the greater part of its length, so that it can be moved axially without disturbing the setting until its lower end clears the hole in the rotating base, when it can be removed sideways. The wheelhead setting pin **(Drawing 10d)** is shaped more or less like the wheel mandrels and is of similar length.

It is important that wear is minimised in the hole in the top of the rotating base in which the vertical pin locates. Grinding effluent will normally fall into this open hole, so a short shouldered brass plug has been made to prevent this occurring - see **Drawing 10c**.

Diamond Shaping of Wheels

Depth of Cut

In Reference 1, Professor Chaddock suggests that the cut in diamond dressing should not exceed 0.00025in. per pass = 0.006mm. The calibration on my Quorn front bar micrometer has 0.025mm divisions and on the rocking lever screw (see Reference 4r) 0.044mm, so any attempt to achieve 0.006mm is just guesswork. Reference 11 suggests 0.025mm per pass and this seems more realistic.

Trailing Angle

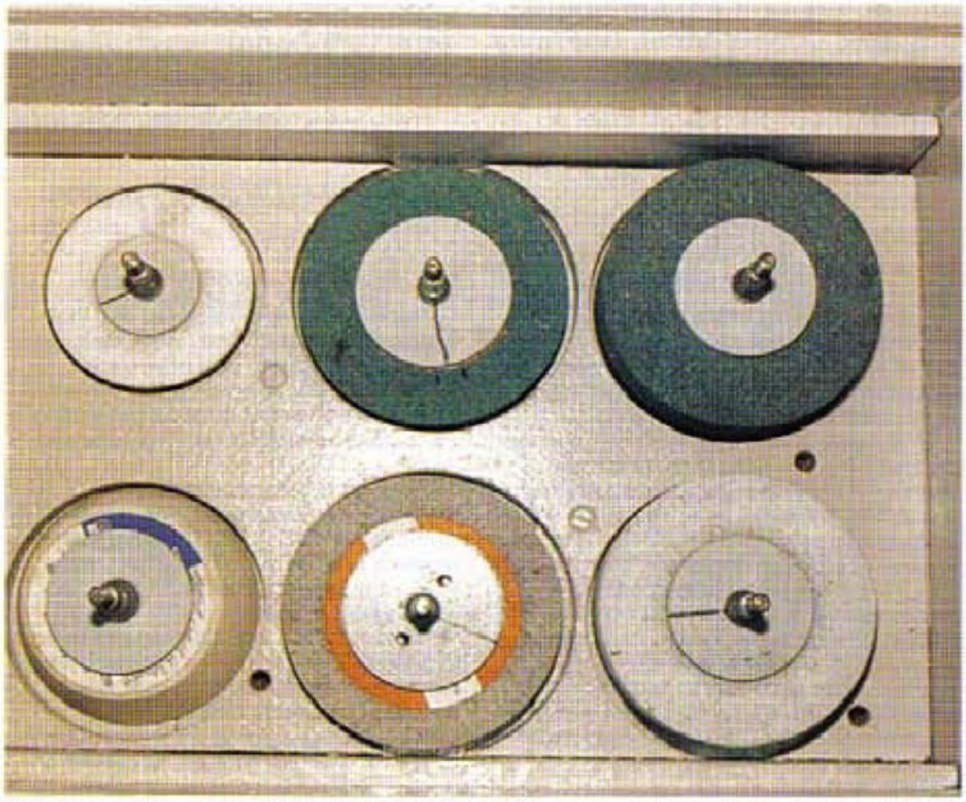
It is a requirement that the diamond point does not touch the wheel normal to its moving surface (i.e. in prolongation of the wheel radius) but at a trailing angle of at least 5 deg. Due to the geometry of the Quorn it may not be possible to place the diamond point in an appropriate position to achieve this, and at a horizontal diameter of the wheel. The diamond point can be moved in and out towards the wheel and rotationally around the front bar. The wheel itself can be moved up and down vertically. Thus it is possible to find a position (using these various movements) where the diamond point can touch the wheel surface in such a way that it is trailing the wheel diameter at that point by the required angle (say 5 deg.) - see **Drawing 11**.

Shaping a Vee Edge

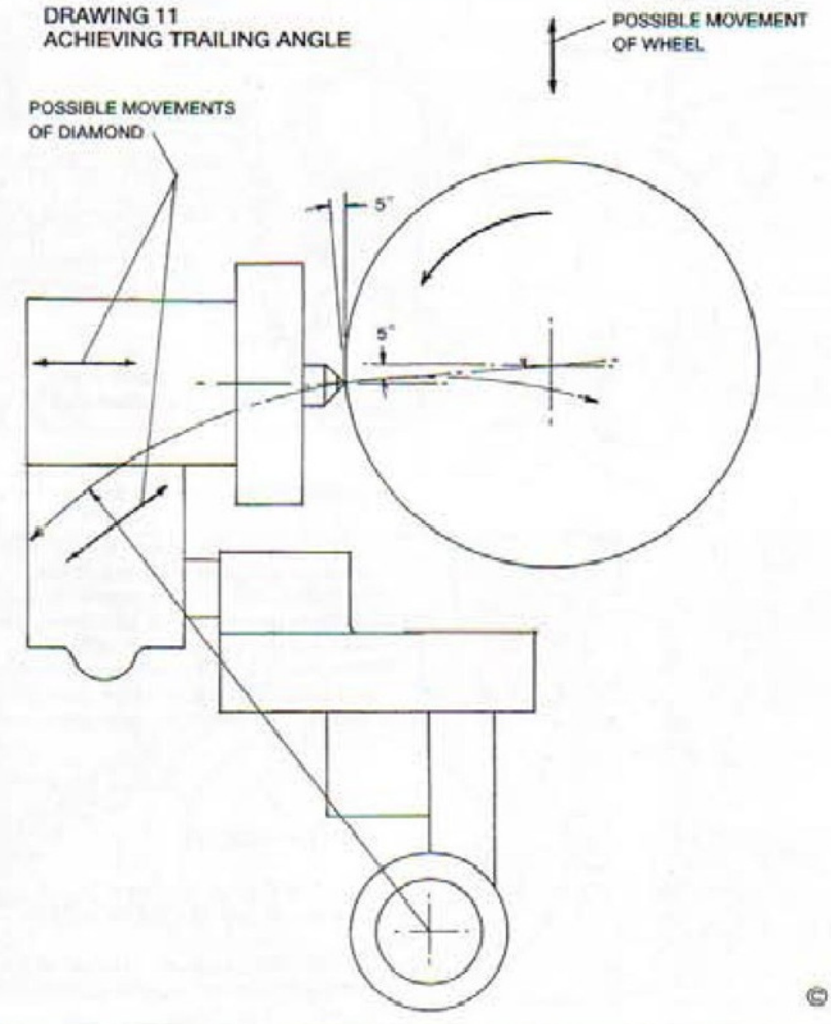
Shaping a wheel or point edge to a Vee is readily achieved by angling the wheelhead by half the included Vee angle. The tilting bracket is set to 5 deg. to give a trailing aspect to the diamond point. The cut is set using the front bar micrometer and taken by rocking the workhead back and forth around the front bar. This shapes the right side of the wheel (see **Drawing 12a** and Reference 1 page 79).

The wheelhead is then reset by angling further in the same direction until it is at the full Vee included angle. The diamond point is moved by 90 deg., the tilting

18. Storage of the main grinding wheels in the lower section of Box 1



DRAWING 11
ACHIEVING TRAILING ANGLE



DRAWING 12
SHAPING VEE EDGES
e.g. 60° INCLUDED ANGLE

bracket reset to 0 deg. and the process repeated. In this instance the cut is set using the rocking lever screw and taken by moving the workhead back and forth along the front bar. For this second operation, the trailing angle is achieved as described under that heading above (see **Drawing 12b** and Reference 1 page 77).

Shaping a Semicircular Edge

It gets a bit more tricky to form a semicircular edge on a narrow wheel or point. In this case the diamond point is first positioned at the required radius R (usually R = 1/2 width of wheel) from the axis of the rotating base, using the setting micrometer - described in Reference 4p. It will usually be found that it is not now possible to traverse the workhead body sufficiently far to the left to be able to bring the diamond point to bear on the wheel where required on the wheel edge. However, the wheel can be slightly angled (even 10 deg. is often enough) and the limits of swing of the rotating base adjusted to suit - see **Drawing 13**.

So the procedure is as follows:-

(i) Set radius R as described above.

(ii) Set trailing angle as described earlier.

(iii) With wheel stationary, position diamond point in centre of wheel width and in prolongation of its centreline as in **Drawing 13a**. Note/mark settings of front bar micrometer and rocking lever screw.

(iv) Back off front bar micrometer and angle rotating base 45 deg. to the right to bring diamond point to just touch the corner of the wheel, as shown in **Drawing 13b**.

(v) Start wheel (downwards rotation near operator). Progressively set cut with front bar micrometer and take the cut by 90 deg. swings of rotating base as shown until front bar micrometer reaches the setting in (iii) above.

(vi) Stop wheel. Back off rocking lever screw and angle rotating base 45 deg. to the left to bring diamond point to just touch the corner of the wheel as shown in **Drawing 13c**.

(vii) Start wheel. Progressively set cut with rocking lever screw and take the cut by 90 deg. swings of the rotating base, as shown, until the rocking lever screw reaches the setting in (iii) above.

(viii) Continue with 180 deg. swings of the rotating base, as **Drawing 13d**, until the diamond point sparks out.

Engraving Divisions

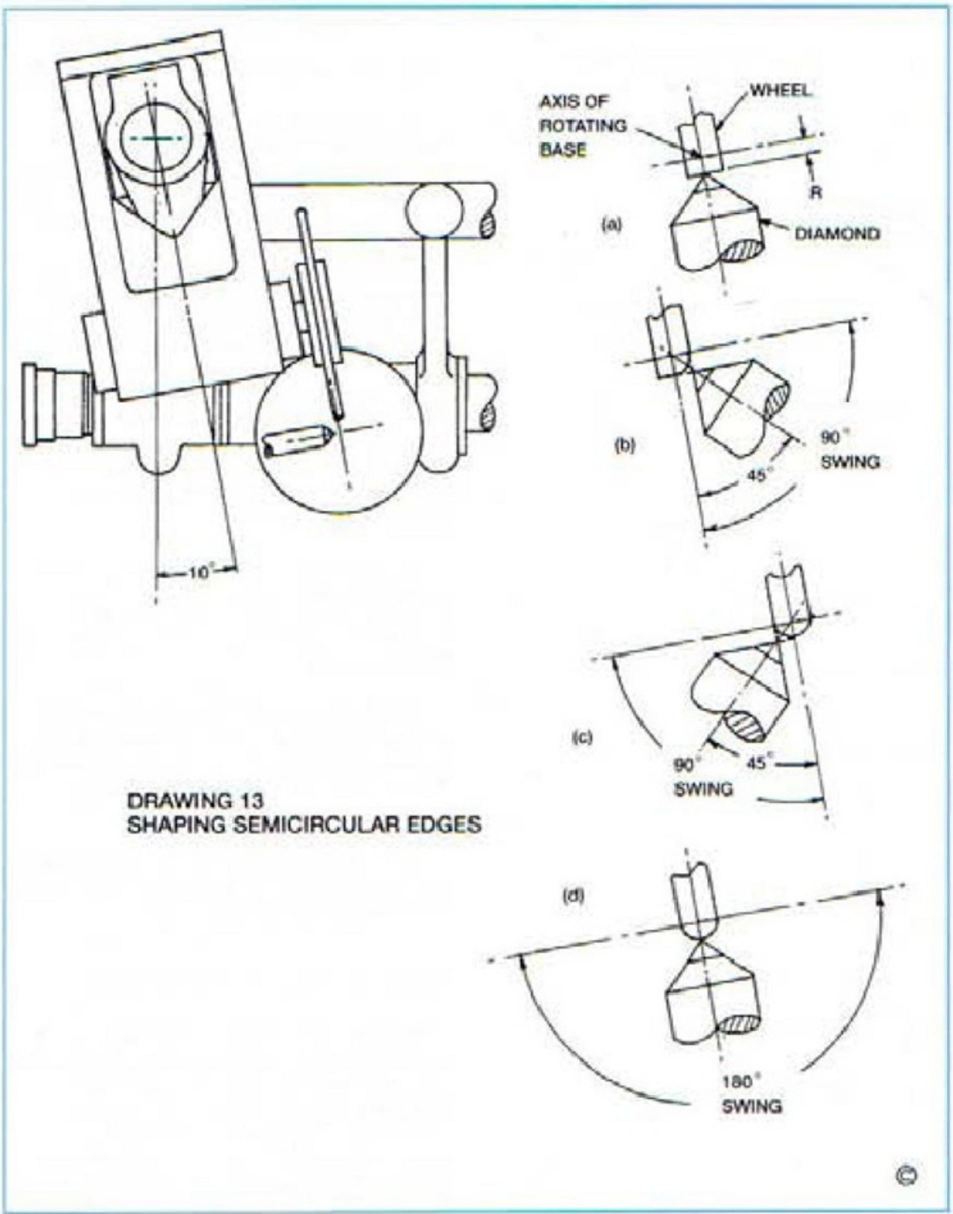
From perusal of the literature it seems that engraving machines use spinning 60 deg. half point tools for this task (see **Drawing 14**), but in my subsequent experience these seem to make excessively wide marks. A locked 60 deg. half point at right angles to the line judders but produces neat marks, so this approach has been used on more recent calibrations.

To fill the marks use enamel (oil) paint. Dip the end of a finger just into the paint surface and rub it over the marks. Immediately rub off the excess and then rub the surface carefully on cloth (bed sheeting or an old handkerchief) on a flat surface such as a glass plate to remove all vestiges of paint from the non-mark surface. Set aside for 24 hours to dry.

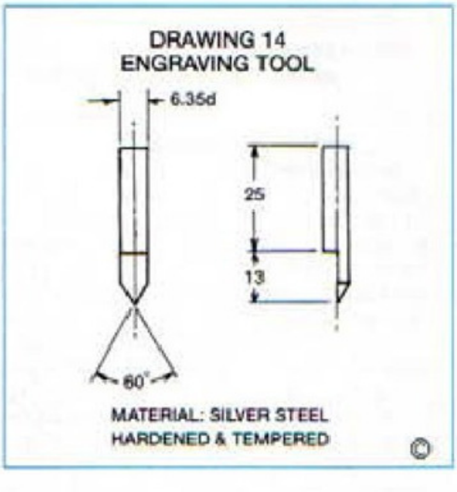
Mounting

The Quorn tends to be front heavy and so for security and convenience it is best bolted down to the bench top. If it were still required to be readily portable, it could be bolted to a sizeable piece of board to ensure stability in use.

It will be found that there is often some difficulty with the workhead ball handles fouling the bench surface, so it seems worthwhile using packers under the base castings to raise the machine about 25mm or so to obviate this problem. If the packers are of appropriate lengths it is possible to arrange matters so that the main bars are exactly horizontal in both directions. This is very helpful in some setting up situations.



DRAWING 13
SHAPING SEMICIRCULAR EDGES



DRAWING 14
ENGRAVING TOOL

MATERIAL: SILVER STEEL
HARDENED & TEMPERED

Storage

Over the years, one gradually accumulates a variety of ancillary pieces to go with the Quorn. These are probably kept in shoe boxes or a spare drawer for a time, but eventually it becomes evident that a more systematic approach is necessary to ensure that each part can readily be found when it is desired to use it.

I greatly envy the handsome polished wood boxes and cabinets made by some workers to house their equipment, and which are illustrated from time to time in ME and MEW. However, I have neither the skills nor the patience to produce such containers, and mine are strictly functional; often they are conversions of existing boxes which I may have to hand at the time.

In essence, my Quorn gear is now held in four boxes which are shown in the accompanying photos.

1. Grinding wheels **(Photos. 18 & 19)** - dimensions 400 x 283 x 135mm.

This box holds a total of 11 mounted wheels, 19 points and 3 internal grinding spindles, plus a truing diamond and a Norbide dressing stick. There is a 13 mm thick template to hold wheels in the lower level and holes in the tray to position the remainder. There are also holes in the template and the tray to clear shafts where appropriate.

2. Main accessories **(Photo. 20)** - dimensions 365 x 280 x 140mm.

In the lower level of this container there are series of pegs, fences, platforms and nails which constrain each item to its own special place, and a similar arrangement is used for those items held on the tray.

3. Guards etc. **(Photo. 21)** - dimensions 450 x 302 x 130mm. All items are in the one section of the box. By their size and shape they more or less stay in place without other constraints.

4. Construction tooling, spare materials etc. **(Photo. 22)** - dimensions 360 x 280 x 135mm.

This box contains special tools used to make the Quorn, together with various surplus items.

No doubt, in the future, more accessories will be made and have to be accommodated, but for the present there is some sort of order and convenience.

Conclusion

Not only is the Quorn a most useful piece of equipment for the home workshop, but also its construction involves great interest and development of skills for the builder during its manufacture. It is strongly recommended as a project, but it will take quite a lot of time to execute - time well spent and most enjoyable.

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:-

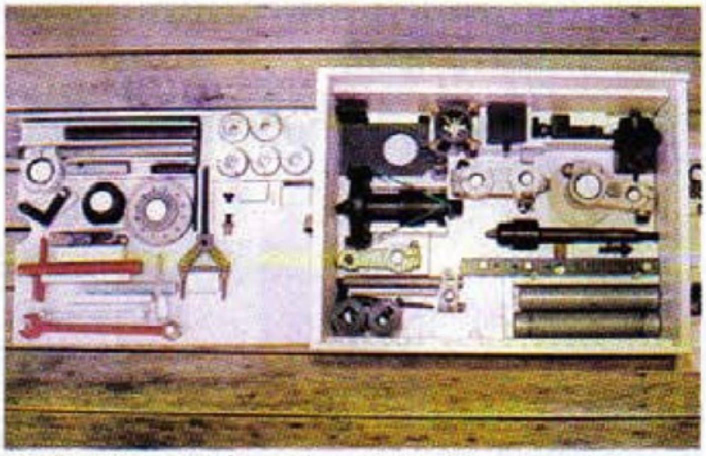
a. 4 Jan 74 pp 19-22
b. 18 Jan 74 pp 68-71
c. 1 Feb 74 pp 121-124, 128
d. 15 Feb 74 pp 185-189
e. 1 Mar 74 pp 242-252
f. 15 Mar 74 pp 289-292
g. 5 Apr 74 pp 343-345
h. 19 Apr 74 pp 385-388
i. 3 May 74 pp 433-435
j. 17 May 74 pp 484-487
k. 7 Jun 74 pp 535-538
1. 21 Jun 74 pp 580-583
m. 5 Jul 74 pp 632-633, 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:-

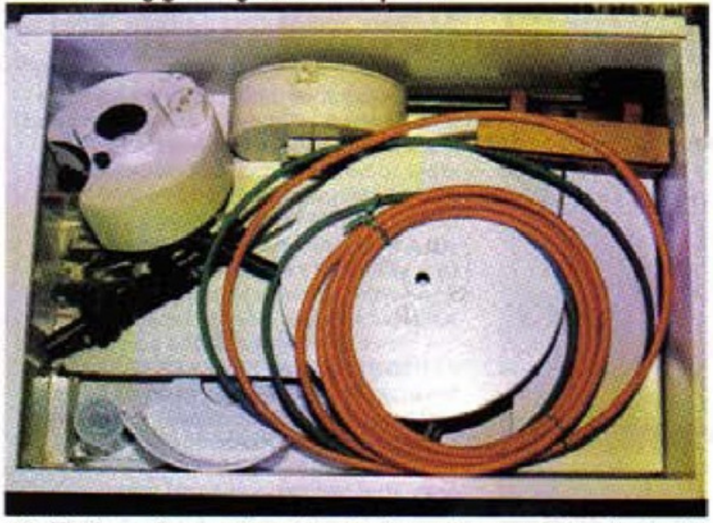
a. 4 Oct 74M.	W. Thomas	pp 965-968
b. 21 Feb 75	"	pp 196-198
c. 7 Mar 75	"	pp 227-229
d. 21 Mar 75	"	pp 303-304
e. 4 Apr 75	"	pp 348-351
f. 20 Jun 75	"	pp 617-618
g. "	A. E. Case	p 618
h. 15 Aug 75	D. H. Chaddock	pp823-824
i. "	C. A. Schofield	pp 824-825

4. 'Model Engineer' and 'Model Engineers' Workshop' articles on modifications, additions to and uses of the

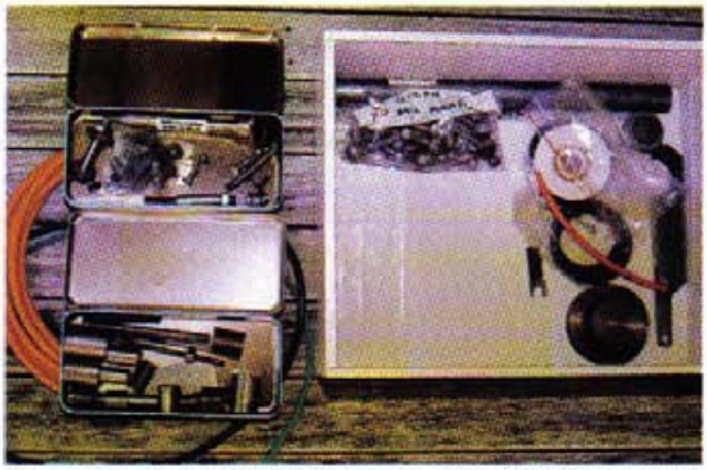
19. *The tray which fits into Box 1 contains the remaining grinding wheels and points*



20. *Box 2 is used to house the majority of the accessories*



21. *The larger items such as the wheel guards are contained in Box 3*



22. *The special tooling used in the manufacture of the Quorn has been retained and is kept in Box 4. The first spindle made can be seen in one of the tins and the displaced ball handles are in one of the plastic bags*

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.

1. 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.

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

10. Spindles - H.Sandhu WPS 27.

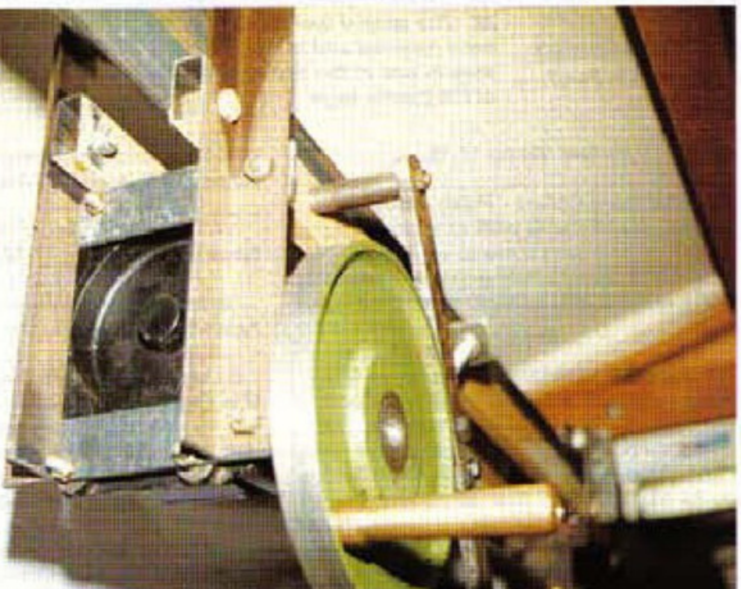
11. Precision Grinding Techniques - Jones & Shipman.

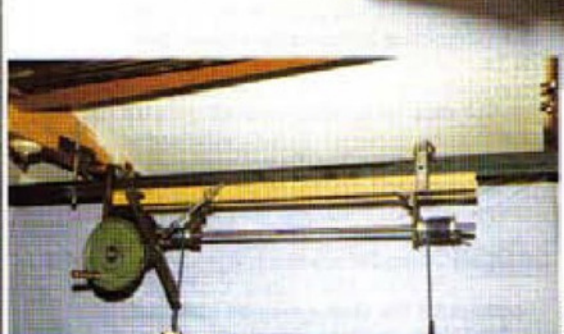
Supplier

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

A WORKSHOP GANTRY

A large copper boiler is a valuable and vulnerable item, so must be handled with care. Stan Wade describes the construction of an aid to safe handling which was fashioned from materials which were to hand.





1. The carriage structure was built up from steel angle and rectangular steel tube. The left hand end houses the gearbox

2. The main shaft runs the length of the unit, with a rope drum at each end. Another length of rectangular steel tube is used as a stretcher, thus allowing slings to be positioned to suit the load

It is always said that necessity is the mother of invention, and this was certainly the case on this occasion.

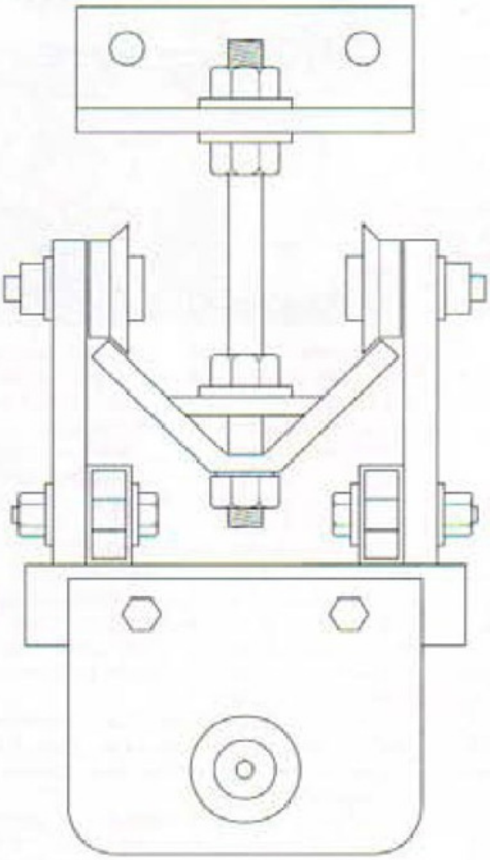
Two friends of mine are building a pair of 'Britannia' locos in 5in. gauge and as they were approaching the boiler fitting stage, some method of lifting the said boilers single-handedly was needed. This was essential as this operation was to be done in the workshop of one of them, and it would not always be possible for the other to be present. It was visualised that this would have to be done several times before final fitting and, as parts would already be painted, a certain amount of care would be needed.

A further complication was that the boiler would also have to be lifted from the bench and carried to the erecting stand - a matter of about two yards. A number of ideas were mooted at our normal Tuesday night meetings and, eventually, the idea of a gantry was suggested and accepted.

