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THE PRACTICAL HOBBY MAGAZINE

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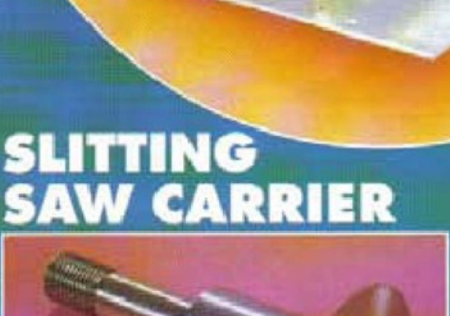

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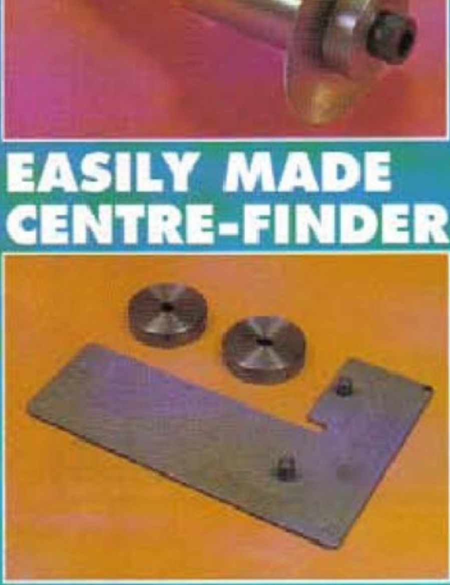

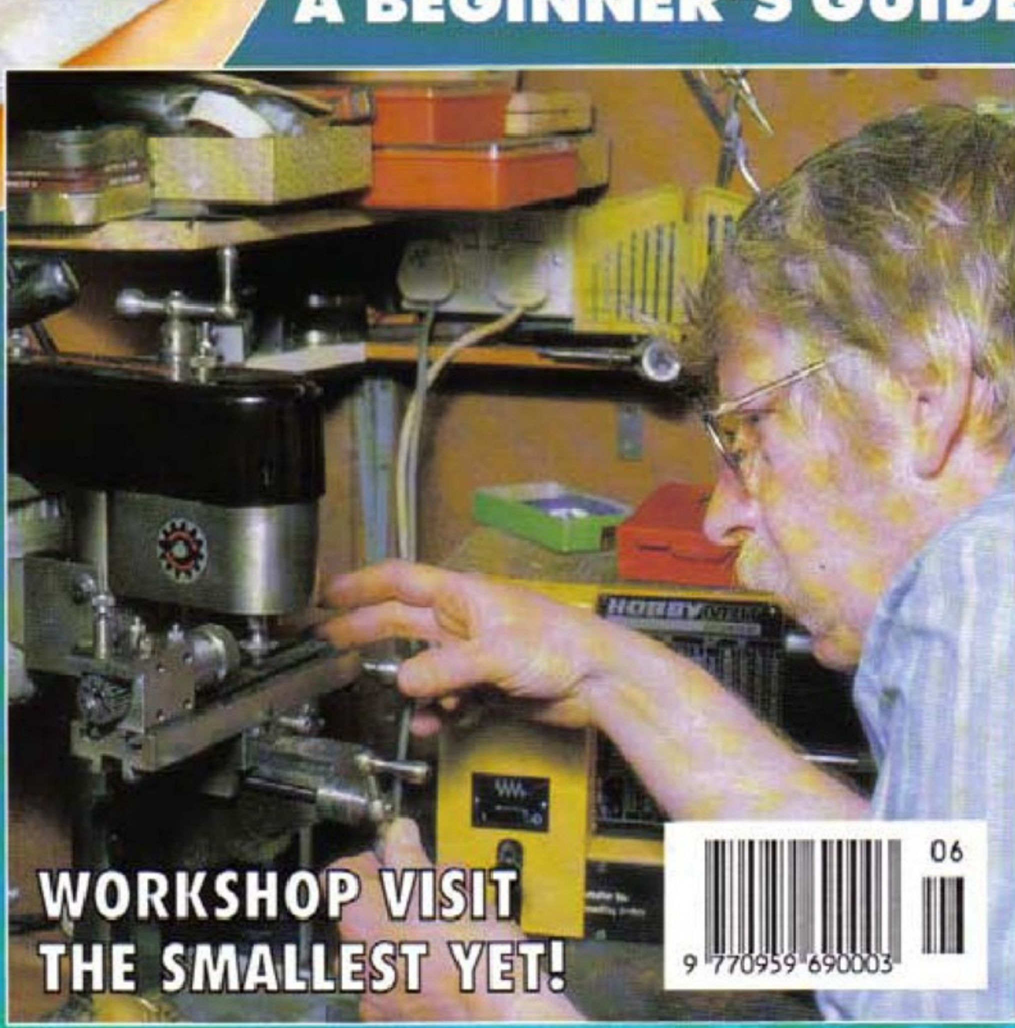

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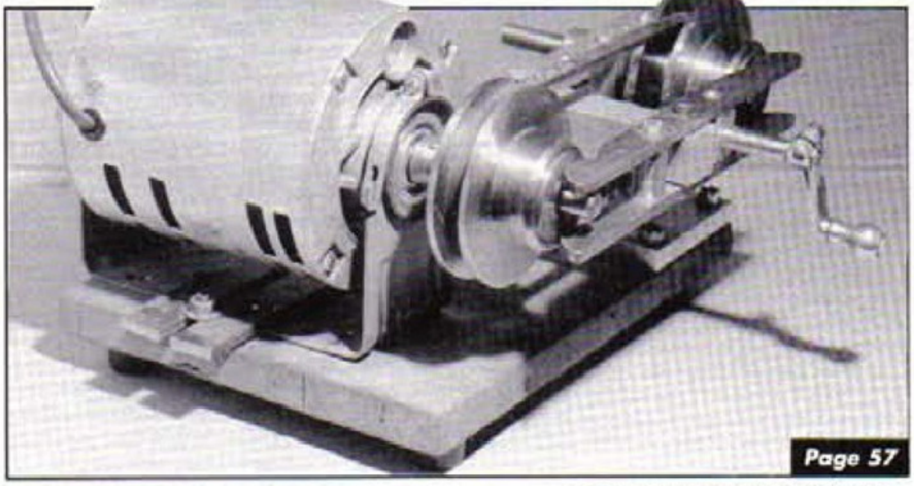

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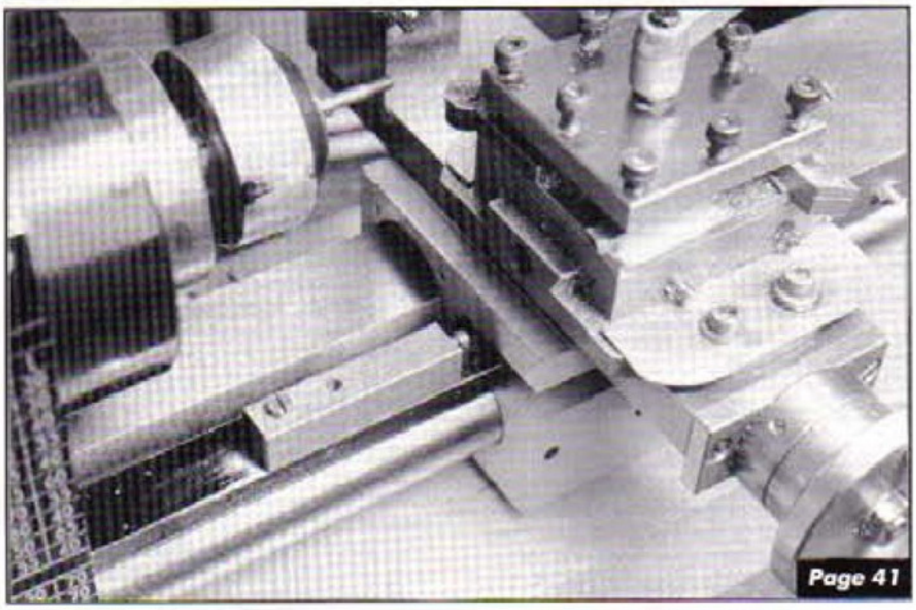

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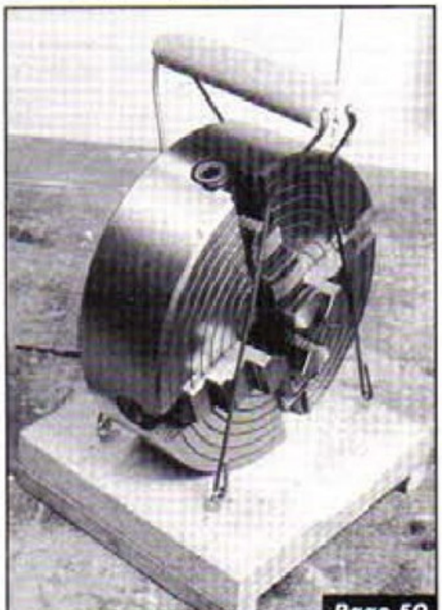

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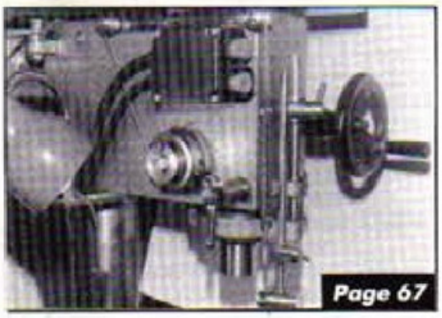

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Modeller on the cover is Chris Ford

Harold Hall

ON THE EDITOR'S BENCH

I have, since taking on the position as editor of *Model Engineers' Workshop*, soon realised how much the computer has started to find its way into homes, and in particular those of readers of this magazine. Whilst most correspondence is still handwritten it is probably no more than 60%.

Most computers as they come will probably only have a word processor installed and some computer games. It is found though that quite a number of readers who send in articles do so with drawings created on some form of computer drawing package. A few of these are just adequate for direct inclusion in *MEW*, typically those on pages 26 and 71 in the April/May 92 issue. Others done with simpler packages require to be re-drawn, as do most manually drawn drawings received.

The drawings packages being used obviously vary between readers; some are probably done using the simple facilities available with some desk top publishing packages. Quite a number of drawings seen in *MEW* are done using the *Autosketch* drawing package, supplied by Autodesk and the publishers of the very widely used *Autocad*. Examples of these are the drawings for the digital readout (Dec/Jan, Feb/Mar) and the lathe back stop in our Apr/May issue.

I visited the recent Cad/Cam exhibition at the National Exhibition Centre Birmingham and enquired about drawing packages available at the lower end of the industrial price range. Prices were not that easy to compare as there were some very special offers for the exhibition only. Typically, the *Autosketch* drawing package can be purchased from many suppliers of software at around £80.00 inc. VAT. This is considerably less than list price.

Autosketch can produce industrial standard drawings. Print-outs using a dot matrix printer are adequate for most applications, though those published in *MEW* are produced on a postscript laser printer. My reason for introducing this subject is to request some help from readers who have CAD packages. I would like to ask readers to produce a simple drawing using your system, then to send this to me with the name of the drawing package and its publisher. Include with this its present-day cost or original cost and the approximate date when purchased. Please indicate the method of printing, also if possible a brief list of the package's facilities, or a copy of the publisher's sales leaflet.

