No. 17
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MODEL ENGINEERS' WORKSHOP

THE PRACTICAL HOBBY MAGAZINE

DRILL SHARPENER
Full-size drawings

BUILD A WOOD PLANER

SPEED CONTROL FOR AC MOTORS

TEE SLOT CUTTING
Making the tooling

ML10 MAGIC
In this enthusiast's workshop

FOCUS ON MILLING MACHINES

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Issue No. 17

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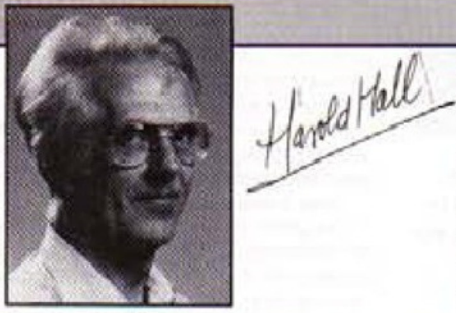


ON THE EDITOR'S BENCH

In this issue

We continue in this issue with our series on motors and their speed control, with some comments on the possibilities for varying the speed of AC motors. One of the strengths of *M.E.W.* is that it meets the need of those individuals who wish to have the satisfaction of making an item of equipment, and for this to be accomplished at a saving in cost over that obtainable commercially. In many cases the finished item will also incorporate facilities considered worthwhile, but not to be found on the commercial products.

From correspondence received, I know that readers are looking for the same benefits from making their own speed controllers. Unfortunately, inverters for the control of AC induction motors are very complex and well beyond the level of complication that could be considered for *M.E.W.* There are doubtless a few readers who have the expertise to construct such an item, and if any reader has accomplished such a feat, I would very much like to learn about this, no article however.

No cheap route

Readers are frequently looking for the possibility of making items using surplus components or materials to save on cost, this would most definitely not be appropriate to the construction of an inverter. Of course there will always be that electronic whiz kid for whom this is not a valid statement. Another factor is that some parts of the circuitry are working at mains potential and use quite expensive components, the potential for danger and expensive mistakes, all make it an impractical proposition. In any case, it is probable that new components, purchased individually, will cost as much, if not more than, a complete commercially available controller.

The article therefore concentrates on those units available commercially, with some background information to enable their working and limitations to be more fully understood.

DC Motor speed controller

In issue No. 3 (winter 1990) of *M.E.W.* an article was publishing relating to a high voltage (110/220V DC) DC motor speed controller. I would like to hear from any reader who successfully or otherwise made this item, and what type of motor they used with it. There would appear to me to be a few errors in the drawings, some of which were referred to in *Scribe a Line* in the following issue. If you can help in this request, an early reply would be helpful, please add your telephone number to your letter.

Brough Superior motor cycles

The article in issue 15 regarding Albert Wallace and his interest in Brough Superior Motor Cycles has been well received, and readers have written detailing their own connections with such machines. Should any readers have now, or have had in the past, a Brough Superior motor cycle, Albert would very much like to hear from you. The information will be helpful in the club's attempt to log the history of all the machines made. Maybe if you have not had a machine yourself, you may know of someone who has one now, or has had one in the past, he would be very happy to learn about any such machines. If you can help, please send your letter to me and it will be forwarded to Albert, who will without doubt make contact with you.

Club Newsletters

Also in issue 15 was mentioned the fact that *M.E.W.* was applicable to many other activities besides model engineering. Many of these would have their own national or international club or association, and I suggested that readers may like to spread the word regarding the magazine amongst the members. It has since occurred to me that most of these national and international clubs will have their own newsletter, in which we may manage to get a mention.

If you belong to such a club, I would be pleased to learn of the address of the club's newsletter editor, to whom I will send a copy of *Model Engineers' Workshop.* Also a workshop visit may be possible and some publicity for the club may result, as it did for the Brough Superior club in issue 15, and the Hornby Railway Collectors' Association (Chris Ford's Workshop) in issue 11.

Correspondence received

Since having taken on the position of Editor of *Model Engineers' Workshop*, one aspect of the situation which I have found both encouraging and surprising, is the amount of correspondence received. Fortunately, very little of this is critical of *M.E.W.* in any way, and in more than a few cases, very much the reverse. Unfortunately this has placed greater demands on my time than had been envisaged, and a little economy appears to be a requirement. Many readers who have corresponded with me will have found that in an attempt to limit the time taken, and to ensure a prompt reply, I use a range of standard letters. Even so, I have reluctantly come to the decision that, for the time being at least, unless correspondence poses a question and therefore requires a reply, an acknowledgement will not be sent. I do hope readers will not find this too unacceptable. The only thing I do not wish to do by making these comments in the magazine, is to dissuade any reader from writing who otherwise would have done. So please do keep sending in your thoughts, and as I mentioned in an earlier issue your telephone number may be of help.

Material Specifications

Have you ever been making a number of parts on the lathe and going along very nicely, until a new bar of material has to be started and found to be not so free cutting as the last. Of course the responsibility for this is both that of the user and the supplier, the supplier cannot be expected to be that specific, if the user is not that demanding, or does not mark up the stock as to what he or she has in their possession.

I can remember the time, at least in the U.K., when potatoes were just potatoes, well maybe we had reds and whites, but that was as far as it went. Now we have potatoes bagged and marked, as a requirement of law I think, with such names as *Cara, Desirée* and *Romano.* To enable the best uses to be made of these we are told which are good for chipping and which for baking etc. To what extent the information is made use of in the home may be questionable, but it is there for those who feel the need. No doubt this information is now available as a result of the discerning consumer demanding it.

Should we, the home workshop user, not be more demanding regarding the materials we purchase? To assist in this some details are intended to be published in a future issue of the magazine as soon as the details can be established. If anyone has any information or observation that they feel may be helpful in preparing the article, I shall be pleased to hear from you.

Mark it

It is probably that material purchased to a given specification will get stored along with other material, and if not adequately marked, its precise type will become obscure. To overcome this, mark one end with the type using number and letter stamps and always cut off material for use from the other. If stamps are not available then just centre punch the end, say one mark for BMS type EN1A, two marks for stainless and so on.

Thought provoking

In the last issue I commented on the standard of design evident in the items published from time to time in *M.E.W.*, and explained that if perfection were the requirement, then filling the magazine on a long term basis would become difficult. Of more importance I considered, was the fact that articles were frequently published to be thought provoking and thereby encourage the reader to put his personal stamp on a design.

Even before this was published a letter was being penned by Chris Ball of Canada making largely the same comments from the reader's point of view. The letter is published in *Scribe a Line.* What do other readers think?

Readers Survey

Elsewhere in this issue you will find a readers survey. We regard these as extremely important, the results give us a good idea of what you think of the magazine and its contents. It also gives the back-up departments to the editorial team a good chance to build up a profile of the readers of *M.E.W.*

Can I ask you to spare a few minutes and fill in the questions, we will even pay the postage. I am sure that a good response will assist everyone involved in the production of the magazine to bring it even closer to what readers require. With all sorts of minority interests in the readership, it will give us guidance on how best to cater for their needs, as well as those of workshop enthusiasts.

SCRIBE A LINE

Your views, your pages! Your opportunity to make your point, ask the question or simply pass on a snippet of interesting advice to others. Your letters for publication in Model Engineers' Workshop are always welcome

Denham lathes

Can any reader help Mr M Sorkin to determine the screw cutting gear train requirement for his Denham lathe?

I have acquired a Denham lathe No. 3091 but without all the gears for screw cutting. I can obtain gears and modify them but am unsure of the sizes (number of teeth) to obtain, as I am having a problem when attempting to cut threads.

When cutting threads I find that subsequent cuts do not always line up with those made earlier. I am an experienced turner having been employed in that trade, and am using the thread indicator as per normal practice. The output for the gear train is not taken from the end of the lathe mandrel as is more normally the case, but from an auxiliary spindle taken from the end of the geared head. I wonder if the ratio between the lathe mandrel and the auxiliary spindle is not 1:1, and is therefore causing me to having a problem. Can any reader advise me, perhaps telling me the number of teeth required on the gear train, or alternatively the way to establish these myself? Does my other reader also own one of these lathes.

Making a Box Angle Plate - ageing castings

Ron Bernhardt, author of a recent article, answers my question regarding the ageing of castings. Fettler and Derek Walters also comment

In answer to your question, at the bottom of column one on page 47 of the article, may I offer the following comment:

"The purpose of the ageing process is to remove the locked in stress/es that are generated, in the casting during the cooling stage, which could otherwise cause permanent distortion subsequent to the finish machining operation/s. Experience has shown that the natural relief of these stresses requires periods of from three months to two years. For industry today, the method is outmoded.

"If one has access to the equipment the easiest and most effective method of stress relief is to heat the casting, in a furnace, to full red heat, about 850 deg. Centigrade, and soak at that temperature for at least one hour (this time period is actually dependent on the bulk of metal in the casting) afterwards the casting is allowed to cool slowly, either in the furnace or remove it to some other safe place protected from the chilling effects of air draughts e.g. buried in ashes, sand or lime.

"Another approach would be to rough machine all of the faces of the casting, including the inside of the box, before any finish machining is carried out.

"I guess any action taken in this regard will depend on the degree of "concern", given to the matter, by the constructor."

From Fettler

I would like to mention that, in answer to your 'Editorial' query on page 47 of Issue 15, castings were left outdoors to 'weather' for at least three months (up to six if time permitted) so that they could normalise and stabilise. There was some concern in the motor trade when high production rates came into being for cylinder blocks and cylinder heads; the 'Old School' reckoned that unless the castings were allowed to weather they would never hold their accuracy or alignment when machined. I have heard it said in this context in days past that "A piece of old iron was far better than a piece of new".

And from Derek Walters

I worked many years man and boy for an internationally respected firm of specialist electric motor manufacturers, cast iron frames and brackets when received were shot (not sand) blasted, coated 'Suncorite 245' (anti corrosion) and left outside for 1 to 2 months as a minimum. Fabricated frames and brackets and shafts were normalised, shot blasted, given 2 coats of 'Suncorite 245', then left outside for 2 weeks as minimum before pre-machining. After pre-machining left a further 1 week before final machining.

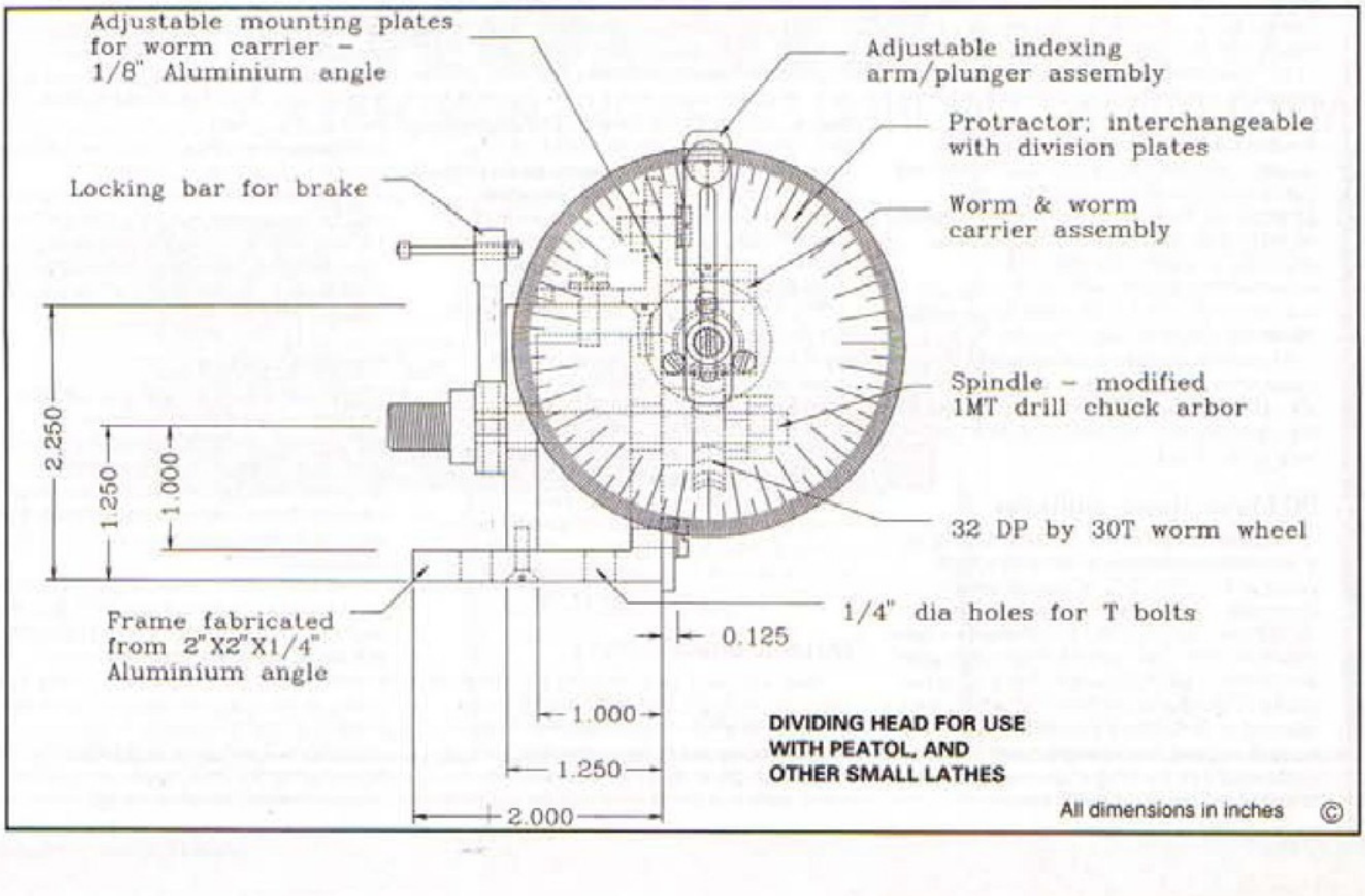
Aluminium cast frames and brackets were shot blasted when received and left for 2 weeks before pre-machining, then a minimum of 2 days before the final. The above is fairly typical of machines built to M.O.D. N and V. standard.

Peatol lathes

Tony Jeffree is in the process of expanding the usefulness of his Peatol lathe, and on route has found his C.A.D. package to be user friendly

I purchased a Peatol lathe about a year ago, intending to learn "the craft" with the aim of trying my hand at clockmaking. I suppose that I am not alone in discovering that with most of my model engineering activities, a considerable proportion of the time is spent in constructing additional jigs and tools to supplement those available commercially; at this rate, my first clock will be complete in around ten years from now...

I realised early on that a dividing head would be an essential accessory for the Peatol lathe, and that with suitable design it could serve a variety of purposes in addition to the obvious one of indexing for



DIVIDING HEAD FOR USE WITH PEATOL, AND OTHER SMALL LATHES

All dimensions in inches ©

gear cutting. Hence, the enclosed diagram, which shows a side view of my prototype dividing head.

I am currently thinking through the constructional details of the 1MT version of this device, with a view to building a second head. The enclosed drawing was done using AutoSketch for Windows; I was given a copy of the software as a Christmas present and thought it would be a good learning exercise to try and draw the head. My verdict so far is that is extremely easy to use, and as you can see, produces drawings of very high quality (subject to the expertise of the designer in using it!).

(Hopefully some articles on making attachments for the Peatol lathe will be published later in the year, as articles have been promised, but not yet received. If you are a Peatol owner, we would like to receive your offer of an article, or two.

The article on CAD has been delayed, in the interest of maintaining a balanced content in the magazine – Ed.)

A thinking curve

Chris Ball of Canada considers that the designs proposed in most *M.E.W.* articles are the starting point, rather than the final conclusion, for any item to be made from them. I am inclined to agree.

May I add that I find the magazine generally excellent and a stimulus to thinking, even if I don't build anything from a particular issue. I like to evolve my own designs, or "improve" on published ones to suit my purposes, but most things are a synthesis of ideas "stolen" from others who, no doubt, did the same thing. We do, after all, learn virtually everything from others, past and present, so that even "original" ideas have the seed sown from somewhere, even if we can't identify it. I did build two of the six-station saddle stops (Apr./May'92) but reduced the number of pieces by adopting the form of Myford's own rear-mounted stop. Thus a central bushing serves as bearing, retainer, index and alignment adjustment – only three main parts in all. I changed the mounting plate for the stop bars to accommodate an existing spring loaded stop (from M.E.*), which is more versatile in some circumstances, so both are available at all times. Nothing very clever, of course, but they probably wouldn't be enhancing my lathe if these authors hadn't been willing to share their efforts. What really irritated me was that Mr. Vickery should use the quick change box for a mount when the idea had not even crossed my mind in the hundreds of times I have studied my lathes! "He who has eyes ..."*

I would like to throw one 'brick,' however. I consider the inclusion of advertising within the body of M.E.W. *not only a nuisance, but a deceptive practice in as much as advertising pages are numbered as though they are part of the text. I find it much more awkward to look back to find ads and don't like articles split up.* M.E. *was, until recently the same, so this would appear to be a poor policy of ASP. I used to be in the habit of reading ads front and back before tackling the letters and articles and knew where to look when I wanted to order. Sorry, but I'll probably tell advertisers I won't deal from internal ads.*

Stainless steels

Here are some comments from a commercial environment on the machining of stainless. These have been sent in by G.F.A. Dartnell

I noticed in M.E.W. *a query about working with stainless steel. I work with stainless steel a lot in my job, solid and sheet form. Our welder uses TIG welding, you get a nice neat weld, no splatters like you do with stick welding. I always clamp my work before welding also clamp stiffeners to help stop distortion, stainless warps a lot when welded. When machining or drilling stainless I drop the speed by about one third of what I would use for mild steel. When using hole saws or jigsaw I run my drill or jigsaw through a speed controller otherwise it burns them out. When cutting stainless I use Rocol cutting fluid, for tapping I use Trefolux cutting paste when turning or milling I have the coolant running full blast. When drilling, tapping, dieing or turning I always use H.S.S. tools.*

I hope this is of some use.

Esoteric materials

M.J. Atkinson would like to know more about the less common materials

Whilst I appreciate the differences between some steels and alloys, I am unable to find information about some of the less popular alloys, such as Hiduminium and magnesium alloy to mention just two.

Would it be possible for any reader to provide information, or details of a source of information, on the various materials available, their properties and uses. I seem to remember an alloy, lighter than HE15 and HE30 aluminium but much harder, which would be ideal for crankcases.

Also where can I find a supply of Delrin?

Stainless steel in Boat building

Derek Walters, one of our boat building readers, comments on the use of stainless steel and other materials in such an environment

I gained experience from building and operating a boat in mainly salt water over a period of late 1960's to 1981, mainly in the Poole/Southampton area, down to Exeter and to Shoreham. Before starting to build I went around several of the yards that still built wooden boats, gleaning useful information on do's and don'ts in general. Keep off stainless fittings because then not much was known about them, keep off brass at all costs unless it was Admiralty brass was the 'word'. The buzz metal then was silicon bronze.

I built my Lysander bilge keeler sail boat from mahogany marine ply, glued, nailed, and screwed using silicone bronze, it was expensive but lasted the boat's life until I sold her. (She is now on the Thames at Lechlade.)

The prop. shaft was sil/broz. in a rubber bearing, the prop. al/broz., both in as new condition when sold.

However, the rudder was very heavy and made from teak, its pintles and screws were Stainless steel, type not known at time of purchase, but came from a well known chandler in Poole.

On a fair calm day off the Dragons Teeth reef off Swanage on going about the rudder fell off without warning, it was saved only by the emergency halyard. I got home by lashing a paddle as a rudder, I could only just control her.

The metal was literally eaten away where the two converging strips came together along the inside, although I always checked the boat prior to setting out, this fault was unseen until it failed. It could easily have cost my life. The pintles were changed for expensive sil/broz. forgings, also the screws. Never, never use brass screws or nails in a wooden boat below the water line, if they failed in a heavy swell she could well split open. Don't use them where they can be in contact with salt water or even salt laden air.

The problem is rapid dezincification of nearly all brasses except Admiralty brass, a hard brass. Looked at under a microscope it looks sponge like, and has only about ⅛ or less of its original tensile strength. This can also apply to chrome plated brass as was found out on the Egyptian dredger, the Kofo *in 1964.*

Forged head and rolled thread steel screws, black steel nuts and washers if shot (not sand) blasted then heavy zinc plated or Sheradised and kept well painted are a good cheap alternative under the water line, fit them using Duckhams Keenol marine grease (so you can part them later), if looked after will probably outlast stainless.

I enclose a photocopy on stainless problems which may prove of interest. (Send a S.A.E. marked 'Stainless Problems' for a copy of this - Ed.)

Square and polygon holes

D.I. Oxley briefly suggests an approach for making hexagon sockets

I was recently shown a copy of Model Engineers' Workshop *(I think it was No. 14) which contained on pages 14-16 an article titled "Drilling square holes" and which also mentioned polygons. The underlying*

message was that one needs a special drill unique to each size of hole and also to each shape, ie, number of sides, together with a hardened guide plate containing a hole of the exact size and shape of that to be subsequently machined. At the end of the operation the hole formed would not accept a true square or polygon by virtue of the internal radii at the corners. For those of us for whom model engineering is a hobby and for whom the formation of such holes will be but a few spread over a lifetime, is all that aggro really necessary? (No, but it is an interesting principle - Ed.)

In the case of holes the skilled craftsman (and I am not amongst their number) can file out to shape from a starter hole. Broaching causes some deformation of the metal and is more appropriate to "garden *engineering". In the case of sockets a machining operation is necessary anyway and it makes sense that the basic method be common to both holes and sockets.*

In Jan 1992 I machined a socket formed on the 6-WD (Wall Drive) principle to suit 0.525in. A/F hex in MS, and more recently machined a hole to suit ⅝in. A/F hex in brass - which I reckon to be the smallest size that can sensibly be tackled by we amateurs.

The Sketch shows the arrangement and the actual machining operation becomes an exercise in setting up with disciplined control over the movement of the various feedscrews.

Boxford: information sought

Roy Stone of the Philippines suggests some areas for possible articles, we will always be pleased to receive your offers. On the other hand, if you are unable to provide a complete article, perhaps you can send some comments on the subjects in the form of a letter for publication in S.A.L.

Boxford lathes never achieved the popularity of the Myford with model engineers although visits to technical colleges and other institutions of learning suggest they found a market amongst the student population.

As a consequence Boxford owners have been starved of information covering accessories and alterations to basic machines. I have long hoped to see an article on a leadscrew hand-wheel, possibly using gears, but to no avail. Any offers?

Some years ago there was mentioned in a letter to Model Engineer *of a motor-cycle clutch grafted to a Boxford underneath drive countershaft, together with a disc brake I believe. Details given were insufficient to really allow a copy to be made and space in the cabinet is extremely limited. Suggestions would be well received.*

More recent accessories for lathes, milling machines, etc. include electronic position read-out devices. A variety of sensing bars seems to be available at widely differing prices and it would be useful to have a comparison between them plus a few hints on fitting methods which the average owner could adopt.

As always I look forward to future issues of M.E.W. *which is a brilliant concept. Does anyone have a surplus of early issues?*

Quick tips – a bumper bundle

My request for quick tips in issue No. 15 has proved very fruitful, but will still be happy to receive more. I am however publishing these from John Redbond and D.M. in Scribe a Line

From John Redbond

1) I have not used a conventional scriber for 30 years or more. I use an Eclipse No. 122 pin chuck with a size 1/5 darning needle. These needles are only 60p for ten and when one becomes blunt I just replace it with a new one. One always has a sharp scriber without having to re-sharpen and I find that my marking out is more accurate.

2) The article on hole gauges prompted this one.

I have a list of the Decimal sizes of all twist drills from ¼in. to 13mm. The list is in size order starting with the smallest and I use these as hole gauges which I find are quite accurate enough for my purposes. I also have three Moore and Wright hole gauges. ½in. to 2⅛in. to cover the larger sizes. I enclose a copy of my list just as an example. (Send a s.a.e. marked Drill Sizes for a copy)

3) The article on the foot switch prompted this one. I use an old, cylinder, vacuum cleaner for clearing dry swarf from my lathe and milling machine and this I control with a foot switch. Not home made but bought from a radio junk shop.

The cleaner will not handle large amounts of "curly" swarf, of course, but it's great for small chippings and cast iron dust.

I know not whether you will class these as "Quick Tips", but I find them very useful.

As for the magazine!. I am not a mechanical engineer by profession but I enjoy reading it very much, I find it very informative and continue to learn from it. I particularly enjoyed the article on building a garden workshop. It is well written and illustrated.

I also take Model Engineer, *and have done for more years than I care to remember. I find the two magazines complement each other very well.*

And from D.M. (with a little bit of humour thrown in)

Thank you for M.E.W. *I have every issue carefully filed and frequently referred to with as much pleasure as at the first reading.*

I note from 'On the Editor's Bench' issue No. 15 that the stock of quick tips is diminishing. You mention also time being at a premium. And I though myself to be the only sufferer! At least that is my excuse for failing to write earlier. Herewith, in haste, are a couple for the quick tip file if of any interest.

1) We probably all find that swarf has a habit of landing on the data plate of the q.c. Gearbox (in my case Myford Super 7) and in the course of its removal, may scratch the surface. To avoid rendering the data illegible, cut a rectangle of clear acrylic sheet or similar material, the same size as the data plate, round off the corners and cut two holes in the sheet. The centre hole should be slightly larger than the boss of the change lever and the second hole in the top right hand corner should be slightly larger than the base of the oil nipple. No other fixing has been found necessary. The thickness of plastic used was about 0.03in. which is sufficiently flexible to be persuaded into position. A paint brush whisks away the swarf in seconds. No scratches in 20 years.

2) How many of us, having produced with great care, an accurately graduated index collar, have experienced the grief following a mistake with the number stamping? 40, 50, 90, 70. Guilty m'lud. Avoid it this way. Place a small square of 'Blue Tack' or similar material as close as possible to the work piece and as a last operation prior to stamping, lightly press the number into the 'Blue Tack'. In this simple way you will not only have selected the correct punch but will also have it "right way up".

3) How often do we find that the finer drills instead of obligingly starting in the centre punched hole try to ride round on the surrounding ridge thrown up by the swaging action of the punch? An old gunsmith's dodge will greatly reduce this tendency. Grind three faces on the centre punch point at 120deg. to produce a point in the form of a three sided pyramid. Stone these faces to produce clean sharp edges. The indentation now produced by the punch will of course be triangular. See the difference!

4) Medium Speed Tip: A representative came into the dispensary the other day and seeing the serrated cap on my lemonade bottle asked if he could have it. Since I don't care for flat lemonade and the bottle was nearly full I suggested he have something else. He said he wanted something to fit this. "This" being the thumb-wheel from an East European camera tripod, the material being aluminium alloy and the periphery smooth. I was amazed that such a thing should have been marketed. Apparently his intention was to saw a slice from the bottle cap and Araldite it into position. It seemed to have the makings of a bodge-up so I suggested he knurl the thumbwheel. A glazed look in the eyes, an open mouth and total silence indicated my ideas was not well received. A prod in the ribs restored picture and sound so I enquired if he had a lathe? No. A thread-restoring file perhaps? No. But you must have a bench vice with reasonably parallel jaws and a 10in. flat file with safe edge? Yes. "In that case", said I, "Salvation is at hand. You can knurl it". Sound went off again so before picture began to jitter, I explained the method.

Place a clam of softer material than the work piece (say a short length of plastic angle) over the fixed jaw of the vice. Lay a piece of wood slightly less in thickness than the diameter of the work piece between the vice jaws so that when placed on the wood the work piece will lie flat at about mid-jaw height. Place a short length of mild steel plate or similar bent at 90deg. over the moving jaw. Grease this and the safe edge of the file. Introduce the file between the vice jaws, safe edge to mild steel clam, milled edge to edge of work piece. Carefully hold the file horizontal and close vice so that the milled edge of the file engraves the edge of the work piece to the depth of the milling. Proceed carefully and with patience. When the above conditions are met, gently tap the end of the file with a soft faced hammer in order to drive the file horizontally through the jaws of the vice. If the right conditions are met a very passable knurl will be rolled onto the edge of the work piece. More than one attempt may be required but a little perseverance will be rewarded.

After about a week, curiosity prevailing, I telephone the enquirer about the result. His sweety pie answered the 'phone. My question was answered in a rather strange way; "I haven't seen him all week. He's been shut away in the shed making tapping noises. He came out yesterday and gave me the housekeeping money all in copper coins, funny thing was though, they all had rough edges like 10p pieces. I can't understand it".

Sounds as if you have a potential new reader of M.E.W.

Weather Vanes

From Mr V J Kelly

I would like to make a weather vane, can any reader please provide me with a design, or details of any book which will include a design or designs.

(A group of designs appeared *M.E.* 6 November 1992 - photocopy reprints are available – Ed).

Garden workshops

The Rev. Ronald Hatfull expresses his views on the subject of workshop wiring

The contribution by M. Hudson in the February/March issue, Building a Garden Workshop *was of particular interest as I built a similar, but smaller, workshop a few years ago.*

Some concern must be expressed, however, about the electrics.

I am of the very firm and considered opinion that all wiring in such buildings should remain visible by being fixed to the surface of the inside of the building and not buried in the internal cladding insulation.

The reasons for this are -

(1) The wiring can be of the correct size for the load, with no risk of over-heating.

(2) With the wiring remaining visible, there is much less risk of it being damaged when fitting up shelving etc. Even when it is known where a wire is situated, or it is thought that it is remembered, it is all too easy to put a drill or a nail through a concealed wire.

(3) Needs change over a period of time and however well the wiring is planned there will come a time when a socket or a light fitting is required in a different place. When the wiring is visible and surface mounted it is a simple matter to make any necessary alteration. With concealed wiring such alterations are very difficult or impossible and which leads to 'temporary' hook-ups with extension leads or other trailing leads that are themselves hazardous.

One other matter of safety is the reference to a 'Distribution Unit'. This is not specified but it must be emphasised that a safety device such as an Earth Leak Circuit Breaker is absolutely essential in a workshop situation. Fuses and 'trips' (ordinary circuit breakers) may protect the wiring but they operate far too slowly to protect an operator of electrical equipment.

(To comply with the requirements of the IEE Regs surface wiring must be protected if run in any position where accidental damage is possible. This is likely to be almost everywhere in the home workshop – Ed.)

Going metric

Jonas Beausang of Sweden wishes we would use more metric units *(so do I - Ed.)*

I enjoy M.E.W. *very much and I have been a subscriber from the start. But I wish more dimensions were given in mm.*

In issue No. 11 the editor stated that he will make an attempt to achieve a gradual change towards metric units. I don't think we have seen much of that yet, but hope for it to come soon. (With so many articles already available, mostly in Imperial units, it is not easy. Converting articles from Imperial to metric is time consuming and difficult and only possible for a few. I do hope you will soon notice a move in this direction, but it will be years and not issues away before the change is complete, Ed.)

I have a Swedish Blonquist lathe, centre height 4½in. It has a 3 phase 1½ hp motor with variable speed control. It has every thing I could wish for except a T-slotted cross slide. I have a drill/mill for milling operations but there are times I wish I had a T-slotted cross-slide.

I have been thinking of bolting on a T-slotted table but the thought of drilling holes in the cross slide puts me off.

The other solution would be to have a professional workshop make one for me and that is expensive I understand. Are there any other solutions? (Have readers any suggestions to offer?)

Oiling Myford Lathes

P J Crampton refers to a recent Scribe a Line letter

I have read the article on this subject in the recent Feb/March M.E. Workshop *it all seems very complicated.*

For some 50 years I have oiled/greased with an unmodified gun on nipples of all construction by the simple expediency of putting a piece of rag between the nipple and the gun.

I have a very ancient Myford Super 7 lathe the only problem nipple being that on the step pulley on the clutch until I ground the business end of the gun down slightly to fit. The same gun works equally well on oil or grease but I usually use car chassis grease.

Hope this will be of help.

Hobbymat modification

D.I. Dawson suggests this simple idea for a catch plate for the Hobbymat MD65 lathe

I have just read Mr R. Knoe's letter in Scribe a Line *for Feb/March 1993 about lathe chuck back plates. I have a Hobbymat MD65 lathe and when the chuck is removed from its backplate, or chuck flange, as the handbook calls it, 3 tapped holes (M6) equally spaced on a pitch circle are revealed. By making up a pin from ⅜in. diameter mild steel and turning one end down to suit the M6 thread, threading it then screwing the pin into one of the 3 holes, the back plate becomes a catch plate with its driving pin or dog. This is ideal for turning between centres and there is no need for a separate catch plate although I believe one is available for the Hobbymat as a faceplate is also of course.*

Dodges for threading

Mr E.T. Bartlett suggests a method for getting worn taps to cut a little larger and dies a little smaller

As Workshop Steward in the Club Workshop a young member came to me and asked have we got an adjustable tap for Myford Mandrel nose thread 1⅛in.x12 TPI He sent off for the Backplate and it was too tight, would only go on halfway. I said better too tight than too loose. I had a suitable tap but it was well worn, it was passed through but did not remove any metal. So it got me thinking; back in the 1930s when I was a Wireman working in large factories, offices and Town Halls where all wiring was carried out in Screwed Tubing (Steel) up to 1½in. diameter with hand dies. These dies were solid, and when you came to doing a running thread for joining 2 tubes that could not be turned due to bends, it was necessary to make easy threads to run the Socket down by hand, a new die would not do this, so the trick was to tin it. You got an old milk tin, cut a strip ⅜in. wide 1¼in. long and fold it in the vice into a right-angle, lengthways. You tucked this into the die for finishing cut. I did a similar thing for the 1⅛in. tap. I held the tap in the vice and screwed backplate by hand with piece of 3 thou. brass shim. It worked perfectly. All wiremen used this method. Screwing tubing all day was hard work compared with plastic tubing and trunkings used today.

Ready made timber buildings

The following is an extract from an interesting letter from Royce Limb

The construction article by Mr M. Hudson prompted the following thoughts. He is to be commended on his thoroughness, which also appears to reveal considerable background knowledge of the subject.

Due to a house move I was more or less compelled to purchase a ready made timber building and in so doing, though it was new, several mistakes were made due mainly to lack of sufficient forethought. I quite enjoy woodwork and would have preferred like Mr Hudson to have built a purpose designed one and taken the time to have done it properly, had circumstances allowed. For anyone thinking of buying new I have found out since that for our purposes to house quite heavy and valuable machinery, buildings advertised in equestrian publications such as loose boxes for horses are much sturdier and can be comparibly better value for money than those such as mine from commercial 'shed' builders. For the the original building measuring 20ft.x10ft. I say original because a 12ft.x6ft. extension has now been married on to one end at right angles to it, to get the welding and cleaning tackle into a more compatible environment (not possessing a garage). This also may be helpful in that the chosen material for this is the profile steel sheets as used nowadays to construct industrial units, except mine are the small 1in. profile and not the very large sort. Carefully thought out and and cut to size very easily done with a 9in. electric disc cutter, five 12ft. sheets did the lot. These were purchased subsequent to an advert by 'Rose Steel Sheets' of Market Rasen, Lincolnshire who I found very helpful and fair on price. The sheets were built on to 2x2in. timber framing with the correct sealed fixings supplied and finished off at the front elevation (the only one seen from the garden) with an attractive door, window and weatherboard assembly, which has resulted in a complimentary and pleasing feature to the workshop. The roof will now require a suitable inner skin as a condensation barrier and provision has been made for air circulation through it.

The sheets are aluminized both sides with exterior finished with a weatherproof coating. They can of course be painted if desired for additional protection.

Rose Steel Sheets are on: 0673 843973. Contact Mr Rowley Boulten.

Balzar or Belzer – can anyone assist?

Brian Oliver of Australia is seeking information regarding a device that he has used in the past, the trade name of which is *Balzar* or perhaps *Belzer.*

This is not a device that I have any knowledge, therefore can any reader help in any way. Does any reader have such a device and could give brief details of its construction and method of use.

Many thanks for a very interesting magazine and the very useful tips. I have a question which I wonder if either yourself or a reader could assist me with.

Many years ago I used a Balzar Backing Off Device, this for making such items as milling cutters, and it worked well. I would like to receive any details of this simple device and whether it can still be purchased, if so, from where?

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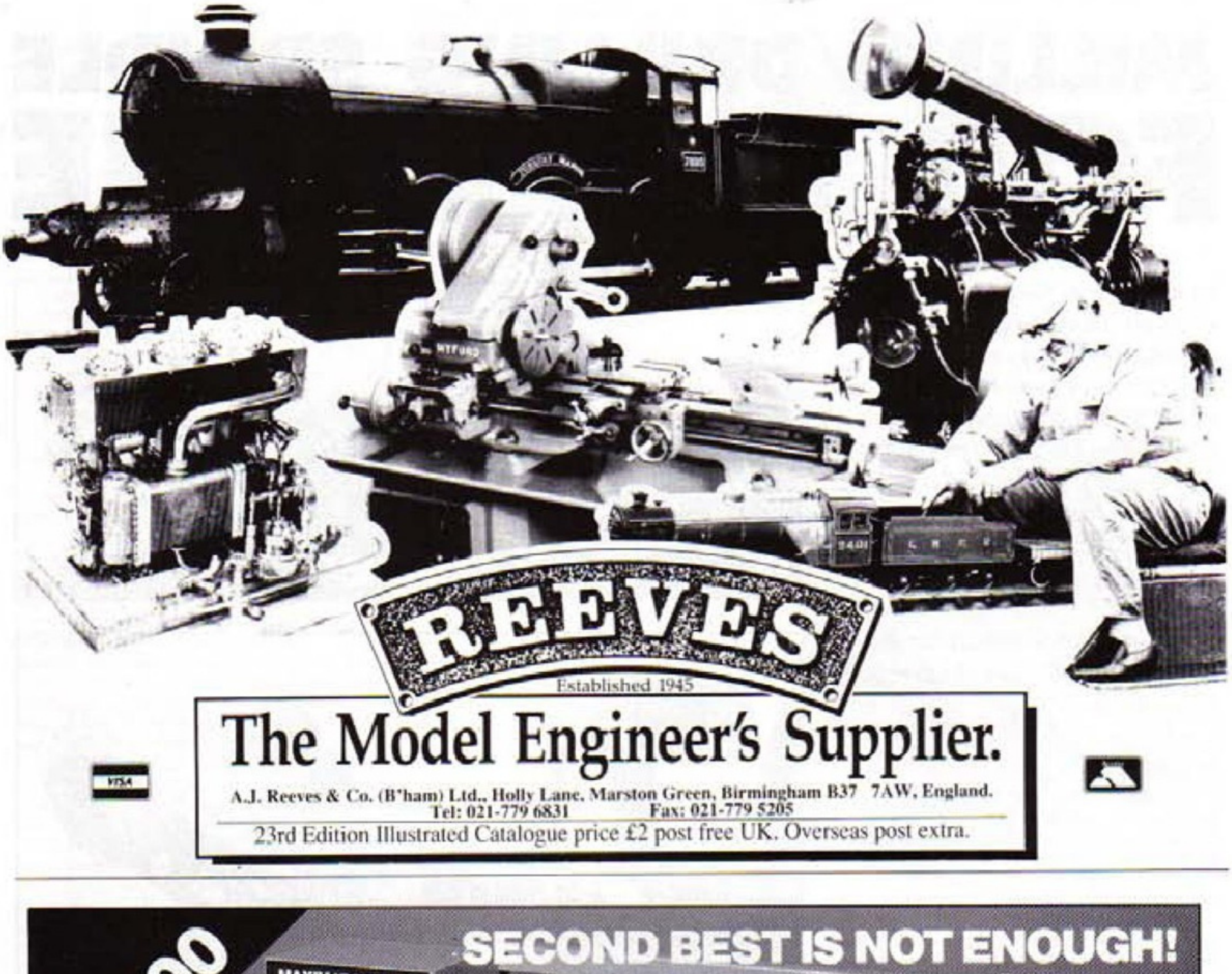
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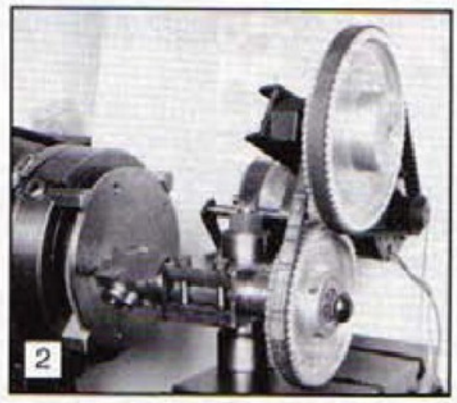
MILLING/DRILLING SPINDLE FOR THE LATHE

In this article Tony Skinner discusses the design for a small milling/drilling spindle he is in the process of establishing. It is to be a rolling bearing version of a sleeve bearing spindle he has already made, this is the one seen in the photographs. He discusses alternative bearing arrangements for the spindle, and gives some brief, but useful, information for the application of rolling bearings in general.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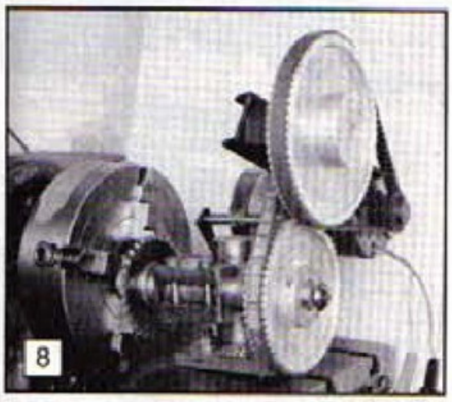
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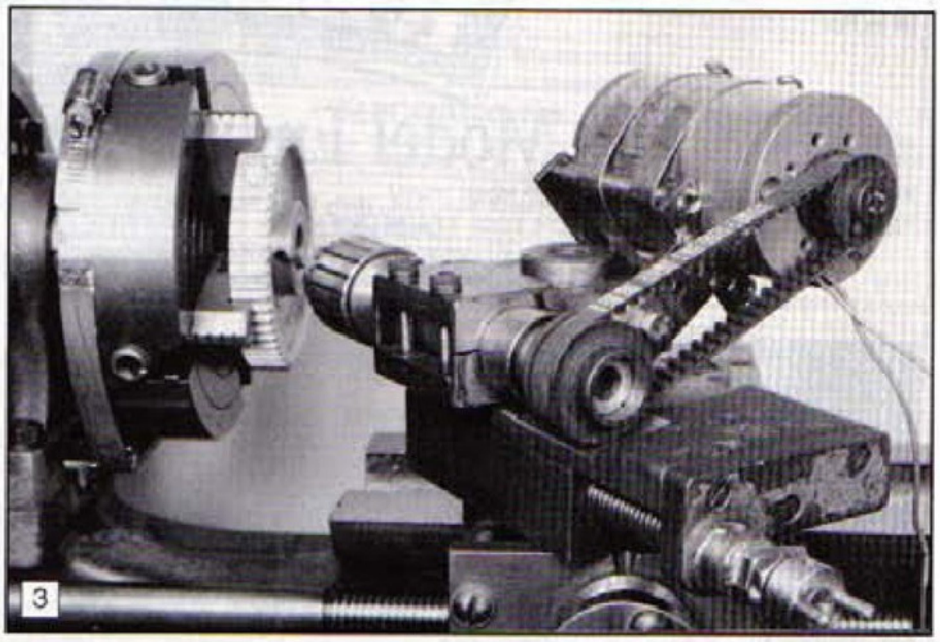
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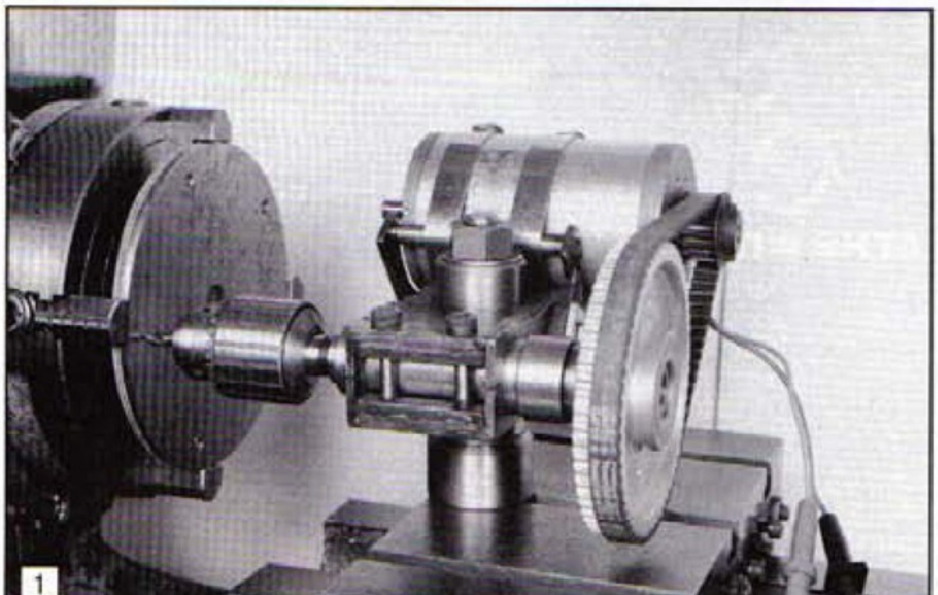
1. Outline

The detailed description of a milling spindle by A. Longworth in Issue 13 is most interesting, and vividly illustrates the great versatility and value that can be provided when such a spindle can be used in conjunction with a lathe.

I have been developing a milling/drilling spindle system to mount on my old Myford Type M lathe (previously Drummond 3½in. flatbed) over very many years. A further substantial development is in the current list of priority projects. However, the following notes show the principles on which its concept is now based and, hopefully, will be of interest to stimulate ideas in other readers.

Photos 1, 2, 3 and **8** show examples from amongst its formats and possible uses, from which other uses can be readily imagined. Section 5 discusses possible modes of use in rather more detail.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The main advantages seen for this concept are as follows.

1) Alternative reduction driven ratios (one- or two-stage) are available between the motor and the spindle, allowing a range of usage formats and a wide range of spindle speeds, from a little under motor speed (of around 3000 r.p.m., down to below 200 r.p.m.).

2) The unit is very compact, and in whatever format the whole unit is used, the sub-units bolt together to form a single assembly which clamps onto a single 1.25in. dia. pillar. This allows use of the unit in a wide range of different ways, e.g. on a vertical pillar bolted to the cross-slide; on a pillar bolted to the vertical slide; the unit clamped to the 1.25in. pillar which is integral with my top-slide (then available for milling or drilling at an angle to the lathe axes); on a pillar which can be tilted along the lathe longitudinal axis (then permitting thread-milling with V-edged disk or single-point cutters).

3) The HTD toothed belts and pulleys used in the drive are very good for power transmission, and can transmit substantial power to the spindle even at the lowest spindle speed.

4) Being somewhat modular in concept, modifications could be made to one sub-unit without very much effect on any others, or, if desired, alternative sub-units could be developed for specific purposes.

It should be carefully noted that my current spindle shown in all the photographs is a plain-bearing 2 MT spindle and is held in a fabricated clamping block. However, I intend, for reasons summarised in Section 4, to change this to a 2 MT spindle running in ball bearings, and this is the form of spindle proposed in Section 4. This change would not affect any of the usages shown. However, if anyone considered a plain-bearing spindle to be adequate for their needs, they could easily adopt that format.

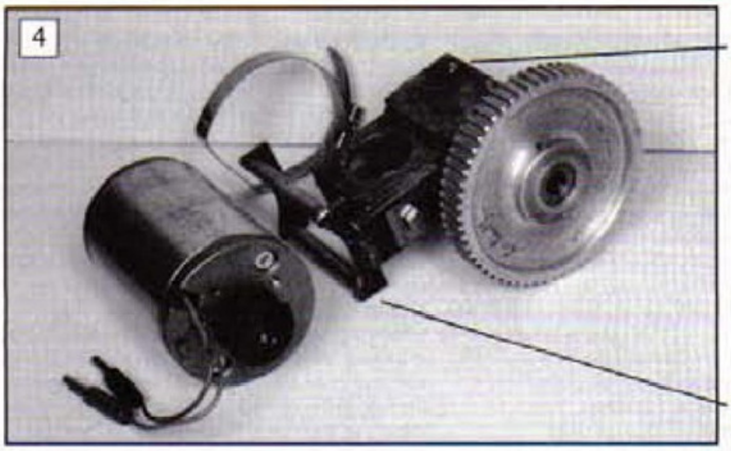
The cross-slide on my lathe is a plain boring table with Tee-slots (see Photo 1). Most straight turning and boring is now done with the Myford Dickson quick change tool system. However, for many years a plain 1.25in. dia. pillar was used, this bolting directly to the cross-slide. Tool-blocks then clamped onto this pillar as required, and this system has proved very rigid, and also versatile in geometry. In fact, the only parting tool used even now is an inverted one mounted in a block at the correct height on its own 1.25in. dia. pillar, which pillar is then bolted to the T-slot at the rear of the cross-slide. This particular pillar does have a base of 1.5in. dia., but this set-up has never shown the slightest evidence of lack of rigidity.

My top-slide bolts onto any of the cross-slide Tee-slots and, as noted above, has an integral 1.25in. dia. pillar onto which tool-blocks etc. can be clamped at the required height (see **Photo 3**).

Clearly, other methods of attaching cylindrical pillars could be fairly easily devised to suit other lathe cross-slides, top-slides etc., and any convenient diameter could be chosen that would give adequate rigidity.

The overall milling/drilling spindle system comprises three main sub-units (and in describing these, where a specific name is to be used repeatedly, it is italicised below). Firstly, there is the 2MT *spindle* (item 3) with its *clamping block* (item 2), which clamping block clamps onto the appropriate 1.25in. dia. pillar. Secondly, a *support frame* (no drawings, see photographs), bolts onto the clamping block and carries the motor parallel with the spindle, with various provisions for adjusting the motor position and drive belt tensions. Lastly, a drive system of toothed belts and pulleys, allows various reduction ratios between motor and spindle speeds of between 1.25:1 up to 19.2:1, to transmit the 60 watt of motor power to the spindle. When this drive system is used in its two-stage reduction format, it uses a *carrier arm* (no drawing) which then carries the *intermediate spindle* (no drawing) with its permanently mounted 72-tooth and 15-tooth pulleys. (See also **Photos 4** and **6**.)

As noted below, some finer details of the design become specific to the motor anyone decides to use. It is perhaps also to be commented that some of these finer



details have an appreciable content of three-dimensional geometry in them, which I was not able to resolve on the drawing board, and so had to solve by "trial and error correction" on the pieces.

2. Motor

The overriding item of this overall system is the motor. This has to be small enough and light enough to mount on the spindle clamping block itself (requirements considered not met by the Parvalux ¼th HP AC motor), and yet powerful enough to do useful machining. However, developments in permanent magnet materials are permitting major improvements in motor performance. The motor used was advertised in *M.E.W.*, in 1991 by Proops Distributors Ltd. However, this company is no longer extant, and possible alternatives are noted below.

The motor used has a plain cylindrical body, 65mm dia. by 95mm long, with 8mm spindles each end of 15 and 25mm length, and weighs 1.2Kg. It is rated at 30V, 2A, 3300 r.p.m., stall current 20A. This is much below ¼th HP, but it has proved remarkably powerful for its 60W and small physical size and, used with due consideration in this layout with the alternative reduction ratios available, is able to do some quite striking machining.

I would not know whether motors approaching these parameters could be available from other second-hand sources. However, Parvalux have some permanent magnet motors whose published parameters sound eminently suitable: key parameters from the Parvalux catalogue are given in **Table 1** below. For

Table 1 Parvalux motors

Motor type	Supply	Body size, mm		R.P.M.	Output power, watts			Approx. weight, Kg
		o.d.	length		cont.	1 hr.	15 min.	
PM 10	DC	66	112	4000	60	75	100	1.2
				3000	45	55	70	
PM 11	DC	66	131	4000	90	110	130	1.6
				3000	65	80	100	
PM 1	DC	78	153	4000	120			2
				3000	90			
SD 13	AC	130	153	2800	150			5.3
SD 11B	DC	99	144	4000	125			2.84
	shunt			3000	95			

comparison, some parameters of their current ⅛th HP AC induction motor, Type SD 13, and a DC shunt motor, SD 11 B, are also included.