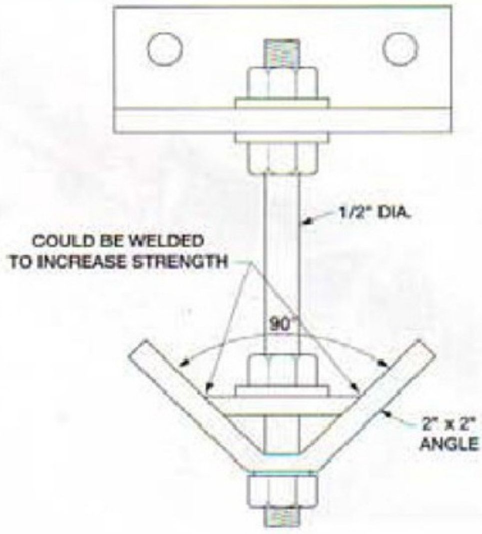
The next item on the agenda was the cost. This had to be minimal and preferably nothing, using materials that were to hand, adapted to suit the job. A gift of two lengths of 2in. x $^1/_4$in. angle iron set the wheels in motion, but as there was not enough material to arrange the angles in T fashion it was decided to mount the angle with the V pointing downwards and to let the wheels run on the resulting top edges, the wheels being made like loco wheels, with a flange to guide them on the rails. **Drawing 1** shows the general arrangement.

The following Tuesday, lo and behold, the rail was in place and looked as if it would carry a full size boiler never mind a 5in. gauge version. **Drawing 2** gives more detail of the railand its supports. Four wheels were turned from a suitable piece of aluminium, then bearings and stub axles made. The carriage was built up from angle and rectangular steel tube (**Photo. 1**). The length was set by the length of the boiler, and it was thought that a shaft running the length of the carriage, fitted with a drum at each end to take a pair of ropes, would take care of the lifting (**Photo. 2**). Rope was used instead of wire cable as the latter is frequently uncontrollable when there is no load on the end. A pleasant hour or so was spent in running this up and down the track, just to demonstrate that it would do so, but, what about turning the shaft? Thinking caps on again.

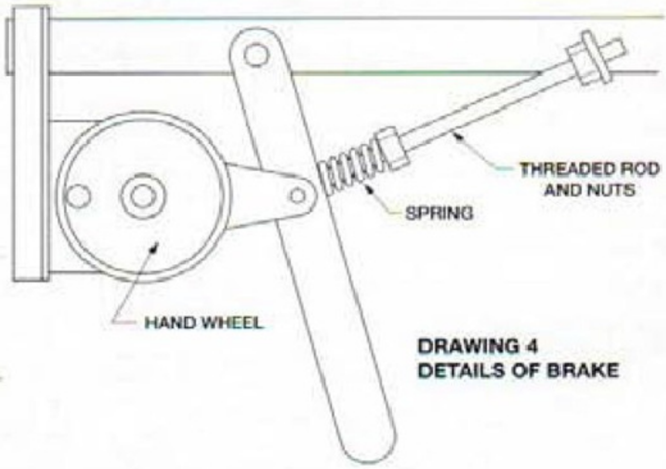
The obvious thing would be a handle linked to the shaft by some sort of gearing, but what? A search around the workshop brought to light a right-angle reduction



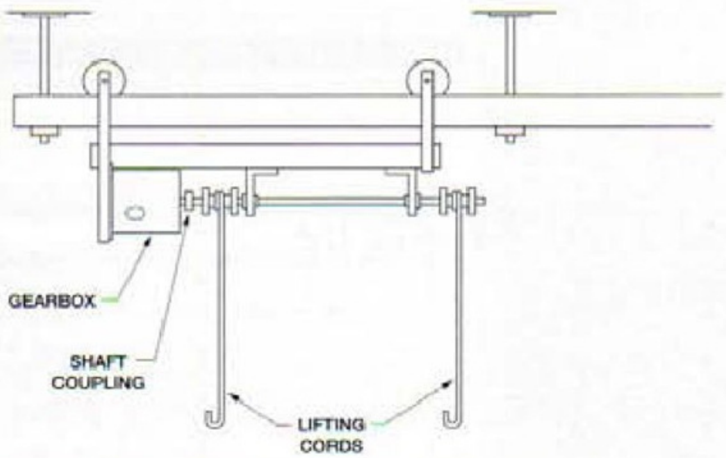
DRAWING 1 GENERAL ARRANGEMENT OF GANTRY AND CARRIAGE



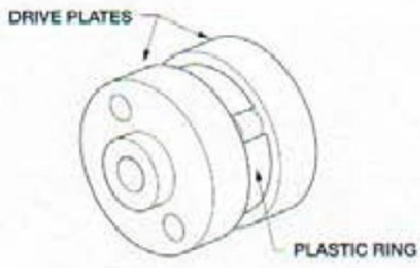
DRAWING 2 RAIL AND SUPPORTS



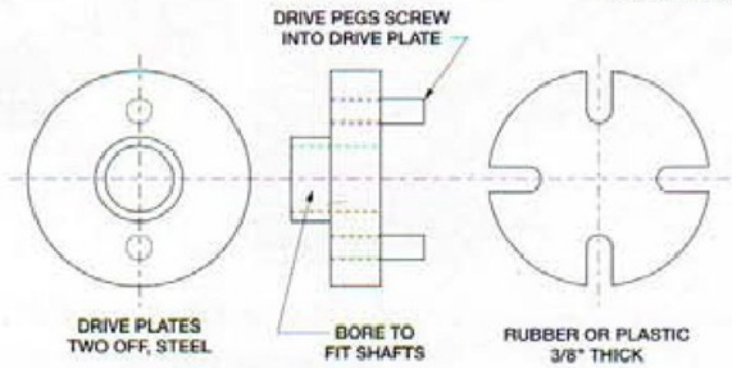
DRAWING 4
DETAILS OF BRAKE



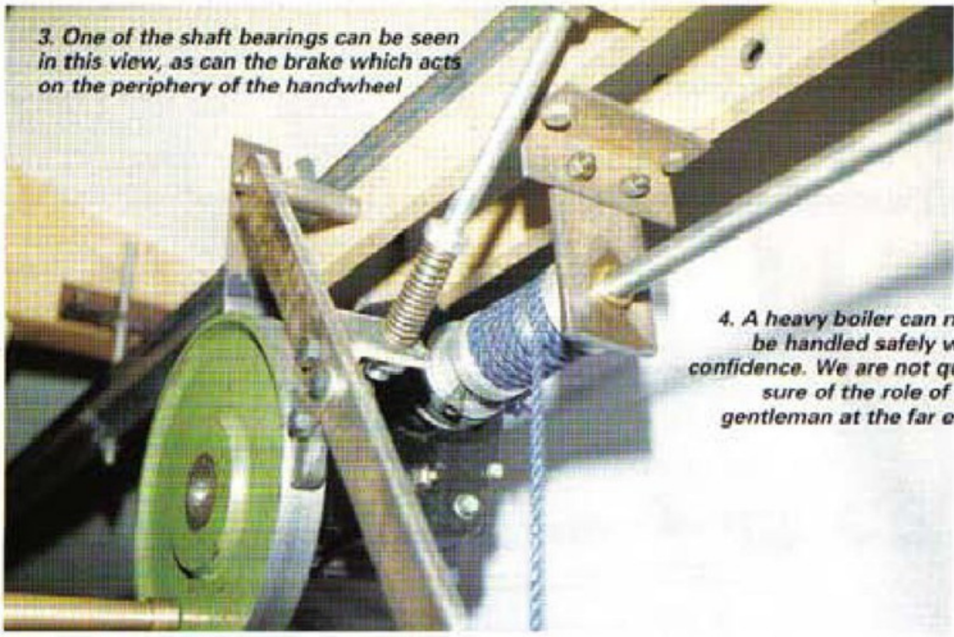
DRAWING 3 ARRANGEMENT OF THE CARRIAGE, INCORPORATING THE GEARBOX



DRAWING 5 COUPLING ASSEMBLY



DRAWING 6 DETAILS OF COUPLING



3. One of the shaft bearings can be seen in this view, as can the brake which acts on the periphery of the handwheel

4. A heavy boiler can now be handled safely with confidence. We are not quite sure of the role of the gentleman at the far end!

gearbox. Fitting this to the carriage and making a flexible coupling to the shaft filled in another evening, the winding handle and wheel being made from a surplus pulley. Now all was ready for the big test (**Drawing 3**).

Ropes were made up and a stretcher and a pair of slings were made to fit the boiler but, unfortunately, although the boiler could be lifted easily enough, it was not possible to let go of the handle because as soon as it was released the boiler came down again. It needed a brake.

Because, unfortunately, the gearbox was of a low ratio, either shaft could be used for input and, depending on which was, used the ratio could be up or down. What was really needed was a high ratio which would only drive as a reduction and thus would be self braking. It would also allow single-handed control, but beggars can't be choosers, so a brake would have to be the answer. The solution can be seen in **Photo. 3** and on **Drawing 4**.

Once all these teething troubles were overcome the gantry was put to use and was an immediate success, thus helping to bring the loco building nearer to a successful conclusion.

Few measurements are given as everything depended on what was available and this controlled, to a great extent, the sizes of the finished parts, but one which may benefit from a bit more detail is the flexible coupling. This has to cope with possible misalignment between the main shaft and the output shaft of the reduction gear box, and could be as simple as a length of hose and two Jubilee clips or a sophisticated commercial item. In this case one was made as shown on **Drawings 5 and 6**.

The main shaft was a length of $^3/_4$in. dia. bright drawn steel, suitable bushes being made and fitted to the plate supports as shown. Rope drums were turned from aluminium bar and drilled to take the end of the rope which was passed through and knotted to secure it.

In all, the exercise has been a success and the gantry has found other uses. It has been very much a case of "How did we manage without it?".

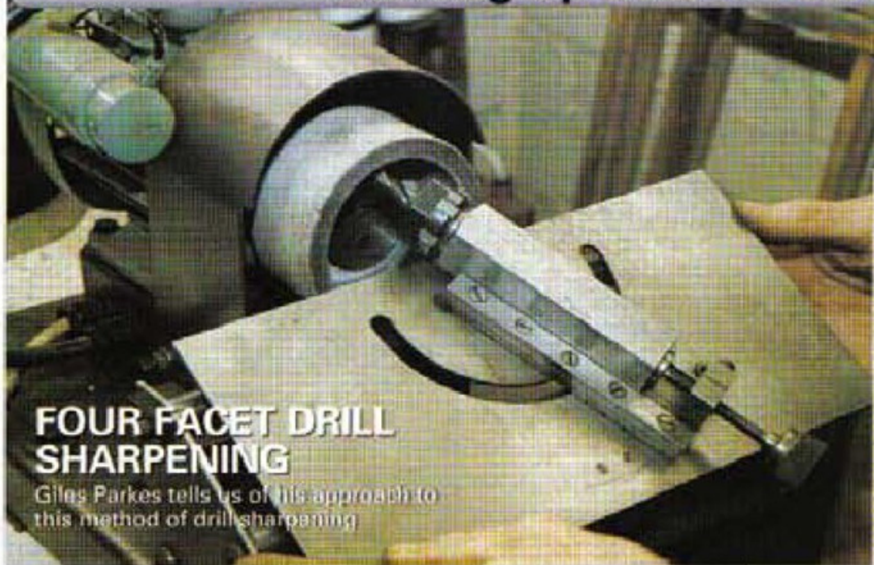
If anyone wishes to copy it, one piece of advice is to make sure that your workshop roof structure will take any weight that you are likely to put on it. YOU HAVE BEEN WARNED!!!!

IN OUR NEXT ISSUE

Coming up in Issue No. 64 will be

WORKHOLDING MANDRELS

A comprehensive survey of the use of a versatile workholding system from Philip Amos



FOUR FACET DRILL SHARPENING

Giles Parkes tells us of his approach to this method of drill sharpening

NYLON COATING

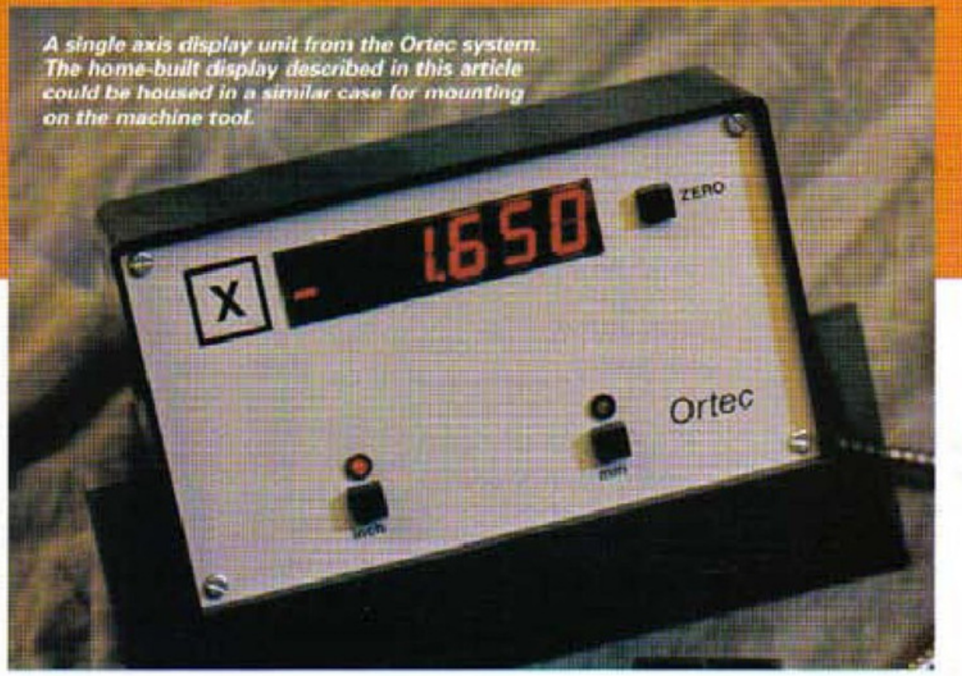
Neil Munro describes the construction of a simple fluidised bed which will allow components to be coated using nylon powder

Issue on sale 26th January 2000

(Contents may be changed)

DIGITAL READ-OUTS FOR THE HOME WORKSHOP part 2

Peter Rawlinson concludes his article on home-built position indication systems by describing the electronic circuits and the associated test procedures



A single axis display unit from the Ortec system. The home-built display described in this article could be housed in a similar case for mounting on the machine tool.

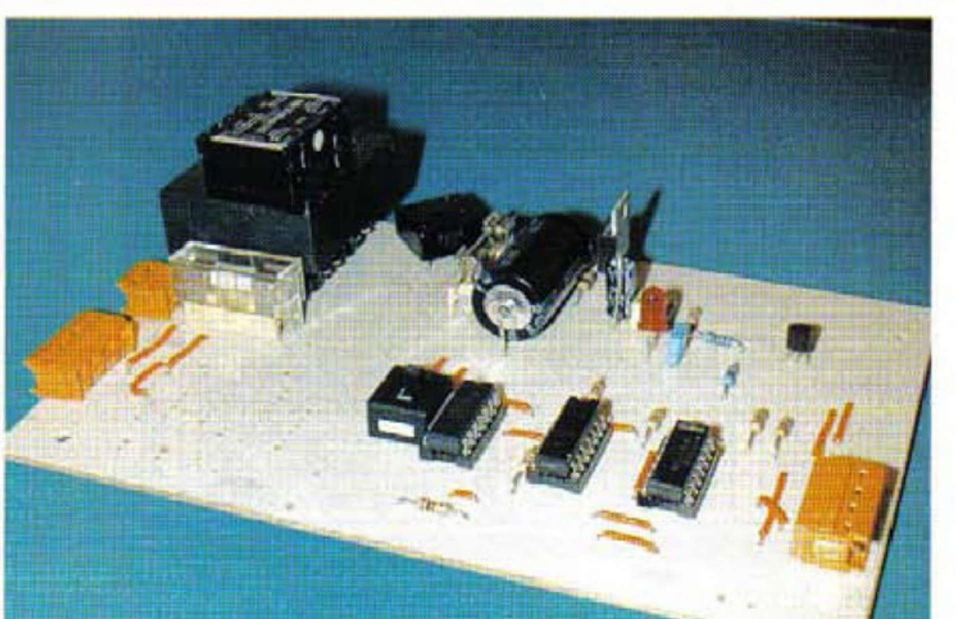
The circuit

The circuit for a single axis system is shown in block diagram form in Figure 3. I decided once again to use purpose-made printed circuit boards for the majority of the modules, with plug and socket connections on each, so that all the units can be finished individually then brought together. The circuits have been arranged on boards as follows:-

1. Voltage regulation (Figures 4A and 4B)
2. Direction and Count (Figures 5A and 5B)
3. Sensor connection (Figures 6A and 6B)
4. Display (Figure 7)

The simple 6 volt AC supply module was not housed on a board, the added complication not being thought worthwhile. The circuit for this is shown in Figure 8

In all, five PCBs are detailed as I have also included a design (Figures 9A and 9B) for a combined power and direction/count PCB (**Photos. 19 and 20**) in case any builder prefers a single unit to house the two sections. It is in most respects the same as the individual parts, the exception being the inlet and outlet wiring which is reversed. It includes a switch which allows the unit to read from either direction and also the mains transformer. I have had second thoughts over this as I am now not sure that this is a good idea as with this arrangement, part of the board is at mains potential. You will note that in **Photo. 20** this section has been covered with tape to prevent electric shock. Many commercial items are made in this fashion, but if you choose to go this way, please be careful. If you wish, this



19. The 'Combined' PCB which houses both the power supply and the Direction and Count circuits

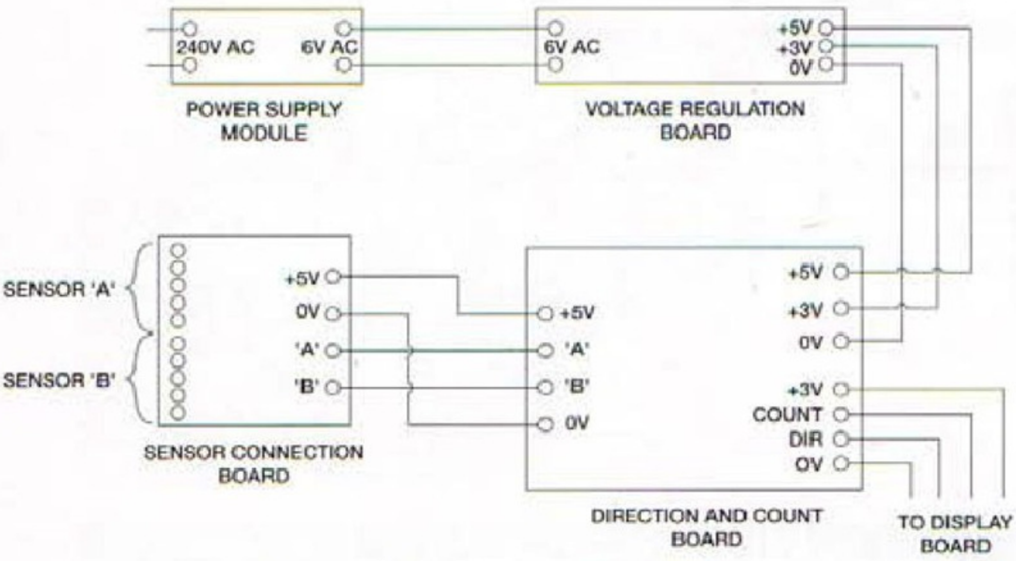


FIG. 3 BLOCK DIAGRAM OF SINGLE AXIS DIGITAL READOUT SYSTEM

©

FIG. 4A VOLTAGE REGULATION BOARD - COMPONENT LAYOUT

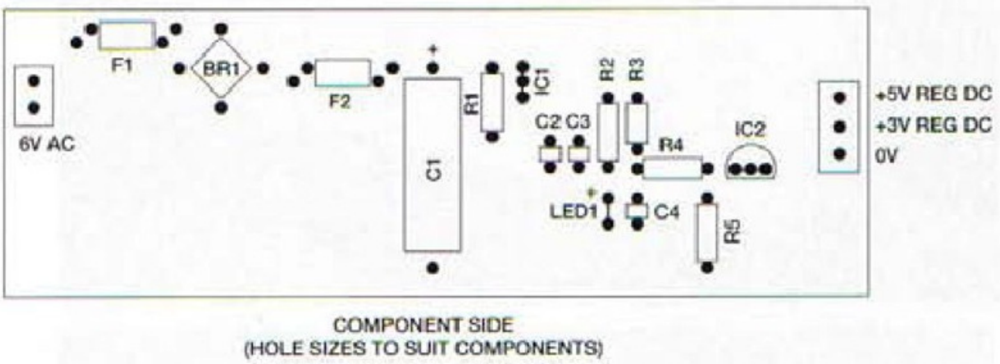
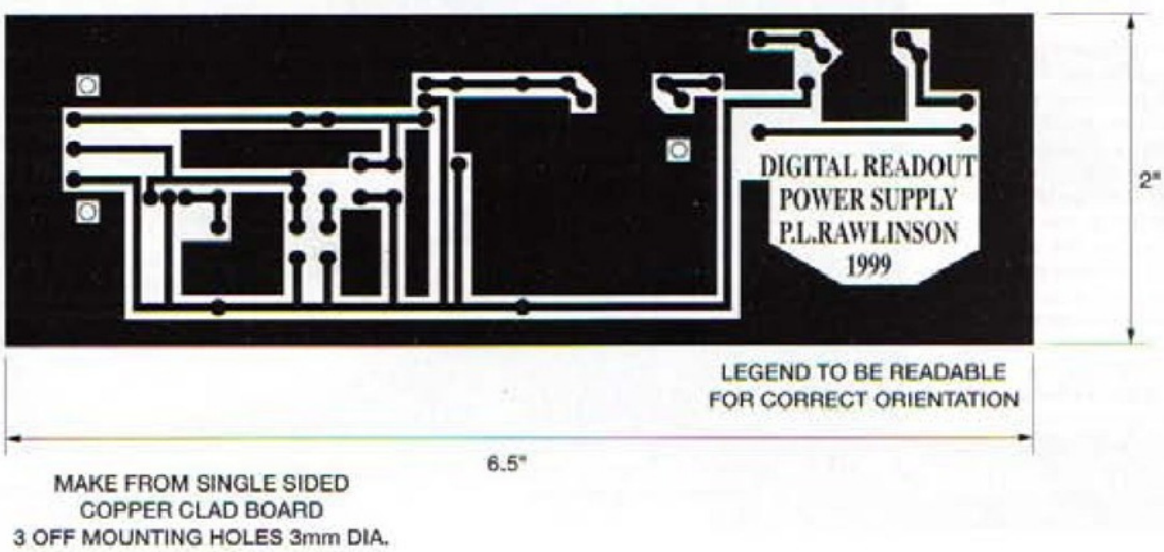


FIG. 4B VOLTAGE REGULATION BOARD - TRACK LAYOUT



transformer can be removed and a remote power supply provided.

My board was originally made to have a frequency multiplier for use with my Mitutoyo Scales, but as this could not be made to work successfully, the components were removed, but the tracks are still visible. The latest drawing for the PCB has been updated, this part having been deleted.

Testing of the combined board will be the same as for the individual sections which will be described in the article.

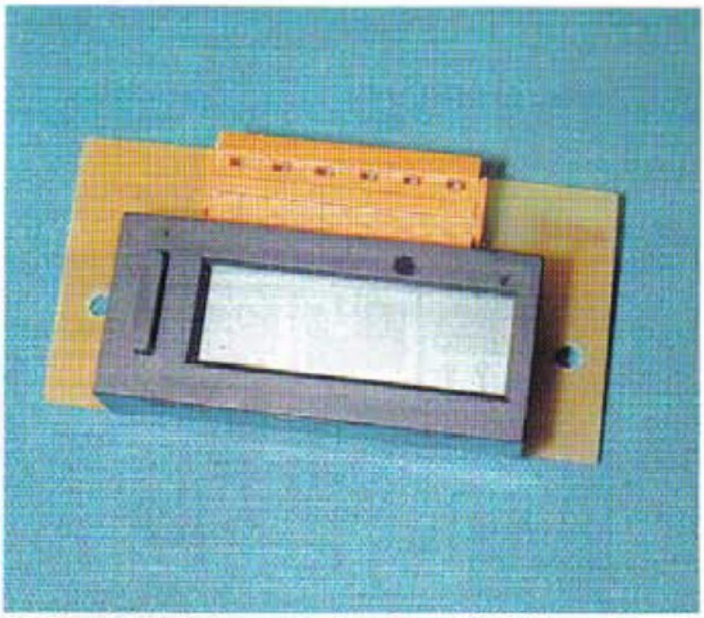
The digital display unit is quite small, only being 48mm long x 21mm wide, and has numerals 8mm high. It does not however have a decimal point, but this is provided by putting a small spot of paint at the appropriate place on the display. The position does not vary, so this is quite satisfactory. The small PCB designed for this unit (**Photo. 21**) allows simple mounting with two screws and spacers. The display is held to the board by one screw and the pins are soldered in, as mentioned, it has provision for a plug and socket system, but the leads can be soldered directly to it if required.

The 'Direction and Count' PCB (**Photo. 22**) is fed with power at both 5V and 3V, together with a common ground line. The 3V supply is only used for the read-out unit and the 5V for both the sensor and the pulse circuit.