I am sorry that I was unable to publicise this exhibition in *Model Engineers' Workshop*, but it was held a few days prior to the publishing of the Apr/May issue. Also I did not have the date for it in time to publish it in the previous issue! Because of the long lead time for publishing *MEW*, it has been decided only to publicise national exhibitions; I do hope model engineering clubs and the like will understand this.

Metrication

Being largely responsible for making the decision to change to metric dimensions at the firm I was working, I have some considerable sympathy for those readers who feel very strongly that this magazine should make the same change.

I made the change around 1970, soon after it was the stated policy in Britain to do so, and personally never regretted the move. Even so, a few areas that were changed had to revert back to imperial, due to the very difficult position with regard to obtaining metric size materials, typically copper bar.

Having now found myself in this position as editor and, as a result, spending much more time in my own imperially calibrated workshop, I find working in inches a 'pain in the neck', to say the least.

I am, though, convinced that to attempt to work in metric dimensions using my imperial machines and measuring equipment would be even more frightening – this particularly as the range of materials available to the home machinist is largely imperial sized. The problem would be particularly difficult when using rectangular bar. There are bound to be many readers who find themselves in this position.

I will, however, be making an attempt to achieve a gradual change towards metric units in *MEW*, but this will take a few years. In view of this policy some articles will be published shortly on converting a workshop to metric working. I do feel strongly that anyone purchasing a major item of machinery should think very hard before buying an imperial machine, and thereby prolonging the change.

Whilst on the subject of the magazine's content, I would like also to comment on a request that was included by a few (perhaps 5 to 10) readers in the recent reader survey. This was for articles publishing the design and manufacture of complete engineering models. You will find from time to time articles which, to a greater or lesser degree, will be closely linked to model engineering. However, it is not the intended policy of this magazine to become involved in complete model designs – these are to be found in abundance in *Model Engineer* magazine.

As there is not time to write to each person returning questionnaires individually, I do hope this will clarify the position for these, and maybe other readers.

Material wants

You will have seen in a previous issue requests for help in locating materials and services. This has hovered between the trade pages and 'Scribe a Line'. It has been decided that this will become a regular feature of the trade pages and will be, at least for the time being, in the format to be seen in this issue.

If you have any problems in locating an item do write in and it will be included as soon as is convenient. You may also know of a supplier for an item enquired about by another reader; if so please do send in the information (do not just assume someone else will come up with the same details, they may not).

It is gratifying to find that actual suppliers are becoming aware of these requests and are contacting me direct.

Electrical safety

I am fast learning that publishing items on electrical matters is fraught with problems relating to safety! A comment by a reader regarding the variable speed drives detailed in the Winter 1990/91 issue led me to realise how easy it is for misunderstandings to arise. The reader appeared to assume that, whilst the unit was fed from the mains, as the power passed through electronic devices being converted to DC and maybe low voltage, the danger from the output was limited.

Can I make it clear that as there is no double wound (that is one with totally separate primary and secondary windings) transformer to isolate the electronics, the motor is still at 240v with respect to earth and therefore lethal. The presence of electronics does not automatically make it safe. This should always be considered to be the case with electronics connected to mains potentials if not fitted with isolating transformers.

A Mr Jerrard has also pointed out a similar danger with regard to the Variacs referred to in the 'Quick Tip' on page 49 of the Feb/March issue. These transformers are not double wound and therefore do not isolate the output from the input. So even if the output was adjusted to, say, 10 volts between output terminals, both terminals could still be at both 240 volts with respect to earth and also lethal.

The history of machines

You may remember that the interest shown by readers in the history of machines tools led me to request information on museums displaying machine tools of interest. I would like to thank readers for the information sent in which has been most helpful. In an attempt to make the information as beneficial to readers during the summer period I have decided to publish some details in this issue.

This has proved to be a bigger task than I had time for at this stage and should preferably have been held over till next spring! But, having made the decision, I have kept with it. I do hope the result will be helpful even if not as thoroughly investigated as I would like.

I would like to request that, as readers visit such places during the summer period, they pick up a leaflet regarding the museum and send it to me in the post with any notes which may be of help. These will be held on file and made use of at a later date.

This month's request for articles

The approach of asking for articles on specific subjects is proving very beneficial, which is very gratifying. This month we have two, perhaps rather more difficult than the average request, but here goes!

1. Making a small electric furnace
2. Making small metal nameplates by other methods than engraving.

Please send in your offer of help before going ahead with producing an article.

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

Holding thin work piece

More ideas for holding thin pieces in the lathe, this time from Mr A T Cambridge, Meopham Kent.

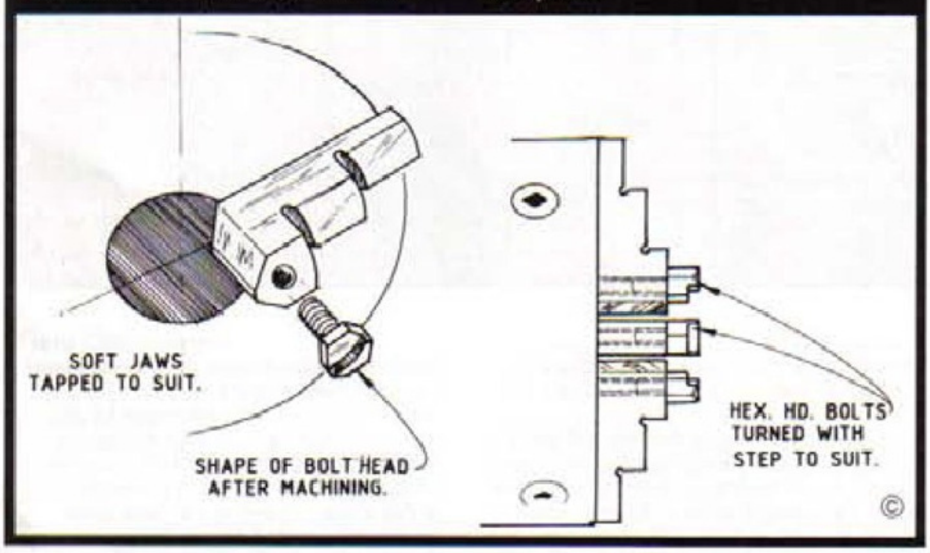
Much has been written and produced, and very nicely made by the photographs, regarding the holding of thin metal parts in the lathe. Well may I pass on this idea, which is simple quick and effective, to other readers.

Fit soft jaws to the chuck which have been drilled and tapped any suitable size on the face. Screw into the tapped holes hexagon headed bolts. Fit suitable size stock bar into jaws and tighten. Turn bolt heads to diameter required. Remove stock bar and the heads will then achieve an excellent hold on the work to be machined.

The bolts can then be discarded, or indeed machined again for the next job in hand.

As can be seen from the sketch it is suitable for inside or outside work holding.

A.T. Cambridge
Meopham



10in Regal lathe

by R K LeBlond Machine Tool Co., Cincinnati, Ohio

Mr M A Sawyer requests help in arranging to cut metric threads using his Regal Lathe.

Is there anyone who could guide me to the conversion to metric screw cutting, the lathe being American has sliding gears! meaning the train between spindle and lead screw gives ratios of 2-¼ to an ⅛ inch pitch lead screw.

When I queried the importers, Wickman, Coventry, and the makers in Ohio, some years ago they were not able to provide the know how, but they did send a rather thin handbook.

This says "Special quadrant and gears can be provided to cut metric or special threads". But it also says "attachments cannot be provided for machines in the field" Anyway that was in 1948.

More yet – by 1948 the 10 inch lathe (that is 5 inch centre height in English) had ceased to be made and only larger were available. There must surely have been others in the UK somewhere and these bigger lathes probably have similar gearing. So who's got one or can remember one.

There is room to add a 127x120T to give me 6 and 4mm threads. Changing the stud gear from 48 to 40 would further provide 5 and 3½mm and the Norton gear box will halve each of these 6 times = range covered. But if that is the way to do it, how does one fit in the gear of double thickness (127x100) (still retaining the slip gears), unless a new stud gear shaft (longer) is provided as well. This seems a bit over the top so surely I'm wrong and dim?

Holtzapffel, lathe prices

Mr T.D. Walshaw of Kendal has some comments to make regarding the cost of early Holtzapffel lathes.

I have just seen the article about a computer simulation of the operation of the Geometric Chuck on p.68 of the September 1991 issue. In his "conclusions" (p.75) the Author suggests that a fully equipped Holtzapffel lathe might have cost £3000 during the 1880's. This, I fear, is a fanciful rumour, and is probably the cause of the inflationary prices expected nowadays by uninformed collectors of old machinery.

Looking through the Holtzapffel ledgers from 1796 to 1924, the highest ever charged for a Screw-Mandrel machine with all accessories was £670. "Common" lathes (those without a traversing mandrel) had a basic price of about £7 in 1797, rising to £18 in 1870; this included plain chucks and handrest etc. In 1913 this machine cost £21. A complete outfit, (including ornamental chucks, cutting frames, spiral apparatus, goniostats and no less than 324 cutting tools and drills) on mahogany stand with chest of drawers, cost £385 at this date. The "average" well equipped ornamental turning lathe could be had for about £130 in 1805 rising to no more than £250 by 1905, and first-class work could be done on a machine costing half these figures.

Then, as now, the well-breeched practitioner could add special purpose equipment almost without limit – Holtzapffel would make anything the customer asked for provided the money was there – but even here popular ideas of prices are usually excessive. In 1913 the Epicycloidal Cutting Frame, with 15 change-wheels and a set of cutters cost only £38, in fitted mahogany case; whilst the Ibbetson 2-part Geometric Chuck (your fig. 5) was priced at £155, including all gears, phasing adjustment accessory and the usual fitted mahogany cabinet.

For comparison, a traversing mandrel Britannia O.T. lathe, with the usual ornamental chucks, cutting frames etc, cost £65-£75 in 1894.

T.D. Walshaw
Kendal

Workshop safety – high profile

Mr G. W. Reeve lecturer in mechanical production engineering at Grantham College makes the following comments on workshop safety (I have requested further clarification from Mr Reeve - Ed).

I had made a rough draft of a letter to you commenting upon the lack of safety awareness in your otherwise excellent publication, when my wife read out to me the results and comments from your survey that made my letter redundant.

I still feel however that I should write and point out your oversight. You show through the medium of photographs unsafe working practices that at first glance seem harmless enough. For example, if you look at the front covers of your nine issues of M.E.W. to date you will find that apart from Stan Bray (issue I) and a Welder (issue 3) the other modellers operating their machines have only reading spectacles on which do not conform to BS2092 and do not have side panels.

Modellers having an engineering background are aware of safety through *imposed legislation and experience of lost fingers, eyes and life much of which could have been avoided. New modellers from other backgrounds will be at risk unless safety is given a high profile through magazines like M.E.W. and like publications which in my humble opinion have that responsibility through promoting model engineering*

May I suggest that in future no photograph be printed unless its subject matter falls in line with the recommendations of the Health & Safety Executive. I know that most modellers workshops do not come within the scope of the Health & Safety at Work Act 1974 but I suggest it is a good practice to adhere to its principles. If not for the modeller him or herself then for their loved one's peace of mind.

Perhaps you could run a series of short articles aimed at the novice on safety which act as a reminder to the experienced. Could craftsmen and women be encouraged to write articles explaining safe approaches to operations and highlighting the dangers of short cut that could hurt?