I gather from the Parvalux catalogue that the rating of these permanent magnet motors would be marginally reduced when powered from a full-wave-rectified supply. These permanent magnet motors, PM 10, PM 11 and PM 1, are available for 12V, 24V, 50V, 110V or 200V DC supplies, and have nominal speeds of 4000 r.p.m. i.e. slightly above mine. Obviously, their input power requirements are somewhat above the output powers listed above.

I have not used these Parvalux permanent magnet motors, but their parameters look extremely attractive and they might be somewhat easier to mount. The reduction in weight and size of the PM motors over the AC motor, and even over the DC shunt motor, is striking!

As people must generally use other motors than that which I used, only outlines are given here of my method of mounting, etc., since this must be adjusted to suit the particular motor used and the user's preference.

As a simple design to get my prototype system going, the support frame for my motor consists of two rods, welded into end-plates so as to be parallel to the spindle, and with all projecting parts of the end-plates filed away so that the motor seats solely onto the two rods. One of these end-plates is slotted, and bolts onto the clamping block. The motor is then clamped in its required position on this support frame by two Jubilee clips. See **Photos 6** and **4.** (See under Section 3 for comments on alignment and tensioning of the drive belts.)

The motor is powered from a transformer and bridge rectifier, normally at 30V. However, the transformer that happened to be available does in fact permit lower voltages to be supplied to the rectifier should this be desired.

3. Drive System

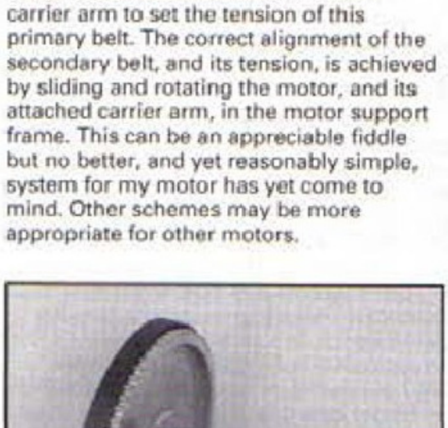
The other crucial feature of the overall concept is the drive system which employs HTD toothed belts and pulleys from The Davall Gear Co., the belts being of 5mm pitch and 9mm width. This system has excellent power transmission capability, including in the final stage of the 2-stage format (far more than a smooth belt could give), together with coping with small diameter drive pulleys with close spacing of the pulleys (which the Poly-V belt system might find somewhat limiting). The system can be used either in a 1-stage, or a 2-stage, reduction drive format. The motor is normally used with a 15-tooth pulley

For normal 1-stage reduction, a 60-tooth pulley is put on the spindle, this being the largest that will permit the spindle to operate at the lathe centre height, giving a 4:1 reduction and a spindle speed of about 800 r.p.m. **Photo 1** illustrates this format. In this mode, the motor is moved longitudinally in its support frame for alignment, and the whole support frame moved out on its slot to set the belt tension.

For very light work, or if space is limited, the spindle can be fitted with a much smaller pulley, as illustrated in **Photo 3**, where the whole unit is mounted on the top slide. The minimum pulley size is that whose central boss can just be bored out to fit the drive end of the spindle: this can be determined from the detailed information in the Davall catalogue. In my case this was the 20-tooth pulley, and the drive grub screws are drilled in through the roots of two teeth.

In the 2-stage reduction format, **Photos 2** and **8,** the 15-tooth pulley on the motor drives a 72-tooth pulley on the intermediate spindle giving a 4.8:1 reduction in this first stage. A 15-tooth pulley is Araldited alongside the 72-tooth pulley on the intermediate spindle: if the 60-tooth pulley is in use on the spindle, then an overall reduction of 19.2:1 is achieved, giving a final spindle speed of under 170 r.p.m., which will permit quite large tools to be mounted in the spindle, e.g. fly-cutters or end mills of at least 1in. diameter. Under these conditions the 15-tooth pulley on the intermediate spindle could transmit of the order of 120W power, which is much more than my motor can supply. To minimise power losses, the intermediate spindle is mounted on two small shielded ball-bearings Araldited side-by-side in a flat-sided housing which just fits between the side arms of the carrier arm. See below and **Photo 6**.

The carrier arm to carry the intermediate spindle is shown in **Photos 6** and **5.** As the end-plate to my motor has very conveniently placed bolt holes, a strip arm bolts to these, and is bent to bring the 72-tooth pulley into correct line with the motor pulley: it has reinforcing side-arms welded to it for stiffening. Shaping this arm to achieve the required alignment was very much a "try it and see" operation, and the whole item could still benefit from a bit more reinforcement where the side-arms join the section that bolts to the motor endplate. A screw-end from the base of the intermediate spindle bearing housing slides in a slot in the outer end of the carrier arm to set the tension of this primary belt. The correct alignment of the secondary belt, and its tension, is achieved by sliding and rotating the motor, and its attached carrier arm, in the motor support frame. This can be an appreciable fiddle but no better, and yet reasonably simple, system for my motor has yet come to mind. Other schemes may be more appropriate for other motors.



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As will be seen in **Photos 5** and **6,** the side-arms have had to be cut away a bit in particular places to clear the second-stage belt in some particular geometries of use. This was another aspect of three-dimensional geometry I could not predict on the drawing board, and had to do by "trial and error-correction".

Clearly MIG welding is a particularly convenient way to attach the side arms. If you do not have this facility, nor any friendly MIG operator in a local ME club or ME evening class, might you be able to get some local garage to weld the pieces up to your direction: Alternatively, I guess that, with careful fitting and pinning, and a good sized blowlamp, the assembly could be silver-soldered, though obtaining any additional stiffening at the edge of the motor endplate, if desired, would be difficult.

The required drive belt length to suit particular pairs of pulley sizes and pulley centre distances has to be worked out fairly carefully. The Davall Stock Gear Catalogue referenced in Section 6 gives the accurate formula for this, together with other essential data. Section 6 also gives data for the belt/pulley combinations that I have found suitable.

If it were essential to drop the spindle speed further, this could be done by reducing the supply voltage, but at the expense of a considerable loss of maximum power and torque.

Clearly, my 60W motor has not the power to give high metal removal rates, but given sharp tools, with moderate cut depths and feeds, extremely useful machining can be done.

At present, the pulleys attach to the motor and 2MT spindle by v-ended Allen grub-screws engaging in grooves in the spindles. Under intermittent cut conditions, these have shown a tendency to vibrate loose, for which no convenient solution has yet been devised.

IT is also to be noted from the information above, that this drive belt system could handle the power from at least the Parvalux PM 11 motor, whilst the overall system could easily cope with that motor weight and size.

4. Spindle and mounting block

The present 2 MT plain-bearing spindle has done all so far asked of it, but is on the list of priority projects for replacement by a ball-bearing unit. This is for five main reasons.

a) For historic reasons, the bronze bearing sleeve to the current spindle is 1in. o.d., which is too thin, so that the clamping force that can be applied to it is very limited, or it pinches the spindle.

b) I feel that having the main spindle in ball-bearings would be better suited to the relatively low power of my motor, and would cope better with the high end-load of drilling.

c) I want to add a 1⅛in. x 12 TPI screw thread to the spindle nose, so that Myford 2 MT collets can be used in this spindle, and it is not worth doing this within the present bronze sleeve.

d) The secondary belt in the two-stage reduction format requires appreciable tension to retain engagement on the relatively small contact arc of the 15-tooth pulley driving the 60-tooth pulley at fairly close centres and heavy load. Again, ball bearings seem more suitable.

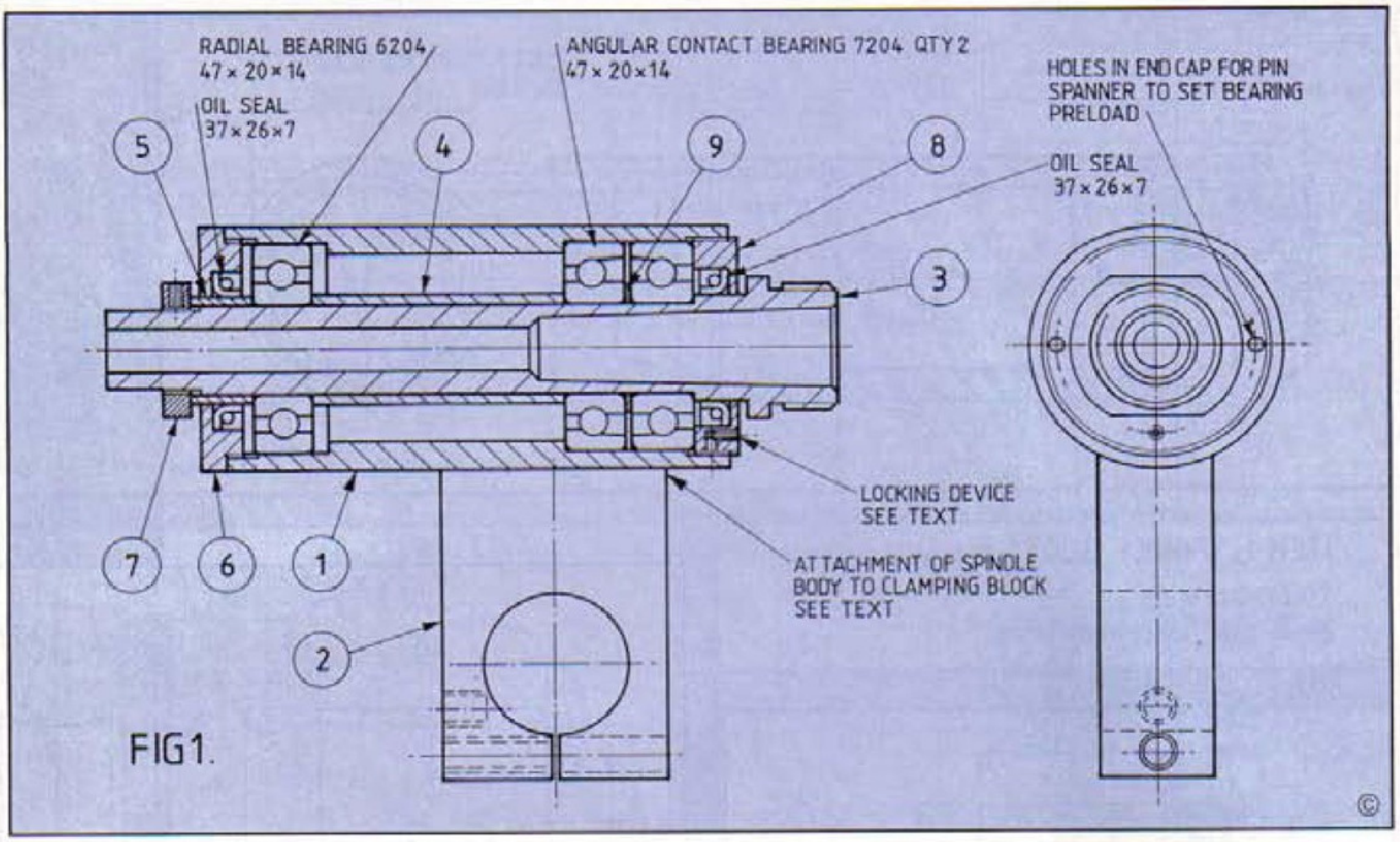


FIG1.

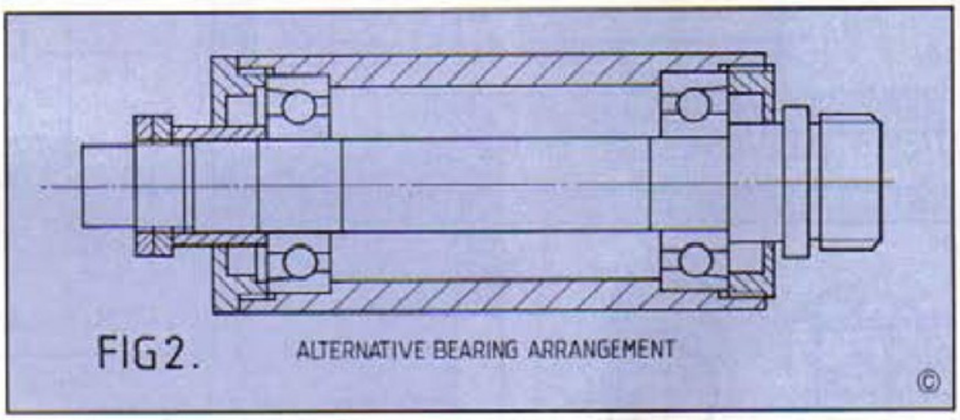


FIG2. ALTERNATIVE BEARING ARRANGEMENT

e) This change to a ball-bearing spindle can be done with only a small increase in dimensions, and, with the somewhat modular concept, has no effect on the other sub-units.

The question of choice of bearings, and their arrangement, raises some interesting questions in view of the power and versatility of this spindle. This is a very new field for me, but the comments below are my best distillation of the information I can glean – if anyone else can improve on them, I should be delighted. Also, the reference bearing guidance rules are formulated for long running hours, particularly in relation to fits of races onto spindles and into housings, and I do not know if these can be eased for the very limited running times likely for most home engineers.

Obviously, as will be more clearly shown in Section 5, this spindle, with its power and versatility, can be subject to very high longitudinal forces (e.g. as when drilling moderate or large holes), but must also withstand large lateral forces when doing many other operations such as milling or flycutting. In addition, on some other occasions, it could be subject to appreciable "pull" forces: by far the largest of these, and with which the spindle in my opinion must be able to cope without risk of damage, would be in drill "breakthrough", and possibly even drill "dig-in".

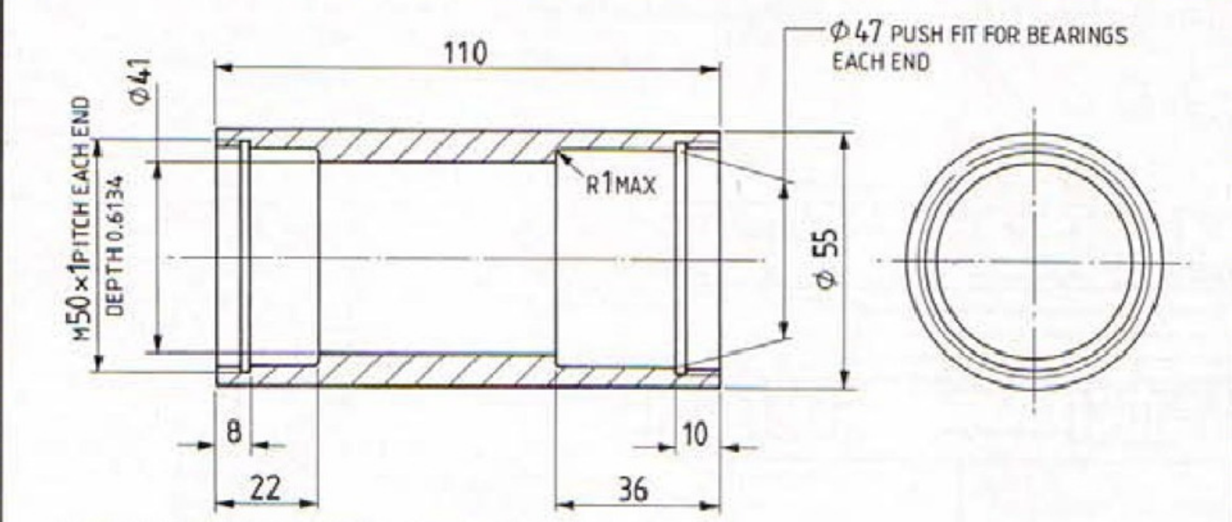
The ball bearing type designed to cope with combinations of high longitudinal and radial forces is the angular contact bearing. In this bearing, one race, usually the inner, is of a deep groove, symmetric, geometry. However, the other race has its arc of curvature almost entirely toward the "thrust" end of the bearing, with only a small projection on the other "non-thrust" end of the race. The dimensions are arranged so that the line of contact of the balls to the races should be inclined at an angle to the radial, with 20 deg. being common. **Figs. 1** and **2** try to illustrate this. However, to ensure that the balls track correctly and close to this under all combinations of radial and longitudinal load, it is desirable that each bearing should be preloaded in its thrust direction. This is normally done by another angular contact bearing set the "other way round", and if these two are correctly adjusted to preload each other, then they can accommodate any proportion of radial to axial load.

It is true that standard deep-groove radial bearings will withstand quite substantial thrust forces in either direction. However, to do this, the inner race must move longitudinally relative to the outer race in order to develop an angular contact to resist the thrust. This means that the bearing must have some radial clearance, and rather more for a higher thrust: as a result, as I understand things, a close-tolerance bearing with smaller radial clearance, and hence smaller contact angle, has a lower thrust capability.

A further point concerning the angular contact bearings is that they are specified to take thrust from one direction only and are nominally "non-separable". This latter means that, as supplied, the inner and outer races will not come apart, and this is achieved by the small interference from the

QUICK TIP

For cross drilling shafts make a single sided vee block by clamping the material in the tool post, or four way turret. If you do not have a proper vee cutter, make a line of overlapping centre drill holes followed by finishing off slowly with a HSS countersink drill. Mark the top of the block to avoid using it the wrong way up. Your cross holes can then be drilled, even at an angle if required by just swivelling the top slide and centre drilling gently to get the hole started. **Colin Porter**

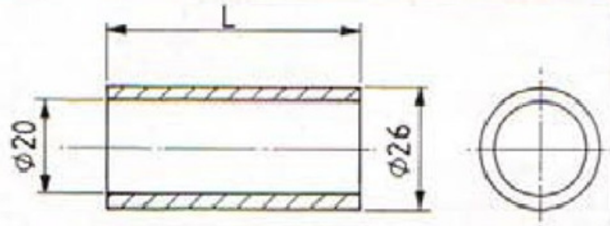


ITEM 1 SPINDLE BODY MILD STEEL QTY 1

DIMENSIONS IN MM

THIRD ANGLE PROJECTION

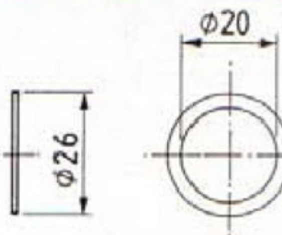
©



ITEM 4 SLEEVE MILD STEEL QTY 1 L=55

ITEM 5 SLEEVE MILD STEEL QTY 1 L=13

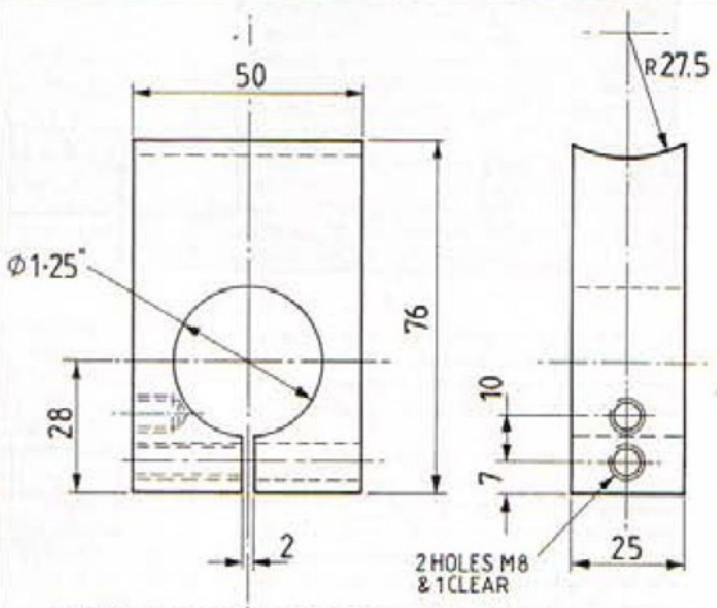
©



ITEM 9 SHIM WASHER

SHIMSTOCK QTY 1

©



ITEM 2 CLAMPING BLOCK MILD STEEL QTY 1

©

outer race on the non-thrust side mentioned earlier. However, a corollary is that if a thrust were applied to an angular contact bearing in the "wrong" direction, i.e. a "pull", there is very little contact angle available to resist this pull so that very high wedging forces could be developed in the shallow taper, with the risk of rapid damage or malfunction. As well as for the possibility of "pull" on the spindle in use, this fact should be remembered in the (hopefully remote) eventuality of having to dismantle the spindle for any reason.

The bearing arrangement that I would expect to use is shown in **Fig.1**, as a drawing of the complete spindle and its clamping block. The key points about this bearing arrangement are:

a) the two angular contact bearings are mounted in the front housing. Their inner races are spaced apart on the spindle by a shim spacer washer, and are clamped longitudinally (together with the rear bearing inner race) by sleeves and a clamp nut. The outer races are preloaded against each other by (very carefully!) tightening up the front screw cap, this cap then being locked against further rotation.

b) the rear of the spindle is located by a standard radial ball bearing, its outer race being just free to slide in its housing to accommodate differential thermal expansion, if any. There might be a marginal advantage for this bearing to be of a higher precision grade with reduced radial internal clearance.

The only alternative bearing arrangement that I see for consideration for the duty of this spindle, is shown in outline in **Fig.2,** where just two angular contact bearings are used and the preload is applied to the rear inner race. However, in my view the arrangement in **Fig.1** is not significantly more complex, and has advantages, as noted below, that outweigh the small extra cost of the additional bearing.

The requirements for both **Fig.1** and **Fig.2** are:

a) to meet installation guidelines, the inner races for both arrangements should be a light press fit on the spindle to avoid "creep" (see Footnote below). This degree of fit is very demanding for the home engineer to produce, although Loctite is available as a fall-back.

b) for both, it is more important not to apply excessive preload to the angular contact bearings through a "mechanically stiff" system, or rapid bearing deterioration may arise – I guess that the amount of movement between "just right" and "excessive" is very small.

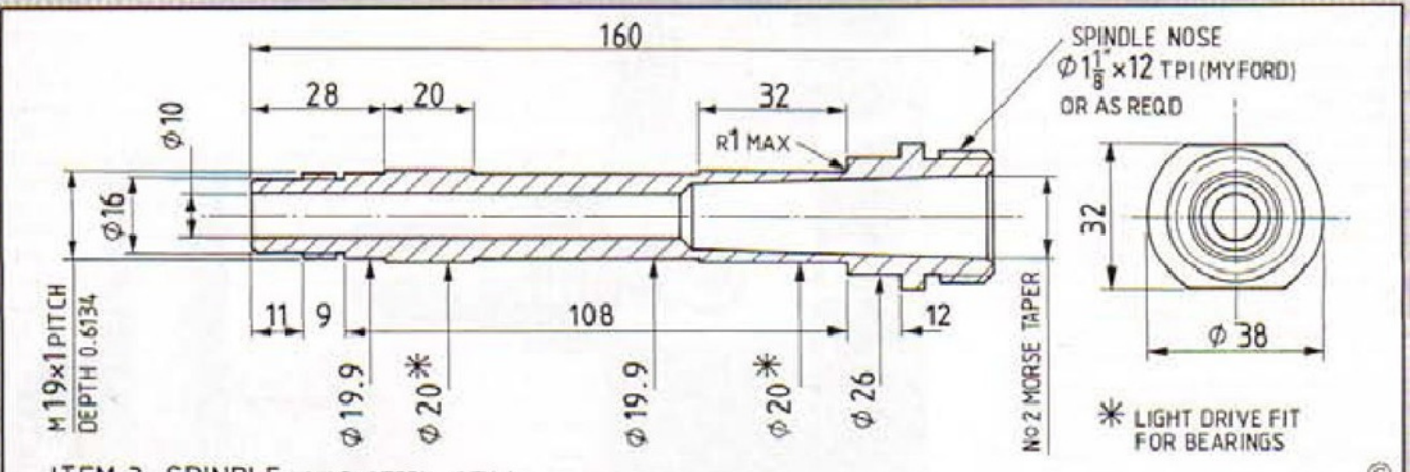
c) for both, the outer races should be as close a fit as possible in their housings consistent with being just able to slide. This is in part to ensure that the unit can be taken apart for maintenance, etc., without risk of damage to the angular contact bearings.

FOOTNOTE

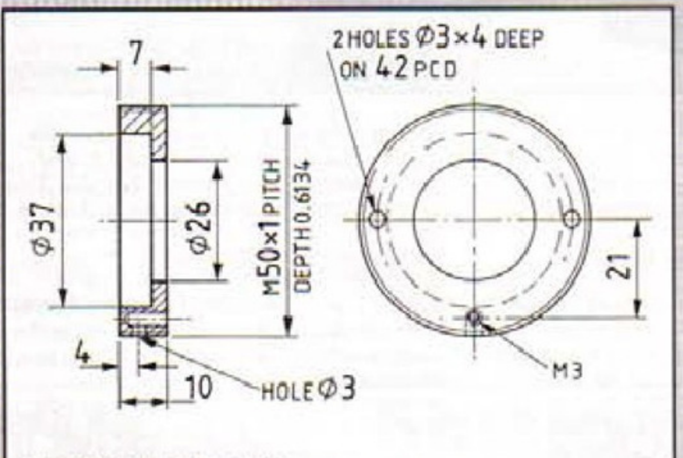
"Creep" of bearing races

The bearing guidelines make repeated reference to avoidance of race "creep", by use of interference fits (or adhesives). The following summary is my attempt at an explanation of this.

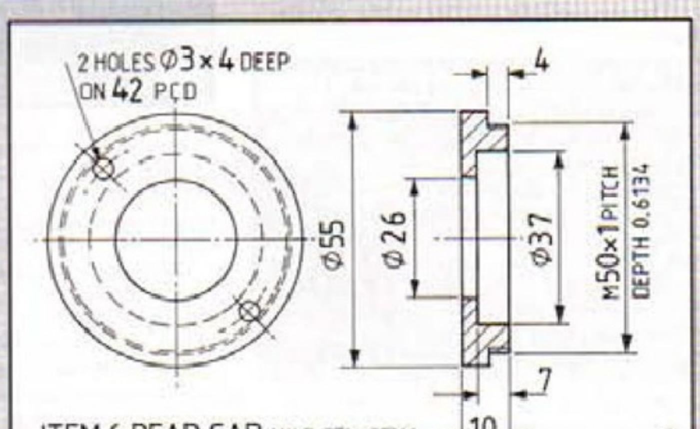
Race "creep" can arise if:



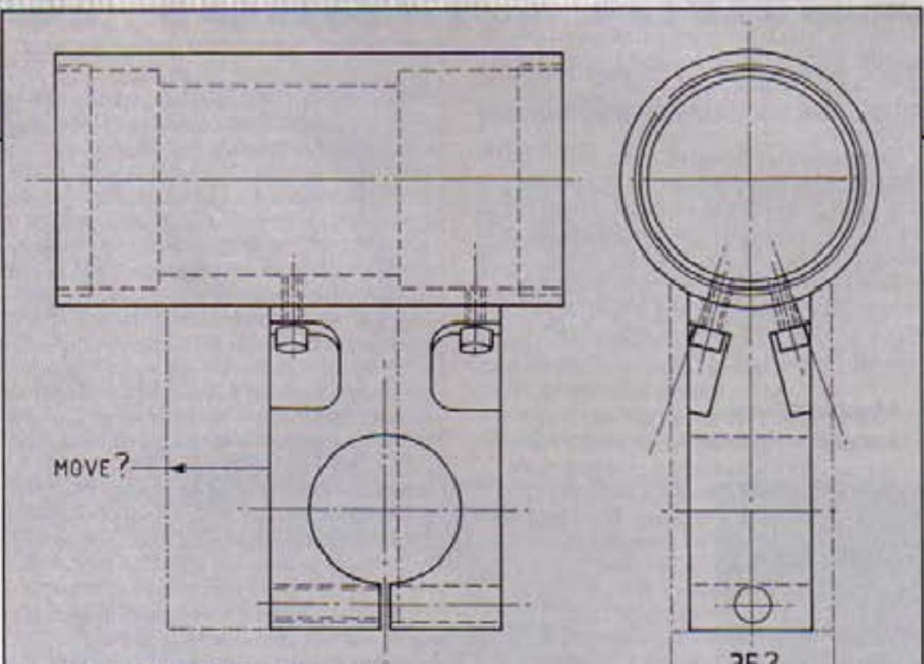
ITEM 3 SPINDLE MILD STEEL QTY 1 ©



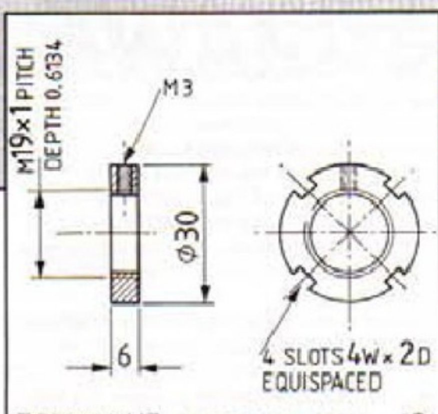
ITEM 8 FRONT CAP MILD STEEL QTY 1 ©



ITEM 6 REAR CAP MILD STL QTY1 ©



EDITOR'S SUGGESTION FOR FIXING ©



ITEM 7 NUT MILD STEEL QTY 1 ©

a) the service radial load line rotates with respect to the race and its seating
b) there is some degree of radial clearance between the race and its seating.

It occurs as a slow differential rotation of the race with respect to the seating. Both have the same linear velocity where they are in contact at the radial load line but, due to their slightly different circumferences due to the radial clearance, they rotate at slightly different speeds, giving rise to the "creep". If creep occurs, wear can arise and further accentuate the effect. Longitudinal clamping is not given any credit – I guess because, in a lubricated environment, the longitudinal force to prevent any radial movement would have to be many times the radial load, and hence is not significant.

Therefore, for a fixed direction of radial load applied to a rotating spindle, the inner race must not have any radial clearance with respect to the spindle. However, if the fixed direction of radial load is applied to a rotating outer race, as in a car wheel on a non-rotating stub axle for instance, then it is the outer race that must not have any radial clearance with respect to its housing.

For both the above cases, the other race of the bearing can be a sliding or loose fit on its seating, as the radial load line direction does not change with respect to the race.

The disadvantages that I see to **Fig.2** are:
a) if the spindle warms up at all, relative to the housing, due to heat from the bearings or from a nearby cutting tool such as a

flycutter, then the preload is very rapidly lost. However, I am not able to judge how important this might be for most home engineers.

b) with the inner race a press fit on the spindle, if it is slightly over-tightened in preloading, it will be necessary to tap the spindle forward within the rear bearing before another attempt can be made, and so preloading may be a bit tricky.

The advantages to the arrangement of **Fig.1** then seem to me to be:

a) the angular contact bearings are so close to each other that there is no significant length for differential thermal expansion

b) because the outer races are a sliding fit, preloading may be appreciably easier because any overload can be immediately released by slackening the cap screw, and similarly preloading can be easily readjusted in service, if ever necessary.

The shim spacer washer on the spindle between the two angular contact bearings can be made out of any convenient shim material. The requirements are that it be accurately flat, of equal thickness all round with no burrs, and a reasonable fit on the spindle. I would hope to produce it by using double-sided adhesive tape to attach a rough-cut shim disc onto a prepared face, and the to trepan out the washer and hand-trim any burrs.

Preloading the two bearings would be done by very carefully screwing in the front screw cap to just remove all trace of spindle end play. This cap would then be locked against any further rotation by a locking device – which device would offer scope for ingenuity, I'm sure! My best current idea is for an Allen grub screw with tapered end, in a longitudinal tapped hole, which hole in turn mates up with a radial hole which emerges into the screw thread of the cap. A copper plug would be in the radial hole, and when required, would be pushed out radially to engage the screw thread of the spindle body by the taper on the end of the Allen grub screw.

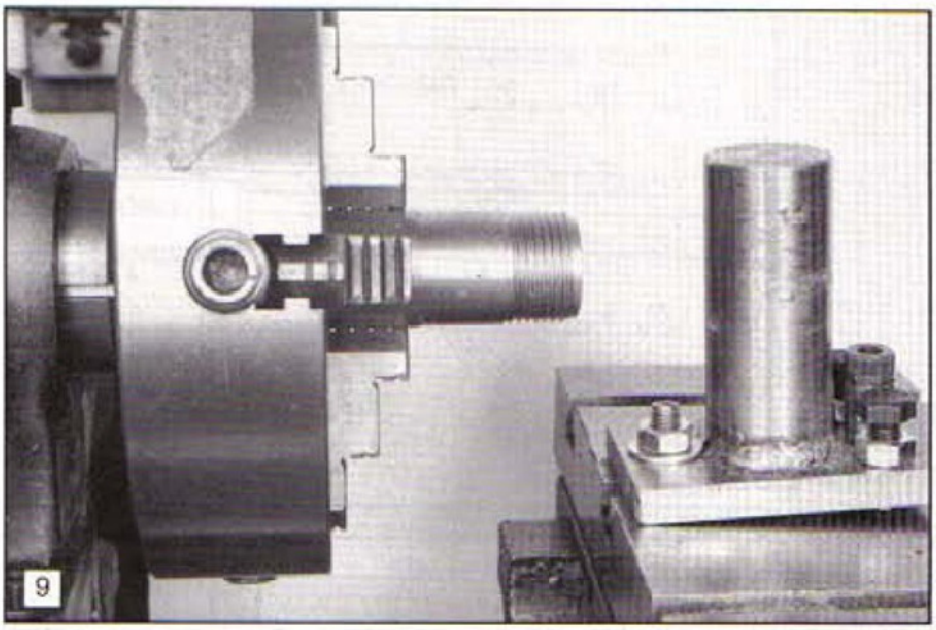
With regard to the method of attaching the spindle body of **Fig.1** to the clamping block, I have MIG welding facilities, but I am undecided between two main possible ways to do this attachment. These are as follows:

a) Glue the clamping block to the finished-machined spindle body with a high strength, peel-resistant adhesive, e.g. Araldite 2005. This might be quite a good application for this sort of adhesive.

b) I think I could get away with welding the top and bottom edges of the block to the rough-machined body by a series of quite small separate tack welds, keeping these tack welds as far away as possible from where the bearing housings will be, and hoping this keeps the residual welding stresses small enough to avoid undue distortion in subsequently machining these housings.

Alternatively, if one made the spindle body rather larger in o.d., and moved the clamping block back to just behind the two angular contact bearings, one could then drill through one side of the finished spindle body a clearance size for Allen capscrew heads and machine a seating for these capscrews in the bore on the other side. The capscrews would then screw into the endface of the block to lock the body on, whilst the entry holes would be plugged.

You choose the lesser-risk route, in relation to your available resources and judgement! At the moment I am torn between *a)* and *b)* partly because I feel it would be valuable to find if either, or both, could meet the requirements.



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Other alternatives could be:

d) A casting.

e) Deep-run weld the top and bottom edges of the block to the body in their rough machined state. However I think one would then have to stress-relieve the finished structure, rather than risk distortion during the subsequent critical boring of the bearing housings from residual welding stresses. Whilst I have a furnace which might be just about large enough, this stress-relieving would still be quite a major undertaking.

f) Silver-solder the mounting block to the spindle body. This would involve raising a fairly large mass to silver-brazing temperature, with all its consequent problems.

The particular dimensions for this mounting block are chosen to enable the unit to go onto my top slide, as shown for the current mounting block in **Photo 3**, but obviously could be modified for other people's specific requirements. However, clearly, this revised spindle design in no way alters the principles of the overall concept and layout.

5. Modes of use

It is to be noted that, when the 60-tooth pulley is on the spindle, the diameter over the belt is 4in. which well exceeds the diameter of the spindle body. Therefore, for certain setups, it may be necessary to provide the spindle with suitable alternative smaller pulleys, possibly with some loss in available reduction ratio. Generally however, the system can be used in either single- or double-reduction format in all setups.

Clearly, for drilling the spindle must always be aligned with the feed axis, whilst for milling it is aligned appropriately for the cutter to be used.

Additionally, it is essential that the workpiece cannot move or loosen, particularly as the unit can apply appreciable power and a lot of torque, which may also be intermittent: this necessitates appropriate clamps for the lathe spindle or chucks. A clamp band for my 6in. chuck is shown in **Photo 7**, and can be seen in use in **Photos 2** and **3.** This clamps comprises a shaped piece of angle iron, onto the outer ends of which are welded two short lengths of rod onto which the chuck body seats. A large Jubilee clip is tack-welded to the underside of the angle iron, and the vertical leg of the angle iron has a clearance hole to bolt to a flat milled on the front of the lathe headstock. Having positioned the spindle and/or chuck, the Jubilee clip and clamp bolt are progressively tightened up to very rigidly lock the chuck position. All slides, other than the one being used to feed the unit, must also be effectively locked against movement.

7

The main modes of use are as follows:

5.1) A pillar is bolted onto the cross-slide, and the unit is clamped to this at the appropriate height. Feed is then by the saddle longitudinal slide or by the cross-slide. **Photos 1** and **2** are examples of this mode – **Photo 2** showing a miniature boring head in use to ensure the true position of a hole previously drilled by the unit. When the unit is working with the spindle horizontal and across the mandrel axis, one can get very short of lateral space. There is then a major premium on having the shortest possible tools, including collet chucks. I have an extra-length cross-slide in the pipeline, but alternatively, it should be reasonably possible to bolt an extension plate onto the cross-slide and bolt the pillar onto the overhang of this.

5.2) Given a suitable pillar on the top-slide, the unit can be clamped onto this at the appropriate height. Feed can then be by the top-slide feed. This enables drilling or milling to be done at angles inclined to the lathe longitudinal or cross axes. Photo 3 shows an example of this, where the grub screws to the toothed pulley could only be put in at an inclined angle.

5.3) A pillar can be mounted on the vertical slide, and the unit clamped onto this.

5.4) For milling V or Acme threads, or anything similar, a pillar can be made for mounting on the cross-slide, whose axis can be inclined to set the cutter place along the helix angle of the thread. **Photo 8** shows a 1⅛in. x 12 TPI thread being milled this way, whilst **Photo 9** shows the inclineable pillar together with the finished thread.

5.5) If ever desirable, it would not seem too difficult, either by casting or welding, to mount the vertical slide above the lathe bed and mount the unit on this to work on items attached to the saddle assembly.

5.6 Can your imagination suggest others?

6. Sources of supply and specific component information

6.1 HTD toothed belts and pulleys

Supplier: Davall Stock Gear Ltd., Traveller's Lane, Welham Green, Hatfield, Herts. AL9 7JB. Tel: (07072) 65432.

Specific component information

Their "Stock Gear Catalogue" is an absolute mine of information on a very wide range of gears and gearboxes, as well as the full design and product information on the HTD toothed belts and pulleys. I would regard it as an essential reference for anyone contemplating using this HTD drive system, and I understand it is now free on application.

As said, all my pulleys were of 5mm pitch and 9mm width, and I give the details below. For any others, you would have to check the details in the catalogue, including particularly the pulley centre distance for different pulley/belt combinations.

Drive pulley Teeth	Cat. No.	Driven pulley Teeth	Cat. No.	Belt Length	Teeth	Cat. No.	Pulley centre distance
15	15-5M-09	60	60-5M-09	400	80	400-5M-09	100
15	15-5M-09	72	72-5M-09	450	90	450-5M-09	107
15	15-5M-09	20	20-5M-09	305	61	305-5M-09	109

Pulley pilot bores, as supplied:
15-tooth and 20-tooth; 7mm
60-tooth and 72-tooth; 8mm

6.2 Motor

Supplier:
Parvalux Electric Motors Ltd., Wallisdown, Bournemouth, Dorset BH11 8PU. Tel: (0202) 512575.

They were very helpful and sent a catalogue on request.

6.3 Oil seals

Supplier:
Oswald Seals Ltd., at following locations:

Hereward Rise, Halesowen Ind. Park, Halesowen, West Midlands B62 8AN. Tel: 021 501 2021.

Unit 19, Maesglas Ind. Estate, Newport, Gwent NP9 2NN. Tel: 0733 842823.

Dartford Trading Park, off Hawley Road, Dartford, Kent DA1 1NX. Tel: 0322 275211.

Tollcross Ind. Estate, Causewayside Street, Tollcross, Glasgow G32 8LP. Tel: 041 778 9993.

Oswald's range of oil seals are identified by their dimensions, i.e. shaft dia., housing bore, and seal length. I understand they will supply by post if sent cash-with-order – ring for prices, etc.

QUICK TIP

We all use Imperial fractions which must be added, subtracted, multiplied and divided and then converted to decimals. I own a couple of reasonably cheap pocket calculators which will do fractional arithmetic and convert to decimal and back at the touch of a key. Both mine happen to be Casio. No doubt other makes will do the same.

Brian. A. Fair

THE WORSHIPFUL COMPANY OF TURNERS ANNUAL AWARDS

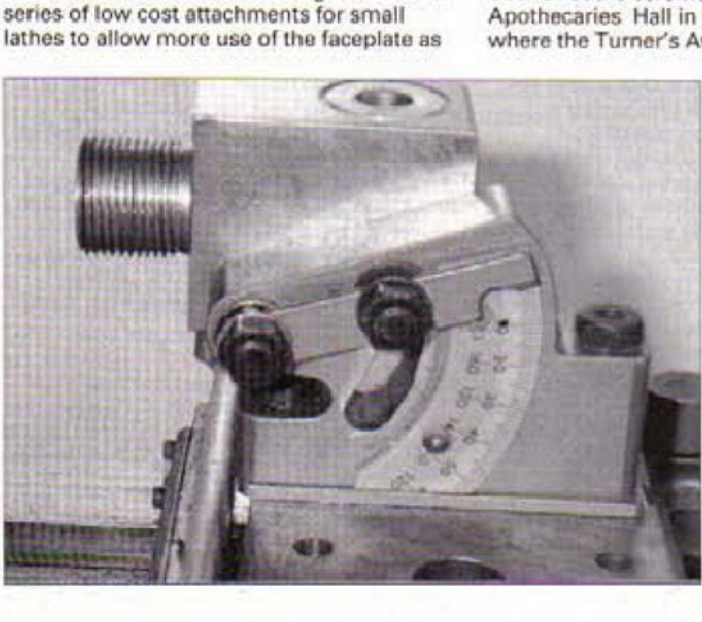
Bronze medal in this prestigious competition goes to an amateur engineer

For the second year running a private entry has won a medal in the Worshipful Company of Turners Annual Design Awards. This competition is designed to encourage innovative work from groups and individuals. For the second year in succession one of the major awards has been given to a model engineer. Last year it went to John Payne for his Quickstep Milling Attachment.

For 1993, Donald Ainley of Lytham St. Annes, Lancs. was awarded a Bronze Medal and £500. Donald's design was for a series of low cost attachments for small lathes to allow more use of the faceplate as a milling table. We show a photograph of the major section of Donald's work, which we understand is to be featured in our sister magazine *Model Engineer* in the not too distant future.

The other photograph shows Mr. Ainley, on the left, being congratulated by Mr. Ivor Owen, CBE, Director General of the Design Council at the ceremony at the Apothecaries Hall in the City of London, where the Turner's Awards Court was held. At the right of the photograph is Mr. Edward Sawney, Master of the Turner's Company.

This is an Annual competition, open to individuals or groups. From the results of the last two years it is obvious that the good amateur is in with a chance against his professional brethren. If you have an innovation or new design to do with turning or workshop practice how about having a go next year. Full information about the competition is available from The Martin Lumby Partnership, 10 Town Street, Newton, Cambridge, CB2 5PE, tel 0223 871525.



USING THE TOOL AND CUTTER GRINDER

PART 2

The cutter grinder in use. Again, as in the first part of this article, photos have been taken prior to stone guard being fitted. Do not operate machine in this condition, do also use safety glasses.

In our last issue Derek Brooks detailed the construction of his excellent tool and cutter grinder. This time he gives some details on the various wheels which he employs with the machine, and goes on to give some instruction on the methods of use which he has found most suited to his methods of working

Before we venture into the uses of the cutter grinder it is essential that we look at the types of wheel needed. Three basic types are required to do most of the jobs that we are likely to come across They are the Cup wheel, the Saucer or dish wheel, and the plain Disc wheel.

The cup wheel, as its name implies, has a hollow cup shape. It is designed to be used on its narrow face and never on its edge. Two diameters of cup wheel will be useful; 3 and 2 inch. The grit size could be anything from 60 to 80 and the hardness should be medium. For such a wheel, The Universal Grinding Company's specification may read something like WA 80 JV; it may also have several other letters mixed into its code. Basically this would be a White Aluminium Oxide Vitrified wheel.

The saucer wheel is designed to be used on its sharp edge. Because of this it needs to be harder than the cup wheel, so that it does not wear away too quickly. Once again 3in. diameter is a convenient size. The same grit size to 80 can be used. WA 80 LV or similar would be the numbers to use. This wheel is used for gashing or nicking out small slots in cutters and for sharpening such things as taps.

The plain disc wheel is the same as the wheel used on an ordinary bench offhand grinder. It should be about 3in. diameter and ⅜ to ½in. thickness. The grade of grit should be similar to that of the saucer wheel. This wheel is used to grind the edge of reamers and milling cutter flutes and is used on its outer edge.

It is a legal requirement that all grinding wheels should have their maximum rated speed marked on them, normally on the paper washers, sometimes stencilled onto the side of the wheel itself.

This speed should never be exceeded. It is also important that the wheel runs true. Both excess speed and wobble could cause the wheel to explode, possibly with drastic consequences to the user and his workshop. 5,000rpm is a reasonable speed to aim for on this machine.

Dressing the wheel

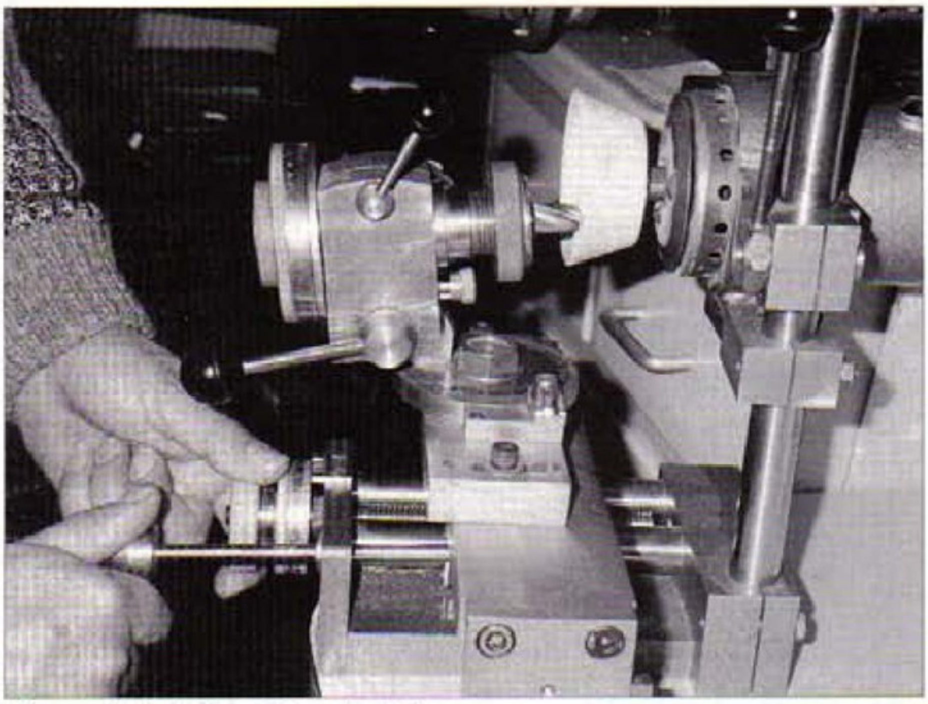
When a wheel is bought it has paper or card washers attached at its centres, on no account should these be removed. They are there to give a flexible grip when the stone is tightened up. After a wheel has been bolted up tight to the arbor it will need to be dressed. A diamond (don't pinch the wife's ring) is needed for this. Such a tool (a Diamond wheel dresser) can be obtained as a chunk of industrial diamond brazed into the end of a steel rod. It would be nice if obtain one having a shank of the same size as one of your collets, say ⅜inch. If you cannot obtain a ⅜in. one, and only have a ⅜in. collet a diamond holder with a shank of 10mm dia. can be turned down to fit your collet. The shanks are normally made from mild steel.

To dress the wheel, the diamond dresser is placed in the tool holder. The head is tilted forwards (that is nose down) 5 to 15 degrees. Adjust the wheel height so that the diamond comes to centre height or slightly below. Start the motor and slowly introduce the diamond to the wheel. Traverse it across the working face of the wheel. Cuts of a quarter of a thou are all that is required. The pass can be rather rapid. Continue with these small cuts until the whole face of the wheel has been cleaned up. The last pass can be made slowly to give a smoother finish on the face. *(If you are carrying out dressing or grinding in the workshop, beware, a large amount of highly abrasive dust will be released, this may well settle on the bed of the lathe or other sensitive surface. It is as well to cover other machinery with disposables such as old newspapers whilst these operations are in progress, or better yet carry out the job in the open air, picking a suitable day. For the sake of operator protection safety glasses are mandatory and some form of dust mask is highly recommended. To avoid having to redress the wheels each time they are changed, each wheel should be permanently mounted on its own arbor.)*

When dressing with a diamond it should always be used in a trailing situation to prevent the diamond being knocked out of its setting. The diamond is also used to shape wheels, such as the sharp corner of the saucer wheel or some fancy shape that is needed for a form cutter. When giving stones a sharp angle care must be taken. Use only light cuts and gentle treatment. Otherwise chips will be broken from these sharp corners.

Tool sharpening

I suggest the first thing that you try to grind is a large slot drill. You will then be able to see what is happening and what you have done. Engage the detent into the rotating head (R.H.) at a zero, insert the drill

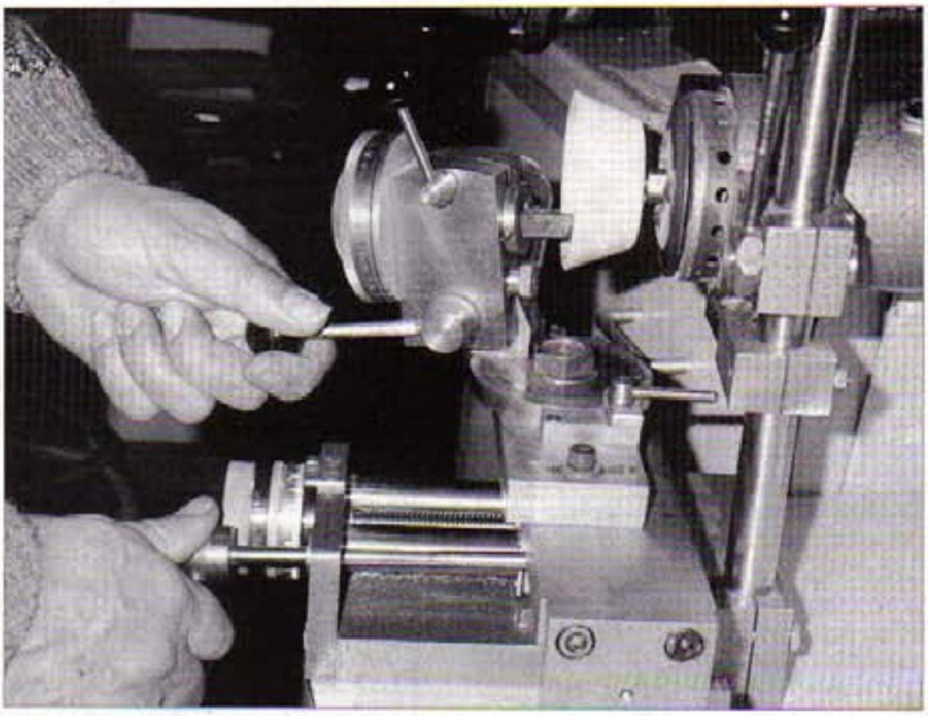


Close up of grinder sharpening a slot drill.

into the tool holder. The cutting edges should be set vertical by placing an engineers' square on the swivelling base (S. B.). Now tighten the collet chuck. Release the detent and rotate the R.H. through 90 deg. and re-engage the detent. The object of the last two operations was to get the cutting edges exactly horizontal. The S.B. should now be offset by one degree so that the heel of the cutter will be ground the most. The reason for this is that when the cutter is being used it cuts at its tip, helping to keep it sharp for a longer period. Now tilt the head backwards to give the correct clearance angle, 6 deg. is a good compromise amount. Lock every thing up. Bring the centre of the wheel to cutting height. Adjust the stop in the end of the table so that the edge of the wheel comes to the centre of the cutter. This will stop you traversing past centre and destroying the opposite tooth. Slowly advance the cutter to the wheel. You will know it is there when you start to see sparks. Gently traverse the cutter across the stone, making sure that you are only removing a minimum of metal from the cutter, just to sharpen the tip – you should not need to reshape its end. Advance the micrometer wheel a quarter of a thou at a time making traversing cuts until the cutter tooth is cleaned up across its whole face. Without altering the setting zero the dial. Wind the cutter back about 10 thou. Release the R.H. pinch bolt and detent and rotate 180 deg. until the detent drops into the correct index hole. Tighten the pinch bolt and commence grinding the second tooth using half thou cuts until the micrometer wheel once again reads zero. This means that both teeth are cut to the same level.