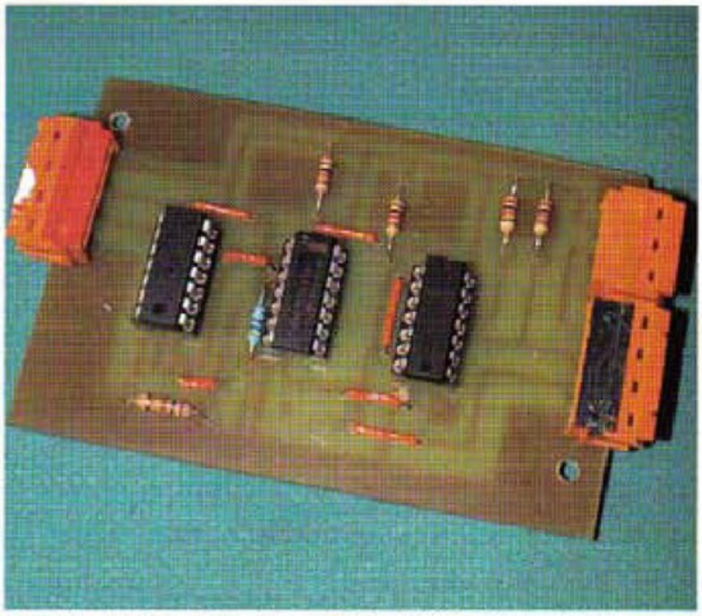
PCB manufacture

The decision to use purpose-made PCBs was influenced by the fact that I now have all the equipment to make them (see

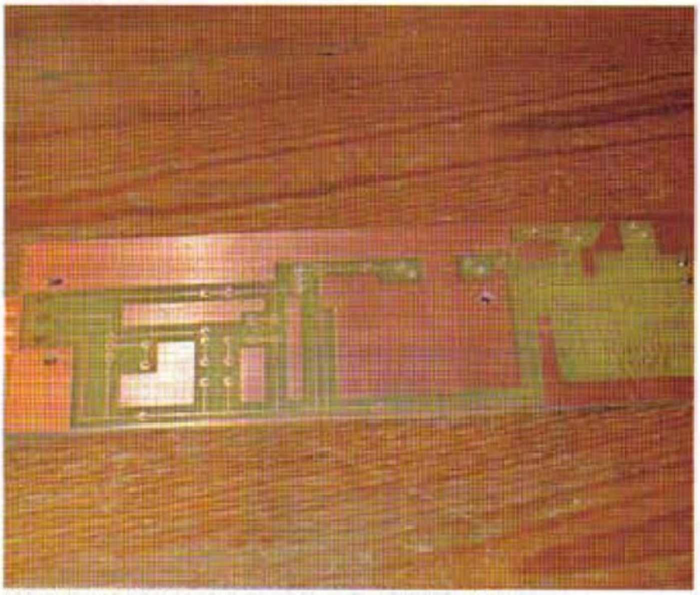
20. The track side of the Combined PCB showing that the tracks which are at mains potential have been protected with insulating tape



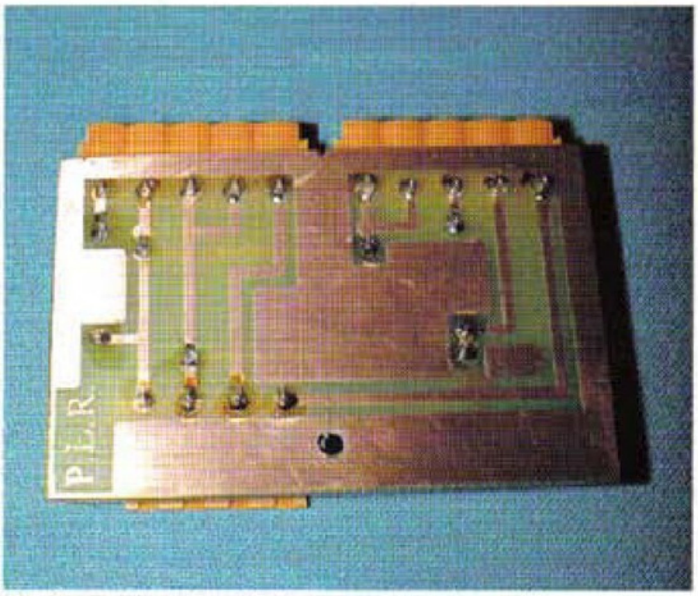
21. The digital display mounted on its small PCB. It is positioned so that the reset switch is to the left



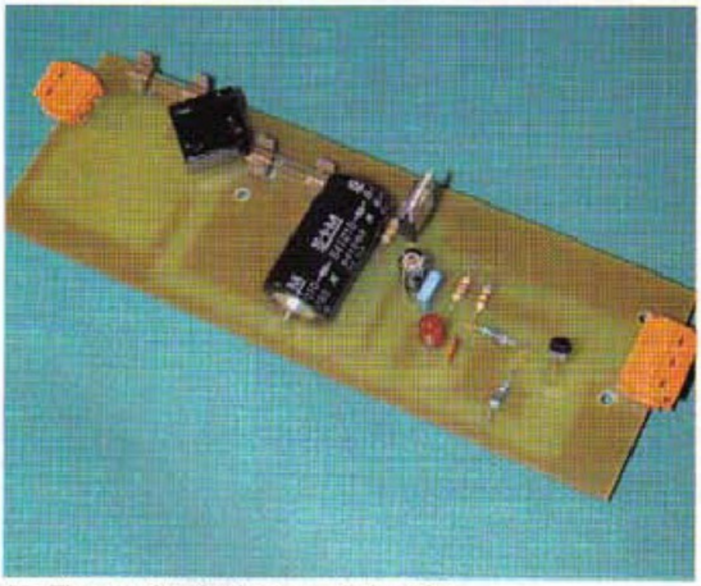
22. The dedicated Direction and Count PCB shown with the components fitted



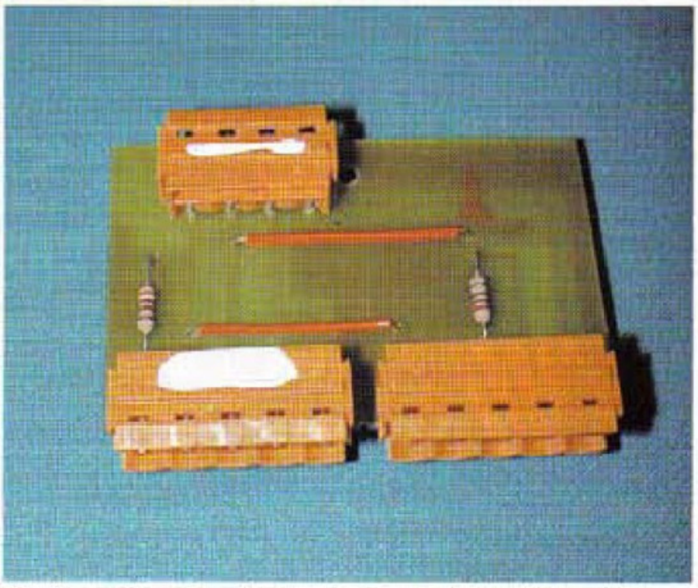
23. The track side of the voltage regulation PCB



24. Connections from the two sensors are brought to a common PCB which is seen here from the track side

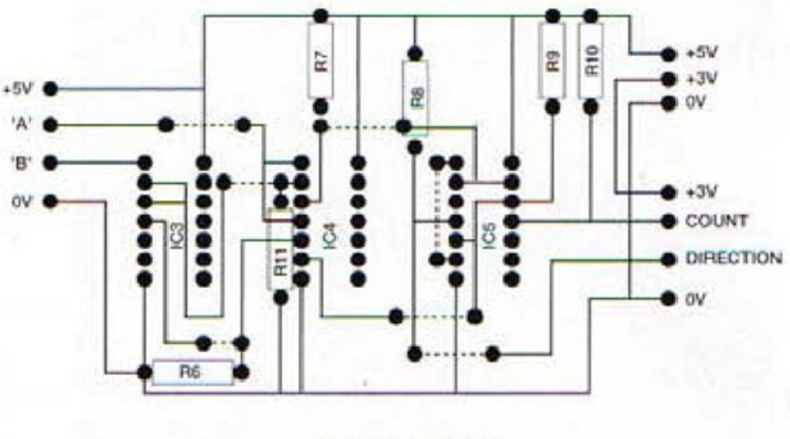


25. The completed voltage regulation PCB



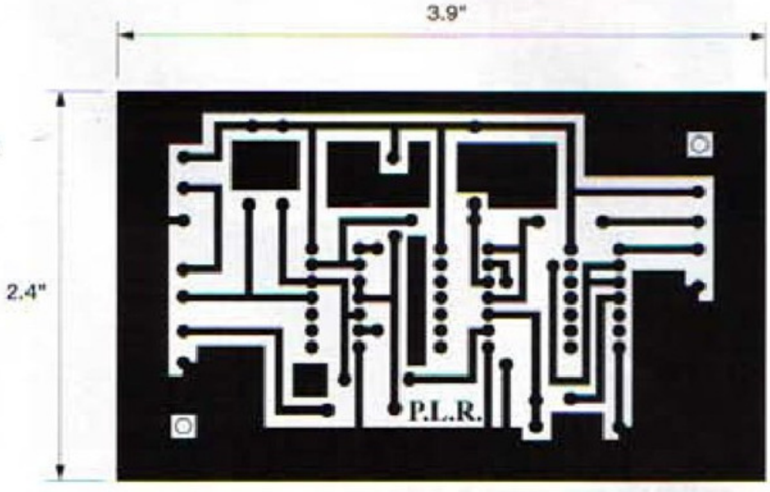
26. Connections from the two sensors are led to the terminal blocks on the nearer side of the board while the one on the far side carries the connections on to the Direction and Count circuits

FIG. 5A DIRECTION AND COUNT BOARD - COMPONENT LAYOUT



········· INDICATES JUMPERS

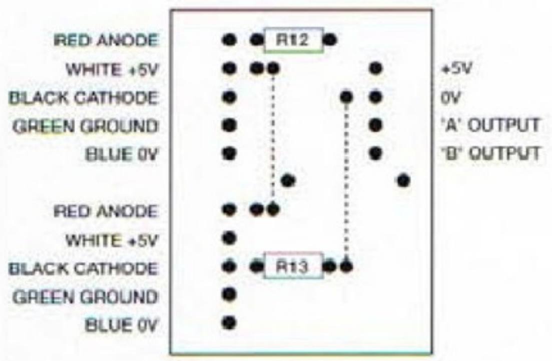
FIG. 5B DIRECTION AND COUNT BOARD - TRACK LAYOUT



2 OFF MOUNTING HOLES 3mm DIA.

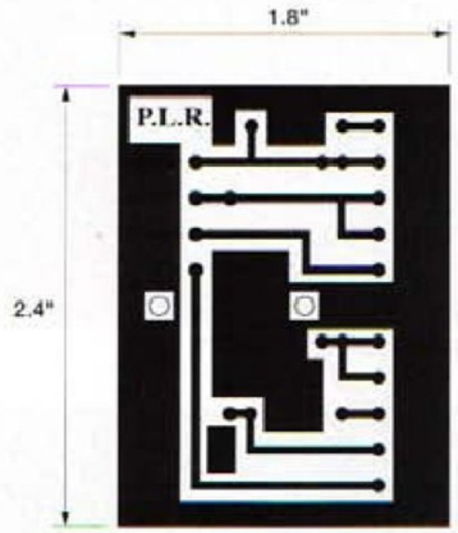
MAKE FROM SINGLE SIDED COPPER CLAD BOARD LEGEND TO BE READABLE FOR CORRECT ORIENTATION

FIG. 6A SENSOR CONNECTION BOARD - COMPONENT LAYOUT



······ INDICATES JUMPERS

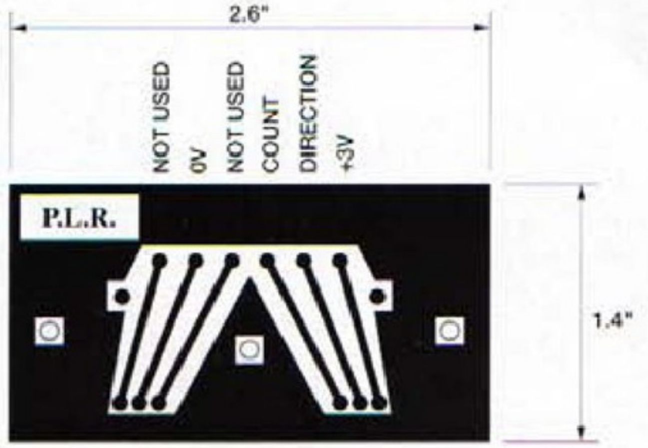
FIG. 6B SENSOR CONNECTION BOARD - TRACK LAYOUT



2 OFF MOUNTING HOLES 3mm DIA.

MAKE FROM SINGLE SIDED COPPER CLAD BOARD

FIG. 7 DIGITAL DISPLAY BOARD - TRACK LAYOUT



2 OFF MOUNTING HOLES 2.2mm DIA.
3 OFF MOUNTING HOLES 3mm DIA.

MAKE FROM SINGLE SIDED COPPER CLAD BOARD

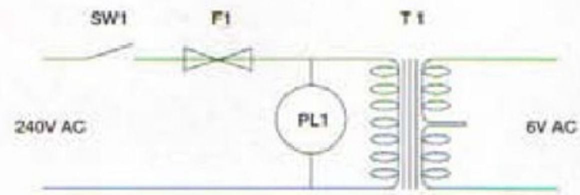


FIG. 8 6V AC SUPPLY MODULE CIRCUIT

the articles on the Spark Eroder). On this second occasion I had little problem either with drawing or making the boards.

To draw the PCB outlines, I use a professional version of a CAD package called TurboCad 5 which has an added advantage of being able to have custom designed block drawings stored in a Symbol library at the side of the 'Drawing Paper'. These symbols can be simply dragged and dropped, as required, into the correct place on a grid set (in this case at 0.1in. centres) on the drawing. It is possible to create a template specifically for the design of PCBs, with much saving of time. Of course, other CAD packages contain similar features and purpose-designed software systems are even better, but would probably mean using more than one software package, with additional costs.

This time I decided to try out a transparency made by photocopying in place of the direct print from my inkjet printer. The only reason for doing so was that the printer ink takes days to dry on a transparency film, so this drawback is avoided by printing on to good quality paper and then photocopying. However, this also has its problems due to a resulting lower density of the black areas. When exposing the board in the light box, it was found that the 12 minute exposure I had used before was way over the top and was causing the areas under the ink to be pitted where the light had penetrated. To solve this, I reduced the exposure period to eight minutes and I now feel that this could be reduced even further to say six minutes, as some pitting is still visible.

The 'wafter' shown in the spark eroder article was used to agitate the etching fluid and is well worth building as it can be created out of spare bits and pieces. I didn't find it necessary to use this device with the developer as a little agitation with a soft artist type paint brush was all that was required. Further development work on the manufacture of PCBs has been going on, however, and I have now made an air agitated vertical tank which speeds etching to such an extent that this part of the process can be carried out in about one tenth of the time. It is planned to describe this unit in a future article.

Photos. 23 and 24 show the track sides of the voltage regulation and sensor connection PCBs after etching but before the components had been fitted (i.e. before they had been "populated"). After all the boards had been etched, populating them took only a couple of hours work, and if all the components had been sorted previously, it would have been considerably quicker! **Photos. 25** and **26** show the two boards mentioned above with the components fitted.

After populating the boards, each one should be thoroughly checked to make sure that none of the tracks has been bridged during the soldering process. If any have been, then the connection should be broken by carefully scraping away the bridge.

FIG. 9A COMBINED BOARD - COMPONENT LAYOUT

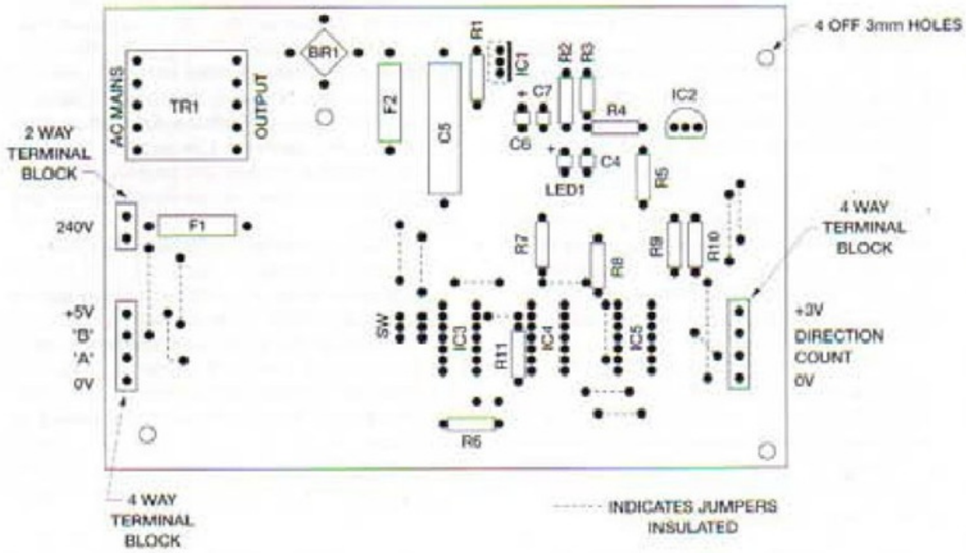
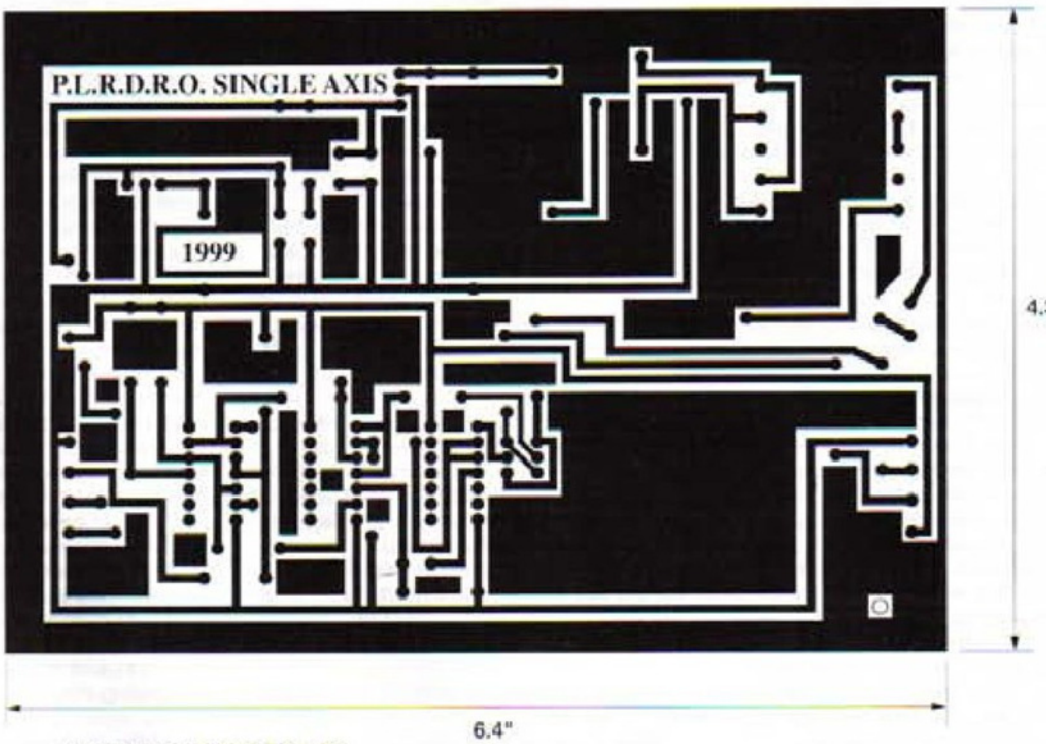


FIG. 9B COMBINED BOARD TRACK LAYOUT



MAKE FROM SINGLE SIDED COPPER CLAD BOARD

Testing

With the boards complete, testing can be started, so it is appropriate at this point to consider safety.

Safety

Before testing any element of the system, the first action is to carry out a thorough re-check that that all wiring is correct and that all connections are secure and protected. Always ensure that the power is turned off between every test and always at the mains, not at some low voltage point. I always feel that a double pole switch should be used, in case the Live and Neutral have been reversed at some point. I understand that there are moves afoot to strap the Neutral and Earth together, but I believe this is only being carried out in very new properties and that the practice is not yet widely spread. If your property is wired in this way then there will, I understand be a warning on or near the electricity supply company's meter.

The first unit to check is the 6 volt AC supply. Before plugging in, make sure the fuse is OK and, with a multi meter, that there is no path to earth. Once again, of course, recheck the wiring, plug to switch, to fuse, to transformer and to output.

Next, plug in and turn on. Remember that the majority of the circuit is at mains potential and could be lethal. Check the input at the various junctions with the multi-meter set at 250 volts or above (assuming that your supply mains potential is 230 volts). Finally check the output voltage, which should be in the order of 6.3 volts. This may vary a little, depending on the size of transformer, and will, of course, be above the nominal value as no load is being applied at the time. Check again when all is working, when a lower measurement will be obtained, this depending on the load being drawn and the size of the transformer.

Next attach the voltage regulation board to the 6V AC supply and again turn on. If all is well the LED should be lit and a check can then be made on the DC voltage readings, these being obtained at the output socket, of course. These should be 0 - 5V and 0 - 3V and if these values are not present then start at the input plug (6V AC) moving on to the rectifier AC then to the output of the rectifier (not forgetting the fuses). These DC voltages can vary, say 4.5 to 5.1 volts and 2.9 to 3.2 volts.

The path is straightforward and can be quickly and simply checked with the multi-meter. It may be found that the LED is unlit, but the voltages are correct. If so, it is odds on that the LED has been fitted the wrong way round. Just turn everything off, remove it and replace it the other way round. The correct way is to have the 'flat' on the LED to the negative or common/earth side of the board.

I would suggest that the next thing to do is to ensure that your Sensor/Transducer is working. As I believe I mentioned in the first part of this article, I had the advantage of having a tried and tested fully working unit to begin with. If you are also going to use a complete commercial unit, then ignore the next piece of the text, but if you are going to build the type of unit described by Harold Hall or use the 'ex-Inkjet printer' or 'stretched wire' systems described in Issue 62, then the next section is definitely for you.

First plug in the 'Pulse and Direction' PCB to the voltage regulation board, but do not fit the I.Cs. Check that the common and 5 volt lines are connected through to the output sockets and, at the same time, check the 3 volt line. If all is well then the digital display can be plugged in and turned on. The screen should light with a 'Zero' in the right hand side (viewed with the 'Reset' button to the left). If all is well, turn off and remove the display panel.

Using the Logic Probe

We now need to use a Logic Probe (**Photo. 27** and I think that I should again give a short explanation of its application. I first described the use of this device in the articles on the Spark Eroder, but for the benefit of new readers, I will run through it again.

The Logic Probe is a 'self-powered low voltage optical voltage meter' set to show specific ranges of voltage. It is sensitive enough to pick up very short pulses and, having a very high input impedance, will not interfere with the correct working of the circuit under test.

As can be seen from the photo, the probe consists of a hand held device which draws its power from the circuit being tested, being equipped with Positive and Negative leads which are attached at convenient positions on the board (the correct way round of course!).

The probe is fitted with three Light Emitting Diodes:-

Red = Hi - Logic High Voltage

Green = Lo - Logic Low Voltage

Yellow = Pulse

It is also fitted with two switches:-

TTL or CMOS	This switch is set to the type of ICs being used
MEM or Pulse	'Pulse' shows the continuous line of pulses being detected, while 'MEM' can be selected if the pulses are too short to see (in other words it 'locks on' if a pulse is detected).

On initial connection the unit's Yellow LED will pulse once. However, if this continues, a ripple in the power supply may be indicated and the circuit should be checked. It could be due to a problem with a capacitor or a faulty rectifier.

Considering the circuits described here we are dealing with pulses which involve the switching of 0 to 5 volts, the indications being as follows:-

Green (Logic Lo) = $<0.8V\pm0.2V$

Red (Logic Hi) = $>2.3V\pm0.2V$

No indication = 0.8V - 2.3V

If you are using the 'Harold Hall' design of sensor, then the next task is to check its operation. This can be done by fixing the two elements to a flat surface with a small gap between them. Provision should be made for a small amount of adjustment so that they may be moved either towards or away from one other. I found that an aluminium hair comb with fine teeth was an ideal 'trigger' for the sensor as it could be located in the gap and slid backwards and forwards in order to generate a signal.

The test routine is to plug in a single sensor (the 'A' pulse circuit) then to connect the leads of the Logic Probe to the printed circuit board in order to energise it. With the probe switched on, the tip is placed on the 'A' input terminal and with the comb in the gap in the sensor, it is slowly pulled through. As long as all the circuitry is correct, the pulse light should flash on and off every time a tooth activates the sensor. If this is not the case, check the wiring especially that the sensor has been wired correctly.

Repeat the operation for the 'B' pulse circuit, and finally with both.

Builders using other types of sensor should have little difficulty in manipulating them in such a way as to produce the equivalent signal to that created by moving the comb as described above, so the test procedure is identical.

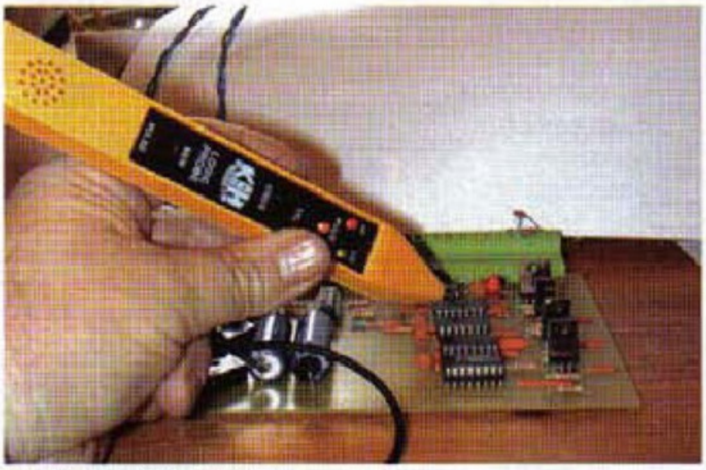
Fitting the ICs

The next task is to fit the ICs. I am given to understand that these components are very susceptible to damage by high voltage 'spikes' of static electricity. Nothing physical will be seen, but they can get hot. To obviate this, it is necessary to make sure that, before handling the PCBs and ICs, any static charge in the body of the handler is dissipated. My previous suggestion of using a simple wrist strap connected to Earth generated much correspondence, with the dangers of accidental contact with a high voltage source (perhaps from a faulty soldering iron) being highlighted. Proprietary earthing straps are available, incorporating a resistor of such a value that the possibility of electrocution is eliminated. Another writer who has had much experience of such matters is confident that, for the majority of types of IC we are likely to use, periodically touching the workbench will dissipate any static charge sufficiently.