G.W. Reeve
Grantham

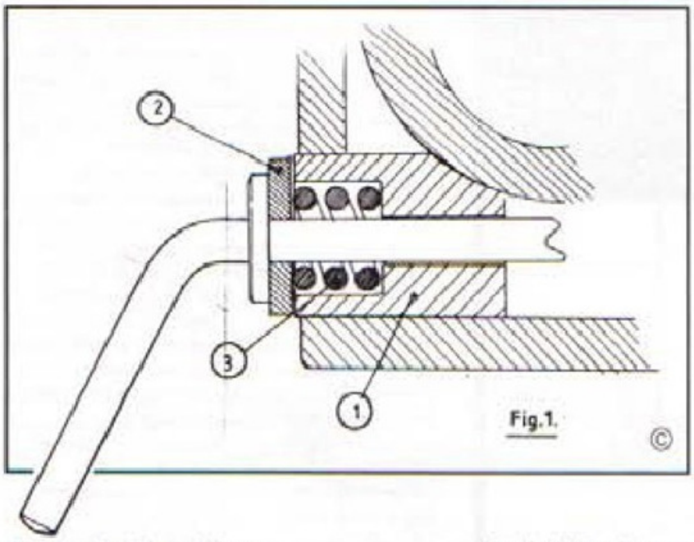


Fig.1. ©

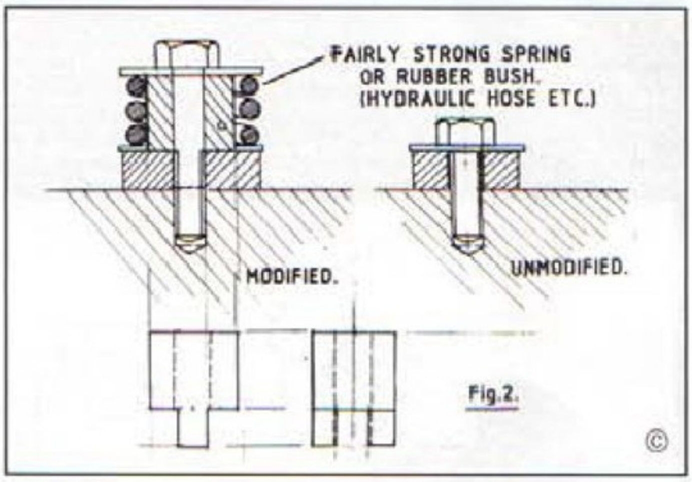


Fig.2. ©

Down feed problems

An Australian explains how he cured his down feed problems.

In reply to Clarkies letter Dec/Jan '92 about snatchy milling of his Taiwanese mill/drill. This is the way that I have tried to solve it. Engineering wise it may not be the right answer, but she'll do me.

As you can see in **Fig.1** *I've turned a chamber to house a strong short spring in the down feed clamp '1', using a washer '2' to compress the spring '3'. When the washer is almost in contact with part '1' one can still adjust the rack sleeve with the machine running.*

I've successfully used end mills up to 20mm diameter like this. Come to think of it I have not checked it with a face or fly cutter, but you blokes can try that yourselves. If it doesn't work on the bigger diameters then you have lost nothing, tighten the bolt further and she'll become fixed again.

I've also changed the spindle belt tightening a bit. Instead of undoing and tightening the two bolts for moving the central pulley, I've put two longer ones in and made them spring loaded (I have used disc springs for the same purpose – Ed) as shown in **fig. 2**. *I then use a spanner on the nut at the lower end of the central pulley spindle to move the position of the pulley assembly.*

Gus Priem
Mr T. Pritchard
Australia.

(See also article elsewhere in this issue for a more technical approach to this problem)

On the same subject this came from Jeff Edwards, also in Australia

I've just got the Dec. '91 issue of M.E.W. *and would like to offer assistance to Mr Clarke of Ryde.*

I have a Taiwanese Mill/Drill which can create the same problem of incorrect down feed as described by Mr Clarke. I attribute this to the backlash in the Quill feed. The tool is moving the amount fed by the handwheel plus dropping to take up the free play in the system.

The easiest way to overcome this is to have the quill lock applied to some degree at all times. Do not release the lever completely when you wish to feed the cutter down to take a deeper cut. Slacken it enough to be able to move the quill but not enough for gravity to enable it to drop freely. When the required depth of cut is achieved, fully lock the lever, and take the cut.

In effect, the mating threads and gears are now always loaded together, whereas if gravity is allowed to act then the head falls until the opposite sides of the next thread meet. In most vertical mills I have seen in Machine ships, some method of counter balancing is employed to exert an upward force on the quill to eliminate this problem.

J Edwards
Henley Beach,
Australia

The above two ideas were sent to Mr Clarke (Isle of Wight, who replies with this amusing letter)

Once again very many thanks for replies to my queries. It is very interesting to note that it took two "Diggers" to come up with the right information. Both solutions work well and are so incredibly simple. I re-machined parts, filed other components, etc. but the solution was too obvious for me to see.

How nice it is to know that there are such good blokes with basic common sense on the other side of the world. I bet Mr. Keating will have a job to persuade such people to give up the Pommy, M.E.W.

I will also modify my mill/drill to make the belt changing easier as advised.

I am now behind with making all the gear that you have in the magazine. I have certainly made at least one item from each issue so far, and envy quite a few more.

One of the major problems here is the availability of raw materials, BMS, Brass, even marking blue is not available on the island (Fyne Fort, can you not help. Ed) (For the benefit of overseas readers who may not understand the relationship between the Australians and the British. Digger and Pom are our friendly terms for each other. Ed)

Mr Clarke
I.O.W.

Unknown 3 phase connection

Mr Gould of Shrewsbury found that he already has 3 phase connected to his house (I also had 3 phase connected by my last home, it had been included for an early storage heater load Ed)

After building my wife some cupboards for the kitchen, only to find the electric meter had to be moved, the electric board people arrived and did the job. When I asked what the extra wires were for that they were sealing up I was told that the main incoming cable was 440v – 3 phase (cost of being converted to a meter £235). Is this a one off case or are there other people who want 3 phase, but do not know they have it?

Mr Gould
Shrewsbury

Metric micrometer

Mr Martin of Chelmsford would like help with his metric micrometer.

I wonder if any one of your readers could help with a problem which I have with a M & W metric micrometer Mod. No. 15, 965 range 0-25mm black frame.

The problem is that the lever and screw which locks the spindle is missing. Has anyone the same micrometer and can tell me

1. How does the lock work.

2. Make me a sketch of the parts including details of the thread so that I can make some replacement parts. M & W cannot help.

Mr Martin
Chelmsford

Plate glass – availability

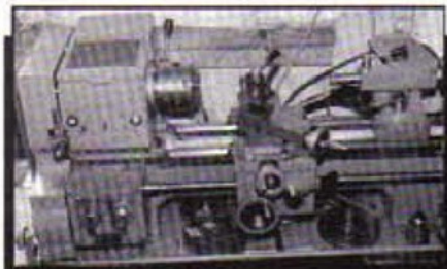
KJ Bradbury of Cheltenham has some comments to make on a quick tip regarding, using plate glass as a surface plate

With reference to the "old and well known" tip on using plate glass as an alternative to a surface plate (Quick Tip page 20 Feb/March), it certainly is showing its age. Why? – well you can't buy plate glass any more – at least not round here!

Plate glass has generally been replaced by "float glass," made by floating molten glass on to a bed of molten tin (I think). Whilst this is much cheaper, it is by no means "optically flat" as I believe the old plate glass was.

Two alternatives come to mind. Firstly to buy an old mirror from a junk shop – this would probably be plate glass. Secondly to ask your friendly merchant for a piece of "wire glass" as used in doors and other vulnerable places (the clear type, not that with a rippled finish). I believe that this is made in the same way as the old plate glass but I cannot guarantee it. Anyway if he is as friendly as my local merchant you'll get an offcut for nothing and you can test it!

K.J. Bradbury
Cheltenham



A mystery lathe

Can anyone help Mr C. Leaning of Totton Hants.

Please find photo of a lathe I own, I wondered if you or any reader might recognise it and be able to tell me the makers name.

It has a 3mm leadscrew, centre height approx 120mm. between centres 430mm approx.

I saw the first issue of M.E.W. *on the bookshelf and have taken it since, I think it is a great magazine and look forward to the delivery of each new copy.*

C. Leaning
Totton

Field Clinometers

Mr Derek Cooke from Katoomba Australia provides the following details on the use of Field Clinometers

Apparently my newsagent had a customer for your magazine, and the firm which deals with overseas publications sent him an extra copy of the Dec 91/Jan 92 edition. I bought this, read it, and placed an order. So the Feb/Mar 92 issue has now arrived, with Mr Thomson's letter on p.8 and the photograph of a venerable field clinometer on p.61. That "Sine-Bar" business can be ascribed to creative advertising. A sine bar is as straight as its maker can make it, and as Mr. Thomson pointed out, the field clinometer relies on the curvature of the swinging arm to provide the division of the degrees into minutes.

Possibly a hundred ex-Gunners have written to clear up misunderstandings, but in case they haven't, here goes. When a gun is aimed at a target which cannot be seen from the gun position, it has obviously got to be pointed in the right direction, and this is achieved by using a gadget called a Dial Sight, which is a cross between a periscope and the azimuth circle of a theodolite and which is aimed at a suitable mark which can be seen. To get the correct range, i.e. distance to the target, an artificial horizon is used – a bubble in a vial in a Sight Clinometer. If the target is at a different height from the gun position an angle is set on the sight clinometer to compensate, and a further angle added (algebraically) to that one by swinging the whole body of the sight clinometer. Howitzers and gun howitzers have a means whereby the amount of propellant behind the projectile can be varied (in order to lob shells over intervening high ground), and the "charge" (i.e. amount of propellant) and range (in yards or metres) are set on a drum, dial or cone (25 pounder), and this produces the second angle mentioned. The gun is then elevated or depressed until the sight clinometer is level – and just as with lathe feeds, backlash is taken up; by making the last move one of elevation in the case of a muzzle-heavy piece, and vice versa. There is more to it than this (of course!), such as compensation for the trunnions not being in a horizontal plane, weather conditions etc. but it is enough to show where the field clinometer comes in.

On or near the breech of a gun you will find a beautifully smooth flat plane, which has two little steel pegs at its rear end, the pegs having flat faces on the forward side. This is the clinometer plane, and it is parallel to the bore. If the elevation sights are damaged, the Gun Position Officer can, after riffling through the range table provided for that particular piece, order a total angle of elevation, but the more frequent use is when calibrating the sights to compensate for wear. (The gunlayer removes the clinometer from the plane before pulling the plug!) Its usual location was in a felt-lined leather case strapped to the gun shield.

My own is a Clinometer, Field, Mk vi (To use the correct Ordnance Dept. terminology), and like Mr Thomson's was made by Watts (in 1941, the year I was commissioned into the Field branch of the Royal Regiment of Artillery), and I found it in 1980 or perhaps '81 in a "surplus" store on the opposite side of Broadway to Sydney Central Station. I bought it because I thought it might "come in useful" one fine day, and for old time's sake. I retired in '82 and in '83, feeling that a bigger, screw-cutting, lathe was needed to supplement the Cooke Scrap-metal Precision lathe, I bought a Twankey (Yankee pattern, Taiwanese make) precision bench lathe. The first use of my clinometer was to level this – a duty repeated whenever I have another pair of hands which can help with the task. It could do with a more sensitive bubble for this task.