If the lands on the end of the cutter have become too broad a secondary relief angle should be ground at about 15 degrees. Look at a new slot drill and compare your work, adjust the angles if necessary.

On the new slot drill you will notice that one tooth goes right to the centre so that it will plunge cut. The other tooth does not. A third relief angle achieves this. I cant emphasize enough don't try to grind large bites. A one thou cut may be enough to sharpen the cutter and that is the object of the exercise not to grind it away. This is specially true for end mills which have a small centre hole. This hole is hard to replace and grind out. So don't take too much off the teeth and ruin the cutter by being heavy handed.



Close up of grinder sharpening a lathe tool.

Grinding Reamers

Reamers do their cutting on their taper lead angle for hand reamers and the bevel angle on machine reamers. Hand reamers have a taper of approximately 1 deg. while the bevel for machine reamers is 45 degrees. The 1 deg. for hand reamers can be set by moving the auxiliary table over by one degree. To get the 45 degrees for machine reamers the reamer has to be placed in the R.H. and the offset made by the rotating base. A tooth rest has to used to keep the reamer at the correct angle to the wheel. The relationship between the wheel and the tooth rest adjusts the rake angle. This applies when doing the taper leads and when grinding down the whole length of the reamer. When doing the whole sides of course they have to be set to run parallel to the traverse. There is a choice to make here, whether to use the edge of a cup wheel or the edge of a plain disc wheel. As with all alternatives there are advantages and disadvantages.

Using a Cup wheel

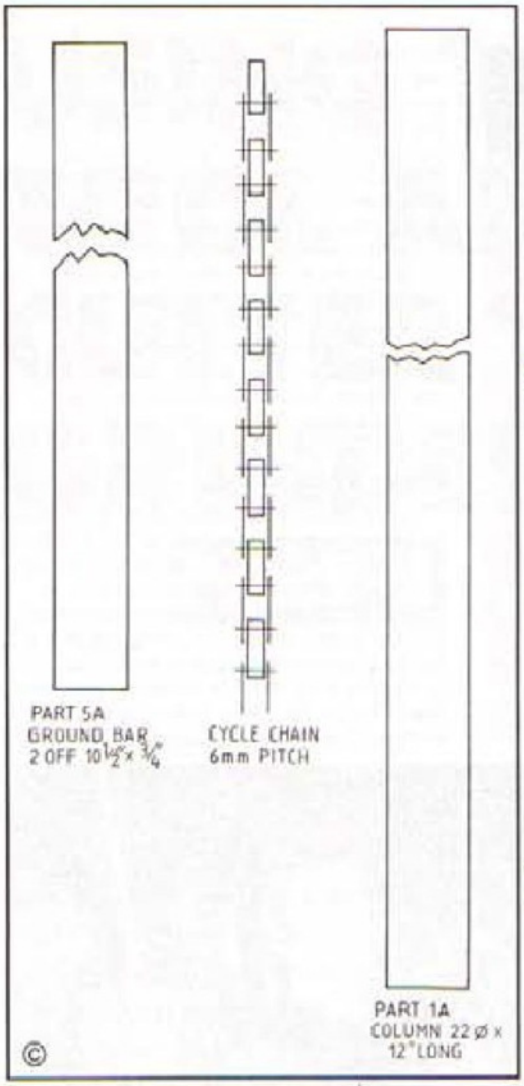
When using a cup wheel edge this is flat, so to get the rake angle the reamer has to be slightly rotated. This is done by altering the height of the tooth rest. This offset is critical; as it is a small amount it is difficult to set. The advantage is that the result is a flat land. Because the wheel edge is flat, it is the diameter of the cutter being ground that controls the offset. Table 1 gives the amounts for the various angles.

Table 1

Cutter dia.	Clearance angle		
in.	5 deg.	6 deg.	7 deg.
¼	0.011	0.013	0.015
⅜	0.015	0.020	0.022
½	0.022	0.026	0.030
⅝	0.028	0.033	0.037
¾	0.033	0,039	0.045
⅞	0.037	0.046	0.052
1	0.044	0.052	0.060

Using a Disc wheel

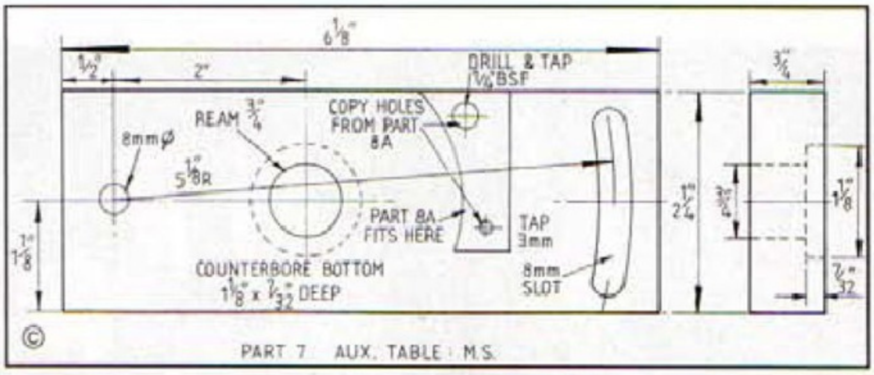
By using a disc wheel it is the wheel that needs offsetting to give the clearance



PART 5A
GROUND BAR
2 OFF 10½" x ¾"

PART 1A
COLUMN 22 Ø x
12" LONG

©



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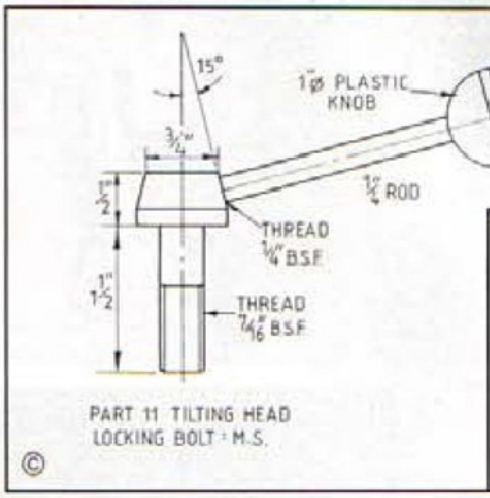
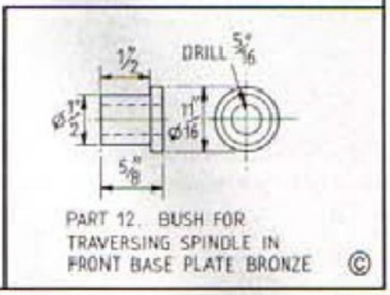
PART 7 AUX. TABLE : M.S.



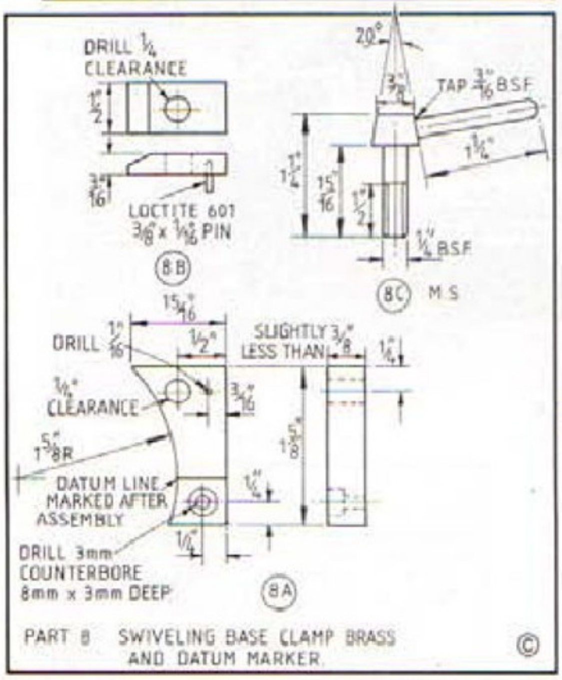
PART 11 TILTING HEAD
LOCKING BOLT : M.S.

©



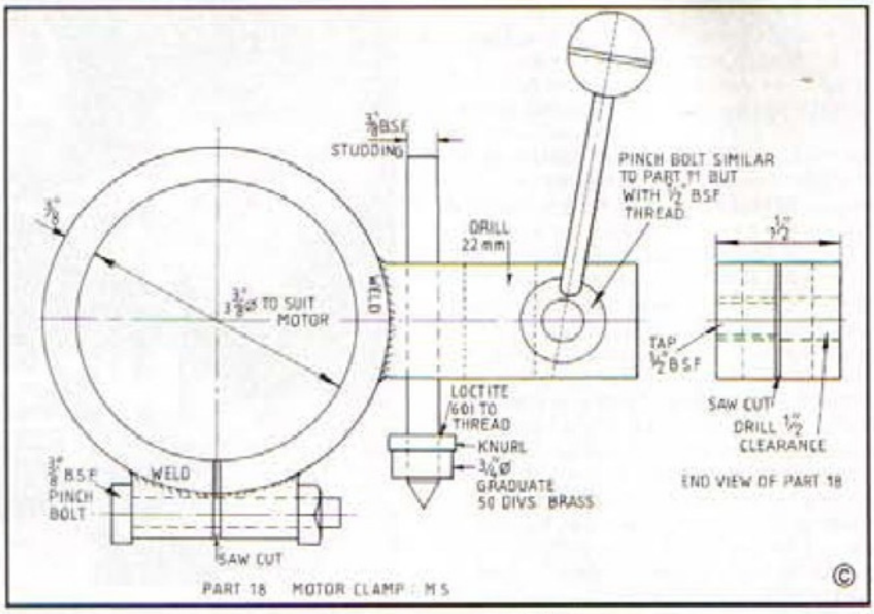
PART 12. BUSH FOR
TRAVERSING SPINDLE IN
FRONT BASE PLATE BRONZE

©



PART 8 SWIVELING BASE CLAMP BRASS
AND DATUM MARKER

©



PART 18 MOTOR CLAMP : M.S.

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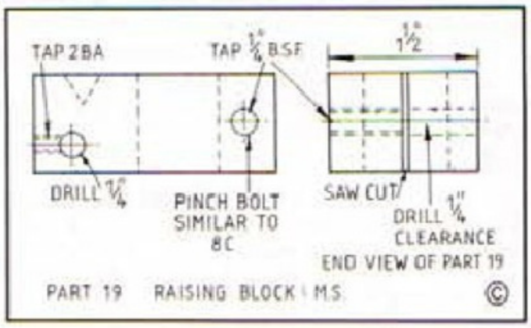
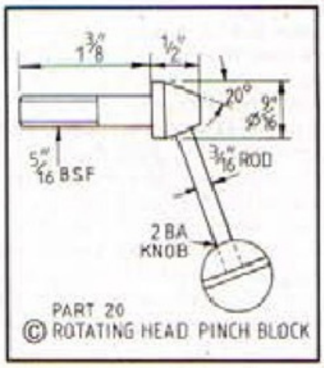


PART 19 RAISING BLOCK : M.S.

©



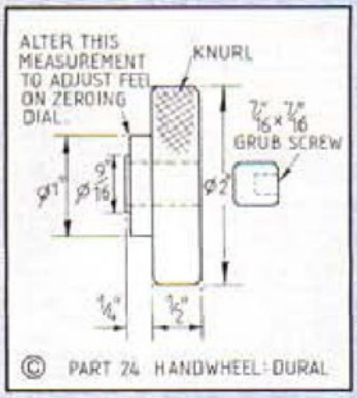
PART 20
© ROTATING HEAD PINCH BLOCK

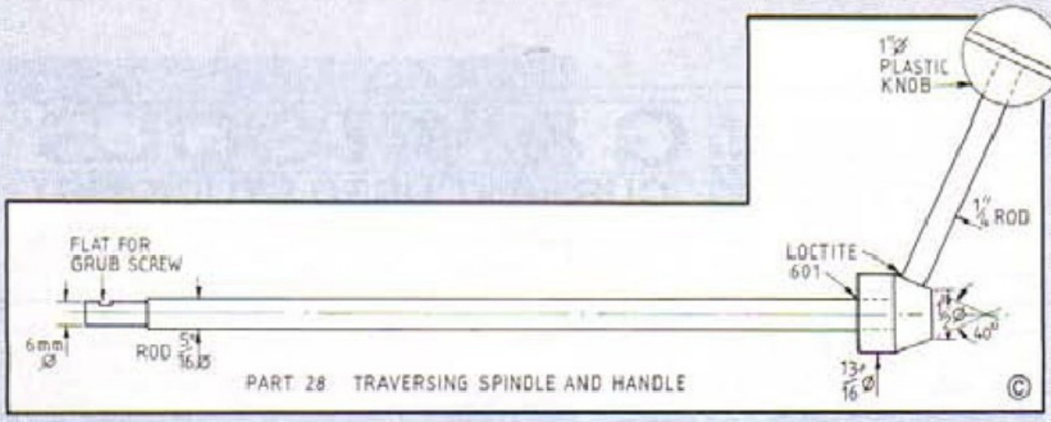
angle. Because the wheel is relatively large the offset movements are also large and therefore much easier to set. The edge this time is hollow ground which makes it slightly weaker and likely to blunt more quickly. This time the rake angle is with respect to the diameter of the wheel. Table 2 and the diagram explains the measurement.

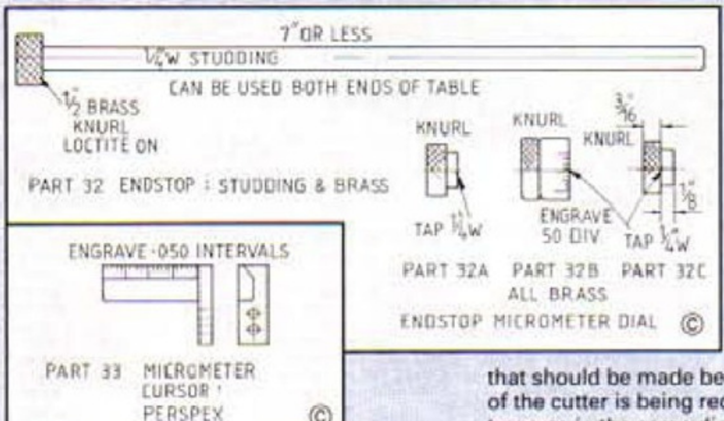
You have another choice to make, whether to grind onto the cutting edge or off it. Grinding off the edge helps to keep the cutter on the tooth rest. This can leave burrs on the edge which have to be removed with an oilstone. Cutting onto the edge gives a keen edge without burrs and

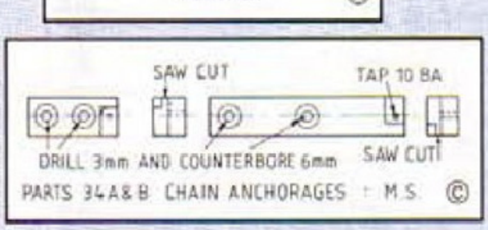
Table 2

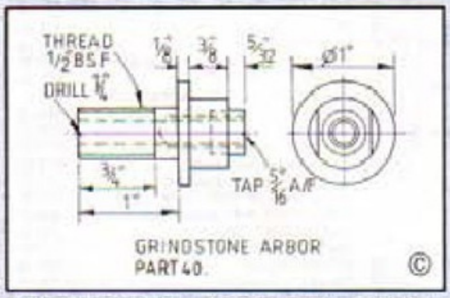
Wheel dia.	Clearance angle		
in.	5deg.	6deg.	7deg.
2	0.090	0.105	0.120
2¼	0.100	0.120	
2¾	0.120	0.145	0.165
3	0.130	0.155	0 180
3¼	0.145	0.170	0.195











there is less tendency to burn the edge. But care must be taken to keep the cutter tight onto the toothrest as the traverse takes place. When using a disc wheel the grinder motor has to be turned upside down on the pillar and rotated through 90 degrees. The raising micrometer has also to be reversed. The tool to be ground can be held in the tool head or between centres which can be bolted to the Tee slot. Because a considerable length of tool is to be ground it would be worth checking the accuracy of the tool's alignment with a dial test indicator (D.T.I.).

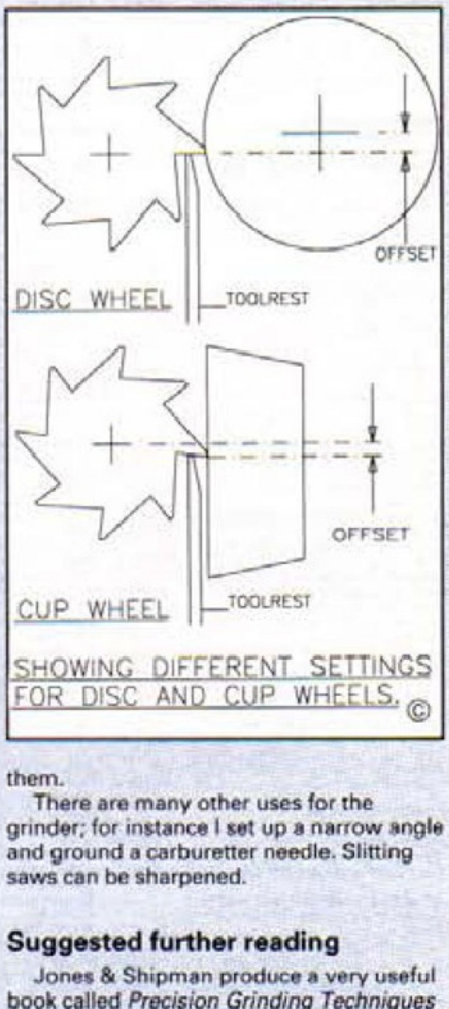
When using a disc wheel it can be positioned by placing a setting pin in both the end of the grinding wheel arbor and a ½in. collet in the tool holder. Place a straight edge across the pin flats and set the motor level by eye. The toothrest is brought up to the straight edge. The wheel height is then altered by the amount given in the table.

If a cup wheel is used the two pins can be brought together until their flats just touch. This is not critical as it is the relationship between the tool and the toothrest that gives the relief angle. The rest should be adjusted below the half pin by the amount given in the table. A D.T.I. or feeler gauge can be used to achieve this. The finest of cuts is all that should be made because the diameter of the cutter is being reduced. Always traverse in the same direction for cutting each flute. The inner flutes of reamers can be sharpened. This does not reduce its diameter, but as I have not tried this I can make no comment. Neither have I done any tapers, but because the machine is equipped with the auxiliary table it is possible. When grinding these edges it is better if the wheel does not have broad contact area. It is good practice to offset the wheel, so that the corner is doing the grinding.

Taps can be sharpened with a disc wheel. They should be held between centres or in a collet with a tooth rest indexing the flutes. This is one of the cases where the wheel edge needs to be dressed to the correct shape.

In the past I have always used the off hand method for grinding lathe tools. I am a bit heavy handed with this, often altering the angles too much. This bad habit often left me with a major reshaping job, with a consequent loss of expensive tooling material and unnecessary expense of my precious leisure time. Another disadvantage when using the edge of a wheel, as on the offhand grinder, is that it gives hollow ground edges. For tools that need straight flat edges I sometimes resorted to the bad but almost universal practice of using the edge of the wheel. Nowadays I use the cutter grinder, it is a real treat now to have tools with the correct relief angles; they really cut much better. It is specially noticeable on screw cutting tools. No longer do I have to grind a bit and check it with a thread gauge. The protractor on the S.B. does this automatically. There is not much point in going through the procedure for grinding these tools, it should be quite obvious. Suffice to say that when forming new tools or altering old ones to a new shape the rough heavy work should be first done on a bench grinder, leaving the precision work to be completed on the tool grinder.

Tipped tools need a green grit, or diamond impregnated wheel to sharpen them.



SHOWING DIFFERENT SETTINGS FOR DISC AND CUP WHEELS. ©

There are many other uses for the grinder; for instance I set up a narrow angle and ground a carburetter needle. Slitting saws can be sharpened.

Suggested further reading

Jones & Shipman produce a very useful book called *Precision Grinding Techniques* their address is Narborough Rd. South. Leicester LE3 2LF and the cost is £3.00.

QUICK TIP

When making a part where precision is not critical, glue a full size drawing to the material. Then you can centre pop, drill, saw and file without the need to use the normal marking out techniques. I cut out a garden rake head from 3mm. aluminium by this method, which is particularly suited to parts being made from sheet metal.

(This method is widely used in the electrical industry for drilling panels on which electrical components are fitted and wired. The layout is drawn full size in the drawing office, then the panel drilled by the fitter wireman using the drawing. Ed.) **Colin Porter**

G & M TOOLS
CURRENT USED STOCK LIST

LATHES
- Boxford AUD 5" x 22", 1ph, Fully Tooled £1600.00
- Boxford BUD 5" x 22", 1ph, Fully Tooled £1400.00
- Boxford CUD 5" x 22", 1ph, Fully Tooled £1250.00
- Boxford AUD 4½" x 18", 1ph, Fully Tooled £1250.00
- Boxford BUD 4½" x 18", 1ph, Fully Tooled £850.00
- Boxford CUD 4½" x 18", 1ph, Fully Tooled £750.00
- Denford Easiturn CNC Lathe with PNC 2C Control, 5" x 20" £1500.00
- Harrison L5 9" x 25", 3ph, tooled £650.00
- Harrison L5 9" x 25", 1ph, tooled £950.00
- Harrison L5 11" x 25", 3ph, tooled £1000.00
- Harrison M300 6" x 25", Gap Bed, 3ph, tooled £1450.00
- Colchester Bantam 5" x 20", taper turning, 1ph, tooled £1400.00
- Colchester Bantam 5" x 20", 3ph, tooled £1250.00
- Colchester Bantam 800 5¼" x 30", tooling, 3ph £1400.00
- Colchester Student 6" x 25", 3ph, tooled £1250.00
- Colchester Master 6½" x 36", 1 ph, gp bed, tooled £1000.00
- Colchester Triumph 7½" x 50", 3ph, tooling £2500.00
- Myford Super 7B cabinet stand, 1ph, tooling, immaculate £2750.00
- Myford ML7R cabinet stand, gearbox, tooling, 1ph, immaculate £2000.00
- Myford Tri-Leva bench lathe, 1ph, tooling, lovely condition £1250.00
- Pultra Lathe, cabinet stand, 1ph, tooling includes div head, collets, capstan att, vertical slide etc... £2200.00
- Pultra bench lathe, lever op tailstock, collets etc £300.00
- Smart & Brown Type M 4" x 20", Toolroom Lathe, 3ph £500.00

DRILLING MACHINES
- Meddings bench pillar drill, 3ph, 1mt £125.00
- Richmond SR2 Radial drill, 3mt, 3ph £2500.00
- Grimston bench drill, 2mt, 3ph, geared head £225.00
- Meddings Articulated Arm Radial Drill, 3ph, 2mt £900.00
- Harrison Floor standing pillar drill, 2mt, 3ph £175.00
- Meddings Pillar Drill, 3ph, ½" chuck £150.00
- Elliott Progress Pillar drill, ½" chuck, needs motor £75.00
- Pollard High Speed bench drill, 3ph £220.00
- Pollard Pillar drill, 1mt, 3ph £75.00
- Grimston Electriska, geared head drill, 2 mt, 3ph £225.00
- Elliott Progress 4E geared head pillar drill, rack op table £800.00
- Fobco Floor standing pillar drill, 3ph £125.00
- Fobco 7 eight drill 2MT £550.00

MILLING MACHINES
- Tom Senior hori/vert, Milling Machine, 3ph £1000.00
- Deckel FP1 Horizontal Mill, Sub Tables, Dividing Head, light, 3ph, coolant, power feeds, etc £1650.00
- Harrison Horizontal milling machine, 3ph £450.00
- Harrison Vert/Hori Milling Machine, 3ph £1400.00
- Henry Milnes Vertical Milling Machine, 3ph, vice, chuck etc £800.00
- Bridgeport Series I 2HP, power feed, anilam DRO, varispeed head £3000.00
- Bridgeport Milling Machine, R8, 42"x9" table 3ph £1650.00
- Bridgeport Milling Machine, 30INT Spindle, 42"x9" table, powerfeed, 3ph £2000.00
- Beaver Mk2 Turret Milling machine 10"x56" table, power feed, 40INT, Digipac DRO, chuck & vice, varispeed head £2750.00
- Elliott sturdimill vertical mill, 40 INT, 50"x10½" table power feed light, coolant, chuck etc £1450.00
- Alexander PG1E Vertical Precision Toolroom Mill, swivel and tilt table, power feeds, 3ph £1500.00
- Elliott Victoria U2 universal milling machine, power feeds, chuck, horizontal arbor etc £750.00
- Marlow vertical mill, 8½"x28" table 3MT spindle, 3ph £650.00
- Boxford VM30 vertical mill, 30INT, 6"x22" table, varispeed head, 3ph £1450.00

POWER HACKSAWS
- Qualters & Smith 6" 3ph £225.00
- Manchester Rapidor 6", 3ph £200.00
- Manchester Rapidor 6", 1ph £200.00
- Rex 6" Power Hacksaw, 3ph £250.00

GRINDERS, LINISHERS, POLISHERS
- Burdett 18" x 6" Surface Grinder, 3ph, mag chuck £1000.00
- Elliott Excel Surface Grinder, Mag. Chuck, 3ph £650.00
- RJH Linisher on Pedestal, 1ph £200.00
- Union Jubilee Double Ended Grinder, 3ph £125.00
- Vison Universal Tool and Cutter Grinder, powered workhead, well tooled, 3ph £750.00
- Clarkson Tool and Cutter Grinder, 3ph, well tooled £650.00
- Clarkson Tool and Cutter Grinder, 3ph, bare machine £250.00
- Wolf D.E. Grinder, 3ph £45.00
- Boya Schultz Die Grinder (bench mounting), 1ph £125.00
- RJH 6" x 10" Linisher mounted on cabinet dust extractor, work light, immaculate, 1 ph £350.00
- RJH 6" x 10" Linisher mounted on cabinet dust extractor, work light, immaculate, 3 phase £300.00

SHAPERS
- Elliott 10m Shaper, 3ph £200.00
- Boxford 8" Shaper, 3ph £300.00
- Boxford 8" Shaper, 1ph £350.00
- Astra 6" Slotter, 3ph £1250.00
- Invicta Type 2M Shaper, fitted swivel vice £450.00
- Elliott 18S Shaper, swivel vice, 3ph £450.00
- Alba 1A Shaper, 3ph £175.00
- Elliott 14M Shaper with swivel vice, 3ph £400.00

BOXFORD SPARES AND TOOLING
- Change Gears (also fit Southbends) 16t-£10, 18t-£11, 20t-£11, 21t-£11, 22t-£11, 23t-£11, 24t-£11, 26t-£11, 27t-£11, 28t-£11, 30t-£12, 31t-£12, 32t-£12, 35t-£12, 36t-£12, 37t-£12, 38t-£14, 40t-£14, 41t-£14, 43t-£14, 44t-£14, 46t-£14, 48t-£14, 52t-£15, 53t-£15, 54t-£15, 56t-£15, 59t-£15, 60t-£15, 64t-£15, 71t-£18, 75t-£18, 79t-£18, 80t-£20, 88t-£22, 100t-£25, 127t-£25,
- 100/127t compound gear £55.00
- 127/135t compound gear £65.00
- 54/18t compound gear £30.00
- 72/18t compound gear £35.00
- Toolpost Grinder, fits 5" machines (new) £275.00
- 6¾" Faceplate (new) £35.00
- 5" Catchplate £15.00
- Collet drawbar, adaptor & nose cap (new) £85.00
- Collets each £18.00

- Brook Crompton, ¾ H.P., motor £115.00
- Danfoss contactor & overload switch for above £28.00
- Boxford lathe cabinets £75.00
- Headstock, saddle & apron parts available P.O.A.
- 4½" tailstocks £125.00
- T-slotted cross slide, fits models A, B, C, AUD, BUD, CUD &Southbends (new) £80.00
- Boxford Boring table (new) £100.00
- Boxford 4½" taper turning attachment £325.00
- Boxford 4" backplate £15.00
- Boxford 6" backplate £20.00
- Boxford change gear cover £40.00
- Boxford American Toolpost £20.00

MYFORD SPARES AND TOOLING
- Myford Super 7 gearbox & leadscrew £350.00
- Myford Lever collet chuck & 15 collets £275.00
- Myford Super 7 Headstock, all covers, clutch, etc £200.00
- Myford Pratt Bernerd 4" S.C. 3 jaw chuck & reverse jaws £115.00
- Myford Leadscrew driving handle £15.00
- Myford 6" 4 jaw and chuck £80.00
- Toolpost Grinder (New) £240.00
- Myford No.71 Machine vice £30.00
- Myford Swivelling vertical slide £130.00

HARRISON SPARES AND TOOLING
- L5 and L6 gears 20T, 25T, 26T £10.00
- 32T, 34T, 35T, 38T £15.00
- 40T, 42T, 43T, 44T, 45T, 46T, 48T £20.00
- 50T, 55T, 56T, 59T £25.00
- 60T, 63T, 64T, 65T, 66T, 69T £30.00
- 70T, 72T, 75T, 76T, 77T £35.00
- 80T, 81T, 84T, 86T, 90T, 94T £40.00
- 100T, 100T Nylon, 108T, 115T, 120T, 120T Nylon £45.00
- 126T, 127T, 130T £50.00
- 9" screw on faceplate £35.00
- 9" loo fitting faceplate £50.00
- 6" screw on catchplate £15.00
- 6" loo fitting catchplate £20.00
- 5" and 6" 2¼" x 6TPI backplates £15.00
- 7½" 2¼" x 6TPI backplates £20.00
- L5 micrometer carriage stop £50.00
- L5 micrometer cross slide stop £35.00
- L5/L6 travelling steady, complete £30.00
- L5/L6 travelling steady, machined casting only £20.00
- Crawford 5218 collets, each £15.00
- L5 4 way toolpost £70.00
- L13 collet drawbar & closer £50.00
- L15 micrometer carriage stop £50.00
- L15 20" faceplate (camlock fitting) £85.00
- Saddle apron, cross slide and tailstock handwheels each £15.00
- Gear charts, name plates and badges from £3.00
- Harrison L15 travelling steady £55.00
- L5 1⅝" bore headstock sleeves £18.00
- J&S double ended boring bars £25.00
- L5 8" 4 jaw ind chuck (1⅝" x 6TPI) £100.00
- L5 gap piece £50.00
- L5 Tailstock £125.00
- L5 saddle assembly £125.00
- L5 headstock assembly £150.00
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- Student 10" 4 jaw ind chuck (L0) £125.00
- Student 5" Crawford trugrip collet chuck and 7 collets £150.00
- Student 1800/Master 2500 10" 4 jaw chuck (camlock) £150.00
- Master 2500 multisize collet chuck £300.00
- Burnerd multisize collet chuck, 12 collets, LO fitting £250.00
- Master 4 way toolpost £100.00
- Colchester Master (roundhead) capstan attachment £300.00
- Triumph, roundhead topslide and 4 way toolpost £100.00
- Student roundhead American toolpost £20.00
- Student roundhead micrometer saddle stop £40.00
- Student single toolpost £20.00
- Triumph 2000 taper turning attachment £500.00
- Bantum 5" capstan attachment £300.00

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- Abwood 4" swivel & tilt machine vice £175.00
- Abwood 6" machine vice £75.00
- 6" swivel machine vice £100.00
- Abwood 8" swivel machine vice £125.00
- 7" heavy duty swivel machine vice £125.00
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- Elliot Super G 5" swivel machine vice £75.00
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- Clarkson 30 INT Dedlock chuck £55.00
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- 40 INT-30 INT adaptors £30.00
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- Pratt 12" 4 jaw chuck, D8 camlock £200.00
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- N.S.F. 10" vernier caliper £30.00
- Starrett 5" depth vernier £15.00
- UPT 5" depth gauge £15.00
- Starrett 2-12" Internal Mic £30.00
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- Matrix E81 Slip gauge set (imp) £100.00
- Chesterman 7" vernier caliper £35.00
- Rabone Chesterman 12"/300mm vernier caliper £48.00
- Benson Verniers 8" vernier caliper £30.00
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- M&W 6"-10" Adj mic £75.00
- Set of 5 Pitter gauge block holders with base and measuring arms cased £125.00
- Coventry Gauges E-41 slip gauge set £100.00
- MSE 12" gauge block holder £24.00
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- Mercer Dial bore gauge 6"-12" £125.00
- M&W 0-150mm adj. Micrometer (VGC) £100.00
- M&W 0-6" adj. Micrometer (VGC) £100.00
- M&W 0-225mm Depth micrometer (VGC) £65.00
- Chesterman 12" Height Gauge (VGC) £75.00
- M&W Vernier bevel protractor £75.00
- M.S.E. Comparator plug gauge set ⅛", 7/32", ½", 9/32", ⅛", 21/32", 7/32" £125.00

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- Horizontal S&F cutters 1" arbor 3½", 4", 5", 6" £4.00, £5.00, £6.00, £8.00 each
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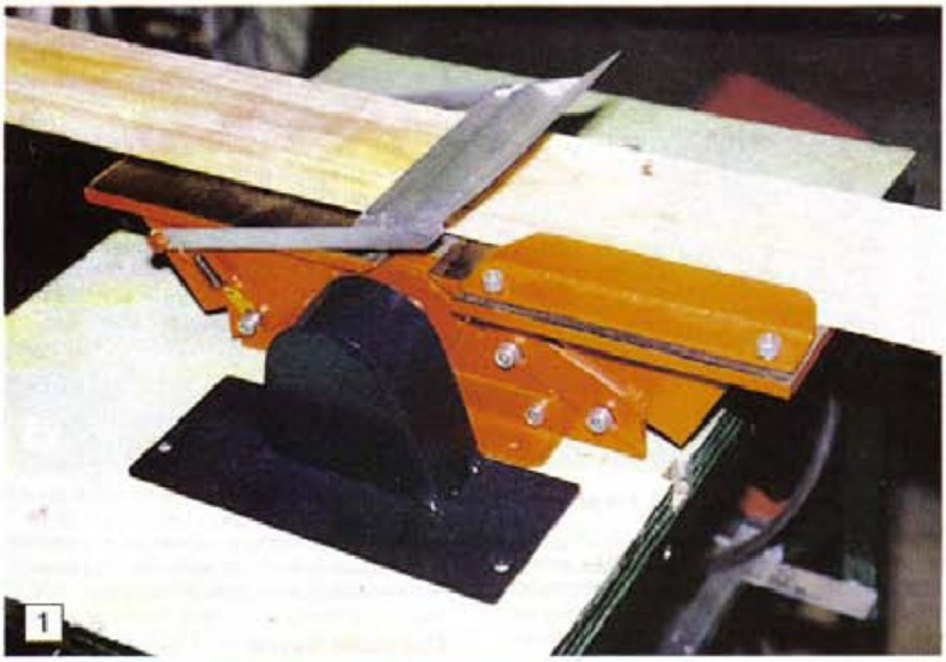


The finished plane being used to plane a length of 3¾in x ¾in. white pine.

Terry Gould provides this design for a wood planer which he suggests will save money by enabling you to recycle secondhand wood. Good for the pocket and good for the environment. Incidentally it is a well proven design as he has apparently made eight of these machines

A WOOD PLANER

Those of us who are into DIY will have at some time or another had the need to plane wood up by hand. This I find time consuming and too much like hard work! While there are many types of electric wood planers on the market, they are all very costly. Wood can be bought planed all round (PAR) but this too is expensive. Rough sawn wood comes much cheaper.

Recycling

However, there is another source of wood to be found. If you look around your nearest industrial estate there will nearly always be one or two who use wooden pallets or packing cases; although it does mean taking them apart and removing all the nails. Once planed up there is some good wood to be had for a modest outlay.

With this new found source of wood, some way had to be found to clean it up. First came an overhead triple drum sander, this had limited success but was dogged by mechanical problems. The second was a 4in. belt sander, this is still in use today. Dust extraction was the main problem here; though a good finish was achieved, in prolonged use the belt got hot and soon became clogged.

The first planer

Next came the first of the planers, this was an overhead type, the wood being passed underneath. I was assuming that by going for overhead I would get all the timber to the same thickness. However, I soon learnt that this type needs in and out feed rollers. Having made more drawings of all that was entailed it soon became clear that the planer was becoming too complicated and above all too big.

It was at this point that Mike Hill who was then my boss came to the rescue. He produced a planer that performed well. After some six months work it was apparent that the bearings were overheating in prolonged use (bronze bearings being used). It was soon after this that it was seen that excessive wear in the bearings was taking place. The main cause being the tension applied to the "V" belt. More about this later.

The original planer was put to one side and plans for my own pattern were made, although keeping to the overall dimensions of the original. The major change was in the bearings.

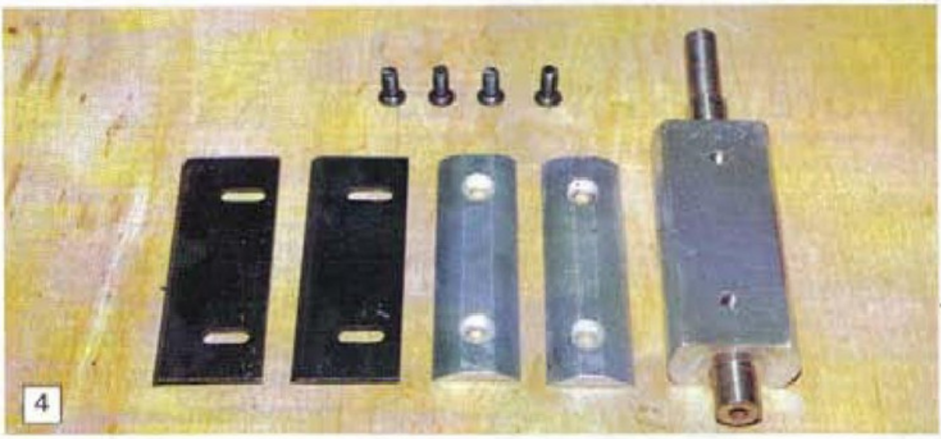
The planer I am going to describe is model number four, which after six years has been the most reliable of all. I will try and highlight any problems I have had with it as I go through the construction of it.

Drive side view but without pulley and guard fitted. Note cutter guard arrangement.

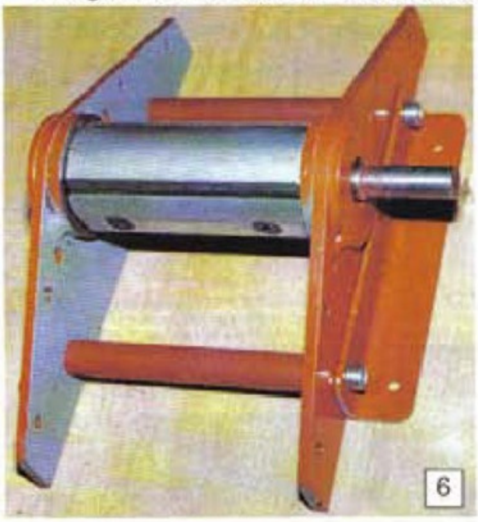
Non-drive side view.

The spindle

For the spindle (14) we need 1⅜in. dia. bar, 7⅝in. long; centre and face one end. The drawing shows a length of 6⁹⁄₁₆in.; this is not too important, the extra ⅝in. is so that the spindle can be turned at one



Cutter spindle parts. The flats seen on the clamping bars are not acceptable, the photo being taken before a second set were made using the correct material.



Main frame and spindle after assembly.

setting and is cut off when all turning is complete.

Machine down the ends to the lengths given, to 1in. diameter. As the centre part of the spindle needs to be 1in. across the flats, I found it best to machine the spindle ends to this diameter, the flats can then be machined to this. Please note, before machining the ends, the centre part here (i.e. the 4in. length of flat) is more important than the length of the spindle ends; it will also be seen that the 15mm diameter portion is longer than necessary for the stated bearings. This was done in case these were not available and the wider type used.

Those who have a milling machine will have no problem with the flats. Those without such a machine will either have to clamp the spindle to the face plate (if you have the capacity to do so), or do as I did and clamp the spindle to the angle plate and mount on the cross side using a fly cutter in the chuck.

Having machined the flats, mark off the position of the two holes for the blades and clamping bars. Drill these right through and tap. The drawing shows them as ¼in. BSW. Normally I would not mix Imperial with metric but in this case I had to simply because I could not get any metric csk screws with socket heads. Why use sockets? Simply because it makes adjustment of the blades better. Previous models have been fitted with slotted and Phillips type heads, both have been awkward to adjust.

Next come the clamping bars (15). These are made from 1¼in. × 5/16in. BMS. Mark off the two holes to match those in the spindle. Drill ¼in. and countersink so that the head of the screws is 3/32in. below the surface of the clamping bars. Do try and get all four countersinks the same depth.

We also need two lengths of 1¼ x ⅛in. at 4in. long, again drilled ¼in. to match the clamping bars. These are packing strips (16), which will go under the clamping bars while the outside diameter is being machined; afterwards they will be used to aid setting up of the front and rear table tops. These strips should be the same thickness as the material used for the blades. Unfortunately we cannot use the blades for this as they are too wide.

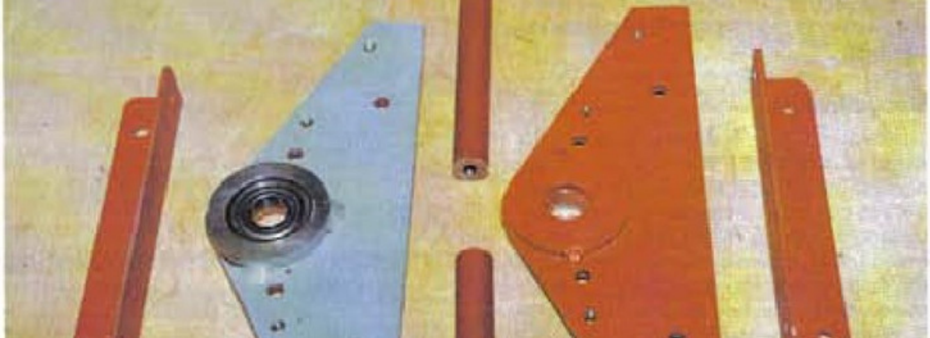
Screw the packers and clamping bars to the spindle. I found here that it was better to have the clamping bars a little longer than the 4in. given length so that they can be machined square.

Using the 3 or 4 jaw chuck, put the pulley end in the chuck (i.e. the longest of the 1in. dia. ends), hold by about ⅝ inch. The other goes on the tail stock centre. First the clamping bars are turned down to 1⅜in. and turned square. Next comes the 15mm dia. portion for the bearings, make this part for a press fit on the bearing. When turning this part a 3/16in. collar is formed 1in. dia. for the bearing to go up against. The last part to turn is the ½in. dia. for the pulley. Using a parting off tool as close to the chuck as you can, cut about half way through, remove the spindle and the rest can be cut off with a hacksaw.

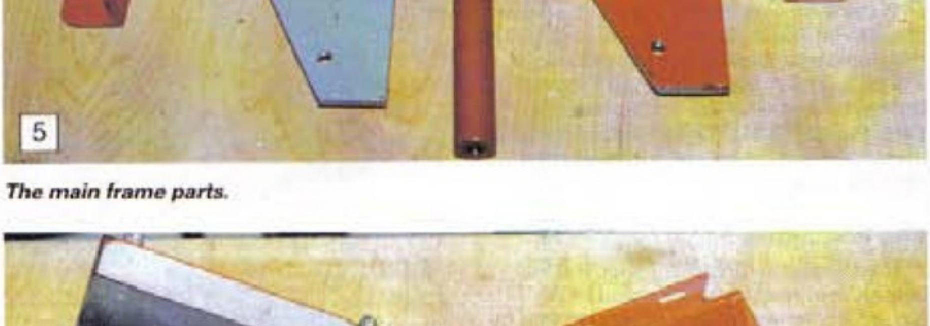
Remove the clamping bars, it would be best to mark each one as you do so, so that they can be fitted back to the same place. Remove all sharp edges with a file.

The main frame

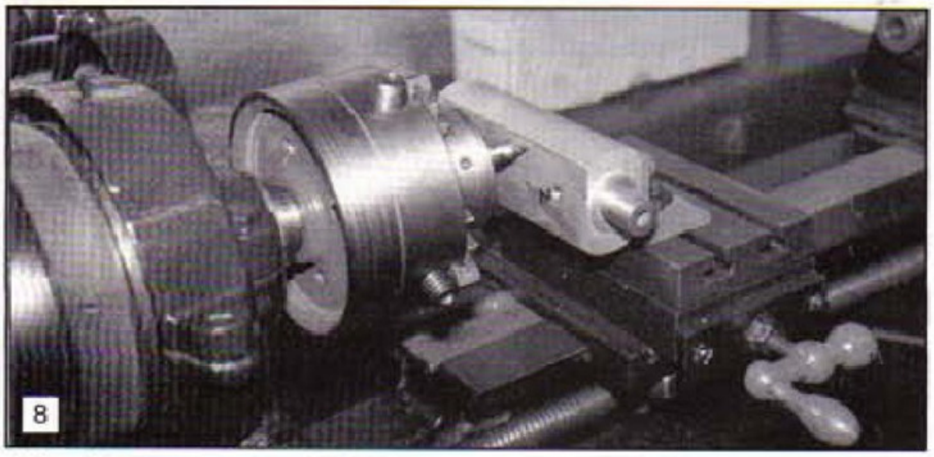
The main frame sides (1) are cut from 3/16in. mild steel. Mine were done by chain drilling with a ¼in. drill, then hacksawing the rest. There is no reason why ¼in. steel cannot be used, all it will mean doing is increasing the width of the bearing support rings. Whatever is used, make sure it is flat. Take one side and mark off the position of the 8 holes, also the centre lines of the spindle. Clamp the two sides together, drill the four 6.5mm holes. Bolts can now be used to hold the sides together and the four 5mm holes can be drilled along with



The main frame parts.



Front and rear tables, note positioning of tack welds.



Using a fly cutter to produce the flats on the spindle.

the 6mm hole on the spindle centre line. Now grind or file the two sides to size.

We now need to make the two inner bearing support rings (10). These are made from 2in. dia. discs 5/16in. thick. Face both sides and centre drill 6mm.

To find the width of these rings, take the thickness of the main frame sides away from the width of the bearing, what is left will be the width of the ring, mine came out at 1/32 inch.

With the main frames still bolted together, place the rings on either side and bolt these together. These rings can now be tack welded on at the three points indicated on the drawing. All bolts can now be removed. Check that the frames are still flat. Now to boring the holes for the bearings.

Mount the angle plate on the cross slide, to this either clamp or bolt the main frames with the bearing rings facing the chuck. Packing will be required between angle plate and main frame to allow room for the drill and boring bar to come through. The two 6.5mm holes either side of the main spindle centre are for the specific purpose of bolting the frame to the angle plate. However, if you have a better way of holding them to the angle plate, these holes may be omitted (but remember that these holes will give positive location for both sides).

Drill out the hole, do this in stages if necessary, to the largest size drill you have. No more than 1¼in. anyway (not that many will have drills anywhere near that size). Before any eagle eyed reader points out, I did not use a drill to do this – see photo – I have used a 1¼in. Rota Broach to cut the hole. For any hole above 5/8in. dia. I much prefer a Rota Broach, they take up much less room than a drill, remove less material and so will cut much faster. They also get used for some milling operations.

To bore the hole for a press fit, a square shank boring tool is used in the 4 jaw with a packer under one jaw, opposite to the tool tip. The depth of cut is put on by adjustment off two of the four jaws. There will be some who will be unhappy with this method. It will be time consuming if you are unable to open out the hole to at least 1in. diameter.

Next comes the two outside discs (8) for retaining the bearings. These are 2in. dia., centre bore 5/8 inch. The thickness of these discs is not too important. It is preferable to bolt these on although I have shown them tack welded – I assumed at the time of construction that these could be simply removed by grinding or sawing, however this does tend to make a mess of the side frames. Fit the retaining washers to the main frame.

For those who want to get the best from their planer, make and fit the blades at this point – you will need a tool post grinder for this. *(See section on making blades – Ed.)*

The bearing can now be fitted to the main frame, then this fitted to the spindle. Lay on a flat surface and check the inside frame width, which should be 4⅛ inches. Make and fit the two main frame spacers (9). Make sure the spindle will revolve freely. Any end float can be reduced by turning a little off the end spacers.

Two lengths of 1in. × 1in. × 1/8in. angle (5) are used to hold the planer to the bench. No holes have been given for this purpose, this is best left to the individual, but should be done at this stage. Drill the two ¼in. holes to suit the frame spacer holes. When bolted in place, this will complete the main frame.

Table tops

Front (3) and rear (2) top sections. No real problems should be found here. I have used 5/16in. thick plate for the front and rear tops, this was all I had at the time. These top plates have a chamfer one end – I used a milling machine to produce mine. I would suggest those who do not have a miller reduce the thickness of these top plates to 3/16 inch. The chamfer can then be produced by filing and/or grinding.

Of these two chamfers, the one on the front table is most important. Its purpose is to prevent tearing of the grain and it reduces all wood chips to a size that will not clog the cutter head and so should be as close to the cutter head as possible (about 1/16in.). We can go one step further for even better results. This chamfer should have a concave form so as to be concentric to the blades. I found this very difficult to produce. The importance of this was not realised until recently. My present planer has this on now, with a much improved surface finish, especially on soft woods. The front table carries a guide bar (6) and an angle guide bar can also be fitted.

We now need the two 1/8in. packing strips again. Saw through to the hole on one side only, so as to form an open slot. Place these under the spindle clamping bars and set to run true on 2 1/16in. diameter. These test strips will aid in setting up of the table tops and we can be sure the blades will clear the chamfer when fitted.