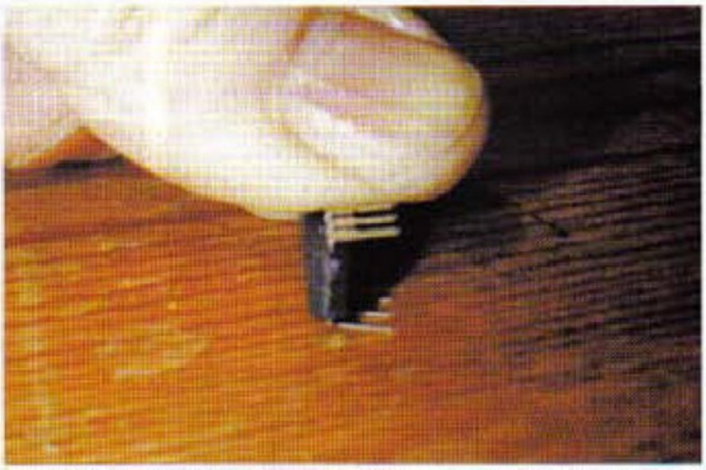
ICs often come with their pins spread too wide apart, so it will become necessary to adjust them by gently bending them to the correct position. This is accomplished by placing one set of pins against a flat surface and bending them gently, repeating on the other side (Photo. 28).

From this point on, in order to save a lot of typing, I shall refer to the IC number and the pin number in the following way:-

IC No. 3, Pin No. 1	(3,1)
IC No. 5 Pin No. 3	(5,3)



27. The Logic Probe in use



28. Straightening the pins on an IC to ensure that they will enter the socket cleanly

Make sure that the correct IC is selected (SN74LSI4N) for IC No. 3, as the pulse board uses three different ones. After correcting the pins, plug the IC into position, making sure that the pins do not catch and bend up, as proper contact is essential.

Fully plug up and switch on. Set the Probe to 'TTL' and 'Pulse' and place the probe tip on to {3,1}. By moving the comb, the 'Red' and 'Green' LEDs should pulse alternately, with the 'Yellow' pulsing with both. Now check pins {3,2}, {3,3} and {3,4}. All should be pulsing in the same way. Now put the probe on {3,1} and adjust the position of the comb until a 'Green' indication is obtained.

Now check:-

{3,2} should be 'Red'

{3,3} should be 'Red'

{3,4} should be 'Green'

Now to check pulse circuit 'B'

Switch off, then leaving IC No. 3 in place, plug in IC No. 4 (DM74ALS03N), following exactly the same routine in respect of straightening the pins if necessary.

Repeat the test procedure detailed above, but this time, of course, referring to IC4 (Pins {4,1} etc.). The same indications should be observed as the comb is moved through the sensor, in exactly the same way.

The next check is that the indication obtained from {4,2} is the same as that from {3,2} and that from {3,4} is the same as that from {4,5}.

Now, if {4,1} and {4,2} are 'Red', then {4,3}, {5,2} and {5,13} should also be 'Red'.

If {4,4} and {4,5} are 'Green', then {4,6}, {5,5} and {5,12} should be 'Red'

If we now check the 'count' by putting the probe on to the count output connection of the Direction and Count PCB it should be found that the pulse is equal between Hi and Lo. By moving the comb carefully through the sensor, the indication can be stopped on either Hi or Lo.

With regard to the 'Direction', it would seem that 'Green' is on predominately for 'SUBTRACT' and 'Red' predominately for 'ADD'. This can now be checked against the digital display, which should be working.

Conclusion

This has been an interesting project and I hope it will give food for thought as I understand that a number of readers have asked the Editor for information on these devices.

I would be interested to hear from anybody who has specialist knowledge on this subject as perhaps a co-operation could be established in order to publish further articles on alternative and improved designs.

As always, I am willing to answer queries, but by telephone only, please, on 01233 712158 (Kent)

Component Suppliers

Farnell	0113 263 6311
Electromail	01536 204555
Maplin	01702 554000
Wren Engineering	0181 462 0586

Component List

1. Voltage Regulation Board (Fig. 4A)

Fuses
F1, F2 — 500mA with PCB mounting holders to suit

Bridge Rectifier
BR1 — SB340

Capacitors

C1	1000µF 35V
C2	20µF 35V
C3	0.1µF
C4	100nF

Resistors

R1	100kΩ
R2	470kΩ
R3	680kΩ
R4	2kΩ
R5	10kΩ

ICs

IC1	7805CT
IC2	TL431CLP

Header sockets and terminal plugs
2 way — 1 off
3 way — 1 off

2. Direction and Count Board (Fig. 5A)

Resistors

R6 to R10	1kΩ
R11	4.7kΩ

ICs

IC3	SN74LS14N
IC4	DM74ALS03AN
IC5	DM74LS132N

DIL Sockets
14 pin 3 off

Header sockets and terminal plugs
4 way 2 off
3 way 1 off

3. Sensor Connection Board (Fig. 6A)

Resistors
R12, R13 — 270Ω

Header sockets and terminal plugs
5 way 2 off
4 way 1 off

4. Digital Display Connection Board (Fig. 7)

Digital display
Farnell No. 254-769

Header socket and terminal plug
6 way 1 off

5. 6V AC Supply (Fig. 8)

Mains transformer
T1 — Primary to suit (240V or 110V)
Secondary 6V
Rating 6VA

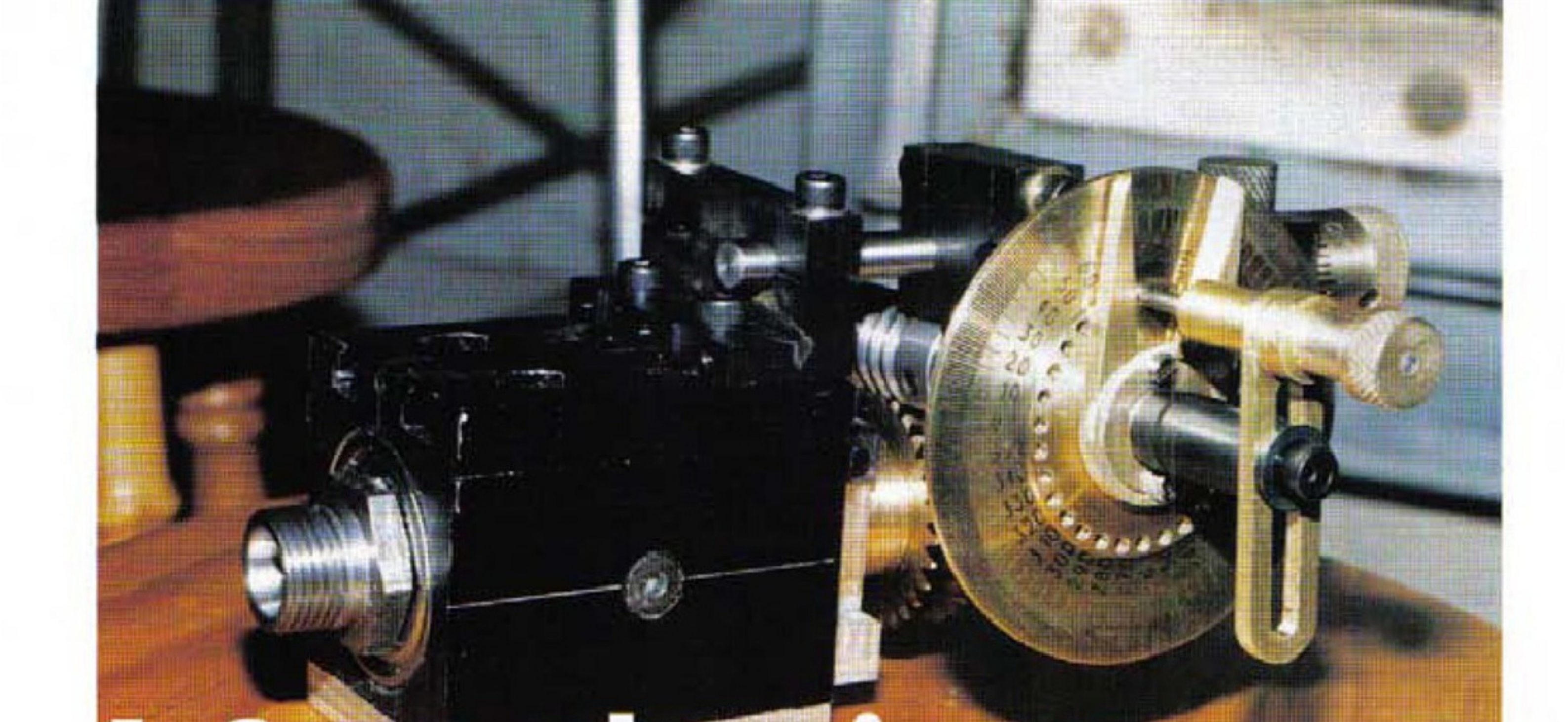
Switch
SW1 — Single pole

Fuse
F1 — 1 amp with suitable holder

Pilot Lamp
PL1 — Neon Indicator to suit

6. Combined Board (Fig. 9A)

Components identical to those used on individual boards, power supply components being suitable for use on a PCB (i.e. Transformer, switch, fuse holder)



A Comprehensive Dividing Capability for the Peatol Lathe and Mill

In the concluding part of the description of this substantial project, Tony Jeffree describes the remaining components of the headstock and tailstock. He has, however, decided that a small modification is needed to some of the items described in Part 1.

Controlling Stepper Motor End Float

Since the first part of this article went to press, I have found the need to modify the stepper motor mounting arrangement slightly, in order to control end float in the stepper motor shaft. The NEMA 23 stepper motor I used in my prototype of the CNC version of the dividing head incorporates a spring to pre-load the motor shaft to the 'fully extended' position. Sufficient axial force on the shaft can cause the spring to deflect, allowing a couple of millimetres of shaft end float. This is not a problem when the rotational force on the output shaft of the dividing head is low, but it is possible for a high rotational force to cause this spring to deflect, resulting in unwanted rotation of the workpiece. Whether this will cause a problem will depend greatly upon the construction of the chosen stepper motor, the strength of any pre-load spring that it contains, and the rotational loads placed on the dividing head by the applications in which it is used.

In any event, the solution is fortunately straightforward. The $^{1}/_{4}$in. diameter motor shaft extension should be cut over-length, allowing it to protrude about $^{3}/_{8}$in. beyond the outer face of the bearing support (**Figure 10**) (**See Part I**). A $^{1}/_{4}$in. ID set screw collar is fitted to the protruding end of the shaft extension, and adjusted to reduce the motor's end float to zero. A flat should be ground or filed on the shaft extension to facilitate later disassembly. If considered desirable, a second set screw collar can be fitted on the inboard side of the bearing support to further reduce the transmission of cutting forces to the motor. Suitable set screw collars can be made by facing a piece of $^{1}/_{2}$in. diameter stock to $^{3}/_{8}$in. in length, boring it axially $^{1}/_{4}$in. diameter, then drilling and tapping a radial hole for a UNF 8-32 (or similar) set screw.

If you have already cut and Loctited the shaft extension into the worm and there is insufficient overhang to take a set screw collar, my apologies! However, the parts can easily be disassembled by carefully warming the joint with a blowtorch until the Loctite bond softens sufficiently to remove the shaft extension. Once cooled, the bore of the worm should be cleaned out to remove traces of the Loctite before fitting the longer shaft extension and Loctiting it in position.

The Simple and Compound Division Components

The construction of the various support components for the two worm drives will now be described, followed by the division plates, indexing arm and sector arms. For those that are only interested in building the simple indexing capability (one worm drive), the construction can be simplified and some components omitted: this will be detailed as the description progresses.

The Primary Worm Carrier

Figure 11 shows this component. The carrier has two split clamps that will take $^{5}/_{16}$in. diameter rods; the left-most of these allows the carrier to be mounted in position, using a $1^{3}/_{4}$in. long steel rod held in one of the corresponding clamps on the Dividing Assembly Mounting Plate (**Figure 6**). The right-most clamp in **Figure 11** can be omitted if only one worm drive will be used, as this is used to mount the secondary worm and its carrier.

The carrier is fitted with an Oilite bush that forms a bearing for the primary worm shaft. Above and below this bush are marked two $^{3}/_{32}$in. diameter holes. These carry a pair of locating pins for the Index Plate Boss (**Figure 17**) which are needed when performing simple indexing without the secondary worm drive fitted; these holes can be omitted in both components if it is intended to leave the secondary drive permanently installed. The $^{3}/_{8}$in. radius shown above the bush gives clearance for the worm and its set screw, and can be adjusted to suit. The hole for the worm shaft bearing is best drilled/bored in the 4-jaw chuck on the lathe to ensure that it is perpendicular to the face of the carrier; the $^{3}/_{8}$in. radius cut-out can be machined at the same setting. Construction of this component is otherwise straightforward.

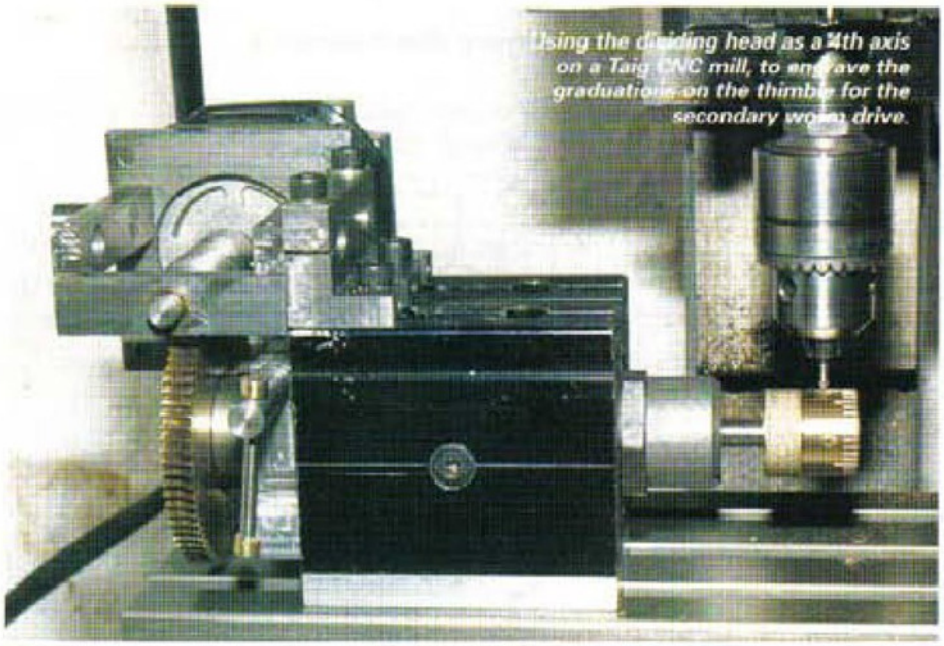
The Secondary Worm Assembly

The Secondary Worm Carrier and the Worm Lock (**Figures 12 and 13**) are machined in the following sequence.

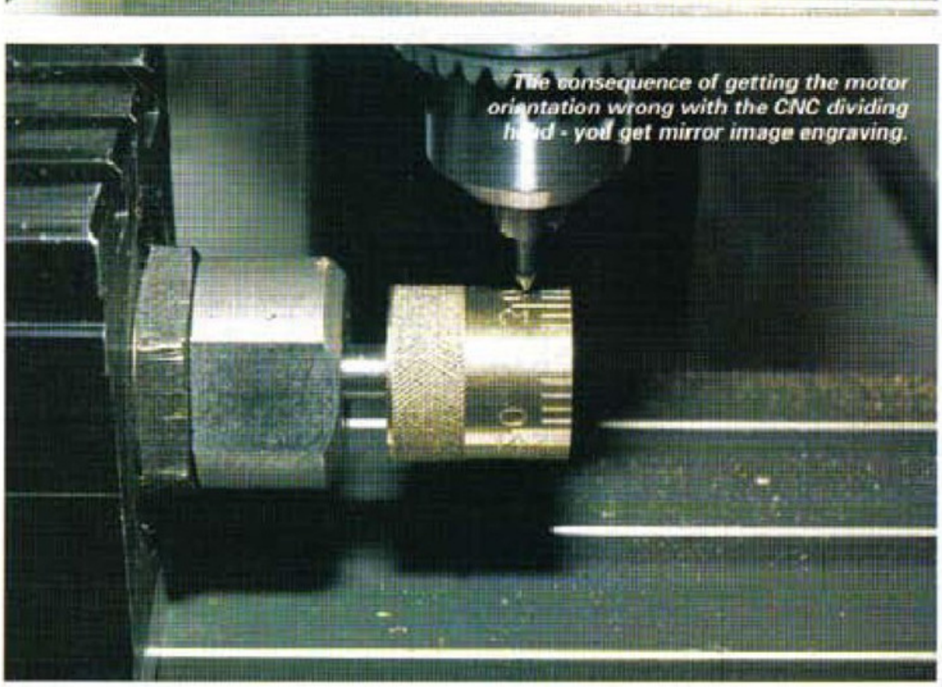
First, cut a length of 3/8in. diameter brass rod to 23/32in. long (1/32 less than 3/4), drill it axially and tap UNF 10-32 for its entire length. Next, cut a piece of 3/4in. square section steel bar to length (1 1/4in.) and carefully mark out the positions of the four holes. My favourite way of doing this is to use the CNC mill with a centre drill fitted as a means of positioning these holes accurately relative to a reference corner, but manual methods are fine too. The bar can now be mounted in the 4-jaw chuck, and accurately centred to bore the 3/8in. diameter hole for the worm lock. Remove the work from the chuck - loosen two of the four jaws to make the next re-positioning operation easier. Now temporarily fix the brass rod in the hole with Superglue, taking care to position it so that it is equi-distant from each face of the steel bar. If you avoid de-greasing these components too thoroughly before gluing, the Superglue will hold them together just fine for the next drilling operation, but will allow the worm lock to be driven out afterwards with a suitable drift. Re-mount the piece to drill the hole for the Oilite bush; again, carefully centre the hole position. The hole is first drilled 1/4in. in diameter; this ensures that the hole in the worm lock will be concentric with the secondary worm shaft, regardless of marking out or machining inaccuracies. Remove the piece from the chuck and use a drift to separate the worm lock from the carrier. Clean off any glue residue. The 1/4in. hole can now be bored out to 5/16in. to take an Oilite bush, and the 3/8in. hole cleaned out with a drill and reamer to remove the central portion of the bush.

The remaining 5/16in. hole and the UNC 8-32 hole for the set screw complete the secondary worm carrier. A 1 3/4in. length of 5/16in. steel rod is used to connect it to the primary worm carrier; file a flat for the set screw 3/8in. from one end. An alternative to the set screw is to fix the rod permanently using Loctite and a steel pin, as there should be no need to remove the rod once fitted.

The worm lock can be re-fitted to its hole in the carrier. If all is well, it should be possible to pass a length of 1/4in. diameter silver steel through the Oilite bush and the worm lock; this will form the shaft for the secondary worm. A 2 3/4in. length of silver steel rod is used for the secondary worm shaft; I chose to use Loctite in addition to a set screw to locate the worm on the shaft. The thumbscrew (**Figure 14**) provides the means of tightening the worm lock; this is straightforward to machine from 1/2in. diameter steel. The thread can be formed by reducing the diameter of the round stock; alternatively, cut a 5/16in. length of stock, axially drill/tap 10-32 UNF and Locktite a length of 10-32 studding in place, finishing the threaded portion to 5/32in.. The latter approach has the advantage that the threads run right up to the shoulder, which makes life simpler. The thumbscrew is finished with a light knurl. Having threaded holes at either end of the worm lock allows the secondary worm to be mounted with either 'handedness' on the primary worm carrier. The lock operates very effectively, requiring little finger pressure to lock and unlock the secondary worm. As there is little force on this worm drive in operation, all that is required is to prevent inadvertent re-positioning of the Worm Thimble.



Using the dividing head as a 4th axis on a Taig CNC mill, to engrave the graduations on the thimble for the secondary worm drive.



The consequence of getting the motor orientation wrong with the CNC dividing head - you get mirror image engraving.

The final operation to perform on the secondary worm carrier is to add witness marks to aid reading the position of the Worm Thimble. I chose to add these marks to the three possible faces; hence, the thimble position can be read from above the dividing head, or from the side, regardless of the handedness with which the components are assembled. I finished the steel components by using a chemical blackening kit; the black surface provides a useful contrast with the witness mark cut into the steel.

The Worm Thimble (**Figure 15**) is machined from a piece of brass round stock, bored 1/4in. diameter and cross-drilled for a UNC 8-32 set screw. The surface of the thimble should be knurled at one end and marked with 40 graduations at the other end.

If you have a CNC mill and have made the CNC drive attachment to use with this dividing head, graduating the thimble is a simple job, as seen in **Photo. 7**. After turning the cylinder to dimensions, the thimble was mounted on a stub of 1/4in. silver steel rod and held in the dividing head with a 1/4in. collet. The head was fixed to the milling table, positioned with its axis running in the X direction, and with the spindle directly above, carrying a small engraving cutter. The dividing head's stepper motor was substituted for the Y-axis motor. I had drawn out the graduations and lettering using my PC drawing package as if the graduations were to be cut into a plane surface. Making the Y dimension exactly 3.6in. long corresponds to a full 360 degree rotation of the thimble (80 steps per degree is 28800 steps per 360 degrees. The mill software thinks it is driving a linear leadscrew at 400 steps per rev and with a 20 TPI thread. So 28800 steps are equivalent to 72 revs of the 'leadscrew' or

©

Figure 11. Primary Worm Carrier
Material: Steel

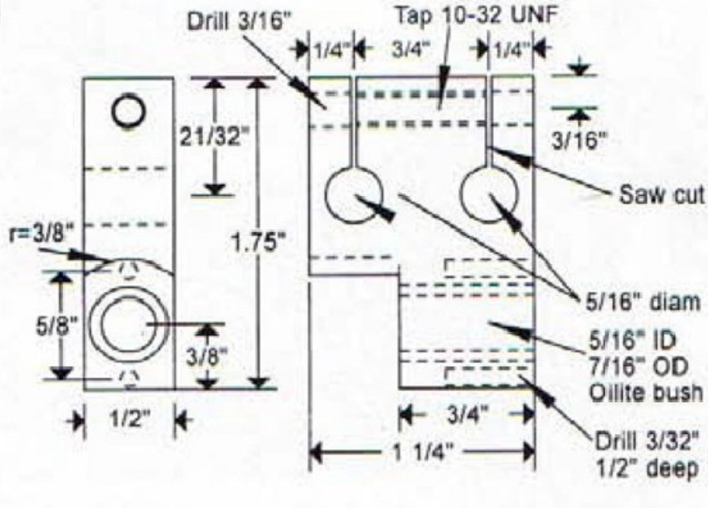


Figure 12. Secondary Worm Carrier
Material: Steel

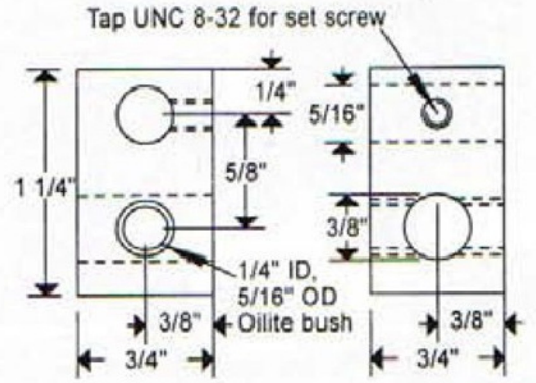


Figure 13. Worm Lock
Material: Brass

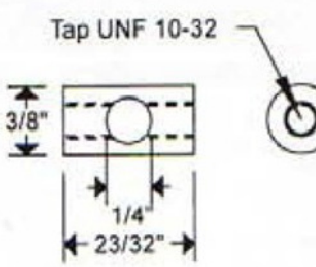


Figure 14. Thumbscrew
Material: Steel

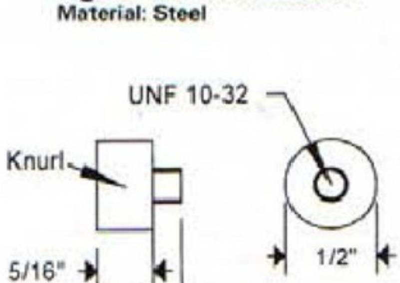
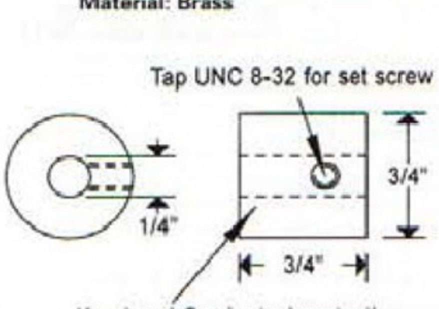


Figure 15. Worm Thimble
Material: Brass



3.6in. of linear travel). Plugging this drawing into the mill software and setting it going produced a perfectly graduated thimble - major marks every ten graduations, slightly shorter ones every five graduations, and perfect numbering of the tens. At least, it worked perfectly the second time; for the first attempt I had fitted the stepper motor the wrong way round and produced perfect mirror-image numbering, as seen in **Photo. 8**.

The thimble can also be graduated using more conventional manual techniques, pressing the partially completed dividing head into service, once a division plate with a circle of holes that is a multiple of four has been made (as described below).

Having engraved the thimble with its graduations and numbers, it is worth making these marks stand out clearly against the metal background. A simple way of achieving this is to fill in the marks with indelible black felt-tip marker ink, allow it to dry, and then carefully remove the excess ink from the high points with very fine emery paper while the thimble is rotated in the lathe. The finished thimble, with the numbering readable without a mirror this time, can be seen in **Photo. 9**.

The Index Plate Boss and Primary Worm Shaft

The Primary Worm Shaft is shown in **Figure 16**. This was cut from silver steel rod; the brass bush shown is Loctited in position. The end with the 2BA-threaded hole is passed through the Oilite bush in the primary worm carrier, from the right hand side as shown in **Figure 11**, and the worm is fitted in position. The 2BA hole allows a screw and washer to be inserted in the end of the shaft as an aid to adjusting end-float in the shaft. Once adjusted, the worm's set screw can be tightened firmly - preferably against a suitable flat filed on the shaft to ease subsequent disassembly if need be. With the primary worm in position on its carrier, the dividing head can be partially assembled and can now be used to perform some of the later operations. However, the primary worm shaft should be left over-length at this point; its final length will be determined once the remaining indexing components are complete.

The Index Plate Boss (which also carries the Secondary Wormwheel) is shown in **Figure 17**. This is machined from 1in. diameter round stock; a suitable sequence is as follows. Cut and face a length of 1in. diameter stock, sufficient to hold in the 3-jaw chuck with about 1¼in. of stock overhanging. Reduce the diameter to ¾in. over the last ¾in. of its length. Bore the axial 5/32in. hole, ensuring that the hole is a little over 1in. in depth. Counterbore 7/16in. diameter to a depth of just over ¼in.; this should be a running fit with the bush on the primary worm shaft.