I was intrigued by Mr Thomson's use of the clinometer as a circle divider: Comes in the "Wish I'd thought of that" category. It is a method which could prove laborious with my El Cheapo calculator, but, as he says, no cumulative error. I do not know how accurate the clinometers are supposed to be, but a 1 minute error in a pitch circle of diameter 100mm would amount to 0.0145mm (slightly over ½ thou), which would be igh enough for most amateur use.

I wonder how they curved the bars? If anyone is contemplating repeating the job on their lathe, it will require an almost 6 metre face-plate?

Derek Cooke
Katoomba, Australia

Suppliers of surplus motors

Can anyone help H.F. Watson of Seaford with his problems

The introduction of Model Engineers Workshop *went by unknown to me until I accidentally came across a copy of the Aug/Sep '91 issue in a bookshop. I promptly placed a regular order with my newsagent, then sent off for all the back issues. I was unfortunate in that only two back numbers were available from you, but the article in one of them, Winter 1990/91, on Speed reduction of machine tools gripped my interest.*

Does anyone know a source of supply for these surplus motors.

I too have a Walker Turner drill which I am using as Mill Drill and this form of speed control would be ideal for it. Also for the bandsaw which was featured in the Feb/Mar '92 issue, which I intend to build as an independent machine with its own motor and speed control system, if I can find the motors.

H.F. Watson
Seaford

Three phase motors on single phase

Mr Jerrard of Exeter makes the following points regarding three phase motors powered from single to three phase converters.

I was very interested in the article on three phase in the workshop, M.E.W. *(Feb/Mar page 46) as for years I have been looking for the proper way of running three phase motors on single phase, and as a result have collected a lot of information.*

One point that should be made clear is that as no ordinary converter (economy, i.e. non electronic. Ed) *can produce a good three phase supply (as indicated in the article). Whilst this is probably alright for most home workshop uses, it does mean that it is impossible to run a motor at its nameplate rating, at best 70%.*

This could be critical if say a three phase motor was used to power a compressor, it is even possible it would not start. This of course can be overcome by the use of a second, motor running on no load as described in the article.

1) It is not a true three phase supply.

2) Do not expect to get full rated power.

3) Beware of compressors run from this system.

Mr Jerrard
Exeter

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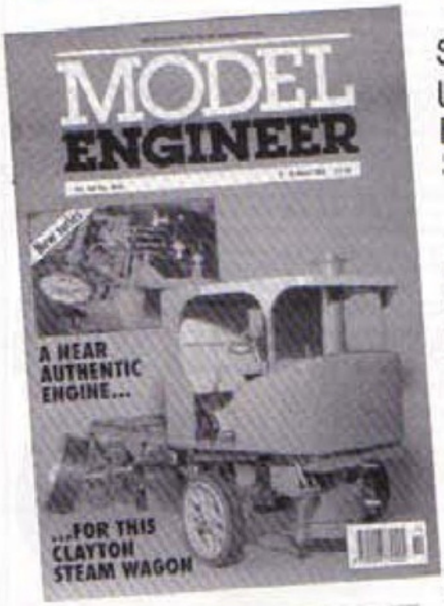

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WORKSHOP GEOMETRY

The following are just a few of the geometrical procedures, which can be used to ease the marking out of engineering components for drilling, or other operations

Following the article in the last issue regarding workshop mathematics, a brief example of some geometric principles which will be of assistance in the home workshop follows. All that is required to make use of these procedures is a good straight edge, scriber, square and a pair of dividers.

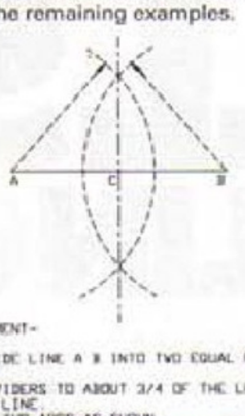
Example 1

To divide the distance between two points into equal halves does not sound much of a problem. In some cases though it may not be that easy, typically if the length is unknown and has to be measured. Some error will result in measuring with a rule.

If then the dimension happens to be a complex one that is not measurable in exact rule increments, this will make accurate measurement even more of a problem.

The resulting complex dimension when divided by two will also not result in exact rule increments and will be very difficult to transfer back to the part being worked on. The vernier attachments detailed on page 66 of the Oct/Nov 91 issue will help. Even so, why become involved in measurements when the following method is both very accurate, and requires no dimensions to be taken or calculated?

This example, using a finely sharpened pair of dividers and a good straight edge, should, with care, be able to produce a result accurate to within a few thou., as should the remaining examples.



REQUIRMENT-

TO DIVIDE LINE A B INTO TWO EQUAL PARTS.

SET DIVIDERS TO ABOUT 3/4 OF THE LENGTH OF THE LINE.
SCRIBE TWO ARCS AS SHOWN.
THE LINE TAKEN BETWEEN THE POINTS WHERE THE ARCS CROSS, WILL CROSS LINE A B AT ITS CENTRE C.

Example 2

Marking a line at right angles to the side of a part can be accomplished easily using a scriber and a precision square. If, on the other hand, the line is to be at right angles to another line in the middle of a part, it will not be possible to use a precision square to achieve this aim.

The following example will enable this to be accomplished with ease, and to a good degree of accuracy. If the arc 2 can be made on the other side of line AB, then the result should be even more accurate. *(See also 'Making a Centre Finder' elsewhere in this issue for a similar procedure. Ed)*

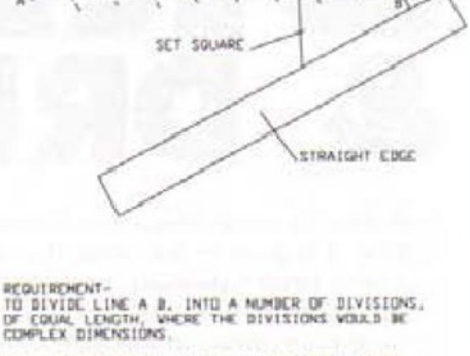
REQUIREMENT-
TO ERRECT A LINE AT RIGHT ANGLES TO LINE A B, AND FROM POINT C.

SET DIVIDERS TO A SUITABLE DIMENSION, AND SCRIBE TWO ARCS (1), FROM POINT C
SET DIVIDERS TO A LITTLE LARGER DIMENSION, AND SCRIBE TWO ARCS (2), FROM POINTS ON LINE A B, CREATED BY ARCS (1)
SET DIVIDERS TO A LONGER LENGTH, AND SCRIBE ARCS (3) FROM SAME POINT.
LINE PASSING THROUGH WHERE TWO SETS OF ARC CROSS, WILL PASS THROUGH POINT C, AND WILL BE AT RIGHT ANGLES TO LINE A B.

Example 3

To divide a line into a given number of equal parts where either the line and/or the divisions are complex dimensions, is a very difficult operation. Even where the dimensions are easy values to read off a rule, the chance of accumulated errors is still possible depending on the approach taken.

This method is capable of giving very accurate results without the requirement to calculate or use any dimension and with no accumulated errors.

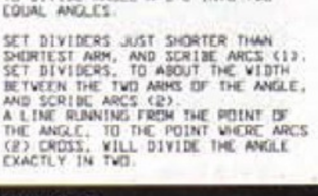


REQUIREMENT-
TO DIVIDE LINE A B, INTO A NUMBER OF DIVISIONS, OF EQUAL LENGTH, WHERE THE DIVISIONS WOULD BE COMPLEX DIMENSIONS.

DRAW AN ADDITIONAL LINE A C AT BETWEEN 40 TO 50 DEGREES FROM LINE A B.
THIS LINE TO BE OF A LENGTH THAT CAN EASILY BE DIVIDED INTO THE NUMBER OF DIVISIONS, SAY 7 INCHES, FOR 7 DIVISIONS.
ALTERNATIVELY, THE LINE CAN BE LONGER THAN REQUIRED, AND MARKED WITH NUMBER OF DIVISIONS, USING A PAIR OF DIVIDERS.
WITH A SQUARE POSITIONED TO PASS THROUGH C AND B, AND A STRAIGHT EDGE PLACED AS SHOWN ABOVE, THE SQUARE CAN BE MOVED ALONG THE STRAIGHT EDGE, AND LINE A B MARKED, TO GIVE THE REQUIRED NUMBER OF DIVISIONS.

Example 4

The final example enables an angle of known or unknown quantity to be divided into two equal angles. Again an accurate result can be achieved without any dimensions being taken.



REQUIREMENT-
TO DIVIDE ANGLE A B C INTO TWO EQUAL ANGLES.

SET DIVIDERS JUST SHORTER THAN SHORTEST ARM, AND SCRIBE ARCS (1).
SET DIVIDERS, TO ABOUT THE WIDTH BETWEEN THE TWO ARMS OF THE ANGLE, AND SCRIBE ARCS (2).
A LINE RUNNING FROM THE POINT OF THE ANGLE, TO THE POINT WHERE ARCS (2) CROSS, WILL DIVIDE THE ANGLE EXACTLY IN TWO.

Postscript

These examples in no way exhaust the possible application of geometrical procedures in the marking out of engineering components. Please write in with your suggestions for other methods that could be adopted to benefit marking out in the home workshop.

QUICK TIPS

To make your own LH dies in smaller sizes use the old watchmaker's trick of threading a piece of silver steel rod right handed, then file the thread to a leaf shaped cross section and, after