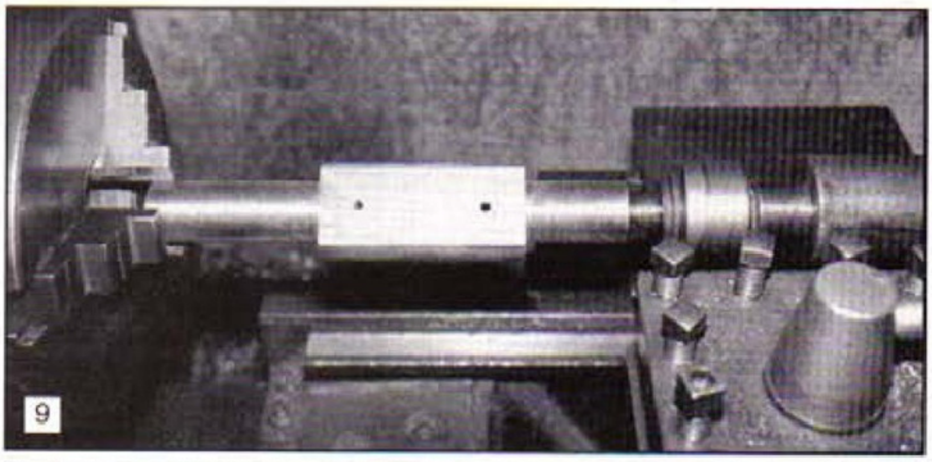
First bolt on the four adjusting strips, these should be fitted with the bolts to the centre of the slots.

The four top side triangles (7A and 7B) are next, the two with the tapped holes go to the rear table. Clamp these to the four adjusting strips (4), one side at a time. Set the front and rear tops level with one another. The top level of these triangular sides need to be 3/16in. below the top of the spindle if you are using a table top thickness of 5/16 inch.

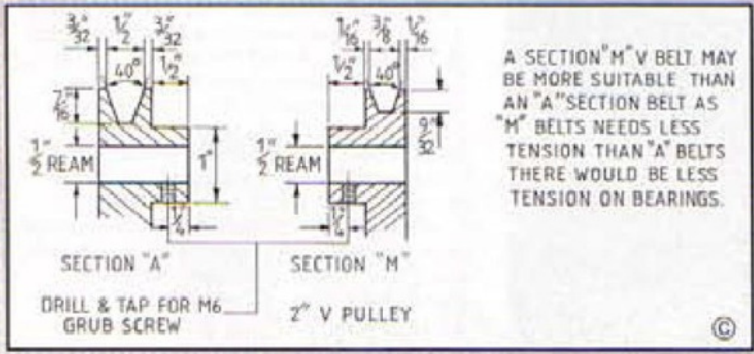
Whatever thickness is used for the table top, when the front and rear tops are added they need to be 1/8in. above the top of the spindle.

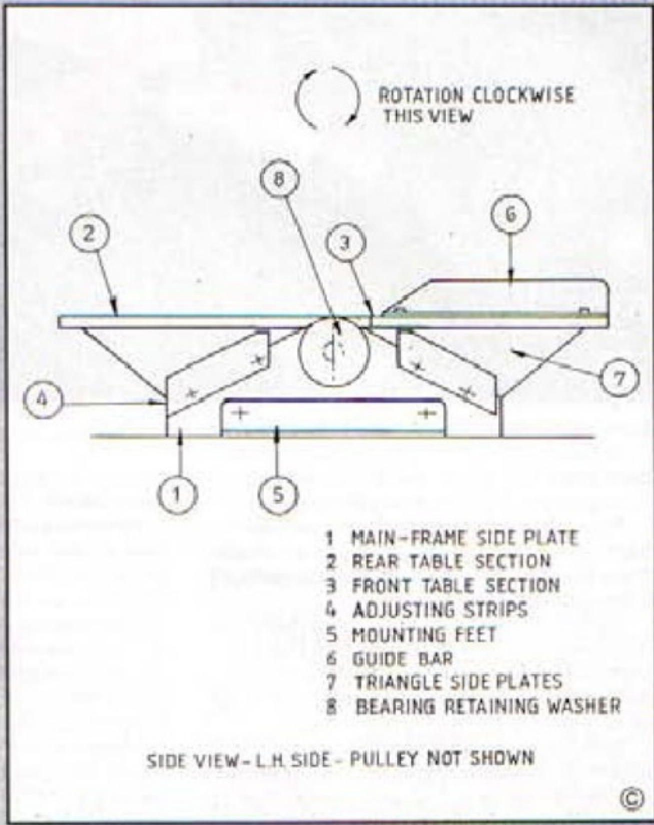
Clamp the other two sides on, set as before but also set level across with the spindle. Tack weld the adjusting strips to the triangle sides. Now place front and rear top plates on. Place a straight edge bar across the two and clamp them to it. Check the top level, 1/8in. above the spindle. Try revolving the spindle to make sure the test bars are not fouling on the chamfer. If all is well, tack weld to the sides, at the same time add front and rear end plates. No detail part drawings are included for these but see front/rear section views (L.H.S.). Now remove front and rear sections and put a few spots of weld on the inside. Reassemble and this will complete the main body of the planer.

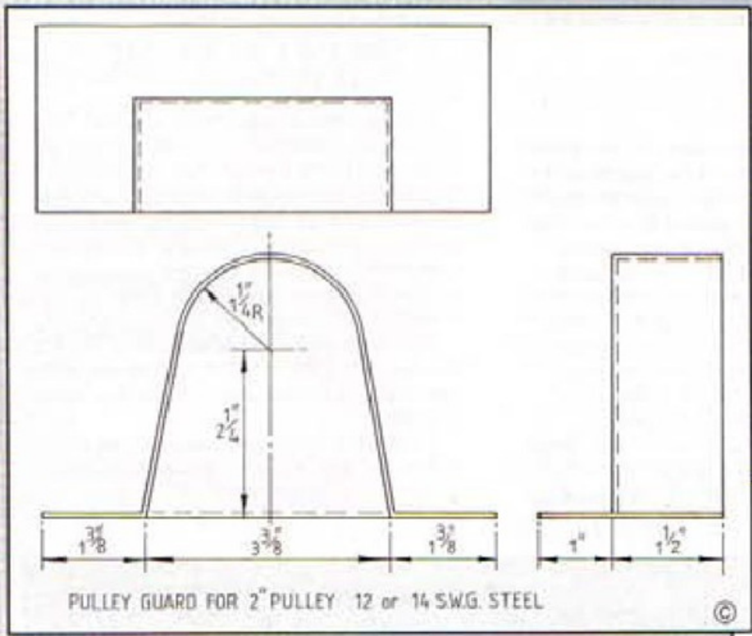
The guide bar for the front table is made from 1in. × 1in. × 1/8in. angle drilled to suit. The spindle guard (11) needs a little explanation. The actual guard is a piece of 14 s.w.g. sheet steel suitably bent to shape in the vice, and spot welded to two ½in. × 1/8in. arms. An expansion spring is used to keep the guard down. The position of this will depend on the size and length of the spring available.

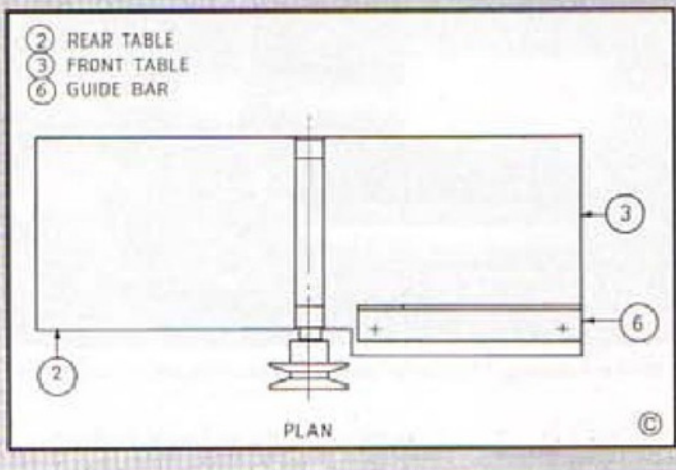


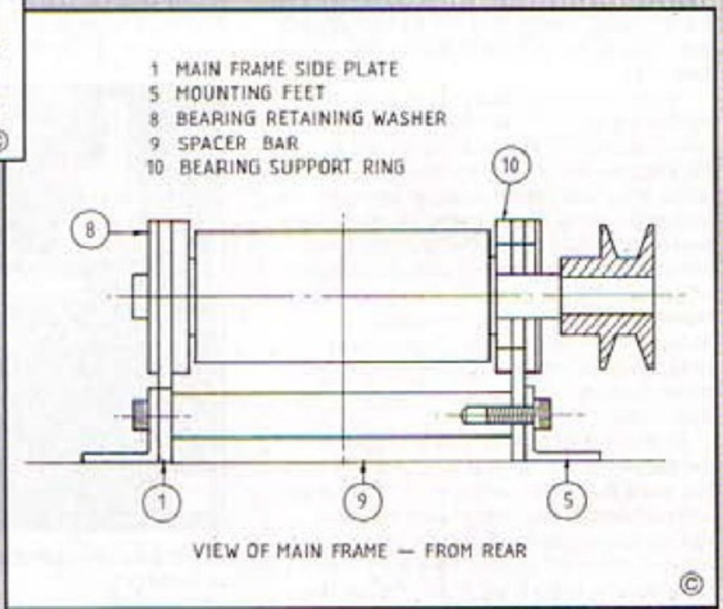
Setting up the spindle for final machining. The clamp plates and packing pieces have still to be fitted.







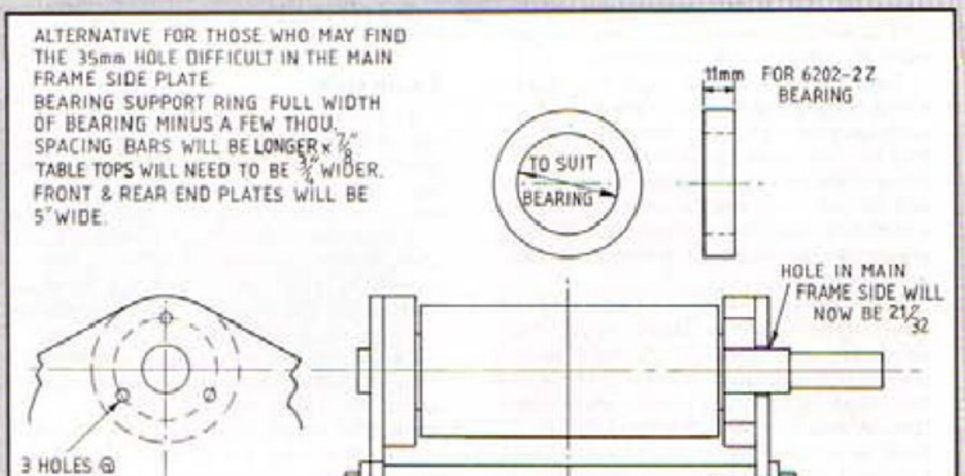


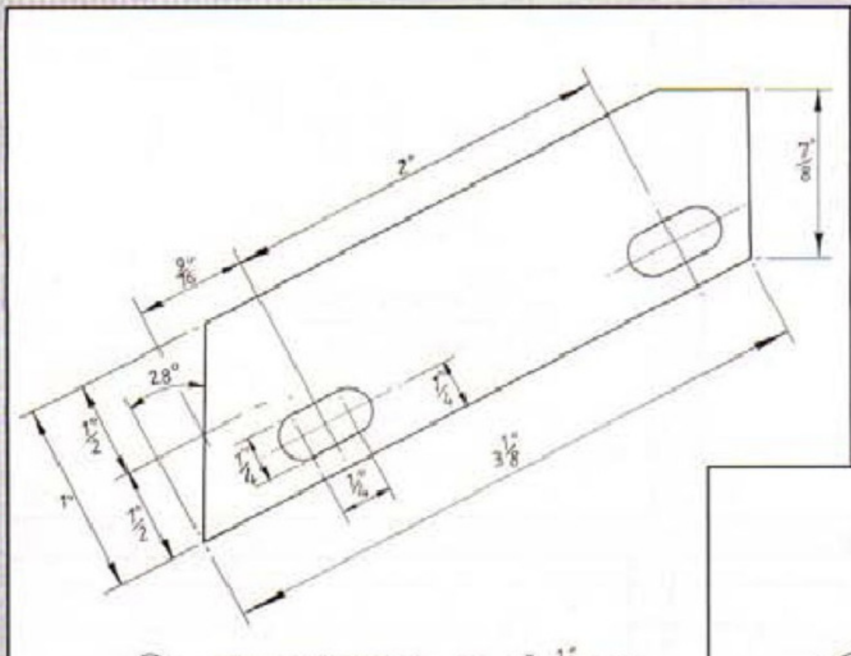


MARKING OUT

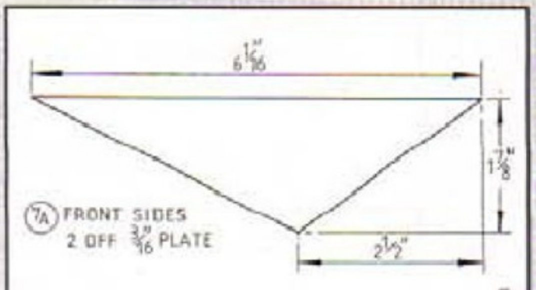
Given a situation when working outdoors away from your workshop, and there is a need to mark the position for drilling a hole located from another deep-drilled component (say a casting being fixed to a baseplate), proceed along the following lines: Damp the area to be marked with oil (or spit!), position the casting and drop a pinch of powdered chalk (dry sand, soil, fine sawdust) down the hole and remove the casting. The circle of powder will show where to centre-pop for drilling.

Fettler

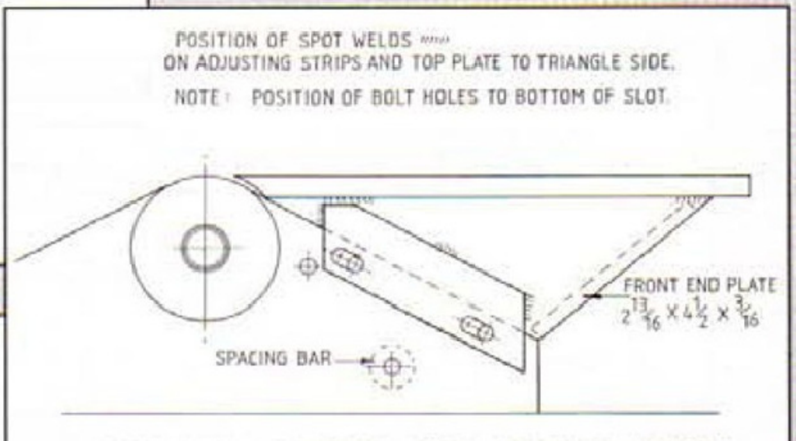




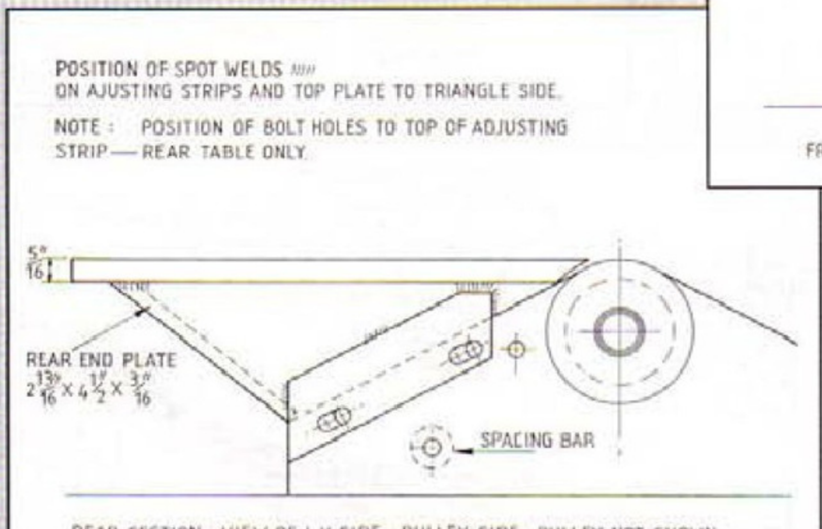
(4) SIDE AJUSTING STRIPS : M.S. 1" x 1/8" 4 OFF ©



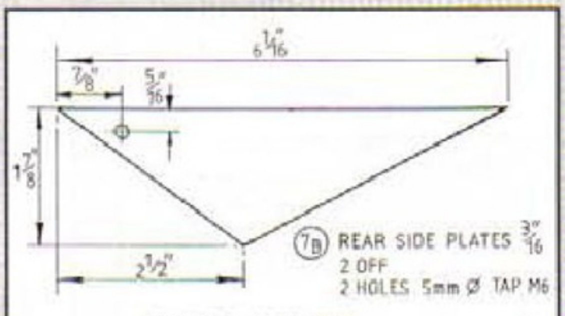
(7A) FRONT SIDES 2 OFF 3/16" PLATE ©



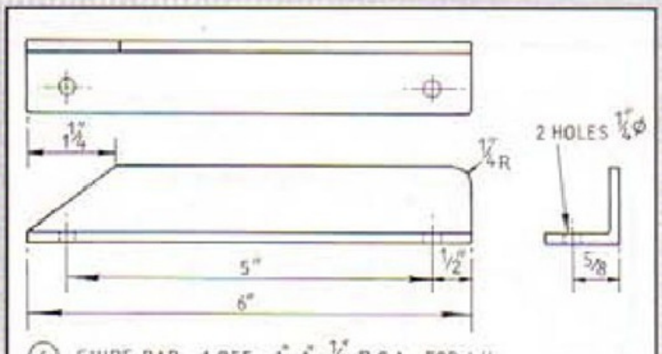
FRONT SECTION—VIEW OF L.H.S.—PULLEY SIDE—PULLEY NOT SHOWN. ©



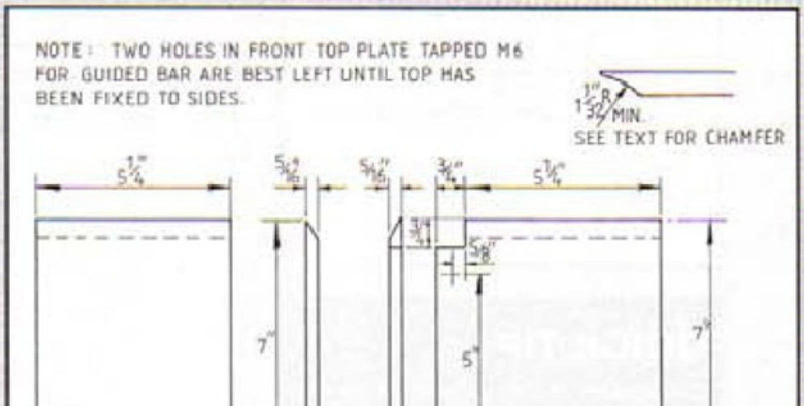
REAR SECTION—VIEW OF L.H SIDE—PULLEY SIDE—PULLEY NOT SHOWN ©



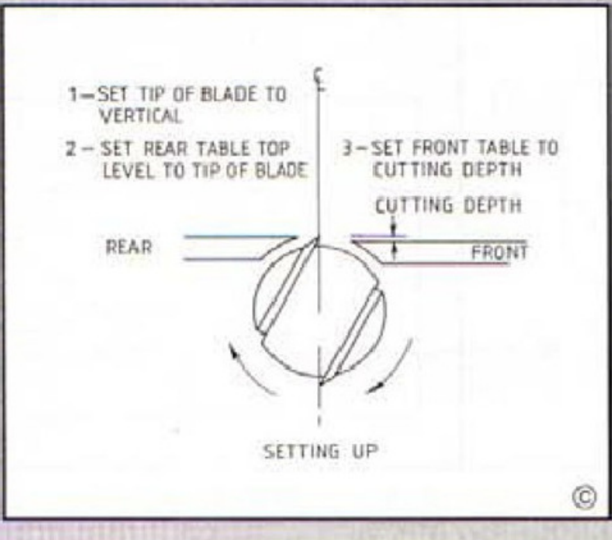
TRIANGLE SIDE PLATES ©

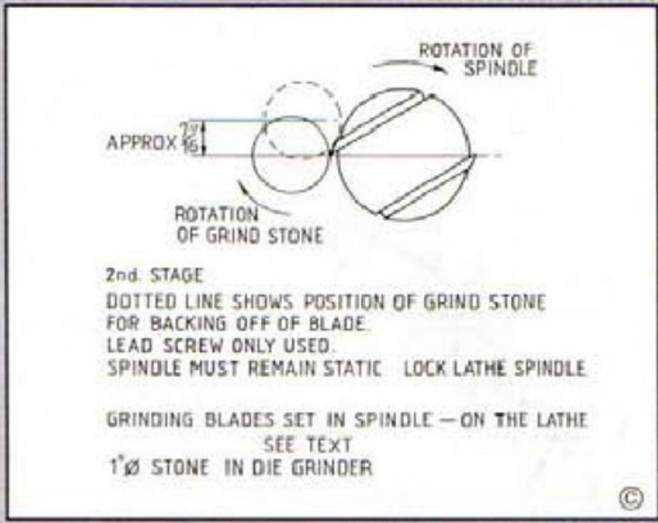


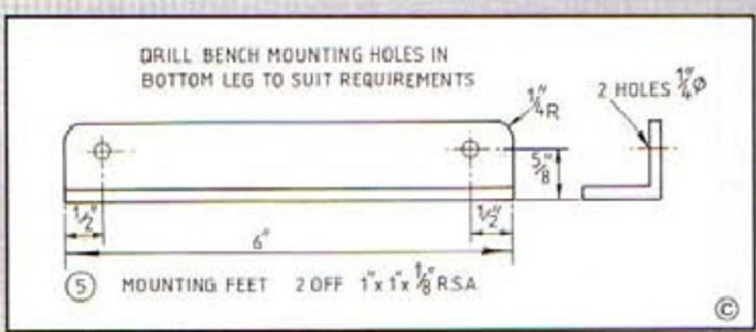
(6) GUIDE BAR 1 OFF 1" x 1" x 1/8" R.S.A. FOR L.H. ©

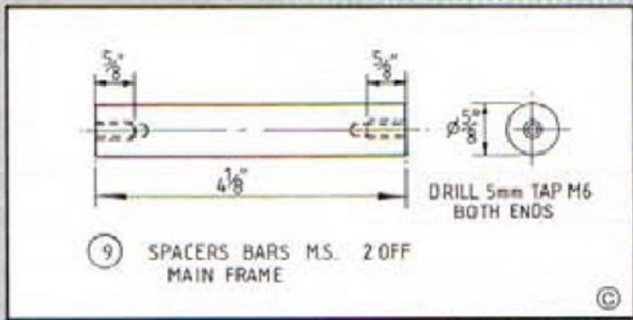


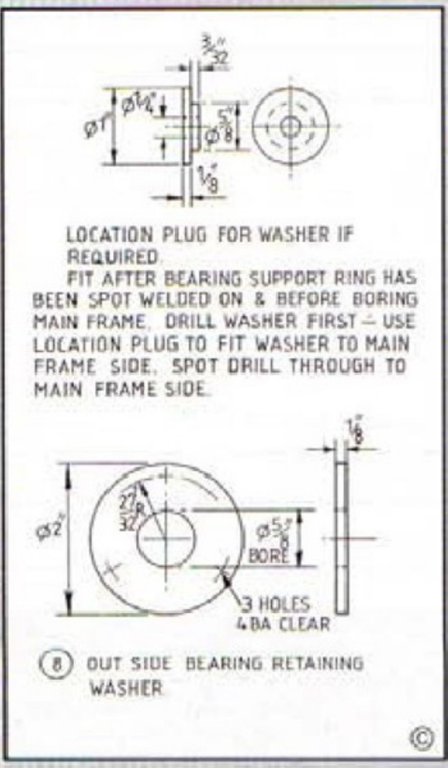
(2) REAR TABLE TOP : M.S. (3) FRONT TABLE TOP : M.S. ©

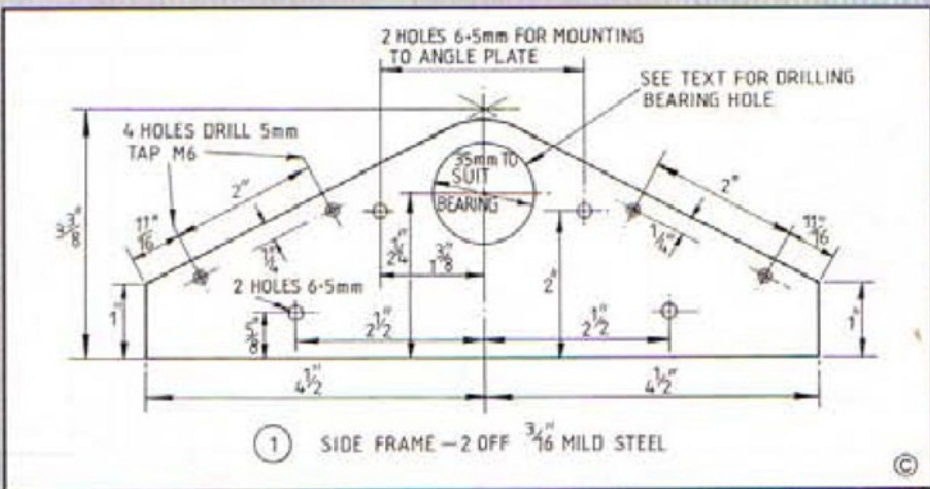


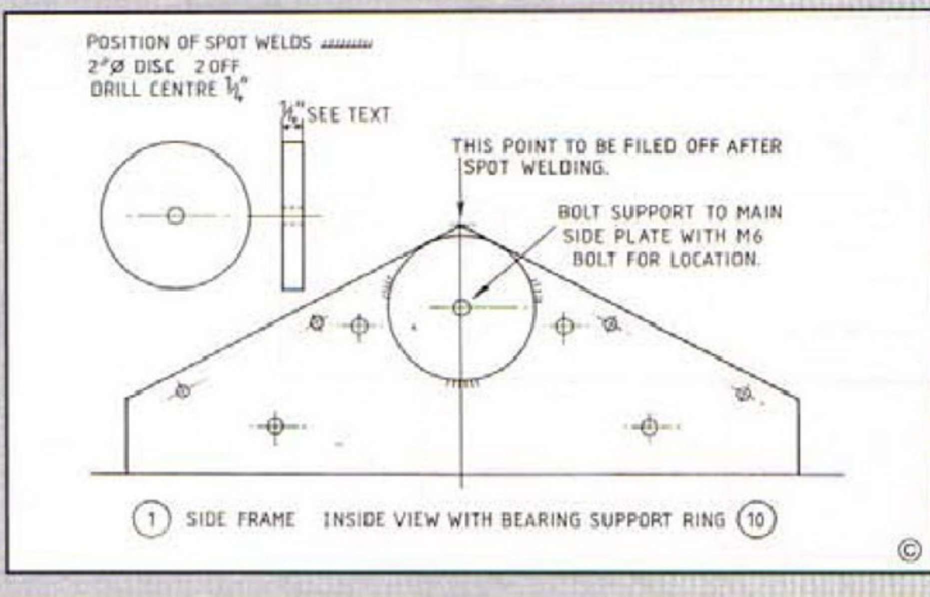






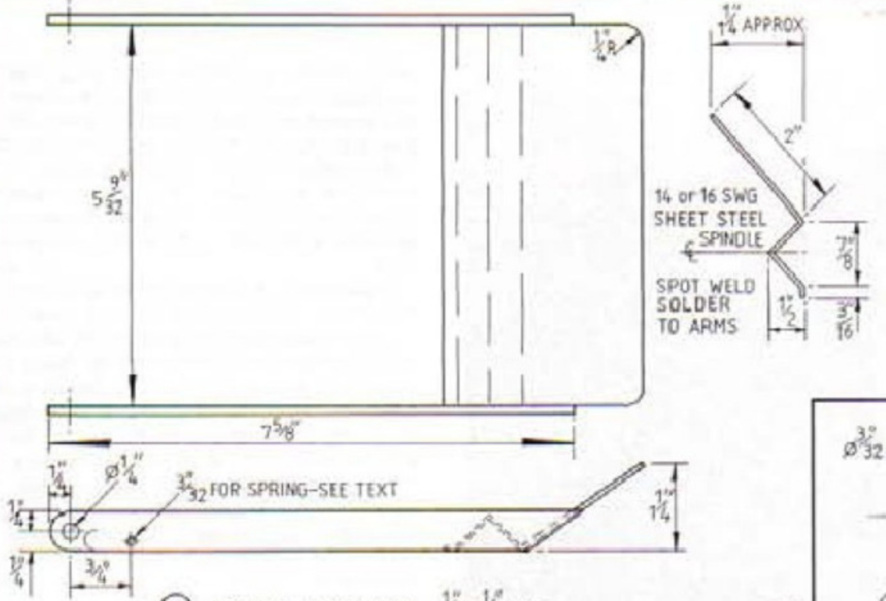




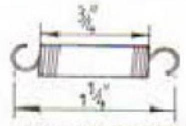


QUICK TIP

Taiwanese mill/drills seem to have a draw bar which is threaded M10. As many collet chucks and tooling to fit in the spindle nose are tapped with alternative threads, it is a good idea to make new drawbars with different threads instead of trying to find M10 tooling. **Alan Jeeves**

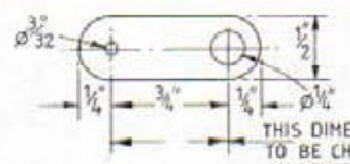


(11) SPINDLE GUARD ARMS — 1/2" x 1/8" M.S. ©



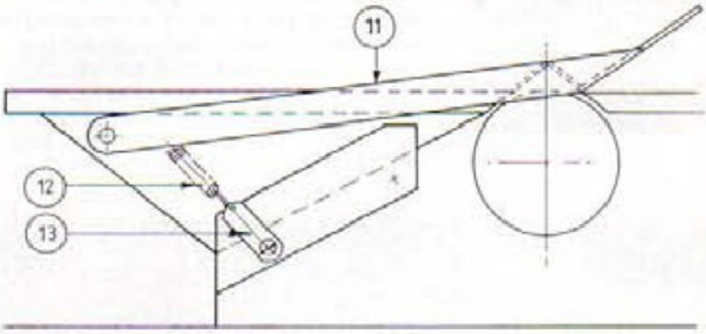
ANY SIZE OF SPRING WILL DO PROVIDING IT WILL HOLD THE GUARD DOWN.

(12) SPRING: ø 1/4" 16 SWG. ©

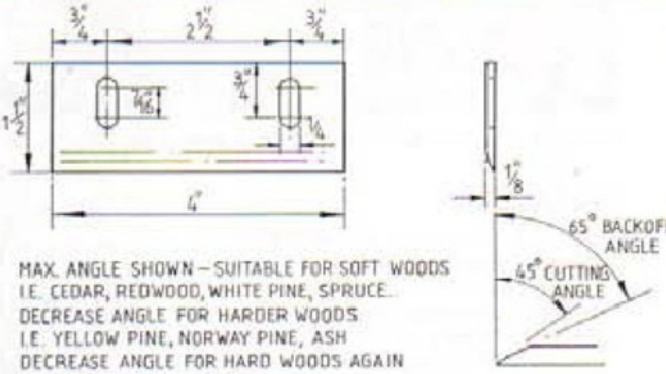


THIS DIMENSION MAY HAVE TO BE CHANGED DEPENDING ON LENGTH OF SPRING USED.

(13) SPRING ANCHOR: 1/2" x 1/16" m.s. ©

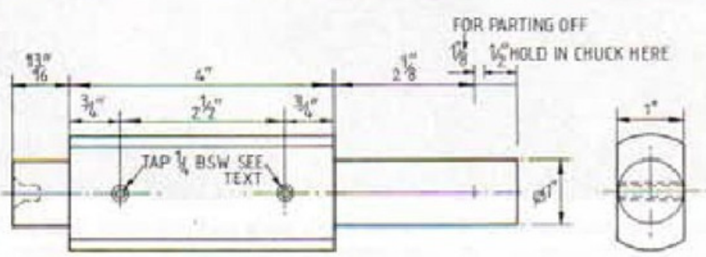


SPINDLE GUARD SET UP
(11) SPINDLE GUARD
(12) SPRING
(13) SPRING ANCHOR ©

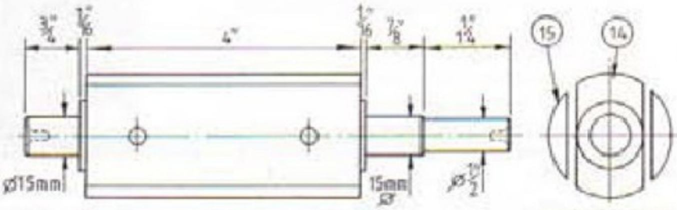


MAX. ANGLE SHOWN – SUITABLE FOR SOFT WOODS I.E. CEDAR, REDWOOD, WHITE PINE, SPRUCE.
DECREASE ANGLE FOR HARDER WOODS I.E. YELLOW PINE, NORWAY PINE, ASH
DECREASE ANGLE FOR HARD WOODS AGAIN I.E. BEECH, MAPLE, BIRCH.

BLADES 2 OFF SABEN-TOOL STEEL KE 672 ©

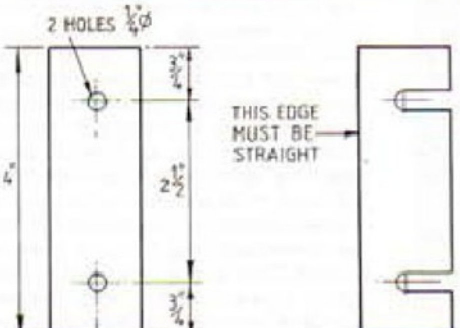


(14) SPINDLE 1 3/4"ø 7 5/8" MIN. LENGTH 1 OFF (INITIAL MACHINING) ©



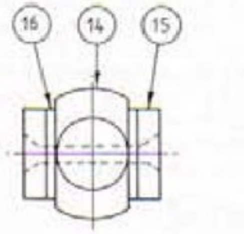
SPACERS REMOVED

(14) (15) SPINDLE 1 3/4"ø M.S. (FINAL MACHINING) ©

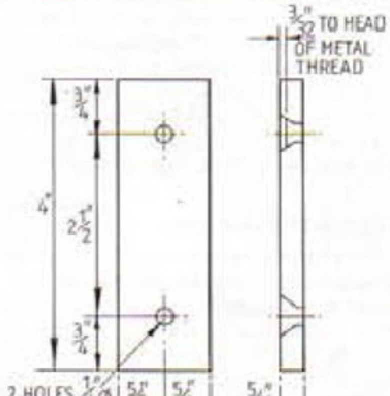


TEST STRIP FOR SETTING FRONT & REAR TABLE TOPS MADE FROM PACKING STRIPS. SEE TEXT

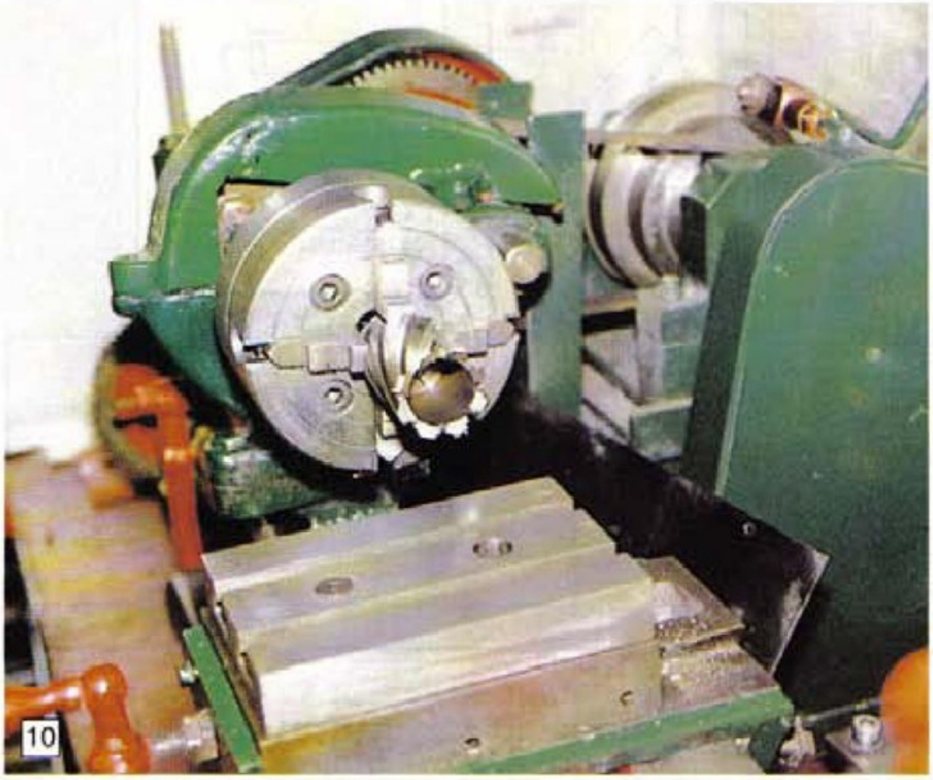
(16) PACKING STRIPS 2 OFF FOR SPINDLE 1 1/4" x 1/8" M.S. ©



CLAMPING BARS & PACKER BOLTED TO SPINDLE READY FOR FINAL MACHINING. ©



(15) SPINDLE CLAMPING BARS 2 OFF 1 1/4" x 5/16" M.S. ©



The Rota Broach ready for making the hole in the side plates.

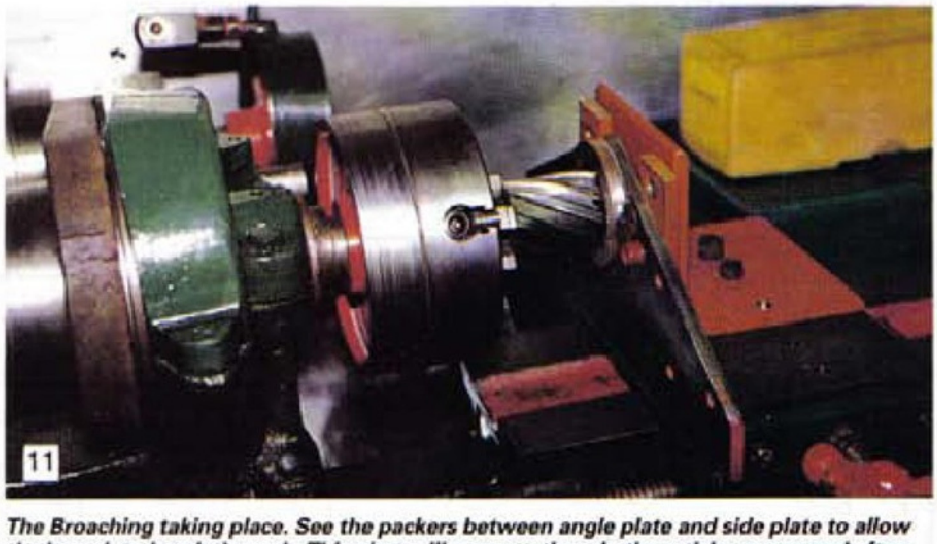
The blades

The cutting blades or knives as the wood fraternity call them, are quite straightforward to make. All work necessary to complete them should be done before hardening.

I used SABEN ground flat stock, KEG672 oil hardening alloy tool steel, 1½in. × ⅛in. which can be bought in 18in. lengths. To harden, quench in oil from 790/810 deg.C. The first pair I made following the makers instructions were a little too hard for some woods, especially wood with a lot of knots in and tended to chip along the cutting edge.

The next pair I made I heated to a dull cherry (in daylight) along the cutting edge only for about ⅓ width of the blade; this was then clamped between two thick plates in the vice and left to cool. The cutting edge can be honed with the oil stone, the cutting edge must be kept straight.

If you have a tool post grinder or similar, the spindle can be set up in the lathe with the blades in and the cutting edge ground this way. I used a die grinder for mine, running the spindle at about 200 r.p.m. **Do not** run the cutting edge into the grinding wheel (see diagram). I am not going to enter into the subject of grinding and types of stone, I think our worthy editor would object. Just use a stone that is not too soft and has a fine grit, if glazing of the stone occurs increase the spindle speed.



The Broaching taking place. See the packers between angle plate and side plate to allow the broach to break through. This photo, like most others in the article, was posed after the actual machining has been completed. (Often the case – Ed). *It should have shown the rear of the angle plate being given additional support by the tailstock barrel.*

Setting the blades

If the blades have been ground in the lathe, the top of the rear table is set level to the tip of the blade, set at its most vertical point. A steel rule on the rear table is all I use. The front table is lowered until the desired depth of cut is reached. Again to check the depth of cut a steel rule is placed on the rear table and the gap measured over the front table. To measure this gap three steel strips were cut from swg mild steel 10-12 and 16 swg. The other method of setting the blades is to leave the clamping bars a little loose. Then turn the planer upside down and place on a hard flat surface. With the rear table hard down the blades can be set to this surface. If a packer is placed under the front table equal to the depth of cut required, this can be set at the same time.

The bearings

The bearings used are 6202 – 2Z – 35mm O/D – 15mm I/D and 11mm wide single row groove type ball bearing race, with seals both sides. The bearings have lasted some six years and are now in need of replacement. As a rough guide mine has done approximately 100ft. of 4in. wide timber (pine) per month for nearly five years. For those who want to do more or intend to plane a lot of hardwoods, then the wider type should be considered and they are double row grooves type 5202 - 2Z – 35mm O/D – 15mm O/D and 0.625in. wide. I am not going to go into the science of bearings, that would take too long, wouldn't it, Mr Editor? *(Hopefully coming – Ed.)*

However, I would like to make one or two points. The bearings used here were chosen by the makers, namely SKF. Do not use any bearings that are smaller, they must be sealed both sides and should have a ball race as opposed to a roller race. Not that many roller race bearings will be found at this size anyway. A roller bearing may take the load but will not stand up to the speed that we require. The last point is, in this case never use secondhand bearings; the results if things go wrong can be disastrous – I know!

The drive

The planer uses an "A" type "V" belt. This came about because all the other machines in the workshop are powered by the same. The main problem here is that the planer requires a small diameter "V" pulley to get the required speed. To get a "V" belt round this pulley requires quite a bit of tension on the belt, this in turn puts more pressure on the bearings. This was the main problem with the original model; the spindle would tilt down on the pulley side. Although the original was recently fitted with Lumen bronze bearings it does not seem to suffer from this problem yet.

The 2in. dia. pulley (which may vary in some cases) is the last item to complete the job. This can be bought or made. A pulley of this size will present no problem. However, before making it, it will be worthwhile getting the drive pulley for the motor. The r.p.m. of the motor will also govern the size of the pulley. Prospective builders may have to do a few sums here and be prepared for a bit of trial and error to get the best results.

As a rough guide, the actual tip of the blade needs to be travelling at between 4200 and 5500 feet per minute. The higher speed is better for soft woods, while the lower speed is better for medium woods.

The following data is what I use and should give some idea of what to aim for.

The blade tips are set on 2in. diameter.

The original planer

Motor 1HP × 1500 r.p.m. - 9½in. dia. drive pulley.

Planer pulley 1⅝in. dia. - spindle r.p.m. 8775.

Giving a blade speed of 4590 ft. per minute.

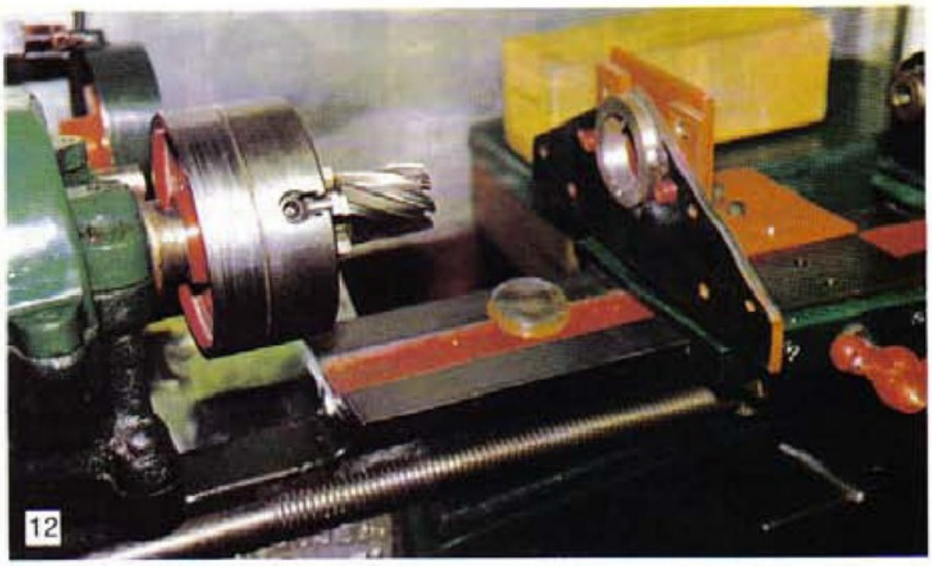
The planer in question

Motor 1½ HP rated at 2850 r.p.m. - 5½in. dia. drive pulley.

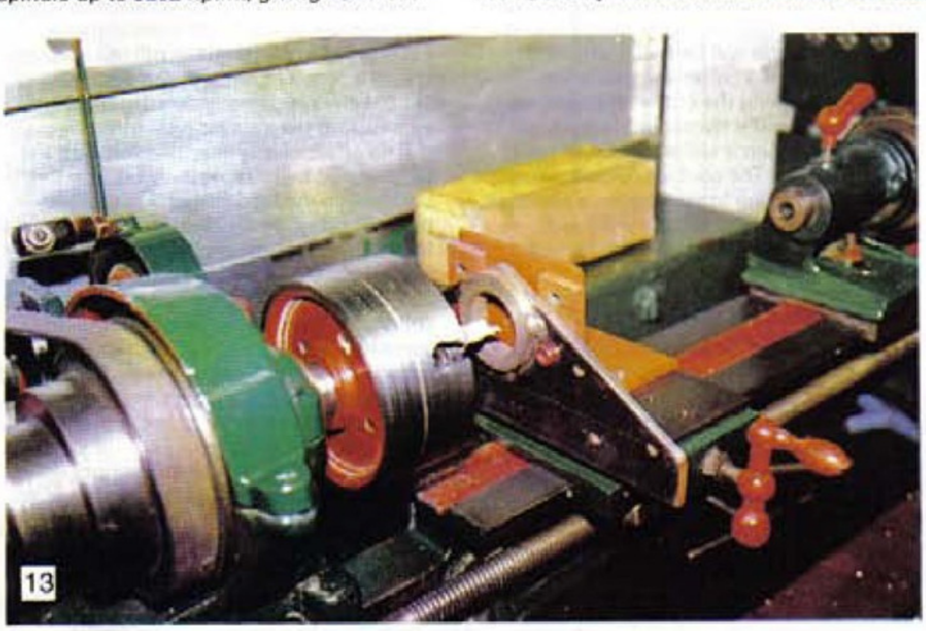
Planer pulley 2in. dia. - spindle r.p.m. 7837.

Giving a blade speed of 4100 ft. per minute.

This has now ben up-rated to drive pulley 6½in. diameter, which brings the spindle up to 9262 r.p.m., giving 4847 feet per minute. A large pulley can be found on car engines suitable for a drive pulley.



***Broaching of the hole complete, see the washer that has been removed laying on the lathe bed.* (Do any other readers use Rota Broaches? - Ed).**



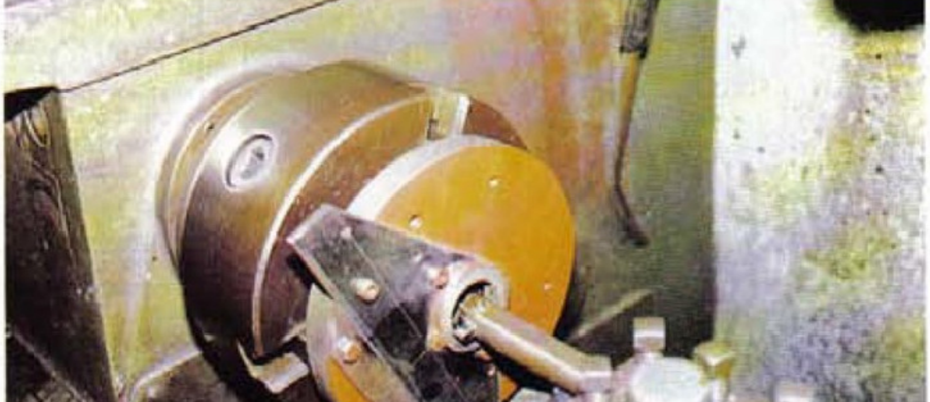
Finally boring the bearing hole to size. The lathe is 3in. centre, made by James Grose of London 1936. I found it on the local tip some years ago.

On the question of balance, to date I have had no problems. Just as well, as to date I have found no simple way of balancing which I can do myself! If any reader has any ideas on this, I would like to hear about them. *(So would I! - Ed.)*

The rate at which the timber is fed across the planer is something that will have to be learnt as this will largely depend on the type of wood, the r.p.m. of the spindle and the depth of cut being taken. Always plane the narrowest edge first. Care should be taken at the start of a cut, also when passing over knots in the wood. It is not uncommon for these knots to fly out, more so in softwood, so keep your head out of the way! Do wear eye and ear protection. Also keep an even pressure on the wood over the leading table. Do use some sort of support for the wood when planing long lengths (I use toilet roll holders, one front and one rear).

It is not advisable to plane ply or chipboard. Any sap that gets on the table tops should be removed straight away. A guard should be made for the planer pulley, this I find is better mounted to the bench, with a pivot one end so that it can swing out of the way. The drawing is for a 2in. dia. pulley. Some alterations may have to be made to the drawing. You may prefer to fit it to the planer main frame, in which case the two ¼in. dia. holes either side of the spindle centre line can be used.

A hole in the bench under the planer will be required, as large as possible, as a phenomenal amount of wood chips can come from a small piece of wood. You may also need some form of guard around the drive belt and motor. The motor in particular should be guarded as there could be a risk of fire if sawdust or shavings enter the motor.



Alternative method of boring side plates for bearings, being done on a larger lathe. A simple fixture was made for doing it this way as I was making a batch of seven planers.

A TEE SLOT CUTTER

Perhaps cutting Tee slots is not as daunting a task as we may consider, and with this single tooth cutter it need not be costly either

I consider it probable that many readers of *M.E.W.* will have never completed a project that required them to make any Tee slots, the reasons will be many and varied. Probably top of the list, will be the fact that in most instances projects requiring Tee slots will be relatively large. Because of this they will be more time consuming than is acceptable. Typical of these would be a small milling machine; even a rotary table or a lathe vertical slide are likely to be major projects for some people.

Another probable reason is lack of experience in such an operation, this coupled with the fact that if it is not mastered the whole project will fail as there is rarely an alternative, as a result creating some reluctance to have a go. That there is some reluctance to take on this task, is confirmed by suppliers of kits frequently offering to carry out this work for the potential purchaser. Cutting Tee slots is also often a service offered in the advertisements of small firms prepared to undertake machining work for the home machinist.

The problem

Yet another reason, and probably of major importance if the project envisaged is both small and a one off, is the cost of a suitable cutter. With a suitable cutter likely to cost in the region of £20.00 plus, this could easily cost more than the project itself. Myself having one such application in mind, buying a cutter could hardly be justified and alternatives would, at least, have to be considered.

Number one possibility was to make a Tee slot cutter, generally as those purchased. This would be made from silver steel, but at 35mm diameter it is likely to cost some £15.00, almost as much as a cutter, there would however be some material left over. Whether this is an economic proposition will depend on the probability of the remainder being found a use. Again there will be those who find the manufacture of a cutter somewhat daunting. Making the cutter will be time consuming, and if hardening is not totally satisfactory, then it will either blunt rapidly or maybe chip. The obvious consequences of this will be having to start again, a situation that probably many readers will have experienced when making such cutters.

A possible solution

The only other serious possibility was to make a single tooth cutter, similar in principle to a fly cutter. The success of this method would obviously depend largely on the rigidity of the cutter shank and its ability to hold the cutter bit securely without moving. The only way to prove this approach was to give it a try.