If you are implementing the secondary worm drive, further reduce the diameter to ½in. over the last ½in. of its length. This forms the shoulder that the secondary worm locates against. Part off to exactly

1in. long. Bore out the axial hole of the 32DP, 30T worm wheel to 1/2in. diameter, so that it is a push fit on to the boss. This operation is tricky - the specified worm wheel is made from Delrin, but with careful packing and centring in the 4-jaw, the wheel can be modified without damage to the teeth. Machine a 3/4in. OD, 1/2in. ID bush 1/4in. long; I used brass for this, but the material used here is not critical. Assemble the modified worm wheel and then the bush onto the boss with Loctite, clamping them in position to make sure all is square while the Loctite sets.

If the secondary worm drive is not being used, or if it is anticipated that the head will sometimes be used without the secondary worm fitted, the two 3/32in. holes can be drilled in the other end of the boss. This can be done using the technique described below for drilling the three holes in the division plate flange, before parting off. A couple of 3/4in. long 3/32in. diameter dowels can then be used to locate the boss in the corresponding holes in the primary worm carrier, preventing the boss from rotating. Of course, you have to remember to remove these dowels before using the secondary worm.

The division plate flange is machined next. This can be achieved by using a short length of 5/32in. diameter bar as a stub arbor, Superglued temporarily in place, allowing the boss to be centred in the 4-jaw (or in the 3-jaw if you have an accurate one). Having cut the flange, you can now demonstrate the usefulness of having a dividing head that can use the same accessories as the Peatol lathe. Unscrew the chuck, still with the boss in position, and mount it on the nose of the embryonic dividing head. Mount the dividing head on the cross-slide, and position it to drill the three 6BA screw holes, using the Jacobs chuck mounted in the lathe headstock. The worm drive can be operated either with a temporary handle clamped onto the worm shaft, or by means of a screwdriver in the slot of the 2BA screw used for adjusting the end float. **Photo. 10** shows a prototype boss being drilled using this set-up, although a different (and less successful, it has to be said!) machining sequence was used for the part shown. Accuracy in positioning these holes is important, as it is necessary for the division plates to be concentric with the boss when they are fitted in position.

The Sector Arms

Figure 18 shows these components, which can either be machined from 1/8in. thick brass plate or from 1/16in. plate components soft soldered together. The construction should be obvious from the drawings; the 1in. OD, 0.8in. ID portion of the right-hand arm is thinned to 1/16in. and fits into the corresponding groove in the left-hand arm. The two 8BA holes are tapped through the thickness of the left-hand arm, and are placed as close as possible to the 0.8in. diameter. Two cheese-headed 8BA screws and washers clamp the two components relative to each other, allowing a chosen number of holes in a division plate to be exposed. It may be necessary to thin the left-hand arm underneath these two screw

©

Figure 16. Primary Worm Shaft
Material: Silver Steel and Brass

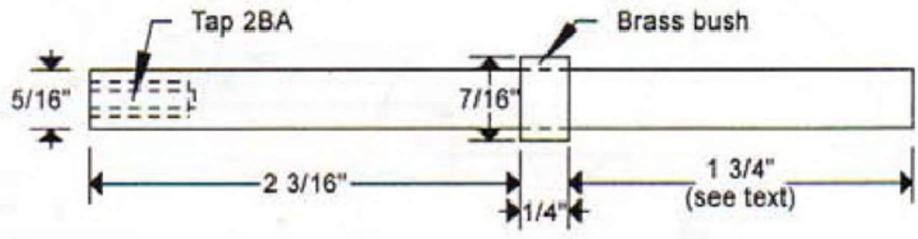


Figure 17. Index Plate Boss and Secondary Wormwheel
Material and construction: See Text

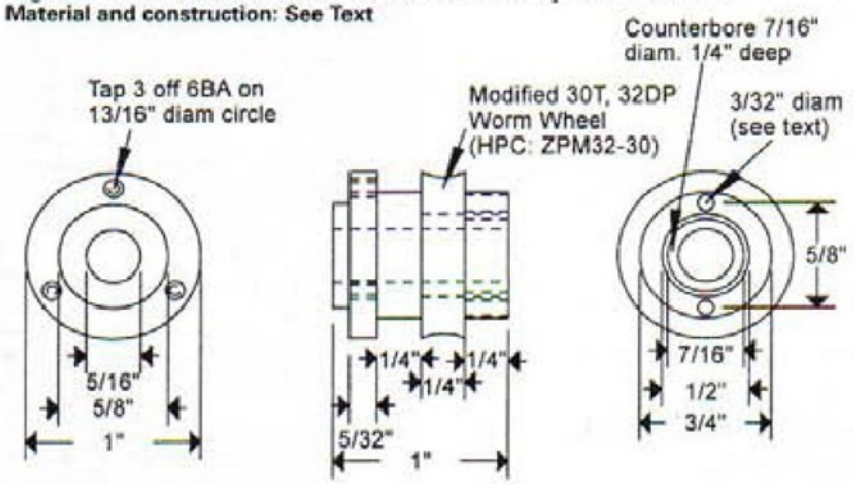


Figure 18. Sector Arms
Material: Brass

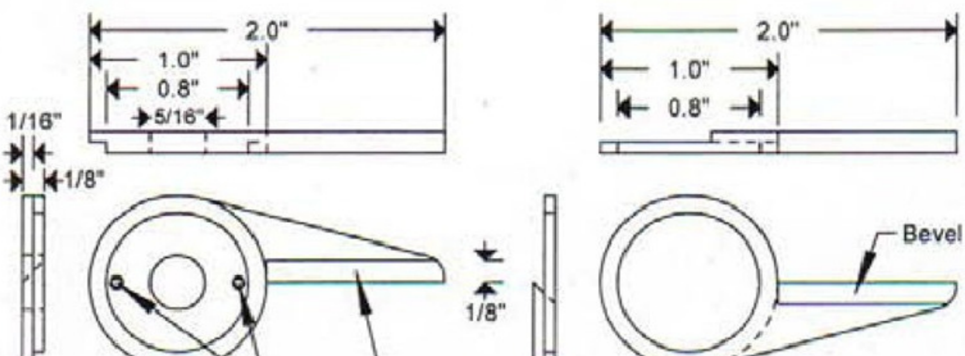


Figure 19. Set Screw Collar
Material: Steel

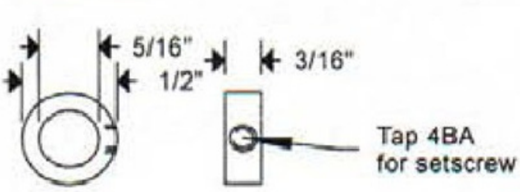


Figure 20. Division Plate Blank
Material: 1/16" Brass Sheet

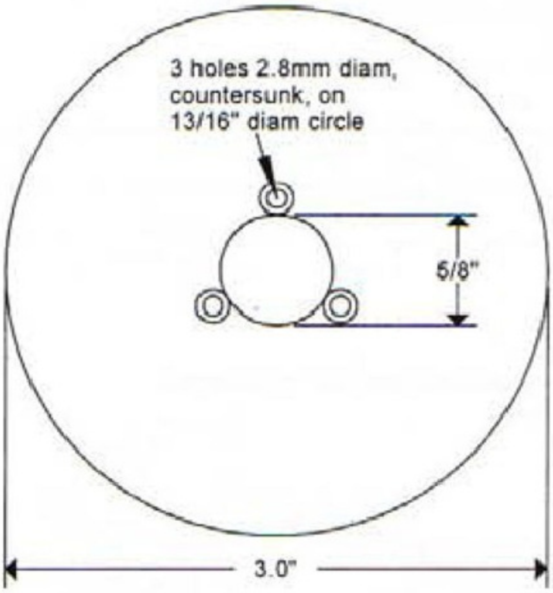


Figure 21. Indexing Arm Boss
Material: Steel

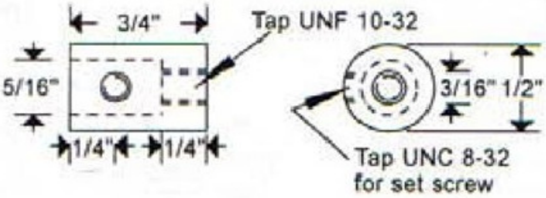


Figure 22. Clamp Washer
Material: Steel

Figure 23. Indexing Arm
Material: 1/8" Brass

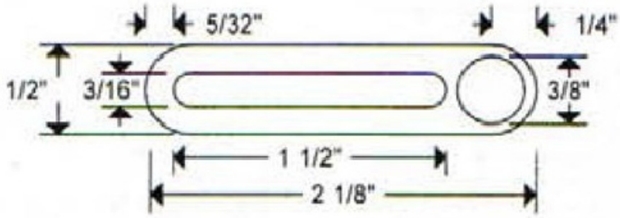


Figure 24. Detent Body
Material: Brass

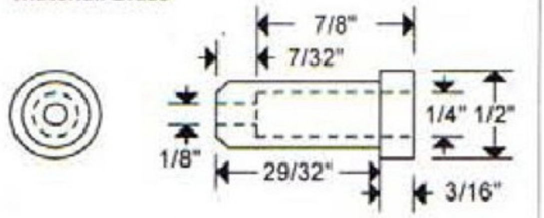


Figure 25. Detent Plug
Material: Brass

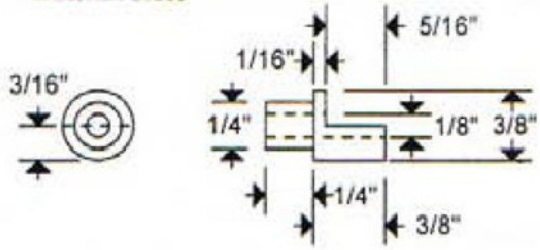


Figure 26. Detent Knob
Material: Brass

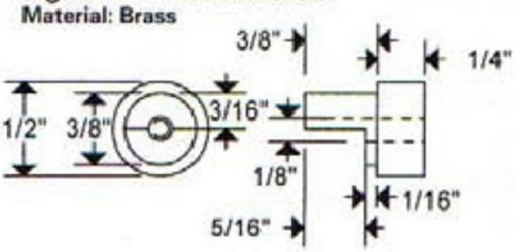


Figure 27. Detent Pin
Material: 1/8" diam Silver Steel & Brass

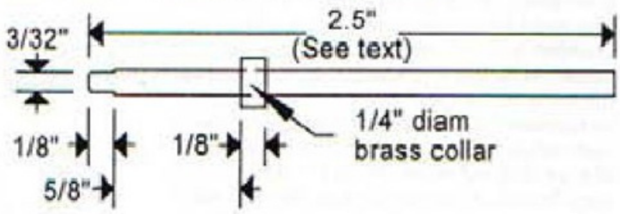


Figure 28. Tailstock Body
Material: Aluminium

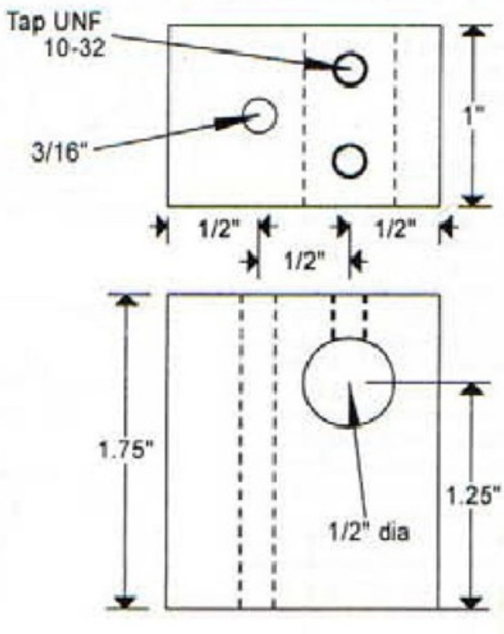


Figure 29. Tailstock Bush
Material: Brass

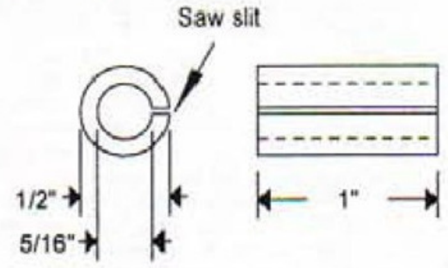
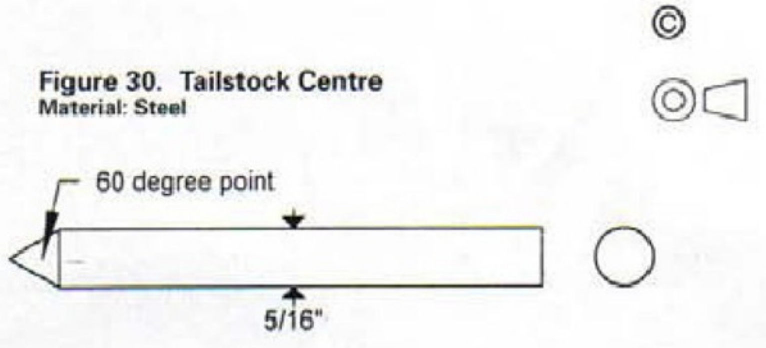
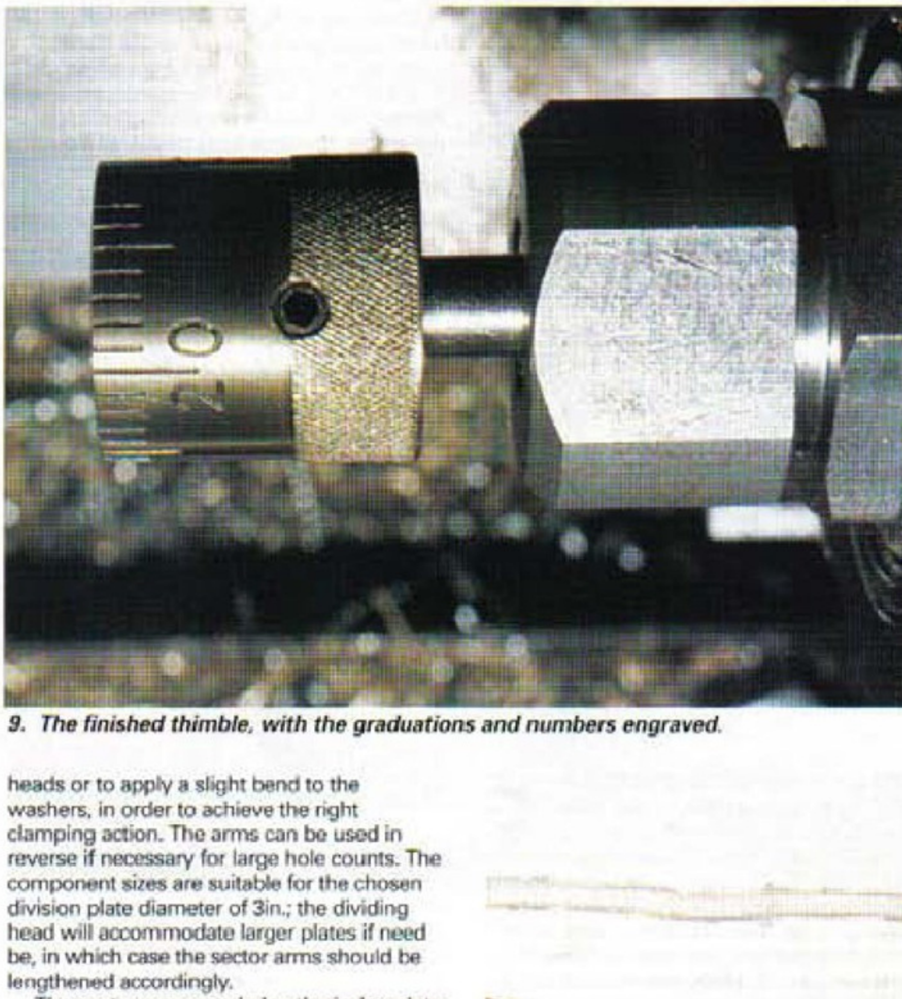


Figure 30. Tailstock Centre
Material: Steel





9. The finished thimble, with the graduations and numbers engraved.

heads or to apply a slight bend to the washers, in order to achieve the right clamping action. The arms can be used in reverse if necessary for large hole counts. The component sizes are suitable for the chosen division plate diameter of 3in.; the dividing head will accommodate larger plates if need be, in which case the sector arms should be lengthened accordingly.

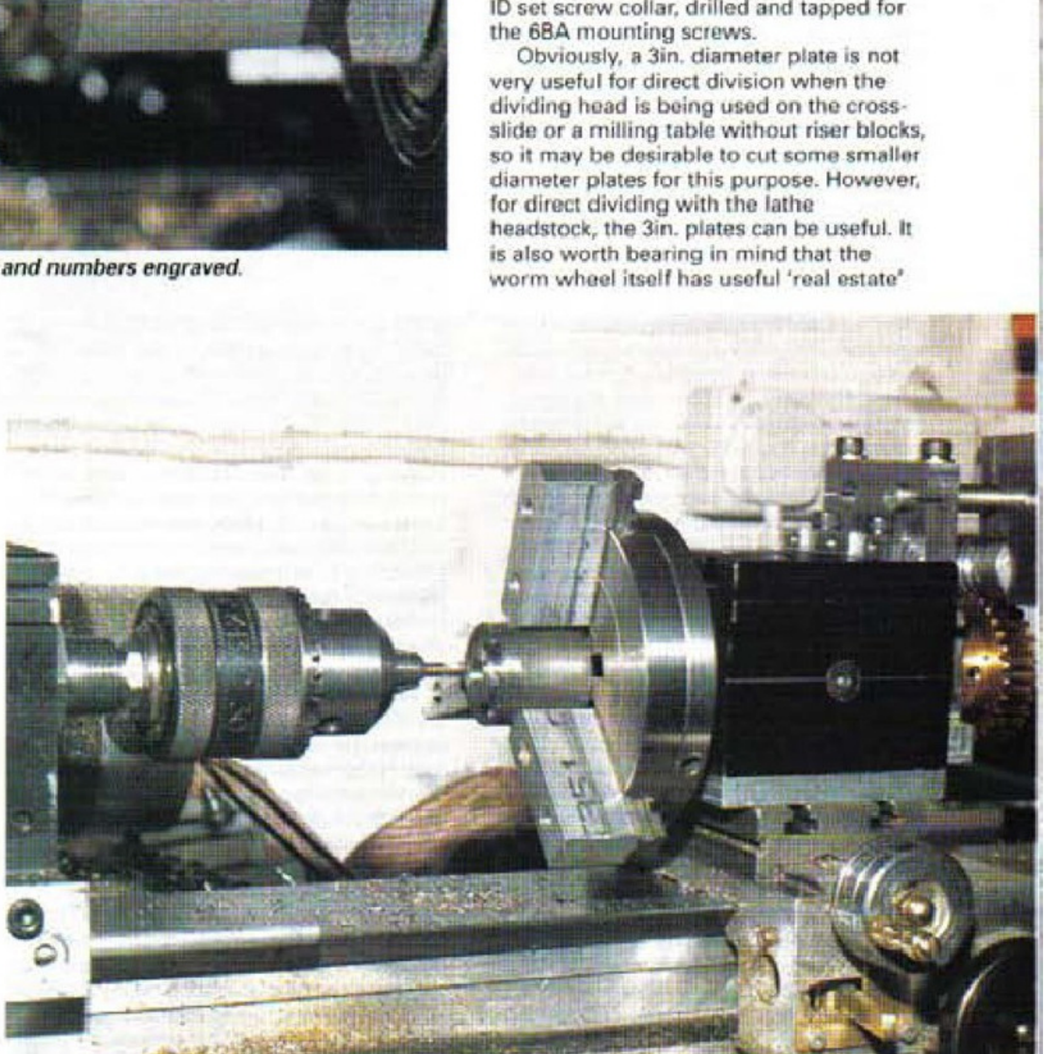
The sector arms, and also the index plate boss, are retained in position by means of a small set screw collar, shown in **Figure 19**. Making this is a simple turning/boring job; the set screw used is 4BA and 1/8in. long, seating in a flat filed in the primary worm shaft. This flat should be deep enough so that the set screw is flush with the surface of the collar when tightened in position. A split spring washer should be placed between the set screw collar and the sector arms and compressed before tightening the set screw; this will provide the necessary friction to ensure that the sector arms remain in the desired position while the indexing arm is rotated.

The construction could have been simplified by combining the set screw collar with the indexing arm clamp; however, the arrangement described allows the indexing arm to be removed and used for direct indexing operations without disturbing the rest of the dividing assembly.

Division Plates and Hole Circles

Figure 20 shows the design of the division plates. These are 3in. in diameter, as that was the size of a set of brass blanks I had to hand; the head will accommodate larger plates if desired. The central hole size of 5/8in. was chosen in order to allow the division plates to fit over the tail of the dividing head spindle to allow their use for direct division, given a suitable mounting arrangement. The options for this kind of use are either to drill and tap the worm wheel to allow it to be used as a division plate boss, or to make up a 1in. OD, 5/8in. ID set screw collar, drilled and tapped for the 6BA mounting screws.

Obviously, a 3in. diameter plate is not very useful for direct division when the dividing head is being used on the cross-slide or a milling table without riser blocks, so it may be desirable to cut some smaller diameter plates for this purpose. However, for direct dividing with the lathe headstock, the 3in. plates can be useful. It is also worth bearing in mind that the worm wheel itself has useful 'real estate'



10. Using the partially completed dividing head to drill and tap the holes on a prototype of the index plate boss.

11. Drilling hole circles on the lathe, using the dividing head to index the hole positions. There is room on the 30-tooth worm wheel for a couple of small-numbered circles.

available on it for a couple of low-numbered hole circles; I cut a 30-hole and a 24-hole circle in mine, as can be seen in progress in **Photo. 11**. A further option for direct dividing in the lathe is to permanently attach a division plate to the inboard face of the lathe's drive pulley.

The decision as to how many plates to cut and what numbers of holes to drill in each hole circle will depend greatly on the applications to which the dividing components will be put. In order to make sensible use of the compound division capability, it is necessary to cut a 30-hole circle; a full rotation of the secondary worm is then equivalent to moving the indexing arm by one hole position. Also, in order to mark the worm thimble with its 40 graduations, a 4-hole circle (or multiple of four) is needed, as mentioned earlier. Arguably, as compound division will then allow positioning with a theoretical resolution of 1/100th of a degree, it may be that you will never need any further hole circles. However, as compound division involves keeping track of two independent movements, it is likely that users will find it convenient to have a set of hole circles that cover the most-used divisions for their applications. As cutting hole circles can be tedious, the best approach here is to cut the 'obvious' circles first - those that allow generation of your most-used divisions, leaving the others until the need arises. A further possibility that can add to the versatility of this device is to mark one division plate as a protractor, with marks at one degree intervals, and longer marks to denote the five and ten degree points. This can be thought of as a simpler alternative to using compound division; in effect, it creates a 360-hole circle, giving 1/30th of a degree of output movement per degree of indexing arm movement. To create such a protractor, a 12-hole (or multiple of 12) circle is needed; this can be easily cut using the 30:1 worm drive, as 2.5 turns of the worm moves the spindle by 1/12th of a revolution. Moving the indexing arm by one hole in the 12-hole circle will rotate the output shaft by one degree. It is then straightforward to mount a blank division plate on the business end of the dividing head, mount the dividing head on the cross-slide, and use a sharp scriber mounted in the lathe headstock to mark out the protractor.

Working out whether a given circle of holes can generate the requisite number of divisions is straightforward. Multiply the number of holes in the circle by the worm drive ratio; if you can divide the result by the desired number of divisions with no remainder, then the chosen circle can be used successfully. For example, the four hole circle will allow the dividing head to generate 40 divisions, as 4 X 30 gives 120, and 120/40 is 3 with no remainder. This also tells you that the indexing arm moves three holes between each division. The same principle applies when using direct division, except the drive ratio is 1:1 instead of 30:1.

The hole circles are easily cut using a 3/32in. diameter drill - the most convenient approach here is to use a No. 3 centre drill, which has this diameter of pilot drill. This pilot drill is also long enough to drill through a 3/32in. plate. Using this size of hole, it is possible to fit an 80-hole circle onto the periphery of a 3in. division plate. Leaving about 1/8in. between circles, with care it is possible to squeeze up to eight circles on to each plate; the smallest circle will be limited to a maximum of around 30 holes. It is worth remembering to mark the plate with the number of holes in each circle; counting holes several months later when you have forgotten what you did is a very tedious experience!

As mentioned above, compound division requires a minimum of two circles, one with 30 holes and one with four holes; the latter in order to be able to mark out the graduations on the thimble. If you plan to cut a protractor, a 12-hole circle would usefully pass as a substitute for the 4-hole circle. It is useful to make up a mounting arbor to help with division plate drilling; this needs to have the right size of shoulder for the plates to mount on, the remainder being machined to suit your preferred method of work holding. The simplest approach is to machine a division plate arbor from one of the blank arbors that can be obtained for the Peatol lathe. These arbors are basically a short length of 1in. diameter steel stock with a female thread at one end that fits the 3/4in. nose thread of the lathe spindle, and a 1in. diameter washer held in place with a UNC 8-32 cap screw at the other. A 5/8in. shoulder can be machined on the blank end of the arbor; the washer and cap screw will then hold the plate firm for drilling. The arbor is then transferred to the dividing head for the plate drilling operations. Once the two initial hole circles have been cut in the first plate, the compound indexing components (and/or the protractor) can be completed, and then the dividing head can be used to cut any other size of hole circle that may be needed.