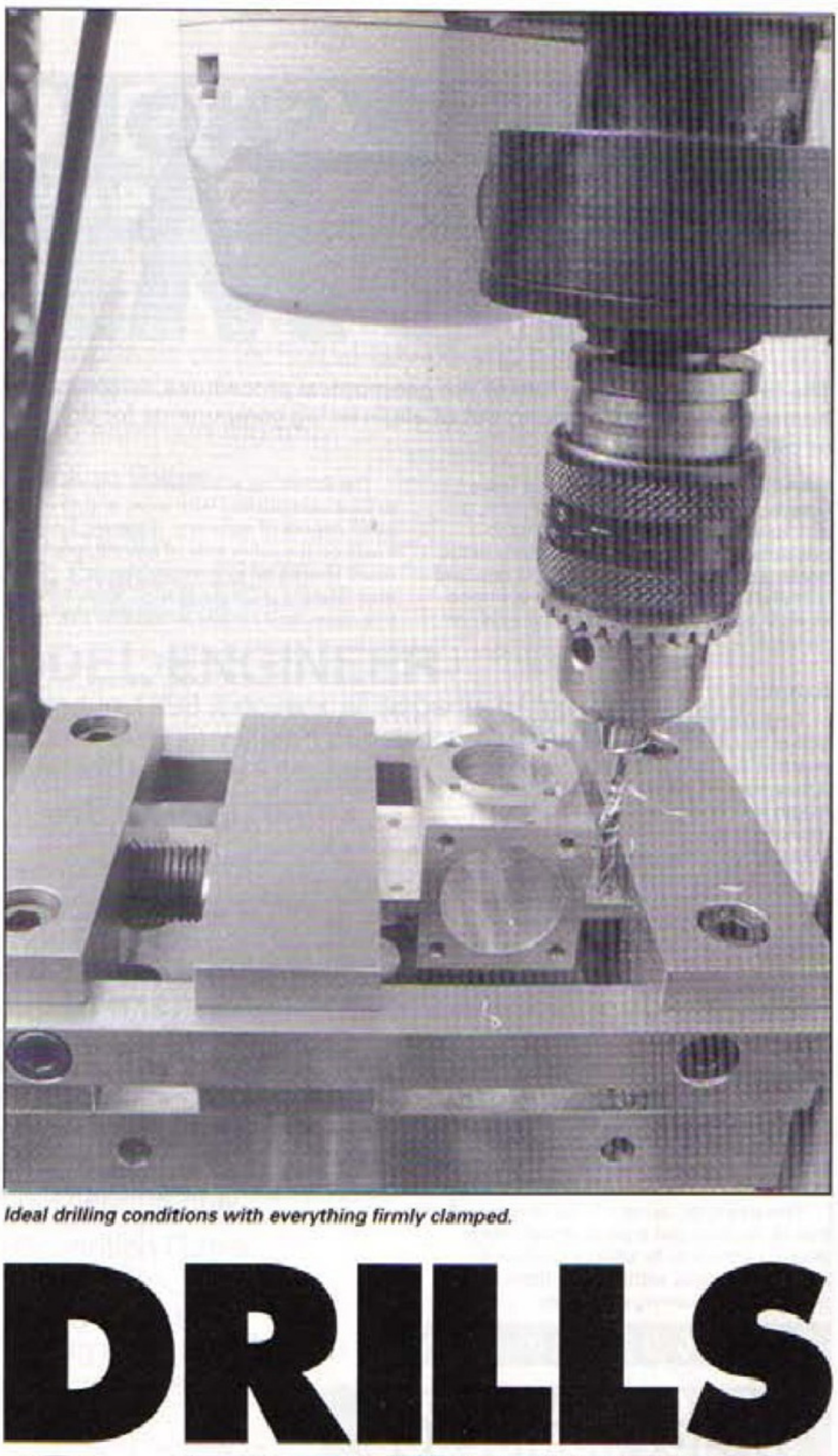
hardening and tempering, turning it anticlockwise whilst pushing it into a tapping size hole in another bit of silver steel (soft condition). The left handed die thus formed is used to thread another piece of silver steel rod to make a normal three cornered tap. Some care is needed with this technique but its a lot easier than turning threads free hand on a plain lathe with a chaser!

Mr. Whatmore

A spade or flat drill.

Thinning the drill web

Reducing the drill rake for drilling brass.



Ideal drilling conditions with everything firmly clamped.

DRILLS & DRILLING

Probably the most frequently carried out operation in the machine is drilling. It is done in the lathe, the milling machine, the pedestal drill and also with hand-held drills, both electric and manually operated. And yet most people will, we are sure, still have something to learn about this common operation. In this article, R. J. Loader of Harlow fills in some of the gaps in readers" knowledge of the subject.

Drilling is one of the most common machining operations and drills are probably the most neglected of all our tools. We expect to go straight to the box or drawer, take out the drill and use it. It doesn't always work like that and it doesn't matter how much we curse drills for cutting oversize, not drilling square or leaving a big burr; mostly it is our own fault. A drill cannot cut properly if it isn't sharp and it is easy to tell a blunt one. It will leave a big ragged burr, take a lot of force to push through the work and get hot very quickly.

We expect too much. There are some things drills aren't designed to do, apart from being used as a pin punch or spotting punch. Even when used for their normal job, they will not cut a very accurate hole, nor give a very good finish. They aren't even suitable for all materials because of their set rake angle. Considering all this, it is a tribute to the manufacturers that they work as well as they do.

Construction

The business of a drill is to make holes and its features are designed for that. Like all cutting tools it has rake and clearance, see **Fig. 1.** The twist or helix is its rake as well as a path for swarf to get out and coolant to get in. It has three clearances, lip clearance is obvious and without it the drill won't cut. Body clearance lets the cutting lands stand out from the drill body so that it doesn't rub. The third clearance is longitudinal clearance, which means that the drill is nominal size at the point end and decreases *very slightly* in diameter toward the shank. It is very small, 0.0007 of an inch per inch of length and the reason for it is to avoid rubbing, especially when drilling deep holes. Measure a drill of about ½in. diameter at the point and at the shank end of the flutes and you will see the difference. If you have done a little sum and come up with the figure of about 0.0025, go to the top of the class. The practical effect is to make a short drill more likely to drill an accurate hole and to increase the width of the web.

When a drill is machined, the flutes leave a web in the middle. If there was no web, the drill would fall in half and for the same reason the drill doesn't come to a point, see **Fig.1.** again. The web is an embarrassment because it is why we have to centre punch or centre drill a start for the drill. It cannot be plunged straight into the work without this start, see **Fig.2.** The web is tapered and gets wider at the shank end, more about that later. The problem is that the web doesn't cut, if you want proof, look at a partly drilled hole and see how shiny the little flat bit in the middle is where it has rubbed.

A lot of the power used in drilling is wasted driving the web through the work. That is why pilot drills are used. A pilot drill isn't a special drill, just a smaller one used to make life a bit easier for the larger one. It should be a bit bigger in diameter than the

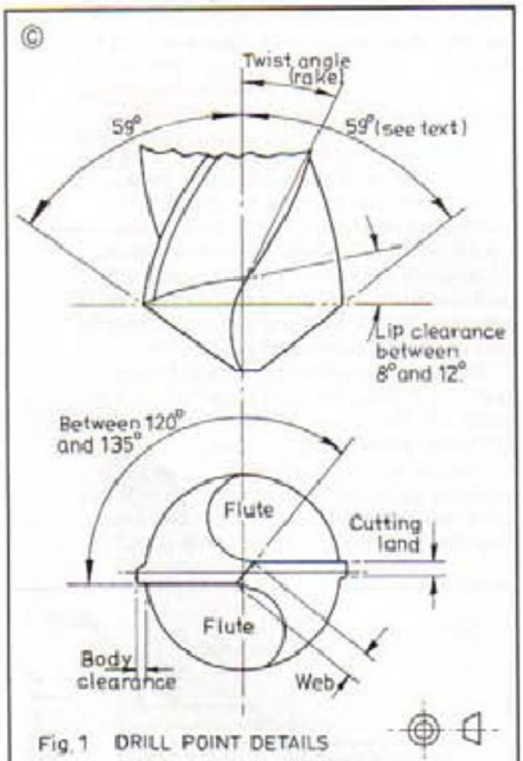
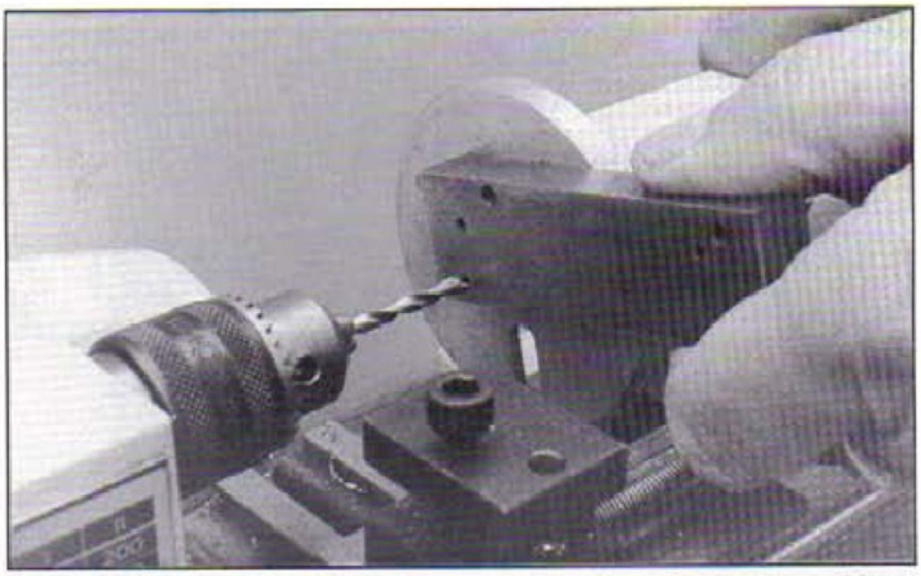


Fig.1 DRILL POINT DETAILS

web of the drill which is to follow. Users of small lathes like me, with Unimats and Toyos will be used to the method of drilling by easy stages. This way the lathe doesn't get overloaded, or the belt slip, break or come off. Which reminds me; Unimat users will find vacuum cleaner belts much better than those pathetic O rings which the makers supply for driving belts; a small defect in a superb little lathe which constantly surprises me with what it will do.

Angles

I'm always puzzled by the point angle of a drill, which the reference books and catalogues quote as 118 degrees included. Why? Why shouldn't it be 120 degrees? What difference would it make for normal use, if it was as small as 90 or as big as 140? Not a scrap most of the time. The



Not such ideal conditions but the sort of improvisation which small lathe owners with no drilling machine will be used to.

main thing is that the point is symmetrical, although as a general rule hard metals need a bigger angle than soft ones. Looking at **Fig.1.** again, the angle formed by the web and the cutting edge will show if there is enough lip clearance.

We cannot do much about the twist or helix angle because it is what the makers machine it to, except for one special case mentioned later. As it is the rake angle, there are quick helix drills for soft materials and slow ones for hard and brittle materials. The usual angle is about 30 degrees. Those of us with deep pockets could have three sets of drills but it is possible to make do quite well with one, making modifications where necessary.

Reducing the rake

Hard brass and some other brittle metals make the drill 'kick' when it breaks through and the work will try to shoot up the drill. It can be quite spectacular and the vehemence with which the driller says, "My word, how unfortunate", is proportional to the distance the work travels up the drill and the amount of blood drawn. The reason for the 'kick' is that the brittle metals need a small rake and the standard drill has a big one. Hard brass needs a rake of 0 degrees. The drill can be modified by grinding a small flat on each cutting edge, reducing the twist to zero or even slightly negative, see **Fig.3.** If the drill is smaller than ¼in. diameter, the flat can be stoned on with an oil stone, under ⅛in. the kick will be light enough to be ignored. Re-grind the drill when it has been used. The photograph shows what a drill ground for brass looks like. If you don't fancy all the palaver of grinding and re-grinding, buy a set of straight fluted drills, they are available.

Thinning the web

When a drill gets short, the web gets very wide. It makes the drill quite hard to push through the work. One solution is to thin the web by grinding back into the flute equally on each side of the web while following the flute angle. It isn't worth doing if the drill is smaller than ⅜in. The photograph is of a ⅜in. drill and it shows that it is a bit awkward. The other solution is to use a big pilot drill.

Countersinking

It is easy to make a drill for countersinking, just grind it to 90 degrees included. When using it, run at a slow speed to avoid chatter and clamp the work if possible. If it cannot be clamped, put a piece of coarse emery cloth under it with the rough side to the underside of the work. If that doesn't work, try turning the machine off as the drill is lowered, so that it is cutting as it is slowing down. Re-grinding the point angle after is a matter of choice, it is a good idea to have a drill kept for the job.

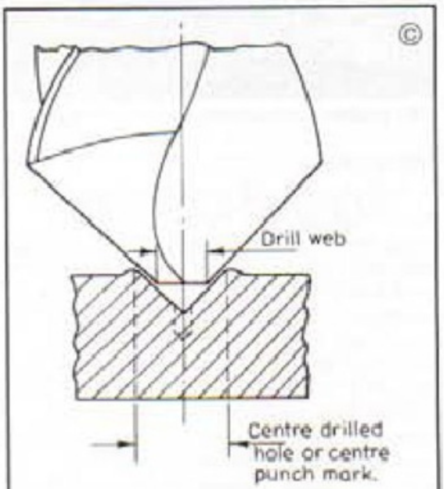


Fig.2

CENTRE DRILLING/PUNCHING IS ESSENTIAL TO ALLOW CUTTING EDGES TO START CUTTING.