The obvious advantage of the normal Tee slot cutter would be the speed of metal removal, due to it having a number of teeth, probably around 10 to 15. Not so obvious is the fact that, as it cuts both arms of the Tee at the same time, the force from the teeth on one side will largely balance out that from the teeth on the other. As a result, the load on the table and its leadscrew will be low.

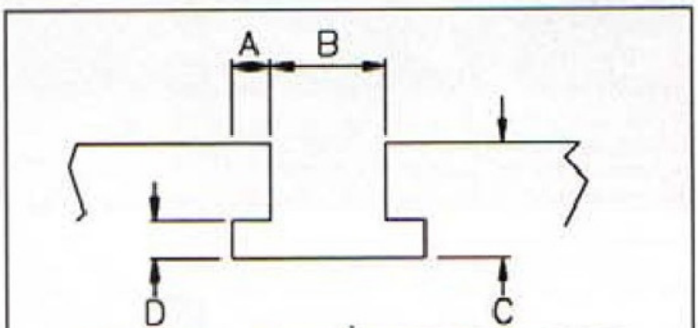
In the case of the single tooth cutter if this were arranged to cut both sides at one pass the force on the table would alternately be towards one end and then the other. Whilst most work carried out on the average mill/drill may, because of its light nature, be undertaken without consideration of this fact, this is not the case in this instance. Even the use of a fly cutter will not normally create a problem, though the possibility should always be considered, particularly when using the smaller mill/drills.

The effect of this alternate force on the table would be to repeatedly take up the backlash in the leadscrew, first one way, then the other. This would result in extreme forces being placed on the table and leadscrew, also the cutter itself. This is obviously not a practical approach. The solution is to arrange the size of the complete cutter such that it is possible to cut one arm of the Tee at a time. This would make the operation rather slow but at least I felt that it had a chance of being practicable.

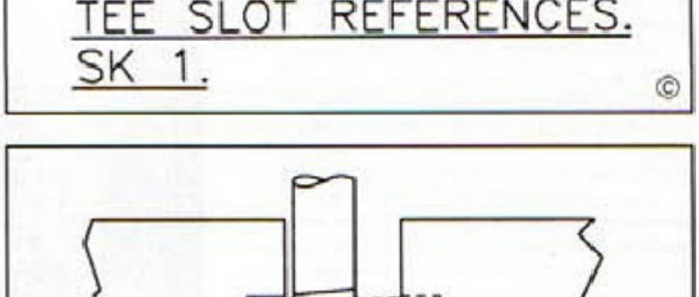
As there are a range of Tee slot sizes, no dimensions are given for the cutters in this article. The dimensions are however quite

Top: A view of the completed and assembled cutter.

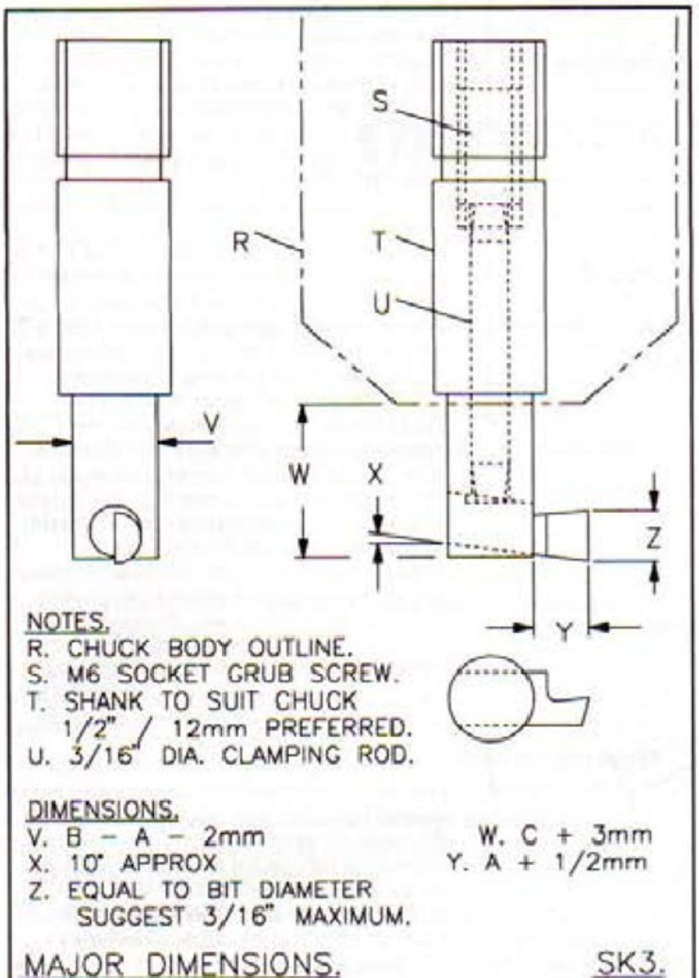
Above: The same cutter, here stripped to its component parts.



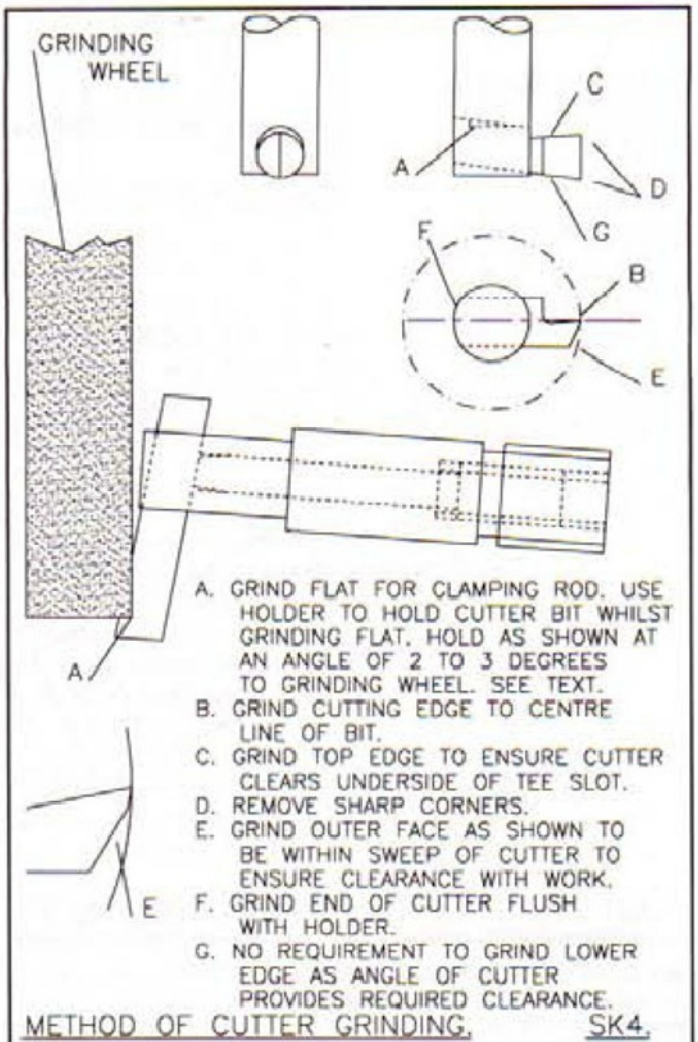
TEE SLOT REFERENCES.
SK 1.



NOTE CUTTER CUTS ON ONE SIDE ONLY AS SHOWN.
RAISE AND LOWER CUTTER TO ACHIEVE REQUIRED WIDTH OF SLOT.
CUTTER ACTION. SK2.



MAJOR DIMENSIONS. SK3.



METHOD OF CUTTER GRINDING. SK4.

critical as, due to the nature of the method, the cutter assembly must be as robust as can be achieved. Because of this, the length of the shank projecting from the chuck must be as short as can be tolerated, and its diameter as large as is possible. **Sketch 2** shows how the cutter is used to cut one side only whilst **Sketch 3** explains how the dimensions are arrived at to make this possible. **Sketch 3** should be read in conjunction with **Sketch 1.**

Manufacture

Making the cutter should present few problems, with the actual grinding of the cutter bit being the most critical. First choose the diameter of the cutter bit, for the larger sizes of Tee slot it is not intended that the width of the arm should be cut at one pass. A diameter of 3/16in. is probably the maximum that can be used, and where the arm has to be wider than this, then it will have to be done in two passes, either by raising or lowering the machine spindle. For smaller slots a 1/8in. bit maybe practicable and the Tee slot arm made at one pass. The bit must initially be at least 1in. longer than ultimately required, the reasons for this will be explained later.

First turn the diameter of the shank to suit the end mill chuck, followed by the thread. Remove from the chuck and turn round and return to the chuck, concentricity is not that important. Now turn the small diameter "V" but leaving it about 1mm over length. Remove again and set up on the drilling machine so as to drill the hole for the cutter bit at an angle of about 10 deg., this is not critical.

Return to the lathe and face the smaller end until the hole on the nearest side is about ½mm from the end. This will ensure that the lower edge of the cutter bit is lower than the shank, and will therefore cut satisfactorily. This is more important than the actual value of dimension "W" which can vary by 1 or 2mm. Again turn the part in the chuck and drill for the clamping rod until it breaks into the cutter hole. Follow this drilling and tapping for the M6 grub screw, this completes the shank.

The clamping rod was made from a short length of 3/16in. dia. silver steel, bright mild steel would do just as well as it should not be hardened. Generously chamfer both ends to prevent the rod becoming captive should any burrs be created by the clamping action.

The cutter bit

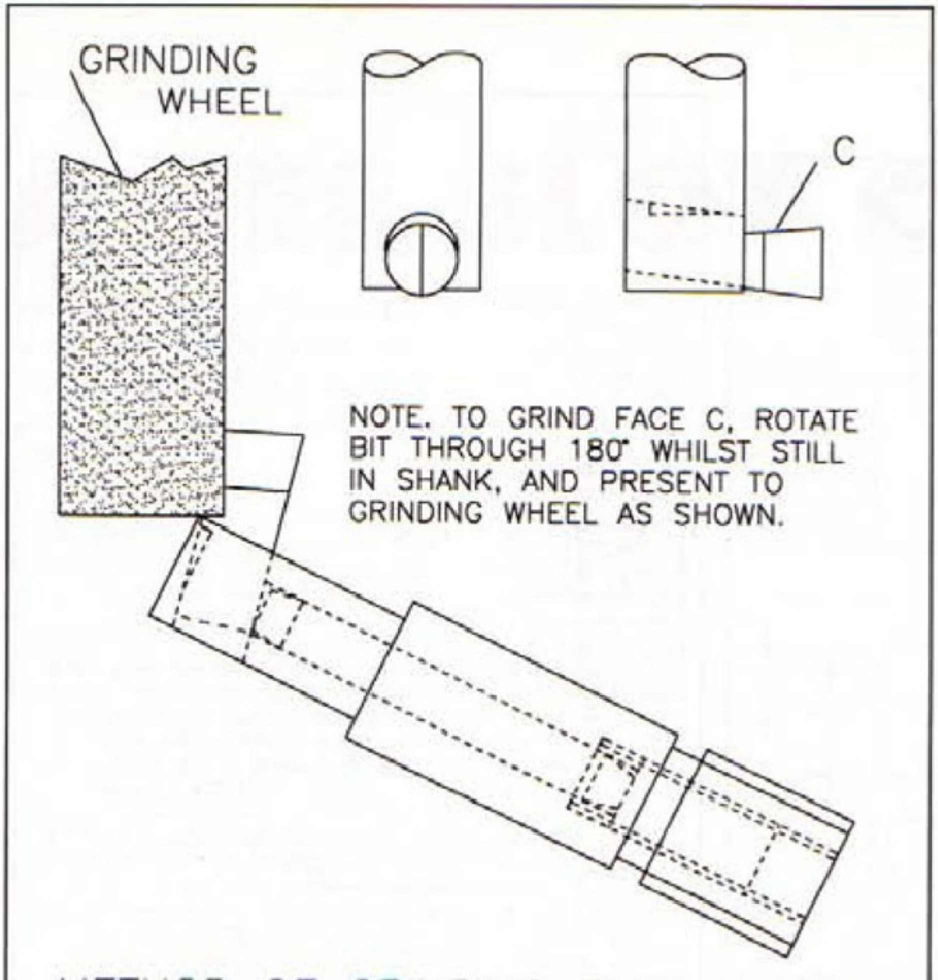
This is not that difficult, but there are some factors that are quite important. Firstly the piece of high speed steel chosen must be at least 1in. longer than that ultimately required. This enables the critical grinding operation for face "A" to be carried out whilst mounted in the shank, otherwise this would require a special jig for holding it, were it shorter. Under no circumstances attempt to grind the cutter whilst holding it in the fingers or even a pair of pliers.

Perhaps surprisingly the flat for the clamping rod is more critical than is likely to be envisaged. The cutter bit will take a pounding with its broad face (3/16in.) and its intermittent cutting action. As a result the tendency will be for the bit to be hammered further into the holder.

If the flat on the bit were ground with the intention of it being exactly at right angles to the length of the shank, this would be probably be OK, if it were achieved. Manufacturing errors would however occur, and the flat could end up such that if the bit was forced further in, the bit would tend to come loose. If on the other hand the error was the other way, then the tendency for the bit to be forced in would make the bit tighter, obviously a better proposition. In view of this it is preferable to make the bit with such an inherent angle, the method for the establishing this situation can be seen **Sketch 4 operation A.** Position the flat such that when placed in the shank, the correct way round, only about 1mm projects from the non-cutting end of the bit.

Remove bit from the holder and replace in its final position. It is now required to reduce the bit to nearer its final length. Whilst still in the shank, commence to grind round the bit some 3mm beyond the point indicated by dimension Y, do not make it too short as you will not want to start again. When reduced to about ½ diameter or less, remove from the shank and place in a vice with the waist adjacent to the end of the jaw. Now place a tube over the outer end and smother the area with several layers of thick cloth so that it is quite impossible for any fragments to fly, lever with the piece of tube and snap the bit into two pieces.

Replace the bit in the shank and grind face "E" followed by face "B". This leaves the upper face "C" to be ground. Unless you have a grinder with a wheel with a thin edge, as frequently used on cutter grinders,



METHOD OF GRINDING FACE C SK5. ©

it will not be possible with the bit mounted in its working position. To accomplish this task loosen the bit and rotate through 180 deg. without removing from the shank, also pull out the bit by 2 to 3mm and re-tighten. The face "C" can now be ground from the end of the shank, **Sketch 5** shows how this is accomplished. It is essential that this face is ground right up to diameter "V" so make it a little longer rather than shorter, it will cause no problem if a little goes into the hole in the shank when it is repositioned.

Finish off by grinding the non-cutter end of the bit almost flush (say 0.1mm) with the shank and by removing the sharp corners as at "D".

In use

The article regarding the DTI base in this issue gives a detailed explanation of the use of this cutter. In this it was used to cut a Tee slot having approximate dimensions of "A" = 5mm "B" = 16mm "C" = 16mm and "D" = 6mm. After learning the lesson relating to face "A", prior to which the cutter moved on 2 or 3 occasions, the operation was very straightforward, albeit slow. The shank had a smaller diameter of 10mm (this is a little larger than the figures arrived at from the suggestions in **Sketch 3)** and showed no sign of not being sufficiently robust. From this I see no likely strength problems when making smaller Tee slots and using a 1/8in. diameter bit. In this case however perhaps diameter "V" could be increased to B-A-1.5mm, in any case "W" is likely to be much shorter. The clamping rod may have to be reduced to 5/32in. or even 1/8in. diameter.

In passing it is worth mentioning that the cutter could usefully double as a normal fly cutter. This could either be with the same bit as made to cut Tee slots, or an alternative bit shaped more appropriately for fly cutting operations.

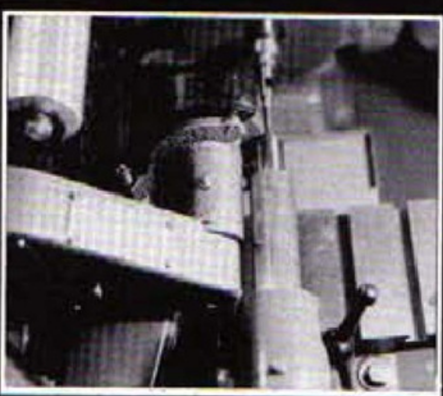
Even if you have no interest in the DTI base, do also read the article elsewhere in this issue, as it goes into much more detail regarding the use of this cutter.

IN OUR NEXT ISSUE!

Coming up in the AUGUST/SEPTEMBER issue No. 18 will be:

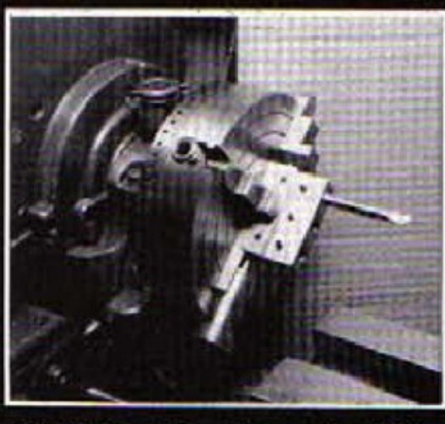
A tool post grinder, a major constructional item

A lathe mounted fret saw, save on space



Low voltage DC motor speed control, investigating the methods and detailing some circuits for the home constructor

A small universal vice, made on the Promill-35, a vice of use to any reader and a useful project for the beginner, the article is written with this in mind



Adapting a four jaw chuck for carrying out precision boring, avoids having to make a complete boring head

AND MUCH MORE

Issue on sale

12th July 1993

Contents may be changed

MODEL ENGINEERS'
WORKSHOP

READER SURVEY

In order to find out a little more about our readers, may we ask you to spare a little time to complete and return this questionnaire? We hope that by careful analysis of your answers we can find out some of your likes, dislikes and views about the magazine and your leisure activities. If you would then like to pop the answers into an envelope and forward to the address at the end of the survey we will pay the postage. Thank you for your co-operation.

1. How many years have you had a workshop?

under 10 1☐ 0 - 19 2☐
20 - 29 3☐ 30 - 39 4☐
40 - 49 5☐ more than above 6☐

2. Which of the following age categories do you fall into?

under 30 years 7☐ 30 - 39 yrs 8☐
40 - 49 yrs 9☐ 50 - 59 yrs 10☐
60 - 69 yrs 11☐ 70 yrs and over 12☐

3. Are you a member of a model engineering club or society? Yes 13☐ No 14☐

4. Are you a member of any other engineering based club or related society (e.g. motor cycle restoration, vintage transport, etc.)? Yes 15☐ No 16☐

5. Do you attend any evening class or outside organised workshop? Yes 17☐ No 18☐

6. What is your main workshop activity?

Engineering models, e.g. locomotives, traction engines etc? 19☐
Other models, e.g. boats, aircraft etc? 20☐
Clocks? 21☐
Vintage transport restoration? 22☐
Workshop equipment? 23☐
Other, please specify 24☐

7. If making workshop equipment is a secondary interest, what percentage of your workshop time is normally spent on this?

Less than 10% 25☐ 11 - 30% 26☐
31 - 50% 27☐ more 28☐

8. How many hours, on average, do you consider you spend in the workshop per week:

Less than 5? 29☐ 5 - 10? 30☐
11 - 15? 31☐ 16 - 20? 32☐
More than 20? 33☐

9. What was your last major purchase in terms of equipment, e.g. lathe, milling machine, drilling machine etc?

Please specify ....
How long ago was this? ....

10. What is your next major purchase likely to be? ....

11. Assuming that the cash is available, do any of the following prevent you from making a purchase:

Lack of space? 34☐
Cannot move heavy equipment into the workshop? 35☐
Products available not fully in line with requirements? 36☐
Other? 37☐

12. Do you anticipate ever building, or have you built a new workshop at your present home? Yes 38☐ No 39☐

If so is it:

An extension to an existing building? Yes 40☐ No 41☐
A new stand alone building? Yes 42☐ No 43☐
A change of use of an existing building or room? Yes 44☐ No 45☐

Would it be:

Brick built? Yes 46☐ No 47☐
Wooden construction? Yes 48☐ No 49☐
Other, please specify Yes 50☐ No 51☐

13. How would you rate *M.E.W.*?

	Very good	Good	Fair	Poor:
Types of article	52☐	53☐	54☐	55☐
Balance between complex and simple articles	56☐	57☐	58☐	59☐
Quality of articles	60☐	61☐	62☐	63☐
Quality of drawings	64☐	65☐	66☐	67☐
Overall quality of M.E.W.	68☐	69☐	70☐	71☐

If you rate any of the above as Fair or Poor, could you please comment ....
....

14. How did you rate following articles, all of which have been published since issue 10?

(VU = Very Useful, U = Useful, INU = Interesting but not useful, NI = Not interesting).

Issue		VU	U	INU	NI
10	An engraving attachment	72☐	73☐	74☐	75☐
10	Toggle clamps	76☐	77☐	78☐	79☐
10	Milling for beginners	80☐	81☐	82☐	83☐
11	Drills and drilling	84☐	85☐	86☐	87☐
11	A small 4 jaw chuck	88☐	89☐	90☐	91☐
11	A centre finder	92☐	93☐	94☐	95☐
12	Attachments for the Hobbymat	96☐	97☐	98☐	99☐
12	Improving a milling vice	100☐	101☐	102☐	103☐
12	MIG and Arc welding	104☐	105☐	106☐	107☐
13	Parallels	108☐	109☐	110☐	111☐
13	Jeclanhide handwheel	112☐	113☐	114☐	115☐
13	Reamers and reaming	116☐	117☐	118☐	119☐
14	Drilling square holes	120☐	121☐	122☐	123☐
14	A small variable speed drive controller	124☐	125☐	126☐	127☐
14	D.T.I. accessories (series)	128☐	129☐	130☐	131☐
14	A sharpening jig for slot drills and end mills	132☐	133☐	134☐	135☐
15	Metal spinning	136☐	137☐	138☐	139☐
15	Building a garden workshop	140☐	141☐	142☐	143☐
15	Hole gauges	144☐	145☐	146☐	147☐

Are there any other articles in recent issues of *M.E.W.*, not mentioned above, which you have found particularly valuable? Please state ....
....
....

15. How do you rate the following?

(VI = very interesting, I = interesting, A = Acceptable, NI = Not at all interesting)

	VI	I	A	NI
Scribe a line	148☐	149☐	150☐	151☐
Quick tips	152☐	153☐	154☐	155☐
Reader visits	156☐	157☐	158☐	159☐
Supplier visits	160☐	161☐	162☐	163☐

Trade counter 164 165 166 167
Product reviews 168 169 170 171

16. Some articles are published with rather more photographic illustrations than normal; especially with the beginner in mind. Typical of these were: Improving a milling vice, (issue 12), and D.T.I. Accessories (issues 14 and 15). How do you rate this approach?

Very useful	172	Useful	173
Acceptable	174	Not acceptable	175

17. Is there any single topic or workshop aspect which you would like to see covered in future issues of *M.E.W.*? ....

....

18. Approximately how much do you spend per year on workshop equipment and materials?

Up to £100	176	£101 - £250	177
£251 - £500	178	More than £500?	179

19. How long have you been reading *M.E.W.*?

Less than 1 year?	180	1 - 2 years?	181
More than 2 years?	182		

20. Do you read any of the following magazines?

	Regular	Occasional
Model Engineer	183	184
Engineering in Miniature	185	186
Locomotives Large and Small	187	188
Other (please specify)	189	190

22. If you are a reader, how do you feel they compare with *M.E.W.*?

	Not as good	As good	Better
M.E.	191	192	193
E.I.M.	194	195	196
L.L.A.S.	197	198	199

23. Please tick any other hobby interests that you or your family may have; other than model engineering:

Model railways	200	Amateur radio	201
Electronics	202	C.B. radio	203
Model cars	204	Woodwork	205
Model boats	206	Model aircraft	207
Full size steam locomotives	208	Clocks	209
Plastic modelling	210	Handicrafts	211
Computing	212		

24. Did you attend the 1993 M.E. Exhibition?
Yes 213 No 214

If no, was this because: 215
Too far to travel? 216
Too expensive? 217
Other commitments? 218
Lack of adequate public transport? 219
No wish to attend? 220

25. Do you work with wood as well as metal?
Yes 221 No 222

26. Of the following occasional free extras, which would you prefer:

Cover mounted gift? 223
Money saving offers? 224
Competitions? 225
Wall charts? 226
Fold out plans? 227
Booklets or supplements? 228

If booklets or supplements which topic(s) would you like to see covered? ....

....

27. If you are currently employed, what is your occupation? ....

28. If you are now retired or unemployed what was your occupation? ....

29. Does anyone else read your copy of *M.E.W.*? Yes 229 No 230

Only myself 231
One or two others 232
Three or four others 233
More than four other people 234

30. Do you normally obtain your copy by:-

Chance purchase? 235
Newsagent home delivery? 236
Newsagent/model shop collection? 237
Subscription by post? 238
Don't buy, read someone else's? 239

31. If you had your copy posted to you on subscription, on which date did you receive this issue? ....

32. Would you like to receive information about the benefits of postal subscription and details of our exclusive offer? Yes 240 No 241

33. If you do not subscribe, from which type of shop do you most often obtain your copy?

High street shop? 242
Travel point? 243
Estate shop? 244
Corner shop? 245
Model shop? 246

34. Thinking about the advertising content, would you please rate the two main types of advertisements

	Display	Classified
Very useful?	247	248
Useful?	249	250
Quite useful?	251	252
Not very useful?	253	254
Not at all useful?	255	256

39. With regard to the advertisements in *M.E.W.* do you:

Read or look through most or nearly all of the ads? 257
Read or look through some of the ads? 258
Read or look for the occasional ad? 259
Very rarely/never look at the ads? 260

40. Please tick the box which represents the annual total of your gross income:

Under £6500	261	£6500 - £9000	262
£9001 - £13000	263	£13001 - £16000	264
£16001 - £19000	265	£19001 - £23000	266
£23001 - £26000	267	over £26000	268

41. Please give any comment or criticism which you feel will help us to improve *M.E.W.* magazine

....

....

42. If you do not wish to receive further information from *M.E.W.* please tick the box 269

Thank you for taking the trouble to complete the questions. Could we ask you to cut out the pages from you magazine, along the dotted line, pop into an envelope addressed to: **Freepost** , *M.E.W.*, Argus House, Boundary Way, Hemel Hempstead, HP2 4BR, no stamp is required

PULL OUT PLAN

A DRILL SHARPENING JIG

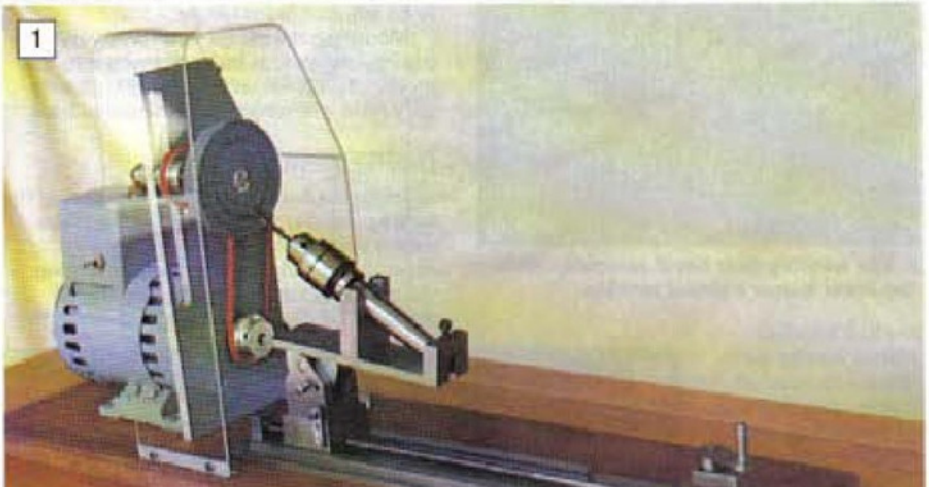
Mr C M MacEke (a member of Bristol S.M.E.E.) provides a novel design for a complete drill sharpening fixture. Not really for a reader in a hurry to pursue some other task, but an interesting project in its own right

The idea for this sharpener developed over a period of time. I had become tired of a lovely spiral coming from one cutting edge and dust coming from the other, particularly when drilling in the lathe. I'd tried other ways of grinding drill bits, from doing it by eye to using one of those jobs you can bolt beside your grinder, using its face edge. Actually it was this that gave me the idea because I could see its merits but at the same time it was very easy to make an error and end up with different length sides. However, I realise that this method does not give the ideal clearance shape but nevertheless, it does give a symmetrical point which is probably more important.

The first consideration was that it had to be possible to turn the drill through 180 deg. as accurately as possible. The best holder is obviously a collet but not practical as too many would be needed to cover the range I wanted to cover, i.e. 1mm to ½in. and at angles from 90 to 180 degrees. I settled on a drill chuck and the ones from the tail stock have a Morse taper attached, at the end of which is a flattened part, called the tang. It is this part that ensures the drill can be turned through 180 degrees.

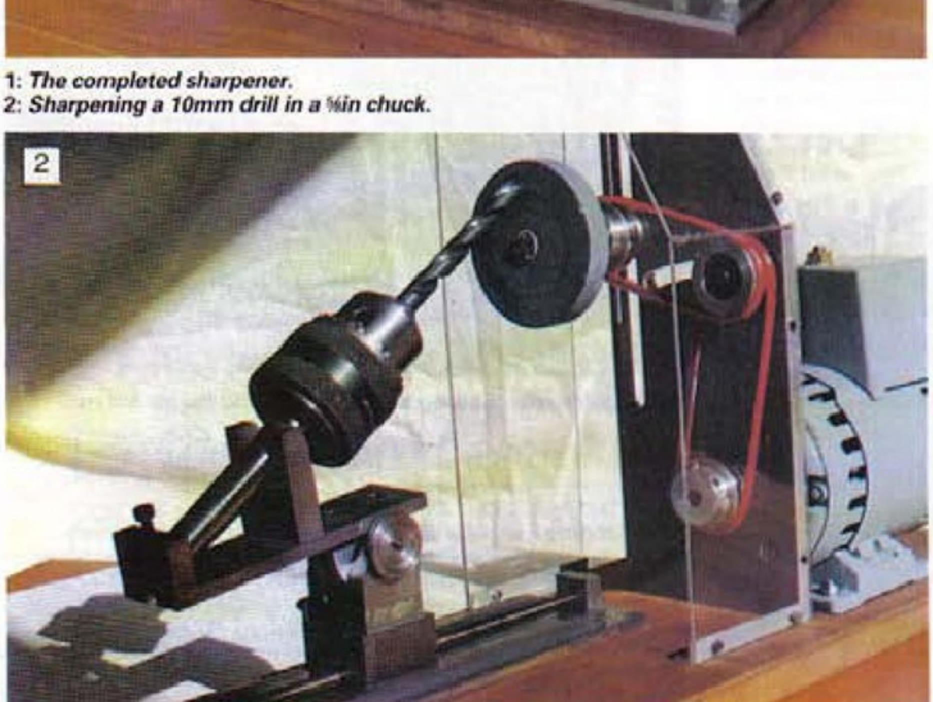
The next criteria was that it would be cheap to build and hopefully from my 'cuminandy' drawer. Thus some of the steel used has a few rust pock-marks but then it is a practical tool and not in a competition. Next, I wanted a small grindstone as the actual surface used to grind on is very small. Mounting grinding wheels can be awkward so I bought a 3in. x ½in. wheel from the local ironmongers for £1.60, which was designed to be used in an electric drill. This being the case, I was limited to 3450 rpm. I felt that this didn't really matter as the amount of steel actually removed in sharpening the average drill is very small. The grinding wheel is not as fine as I'd like but it has proved quite adequate, at least until I can find a better one. I managed to obtain a neat little ¼ HP motor with 2850 rpm and I decided it wasn't really necessary to gear the speeds up to the maximum permissible and so the pulley wheels are all the same diameter. You may need to alter the sizes of yours to match motor and grinding wheel speeds.

If you have a milling machine, life is much easier when making some of the parts but there are ways of avoiding it. For instance, making the 'L' shaped guides, item 17, could be constructed from two pieces: a ⅝in. x ⅜in. flat, bolted through a ¼in. square to the base. May I recommend that if you do, you use superglue to hold them together when drilling through. Another tool which is in constant use is a combined disk and belt sander. It cleans up steel work and sands everything to a perfect right angle (or any angle you choose) which saves the time consuming job of filing and hand sanding. Some of the pieces need to be as accurate as you can make them in this respect.



1: ***The completed sharpener.***

2: ***Sharpening a 10mm drill in a ⅜in chuck.***



Drill chuck holder

The construction of this is very straightforward and the only tedious part is slotting item 4. This is where the milling machine is useful, otherwise it means sawing and drilling to remove the majority and filing the base of the slot to an angle of about 25 deg. but it need not be precise. It serves to keep the drill chuck at almost the correct angle for normal drill grinding. The precision comes later when fitting the locating pin.

I used countersunk screws throughout, simply because I had them but you could go to the expense of cap-heads. After it's assembled, a few seconds on the belt sander cleans off any projecting screw had and leaves a nice finish to the steel. The slot in item 3 should be a good fit for the tang of the Morse taper to slot in. I've used a locking screw so that any slack can be taken up. The hinge, item 2, needs to be substantial, so cut a piece ⅝in. wide off the end of a 1⅝in. diameter bar. Why 1⅝ inch?

Simply because I had it. Face both sides and ream a centre hole 5/16in. diameter. Cut a piece off to leave a flat which is 3/8in. above the centre hole. It helps if you can mill it flat and sand to a right angle as this is one part that needs to be fitted square to avoid binding in the hinge.

The other two parts forming the trunnion items 7A and 7B are self explanatory although it is important that the gap between is a close fit with the centre of the hinge. It is also important that the two side pieces are identical and I made mine by sticking them together with double sided tape and giving them a good squeeze in the vice before I drilled the centre hole and squared off their bases. To make sure they are fitted in the correct place, assemble the three parts with the 5/16in. centre shaft (item 5) and the locking ring (item 11). A piece of thin paper included will ensure clearance after fitting. Now the unit can be stuck to its base (item 8) with the same tape and 2BA tapping size holes drilled through. Dis-assemble, drill and countersink the base 2BA clearance.

The ½in. dia. pivot, item 12, is to fit the bearing used, so check your bearing doesn't differ. At this stage DON'T drill any locating dowel holes.

Slide (item 10)

This block was a very convenient lump which I had in my drawer, hence its size. You may feel a wider block and larger bearing would make it more stable.

The 3/8in. slots milled in the sides need to be accurately placed as the whole unit must slide along the base, not bind at the ends nor be clear of the base plate. The rigidity is vital for accuracy. Boring out the centre for the bearing and also drilling the ¼in. BSF hole must be done in the four jaw chuck. Be careful when assembling; the swivel unit once fitted is difficult to get apart! I made my bearing a press fit into the base but made the ½in. dia. pivot a loose fit so that I could easily pull it apart and later used Loctite to hold it firmly. When you tap the thread you will probably find, as I did, that the tap isn't long enough to do the whole block. In this case counterbore the remaining part from the handle end.

The little plate (item 9) with the adjustable caphead screw ensures that you can't go past a certain point and that both sides of the drill are ground to the same dimension. A little practice is necessary here to obtain the correct setting.

Winding gear and base plate

There are no problems beyond getting everything square. Distances and sizes may depend upon the two bevel gears (**photograph 4**) you use. Mine came from an old adding machine. Similar ones are available for loco reversers. The length of the plate was determined by the length of the longest drill I might need to sharpen. If you don't need to go up to ½in. dia. then you could of course, shorten everything.

Before assembling anything, make up a short piece of ¼in. BSF studding and turn to a point. Screw this into the slide and use the point as a marker to get the exact height of the bearing in the bearing block (item 16) which is coated with marking blue, as seen in **photograph 3**. Reverse the pointer and do the same the other end (item 15). Although this gives the exact height, bear in mind that when everything is bolted down there will be a clamping effect on the sliding block. This is where

4: The winding gear bevel assembly. Note the brass spacer a thrust washer.

my belt sander comes into its own. Gradually sand off a little from the base of the sliding block until the unit winds freely for its whole l ength. This part is a slow process but worth getting right. Turn down the end of the shaft (item 18) to 3/16in., which will be the bearing end, for 3/8 inch. I used the lathe to cut the thread by the usual method of holding the die in the chuck and using backgear. A metal wedge in the split die and plenty of cutting compound will give excellent results on leaded steel. The other end of the shaft is held in the drill chuck of the tailstock which is left undone and free to slide. The slowest speed and an accurate thread is easily cut. It may need a second pass if you used a thick wedge so check with the block.

After the guides (item 17) are bolted to the base plate, as seen in **photograph 5**, make sure that the slide will slide freely with no tight spots before you screw in the centre shaft. To slow down rusting, I gave everything a good coating of silicone wax polish (not the spray kind as that contains a lot of water).

Motor and pulley plate (item 13)

I happened to have a piece of dural 3/8in. thick which was just the job as it made the milling of the slots so much easier. One useful point here is that it can be assembled the other way round for left-handed use, photographs 7 and 8 show this assembly.

The pulley assembly drawings have no measurements because I used spare bearings from the same drawer and since bearings are so expensive to buy you may want to do as I did or make up solid bearings from phosphor bronze. The important thing is that they can be easily undone and slid into position. The centre pulley just idles and keeps the belt tight, allowing the grindstone to be adjustable for height.

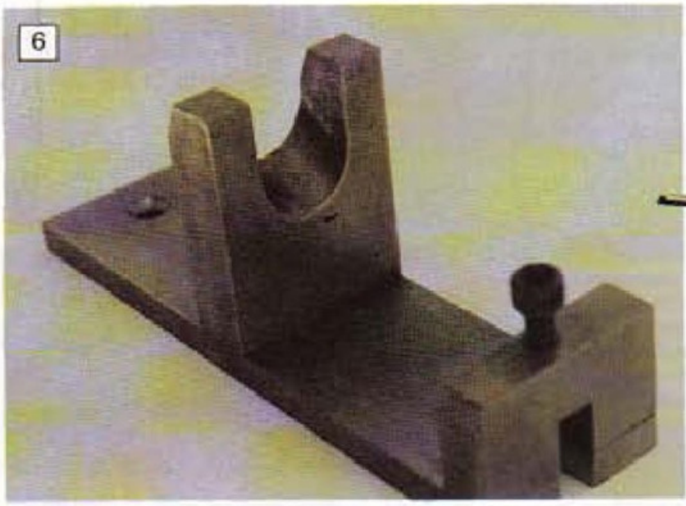
Mounting the motor itself was very convenient as four bolts screwed into the motor casing, the whole assembly being very rigid when bolted to a wooden base.

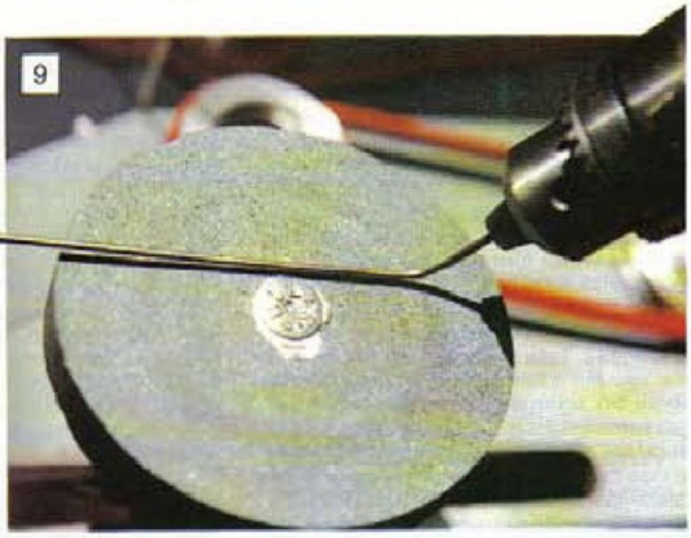
Dowel (item 6)

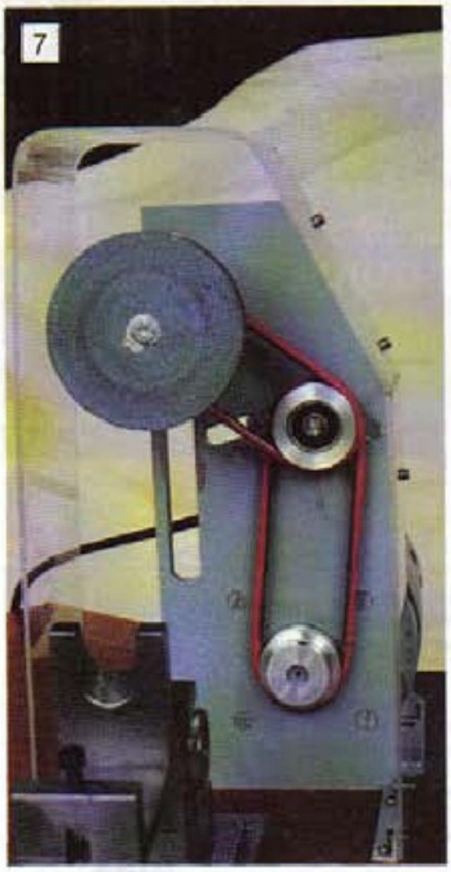
I drilled a hole in the foremost part of the hinge purely at random and without the centre part being present. After re-assembling came the problem of setting the grinding angle. I began with the standard 59 degrees. Taking a piece of thin

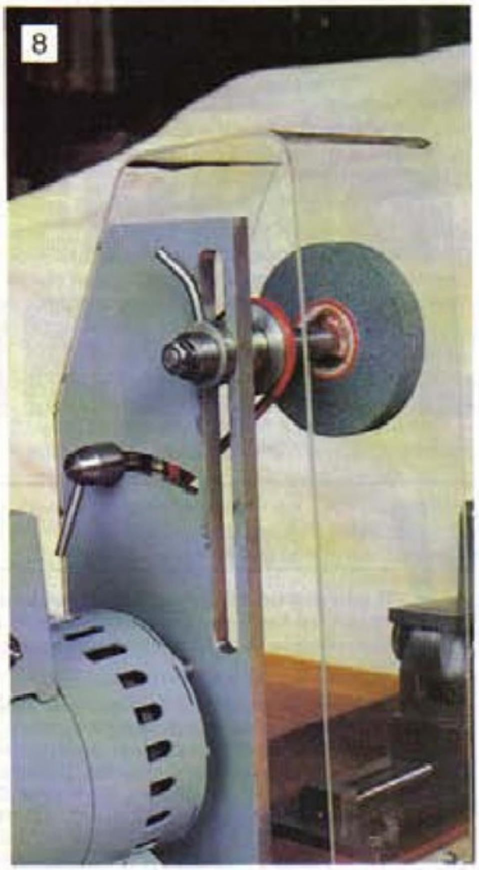
5: The guide rails showing slide assembly and the leadscrew.

3: The almost complete slide assembly, fitted with temporary scriber for marking position of bearing hole in end bearing block items 15/16.









6: Close up of the drill chuck carrier assembly.

7: Wheel side of the motor and pulley plate assembly.

8: Rear view of the motor and pulley assembly showing the locking rings.

9: Set-up for drilling the locating dowel hole.

10: Close up of the hinge assembly showing the locating dowel in position.

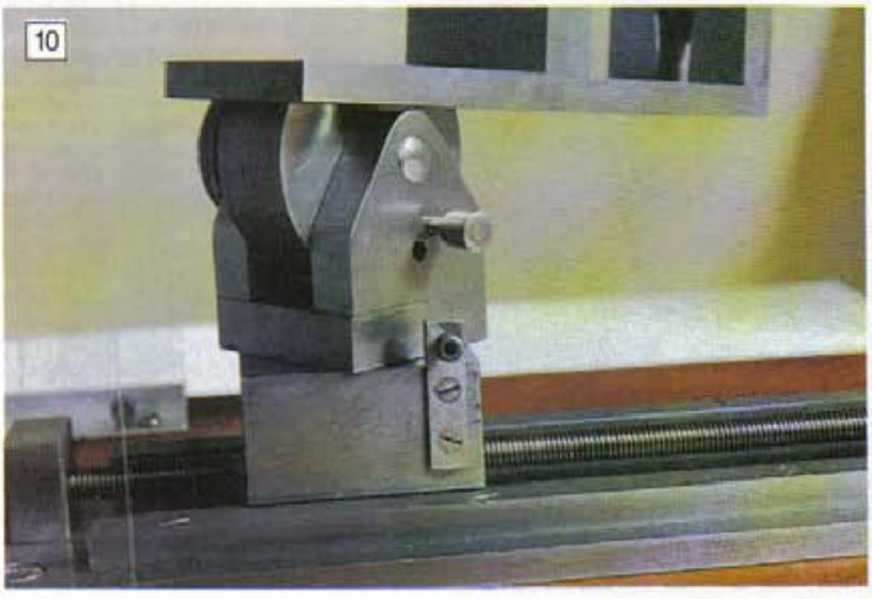
rod, I bent it to an angle of 118 degrees or as near as I could possibly do it, put it in the drill chuck with the bent part vertical as in **photograph 9.** The handle is wound until the rod is touching the stone and then the chuck is moved until the rod is as close to parallel with the stone as possible. Do up the locking ring and remove from the base. The hole can now be drilled through and into the centre part. Re-check that all is correct. I drilled several holes when experimenting with different angles because the holes in the centre part were too close together to drill.

When you are satisfied that all is done then now is the time to Loctite the centre bearing. One point to mention here is that if you are building a left-handed version then the stop plate and the locking pin need to be on the other side.

Guard

Finally comes the safety aspect. It's very tempting with small belts and wheels to be tempted to leave guards off, but the minute particles coming off a grindstone can do a lot of damage to eyes. Besides, this one is so cheap and simple to make it really isn't worth it. It is transparent so it doesn't block the view; it lets in light and doesn't interfere with accessibility.

The clear plastic is acrylic sheet obtainable from DIY stores and is about $\frac{3}{32}$in. thick. It is brittle and when sawing, half melts and catches the saw causing a crack. The best saw is a band saw. Cut off a length $3\frac{1}{4}$in. wide. This is the size which suited my layout. It projects from the pulley plate to $\frac{1}{4}$in. beyond the front of the stone. Putting the grindstone at its highest point, bend the sheet to go round, using the rear of the plate as an attachment point. The



guard is held with 6BA screws which have a washer and screw into tapped holes on the edge of the plate. The guard is attached at the front and back to the wooden base with ½in. angle. My acrylic wasn't long enough to make it in one piece so I had to make a join. This was at the back, on a bend. The adhesive is as thin as water and capillarity takes it along the joint, melts the surfaces which fuse together as it evaporates leaving a very strong joint.

Bending the acrylic is quite easy. It is very brittle and breaks when bent, so heat is required. Take a piece of bar about 1in. dia. and put it horizontally in the vice with about 5in. protruding. Heat this with your gas torch until it is too hot to touch. Hold the sheet where you wish the bend to be, across the hot bar and gently rock it see-saw fashion to spread the heat. At the same time apply a little downward pressure. Very soon the sheet will bend and soon hardens when removed from the heat source. A little practice might be useful as too hot and the acrylic melts. There will be some marking on the surface but this won't be too serious. The whole guard is rigid, lets in the light and is surprisingly strong.

To use the tool

To sharpen the drills the bits should not go past the cutting edge when swinging the drill against the stone. Hence the stop. Gradually turn the handle until the drill is just touching, as hardly any metal has to be removed to sharpen the bit. Swing on its pivot, back and forth with possibly some adjustments to the handle until you are satisfied that enough material has been removed. Take the chuck out of the holder and pass it through 180 deg. and with the same setting repeat for the other cutting edge. It is advisable to do up the locking screw each time especially if the fit is not a tight one. The end result should be a symmetrical point with possibly some flash on the cutting edge. Don't try and force the speed of removal, a slow gentle action produces the best result. My small chuck holder wouldn't hold enough of the drill shank, so I drilled a hole through the base of the chuck down into the taper. For the really small drills, hold them with only a short piece protruding from the chuck. This may hold the drill off centre but I haven't found this. The direction the grindstone rotates is not very important because you can use the surface above or below the centre arbor. The direction is important with the smaller drills. Any tendency to dig in and the drill is no more. The grindstone needs to be coming from behind, i.e. clockwise for the right-handed version. Placing the drill in the chuck is important and is best described by looking at the diagram.

Mine has been in use for only a short while but I must admit the quality of drilling, not to mention the speed, has greatly improved.

(The success of this device depends on the fairly precise rotation of the drill through 180 degrees when sharpening the second side, but more importantly that the drill is not moved axially, either forward or backward, as a result of this operation. A change of even one thou. in the axial position, after rotation, will effect the ability of the cutting edges to cut evenly.

As the tang of a Morse taper shank may not be sufficiently precise to ensure that the axial position is not changed, careful consideration should be given to this fact. A stop bearing on the end of the tang, perhaps a pointed stop in the centre drilled end, may be worth considering to ensure precision.

(In view of the brittle nature of the shroud material suggested, an alternative such as polycarbonate or even aluminium may be preferable – Ed.)

QUICK TIP

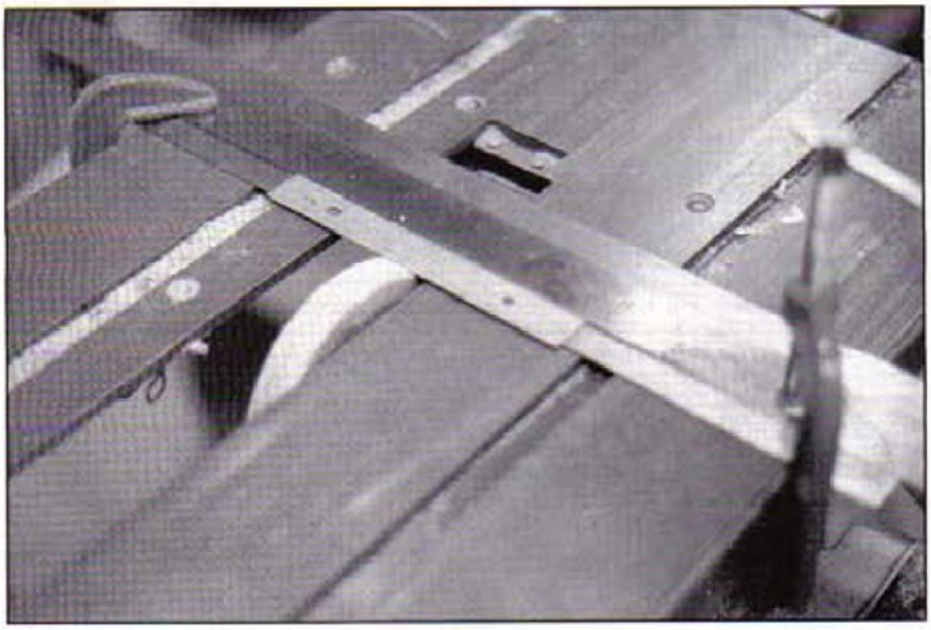
Broken centre drills can be re-cycled by grinding the countersink section off leaving a flat face with 2 flutes. The 2 cutting edges on the face can be backed off and the result used for milling key-ways and slots. **Alan Jeeves**

QUICK TIP

Coat your file teeth with ordinary chalk when filing metal at the bench. This will help prevent filings from clogging the teeth as the metal is removed from the work. **Alan Jeeves**

QUICK TIP

Grind a mark on the 'bottom side' face of the shank of letter and number stamps. This will help prevent inadvertantly setting the characters sideways or upside down. **Fettler**



Geoff Gray suggests an easy way of sharpening the blades from your motorized wood planer, perhaps the one whose construction is described elsewhere in this issue.

SHARPENING WOOD PLANER BLADES

I do a fair amount of woodwork and I have a combination set of 8in. circular saw, 5in. planer thicknesser and spindle moulder. The planer blades are described as disposable when both sides are blunt.