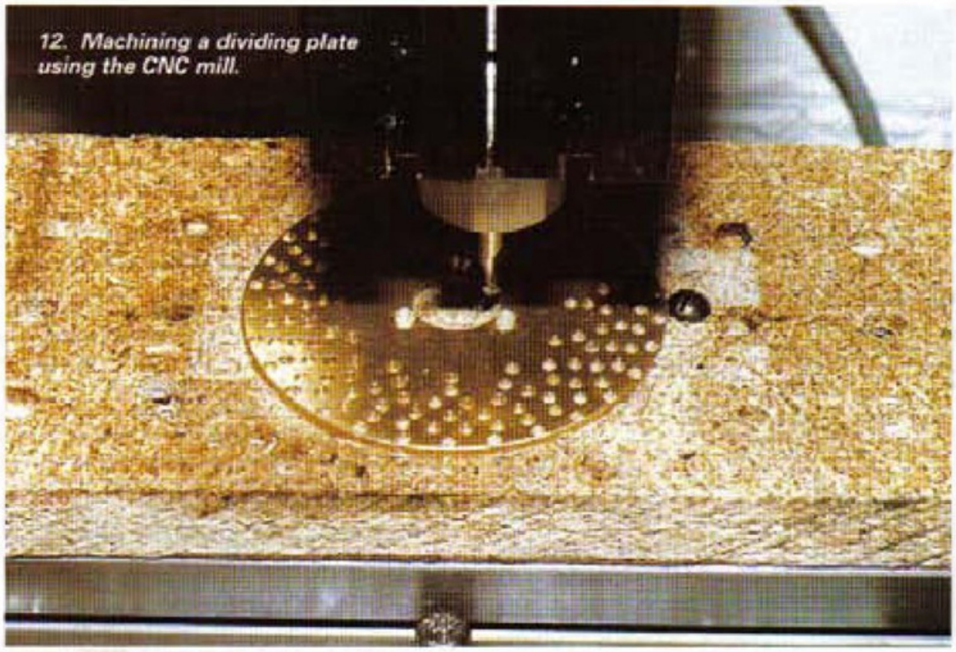
Of course, if you have a CNC mill to hand, cutting division plates is a trivial exercise; my plates were all cut using the Taig CNC mill, as was the protractor. **Photo. 12** shows a plate being machined; I attached it to a backing board, and then drilled the hole circles, using a centre drill, under CNC control. Next, the central countersunk holes were drilled, then the central 5/8in. hole milled out using a 1/8in. end mill. **Photo. 13** shows the protractor engraving in progress; the graduations have been added to a plate that has a single 30-hole circle, and the mill is now adding the numbering to mark each 10 deg. interval. As with the graduated thimble, the approach of filling the engraved marks with black felt tip greatly enhances the readability of the scale. The engraving cutter I used for these parts is one sold for the Dremel hand tools, with a small conical cutting tip; simple cutters can also be made by grinding a V-tip onto a broken centre drill. Since then, I have acquired a proper carbide engraving bit, ground to the right relief angles (Ref. 11), which should improve the quality of my engraving.

The Indexing Arm Components

Figure 21 shows the Indexing Arm Boss - a 3/4in. length of 1/2in. diameter steel, bored 5/16in. at one end and tapped 10-32 UNF at the other, and fitted with an 8-32 UNC set screw. A 1/2in. diameter washer is also needed, shown in **Figure 22**. The boss fits on to the end of the primary worm shaft, located by the 8-32 set screw. A 10-32 cap screw is used, with the washer, to clamp the indexing arm in position.

The indexing arm itself is shown in **Figure 23**, cut from 1/8in. thick brass plate. The 3/8in. diameter hole takes the detent assembly; the longitudinal slot allows adjustment of the detent position relative to the division plate.

The body of the detent assembly is shown in **Figure 24**. This is soft soldered into the 3/8in. diameter hole in the indexing arm, ensuring that it ends up perpendicular to the arm. The detent plug (**Figure 25**) and the detent knob (**Figure 26**) are designed to allow the detent pin (**Figure 27**) to be locked in the raised position. When moving the detent from one division plate hole to the next, you pull back the knob and rotate it half a turn to lock; another half turn allows the pin to be dropped into the next hole. A short



12. *Machining a dividing plate using the CNC mill.*

13. *Graduating and numbering a dividing plate to produce a 360-degree protractor, using the CNC mill.*

spring will be needed to complete this assembly; it needs to be about $^1/_2$in. long, with an ID greater than $^1/_8$in. and an OD less than $^1/_4$in. In operation, this spring will be required to compress by $^5/_{16}$in.. The one I used happened to be on hand in my junk box; a suitable spring could be wound from piano wire if necessary.

The detent pin was made from a length of $^1/_8$in. silver steel rod. The last $^1/_8$in. is reduced to $^3/_{32}$in. diameter to match the size of holes drilled in the division plates; the diagram shows this as parallel turned, but a taper could be turned if preferred. The brass collar is soft soldered (or Loctited) in place $^3/_4$in. from the tip of the pin. This component should not be cut to final length until the other detent components are complete and ready to assemble. A trial assembly will indicate the exact pin length required - fit the pin into the body, followed by the spring, the plug and the knob, the latter fitted in the lowered position. Mark the pin for cutting so that its end will be flush with the top of the knob. Final assembly can then be achieved by using a drop of Loctite to fix the plug into the body and a second drop to attach the knob to the pin.

The final length of the primary worm shaft can now be determined. With the indexing arm boss in place on the end of the over-length shaft, attach the indexing arm and detent assembly and measure the distance between the shoulder on the point of the detent pin and the surface of the division plate. This tells you by how much the shaft should be shortened. Once the shaft is cut to length, file a flat to act as a pad for the set screw. I found that filing the last $^3/_4$in. of the shaft flat formed a suitable pad, both for this screw and for the set screw collar.

Tailstock Support

For some operations, particularly when working on long items, it will be necessary to support the free end of the work piece using a tailstock of some kind. Clearly, if the dividing components are being used with the Peatol lathe headstock, it may be sufficient to press the Peatol tailstock into service for this purpose. However, particularly when using the dividing head in the mill, it will sometimes be necessary to have a separate tailstock that can be clamped to the milling table.

Figures 28, 29 and 30 show the components of a simple tailstock that can be used with the dividing head. The intent is that it should be used with the axis of the dividing head aligned with the X-axis of the milling table, and it assumes that the T-slots are on 1in. centres also aligned with the X-axis, as is the case with the Taig mill.

The body of the tailstock, **Figure 28**, is a block of aluminium with a $^3/_{16}$in. vertical through hole for a UNF 10-32 T-bolt, two tapped vertical holes for 10-32 pinch bolts, and an axial through hole $^1/_2$in. diameter. The $^1/_2$in. diameter hole is nominally 1.25in. from the base of the block; however, this should be adjusted to match the centre height of the dividing head. The $^1/_2$in. diameter hole and the T-bolt hole are offset $^1/_2$in. relative to each other, to bring the $^1/_2$in. hole on to the same axis as the dividing head spindle when both items are mounted on the milling table. **Figure 29** shows a $^5/_{16}$in. ID split bush that fits into the $^1/_2$in. hole, and **Figure 30** shows a plain centre cut from $^5/_{16}$in. steel. The split bush and clamping screws allow the centre position to be adjusted. The length of the tailstock centre can be chosen to suit the application. Similarly, if a sturdier centre is needed, dispense with the split bush and cut a $^1/_2$in. diameter centre.

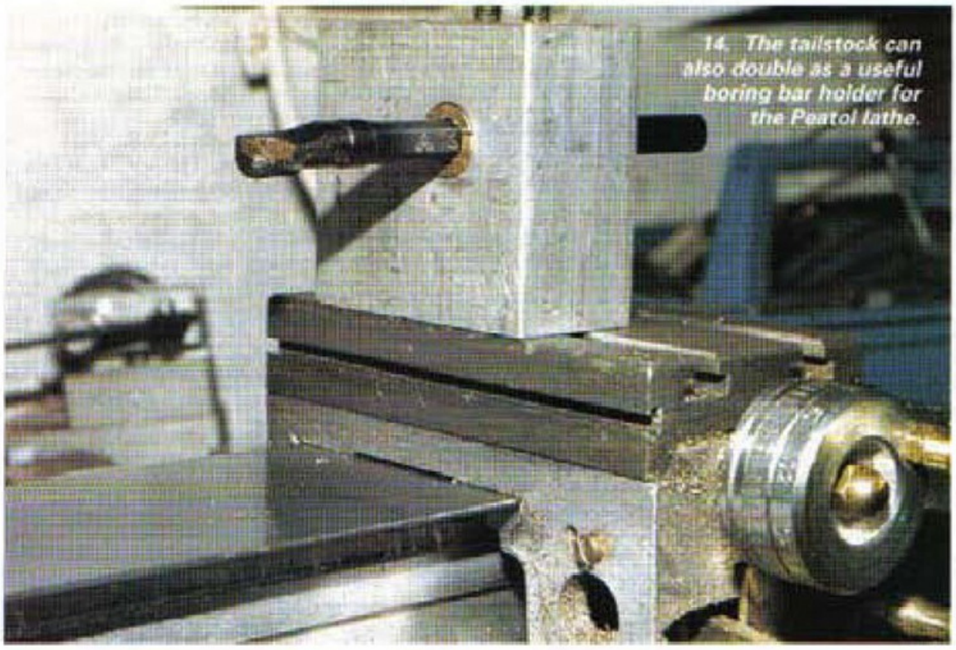
Conveniently, this tailstock design also doubles very nicely as a boring tool holder for use in the Peatol lathe - in fact, the design is simply a slight modification of a boring bar holder that I made some while ago, before embarking on the dividing head design. The Sumitomo boring bar mentioned earlier fits the $^5/_{16}$in. ID bush, and further bushes can be made to suit other bar diameters. **Photo. 14** shows the tailstock in use as a boring bar holder, fitted with a slightly larger boring bar with a Sandvik carbide insert (Ref. 12).

Putting it all together.

This completes the constructional details. The remaining paragraphs describe how the components can be combined to provide the different indexing functions. The photos used show the division components used with the dividing head spindle, but all set-ups illustrated can just as easily be achieved with the division components attached to the lathe itself.

Direct Dividing Set-up

The set-up for direct dividing can be seen in **Photo. 15**. The support bracket is bolted in place on top of the spindle, and a length of $^5/_{16}$in. steel bar is used as a support for the detent. The complete indexing arm assembly, including the boss, is used as the detent; the adjustable clamp on the support bracket allows the detent pin to be aligned with the selected hole circle - in this case, one of the circles I drilled in the 30T worm wheel. Using this arrangement, it is highly advisable to make use of the spindle brake to lock the spindle between operations.



14. The tailstock can also double as a useful boring bar holder for the Peatol lathe.

15. The dividing head configured for direct division, using hole circles cut in the back of the worm gear.

Simple and Compound Dividing Set-up

Photo. 16 and the photo at the head of this article show the dividing head fitted for compound division, configured for use on the lathe cross-slide with the spindle pointing to the left. Reversing the handedness is achieved as follows. Remove the dividing assembly from the support bracket and reverse the fitting of the brake pinch bolt assembly. Remove the secondary worm assembly by loosening its pinch bolt, flip it over and re-fit it from the other side; unscrew the thumbscrew and re-fit it in the other end of the worm lock. Loosen the pinch bolt holding the 5/16in. support bar into the primary worm carrier and slide it through, so that it now protrudes from the other side; re-tighten the pinch bolt. The dividing assembly can now be re-fitted to the support bracket, using the other of the two split clamps.

Simple Division

For simple division, ignore the secondary worm; lock it in position using the thumb screw or remove it and fit the pins to lock the indexing plate boss in position. Select the desired hole circle, adjusting the indexing arm clamp to line up the indexing pin correctly. Calculate how many complete revolutions, plus how many holes in the circle, are needed between each division, and adjust the sector arms to expose the requisite number of holes in the circle. This calculation goes as follows:

Multiply the number of holes in the circle by the ratio of the worm drive. For example, with a 20-hole circle, this gives 600.

Divide the result by the required number of divisions. For example, to achieve 12 divisions with this combination, 600/12 = 50.

Divide the resultant number by the drive ratio to give an integer result (which may be zero) and a remainder. The integer result (1 in this example) tells you how many full turns of the indexing arm; the remainder (20 in this example) tells you how many holes in the hole circle in addition to the number of full turns. Set the sector arms to expose one more than the number of holes given by the remainder.

Compound Division

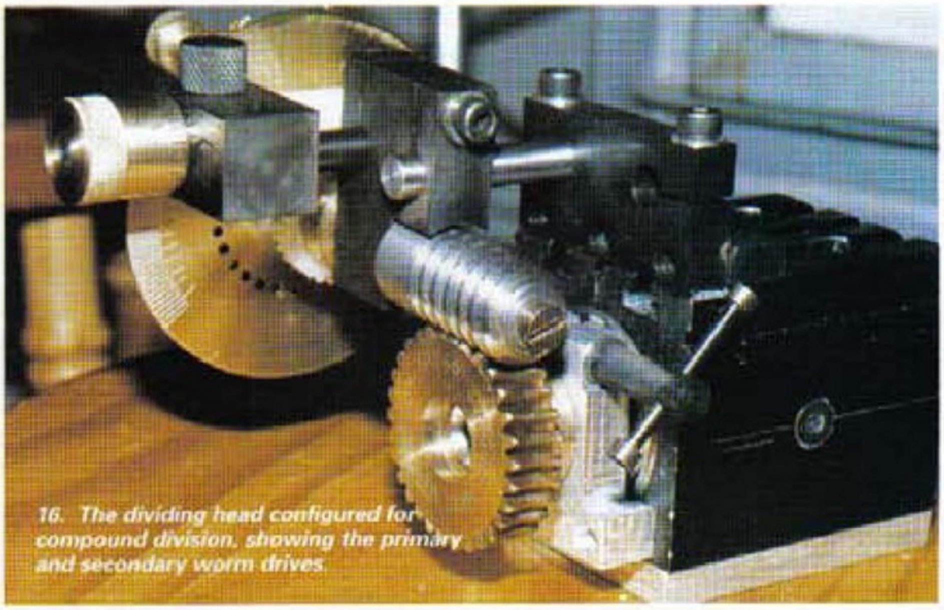
The dividing attachment is assembled with the secondary worm drive in place, and a plate with a 30-hole circle fitted to the indexing plate boss. With this arrangement, the dividing attachment becomes a means of positioning the output spindle in increments of 1/100th of a degree, corresponding to a single division on the graduated thimble. Hence, a full rotation of the graduated thimble (40 divisions) gives 0.4 deg. of spindle rotation; this is exactly the same as moving the indexing arm by one hole in the 30-hole circle. A full rotation of the indexing arm gives 12 deg. on the spindle; 30 rotations of the indexing arm gives a full 360 deg. In order to index between divisions, it is likely to be necessary to move both the indexing arm and the thimble. To calculate the necessary movements, divide 360 by the number of divisions required giving a (probably fractional) number of degrees per division. This can then be converted into the number of full turns of the indexing arm plus the number of holes in the 30-hole circle, plus the number of divisions on the thimble. For example, creating 16 equal divisions requires 22.5 deg. per division. This is equivalent to one full rotation of the indexing arm (12 deg.), plus 26 holes in the 30-hole circle (10.4 deg.) plus 10 divisions on the thimble (0.1 deg.), giving a total of 22.5.

Where the calculation does not result in an integral number of 1/100ths of a degree per division, an allowance needs to be made for the error in calculating the movements per division by adding in an extra 1/100th of a degree every so often, so that the error is evenly spread out among the divisions rather than being 'concentrated' in the last division. To give a very simple example, if you wanted to produce 320 divisions, then it would be necessary to rotate the spindle by 1.125 deg. per division. This is equivalent to 2 holes in the 30-hole circle, plus 32 divisions on the thimble, giving 1.12 deg. However, this is 0.005 of a degree too little; on all but the last division, this would not be noticeable, but the error in the size of the last division would be 320 times the individual error, or 1.6 deg. The last division would end up more than twice the desired width. The solution is to use 32/100ths on the thimble for the first, third, fifth,........ and 319th division, and use 33/100ths for the even numbered divisions.

Keeping track of the next setting of the thimble can be tricky, especially if the number is changing from division to division. The safest approach is to calculate it all out beforehand and to make up a table detailing where you expect to move the indexing arm and thimble to create each division. The alternative is to work it out in your head....and run the risk of messing up your evening's work.

Using A Protractor As An Alternative To Compound Division

For many purposes, a protractor can be used as a simpler alternative to compound division. The protractor can be viewed as a 360-hole circle, or as a means of positioning the output spindle to a resolution of 1/30th of a degree. Either way, the calculations involved are similar to those described above; again, it is well worth writing out a table of protractor positions for each division in order to avoid turning your hard work into scrap by careless application of mental arithmetic!



16. The dividing head configured for compound division, showing the primary and secondary worm drives.

CNC Dividing Set-up

Photo. 7 shows how the stepper motor assembly is attached to the dividing head. For most purposes, the motor will only be used with one handedness, as the CNC control software will make an assumption as to which way the motor (and hence, the spindle) will rotate for positive and negative movements of that axis. If your control software and hardware is capable of driving four axes simultaneously, then you can choose the physical orientation that you prefer, and then define the appropriate direction of rotation by means of software configuration parameters. If, as in the example I gave earlier of graduating the thimble, you 'borrow' the X or Y axis control signals to drive the 4th axis motor, you probably don't want to change software settings each time you switch between linear and rotary axes, so you will be stuck with fitting the motor in one orientation only, and will have to experiment to work out what that orientation should be. However, the ability to rapidly change the handedness of the dividing head by reversing the motor mounting position makes for some amusing possibilities; for example, you could produce left-handed and right-handed versions of a component from the same CNC control program just by reversing the orientation of the motor.

References

11. Engraving equipment and cutters can be obtained from Pantograph Services, Unit 8, Felnex Close, Cross Green, Leeds LS9 0SR.
Tel: 0113 249 6161. Fax: 0113 249 7033.

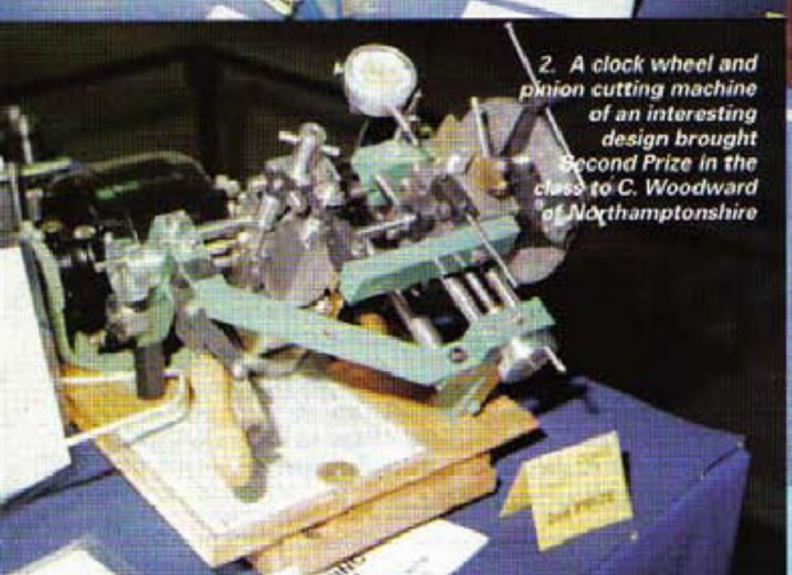
12. Supplied by Greenwood Tools, Sherwood House, Sherwood Road, Bromsgrove, Worcs. B60 3DR.
Tel: 01527 877576. Fax: 01527 579365.

THE MIDLANDS MODEL ENGINEERING EXHIBITION

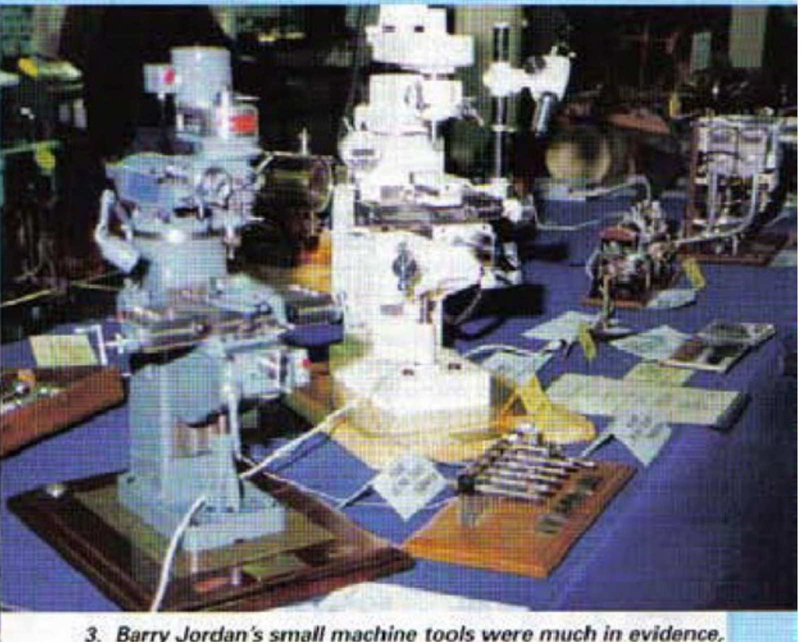
A brief look at some of the exhibits seen at Donington Park

This year's Midlands Model Engineering Exhibition took place over a six day period in October and was well supported. Although the Machine Tool and Workshop Equipment classes contained only a modest number of entries (seven in Competition and three in Display according to the Souvenir Guide) the quality was good. These were, however augmented by a wide range of nicely made tooling on the Club and Society stands, as can be seen from this selection of photographs which illustrate only a portion of what was to be seen.

1. First Prize in Competition Class 7 was awarded to M. Leafe of West Yorkshire for this well equipped tool and cutter grinder



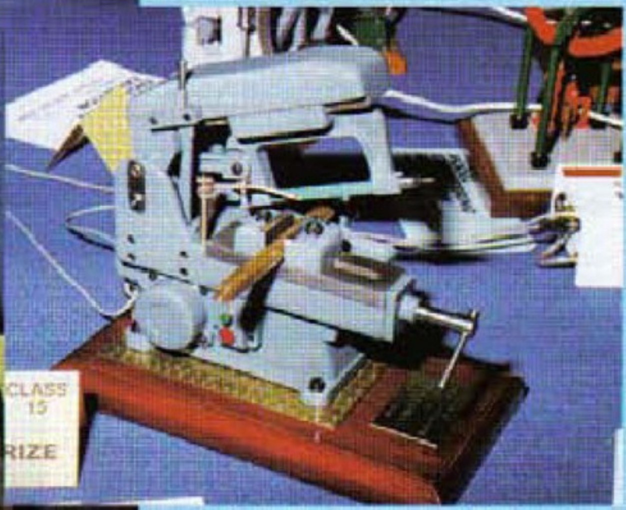
2. A clock wheel and pinion cutting machine of an interesting design brought Second Prize in the class to C. Woodward of Northamptonshire



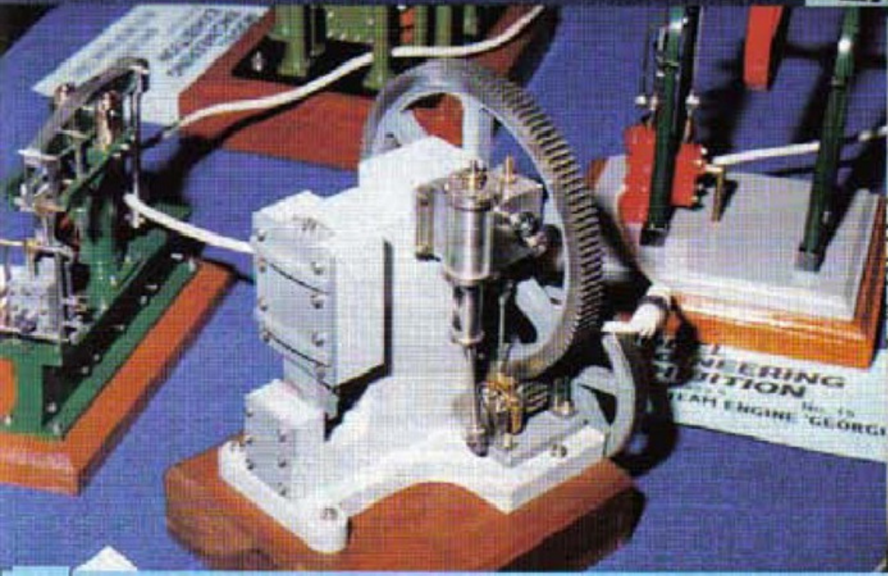
3. Barry Jordan's small machine tools were much in evidence, his new small milling machine, featured on the front cover of Issue 61 of M.E.W., gained Third Prize. It his seen here with his miniature Bridgeport milling machine which was in the Display section

4. This half size version of the Drummond round bed lathe brought back memories to many of the model engineers present, and a Very Highly commended award to its builder, P. Arnold of Lincolnshire

5. Careful workmanship by D. Harper of Warwickshire was rewarded by a Commended certificate for his ball turning attachment

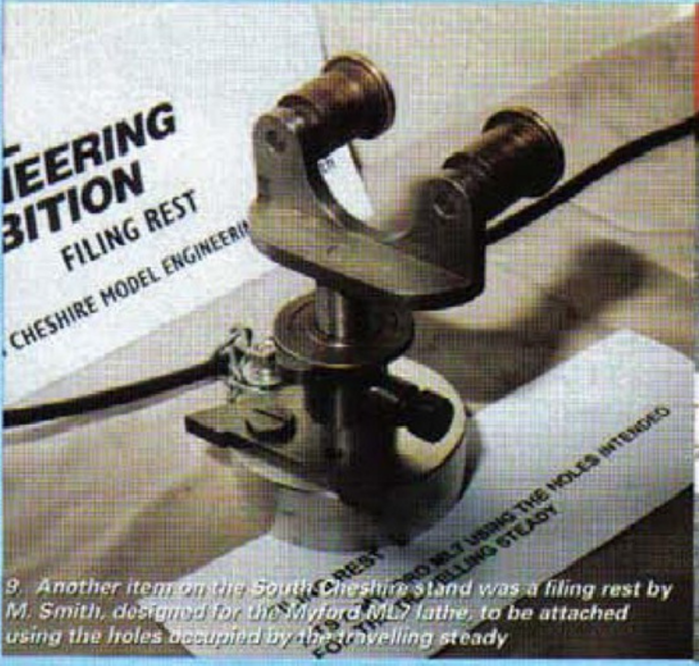


6. Being classed as a model rather than a small machine tool, Barry Jordan's 1/5th scale Qualters & Smith 'Sawmaster' power hacksaw was entered in Class 15 where it was awarded First Prize

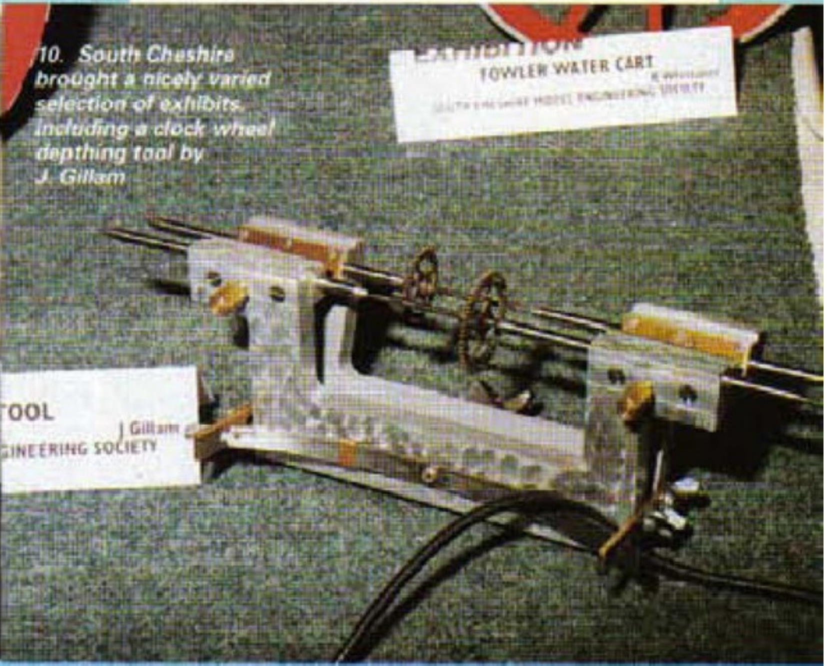


7. J. D. Walton's 1/24th scale steam powered guillotine was transferred from the Miscellaneous Class to Class 5 (Stationary Engines) where it was awarded Third Prize

8. M. W. Smith entered this version of the Martin Cleeve swing clear toolholder for display on the South Cheshire MES stand. It is suggested that it was made by the designer as it is stamped with his Patent number



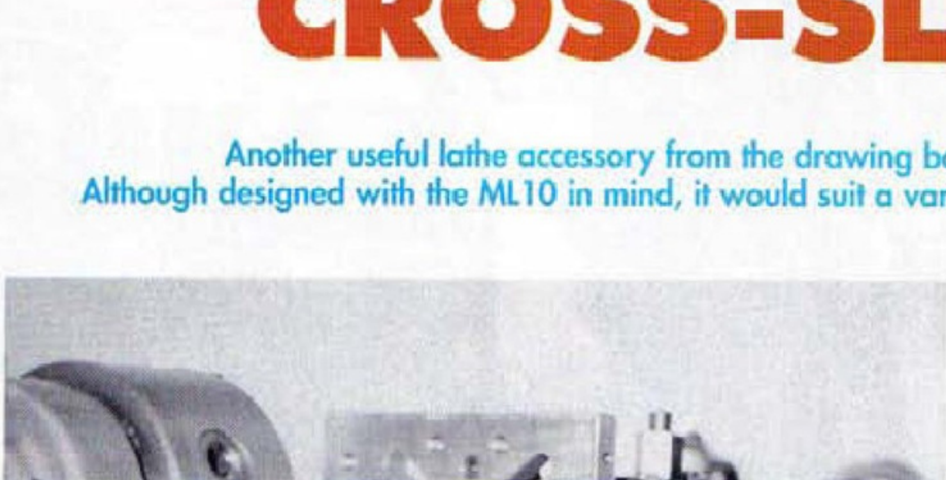
9. Another item on the South Cheshire stand was a filing rest by M. Smith, designed for the Myford ML7 lathe, to be attached using the holes occupied by the travelling steady



10. South Cheshire brought a nicely varied selection of exhibits, including a clock wheel depthing tool by J. Gillam

A SPECIAL ANGLE PLATE FOR THE MYFORD ML10 CROSS-SLIDE

Another useful lathe accessory from the drawing board of Len Walker. Although designed with the ML10 in mind, it would suit a variety of lathes of a similar size



A variety of tapped clamping holes and milled slots allows secure mounting of a wide range of workpieces.