Drilling oversize

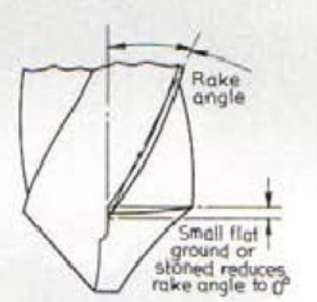
It is sometimes necessary to make a drill cut oversize by grinding one cutting edge slightly longer than the other. The clever bit is to get it to cut the size wanted and it takes patience and time. Try-outs should be done on scrap material of the same as the work. It is not a text-book recommended method and should only be done when there is no other way, but it has got me out of trouble several times in the past. **RE-GRIND THE DRILL WHEN FINISHED.**

Drilling undersize

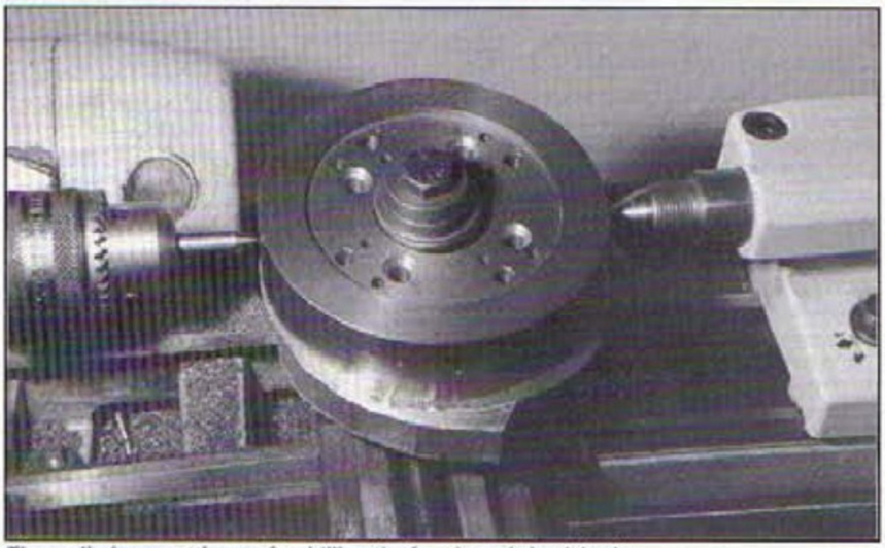
This is not easy and only works with the smaller drills under ⅛in. The cutting lands are rubbed down with an oil stone. It is a long and tedious job but I have done it and it does work. Put the drill in a special drawer, tin or box after use and *label it undersize*, or Murphy's Law will apply.

Flat bottoming

It is often useful to be able to flatten the bottom of a drilled hole. The best way is to use a 'D' bit, or even better a slot drill, but if neither is to hand, a drill must be ground. It isn't just a matter of grinding the drill off flat, each flute must have clearance back from its cutting edge or it will rub and vibrate. Work must be clamped firmly and a slow speed will give best results. This is one case when the drill *must* be re-ground after use.



MODIFYING THE DRILL RAKE FOR HARD BRASS AND SIMILARLY BRITTLE METALS
Fig.3



The preliminary setting up for drilling the four jawed chuck body.

Materials

The drill material controls its cost and how it can be used. The best drills are made from high speed steel. They will have the letters HSS or HS on the shank and cost a lot more than the ones you find on the weekend market. They will also have a blue-black finish, which is a thermal process, microscopically thin, but which acts as a corrosion inhibitor and an anti-friction layer. HSS drills will cut at high speeds and tolerate mis-use. Their main asset is the ability to stand up to heat, which is nice for those who, like me, work indoors and have to be careful about coolant spraying about. There is one group of steels which even HSS doesn't like cutting. Any tough alloy steel can be difficult to drill but stainless takes the first prize. For the slightest reason it will rub the cutting lands off the drill and the first signs are a dull red glow from the drill point and the coolant vapourising when it hits the work. The causes can be many but the most usual ones are; a blunt drill, too high a speed, not enough coolant or the driller winding the handle as if it were a mangle.

If the drill had been carbon tool steel, the other drill material, it would have broken down even quicker because CTS cannot stand much heat. They are cheaper than HSS and have a shiny finish. If a drill doesn't have HSS on the shank, assume that it is CTS. Run it at a slower speed than HSS ones and *keep it cool.*

Identification is often tricky, especially when the marks on the shank have been scored off where the drill has spun in the chuck. Size can be found by measuring but material needs to be confirmed by the spark test.

When a drill is ground, if the sparks are dull red and not too many of them, it is HSS. If the sparks are white or yellow, bushy with little bursting stars, it is CTS. To have a good look at what you are looking for, sharpen a HSS toolbit. For the CTS grind the blunt end of a centre or pin punch, there's bound to be one which is slightly mushroomed. Don't make assumptions about drills because HSS ones can have a shiny finish and the weekend market probably have some way of making cheap drills look like HSS ones. If in doubt, look at the sparks.

Marks from where the drill has spun in the chuck can be filed off because drill shanks are left soft. This is most useful to small lathe users as the shanks of the larger drills can be turned down to fit the smaller chucks.

There are special drills for many applications which model engineers will rarely come across, but one or two are worth a mention.

Long series drills

These are ordinary in every respect except that the cutting length is much longer than standard. They can be made by silver soldering a standard drill into a mild steel extension. **Fig.4.** shows how it is done. The extension diameter must be smaller than the drill diameter to prevent jamming. It is drilled and the drill shank is machined, so that the fit is nice and close. A small hole or slot is cut to let the air out, so that the soldier will penetrate and the two parts stay put when heated. While soldering, bury the business end of the drill in wet sand, so that the heat won't do any damage.

I once had to make some tube 12in. long with an inside diameter of ⅜in. and an outside diameter of 1 in. That was the longest long series drill I have used. It was a long and careful process with frequent withdrawing to clear the chips and get some coolant to the drill point.

Stub drills

The opposite of long series, shorter than standard and stronger with thicker webs. Often used for capstans and autos and on tapping machines. Very useful in the smaller sizes because they are less likely to break.

Flat or Spade drills

These are simple to make by forging a flat on the end of a piece of silver steel, filing it to shape as shown in **Fig.5.** and hardening and tempering it. It can have rake filed on if wanted. They vibrate when cutting and are only useful for wood and soft materials. The one in the photograph is one I made as a curiosity, but I have used it and it will drill wood and brass.

Of the other 'specials', there are taper drills for drilling holes for taper reamers to finish off. They have staggered gashes in the flutes to break up the chips.

Core drills takes the hassle out of opening up cored holes in castings or those punched or forged. These holes are rarely true and two-fluted drill will jump about.

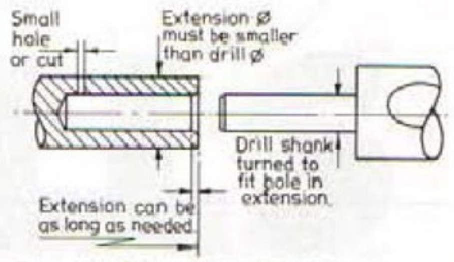


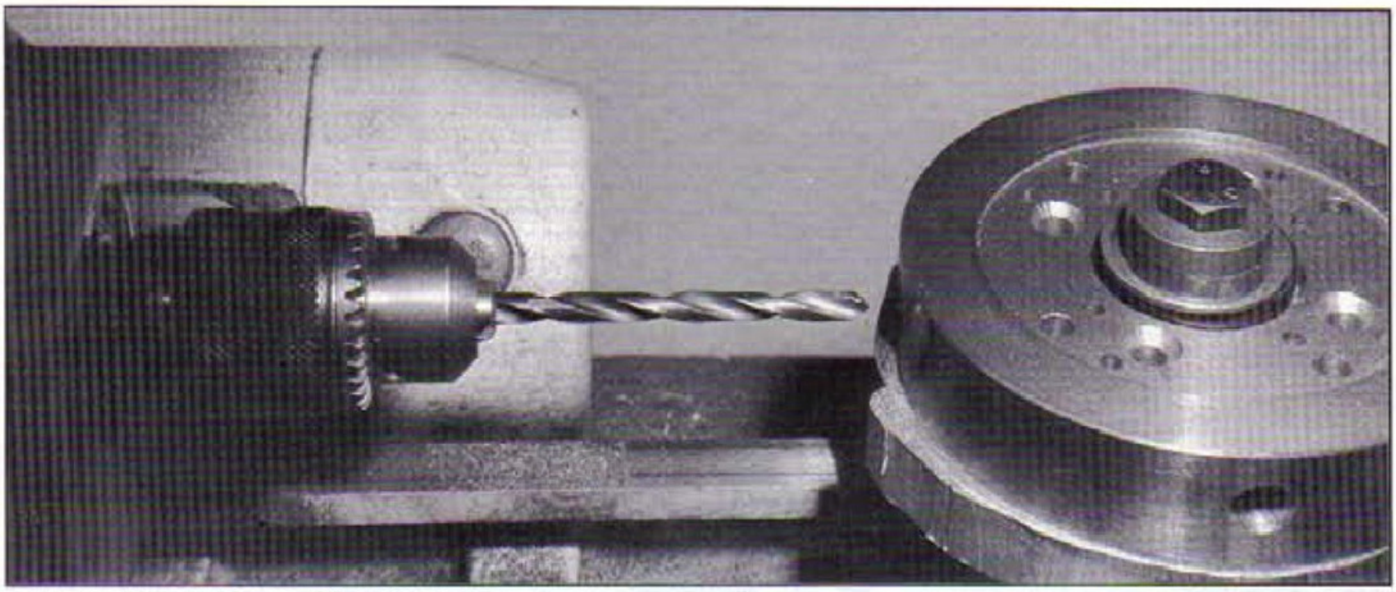
Fig 4 MAKING AN EXTENDED DRILL

©

QUICK TIP

The need for storage in the home workshop is ever expanding and the decline in the number of products sold in small tins has made "free" storage more difficult to obtain. If you are forced to buy plastic drawers or boxes a useful economy tip is to use one compartment for two sorts of screw or nut etc. The trick is to mix two items that are obviously different so that selection of the item you want is easy.

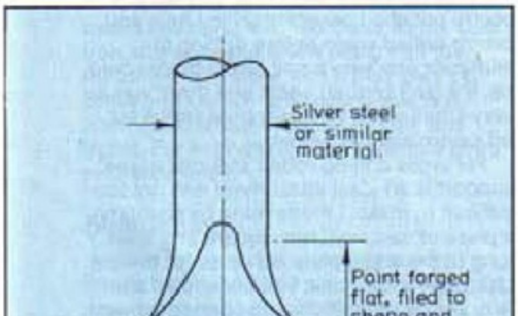
JohnJennings



An intermediate stage in the drilling of the body.

Core drills usually have three flutes and find a common centre of rotation. They cannot drill a hole, merely open one up.

Straight flute drills are used for hard brass, they are the same as ordinary drills but the flutes are straight because there is no rake.