A cheap and simple method of grinding the blades was needed and the method I will describe was shown to me by the works engineer of a large furniture factory.

Referring to the photo you will see that the circular saw blade has been replaced by a grinding wheel of about 5in. diameter. An adaptor bush will probably be required here and can be turned from nylon or aluminium alloy. Now place a piece of 2in.x1/16in. BMS or similar across the saw table, long enough to be clamped at the ends. Place a planer blade on the BMS, touching the grinding wheel and set the height of the wheel to give the correct grinding angle to the planer blade. In my case, this was achieved by adjusting the height of the saw table.

Now place a 2ft. straight edge or similar on top of the BMS and lightly clamp each end to the saw table. It does not have to be dead square across and the clamping should be done with the planer blade just clear of the grinding wheel.

With the grinding wheel running, gently tap one end of the straight edge towards the grinding wheel until the blade just sparks whilst holding the blade in position. Now slide the blade sideways across the grinding wheel back and forth and moving the straight edge a thou. at a time until you have a sharp edge on the blade. I have never had any trouble with debris from the grinding wheel getting under the blade.

There will be some who will consider tapping the straight edge to be somewhat imprecise and prefer the toolroom approach. This could be done with a ¼in.x40TPI screw with 25 notches in the head. A suitable nut could be clamped to the saw table to push the straight edge a thou at a time. This is actually only ½ a thou opposite the grinding wheel since the straight edge is pivoting under the opposite clamp.

For those of you who don't want their finger nails trimmed on the grinding wheel, cut a piece of ½in. plywood 5in.x3in. with one long edge perfectly straight and fix it to the planer blade with double sided sticky tape. This idea will please the editor no end especially if you put a guard over the grinding wheel.

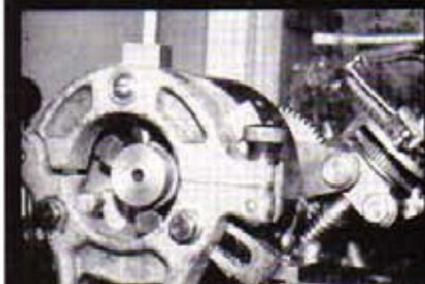
To get back to work, now grind one edge of the second blade to the same setting, that is without moving the straight edge. Next grind the other edge of this second blade moving the straight edge as required. Then without moving the straight edge grind the other edge of the first blade. This will result in a matched pair of blades whose balance will be well within that required.

No damage is done to the reground edge rubbing on the straight edge and I always finish the edges with an Arkansas stone anyway.

I have two sets of blades which I grind at one session and to the same setting so that I have four interchangeable blades. I don't grind all the nicks (if any) out of a blade edge as the blades have 0.1in. end float in the cutter block and the chances of the nicks in any two blades lining up to produce a ridge in the workpiece are about as remote as my first birthday.

(In the interests of safety do ensure that the grinding wheel to be used is correctly rated for the job and will not overspeed on the machine, and wear protective spectacles when grinding. – Ed.).

QUICK TIP



As an aid to positioning number stamps to achieve a consistent result when marking graduated thimbles, make a special jaw for using in the fixed steady, as seen in the two photographs.

J.M.Service

A "SCREWY" HISTORY

Don Unwin has, through the last two issues of *M.E.W.*, looked at something of the history of the lathe, latterly as it applied to the model engineer. Now he turns his attentions to the endeavours of mankind to make screw fastenings, a subject which is inextricably bound up with the history of man's advances in the fields of mechanical engineering

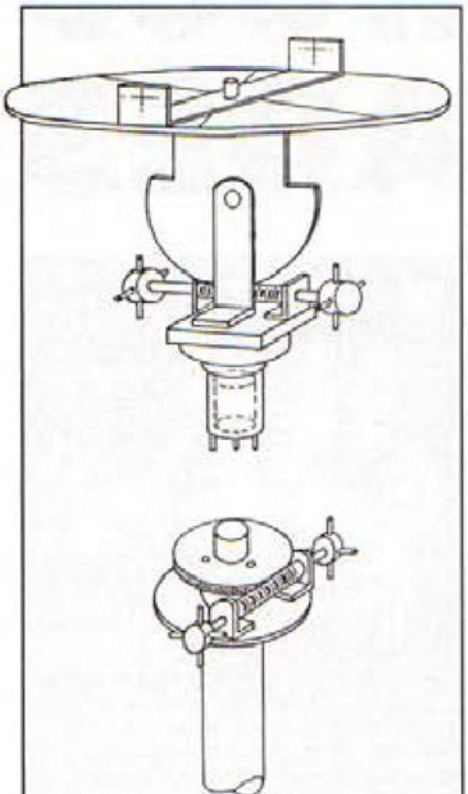


Fig.1: Hero's Dioptre surveying instrument, 1st century AD.

All machines make extensive use of the screw thread and screw fastenings, think what very crude machine your lathe would be without them!

Screw threads, albeit of wood, are very old indeed. It is believed by some industrial historians to have been invented about 360BC by Archytas of Tarus, a Greek city in southern Italy.

Hero of Alexandra 1st century AD, the Greek mechanician sketched crude taps and dies for wood and ivory and describes several uses of the screw threads on presses for olives, wine, cloth bale compression and jacks. He incorporates screws as worms in his Dioptra, a surveying instrument. **Fig.1.**

The method he describes was to wrap a wedged or triangular shaped piece of soft metal such as lead round the wood shaft, the helix was marked then the wedge shaped piece moved along to the next turn and the operation repeated for the required thread length which was then cut by hand using chisels and files. A Pompeiian wall painting also shows this method of cutting the screw threads.

Hero also describes a device for cutting internal threads. **Fig.2.**

The earliest example

What is the earliest example of a screw as a fastening is a single isolated threaded wrought iron nut of Roman origin dated as being made between 180AD and 260AD, which has been discovered in Germany but no bolt of comparable date ha been found.

Metal screws were used as fastenings on jewellery and armour in the 14th century, then soon after by locksmiths and were in common use by instrument and clock makers by 1650.

Although examination of 16th century fire-arms show that gunsmiths were using crude wood screws at that time carpenters did not use the 'screw nail' as it was then called until the 17th century, first using hand made nails then wedges and pegs.

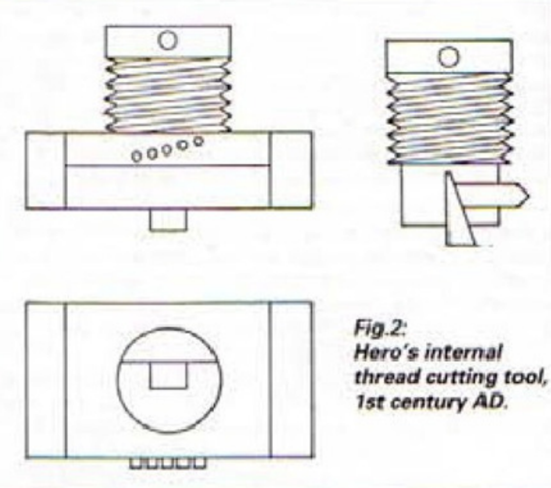


Fig.2: Hero's internal thread cutting tool, 1st century AD.

There is some indication that wood screws were known in Roman times and in 1588 the Italian engineer Agostino Ramilli mentions them. They were hand made with filed threads, blunt ends, square or countersunk heads and hence very expensive, **Fig.3.** In 1760 Job and William Wyatt patented a special lathe and started up a wood screw factory in an old corn mill in 1760. By 1792 Shorthose, Wood & Co. had taken the business over and were making 1200 gross per week in a larger factory employing mainly children, an early example of 'mass production'. Blunt end wood screws which required a hole to start continued to be made, basically using Wyatt's process until 1849 when William G. Angell in America adopted a machine invented in 1846 by Thomas J. Sloane and introduced the gimlet pointed wood screw. In Britain John Nettlefold, working under licence manufactured the Sloane machines and re-equipped his Birmingham screw factory in 1854. In addition to pointing the screws his machines slotted the head.

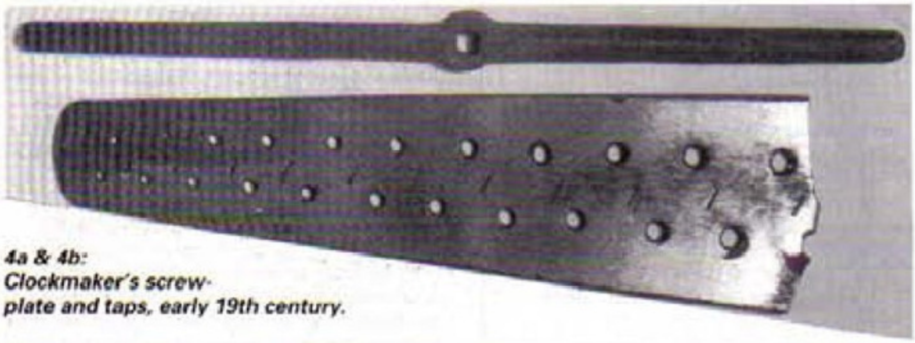
To return to metal screws, Joseph Moxon in his treatise *Mechanick Exercises*, (1683) gives the first description of making screws and nuts. He says:- "Swage the end of an iron rod by pounding the red-hot metal into a square cavity" then threading it by twisting it round in a 'screw-plate'. This he says consists of a thin steel bar or plate with handles and pierced with various sizes of threaded holes. It would appear that the thread was not cut but squeezed on the bolt. A steel screw, presumably produced in the same manner, was "transformed into a thread cutter by fluting its sides across the threads" probably by filing flats as later clockmakers taps, **Fig.4.** This tool is then "twisted into a previously drilled hole of appropriate size". As the cutting action was poor these taps did little more than squeeze the threads in the same manner as the screw-plate. These methods produced the rather shallow threads which were characteristic of early clock and instrument makers screws which also had slightly conical heads with vee screwdriver slots.

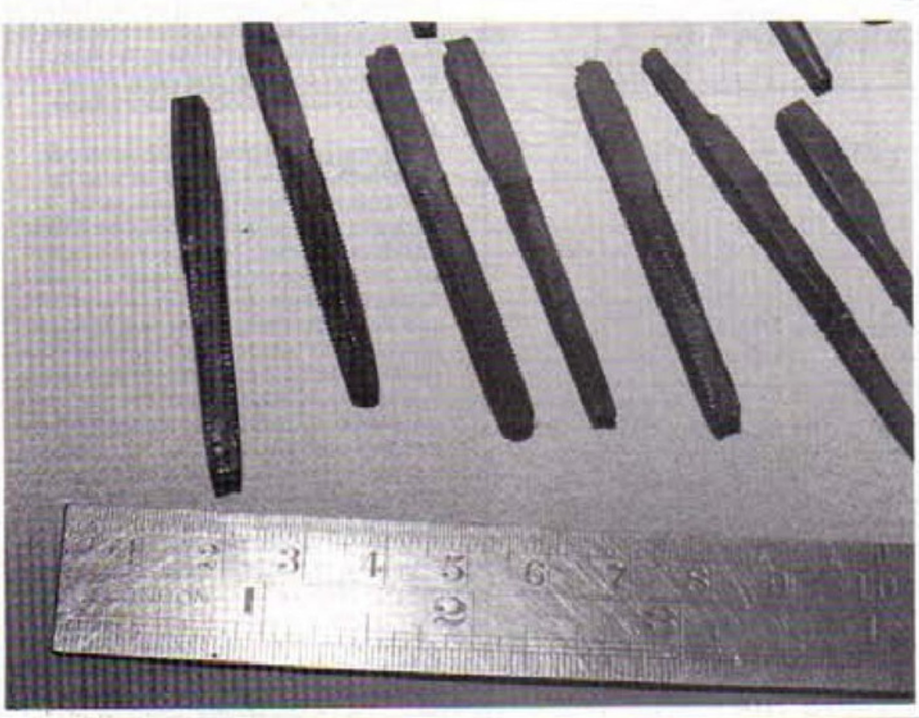
Some sort of male thread was needed to produce the screw-plate holes and these were made by filing or on the "mandril lathe" as described by Plumier in his slightly later treatise of 1701. He illustrates the early mandril lathe with means to cut the short screw threads. The first types had a single threaded portion on the tail end of the mandril into which was wedged a piece of wood to form a nut. As the mandril was rotated it advanced forward thus allowing a fixed but hand held tool to cut a similar pitch thread on the work.

Fig.3: Hand-made blunt end screw or 'screw-nail', 1775.

The short threads on the iron mandril were produced by wrapping a piece of suitably marked paper round the shaft then filing the thread with a triangular file and finally chasing with a 'metal comb' or chaser of the correct pitch, **Fig.5.** This would of course also be produced by filing but would average out the errors to some extent.

The next development was for the mandril to have a number of different pitch portions and means to wedge the appropriate 'nut' into the chosen pitch, **Fig.6.**





4a & 4b:
Clockmaker's screw-plate and taps, early 19th century.

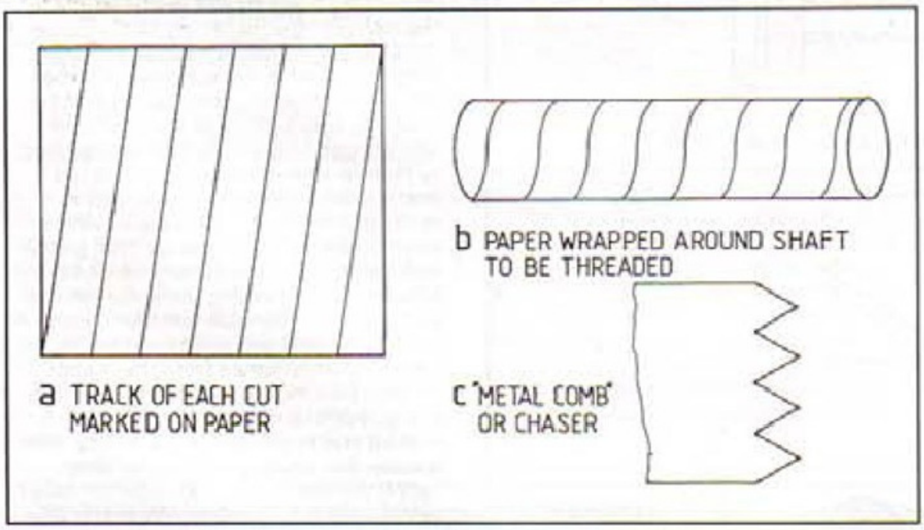


Fig.5: Thread marking out and cutting, Plumier 1702.

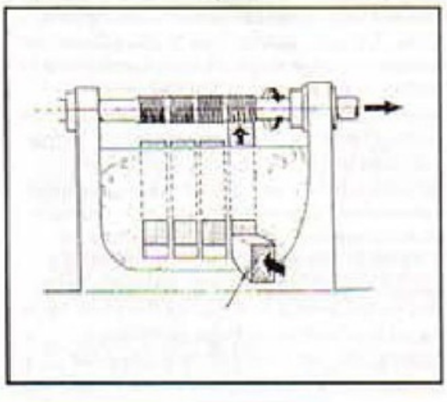


Fig.6: Multiple thread mandril lathe headstock, Plumier 1702.

Earlier J. Besson in his treatise of 1579 had illustrated his screw cutting lathe, but he was primarily concerned with ornamental work and not the production of screw threads.

In 1750 Antoine Thiout who had devised a screw-cutting machine suitable for short threads with means to vary the pitch being cut using a system of levers also made a machine to cut the spiral thread on clock and watch fusee barrels. **Fig.7.**

Jesse Ramsden, one of the leading scientific instrument makers of the 18th century, made, in 1770, two screw cutting machines for producing precision threads. The first, **Fig.8,** copied a screw with a long nut and change gears to select the pitch to be cut. The second, **Fig.9,** made long screws from a short original flexible tape winding round a drum to pull the carriage along. Both machines used a diamond tool to cut the threads.

Threads larger than could be made by screw-plate were produced by squeezing between adjustable "stocks and dies", **Fig.10,** a drawing from Planche's *Encyclopedie* of 1784. The stocks can be seen hanging on the wall in Diderot's 1771 illustration of a turner's workshop, shown in **Fig.5** of the 'Lathe' article.

The first standard threads

The threads made in this way varied in pitch and diameter so that each nut and bolt had to be matched and individually marked for identification. This made assembly of machines a tiresome business which was not eliminated until larger engineering firms, influenced by Maudslay and Clement, introduced standard ranges of threads in their works. Even then each had their own standard diameters and pitches making interchangeability between different manufacturers difficult. In the 1840's Joseph Whitworth realised that this was a problem and that a National standard was needed. He obtained and measured samples of screw threads from all the leading engineering firms and arrived at an average range for which he chose the thread angle of 55 deg. giving a constant proportion between pitch and depth. At the time a great deal of threading was in cast iron as well as wrought iron so he adopted coarser pitches than could have been used on wrought iron only. He announced his proposed standards to the Institute of Civil Engineers in 1841 and by 1860 they were in general use. The age of steel required a range of finer pitches and Frederick Lanchester devised his own 'M' range for his motor cars which was similar to the British Standard Fine (B.S.F.) series which became common from the 1920's.

In America William Sellers proposed his range in 1865 which was adopted as the national standard in 1868. He used a thread angle of 60 deg. with a profile which was cheaper to make than Whitworth's. This profile was adopted as the European standard at a Zurich conference in 1898.

The threads produced by all of the early methods were quite short but in the 18th century a few heavy machine tools, mainly boring machines, were appearing which needed much longer screw threads. That intrepid inventor or recorder of mechanical devices of all types, Leonardo da Vinci, 1452-1519, describes a screw cutting machine which could cut longer threads and even had change wheels! **Fig.11.** As with so many of da Vinci's devices it is not known if it was actually made. However David Wilkinson of Pawtucket in America, patented a machine of exactly the same idea in 1798!

Another method used to make longer threads was to wind two closely touching wire spirals on the shaft then remove one and dip the shaft in a molten tin bath to solder the spiral in place. This was then used as a screw or fitted with a nut coupled to a tool cutting a thread further along the shaft. Maudslay used a variant of this in which he used flat strips of metal instead of wire.

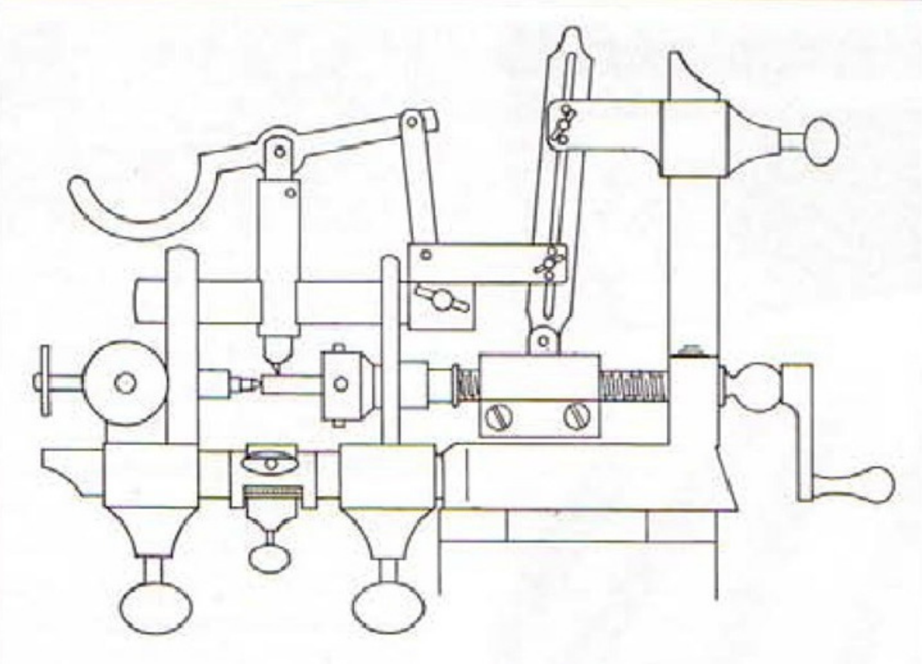


Fig.7: Thouit's fusee cutting engine, 1750.

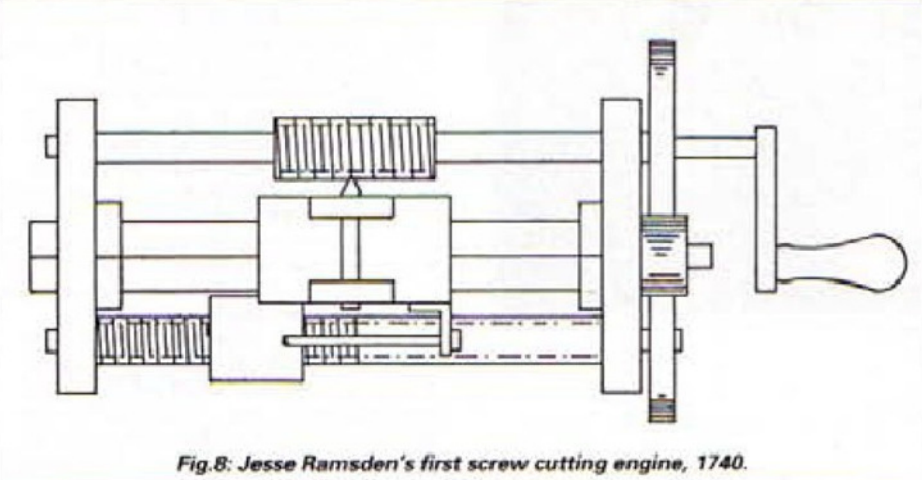


Fig.8: Jesse Ramsden's first screw cutting engine, 1740.

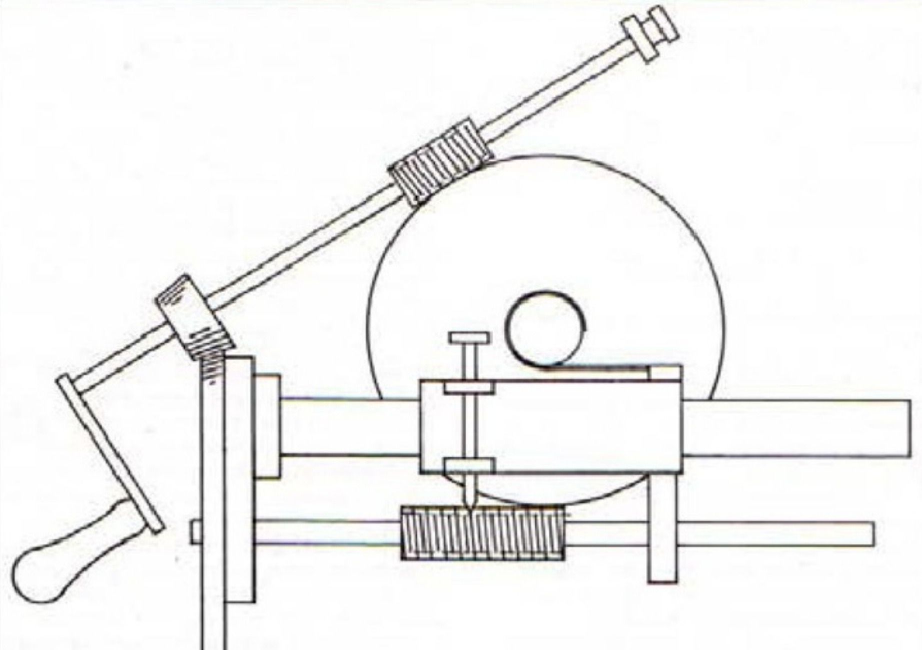


Fig.9: Jesse Ramsden's second screw cutting engine, 1740.

However the method Maudslay devised to produce his accurate threads was to have a crescent shape knife-like tool which was mounted at the required helix angle and pressed against the shaft. As the shaft, which was of wood, tin, brass or some soft material, was rotated it carried the tool along at the correct pitch. A long nut was then fitted and the screw used to make other threads in iron. To enable accurate pitches to be obtained he fitted the knife angle adjustment with a tangent screw and graduated scale. It was the method he used to make the lead screws of his first lathes in 1797 and 1800 and also accurate screws for the astronomical instruments he made. Bronze nuts could be cast round these threads by using wood ash as a release agent.

For one special purpose he wanted a screw with a pitch 0.1% smaller than he could get using change wheels, so he devised a supplementary tool slide driven by a 10:1 bell crank, the long arm of which was moved by a sine bar similar to a taper turning bar on the bed. He introduced taps and dies with three or more cutting edges instead of the contemporary taps and dies which produced the threads by squeezing. In his works he standardised the diameters and pitches of screw threads, making their own taps and dies.

Clement improved on the taps of the time by making them with shanks of reduced diameter so that they would pass through the tapped hole, whilst J. G. Bodmer in 1841 had devised a 'relieving lathe' to produce taps with spiral relief to improve the cutting.

Although not strictly a screwing tool, James Nasmyth in 1840 devised and provided his fitters with a tool to enable them to tap holes square with the surface, **Fig.12.**

You may be wondering how the large long screws were made. An old workman of the Soho Foundry described one of the methods. A strip of paper marked in ink with oblique lines similar to that described by Plumier was wrapped round the rod then the spiral marked through with a centre punch. These punch marks were joined together by a triangular filed groove then the thread cut with hammer and chisel followed by much filing whilst the rod was supported in a triangular wooden trestle. A nut of soft metal was cast round the screw with adjustable cutters fitted into it and turned by six men on a capstan fitted to it, a long, skillful and tedious task. This method was in use well into the early 19th century. The development of the lathe during the 19th century however improved matters, for example Richard Roberts made his screw cutting lathe in 1820 with change wheels, means to index for multi-start threads and quick withdrawal of the tool slide. The tool holder had angle adjustment to suit the helix angle. A later example was that of J. Parkinson of Shipley who patented in 1899 and made in 1902 a screw cutting lathe for long threads in which the tool was fed in, traversed, withdrawn, returned, fed in and the next cut produced automatically, on either single or multiple start screws.

In 1835 Joseph Whitworth patented a machine for automatically screwing bolts and studs; whilst in America Stephen Fitch made the first turret lathe in 1845 for making the vast number of screws for percussion caps required for the small

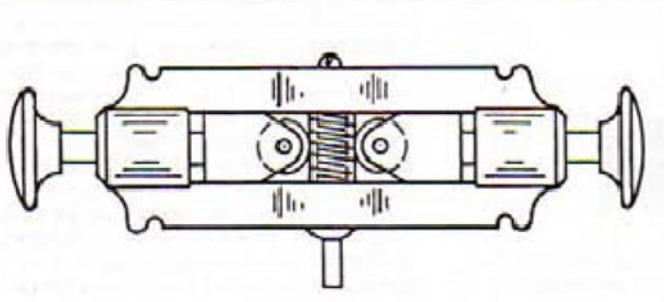


Fig.10: Thread screwing tool, 1784.

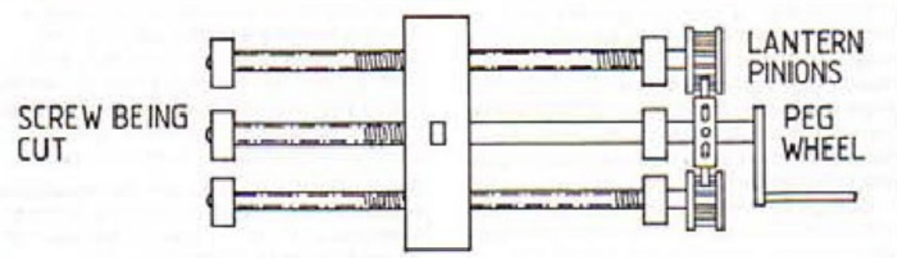


Fig.11: Leonardo da Vinci's screw cutting machine, c1500.

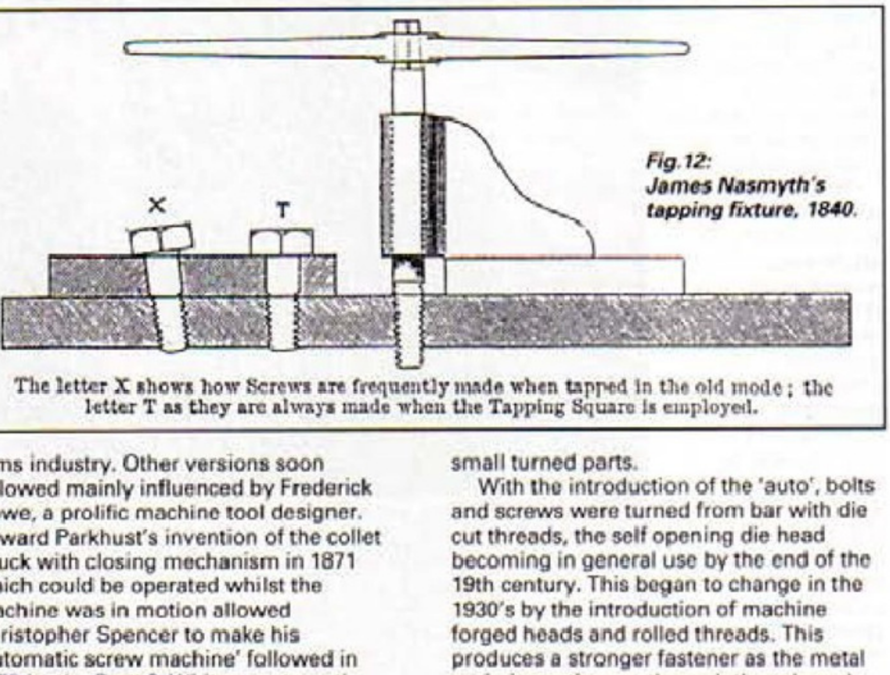


Fig.12: James Nasmyth's tapping fixture, 1840.

The letter X shows how Screws are frequently made when tapped in the old mode; the letter T as they are always made when the Tapping Square is employed.

arms industry. Other versions soon followed mainly influenced by Frederick Howe, a prolific machine tool designer. Edward Parkhust's invention of the collet chuck with closing mechanism in 1871 which could be operated whilst the machine was in motion allowed Christopher Spencer to make his 'automatic screw machine' followed in 1873 by the Pratt & Whitney automatic screw machine with 'brain wheel' or cam drum to impart the various movements to the work and tools. Multiple spindle automatic screw machines were the next development, known as automatic lathes or 'autos' in UK, primarily for making metal screws and nuts although of course used for all sorts of small turned parts.

With the introduction of the 'auto', bolts and screws were turned from bar with die cut threads, the self opening die head becoming in general use by the end of the 19th century. This began to change in the 1930's by the introduction of machine forged heads and rolled threads. This produces a stronger fastener as the metal grain is continuous through threads and head.

Thread milling machines appeared in 1897 designed by H. Liebert and made by Holroyds of Milnrow. These were essentially a slowly revolving screw-cutting lathe with the tool replaced by a rotating milling cutter with the thread profile. Thread grinding had to wait much longer for the development of grinding wheels which would retain their form and the necessary wheel dressing techniques which was not until the mid 1930's. The first machines used a single thread profiled stone which was traversed along by a lead screw as in a screw cutting lathe and thread milling machine, the wheel profile being copied from a master by a wheel dressing device. Thread grinding was extensively used for grinding die-head cutters and chasers and similar cutters with a thread form.

Then in 1944 A. Scrivener of Birmingham patented a multiple thread grinder whilst in 1947 Landis made a machine in which the wheel is crush formed by being pressed against a hardened steel roller of the correct profile. The wheel is wide and has many threads on it so that it can grind many threads in one rotation of the work. This method was and still is used extensively for grinding taps.

With that I think I will finish this 'Screwy' story.

HIDDEN DETAIL

Fettler asks...

Why it is that after you've just made the smallest and most intricate part for your project when, smugly, having set it on the bench to admire it, it rolls toward you as if with a life of its own, drops off the edge, lands on your foot, and promptly seeks cover in the grot in one of the most inaccessible unswept recesses of your workshop?

Then, why is it that if you don't find it, and take the advice (?) often given, and drop a similar item in like manner to watch where it goes – on the mistaken premise that it will lead you to the first – you lose sight of that as well?

I even lost a small BA spanner for 6 weeks on one occasion, and now I've lost my 'pet' 4in. rule, and my workshop floor is cleaner now than ever it was. I reckon they both grew legs and ran off when I wasn't looking!

DIAL TEST INDICATOR BASE

This heavy duty dial test indicator base will provide some useful experience in the machining of cast iron and in particular machining Tee slots. The end product will prove a very useful addition to the workshop

Mounting and aligning a part in the confines of a milling machine table can often be a difficult operation. Frequently some positioning of the part, onto an angle plate or into a vice, will be easier if done prior to mounting them onto the machine table. This will normally require the set up to be established, using the surface plate and various items of measuring equipment. This example is but one of many where the use of the surface plate and measuring equipment will prove useful. One of the items used will be the dial test indicator (DTI), but using this can be problematical if a sufficiently robust method of mounting is not available.

Attempting to use a surface gauge to mount the indicator may suffice, but the tendency will be for the weight of the indicator to tip the gauge over. To overcome this, using a magnetic base is a possibility, but in this case it will not be easy to move it around to take comparative measurements. Of course the magnetic effect can be turned off, but having a small base it will not be that precise. It will also require the magnet to be made effective each time the item is parked, or else it may fall over.

A heavy duty industrial base

The solution to this is to use the much heavier bases which are made for the purpose. These are really industrial items, and a quick flip through the pages of the many catalogues I have, showed they were not an item readily available to the home machinist. It must be said that they could not be found in the limited range of industrial suppliers catalogues in my possession.

One method of overcoming this problem is to make one's own. A suitable casting is available for the purpose from The College Engineering Supply. The casting is a large one and conforms to the sizes that an industrial base is likely to be made. The dimensions quoted by CES are 225mm long, 76mm wide and 52mm high. Even if ready made industrial bases were available, it is probable that these would be considered too large by the majority of home workshop owners, as perhaps would that supplied by CES.

College Engineering Supply are aware of this situation and are prepared to supply a shorter piece by cutting the casting into two, this fact is not mentioned in their catalogue. At the time of writing this article, a full length casting will cost, with postage, around £20.00. However, do check the latest price prior to placing any order.

The casting comes with full drawings for the base itself and also the parts to make a complete DTI carrier. The drawings for the additional parts conform to the heavy duty nature of an industrial unit. This can be seen from CES's assembly drawing published with this article (with their kind permission). These were not made with the base as it is intended to use the items published in issues 14 and 15 of *M.E.W.* If a shorter length base is to be made then these lighter weight parts should be perfectly adequate. Some readers may however prefer to make the fully industrial version as illustrated on the CES drawings.

The base made in this article was obtained as a full length casting and, as will be seen from the photographs, all the machining along its length was done in this stage. Following this it was cut into two pieces of roughly ⅓rd and ⅔rds. This would give more flexibility in their ultimate use, rather than having two identical lengths.

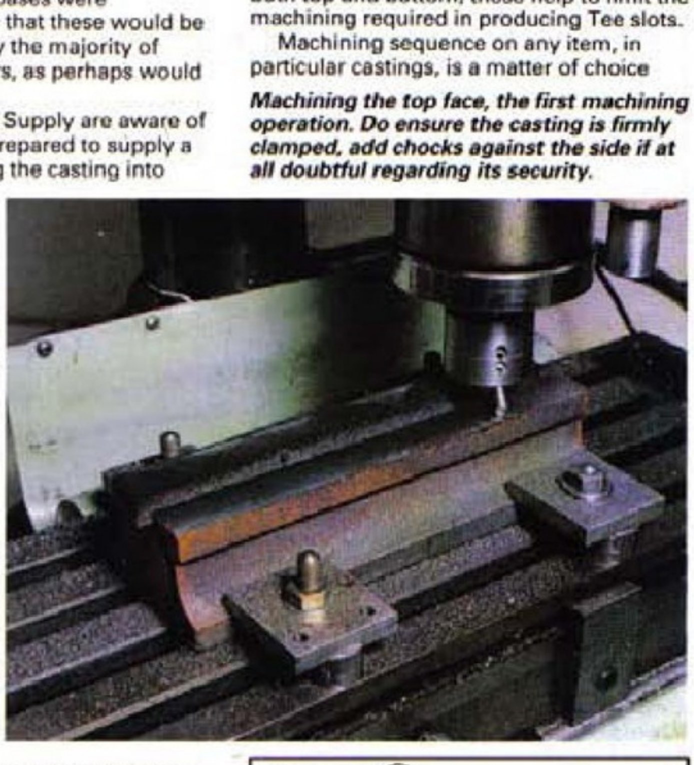
Experience in machining Tee slots

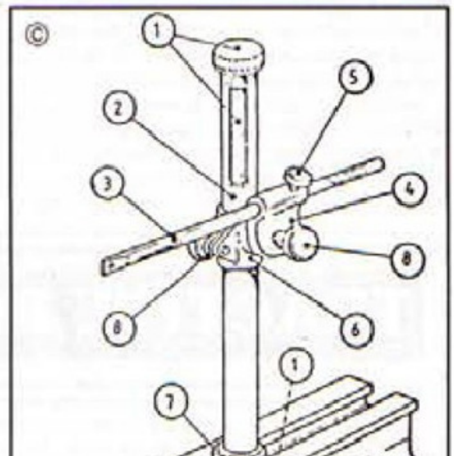
The casting presents a useful exercise in the machining of cast iron for those with limited experience, particularly so in the case of machining the Tee slot/s, where it would provide a useful introduction into machining these. This would be especially so for that reader who would like to take on some more ambitious project, but is apprehensive of this operation. Cost of the cutter is also likely to be a deterrent, this was overcome by the use of a single tooth cutter which, after a few teething troubles, performed extremely well. Details of the cutter are given in an article elsewhere in this issue.

As can be seen from the drawing, there is intended to be a Tee slot in both the top and the bottom of the base. In view of the limited time available, and considering the lower one to be unsuited to my needs, a Tee slot was made in the top only. The casting comes with generous slots along both top and bottom, these help to limit the machining required in producing Tee slots.

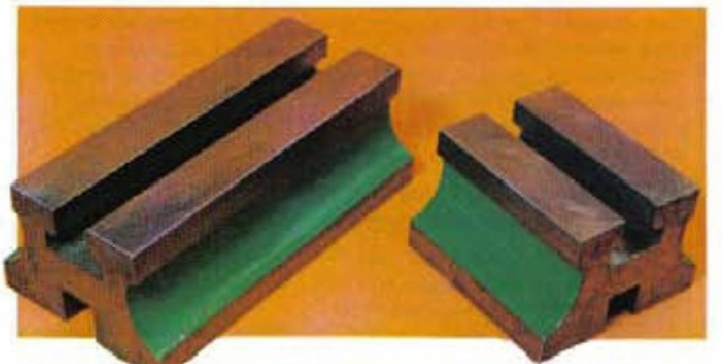
Machining sequence on any item, in particular castings, is a matter of choice and available equipment, though in this case the alternatives are minimal. The base of the casting had been generously finished

Machining the top face, the first machining operation. Do ensure the casting is firmly clamped, add chocks against the side if at all doubtful regarding its security.

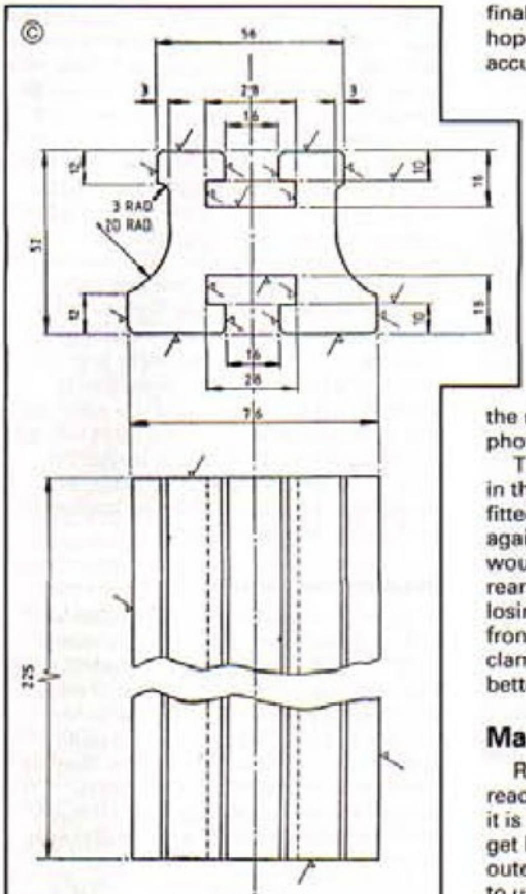




Drawing courtesy of College Engineering Supply



The completed heavy duty base.



The base being machined, being wider it will require to be machined in two passes.

by the suppliers, and appeared to rest on the surface plate without any noticeable rock. If rock was evident the casting would distort when clamped to the table and obtaining a flat machined surface on the top would be difficult. When turning this over for machining the base the error would be transferred back to this face.

It was decided to machine the top with the base clamped to the table, then to check the top on the surface plate prior to placing it, face down, on the machine table and machining the base. The bottom would then be checked on the surface plate using blue, and scraped to ensure sufficient contact to avoid distortion when next mounted on the table. When mounted, a final light skim would be made over the top, hopefully by this approach a reasonably accurate result would be obtained.

Clamping securely

With this sequence chosen it was time to commence. The casting was mounted onto the table and clamped securely, in view of the curved faces this was not as easy as it could have been. It must be stressed that there can be no half measures here. When placing the top onto the table, the clamp plates which I had used with the base proved too short and a pair of flimsier clamps had to be used on the rear side, just visible in one of the photographs.

To assist with making the casting secure in this instance, two additional plates were fitted at the back and these firmly placed against the rear edge of the casting. These would prevent the casting moving to the rear and, as a result, the front clamps losing their grip. Such plates could be used front and/or rear, top and/or bottom, as the clamps available dictated their necessity, better be safe rather than sorry.

Machining cast iron

Returning now to the machining. As most readers will know, when machining cast iron it is essential to take a deep enough cut to get below the hard skin that lurks in the outer few thou. I suppose it was the desire to use my new fly cutter, that I had recently made, which resulted in my forgetting the tipped face cutter supplied with my mill/drill. I have used this on a number of occasions but not for some while, had I used it t he task would have been somewhat easier and definitely quicker. That is not to say I found it that difficult.

When machining the top with the fly cutter, I found that with the cutter projecting by what I considered an acceptable maximum, the width of the top could just be machined at one pass or so I thought. The thickness of the casting varied over its length, with one side particularly thicker than the other. This resulted in the depth of cut on the shallower side being insufficient to get below the skin, if that on the other side was not too deep for the comfort of the machine and the cutter.

After a few blunted cutters, I decided to cut my losses and machine each side separately until the final skim. In any case with the bottom being wider this would have to be done in two passes. At this stage no machining of the Tee slot was carried out. With the top machined and checked to ensure it was reasonably flat, the casting was turned over and returned to the machine for facing the bottom.

The base was machined again using the fly cutter, and with the experience gained on the top the problems experienced were minimal. Whilst still on the machine some work was now carried out on the slot and the two edges. Machining the slot was done one side at a time, so an end mill, rather that a slot drill, was selected. Because of the nature of the material, still with outer skin to the slot, the largest diameter available was selected for maximum rigidity. I also chose an older cutter rather than a newer one, it would be a pity to damage the fine cutting edges of a new or nearly new cutter.

The two sides of the slot were machined to the width required, also to the depth of the finished slot, this would yield two benefits when it came to making the Tee slot. Firstly, the Tee slot cutter had the minimum material to remove, but even more important, having removed the outer skin totally the probability of any hard spots being encountered was largely eliminated.

At the same visit to the milling machine the two sides were machined. With an end mill of around ½in/12mm dia. it was possible to do each side in two passes. The first cut being made to half the width of the face, then the cutter lowered to complete that side on the second pass. When making the second pass the cutter was set about ½ thou. deeper, ensuring that no line between the two cuts would be visible. As the upper part on an end mill gets far less use, the edges at this point should still be reasonably sharp, and cutting over such a width in this manner presents no problem. In any case, cast iron is an easy material to machine once the outer skin has been removed. This was followed by the same process on the second side.

The base was now removed from the machine and the bottom, just machined, checked on the surface plate using engineers' blue. Whilst no rock could be felt the engineers' blue showed that about ⅓rd of one side was not making contact with the surface plate. I could not determine why the error existed. It could have been the casting having been distorted when clamped to the table, the casting having moved due to

Machining the sides whilst still on the table after machining the base.

stresses being relieved as a result of the machining, or even the fly cutter having moved slightly. In any case the effect was small, probably no more than a thou.

The bottom was therefore scraped, and checked against the surface plate, until an adequate result was achieved. At this stage it was necessary only to ensure that the two faces were generally in contact over the whole area. If a precision result is sought, this would be best left to be the final operation, even after cutting into two if this is to be done. Techniques of scraping a surface flat have been well covered elsewhere *(see June/July 1991 issue – Ed.)* so I will not go into the process in this article.

With the bottom sufficiently flat the casting could be returned to the milling machine for finishing the top complete with Tee slot. Whilst not of any real importance as far as I could see it would be preferable to ensure the top edges and slot were central and parallel to those of the bottom. Mounting the item on the table and using an edge finder, with the requirements to considering cutter diameter and calculate table movements, was considered unnecessarily complex, as absolute precision was not required.

As an acceptable alternative the casting was placed on a surface plate, with one of its machined edges in contact with the plate and its bottom against an angle plate. Using a height gauge, though a surface gauge would have been sufficiently precise, a line was scribed along the upper face in an appropriate position, the base was then turned over and the action repeated. The sides were then machined up to these lines, which proved sufficiently accurate and very much simpler than a complicated set-up on the milling machine.

It was however essential that the casting, when returned to the milling machine table, was placed such that the already machined edges ran parallel with the table movement. This was accomplished using a depth micrometer measuring from the edge of the table. In the absence of either this or a vernier, a rule would have been sufficiently accurate.

The two sides were then machined up to the scribed lines and the resulting width measured. From this value, and the required width of the Tee slot, the widths of the two sides were calculated. Using this value, the central slot was machined to arrive at the required slot width, the slot was also machined to its final depth.

Making the Tee slots

The endmill was now replaced by the single tooth cutter already made and described elsewhere in this issue. The cutter was positioned very close to the end of the base such that when rotated the tooth just entered the centre area of the slot. Now with the machine rotating, the cutter was gradually lowered until the cutting edge just touched the bottom of the slot. The cutter was then removed from the slot area and lowered by about 3 thou., this ensured that a light skim of the bottom of the existing slot was taken, resulting in a smooth bottomed Tee slot.

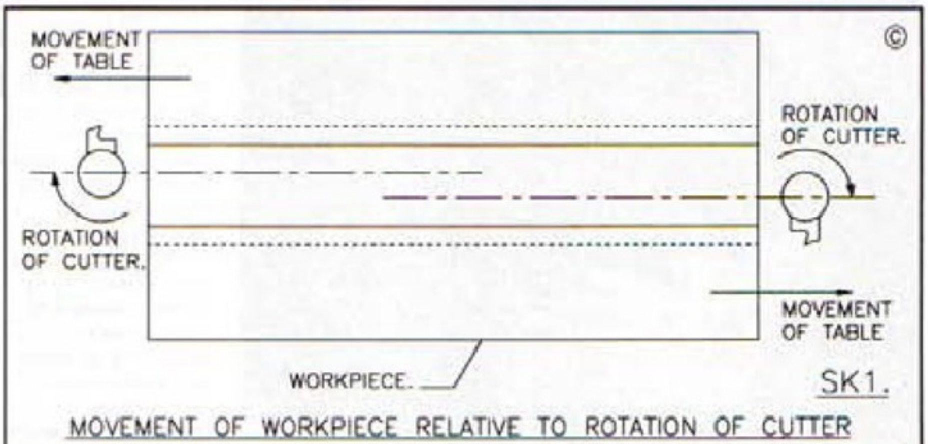
The Tee slot nearing completion.

The table was positioned such that the full width of the arm of the Tee would be produced at one pass, and machining the Tee slot commenced. It is essential however that the direction of movement of the table, and the side of the slot being machined, are compatible. For this to be so, the rotation of the cutter must oppose the direction of table movement and not assist, this requirement is illustrated in **Sketch 1.** If this is not done the action of the cutter will be to move the table forward taking up the backlash in the leadscrew. This will cause the feed to be irregular, resulting in undue forces being applied to both cutter and leadscrew.

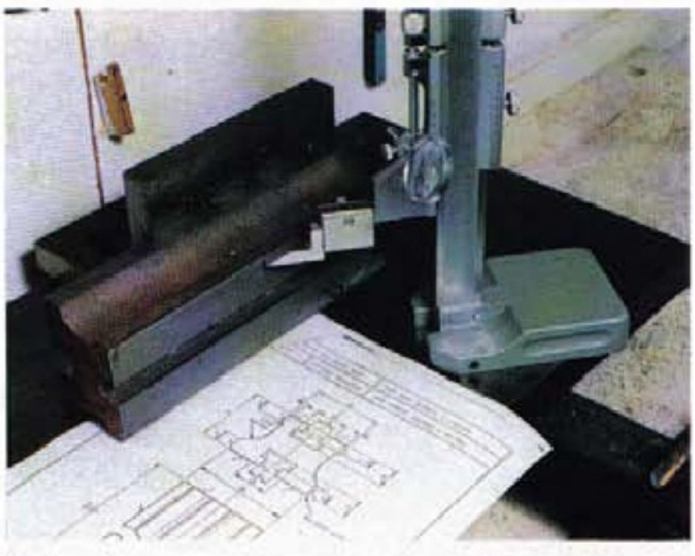
Inadequate table lock

Even so, it was with the appropriate cutting action that I still ran into a minor problem with my East Asian mill/drill. It has been said many times that most of these machines represent excellent value for money and that their accuracy is quite acceptable, mine is no exception. They do however have minor irritating faults, particularly the earlier versions. I though that I had eliminated all such weaknesses on my machine, most quite simply.

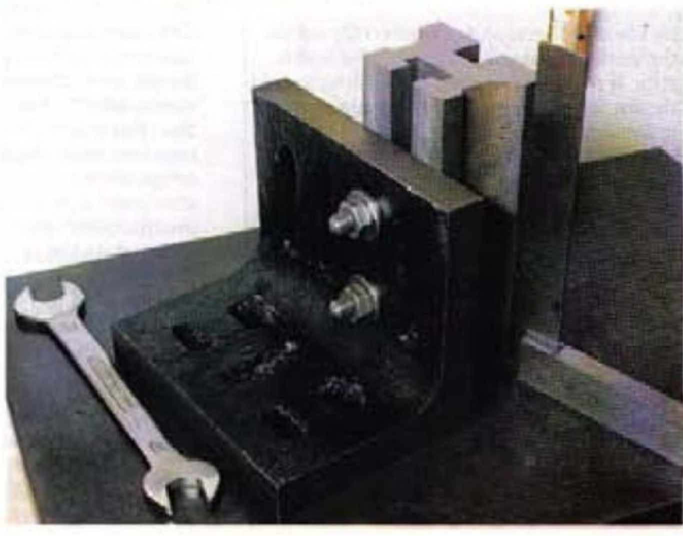
The table locks were in the form of a screw (M8) having a small sheet metal flag to enable them to be tightened. The flimsy nature of the flag, and the rather coarse thread, gave these a less than positive feel,



Marking the width of the top to ensure it is central to the already machined bottom. One side of the top is marked then the casting turned over and the other side marked.



After cutting casting into two pieces, one piece being set up on the angle plate for machining the ends. Note the use of the Tee slots for holding the casting to the angle plate.



but they had always functioned satisfactorily. With the rather heavy intermittent cut created by the Tee slot cutter, the cross feed lock kept vibrating loose. I attempted to overcome this by holding the lock on whilst feeding the table with the other hand, this proved unacceptable.