This item came about from the need to extend the scope of work which can be machined while held in the toolpost. The travel of the cross-slide was largely wasted, as only the last couple of inches could be used to bring work in line with a cutter held in the chuck. Of course, work can be clamped to a block mounted on the cross-slide and packed up to the required height, but in this case the width of the top slide severely reduces the working area. So, methinks, if an 'extended' angle plate could be devised (fitting around the tool post), the whole area available from the cross-slide travel could be utilised.

This remained on the 'ideas shelf' for quite some time until, much later, I received, from a friend, a lovely piece of heavy angle iron. It came from a shipyard, and I had never before seen such a lovely heavy section, - and it was an accurate 90 deg. too! (Do they have a special source of supply?).

At this point, I was only concerned with making a simple angle plate, but, looking at this lovely angle lying on the bench, it occurred to me that, with a piece carved out of one flange, I could have an angle plate which could be used for all general marking-out and machining AND also for mounting on the cross-slide, - thus satisfying my original requirement to extend the milling area. Bingo!

I am aware that few of readers who may wish to make a similar attachment will be as lucky in finding a suitable piece of material, so arrangements have been made with College Engineering Supply to produce a casting from which the same form can be produced. Some extra machining is likely to be necessary, but the finished article will have the additional benefits which good cast iron brings to machine tools.

Construction

The construction was carried out at an evening class, - I was very glad to have the use of a decent sized milling machine to square up the job, and to form the large cut-out, as no suitable bandsaw was available. This operation was facilitated by drilling two holes, each of $^{11}/_{16}$in. dia. at the centres of the $^{3}/_{8}$in. radii, then using a $^{1}/_{2}$in. dia. end mill in successively deeper cuts to remove the waste piece. This piece will, no doubt, be used in some future project! Using an $^{11}/_{16}$in. dia. drill leaves $^{1}/_{32}$in. spare to clean up.

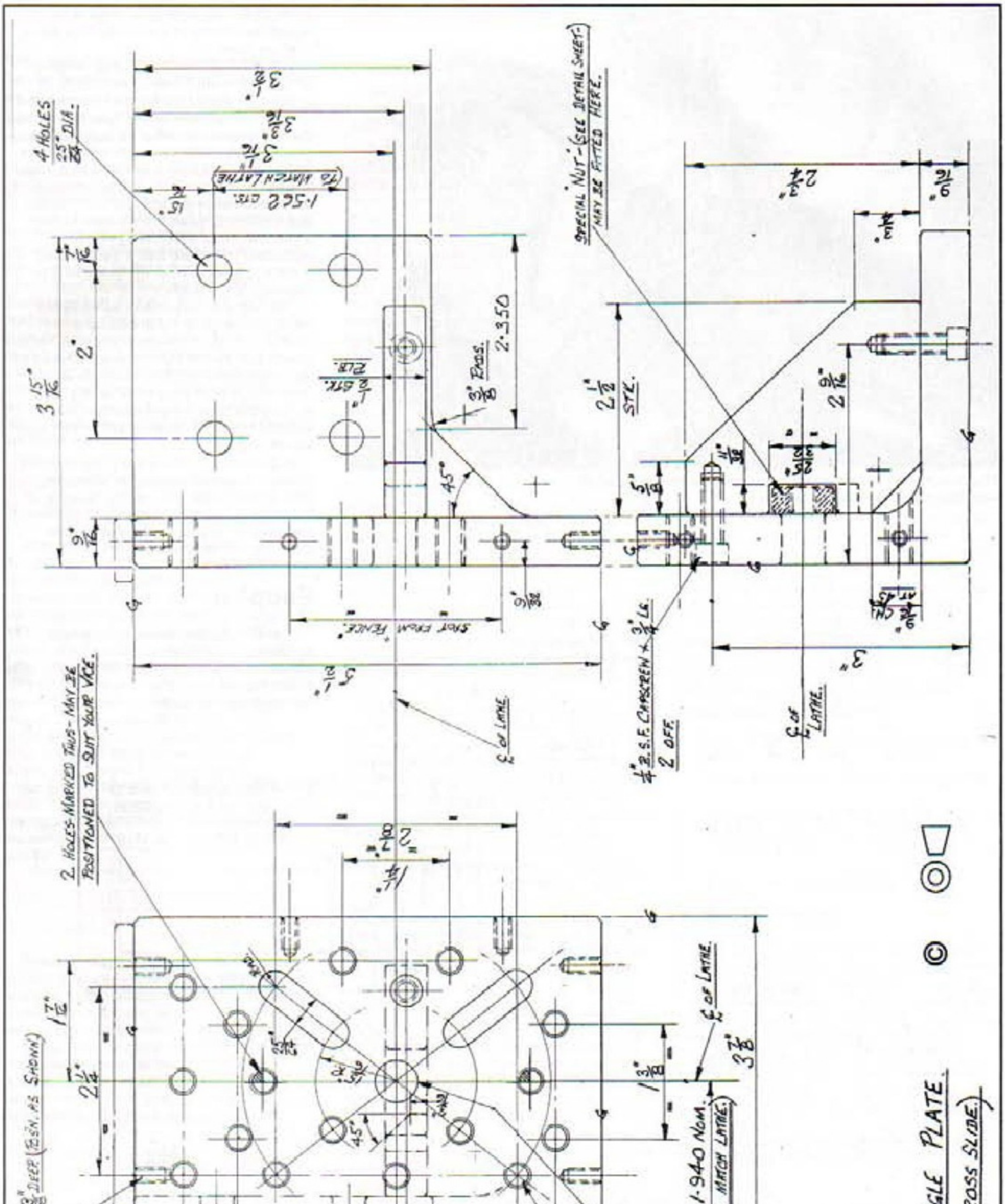
The outside 90 deg. faces were ground square (also the ends) with the job very firmly clamped to an accurate angle plate, on a large surface grinder. If you are not practised at this type of operation, do get your instructor to check that all is secure and safe before proceeding.

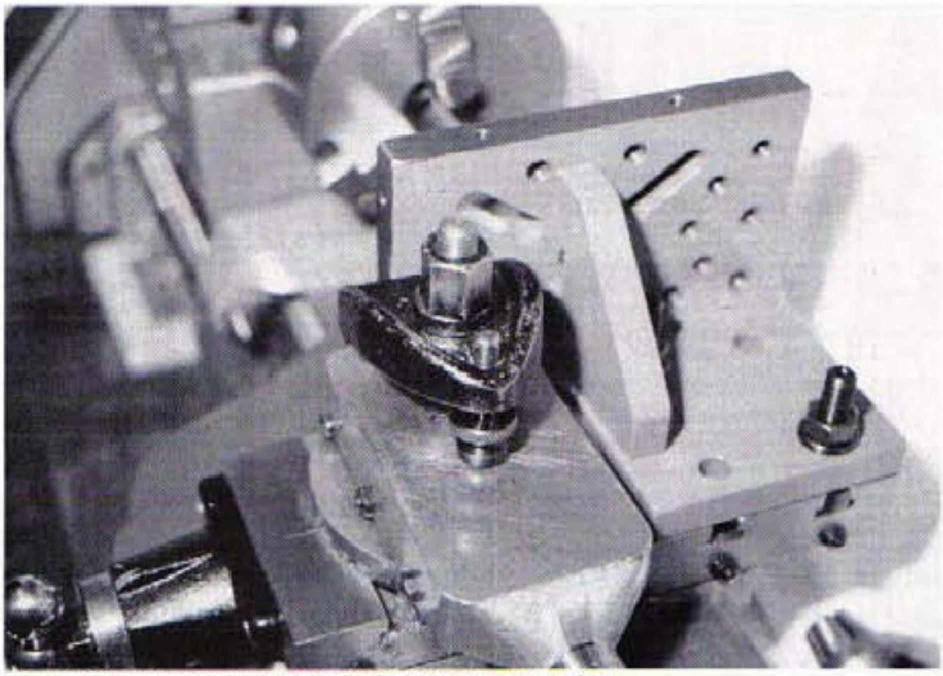
To ensure that the component was securely mounted, two large clamps were used, one on each side, and to facilitate this, the $2^{1}/_{2}$in. x $^{1}/_{2}$in. rib was left off at this stage. If no surface grinder is available, then careful fly cutting will probably have to suffice.

After marking off and drilling the four $^{25}/_{64}$in. dia. fixing holes, the angle plate could be secured to the cross-slide using two of the tee-bolts in order to accurately mark the lathe centre height. This can be done using a hard centre in the spindle (for once!) to scribe a line on a face previously coated with layout blue.

With the angle plate removed from the lathe, all the holes and slots other than the 0.500in. dia. centre hole could be marked out then drilled, milled and tapped as appropriate. Leaving the rib off makes it easier to tap one of the fixing holes. The gauge plate 'fence' was used as a jig to position the 2BA securing screw holes in the top and end faces.

The next task was to bolt the job back on the cross-slide and set it at 90 deg. to the axis of the lathe, using a dial indicator held in the chuck. The location of the centre of the 0.500in. dia. hole could then be lined up with a centre fitted in the headstock mandrel. After clamping the


SPECIAL ANGLE PLATE.
(FOR ML10 CROSS SLIDE.)
4 HOLES 25/64" DIA.
1·562 DIA. (TO MATCH LATHE)
SPECIAL 'NUT' - (SEE DETAIL SHEET) - MAY BE FITTED HERE.
2 HOLES MARKED THUS - MAY BE POSITIONED TO SUIT YOUR VICE.
SPOT FROM 'FENCE'.
℄ OF LATHE.
1/4" B.S.F. CAPSCREW × 3/4" LG. 2 OFF.
℄ OF LATHE.
6 HOLES - TAP 2 B.A. × 3/8" DEEP (1 ESN. AS SHOWN) (SPOT FROM 'FENCE')
16 HOLES - TAP 8 MM.
BORE ·500 DIA. (FROM HEADSTOCK ON FINAL ASSEMBLY.)
1·940 NOM. (TO MATCH LATHE.)
℄ OF LATHE.
2·350
2 1/2" STK.
3/8" PLATE
©



The design permits the plate to be fixed to the cross-slide with the top slide still in position

cross-slide, this 'reference' hole was drilled and bored to a slide fit on a piece of silver steel.

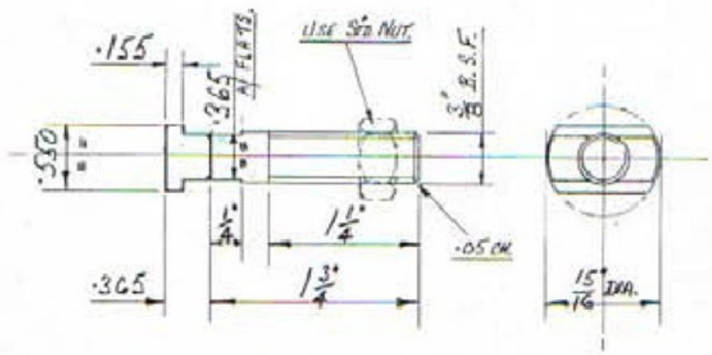
The rib was then fitted, after making sure that it would 'bed down' nicely in position. A smear of Araldite was applied to the mating faces before fully tightening the two capscrews. This rib may not add greatly to the stiffness or damping of the angle plate, but it certainly makes it easier to handle and position. The positioning of the holes makes it a little difficult for the cast version to have the rib built in, so some additional machining will be necessary to ensure that a flat bedding surface is available on the inner face of each leg of the angle.

The fence is very useful as an aid to setting up work or for positioning repetition jobs. The special nut strip (when inserted in the rib slot) allows a stud to be fed through the 0.500in. dia. hole if required for clamping work in this area. Making the four tee-bolts longer than actually required allows them to be used for other jobs.

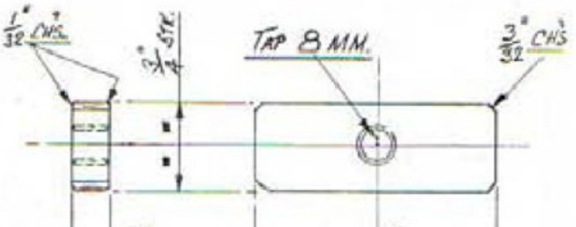
In conclusion, this angle plate is heavy enough to damp out a lot of vibration, thus enabling the full cutting capacity of the lathe to be used. It seems to me that if there wasn't a gadget like this before, there should have been!

Supplier

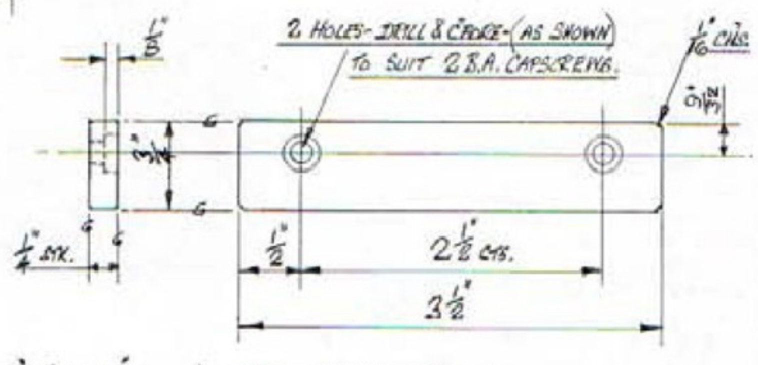
The College Engineering Supply, 2 Sandy Lane, Codsall, Wolverhampton WV8 1EJ Tel/Fax 01902 842284 email: coll.eng@zetnet.co.uk



'TEE' BOLT. 4 OFF B.M.S.



SPECIAL 'NUT.' 1 OFF B.M.S. (CAN BE USED BEHIND ·500 DIA CENTRE HOLE)



'FENCE'. 1 OFF GAUGE PLATE.

WASHER. 4 OFF. B.M.S.

©

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

Wren Engineering - Change of address

Wren Engineering, who supply components for a number of the projects described in M.E.W. have informed us of a change of location. They are now at 12 Gravel Road, Bromley, Kent BR2 8PF, Tel. 0181 462 0586

High and Low Temperature Solders for Model Engineers

A recent letter in Scribe A Line warned that if EU proposals come to fruition, it is unlikely that traditional tin/lead solder alloys will continue to be manufactured. News comes from Model Engineering Solders of Warrington that they that they are hoping to hold stocks of these traditional solders so that they can continue to supply them for many years to come. They are able to supply a wide range of high and low temperature solders in cored wire or solder cream form and also stock a double strength solder.

Model Engineering Solders can be contacted on 01925 602759

Imperial size steel from Hemingway

With the increasing use of metric standards in industry, a number of readers have reported increasing difficulty in obtaining steel sections in Imperial sizes from their local stockists. Hemingway of Burstwick, Hull have been in contact to say that they have made arrangements with one of the largest suppliers of specialist steels in the UK in order to be able to offer over 100 sizes of round, flat, square, ground steel and silver steel in Imperial sizes, all conforming to British Standards (e.g. rounds, bright drawn mild steel, lead bearing free cutting to BS970:1955 EN1A). 24in. lengths are available, but their catalogue gives prices and lengths for 12in. lengths.

Hemingway, Wadworth House, Greens Lane, Burstwick, Hull HU12 9EY Tel./Fax 01964 670701

Compu-Edit Graphics Code Manager

Readers using HPGL code for CNC applications will be interested in this complete graphics code manager which allows code to be edited in a 'cut and paste' way. The full version also has a 'reverse edit' feature.

Those wishing to try the system will find a shareware version on the Internet at www.eclipse.co.uk/cj.engineering. The full version costs £28.00 (include. p&p UK only).

Compu-Edit, P.O. Box 5, Exeter EX5 4YP

UNI-THREAD Wire Thread Inserts

Wire thread inserts form a tried and tested way of repairing damaged threads or providing a stronger thread in soft materials. A new supplier has entered the market in recent months. Their trade price list is now available, featuring a wide range of inserts in a variety of thread types and sizes. The thread forms available include BSF, BSW, BA, Unified (Fine and Coarse), Metric (Fine, Medium and Coarse) as well as Cycle, Pipe and Sparking Plug varieties.

In addition to the inserts, which are normally supplied in lengths equal to 1½ times the nominal thread diameter (quotes for other lengths being provided on request), the appropriate drills, taps, insert tools and break-off tools can also be supplied. The tools will be included in boxed kits which are soon to become available.

Uni-Thread, Marldon House, Love Lane, Marldon, South Devon TQ3 1SP Tel. 01803 559595 Fax 01803 527568 E-mail: UniThread@aol.com

Newsline from Reevescene

Reevescene is the customer support club of the well-known model engineering supplier, A. J. Reeves & Co. (Birmingham) Ltd. of Marston Green. For a modest annual subscription, members receive a free copy of the latest catalogue plus regular price-list updates, and a purchase discount voucher system is operated. From time to time, special offers are available and the house journal, 'Newsline' is circulated quarterly.

The September 1999 issue of this 32 page journal has just come to hand and it contains much of interest, with contributions from a number of well-known modellers and news of a new range of items aimed at the full-size steam boating fraternity.

Sales Director, John Crisp reviews an eventful year 'out and about', with thoughts on the various events he has attended during the year. His notes well illustrate the point that those engaged in the model engineering trade have to be tending their customer's needs on most week-ends, as well as keeping the business running during the week.

Newsline is a useful and interesting publication and membership of Reevescene can bring significant advantage to regular customers.

A. J. Reeves & Co. (Birmingham) Ltd., Holly Lane, Marston Green, Birmingham B37 7AW Tel. 0121 779 6831 Fax 0121 779 5205 E-mail: ajreeves@dial.pipex.com

New catalogue from Frost

Frost Auto Restoration Techniques of Rochdale, Lancashire have recently issued Vol. 19 of their catalogue. As the name implies, their business is aimed mainly at the vehicle repair and restoration sector, but they sell many items which will have a wider appeal. Anyone working with sheet metal will find much to interest them, a number of the tools illustrated having been seen in these pages over the years. Metal shears, nibblers, the Pencut tool and deburring tools are just a few of the items which would find employment in the home workshop. Materials are also stocked in sizes which can be easily handled. 1.0mm and 1.2mm steel is available in 600mm x 900mm sheets as is 1.2mm and 1.6mm aluminium.

Frost Auto Restoration Techniques, Crawford Street, Rochdale, Lancashire OL16 5NU Tel. 01706 658619 Fax 01706 860338

Garryflex Blocks

Since Peter Clark described the use of Garryflex rubberised abrasive blocks we have had a number of requests for information on where they can be obtained. We have contacted the manufacturers, Garryson Limited, who suggest that anyone having difficulty in obtaining supplies should contact them for details of their nearest stockists.

Garryson Limited, Spring Road, Ibstock, Leicestershire LE67 6LR Tel. 01530 261145 Fax 01530 262801 email: garryson@compuserve.com

A message from Chronos

Chronos Limited of St. Albans, one of our regular advertisers, have asked us to pass on their apologies to any reader who has experienced difficulty in making contact with them by telephone in recent months. The volume of calls they have been receiving has overwhelmed their system, so they have responded by adding five extra telephone lines and recruiting extra staff, both in Sales and Despatch.

Prospective customers should use the following numbers in future:-

Free Catalogue Hotline - 01727 832860

Sales & Technical Queries - 01727 832793

To place an order - 01727 832793

To follow up an order - 01727 832860

E-mail - SALES@CHRONOS.LTD.UK

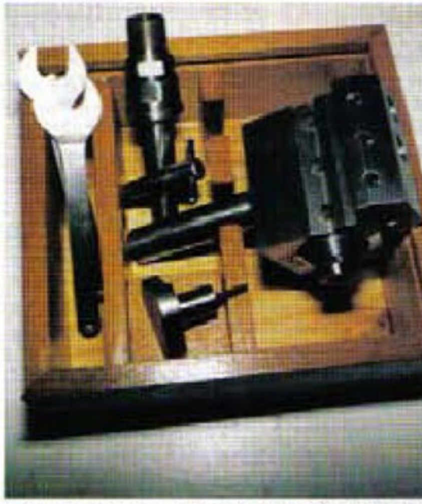
Fax - 01727 848130

On the product front, they have recently introduced a set of ten HSS boring tools with ½in. dia. shanks, as seen in the accompanying photo. The set is available at £35.00 including VAT. Also to be seen are two examples of a range of five indexable tip boring tools which come in heights from 8.5mm to 22mm, the corresponding lengths being 128mm to 220mm. The price range is £18.00 to £25.00, good quality spare tips costing £3.50.

Chronos Limited, Unit 8 Executive Park, 229/231 Hatfield Road, St. Albans, Herts AL1 4TA

IMS UPDATE

A $1^1/_2$in. scale Fowler ploughing engine entered in Class A4 is by Harold White of West Sussex



This boring head, entered in Class A5 is the work of Malcolm Leafe of Dewsbury, West Yorkshire

Final preparations for the International Model Show and the 69th Model Engineer Exhibition are well in hand. Entries are being received at a steady rate and it is encouraging to see that the Engineering classes are likely to be supported in a better way than has been evident for some years. Huge numbers of entries are never to be expected in the Competition classes because, with standards of workmanship, fidelity to prototype and of presentation now being so high, models of this quality are not being completed at a rate which is likely to bring large numbers in any one year. What we are seeing, however, is more support for the Loan section, where exhibits of a high standard which perhaps have won awards in previous years or are not yet quite finished in the form necessary to be able to compete for a medal are being offered. Taken together, the numbers and quality of exhibits on display is promising to make an impressive sight. A further selection of photographs of items already entered is included here.

Neville Wilkinson's $^1/_{20}$th scale working model of a Liebherr 984 excavator features hydraulic actuation and is fully radio controlled. It is also entered in Class A4

Turning now to the Trade side of the exhibition, it appears that the change of date and venue have made it possible for some of the model engineering suppliers who found it difficult to be present in recent years to make a welcome reappearance. Confirmation is still awaited from a small number, but those companies which have made definite bookings are listed below. If you are planning to purchase from any of the traders present, then you may consider giving them a call beforehand, letting them know when you are likely to be attending, so that they may have your order ready and waiting for you. Its a good way of saving carriage charges, particularly on the heavier items like castings.

All the modelling disciplines covered by the Nexus hobby magazine range will be represented at Alexandra Palace, with the boat pool, car track and flying area providing interesting and entertaining demonstrations every day. This year, the flying activities will take place in Alexandra Palace's vast Ice Skating Arena, where in addition to the customary fixed wing aircraft and helicopter flying programmes, the younger element will be able to take part in the Dart flying finals.

Taking a firm view that recruitment to the 'heavier' end of the modelling spectrum will only be maintained if younger people are encouraged to forsake the 'flickering screen' for some creative activity, the organisers have also arranged for exhibition teams from modelling giants Hornby and Corgi to be present, together with the ever-popular 'Blue Peter' model railway layout. The aim is to create an atmosphere in which all members of the family can feel welcome and to engender the feeling that model engineering and model making in general is a pastime in which all can share. It is only in this way that the traders who are a vital element in the continuing success of our hobby will feel confident that they will have a market in the foreseeable future and will continue to invest in order to provide the tools, castings and materials that will be needed to keep our hobby alive.