FLAT OR "SPADE" DRILL
Fig.5

©

Ways and means

Speed selection is the most important part of the drilling process. Drills break easily, especially in the smaller sizes and by far the easiest to break are centre drills, usually because the speed is too slow. Working out the speed for centre drilling should take the diameter of the pilot, not the body, for the sum. Using the normal formula and method, the calculated speed for a No.1. centre drill to make a starting hole in mild steel would be just over 10,000 revs. My lathe will only do 4,000 revs flat out and most won't manage more than 2,000. So the smaller centre drills are in trouble straight away. The remedy is to use as large a centre drill as possible and when using centre drills under No.4. size or drills under 1/16in. to use *maximum speed.*

The two photographs of a drill in action are a contrast in equipment more than anything else. The one shows drilling at its best, with everything clamped solidly; the other shows how I have to do most of my drilling, as I lack a drilling machine at present. My method is not the one to use if a better one is available, but it isn't as unsafe as it looks. Any job bigger or more awkward is clamped, the one shown is as far as I'd go without clamping. The size of the drill is the limiting factor, bigger than 3/16in needs clamping.

Each material drills differently. Hard brass has been dealt with earlier; the other sort of brass, called cartridge brass is much less brittle and can be drilled the same as mild steel. It is yellower in colour and the swarf will come off in strings and coils, hard brass comes off in a rasping shower of small bits. Cast iron cuts something like hard brass and can kick when the drill breaks through, so both should always be clamped if possible. Stainless and alloy steels get very hot when cut, so use coolant or drill in easy stages, to give the metal time to cool down. Bronze too, gets hot, especially the wrought sort with the coppery finish, so treat like stainless. All the ductile metals will make swarf with sharp edges so clear it with pliers and *wait till the drill stops.* The brittle metals will make swarf which flies about, *so wear eye protection.* There are few metals which can be cut dry, brass, the hard type, and cast iron are the only two which need no lubricant. Modern types of coolant have been so carefully developed that it is safe to use coolant for most metals. If the work is small it is not so necessary and for most metals, if nothing else is to hand, lubricating oil is all right; I use Castrol GTX for all the machining, tapping and reaming I have to do and find it quite suitable.

Drilling in the lathe

I've made this a separate section because the lathe is often the only machine available for drilling, especially for those whose facilities are limited. Also, small lathes can impose some extra difficulties and restrictions.

The tailstock travel on my Unimat is 20mm. and it makes drilling deep holes a bit of a caper because the whole tailstock needs moving for clearing chips and applying coolant, on any hole deeper than the 20mm. It is vital that the tailstock *is* moved, if not the drill will soon get choked and the cutting edges will lack the lubrication they need. Luckily, holes deeper than 20mm. don't come up too often.

Another limiting factor is the 8mm. capacity of the drill chuck, but there are remedies for this. Larger drill shanks can be turned down, or held in the three jawed chuck screwed to the tailstock spindle. Unfortunately, for bar work, 2 chucks would be needed, one to hold the work and one to hold the drill. One solution is to make an adaptor to adapt the lathe spindle thread to fit a Black and Decker spare chuck of 1/2in. capacity. They don't cost a fortune and the adaptor only needs an M14x1 tapped hole in one end and a 3/8in. UNF in the other one, each concentric with each other of course. The M14x1 can be changed to suit whatever the lathe spindle is. The only snag with this adaptor is the longer overhang.

Lastly, there is no guarantee, apart from the manufacturers' good faith, that the tailstock is precisely on centre. Errors are very rare but the alignment can be checked by putting *spotlessly clean* centres in *spotlessly clean* headstock and tailstock sockets, and bringing them together with the tailstock locked. Large errors will be obvious; small ones can be seen by trapping a thin rigid shim or a razor blade lightly between the centre points, as shown in **Fig.7.** It should be at right angles to the lathe axis in both vertical and horizontal planes. On lathes which have adjustable tailstocks any error can be taken out, if there is no adjustment you have trouble.

So much for limitations. For most bar work drilling is straightforward.

Drilling from the tailstock

Always use a centre drill, that is the key to accurate drilling. Even if the countersink part of the centre drill cannot be used, the pilot will give a good start because it has a very rigid construction and doesn't deviate from the centre but always remember that the pilot is comparatively fragile when it starts cutting and needs a high speed and careful feeding. Tailstocks are not as sensitive as they could be, so the pilot should be fed in a bit at a time, frequently withdrawing to clear swarf and lubricate. Once the countersink part is cutting the pilot isn't so vulnerable.

Remember too, that centre drills need sharpening just as much as other drills because the pilot takes quite a hammering. So *look at it* before using and if there is any doubt, sharpen it. Apart from the very large ones, the best way is to do it by hand with a small coarse oil stone; it removes less than grinding and is more sensitive. Be careful though, that the pilot hasn't been sharpened so much that it is too short to seat a lathe centre correctly, see **Fig.7.**

With the power available, small lathes benefit from a pilot drill or a series of them when drilling larger sized holes and they will follow easier if each increase in size is prepared by countersinking to at least the diameter of the next drill with a large centre drill or a 60 degree countersink.

Deep holes especially can be a bit awkward and will wander off centre if everything isn't exactly right, so always centre drill deeply. If you don't want the angle to show, make the work a bit longer and face off after.

If a long component needs drilling right through with the hole and the diameter concentric, make the outside diameter oversize, drill the hole, then finish the outside diameter between centres. The countersink for the centres to bear on only needs to be a thin land and when finished will only look like generous de-burring. If it is a deep blind hole it can be done the same way and plugged after.

When, in spite of everything, a drill doesn't start true, it will be obvious by the way it wobbles. Don't expect it to magically correct itself, it won't. Once the drill has started cock-eyed it will only get worse. Face off and start again if you can. If there is no material to spare, try using a slot drill or end mill to clean out the eccentric bit, re-centre and start again.

A wobbling drill usually means that the shank is badly scored and not fitting correctly in the chuck. Remember that shanks are soft and scars can be filed or even turned off. I know that this will probably obscure all the information on the shank, but the scoring would have done that anyway. The soft shank also allows the drill to be straightened if it is bent. Knock it back in a vice with soft jaws, using a *soft* heavy hammer. *DO NOT* do it in the chuck. If the cutting portion is bent, forget it and throw the drill away. Luckily, bent drills are rare, badly scored shanks are much less so. Check for wobble by putting the clean drill in a clean chuck and turning on.

One small thing my Unimat lacks is a scale on the tailstock barrel. It is one of those jobs which I'm always going to do when I have a bit of spare time. Meanwhile, I use an internal caliper to gauge the distance between the tailstock casting and the back of the chuck, as shown in **Fig.8.** For more accurate depths the graduated scale on the handwheel is very useful.

With the body drilling complete, the drill and tailstock centre line up for spotting the holes in the centre bush.

Other drilling methods

There are several other ways of drilling other than using the tailstock. The photograph of the hand-held job is only suitable for small and easily drilled work which can be *safely* hand-held. It is an easy method, with the face plate on the tailstock and the drill chuck in the headstock, the drill will go down the hole in the middle when it breaks through and do no damage. If there is any question of movement causing accuracy or safety problems, I clamp the work.

Where work must be clamped and accurately set up, I use an angle plate clamped to the cross slide. It is a 2in. one which I bought un-drilled and I drilled four 9/32in. holes in each angle. It clamps to the cross slide with 1/4in. BSF bolts in Tee nuts. Once the angle plate has been set true and clamped, it makes an accurate datum and the work can also be moved in the horizontal plane. I also use this set-up for light milling, but that's another story.

Work which cannot be held in the chuck or which is awkward to set up can often be drilled by clamping it directly to the cross slide with suitable packing for height and a method of lining it up. It has the advantage of being in line with the lathe axis and also gives a reasonable travel. The series of photographs show what I mean, when applied to the drilling of a four jawed chuck body for the jaw screws and slots.

It was set to the correct height by packing underneath and lined up by using a point in the drill chuck and a centre in the tailstock. The point and centre located in accurately marked and punched centre holes. The preliminary set-up is shown in a photograph. The body was centre drilled, then drilled by stages to 5/16in. Another photograph shows an intermediate stage in the drilling with a completed 5/16in. hole facing outwards.

Square, flat or rectangular work can be drilled in a four jawed chuck as shown in the photograph. The work is set true to a centre punched or centre drilled hole and centre drilled again before drilling to eliminate any very small errors there could be. If it isn't centred again and there was a very small error, the drill could start a bit off centre and get worse.

For cross drilling round sections a 'vee' support is an ideal attachment and not too difficult to make. I made mine by clamping a piece of cast iron, 3/4in. square and 1 3/4in. long to the angle plate set up as for drilling. Using the cross slide, I milled a relief slot 1/4in. across the middle and opened up with a countersinking cutter to make the 90 degree angle. A small hole was drilled through the centre on the same setting. The shank was made from 1 1/4in. mild steel with a spigot to fit the hole in the middle of the 'vee' part and made to fit whatever the tailstock is. The two parts were joined by cap head screws and the assembly is shown in **Fig.8.** I haven't dimensioned everything, just enough to give a general idea.

Remember that most workshop accidents are from drilling and be careful. Use the drill guard and eye protection, clamp the work if you can, use a stop if you cannot. Invest in a pair of heavy armoured gloves for holding work which cannot be clamped and keep dangling objects well away from the spinning chuck or drill; even a perfectly smooth shaft will pick up anything within range.

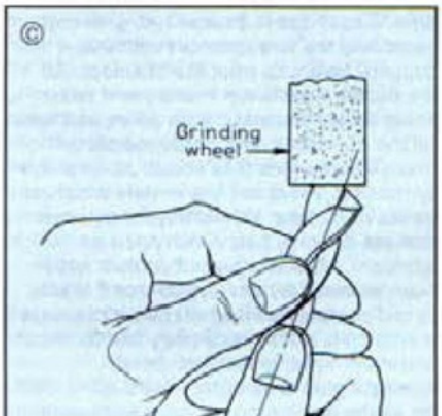


Fig 6 THE GRIP FOR DRILL GRINDING

QUICK TIP

The Arrand milling cutter holder has a 3/8 BSW thread for the draw bar. The draw bar on the Dore Westbury miller is 5/16 BSF. To adapt to the smaller bar simply drill through the 3/8 BSW thread to a depth of 1 3/8 inches and tap for 5/16 BSF. You will not damage the 3/8 BSW thread; a longer draw bar will be required, mine is 14 3/4 inches long.