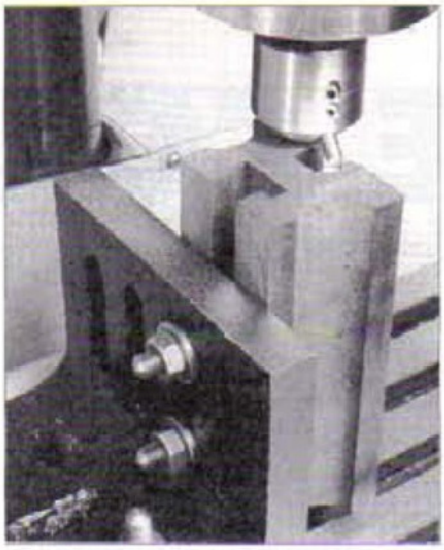
To overcome the problem on a temporary basis, the screw was replaced by a hex head screw which was tightened using a spanner. I rather think a further minor modification is called for, probably a finer screw thread and an improved method of tightening, maybe a longer and captive tommy bar.

I also had a similar problem with the down feed, this also tended to vibrate loose and as the final feed handwheel is not balanced and depending on its position can rotate, when the lock became loose the cutter spindle would rise. This was less of a problem than the table lock, as by tightening the lock rather more than was normally done, no further trouble was experienced.

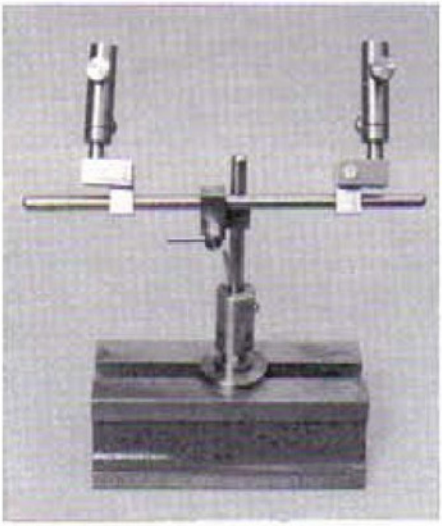
These two situations serve to indicate the heavy nature of this operation, compared to work normally carried out on the machine, but having overcome the problems, cutting the Tee slot proceeded with relative ease. It must be said, that having experienced the problems and overcome them, machine and cutter were working well within their capacity, and were in no way unhappy to be carrying out this task.

With one side finished the lock on the cross slide was released and the table moved to enable the other arm of the Tee slot to be machined, still at the same level as the first side. With the Tee slot now having been started on both sides, the cutter was returned to the start position of the second side once again. The cutter was raised to give the correct height of the slot's arm, and a second cut taken, this was then followed by repositioning the cutter as required to complete the first side. This sequence of machining is illustrated in **Sketch 2.**

Whilst the CES drawing indicates a Tee slot both in the top and the bottom of the base, as indicated above I chose not to include one in the bottom. Time was in short supply and I could see no useful purpose for it, perhaps one day it may be found a worthwhile addition. *(Any ideas on its uses? – Ed.)*

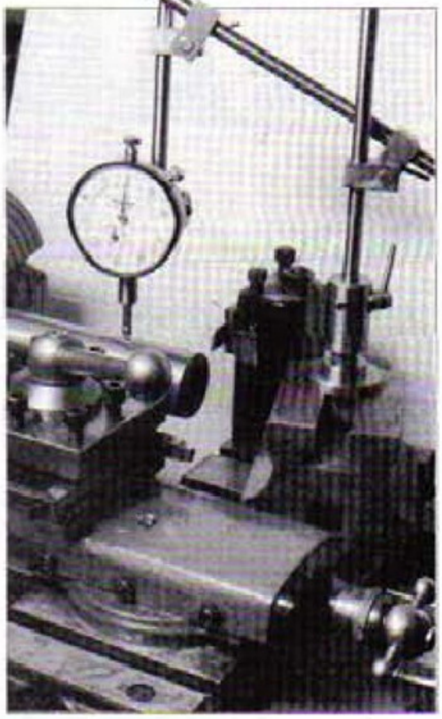


Machining one end of the longer base.



Being used as a base for a heavy duty helping hand.

The base was now cut into two pieces of approximately ⅓rd and ⅔rds length and their ends machined. This was easily done using the Tee slots to clamp the pieces to a slotted angle plate, they were lightly clamped and set upright using a square, before being clamped firmly and the ends machined. All the edges were then generously chamfered using a file, if you have a bevel cutter you may prefer to do this on the milling machine for a more professional result. Following this the individual bases were returned to the surface plate and, using engineers' blue, finally scraped to be reasonably flat. The sides of the castings were cleaned up and then painted.



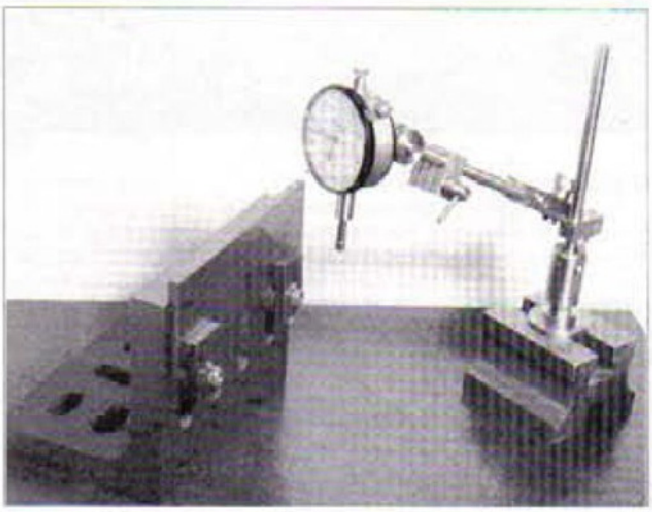
Supporting a dial test indicator on the lathe.

The bases are being used with the accessories detailed in issues 14 and 15 of *M.E.W.* as can be seen in the various photographs. Some readers may prefer to go all the way and make the complete item as per the CES drawings.

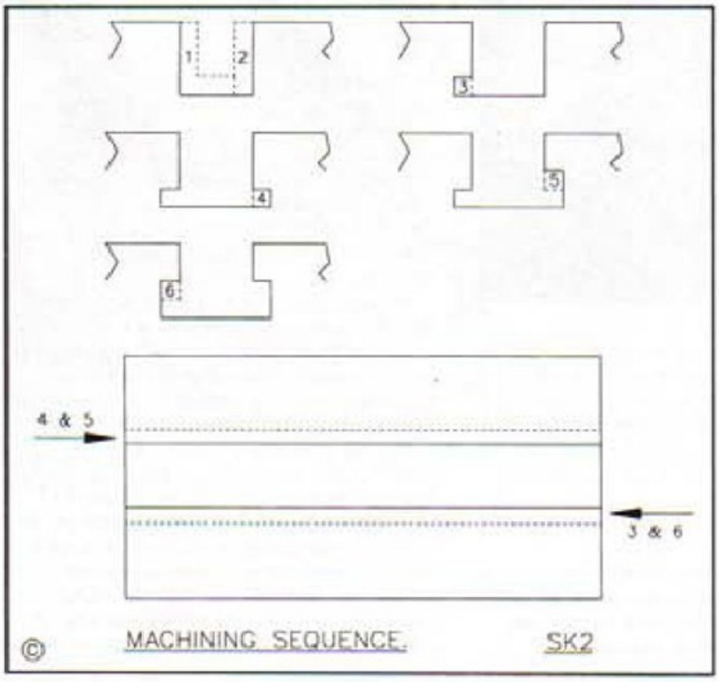
Supplier details

College Engineering Supply, 2 Sandy Lane, Codsall, Wolverhampton WV8 1EJ. Tel. 0902 842284.

Copies of articles previously published and mentioned above can be obtained £1.50 for UK readers and £2.00 overseas readers. Requests should be sent to the Photostat Service, Argus Specialist Publications, Boundary Way, Hemel Hempstead, Herts. HP2 7ST, quoting as much information as possible.



In use on the surface plate.



TRADE COUNTER

A first look at products which may be new to you

Machine Mart expanding

And still they come

Machine Mart have now opened a further four stores.

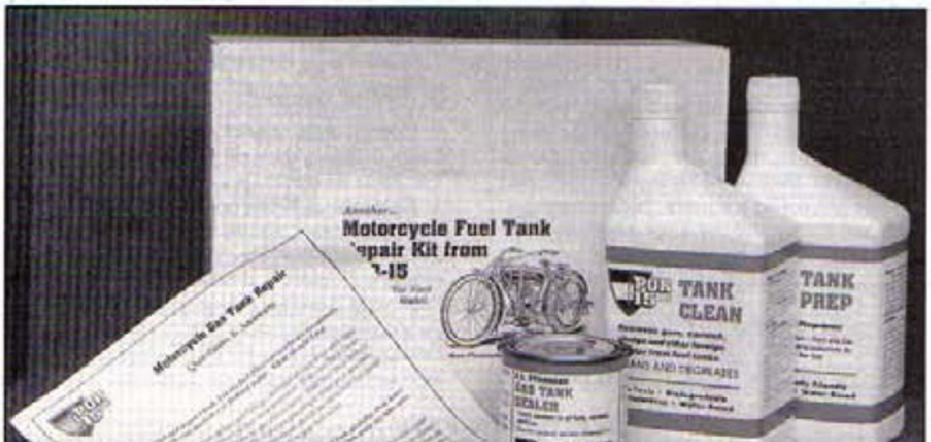
No. 29 London Road, Carlisle.
No. 30 Samlet Road, Llansamlet, Swansea.
No. 31 Copnor Road, Portsmouth.
No. 32 Chesterfield Road South, Mansfield.

An interesting catalogue

If you are into modelling to a very small scale or any other form of miniature activity, then the catalogue from John K. Flack will be of interest. Typically a wide range of brass sections such as H section from 4mm x 4mm down to an incredible 1mm x 1mm, it is almost necessary to get out the magnifying lens to determine that it is H section. Similarly angles from 6mm x 6mm down to 1mm x 1mm and many other sections such as T and U etc.

As far as tools are concerned they also are on the small side, taps from 4BA down to 16BA, drills down to 0.24mm, slitting saws down to 0.0025in. thick and many many more.

Other materials include plywood, Styrene rod and tube, Cobex, all in very small sizes. For a copy of the catalogue, send 3 first class stamps to John K. Flack, 107 Hillcrest Road, Bromley, Kent, BR1 4SA. Tel 081 857 4611.



Motorcycle fuel tank repair kit

This one will be of special interest to the many readers who are involved in the restoration of vintage motor motorcycles or cars. If you have a leaking petrol tank, or one that has flaking rust internally which causes the carburetor fuel filters to become clogged, then the fuel tank repair kit supplied by Frost Auto Restoration Techniques will be of considerable benefit.

The kit contains:-

Tank Clean, this dissolves and removes the gum and varnish that may have accumulated over the years.

Tank Prep, this removes rust, and prepares the inside of the tank surfaces for the sealer by leaving a zinc phosphate coating on the metal.

Tank Sealer, this coats the inside surface of your tank with a rock-hard, yet flexible, non-porous coating that is impervious to all fuels.

Cloth Patch, this is for sealing large holes or for reinforcing weak areas. When used with the sealer it becomes hard as steel.

Brush, for use in applying patching system to exterior of tank.

For details send to Frost Auto Restoration Techniques Ltd., Crawford Street, Rochdale, OL16 5NU. Tel. 0706 58619. Fax. 0706 860338.

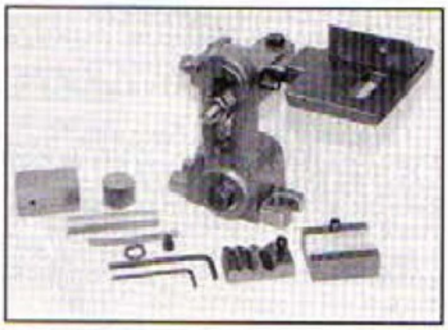
The Faster Blaster

Another product of interest to our vintage vehicle restorers, but this one also of interest to other activities, is the Faster Blaster, new from G.L.R. This is a grit blaster which can work over a range of pressures from 15 psi for etching glass, cleaning wood and other delicate tasks, up to 150 psi for the removal of stubborn rust and similar tasks. This is a portable, British made, machine and costs £95-00 + £7-50 delivery, these prices include VAT.

Another new product from G.L.R. is a range of metal polishing items including various compounds and mops in a range of sizes. For details of these and a copy of the latest catalogue, send to G.L.R. Distributors Ltd, Great Northern Works, Hartham Lane, Hertford, SG14 1QN. Tel 0992 552962. Fax 0992 551726.

The Hart

Hart Engineering have reintroduced their multi purpose tool and cutter grinding rest, available in kit form for home machining and assembly. The kit comprises three main castings and a few smaller ones, also



included are all other raw material requirements, mostly mild steel, and all hardware, screws, washers and nuts etc.

A full set of detail drawings are included, together with manufacturing instructions, these are assuming that the rest will be made using a lathe only for all turning and milling operations. Instructions for using the rest are also included.

The rest can be used for the grinding of lathe tools, end mills and also drills etc.

For details send to Hart Engineering, 19 Greenfield, Rhosddu, Wrexham, Clwyd, LL11 2N4. Tel 0978 359207

A Super CAD system

Leonardo Computer Systems Ltd have made a very special offer to *M.E.W.* readers of the SilverScreen 3D CAD system for £399-00, a saving of £100-00 (VAT extra). A demonstration package is available at around £25-00. The following brief report on the demonstration package has been provided by R.F. Parsons.

Leonardo Computer Systems Ltd have issued a basic version of their SilverScreen 3D CAD package. The Basic DOS edition is available from Leonardo Computer Systems Ltd, Innovations Centre, University of Reading, Reading RG6 2BX. Tel:- 0734 753477 Fax: 0734 756575, and is offered to *M.E.W.* readers at the discounted price of £399 + VAT.

This package is designed to run on I.B.M. compatible P.C.s under Ms Dos. The *minimum* requirements are 640k of available RAM, Maths Co-processor and EGA Video. The software is provided on 1.4mb 3½in. diskettes although I understand from Leonardo that other formats might be made available on request.

SilverScreen is a very sophisticated full 3D CAD package which allows the user to draw things as 3-Dimensional objects in 3 Dimensions, instead of drawing them as the projections of the object in 2 dimensions. It contains a great many useful facilities.

During my review I found the SilverScreen package was simple to install. The step by step tutorials were easy to follow and the results, as displayed on the screen, were easy to interpret. Because I had no plotters/printer available I was unable to test the printed output. After about an hour's practice I felt that I could use the package. It had one or two minor quirks which I found a bit annoying. The

'Camera Walk' facility which allows the user to view the drawing was fascinating, especially when I 'walked through' a hole in my drawing.

Because my computer has no Maths Co-processor I 'borrowed' one from a local computer manufacturer (usual disclaimer). I would like to thank Lofgren (UK) Ltd of Old Road, Shotover Hill, Headington, Oxford. Tel: 0865 742338 for their kindness in letting me use one of their elegant 486-33 machines for the trials.

For details, send to:- Leonardo Computer Systems Ltd., Reading University Innovation Centre, Whitenights, Reading, RG6 2BX. Tel 0734 753477, Fax 0734 756575.

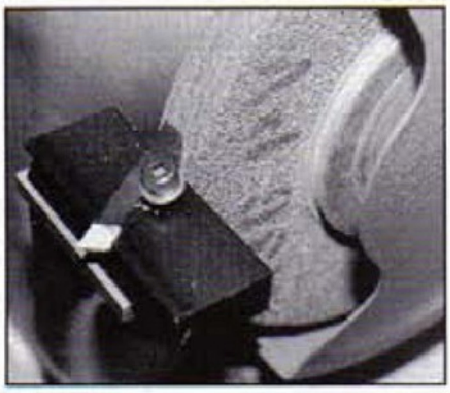
Soft Iron

A recent request for details of a supplier of soft iron (Swedish iron) has brought this response from a reader. D.C. Products Ltd, High Wycombe, Bucks, Tel 0494 881654. They apparently also supply a range of other difficult to obtain materials, metals and plastics. Mail order only, no callers.

New mini soldering irons from Weller

Cooper Tools, manufacturers of the market leading brand of soldering equipment Weller, have introduced a new range of mini, lightweight soldering irons. The Weller Mini Series 2000 features a choice of seven different soldering irons rated at 12, 15 and 20 watts. As easy and light to hold as a pen, new mini irons have long lasting nickel soldering tips. All models come complete with moulded-on 13-amp 3 pin plug.

For further information contact: Cooper Tools, Sedling Road, Wear, Washington, Tyne & Wear, NE38 9BZ. Tel: 091 416 6062. Telex: 53641. Fax: 091 417 9421.

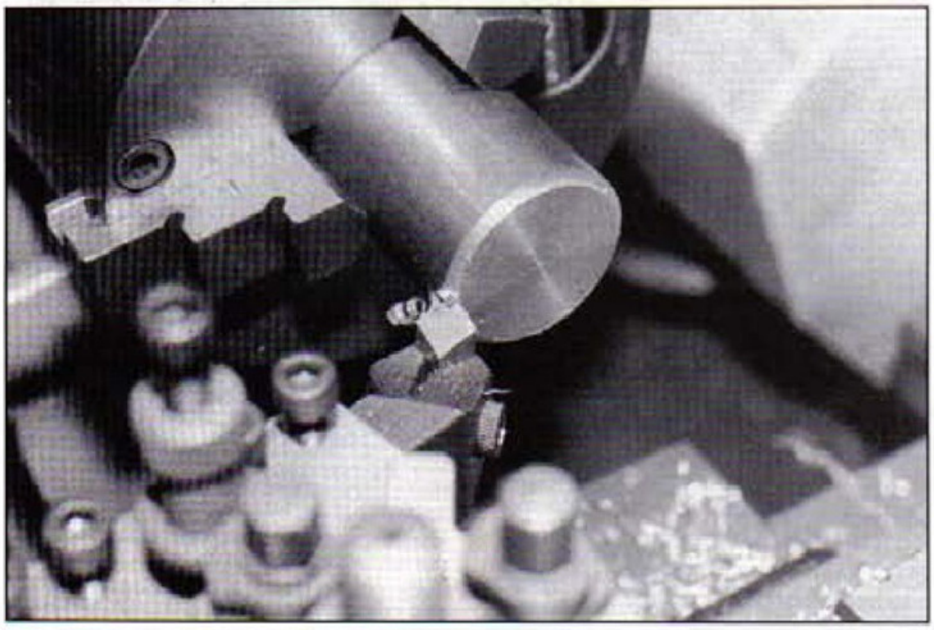


Clip on magifier from Asset Optics

Workshop enthusiasts who wear spectacles for close work and who need extra magnifying power for even closer work, may be glad to know that Asset Optics have come up with a very useful clip-on monocular lens available in three dioptres. The unit attaches to one lens of the wearer's spectacles via a spring clip with a protected cushioned wire frame that will not damage the spectacles' lens. When not in use it simply folds up wards on its spring loaded hinge out of the line of sight. It is vastly superior to the stick on loupes for spectacle wearers and is far more convenient than a Jeweller's eyepiece.

There are three powers of magnification available; 6.0, 10.0 and 15.0 dioptres. Intending users should first determine the strength of their spectacle lens which is increased by the addition of the Magniclip. For example, if your spectacles are plus 2.0 dioptre and you use a 6.0 dioptre the result is 8.0. So check first.

Price: £16 or £40 for a set of three; the prices include postage. Asset Optics. Sunrise Cottage. Jubilee Lane, Milton-u-Wychwood, Oxon, 0X7 6EW.



Diamond Tool Holder from D & P Burke, Toolmakers

The toolholders manufactured and supplied by D. & P. Burke of Victoria, Australia are of the tangential type, designed to secure square high speed steel tool material. Three variants are currently available in sizes to suit virtually all of the popular lathes, each kit containing the appropriate toolholder together with a length of high speed steel, Allen key and tool grinding fixture.

Regularly advertised in *M.E.*, all three toolholders are available for A$98 plus A$12 air mail from D. & P. Burke Toolmakers, 27 Woodstock Road, Mount Waverley, Victoria 3149, Australia; tel 61-3-807-6316, fax 61-3-807-9620.

QUICK TIP

When hardening components which are tapered or otherwise unevenly shaped, improved quenching will result if the thickest end is plunged into the coolant first, whilst also reducing the risk of cracking. **Alan Jeeves**

We visit – GEOFF WALKER'S WORKSHOP

Our workshop visit in this issue is to Geoff Walker, a reader whose interests are based on model engineering but, like many, having a growing interest in making workshop equipment.

1: Geoff 's original lathe, an Adept.

2: The Myford ML10 fitted with a division line cutting tool.

This time we visit Geoff Walker, whose workshop activity closely follows that of many other readers of this magazine, being an interest in model engineering but also an equal if not greater interest in making workshop equipment. In fact Geoff admits that whilst he has made two stationary steam engines, in the 15 years since starting his metal working workshop in earnest, he has now an increased interest in workshop equipment. His latest project is a Stent tool and cutter grinder from Blackgates Engineering.

Geoff's daily employment has been of an engineering related nature having been involved in design and management for a civil engineering company, with particular involvement with the petro- chemical industry. He had no formal workshop training from his industrial activities, but has attended college workshop classes for the last six years.

First lathe

His first introduction to a home metal working workshop came when he purchased a small Adept lathe, seen in **photograph 1**, when he was about 25 years old. He has kept that machine to this day. The lathe is about 300mm long and the four jaw chuck about 50mm diameter. Very little use has been made of this over the years, except for a few items such as camera tripod heads which have been made on it. This indicates another of Geoff's leisure interests; photography.

His workshop is a brick built extension to the garage, which he built himself, originally for the purposes of woodworking activities. It was about 15 years ago that he decided to branch out into metal working and in particular model engineering; as a result he purchased the Myford ML10 seen in **photograph 2**. This marked the start of a quite extensive workshop developed over the years.

Making some accessories

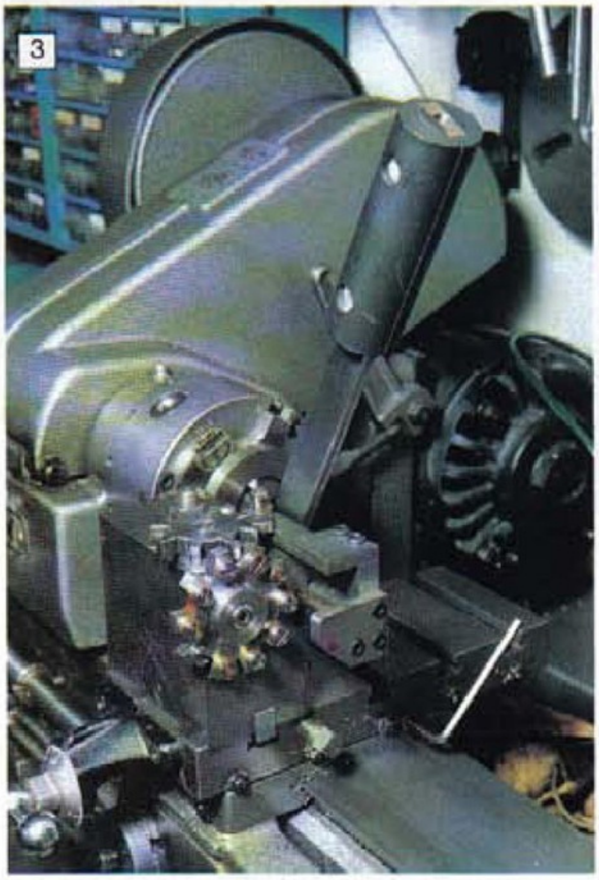
Like so many who have gone down this road, Geoff soon realized that many items of workshop equipment are desirable so as to adequately carry out one's own brand of activity. As a result, accessories were made, some to save money and some because they could not be purchased. Typical of this later category is the division line cutting device. Geoff is seen operating this on the front cover and the major part of the mechanism can be seen in **photograph 3**. The tool consists of a slide which is operated by a lever and which carries the cutter to make the division line. The reciprocating motion of the cutter slide automatically rotates a turret which carries stops that can be adjusted to set the length of the lines, adjustment is by differing thickness washers under the screw heads. The turret has ten positions and will normally be set to give the longest line for the tenth position an intermediate length for the fifth line with the remainder all constant length and shorter.

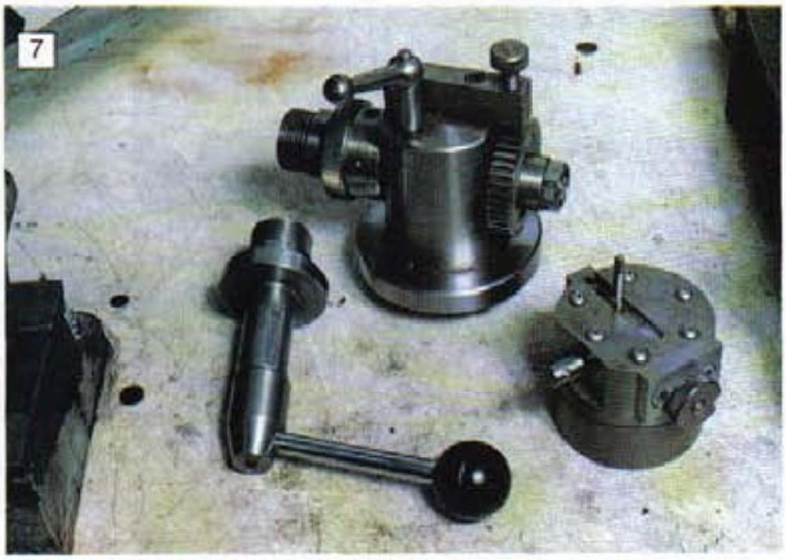
Amongst other accessories that Geoff has made, is a thread cutting tool holder for use on the lathe. The purpose of this is to enable the tool to be lifted clear of the thread when a cut has been completed. This allows the cutter to be returned to the start without having to wind the cross slide out and maybe lose position. This is shown in the cutting position in **photograph 4** and raised in **photograph 5**.

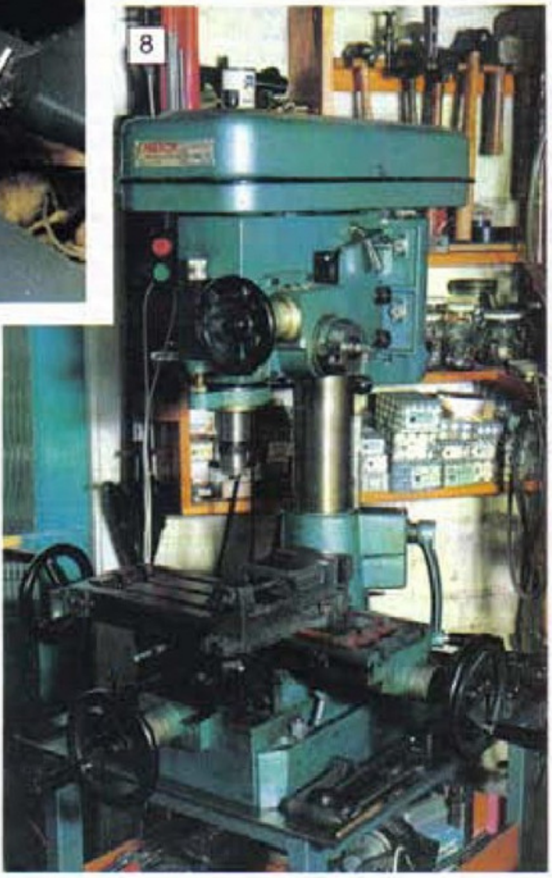
A novel idea

A very novel idea is that seen in **photograph 6**, this is a simple holder for a slot drill that enables it to be fitted to the lathe top slide and used as a boring tool, I must try this one myself.

Geoff 's dividing head is a very adaptable piece of kit and is seen in **photograph 7**. Centre rear of the photograph is the fairly







3: Close-up of the division line cutting tool. The turret automatically indexes and sets the length of the line made. Adjustment is by means of packing washers placed under the screw heads.

4: A thread cutting tool holder seen lowered to make the cut.

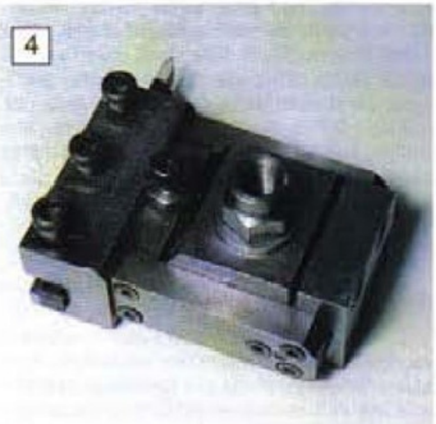
5: The holder raised. This permits the tool to be returned to the start without the need to wind the tool away using the cross slide, with a possible loss of position.

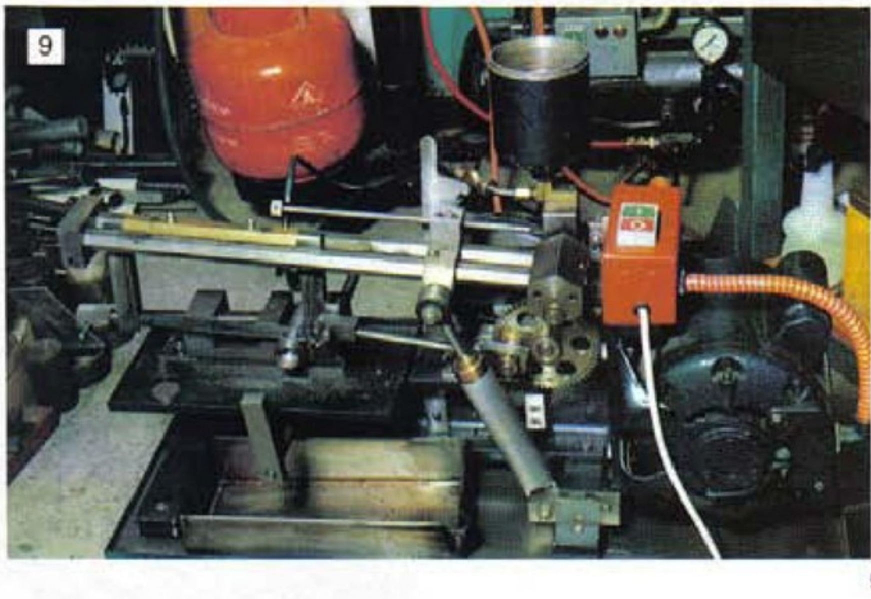
6: This simple holder permits a slot drill to be mounted onto the lathe top slide and thereby used as a boring tool.

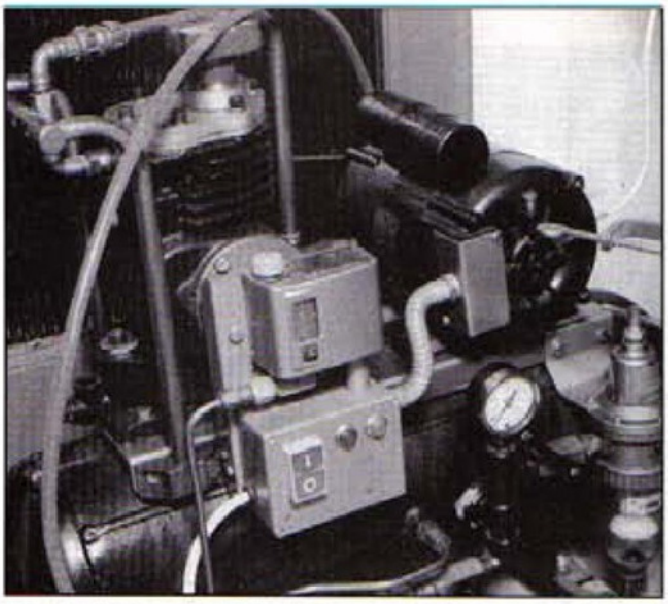
7: Geoff 's multi purpose dividing head-cum-ball turning attachment, cum rotary table etc. etc.

8: The Naerok Mill/drill, mounted on a stand made whilst attending a welding course at the local college.

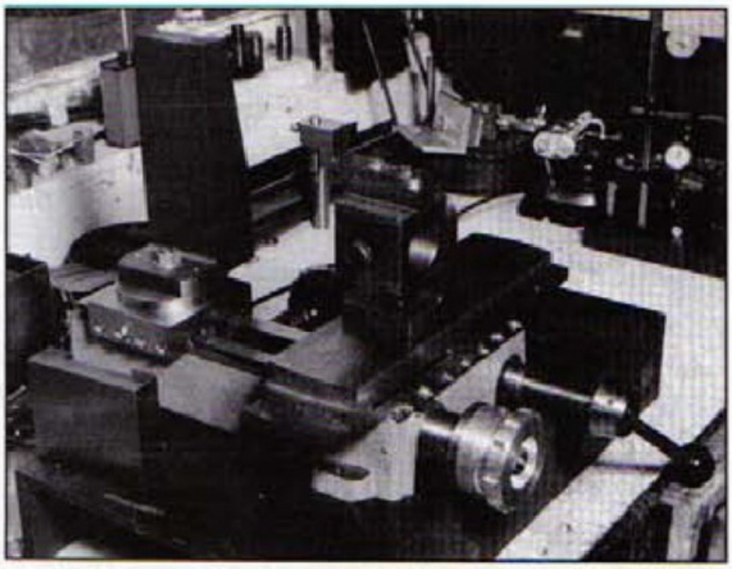
9: One of Geoff 's major projects, a motorized hack saw.



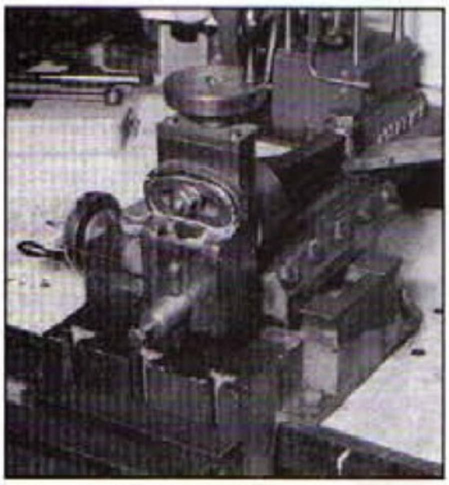




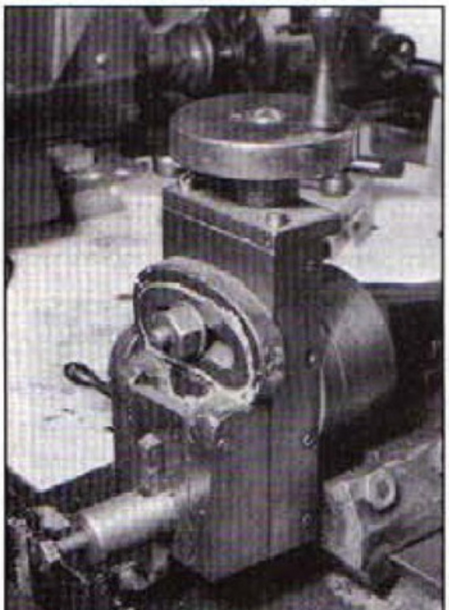
10: *Another major project, a compressor. Main components are a much modified lawn mower engine and an air brake cylinder from a lorry.*



14: *The Stent tool and cutter grinder, well on the way to completion.*



11: *The Adept No. 2 hand shaper.*



12: *Close-up of the shaper.*

conventional simple dividing device, however not seen in the photograph, as it was in use on the lathe for another purpose, is a mounting arrangement which permits the unit to be mounted with the spindle in a vertical position. This allows it to be used on the drilling machine for holes on a PCD. With the gear removed and the hand driven spindle fitted it can be used for generating radii on the milling machine, however a longer handle is required. The spindle nose dimensions permit a lathe chuck or backplate to be fitted. With the device, bottom right of photograph, fitted and hand operated, it can be used on the lathe as a ball turning device.

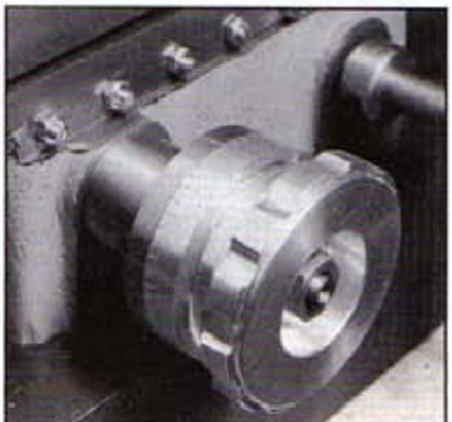
College attendance

During the last six years Geoff has attended the local college, one night a week, initially this was to learn the art of welding. Having accomplished this he remained with the welding course for three years, using the facilities provided, to enable him to make items of workshop equipment. Typical of this is the milling machine stand just visible in **photograph 6**.

After this he joined the model engineering classes partly for guidance but largely to make use of the workshop equipment.

Two quite sizeable items of equipment that he has made are the power hack saw seen in **photograph 9**, and the compressor in **photograph 10**, the latter is very interesting. In this, the compressor is made from a lawn mower engine fitted with a special cylinder head made from a block of aluminium and containing the necessary valves. The reservoir is a lorry air brake cylinder.

13: *The completed index for the Stent. Geoff prefers the serrated edge to the wheel rather than knurling, which in any case would be a little on the large size for his ML10.*



An Adept No.2 hand shaper

One of Geoff's machines is his Adept No.2 hand shaper, this type of machine is not that often found in the home workshop these days. This is a pity, as in many cases it will produce a better and more regular finish than that obtained on a vertical milling machine, using easily sharpened single point tooling; these are the reasons given by Geoff for making much use of his machine. The Adept No. 2 is a simple hand operated machine and cross feed has to be applied also by hand, rather than automatically by the backward stroke of the slide. This makes it difficult to apply an equal width of cut each time as the cross feed is not calibrated, even so, the finish is considered better than that provided by the milling machine. **Photographs 11 and 12** show the shaping machine. There are plans to provide more information regarding the shaper in the pages of *Model Engineers' Workshop* at some future date.

Stationary steam engines

During the 15 years that Geoff has had a workshop he has made two stationary steam engines, these are the Stuart No. 9 and the *James Coombes*. One of these can just be glimpsed in the rear of **photograph 11.** Geoff admits however that whilst the construction is complete he has not found time to complete the painting, and now has a greater tendency towards making workshop equipment, which at present takes the form of the Stent Tool and Cutter grinder, seen in **photographs 13 and 14** showing the progress to date. This was started at the commencement of the autumn term at college and in the case of the larger components has been made using the colleges facilities. It is expected that it will be completed before the summer recess.

I am sure that other readers will join me in thanking Geoff for allowing us access to his workshop - I know that I came away with a few ideas, I hope that readers will pick up a few as well.

Supplier details

The Stent tool and cutter grinder can be obtained in kit form from: Blackgates Engineering, 209 Wakefield Road, Drighlington, Bradford, West Yorkshire, DB11 IEB. Tel. 0532 853652.

1

The complete Promill-35 milling machine with AC variable speed controller.

THE RISHTON PROMILL-35

The Promill-35 milling machine made by Precision Engineers Ltd is reviewed in the article, and found to be worth the serious consideration of the home workshop user

I doubt if anyone looking at Precision Engineers Ltd's Promill-35 milling machine for the first time will fail to be impressed by its appearance of quality. Of course it is often said that such appearances may only be skin deep, but close examination of the finer details will, I am sure, not make one change one's mind. The paint work is good but the quality goes far beyond that. The machine would appear to be amongst the few real quality small machines.

AC Variable speed controls

One aspect of the machine which is of considerable interest is the variable speed system, this is a single to three phase inverter with three phase motor. Both motor and inverter are made by Brush Crompton, one of the largest British manufacturers of electrical equipment, predominantly for industrial situations. Their equipment will be found fitted to a wide range of machines, not just machine tools, and many of these are expected to run 24 hours a day, 7 days a week.

As a result, the motor fitted to this machine should have the quality and reliability demanded of such an item in industry these days.

How delivered

The machine comes packed in two packing cases so as to minimize the weight problem; the total machine weighs 55Kg. One case contains the co-ordinate table assembly, whilst the other has the column and head assembly, already assembled. Building up the machine consists of lifting the column into the socket in the table assembly and then lowering it to the foot of the socket, it will stand there satisfactorily until the two fixing screws are tightened.

A cable must be provided by the purchaser for connecting the main supply into the inverter. Very adequate instructions are provided for this, as are instructions for making adjustments to top and bottom speeds, ramp (acceleration/deceleration) times and other features.

The biggest task prior to putting the machine to work will be the removal of all the rust protecting substances applied to the machine. A rag well soaked in white spirit will remove the protection, but it will take a quite a time, still this is no bad thing as the machine is guaranteed to arrive in pristine condition. If the machine is then to stored in humid conditions do remember to apply some light oil, the virgin surface exposed when the protective coating is removed is very prone to rust.

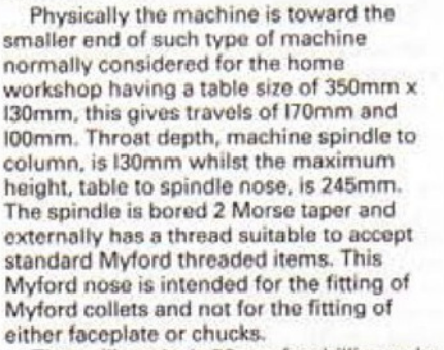
The machine is available with either metric or Imperial calibrations and is quoted as requiring a 220-240 volt 50 Hz supply. The machine comes with a draw bar, either Imperial or metric, and a few small tools, otherwise all other accessories must be purchased if required.

Specification

Physically the machine is toward the smaller end of such type of machine normally considered for the home workshop having a table size of 350mm x 130mm, this gives travels of 170mm and 100mm. Throat depth, machine spindle to column, is 130mm whilst the maximum height, table to spindle nose, is 245mm. The spindle is bored 2 Morse taper and externally has a thread suitable to accept standard Myford threaded items. This Myford nose is intended for the fitting of Myford collets and not for the fitting of either faceplate or chucks.

The quill stroke is 50mm for drilling only, down feed for milling is by raising and lowering the complete head. To maintain position when altering the position of the head, the column, whilst round, is fitted with a substantial key along its length.

Motor power is 250W with an output speed range of 200 -2500 rpm. The inverter controls can be adjusted to make top speed 4500rpm, however there is considerable loss of torque at this setting and it is suitable for drilling small holes only. The head can rotate 90 deg. either way whilst the column can rotate through a full 360 degrees.



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The single to three phase inverter fitted to the machine.

The machine in detail

The head

The complete machine can be seen in **photograph 1** and as already mentioned, presents a very favourable first impression. The speed controller is mounted to the left of the head and contains on its fascia the operator controls, these are start, stop and a speed setting potentiometer, as seen in **photograph 2.** Being made for a wide variety of machines the controller cannot have a speed calibrated dial, but one soon gets to know the correct position and sound of motor for each application. As it is possible to vary the speed whilst the machine is cutting, it is possible to tune the speed to the application.

3

The well constructed interior of the inverter, made to industrial standards and likely to be very reliable.

The front fascia also has a lamp to indicate power on and another to indicate the controller safety circuit has tripped due to some fault. This will either be due to an overload on the motor causing current to be drawn greater than full load, or motor over temperature due to long term slight overload or working at slow speed, or just possibly working in a very high ambient temperature. The motor is fitted with an over temperature sensor to enable this protection to be achieved. The controller has facilities for remote controls, but this is an unlikely requirement other than maybe a remote stop contact.

The inside of the inverter, **photograph 3**, contains some adjustments which the owner may require to vary, most likely top and bottom speed. As these have to be set whilst the machine is running, the inside is alive at mains potential and great care must be taken not to touch other parts of its interior. This fact is clearly stated in the operators instructions, as are the details for adjusting these and other characteristics. The adjustment of top and bottom speed is made by a small screwdriver, no need to place ones fingers into the area, and the use of an insulated screwdriver is strongly advised.

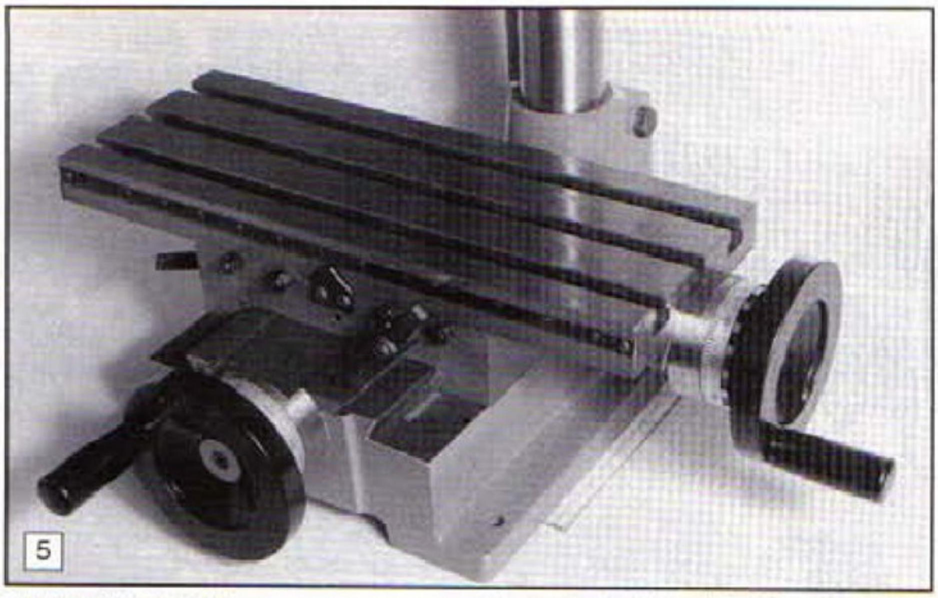
The motor is flange mounted and the belt drive between motor and spindle is entirely shrouded inside the head. It is easily accessible by the removal of four cap screws, permitting the top of the head complete with motor to be very easily removed. The motor mounting can be seen in **photograph 4.** Also seen in this

Showing the head, in particular the dials for down feed, quill feed and head angle.

photograph are the dials for the quill and the head down feed, and these, as are the table feed dials, are large and very clearly marked. They also are friction fitted with a very positive feel about them, no chance of them moving whilst a feed is being made. The calibration for head swivel, also seen in the photograph is similarly very clear. The item in front of the motor is the removable cover for the spindle, this is primarily for access to the draw bar.

The compound table

This is of conventional design, for this type of machine but this statement hides its outstanding quality as seen in **photograph 5.** Most impressive are the leadscrew friction dials, as can be seen in **photographs 6 and 7.** These are around 65mm diameter and the divisions broad as can be seen in **photograph 7**, the dials are fitted with a serrated edge which makes operating them very pleasing, this is best

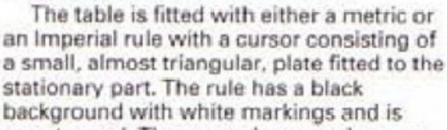


The combination table.

Leadscrew friction dials are of a very high standard.

seen in **photograph 7.** The handwheels are also large and pleasant to use.

The table is fitted with either a metric or an Imperial rule with a cursor consisting of a small, almost triangular, plate fitted to the stationary part. The rule has a black background with white markings and is easy to read. The cursor however has one small failing, unless I had a rogue, the small plate is painted black and has only an indented line on it, also appearing black. As a result it is therefore almost impossible to see, to overcome this, as can be seen in **photograph 7**, the indent was filled with white paint, a simple solution.



Note the robust two leaf leadscrew cover in this view, also showing the table rule and locking screw.

The telescoping cover to the lower leadscrew was very substantial, being some 1.5mm thick, again seen in **photograph 7**. The various locking handles for such things as table locks, column locks and quill locks are very easy to operate, having a very nice facility for ensuring that they lock with the handle in the most suitable position. To make use of this, the handle can be pulled away; it is normally held in position under spring pressure; from the body of the machine when it becomes able to rotate freely. Now the handle can be rotated to the most desirable rest position and allowed to return; when it will again become captive to the locking screw. **Photograph 8**, the quill locking screw, is a typical example.

All the locking levers are of this type, this one for the quill, and have a nice facility for ensuring they tighten with the arm in the best possible position.

A number of accessories were supplied with the machine being reviewed, though if required they have to be purchased additionally. These were a small vice, made by Precision Engineers Ltd, a Clarkson milling cutter chuck and a tool guard. The vice has 75mm wide jaws and opens to 60mm. One rather nice feature is the provision of a number of fixing holes, these positioned so as to allow the vice to be set at angles of 45 and 60 deg. using only the Tee slots in the machine table. The keep plate below the vice jaw is only as long as the jaw itself, this is surprising as there is plenty of room for it to be extended forward, this would help considerably to prevent jaw lift.

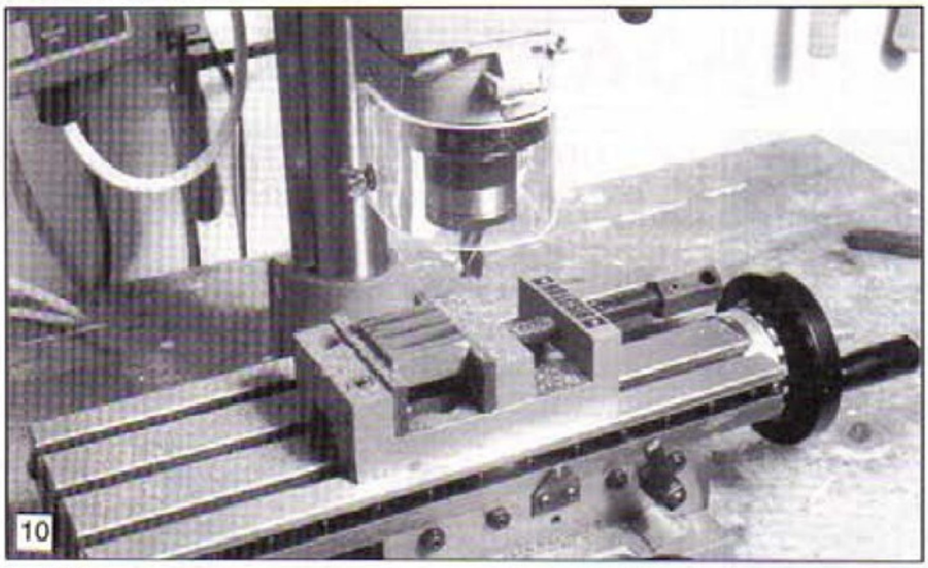
Of course, the vice is well made and jaw lift is minimal when new, but could become more of a problem as wear takes place, extension of the keep plate towards the front would be an easy operation for the owner in this event. The vice can be seen in **photograph 9**. The cutter chuck, being made by Clarkson, is of excellent quality as one would expect from this company.

The very nice small vice, having 75mm wide jaws and 60mm opening.

In use

The machine is a delight to use, typical of this situation are the large friction dials on the leadscrews and quill down feed, these have a quality that makes them very easy to use. There is however one minor irritant that appears to have come about due to a repositioning of the speed controller. Readers who have studied this machine in the past, will see from **photograph 1** that the controller, which used to be on a long arm, is now fixed by means of shorter arms and mounted from the head. This has obviously made the mounting much more rigid, but unfortunately this makes access to the head to column clamps rather inaccessible.

It was when putting the machine to the task of actual metal removal, **photograph 10,** that the quality of the machine became



A trial run.

apparent, it was however somewhat confused by other circumstances. I had for a long time been carrying out end milling operations on my own machine, using cutters which were way past their best, and accepting the rather poor quality result, probably, I must admit, as inevitable.

The testing of the Promill-35 coincided with my having obtained a completely new set of end mills and slot drills. So having put the mill to work, was the finish being achieved, seen in **photographs 11 and 12**, as a result of the new cutters or the quality of the machine itself? There was no option but to try an identical test on my economy mill, and whilst with the new cutters a much more acceptable result was achieved, it was still a long way off that achieved using the same cutter in the Rishton Promill-35.

A close-up view.