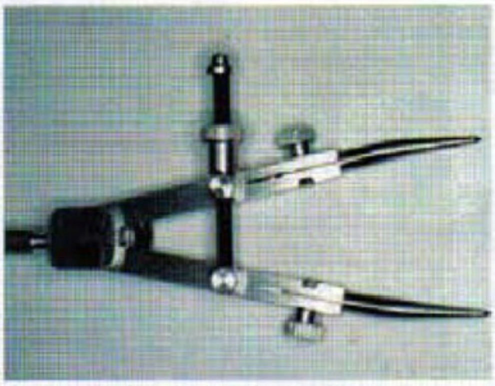
Support from the Clubs and Societies is stronger than ever, and although one or two of the organisations present in recent years have not found it possible to arrange continuously manned stands, they are sending substantial groups of exhibits which will illustrate the latest advances in their branch of the hobby. Of particular note here are the miniature gas turbine engines and the tether cars which have been promised.

Once again, the Society of Model and Experimental Engineers will operate their workshop, demonstrating a variety of machining techniques and ever-willing to discuss the finer points of model engineering and to deal with queries.

A wide variety of miniature internal combustion engines will be on display, with many of them being run in a demonstration area, with acknowledged experts from that branch of the hobby on duty to explain the fascination of this popular activity.

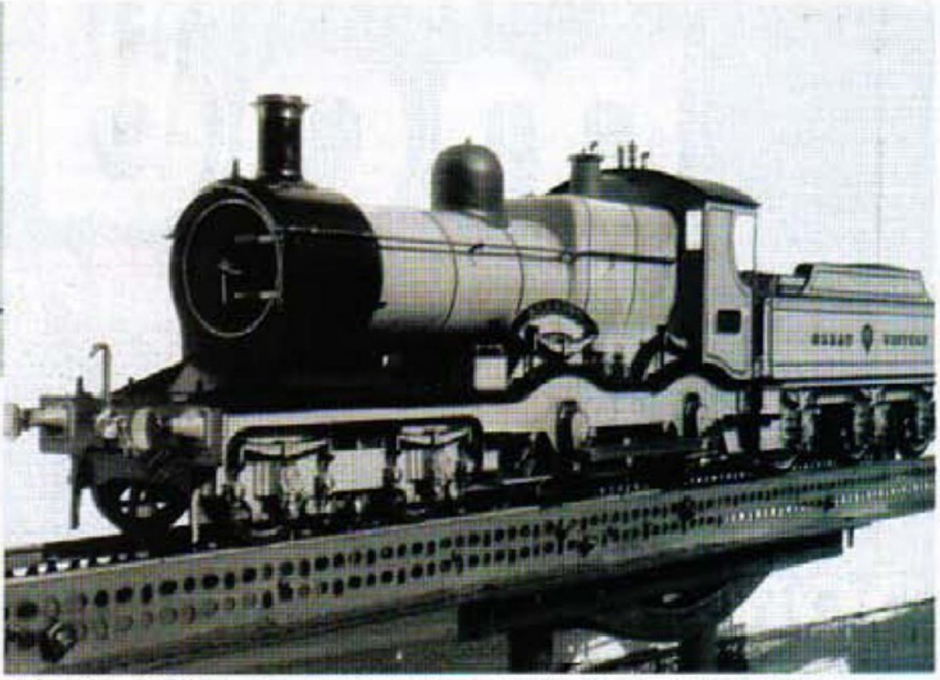
The miniature traction engine enthusiast will also be catered for, with a 'Road Steam Clinic' established as a contact point for experienced builders and newcomers to exchange news and views.

Viewed overall, this year's exhibition appears to offer something for everyone interested in model making, with a stronger influence from the engineering side than has perhaps been evident in recent years.

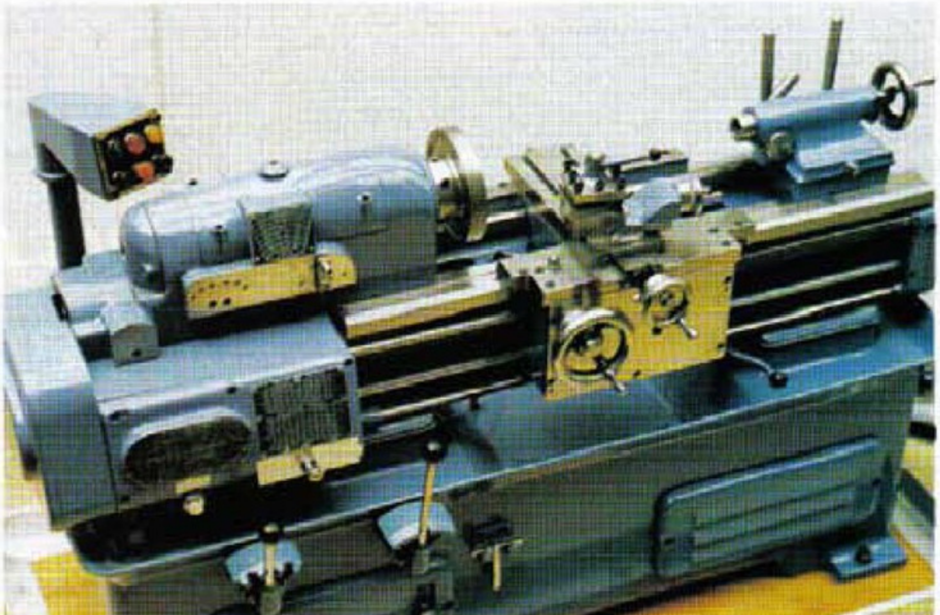


Also in Class A5 is Bob Loader's Calivider which was described in Issue 48 of M.E.W.

We have persuaded Chief Judge Ivan Law to exhibit his Universal Spiralling and Differential Indexing Dividing Head in the Loan Section



Peter Rich of St. Brides, Newport is well known for his high quality locomotive models. His latest creation is this 5in. gauge Great Western 4-4-0 No.3312 'Bulldog'. It is pictured here in 'shop grey', but has now been fully painted



Bob Mellows' Holbrook Model 'C' lathe to 1/6th scale has been seen in the Loan section before, and is making a welcome return so that we may inspect progress

Trade Exhibitors with confirmed bookings at time of going to press

AB Tools
Balsacraft
Colin Bliss Models
Bruce Engineering
Canville Ltd
Chester UK
Chronos Limited
The College Engineering Supply
DD Tools
Derma Shield
P. Dunk
EKP Supplies
Elegance Natural SkinCare
Euromodels
Fantastic Foam
Albie Fox Personalised Embroidery
Frehei Drill Bits
G.L.R. Distributors Ltd.
Hasell Composites
W. Hobby Ltd.
Hobbystores
Home and Workshop Machinery
JB Cutting Tools
S.A.R.L. Kado
Keysolar Systems
L.A. Services
L.B. Restoration
Langdon (London) Ltd
Maxitrak
Mike Thomas Marketing
Mill Hill Supplies
John Mills Ltd
Myford
Paper'n'Steam Galore
Peatol Machine Tools
Perma-Grit Tools
Phoenix Promotions
Powerball
Pro Machine Tools
Proops Brothers
Rapid Connect
RCTS
RCV Engines
RDG Tools
Rebel Boats
A.J. Reeves (Birmingham) Ltd.
Rexon UK Ltd.
Rockets and Things
Rotagrip
Shesto Ltd
Shop Smith
Somoso Products
Starkie & Starkie Ltd.
Tools 2000
Tools UK
Toolstop
Tracy Tools
Turner Products
Varley and Dyke Partnesrhip
Warren Machine Tools
Wilmington Engineering
Winson Model Technology

SCRIBE A LINE

Cheap Surface Plates ·

From Glyn E. Jones, Ashburton, Devon

Having recently set up my workshop on return from overseas, I noted that my faithful sheet of plate glass was in dire need of replacement.

I approached a local firm who specialise in stone and marble and supply, inter alia, kitchen worktops which, of course, have cut-outs for sinks. Having explained my needs, I was taken through the works - passing a very impressive array of machines - to a stack of such cut-outs, and selected one. It is about one inch thick, a bit rough on the edges, but with a fine polished top. I parted with a fiver, on the understanding that if it was not as flat as I needed, it would be repolished. I have tested it with my limited equipment and as far as I can tell it more than meets my needs. I also got one for my mentor Tony H., currently in the Far East, so if you read this Tony, there's one waiting!

One additional advantage of these cut-outs is that you should be able to choose from a range of colours to match your machines etc., - mine is a sort of oily black, with streaks of what look like rust - colour co-ordination at it's best!

Electrical safety

From Dennis Rogers, Wells, Somerset

I would like to comment on the letter from Colin Long regarding electrical safety in Issue No. 58.

I don't claim to be an expert in anything in particular, however, I have been in the industrial electrical business for around sixty years. I note that in the interest of electrical safety he does not mention specifically the auto transformer, many of which can be purchased in what I call technical junk shops. These transformers can, of course, be lethal as the whole winding is at mains potential in relation to earth, despite the fact that they can produce very low voltages. I would suggest that anyone carrying out experiments using mains voltages may be wise to operate through an R.C.D.

Just after the last war, when I was working in Power Stations, when money was as hard to come by as transformers, many of us used to construct transformers using any suitable available materials, particularly old current transformers. The most popular items to construct were battery chargers and power supplies for our portable radios. The information we used was taken from the many publications available on the subject. George Newnes published at least twenty four books for us amateurs, one of which I still have, called Practical Design of Small Motors and Transformers.

I think that Colin would be even more shocked to read how to construct a commutator for a universal mains motor using the average model maker's lathe.

I would suggest that anyone interested in constructing transformers should purchase one of the readily available transformer kits. These kits make things a bit more simple because the primary is pre-wound thus removing what could be a hazardous part of the construction. It allows you to do more or less what you want with the secondary. Full instructions are provided with each kit, however, the secondary wire is not provided but is easily obtained from the same source.

Following on from this, if I want to produce odd voltages, I tend to use a Variac in conjunction with a transformer. The Variac is only a variable auto transformer, therefore the same safety precautions must be used.

I would now like to say how much I enjoy your magazine. I have been taking it from day one, and some of the articles are just what I want. I am not a model engineer, however I do construct clocks which gets me away from amps and ohms etc.

Finally I would like to say that I have covered many aspects of engineering during my life and finally graduated to the dizzy heights of Chief Engineer, where the terms of employment were very simple, as explained by my employer i.e. if your men can't do the job you will and if you can't do it we will get someone who can, and I hope we have a good working relationship (which we did)! To anyone aspiring to be a Chief Engineer, my advice would be, make sure that you employ competent people and find out if they can do the job while you can still get rid of them.

Keep up the good work with the magazine, I hope that I can take it for a few more years yet. (From a very old engineer).

Three phase from an Inverter

From Ken Willson, Fleet, Hampshire

Shelley Curtis (Operating 3 Phase Machinery, MEW No. 62) introduces readers to Inverters very nicely. I avoided the trauma of so-called converters because of their inherent disadvantages as Shelley found, however there is one point he does not mention.

He says he wanted to run his machinery at constant frequency (50Hz) and hence nearly constant speed, so he has missed the opportunity of utilising the other attribute, namely varying the frequency. On the Eurotherm 601 you can use a multi-turn potentiometer (sourced from Electromail) using the 'Remote' switching facility and not only vary the speed, within sensible limits dependent upon your machinery, BUT use it to avoid those occasional resonances which can cause tool chatter.

My own Myford Super 7 not only runs sweeter on 3 phase, you can run under power for clocking and similar alignment, like checking face plate mounted component balance at very interesting low speeds without much risk. With the right motor you can also avoid frequent belt changing over sensible ranges.

Last but by no means least, I mounted mine within a closed box, fan cooled with the Run, Reverse and Jog switches mounted alongside the Speed Control.

From Neil Hemingway, Rochdale, Lancashire

It must be some 40 years ago, when the Rochdale M.E. Society was building its track in Springfield Park, that I first came to use a Myford Super 7 fitted with a 3 phase motor. My job as part of the working party was to face to length what seemed like an unending number of track spacers. All this was done on the business premises of one of our members. What struck me about a 3 phase motor was how smoothly it ran and how responsive it was to the Forward - Off - Reverse Switch. I decided there and then that 3 phase motors were worth serious consideration. Matters lay dormant until recently when retirement offered the opportunity to delve further into this 3 phase motor business. While the electricity people were quite willing to lay a 3-phase supply to my house. The digging of a cable trench across a front lawn was not the sort of project that one wisely puts before the 'chair-woman' of the board. So this idea was dismissed. The next solution was to examine how a single-phase domestic supply could be converted into 3 phase. Two options were available. One was to buy a Converter. These appeared to be a box of electrics, the input into the box being from the ring main and the output used to power the motor. Very useful if you have bought a machine tool where converting the in-built motor(s) and associated switching to single phase could be difficult and expensive. The second option was to buy an Inverter which I look upon as a box of electronics. At this point a very worthwhile investment was made by the purchase of book Number 24 in the Workshop Practice Series, namely 'Electric Motors in the Home Workshop' by Jim Cox. An excellent book and well worth having. This book persuaded me to look deeper into the Inverter market and see just what these boxes of electronics had to offer.

1) On/Off, Forward and Reverse was all done by what is known as 'solid state switching' In other words there are no mechanical switch contacts.

2) The speed of an induction motor is governed by the frequency of the supply. So, by varying the output frequency of the Inverter, the motor speed can be varied. An Inverter has the ability to put out a frequency that the user varies according to needs by just pushing either the 'speed up' or 'slow down' buttons. So a decision was made to buy an Inverter and one made by Siemens in the UK was chosen. At the same time a remote control unit was purchased, a device which looks somewhat like a calculator, having a visual display of just what is going on inside the Inverter. This remote unit is supplied at 15 volts making for safety. It must be realised that a motor made to run more slowly

cannot deliver the same horsepower. So far this has not proved to be any disadvantage, the $^1/_2$ h.p. 1400 rpm 3 phase motor now fitted to the S7 not having shown itself to be under-powered. The cooling fan fitted to the motor runs at motor speed so the amount of air to cool the motor is diminished as the speed is reduced. As yet, the motor has not become over-heated during use.

Has the effort and expense involved been worthwhile? I like to think it has. I can vary the mandrel speed at will; with back gear engaged and on the lowest countershaft speed and the Inverter set to a very low output frequency, such that the lathe mandrel just about creeps round. I have done some thread milling using my QuickStep tool post mounted milling attachment. Hitting the reverse button while the motor is running causes the motor to slow to a stop and then slowly pick up speed in the reverse direction. This slowing down of the motor before it reverses has not shown any tendency for the lathe chuck to unscrew. Metric threads are more conveniently screw cut. Leave the half nuts in engagement and reverse the motor after each successive pass of the tool. The solid state switching within the Inverter well takes care of things. Thread cutting using a tailstock die holder is less strenuous. Run the die up at low speed, reverse and run off at a higher speed. The Inverter does allow for the injection into the motor of a burst of D.C. which has the effect of applying a brake to the motor. So far, I have not used this option.

From Malcolm Stone, Cinderford, Gloucestershire

I read with great interest the article on this subject which appeared in Issue 62 of M.E.W.

As someone who has been involved in the marketing of electric motors of all types over many years, I feel that some additional comments may be worth making.

Electric motors designed for use on hobbyist and even professional machine tools are nearly always either three phase or single phase. The greatest benefit of a three phase motor over a single phase motor is that, (for the same motor frame size), the three phase motor will produce more torque. A three phase motor can also be controlled more easily in terms of its speed, acceleration / deceleration time and torque output etc. than can a single phase motor. The use of an inverter such as the Eurodrive 601 series will give this control of a three phase motor from a single phase supply.

If the features of speed control and so on given by the inverter are not going to be used, why not just replace the three phase motor by a similar output single phase motor?

Three phase motors are cheaper to produce than single phase motors and tend to be smaller than single phase for the same output. Typically a 2 pole (that is nominal 3000 rpm) three phase, foot mounted 0.5 hp motor would cost £66.00. A single phase 0.5 hp motor would cost £85.50. There are many sources from which these motors may be procured. It must however be appreciated that the starting torque of the single phase motor will be lower than the three phase motor.

There is at least one company manufacturing a motor specifically designed for either single or three phase operation; comparative performance is; in three phase, 380 volts operation the motor will output 400 watts at 2,600 rpm nominal loaded speed and is 72.72% efficient. In single phase mode it will output 250 watts at 2800 rpm nominal loaded speed and is 69.44% efficient.

Three phase a.c / inverter drive systems are not the only choice for readers who need a variable speed motor for either their tool-room machinery or as a drive in the models they are making.

Brushless DC motors offer wide speed control (typically 300 rpm to 6000 rpm) with constant torque. They are simple to use, have an exceptionally long life and are being used more and more in electrically powered models, domestic and industrial applications.

A Lazy Susan for a file rack

From Charly Loveland, Mirfield, West Yorkshire

With reference to Tony Birkinshaw's article in Issue 62, readers may be interested to know that 'Turntable Bearing Rings' are available from W. Hobby Ltd. of Knight's Hill Square, London SE27 0HH (Tel. 0181 761 4244). Their catalogue, which is widely available (e.g. from W. H. Smith) lists Turntable Rings in four sizes:-

76mm diameter	Max. load	200lb/90kg
102mm dia.	"	300lb/135kg
152mm dia.	"	500lb/225kg
305mm dia.	"	1000lb/450kg

Tricycles

We have had an excellent response to Geoffrey Walsh's request for information on the availability of a differential for a tricycle (Scribe A Line, Issue 61). Hopefully, by now, his search has been brought to a successful conclusion. Many of the replies pointed to the same sources of supply or information, so there is little point in duplicating them here. We did, however, think that the following two letters contained information which would interest readers.

From John Thornton, Warwick

My attention has been drawn to Mr Geoffrey Walsh's letter and as an eighty year old and a keen tricyclist who owns and regularly rides four tricycles, each different in their handling characteristics, I believe that I may be able to help.
Two of my machines have the Starley-Abingdon differential rear axle which was patented by William Starley on 25th April 1892 and made by the Abingdon Company of Tyseley, Birmingham until the factory was bombed early in the Second World War. The other two are one wheel drive, one having a drum brake on the offside wheel while the nearside is the driver. The other OWD machine is, most unusually, driven by the offside wheel, the whole axle revolving, with the nearside wheel revolving freely on ball races.

Whether a rear wheel driven tricycle is of either type, it has no effect on the steering because, as with a motor-cycle combination, one compensates instinctively. It is interesting to note that the offside brake which, at least in theory, ought to cause the machine to pivot on that wheel when applied hard has absolutely no perceptible effect whatsoever on the steering because of one's instinctive reaction in steering towards the kerb. However, there is one circumstance in which the OWD machine is at a disadvantage compared with the TWD and that is when attempting to climb a, say, one-in-four hill when (or so I am told) the nearside driver will turn the machine round!

Both types are equally popular with riders, indeed racing tricyclists tended to favour OWD types because they are lighter.

Now to types; the most common is the two-rear wheel type. Next, the no-longer-made two-front-wheel Kendrick type which, because of the Ackerman steering arrangements is rather heavier, but does have the advantage of allowing any desired gear arrangement, as with a bicycle. Then there is the recumbent - a type of machine that has its followers but is very expensive and, at least in my opinion, has several disadvantages.

Tricycle riding and building is, like church bell change ringing, almost exclusively an English (not British) preoccupation for I have never heard of a foreign made tricycle. There are at least three firms in England building tricycles at the present moment but many people buy second-hand machines, which are frequently offered in the various cycling journals. However, if the gentleman in question wants a tricycle to potter about on - as opposed to long runs - it might be an idea for him to try to acquire a Pashley - of Stratford-upon-Avon - 'Picador' small-wheel, the nearside wheel being driven through a Sturmey-Archer three-speed hub gear. It is a shopping tricycle favoured by mothers of small children, the latter often being seen perched on rear facing seats over the rear axle. Having relatively small wheels compared with other tricycles, these machines are very stable because of the low centre of gravity. It might be possible to obtain a second-hand specimen by advertising in the local newspaper.

As it happens, we have just received, from Leonard Woods of Koesching, Germany, details of 'Kynast' tricycles of the 'shopping' type, which are made in that country.

From Colin Porter, Blackpool

In reply to Geoffrey Walsh' letter about his friend who is considering a trike, a differential will not cure any steering problem.

Heavy steering is liable to be caused by:- tight head bearings; too much steering trail giving over-strong straight-ahead steering; or simply by the camber of the road tilting the trike to one side and thereby producing auto-steer in the same way as leaning a bike for a corner when riding 'hands off' (although the same effect occurs when riding 'hands on' but one is not so aware of it). The steeper the camber is, the more pronounced the effect. The auto-steer consequently requires a continuous counter effort to maintain a straight line, unless one is riding on the crown of the road.

Although having no experience of riding a trike with two front wheels, I suspect if the trail of the kingpins was reduced enough not to steer down the camber, the steering would be very twitchy and have no inherent straight line stability. A similar effect is obtained if the head angle is too steep for the trail on a normally steered cycle.

In addition, it takes time to acclimatise to a trike. You have to lean your body more on corners, since the trike cannot be leaned (unless one of our ingenious readers makes one) and the steering flicks to one side if one of the off-centre wheels hits a bump or a hole. But it can all be got used to.

Machining hobs

From H. D. Turner, Wakefield, Yorks

The gremlins appear to have got into the letter from Mr. King (Scribe a Line Issue 61) concerning the gear ratio for 3.1416. I think the ratio Mr. King intended is 77/50 x 51/25 which gives the ratio exactly. He would hardly need to use his Brocot tables for these values as 3.1416 will directly factorise to give this ratio. As this value is only an approximation for pi, I was intrigued enough to try to find a closer ratio, limiting the gear sizes to between 20 and 100 teeth and using four gears. My Brocot tables didn't produce anything any nearer, so I decided to use the brute force method, trying every possible combination on a computer. Well, after a couple of hours, the computer finished its job without finding anything more accurate, so Mr. King's value appears to be the best approximation.

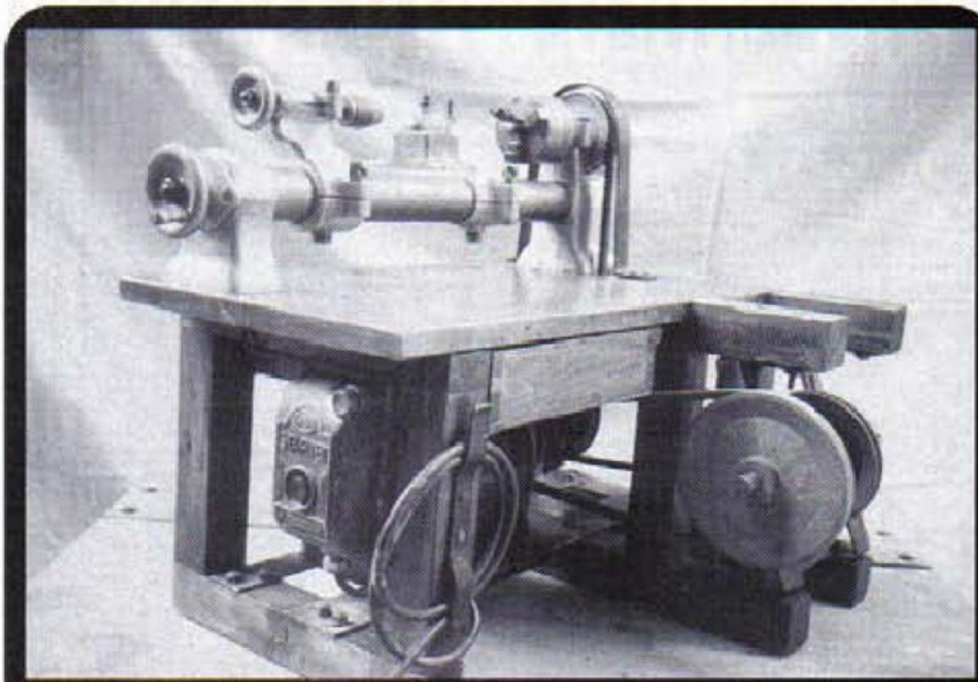
Trimming bolts and screws

From John Feeley, Windsor, Berkshire

With reference to the article by Philip Amos in Issue 59, I was faced with the same problem of trimming small screws, and set about making a lantern chuck device similar to the one described, when I realised that I already had the basis of such a tool.

Owners of Myford 7 lathes who also have the benefit of a set of collets can make use of the nosepiece in conjunction with a No. 2 Morse taper stub mandrel, turned down to provide a seating for the shouldered discs.

Mine has served me well for many years.



'Little John' drive belts

From B. C. Spick, Grantham, Lincs

I have just purchased a second-hand 'Little John' 5in. lathe and I am in the process of a complete refurbishment. I have an Operators Handbook!! for this machine, but this lacks any details of parts breakdown for dismantling. I am particularly interested in information on the drive belts. As owners of these and similar lathes (e. g. Raglan) will be aware, they are provided with a variable speed drive. There are no numbers on the belts which I have and both these and the two mandrel drive belts need replacing. It would be very much appreciated if anyone among our 'esteemed clan' of model engineers could help me with identification numbers of these belts and where I could purchase them. As always, any other information on the Little John would be very welcome.

The Wade lathe

From Arthur Whittaker, Southampton

A friend who was moving away to the depth of Wales was clearing out his workshop. He arrived at the door unannounced and said "I was going to throw this out but then I thought you might be interested in it".

"This" was sitting in the boot of his car and turned out to be a small metal turning lathe with a round bed, as shown in the enclosed photographs. It is mounted on a timber base which supports the motor and belt drives.

The headstock, cross-slide assembly and tailstock are cast from light alloy. The centre height is 2in, and the between-centres dimension is 12in.. It is fitted with a $2\frac{3}{4}$in. diameter 3-jaw chuck. The bed is $1\frac{3}{4}$in. diameter x 20in. long. The mandrel is $\frac{5}{8}$in. diameter x $\frac{5}{16}$in. bore.

There are two labels on the lathe. One reads "Buck & Ryan, London". The other reads "The Wade Lathe, Patent Applied for, Manufactured by D.A.V. Small Tools Ltd, Portland Road, Hove Sussex, England."

I would be grateful if any of your readers have any information on the history of this lathe and the manufacturer. I am particularly interested in how to set up the cross-slide and tailstock: although the keys are a snug fit in the slot in the bottom of the round bed, there is lot of slop between the key and the bolt which screws into it.