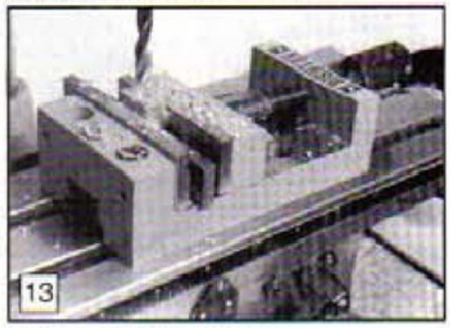
An excellent finish was achieved as can be seen in this view.

The variable speed control system was very impressive and a very distinct advance over the use of levers, as for a geared head, and even more so for the more probable belt changing arrangement. However, the relatively light load of the endmill did not make any real demands on the system. Most readers will have learnt, I hope, from the articles on speed control, that in most cases when a motor is reduced in speed, the output power available reduces proportionately. On the other hand when speed reduction is by gear or belt changing, the full motor power is still available and additional torque is present at the output spindle as a result.

Using the drilling facility

To test the system under a heavier load it was decided to make some additional Tee nuts, which I knew would be required for later uses of the machine, and use the drilling facility to make these. **Photographs 13 and 14** show this taking place. The hole being drilled was in the order of 7.2mm and drilled at one go, no smaller hole having been drilled first. Rate of cut was deliberately heavy and the drive system showed not the slightest sign of being unhappy. However the relatively short arms on the quill down feed gave one the impression that the designers did not expect this down feed pressure to be exceeded. Of course larger holes could easily be produced by increasing the size in stages.

The tests made at this stage are quite simple but, so as to put the machine to work on more involved tasks, the machine will be used to complete some projects which will appear in *M.E.W.* in future issues.



In use as a drilling machine.

Even with a substantial down feed the motor showed no sign of being unhappy.

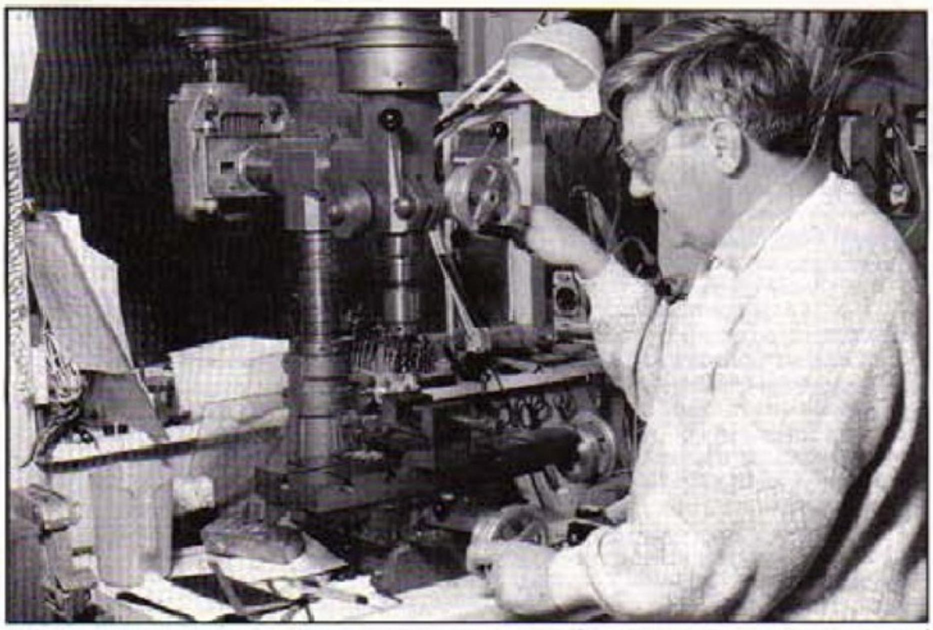
Conclusions

The tests show that the outward appearance of quality is more than skin deep and that it is a machine capable of excellent results. Also the standard of design and manufacture is such that these excellent results are likely to be maintained over a very long working life.

One advantage of being a reviewer of such machines is that one has the opportunity of operating machines of high quality, on the other hand one is faced with the distress of having eventually to return the machine to its rightful owners. My economy mill will never seem the same again, and I really must attempt to improve the finish achieved. The taper roller bearings have been tightened up a little perhaps they require to be still a little stiffer. Perhaps I will carry out some tests and publish the results if at all interesting.

For details of machine

Contact Precision Engineers Ltd, Mary Street, Rishton, Blackburn, BB1 4RF.



Derek at his own machine. The remaining photographs are of a friend's machine being built.

MAKING A DORE WESTBURY MILLING MACHINE

Derek Brooks built his Dore Westbury milling machine, a machine of which he speaks very highly; in the very short time of two weeks, admittedly burning much midnight oil. In this article he gives a brief account of his experiences in completing the task, and some facts and figures regarding the machine.

Before I write about The Dore Westbury Milling machine I should mention a little about myself. The nearest that I come to being an expert in the manufacture of an engineering project is picking up a brush and painting it. I am a self taught amateur engineer of some six years' standing. I have quite a bit of patience and quite a lot of tenacity. What I am really saying is if I have the guts to take on a project like this, what's stopping you?

For many years now I have struggled to do milling on my lathe using a vertical slide. This is all very well in the absence of a milling machine but can be very frustrating not being able to see the back of the job. What is more, sometimes it is almost impossible to work on the wrong side of an object. I decided that it really was time to look for a milling machine.

At first I thought that I had only two options, buy a new one or buy a secondhand one. The new ones that I could afford did not have all the options that I would have liked. The cheaper ones were not robust enough. I had read articles which gave the impression that they were inclined to have vibrations which gave chatter. The secondhand market available to me were mostly of the large free-standing variety. Room in the workshop is at a premium so that was out. At this stage a friend asked if I had considered a kit of castings. At first I looked upon this as a daunting task, but he pointed me in the direction of the Dore Westbury. I wrote for the brochures and found to my surprise that it had a much better specification than many of its commercial competitors. For example the quill travel is 4½in. which enables drills to be changed from small to large ones without changing the pillar height. The head can be angled anything from vertical to horizontal. This does away with the need for a variable angle vice. The throat, that is the distance between the chuck centre and the column can be varied between 4½ and 8½ inches. With a standard column the height between spindle and table can be varied between 0 and 14in. and with the long column between 0 and 20 inches. With the gearbox fitted the machine has ten speeds varying from 32 to 1880 rpm. The spindle has a Myford nose which is very useful. For instance you can use collets and when you need to ensure that the spindle is set square to the table your faceplate can be screwed on and lowered onto the table before locking the cross tube bolts.

The supplier of the Dore Westbury Milling machine is Model Engineering Services of Sheffield (Tel. 0246 433218). As I am also a Yorkshireman I elected to collect my kit myself. This had a double bonus. The first is it saved the carriage. The second was a real treat, allowing me to meet the proprietor Mr Ivan Law who is a mine of engineering knowledge. You may have met him already demonstrating gear cutting at the Model Engineer Exhibition, where he holds the office of Chief Judge.

I should warn you that the kit is quite heavy, but no more than the average car will take. Customers should also telephone prior to visiting to ensure that all the parts are in stock. Of course it is also possible to have the bits delivered.

The alternatives available

You have several choices to make before ordering. You can make the machine with or without the gear box. If you decide to do it without, a gear box can be added at a later date. You have a choice of long or short column, with or without motorised feed on the bed, with or without the motor. It is also possible to have either a No.2 or a No.3 Morse taper in the spindle. You have two sizes of bed to choose from: either 16in. x 5½in. or 20in. x 6in., the former has 5½in. x 12in. travel and the latter 5½in. x 16 inch. The kit does not include a chuck. A Modeloy milling chuck can be bought as an extra and is recommended by Mr Law. Another possible extra is a belt guard.

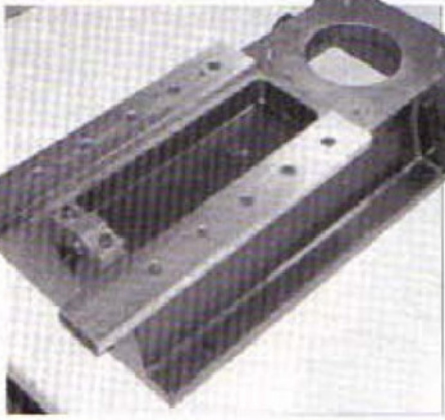
Starting work

The drawings are well presented and easy to read and follow. A parts list and working instructions booklet is also supplied. If you follow the booklet through things are done in a logical order. Each part is numbered and described, some care is needed here to select the correct piece, don't just grab the first bit of bar or rod that is the correct diameter. Look for the right length and quality of metal. The parts list is quite explicit about where each piece fits into the final assembly.

When following the instructions don't go galloping ahead. Read through the rest of the paragraph to be sure that the size you are working to is not controlled by another part. To be fair you are usually warned about such fits. I missed one such warning which had to do with using a bearing as a plug gauge. This made an annoying rectification job necessary. There are several useful photographs at the end of the booklet which are very helpful.

A wide variety of parts

The parts themselves come as a variety of metals from rather large castings in iron through alloy castings to bars and rods. One amusing thing that I found was the small pieces of rod were not cut at right angles. Perhaps Ivan is making sure everyone trues up the ends and does not use them as sent. The cast iron parts on the whole were good. A few however specially the thinner pieces had the hard chill skin right through. As these came in unimportant places it was sufficient to grind the small spots smooth. The company is proud of the high quality of their products, so any bad castings would, I am sure, be replaced without trouble. Many of the difficult parts are already worked for you. The table and its bottom slide ways are ground. The spindle is bored through with one end bored to No.2 Morse taper. The pillar is turned and threaded. The cross tube the column head and the spindle head are



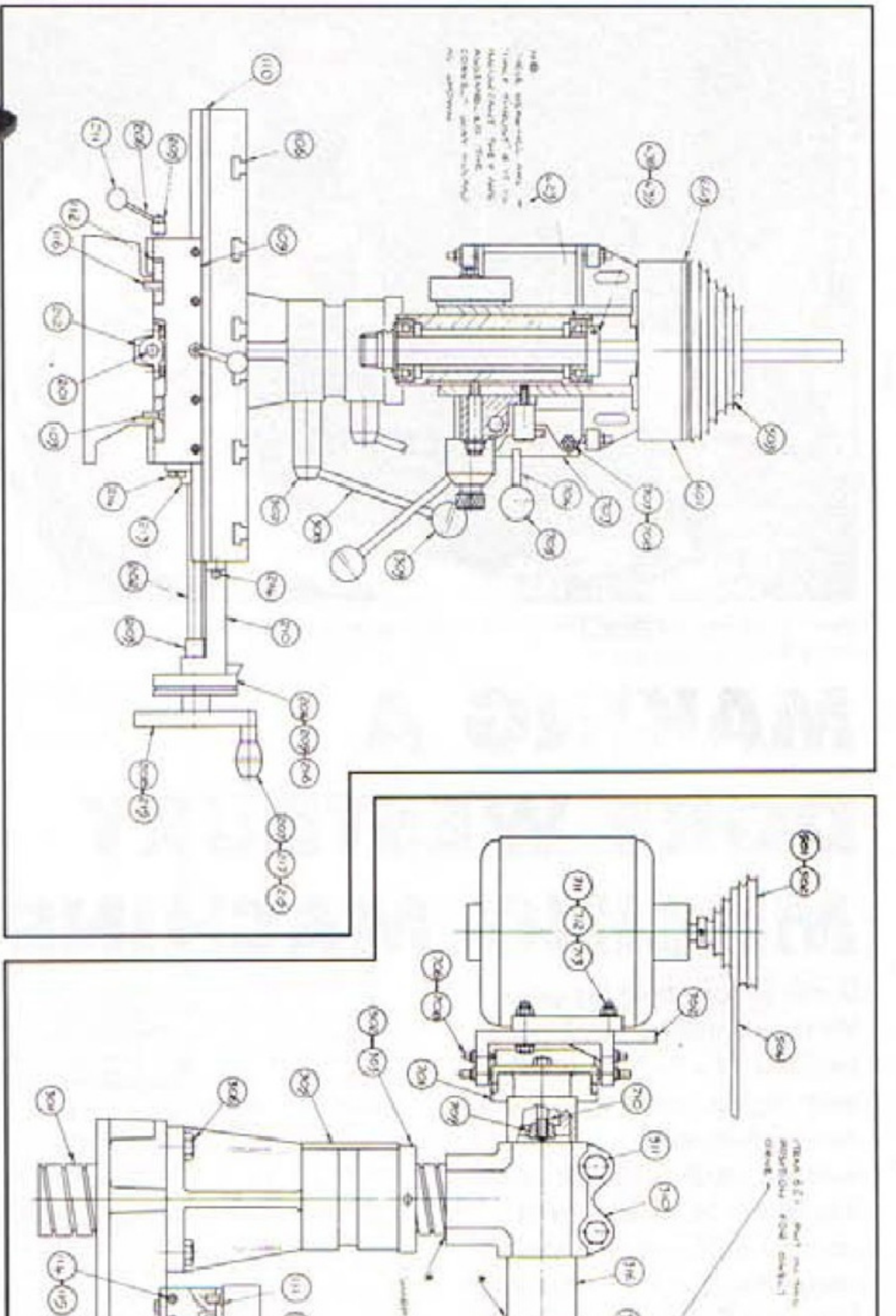
The machine base is the largest item to deal with.

virtually done. The wormshaft and gears are cut. The lead screws and nuts are threaded.

As I have already mentioned the instructions follow a logical pattern. In other words you start at the bottom and work your way up. The whole job can be done on an ML7 lathe and vertical pillar drill. Since making the Dore Westbury I have sold my pillar drill as it was redundant. You will also need several Imperial taps and dies and a few common hand tools found in any workshop. The designer makes good use of the copying method for making matching screw holes, a very simple way of making one off fits. I have already admitted to one mistake I may as well admit to the other to save you falling into the same trap. I made the ⅝in. hole in the bearing support bracket too low; this raised the bracket when fitted, making it impossible to feed a Tee bolt into the end slot. It does say in the brief, check with the assembly as a number of factors affect its position.

The hand wheels and micrometer dials are a pleasure to turn. The metal is nice and crisp and looks really clean and white after turning. It was my first attempt at dividing so a trial run was made on a dial before it was reduced to its finished diameter. One suggestion to help here which is not given in the instructions: fasten a piece of stout cord to a chuck jaw wrap one or more turns round the chuck body, fasten a heavy weight to the other end and dangle this down the side of the lathe. This will eliminate backlash and

PART OF SUPPLIER'S ASSEMBLY DRAWING

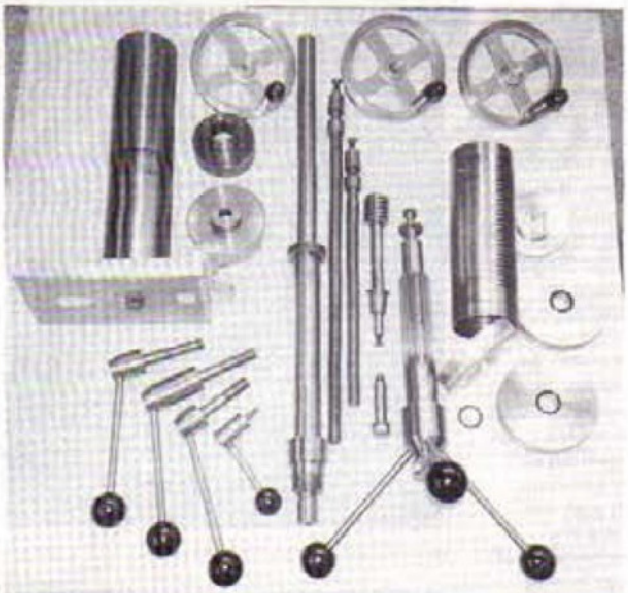


The X Y table seen from below.

make the graduations equal. The instructions say make sure that the tapers on the nuts match the tapers on the dials. To ensure this you should cut one from the front as normal turning and the other from the back with the tool inverted. The leadscrew dials are zeroable using an 'O' ring for the friction drive. This works very well providing the machining of their grooves is done accurately.

A wooden steady for the lathe

The column base was the clumsiest piece to handle. Do follow the instructions and you will have no problems. Do not be afraid to use the suggested wooden steady it works very well. I made mine from mahogany, it has now been used again on a



Smaller components ready for assembly.

was not a major task to make a new one. Do make sure that the Morse taper hole in the end of the spindle and the taper plug is clean before mating them for turning.

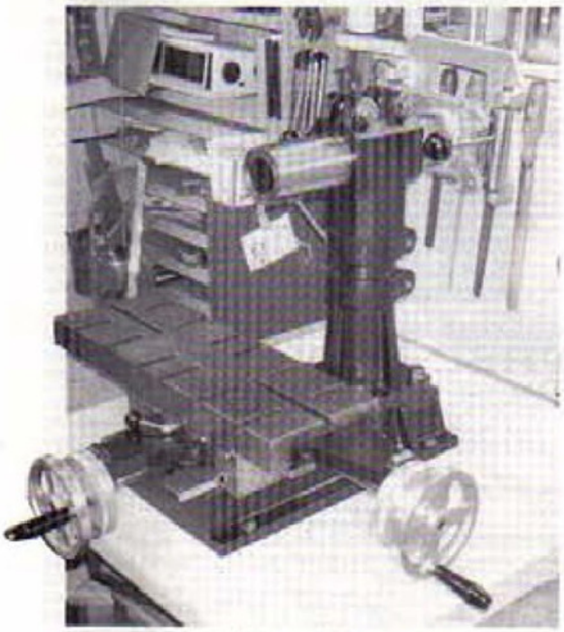
The gear box casting is the other part that had some hard spots these were on the edges next to where the locking pins are located. As the cleaning up is only on the outside gentle grinding easily solved the problem. The planetary gearbox is mounted on the top of the spindle. Its gears are provided ready cut. The two pulleys are the other items that need a 6in. chuck in their manufacture. There are a lot of dimensions to observe but are only to rule measurements. When cutting the semi-circular grooves it pays to rock the tool to the left and right as the cross slide is advanced. This keeps the tool cutting on one side only.

Assembly

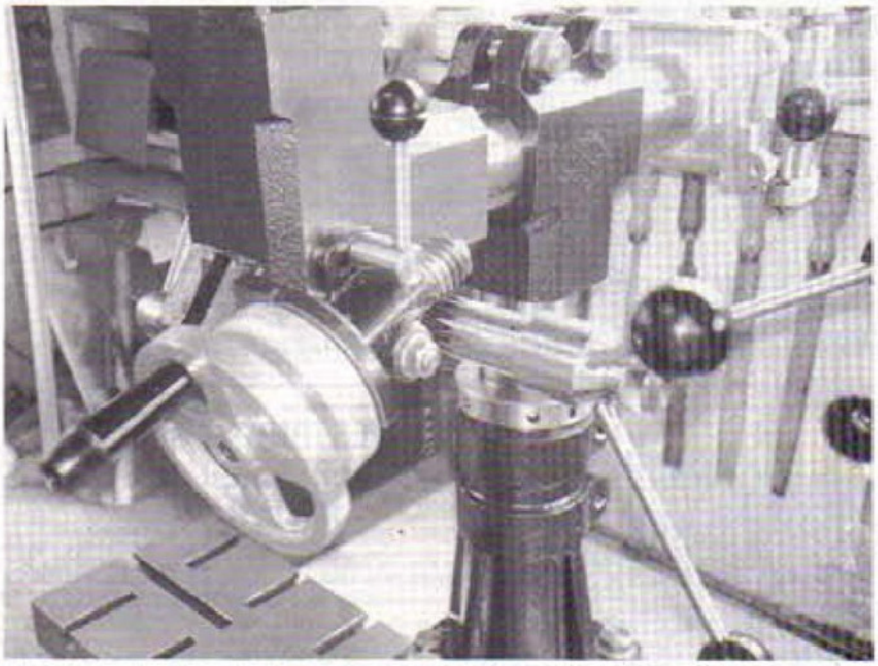
Assembly is well described and so needs no embroidering from me, except for the fitting of the column and spindle heads to their respective tubes. Before attempting to glue these parts together they must be tried for fit. Mine had slight distortions and did not slip together easily. In fact they got wedged together without any Loctite on them. The parts need to be well cleaned up, as always when using these glues. A slack fit is acceptable, in fact recommended, so that a film of adhesive can run all the way round the joint.

Useful photographs

A very useful set of photographs are



Lower section of the machine now complete and waiting the head.



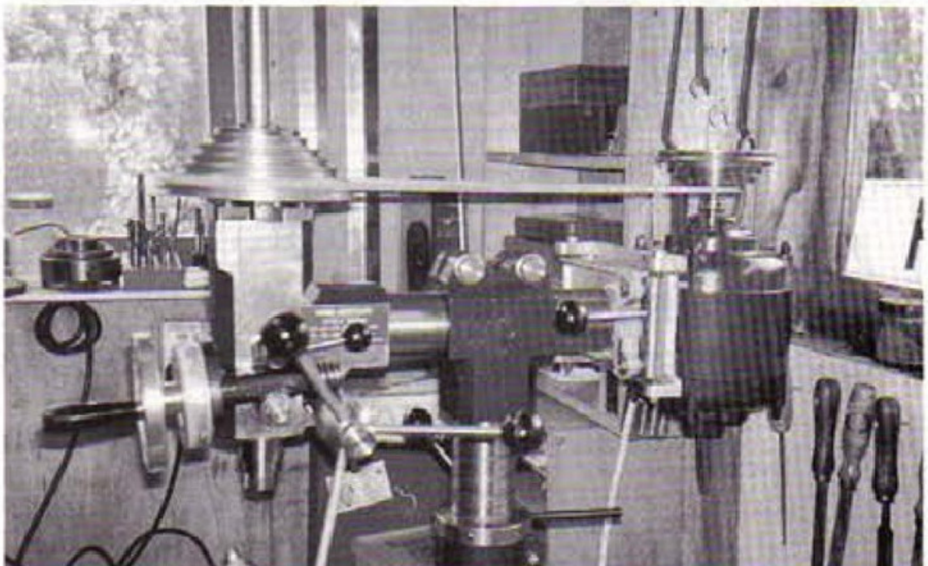
Close-up of the down feed arrangements. Note the method of engaging and disengaging the fine feed facility.

friend's milling machine kit. So it has helped make two cross tubes and two quill tubes. I wish that I had made the split in the front of the Spindle head a little longer it would have made the clamping action a bit firmer.

Minor problems

Many frustrating minutes were spent trying to wind the return spring round the pinion shaft and into the spring housing. You would swear (you probably have already been swearing if you allowed the spring to slip and skinned your hand) that there is too much spring to go into the cup. I'll let you into the secret. Wind the spring into the inside of the cup first and then pop it onto the shaft and engage the inside pin.

The author admits that the Wormshaft bracket is an awkward customer I found it doubly awkward as this was one of two pieces that I had to resort to grinding clean. Fortunately it was not in a critical position. My friend cracked his spindle nut when tightening it. Either he is a strong lad or there was a flaw in the metal. However it



The drive arrangement, this one without gearbox.

printed in the latter pages of the instructions, helping to supplement the description in the text.

I managed to make this kit in a fortnight, during my Christmas break. I must admit I did burn a lot of midnight oil, but did have Christmas Day off. Ivan Law could not believe it, so do allow a bit more time to complete yours at a leisurely pace. It must be nice to have power feed for the cross slide but that may be a luxury yet to come. Another thing worth considering fitting would be stops, so that these could be used instead of working from the edge of the job. This is specially true when working with irregular shaped pieces of metal. My machine is powered by a ½hp motor by Machine Mart, which has not yet refused to do anything I have asked it although it does need some assistance to start it when in high speed. This is achieved by spinning the gearbox or slipping the belt with the tensioner. A vice of some sort is a big advantage and is the most used method of holding work. The table however is well endowed with tee slots as an alternative holding down method. I don't know how I managed without a milling machine. I would say it was the best investment that I have made in the engineering field. *(Our thanks to Model Engineering Services for their permission to use extracts from their drawings to accompany this article. – Ed.)*

Completed and ready for use.

THE SUMMER UNIVERSITY

It may be of interest to readers to learn of two courses proposed for the Summer at Loughborough University. These are entitled Model Engineering and are from 25-31 July and 1-7 August. Both are residential. Tutors are Don Taylor and Richard Smith.

This is part of a series of courses run at the University. A 16 page colour brochure and full details as to other courses, prices etc. can be obtained from: Centre for Extension Studies, University of Technology, Loughborough, Leicestershire, LE11 3TU. Contact is Margaret Gill on 0509 222153, or 24 hour service 0509 222162.

QUICK TIP

When sharpening spring joint dividers they can be dismantled by opening fully with the adjusting nut and then pulling closed by hand. Put a wedge into the spring (e.g. use a drill drift) and release the legs. Each leg can now be removed from the pivot roller and separated from the adjusting screw. Each point can be sharpened individually and the instrument re-assembled in reverse order. **Alan Jeeves**

This third part of the series on electric motors examines the speed control of AC motors, and explores what is commercially available for this purpose. This article is by Chris Boucher F.I.E.E.

SPEED CONTROL OF AC MOTORS

Most home machinists at some time or other come across a situation where speed control of a machine tool motor is desirable. Often this can be achieved by mechanical means such as stepped pulleys, but on other occasions electrical control may be considered. Whether this is possible and the cost depends very much on the type of motor and each type will be considered in turn. Only general guidance can be given and readers are strongly urged to consult the motor manufacturer if they have the slightest doubt on any proposed course of action. It is assumed that readers will be familiar with the article entitled Electric Motors AC in *M.E.W.* issue 15.

Types of single phase motors

Series Wound Motor

This type of motor is common to such tools as pistol drills. The circuit is shown in **Fig. 1** and the type of motor can easily be

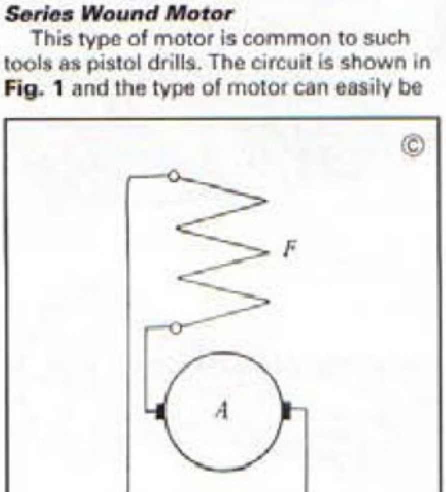


Fig 1: Connections of simple series motor.

recognized by the commutator and brushes. The speed is easy to control by reducing the applied voltage using a thyristor controller, (light dimmer). These items can readily be purchased at any electrical retailers or made up from components by anyone who can follow an electronic wiring diagram. It goes without saying that the rated wattage of the thyristor control must be at least equal to the rating of the motor concerned. Unfortunately there is a considerable drop in the torque of these motors as the applied voltage is reduced. If attempts are made to run a motor at very low speeds for prolonged periods, watch for overheating.

A cooling fan is almost invariably incorporated in the rotor of any motor and if the speed drops well below the design specification forced air cooling may be required. This warning applies to all types of motor and speed control mentioned in this article.

Repulsion Motor

This type of motor has not so far been mentioned in this series of articles and is much less common than the other types which have been discussed. The circuit diagram can be seen in **Fig. 2.** Since this motor has a commutator and brushes, it may be difficult to differentiate this from a series wound motor from the outside, but the wiring is in fact quite different, with the brushes being short circuited and not connected to the main circuit at all. It is beyond the scope of this article to explain the theory of operation, but the motor receives its name from the magnetic effect between the rotor and the stator and the position of the brushes is crucial. By moving the brushes round the commutator, speed control and even reversal can be achieved although in practice the latter is more usually accomplished by the use of a separate winding, see **Fig. 3**. Unfortunately,

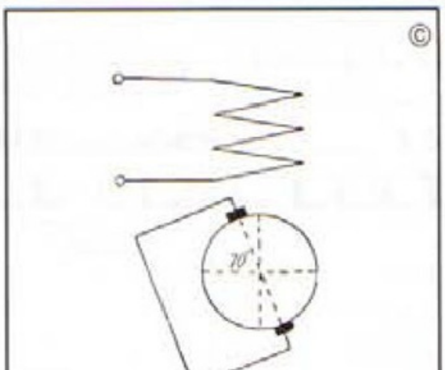


Fig 2: Connections to a repulsion motor. Note that the brushes are short circuited and set at an angle to the normal position.

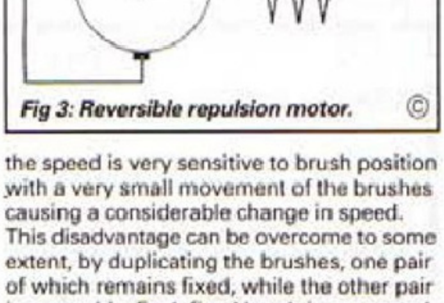


Fig 3: Reversible repulsion motor. ©

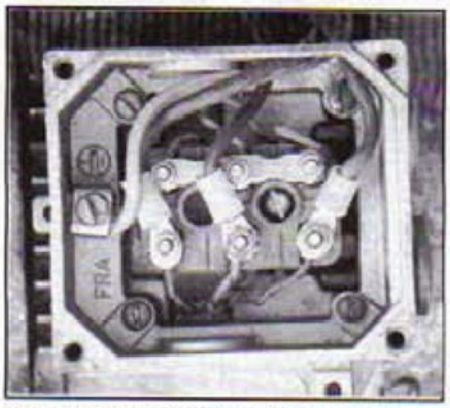
the speed is very sensitive to brush position with a very small movement of the brushes causing a considerable change in speed. This disadvantage can be overcome to some extent, by duplicating the brushes, one pair of which remains fixed, while the other pair is moveable. Each fixed brush is connected to the opposed movable brush, thereby obtaining a more accurate speed control. The torque characteristic of this type of motor is very similar to the series motor.

Induction Motor

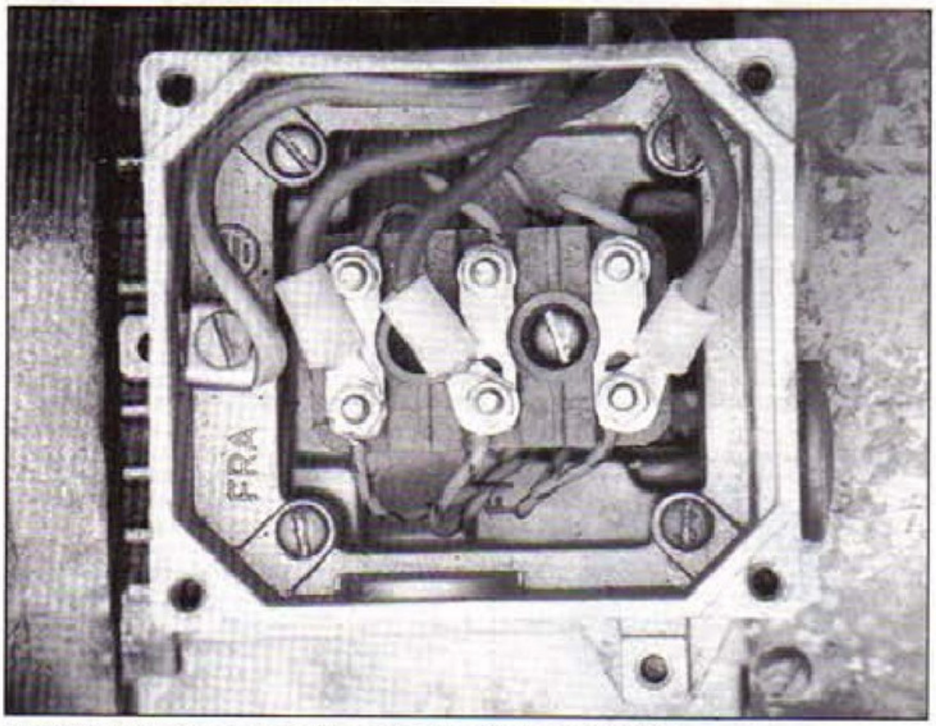
The principle of the induction motor has been fully covered in previous articles and this is certainly the most common type of motor to be found on any machine tool. The formula for the speed of the machine is:

$$N(\text{speed}) = \frac{F(\text{frequency}) \times 60}{P(\text{pairs of poles})}$$

It follows that there are two means of changing the speed of an induction motor, i.e. by varying the number of pairs of poles or the frequency. On the normal electricity supply of 50Hz, the maximum speed (ignoring slip) would be $50 \times \frac{60}{1} = 3000$ rpm. With two pairs of poles this becomes 1500 rpm and with three pairs l000rpm. Some motors are in fact designed so that the number of poles in circuit can be changed by switching giving a number of fixed speeds. The frequency can also be altered by means of an inverter which will be fully discussed later in the article under the heading of three phase induction motors. In theory an inverter can be used on single phase, but is not recommended to reduce the speed on a normal capacitor start motor, since the centrifugal switch will automatically engage at low speeds and burn out the starter winding. There is however a different type of motor with the capacitor permanently in circuit. This is known as a "capacitor run" motor and this type can safely be used with an inverter. One firm has been found which specialises in single phase inverters and suitable motors. This is Parvalux and their details are given in the bibliography at the end of this article. As we go to press we understand that a single phase inverter may shortly be on the market specifically designed to overcome the problem of the starter winding burning out if the centrifugal switch closes at low speeds. If the price is right this type of inverter may be a boon to many home machinists who require speed control but only have single phase supply/motors. A further short article will be published once this device has been tested.



The same terminal box with the straps altered to the more normal star connections for 415 volt operation.



Typical 3 phase motor terminal box connected for delta operation.

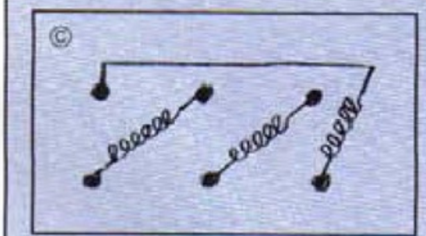


Fig 4: Motor winding connections to a three phase motor terminal box. (Jumper strips omitted.)

Three phase

By far the best method for a home machinist to obtain precise speed control on machine tool motors is by using an inverter taken from a single phase supply to run a three phase motor. Before going on to discuss these in detail it is necessary to explain the difference between a three phase converter and an inverter. The converter was fully described in *M.E.W.*, Feb/Mar 1992 issue and is a unit designed to change a single phase 240v supply to three phase 415 volts at a constant frequency of 5OHz. The third phase is only fully operative after starting and it is not possible to alter the frequency of a converter and hence the speed of the motor. An inverter, on the other hand, is a device which will provide a variable frequency 240 volt three phase output from a single phase 240 volt 50Hz input. By using a three phase motor in delta connection instead of star, it is possible to run industrial machine tool motors from the normal domestic supply. The differences between star and delta connection have been fully explained in the previous article, but a further explanation of the connections of the six terminals is not out of place. In a great number of cases jumper straps are provided to make the connections for you. The two photographs of a terminal box plus the wiring diagram in **Fig. 4** make this clear. In both cases the leads with the yellow crimped terminals are the 3 phase supply.

Principles of an inverter

A schematic diagram of an inverter is shown in **Figure 5**. The incoming 240 volt supply is connected to the rectifier (1) where it is rectified to a low ripple DC

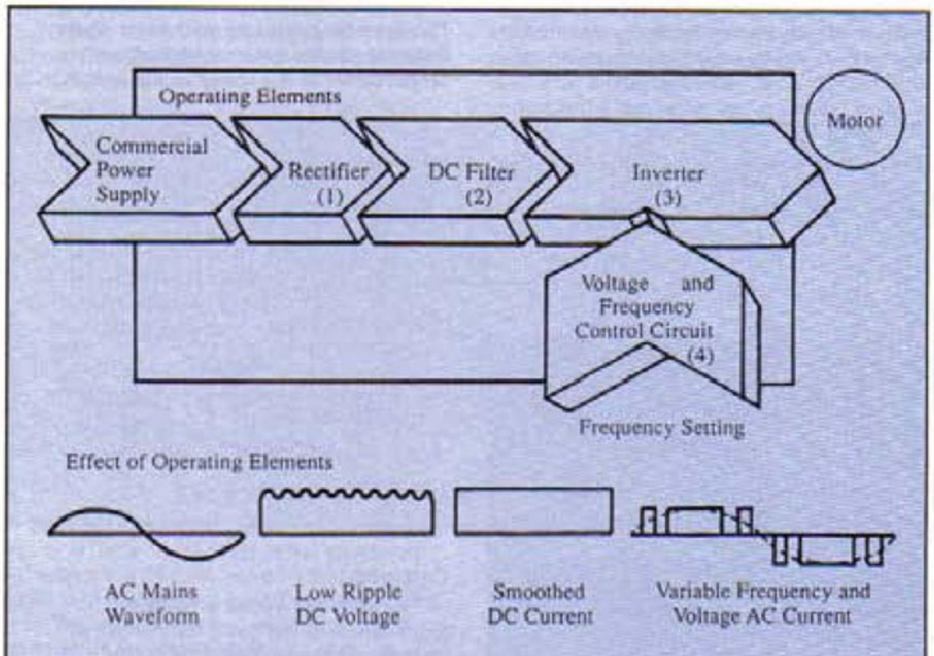
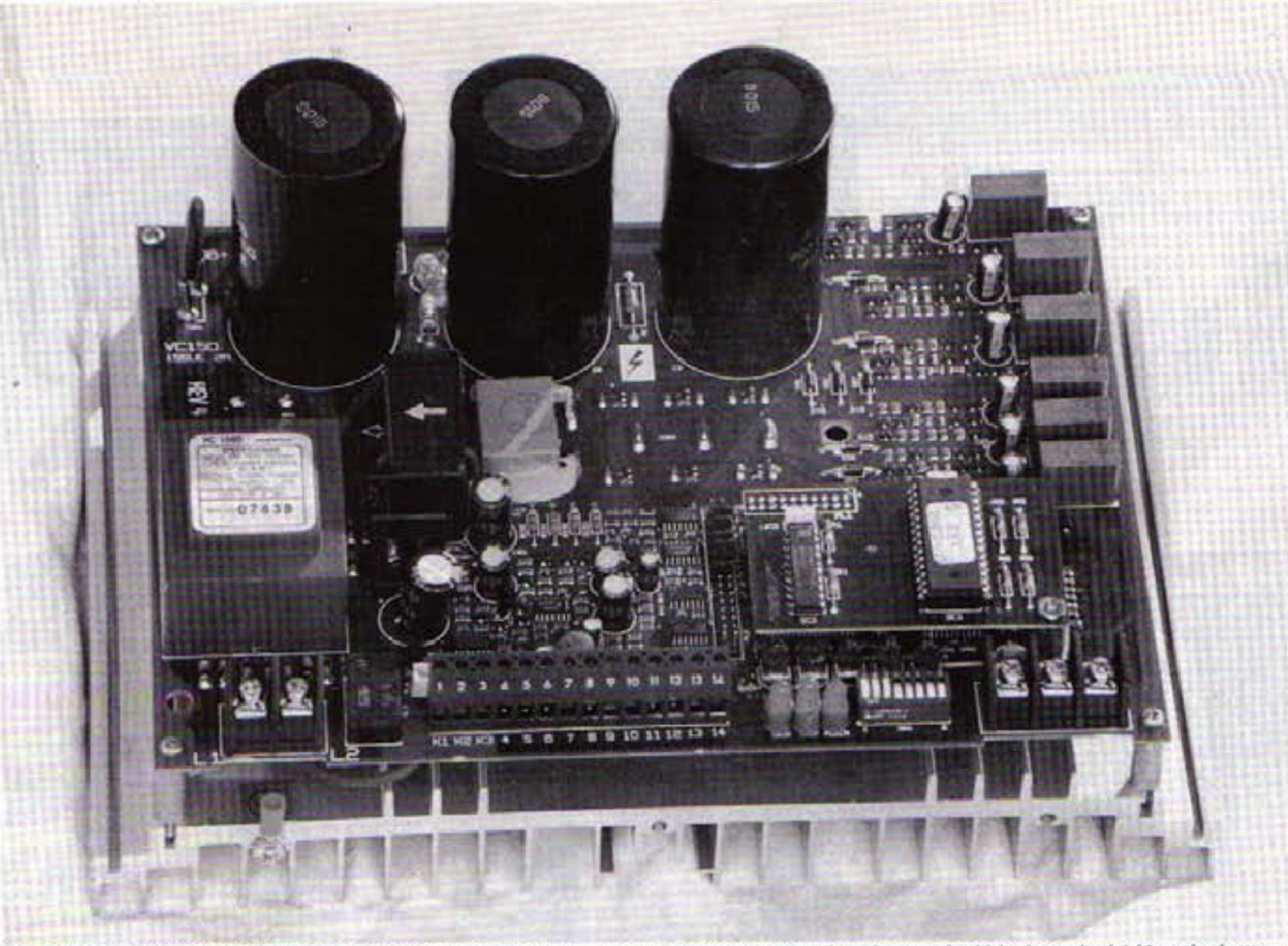


Fig 5: Inverter (schematic).



The PCB of a typical inverter. In this case the control circuits are separate and connected to the terminal block marked 1-14 at the bottom of the photograph.

voltage. This is smoothed in the DC filter circuit (2) before being fed to the inverter (3) where it is inverted to a variable frequency and voltage in response to the inverter's operating controls. These processes are regulated by the control circuit (4). As the frequency is changed the ratio of applied motor voltage to frequency must be kept constant in order to keep the torque the same over the operating range. The frequency is controlled by supplying positive pulses in one half of the cycle and negative pulses in the next. The output voltage wave form of a sine wave pulse width modulation inverter is represented in **Figure 6.** It can be seen that the pulse widths (both positive and negative) are

This inverter potentiometer has a digital frequency calibration which is directly proportional to the speed of the motor.

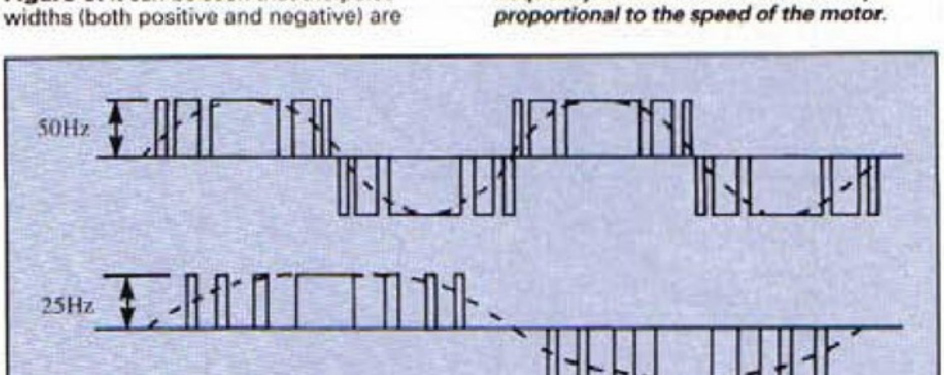


Fig 6: Output voltage waveform of sine-wave PWM Inverter.

symmetrically balanced, with the shorter pulses ranged in equal proportions either side of a central longer pulse width, thus producing a simulated sine wave form current flow through the inductance of the AC motor.

Options

The above is a very simplified explanation of the basic function of an inverter. There are however many refinements which are incorporated into some models. Some examples are:

Variable speed control by means of a calibrated potentiometer to give a direct readout of speed. (see photograph)

Emergency stop. By using electronic braking a very fast stop can be achieved. The deceleration time is fully adjustable.

Inching. This facility allows the workpiece to be "nudged" round. (but watch that the motor does not overheat)

Torque Boost. This allows the motor torque to be increased by up to 50% at low motor speeds.

Acceleration. The rate of acceleration is adjustable giving a soft start facility.

Reverse. This can be achieved by a simple switch with adjustable deceleration and acceleration providing a "soft" changeover.

Full protection. The circuit will trip on current limit, over voltage, under voltage, peak current, etc.

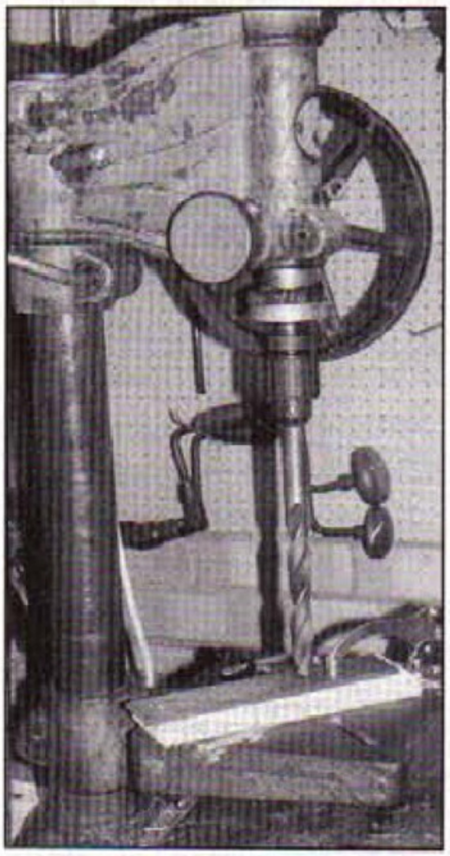
The majority of the above controls are achieved by adjusting a preset potentiometer on the PCB.

Points to watch

Mention has already been made of the requirement to provide forced air cooling if continuous low speed running is contemplated. If the frequency is increased above 50Hz the speed will exceed the rated rpm on the motor nameplate. A small increase of say 10% is acceptable, but motor manufacturers should be consulted if long periods of running at very high speeds are contemplated, since the bearings may not have been designed to take the load.

The mains supply to the inverter must be protected by either fuses or an MCB. If a no volt release direct on line starter is used (recommended for machine tools) then it should be in the supply circuit to the inverter.

A permanent connection should be maintained between the three phase output terminals of the controller and the input terminals of the motor at all times. This restriction could cause problems to the home machinist who may have several motors with a need to leave them permanently wired up, but only one is required to run at a time. There is a way round this by using isolators between the inverter and the motors incorporating an early-break contact coupled into the trip input. This ensures that the inverter output is inhibited before the motor lines open. The inverter manufacturer should be consulted before wiring isolators in this manner. Because some large capacitors are used in the circuit which may maintain their charge after the unit has been switched off, it is recommended that the unit is left for 5 minutes after disconnecting the supply before working on the equipment. All units will be supplied complete with covers and mounted on a heatsink which will require an adequate air flow. Some units will be delivered complete with control equipment. This can vary from simple analogue controls, to sophisticated digital displays giving a direct reading of the frequency. In other cases the user is left to provide switches, potentiometers, etc, for the control circuit. This is very simple to wire up and full instructions are given. This is of course low voltage so there are no risks of electric shock, but RF interference may be generated and screened cable is recommended for wiring the control circuit. In extreme cases an RFI filter may have to be fitted. Most manufacturers recommend derating the motor by 5% or 10% since, as the inverter output is not exactly sinusoidal, the available motor output torque will be less than the rated value. In practice the author could detect no loss of torque when using an inverter on a pedestal drill fitted with ⅓rd HP motor running at very low speeds drilling a ¾in. hole.



An inverter under test, drilling a ¾in. dia. hole at very low speed. (Note. Drill guard removed for photographic purposes).

Prices

As would be expected the price of these units vary enormously depending on the power output required and to some extent on the additional facilities provided. The cheapest unit found was from Parvalux at £138-06 for the non reversing model, but this would only run a ½ HP motor. For anyone contemplating a 3 phase supply for the first time this price compares very favourably with a converter, with the added advantage of speed control. The range offered by Allspeeds is also well worth considering. Prices start at £149, but the 1.5Kw model which should satisfy most home machinists needs is priced at £239.

Acknowledgements

The author would like to thank Allspeeds & Mitsubishi Electric UK Ltd for permission to reproduce their publicity literature and ND Electrical for the loan of equipment for testing.

Bibliography

The following firms have been identified has manufacturers/suppliers of inverters although the list is by no means exhaustive:-

Mitsubishi Electric U.K. Ltd, Travellers Lane, Hatfield, Herts. AL10 8BX. Tel. 0707 276100

MTE Ltd, Leigh-on-Sea Essex SS9 5LS Tel 0702 421124

I.M.O. Ltd, 1000 North Circular Rd, London NW2 7JP Tel 081-452-6444

Brook Crompton Controls, Monkton Rd, Wakefield, West Yorkshire WF2 7AL Tel 0924 368251

Ashe Controls Ltd, St Johns Works, Bluestem Rd, Ransomes Industrial Park, Ipswich 1P3 9RR. Tel 0473 710912

A & M Drive Systems, Camberley, Surrey GU16 5TU Tel 0276 26651

Graseby Controls Ltd, Oulton Works, School Rd, Lowestoft, Suffolk NR33 9NA Tel 0502 582411

Weaverbrook Ltd, 21, High Street, Builth Wells, Powys, LD2 3DL Tel 0982 553300

Parvalux Ltd, Wallisdown, Bournemouth, Dorset, BHII 8PU Tel 0202 512575

Allspeeds Ltd PO Box 43 Royal Works, Accrington, Lancs BB5 5LP Tel 0254 235441

Simplatroll Ltd, Caxton Rd, Bedford, MK4I OHT Tel 0234 350044

N.D. Electrical, 29-35 Holly Rd, Twickenham, Middlesex TWI 4EA. Tel 081-892-2722

Toshiba International (Europe) Ltd, 1, Roundwood Avenue, Stockley Park, Uxbridge, Middlesex UBII IAR. Tel 081-848-4466

Postscript by the Editor

In view of my silly mistake, relating to star and delta connection in the article on AC motors in *M.E.W.* issue 15 (Feb/Mar 1993) and the importance of getting it right, I feel that perhaps a few additional comments are worthwhile.

As with many things in a changing world it is not possible to be absolute in the following statements, so any reader doubtful in a particular circumstance should make contact with the motor and/or inverter supplier. Of course the theory stated in the article was correct and will always apply, that is, that a delta connected motor will always require a lower voltage than when star connected, by a factor of 0.577.

1). Modern motors, say less than 20 years old, and about 3KW and less in size, will be dual voltage 415v star connected and 240V delta connected. To achieve this, the motor terminal block will have six terminals with links to permit the change from star to delta to be made. The nameplate, or terminal diagram inside the terminal cover, is likely to make this clear.

2). In practice it is likely that the motor nameplate will quote the motor as being able to work on a range of voltages, typically 380/420V star and 220/240 delta.

3). These voltages are for use on 50 Hz supplies. The nameplate may quote additionally, slightly higher values for use on 60 Hz

4). Older motors are less standard, if only three terminals are fitted the motor will be suitable for name plate voltage only. If six terminals are provided it maybe as above, but may be delta wound for 4l5v, in which case it would require 719v if star connected. If the nameplate does not make it clear seek expert advice, if the nameplate has a type and/or a serial number try the motor manufacturer.

5). Whilst it is very unlikely to apply to the size of motor in common use in home workshops, motors larger than 3Kw will be delta connected. This is how I came to make the mistake having only been involved with much larger motors for many years. I should have checked my statement with my theory! The reason for the delta connections is so that they can benefit from being used with a star/delta starter, briefly mentioned in issue 15 page 20. They would of course require 719v if star connected.

If you did not read the letter in issue 16 *Scribe a line* from Jim Cox, and are unaware of the error, please note the following.

Final paragraph page 20 centre column should read "One bonus of the requirement for six terminals is that a 4l5v star connected motor can be run on a 240v supply if delta connected———a special low voltage motor or, a star connected 415v motor connected in delta. Also end of third paragraph final column——as being for 380/420v star connected and 220/240v delta so as———Please amend your copy for yours and other readers benefit in the future.

QUICK TIP

When spinning in the lathe a good tool can be made by mounting a ball race on to a piece of square section mild steel. Then, by pressing this on to the metal to be spun, following and pressing the workpiece on to the shaped former in the chuck, the required form can be achieved. I hope this will be of help as I use this method quite often.

N. Smith