H.White

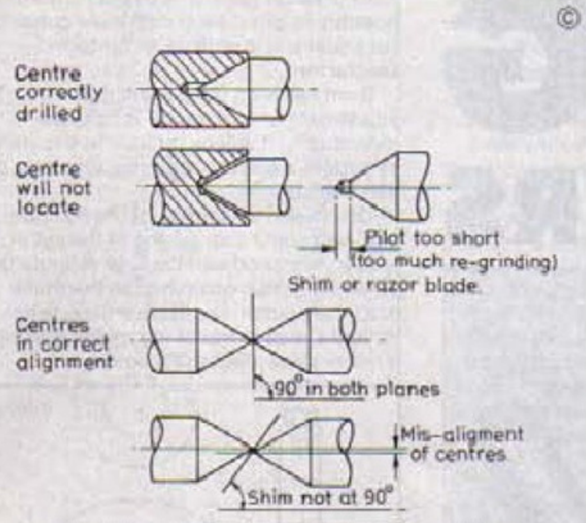


Fig. 7 POTENTIAL PROBLEMS WITH LATHE CENTRES

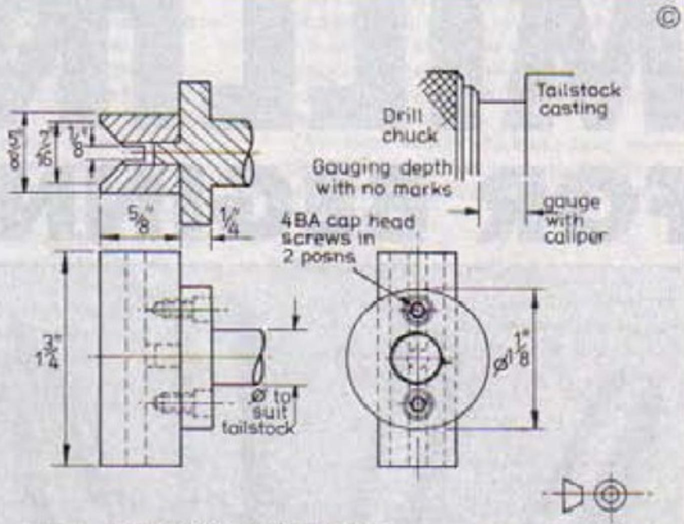


Fig 8 TAILSTOCK 'VEE' SUPPORT

Speeds

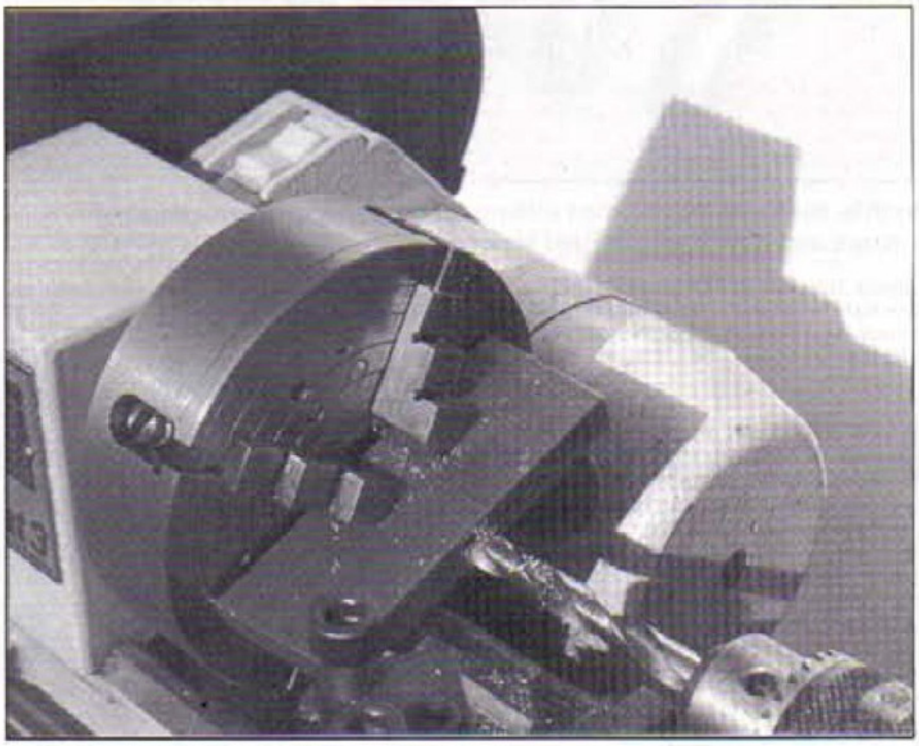
The best guides to speeds are in most of the engineering handbooks and a lot of companies do charts so all I'll do is to give some general guidance. Begin with the figure of 400 revs/min. for 1in. diameter mild steel and work from there. So ½in. needs 800 revs, ¼in. 1600, and so on. Cast iron and alloy steels will cut at half the figure for mild steel, less if they play up. Brass and bronze will take double and aluminium alloys between double and treble. For everything else, consult a good reference book.

Sharpening

I was lucky and in my engineering formative years, I had a succession of apprentice masters who taught me to sharpen a drill. It took a long time and those who don't have the same privilege will be better off getting a drill grinding attachment. If you must learn, you will have to master a compound movement. The drill is held as shown in **Fig.6.** with the cutting edge at 90 degrees to the wheel surface. It is given a twisting movement to the right and at the same time the shank is lowered. The best way to get an idea of how it should feel, is to try the motion with a correctly ground drill, with the wheel stopped. Take it from there and the best of luck, practice with a drill of about ¼in. and be prepared to take a lot of time learning.

When a drill is ground right, it will only need the lightest of pressure to get it cutting and the chips will be equal from each flute.

Drills under 3/32in. can be held on the grinding wheel with the cutting edge rotated a bit and don't need any fancy compound moving. They will be quite all right with flat sides. For even smaller ones, don't bother with the grinding wheel at all, use a sharpening stone with an eye glass to see what you are doing. I learned this when I'd broken the last No.80 drill (0.0135in.) in the stores and had to find a way of sharpening it. The chances are that a very small drill will snap when touched to the wheel, because the grinding wheels used for tools have far too coarse a grit size and drills smaller than 1/32in. break very easily.



One method of drilling in the four jawed chuck.

Always follow the makers instructions when grinding, not only drills but other tools as well. The label or handbook will say, 'grind dry on a free cutting wheel'. This is not always easy to obey to the letter, but in practical terms it means; make sure that the wheel isn't glazed and if you must cool the drill in water, do it before the heat has discoloured it. Use the surface of the wheel and not the sides, that is how it is designed to cut.

For the actual sizes of drills for tapping and clearance of the common threads, and much more useful information, invest in a good handbook or get *Model Engineer* of 1st-14th November 1991, there is an excellent wall chart in that issue.

This has only been a quick and short look at the subject, an appreciation of the marvellous piece of engineering which a twist drill is. So next time you drill a hole, spare a thought for those who were the first to think out the problem of making holes easier to cut. Some of them will have been forgotten or never known, but the names of some live on; like Henry Morse, who was one of the initiators of the twist in the drill; J.R. Brown of the machine tool company Brown and Sharpe and other machine tool builders. Both Morse and Brown were American. Morse was also involved in the taper of the same name. Brown was one of the designers and builders of the first universal milling machines, without which the twist in the drill could not be milled; previously the twists had been filed. They were the really clever ones who worked from first principles, without the volume of references and data we have today.

Don't sell them short, look after your drills, a lot of skill, care and trouble has gone into the development of these indispensible cutters.

PART 2 MILLING FOR BEGINNERS

In this, the second article on milling for beginners, the question of cutters and how they are held is considered

Above, four end mills plus a slot mill on the right; note end mill on left has a plain shank. Right, small slot drills with a ¼" shanks.

In the second part of this series on milling equipment and processes for beginners, cutters and the method of holding them is considered. Probably no other situation catches the newcomer by surprise, more than the problems with regard to holding the simple end mill. The beginner will therefore find there is more to this subject than has probably been anticipated.

Types of cutter

The most likely types of cutter evident in the home workshop will be as follows:
Fly cutters
End mills/Slot drills
Disc type cutters (Gear Cutters etc.)
Slitting saws

Fly cutters

This cutter is very much in evidence in the home workshop; it is probable that this is because of its ability to be easily and cheaply made, rather than purchased. In its most basic form it consists of a single cutter held in a holder. The cutter may be a piece of round high speed steel, maybe even an old broken centre drill.

The holder can take a number of forms but really there are only two major differences, these being the method of holding the fly cutter in the machine. One method is to make the holder complete with its own taper, the advantage of this one-piece construction being its rigidity in use, whilst the disadvantage is purely being the need to turn the taper in the first place.

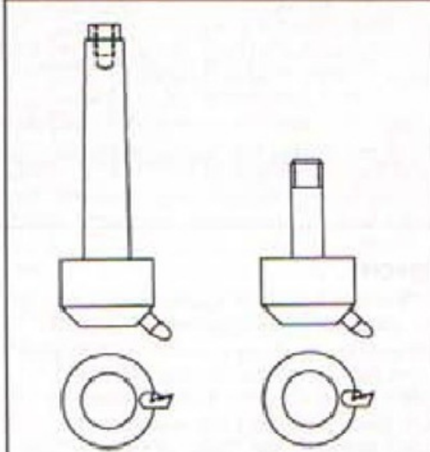
Alternatively the holder can have a parallel shank, this to be used with the end mill chuck; in this case the shank may also beneficially have a threaded end as is the case with end mills.

The application of the fly cutter is primarily for the machining of relatively large flat surfaces and it is here that it has no real alternative. Having said that, the face cutters which are frequently supplied with the machine are also ideal for this application. In essence these are only multi-cutter fly cutters, having a number of individual cutters fixed to a single holder.

Home-made cutters could also have more than one cutter, but unless some form of cutter grinder is available making it possible to grind each individual cutter to cut equally, it is unlikely to function satisfactorily.

Even allowing for the fact that adjustment of each cutter is possible individually, it will be difficult to ensure that all cutters are set to the same diameter and depth of cut.

One major advantage of the fly cutter is that, by careful sharpening of the cutter end, a very good surface finish should be obtained. When compared to the multi-tooth face cutter, its disadvantage is its limited speed in removing metal, making it a rather slow process for some

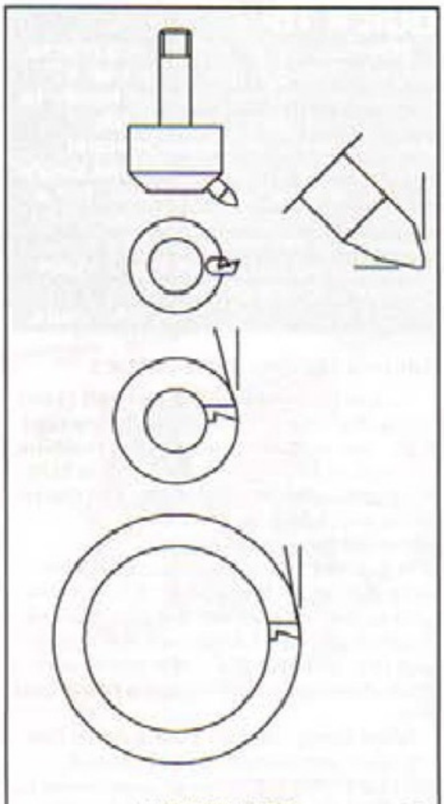


SKETCH 17. ©

applications.

The fly cutter can be used for milling other forms, such as steps, but unless these are large the end mill is likely to be the method to adopt. Fly cutters can be made in differing sizes to cover a range of diameters, their basic construction being illustrated in **sketch 17**.

Do ensure when adjusting the position of the cutter within the holder, that the actual overhang of the cutter is a minimum to achieve maximum rigidity. Even so, the amount should be sufficient to enable the swarf room to clear the area, and also for the surface being machined to be seen easily.



SKETCH 17A. ©

The shape of the cutter end which creates the rake and clearance angles should generally follow those for lathe tools and is therefore not discussed here in detail.

One point which must be observed though is the clearance on the outer face. As this is, in effect, following an arc it requires to be a few degrees greater than the effective angle created by the arc at the point of the cutter. The clearance angle will therefore depend on the radius created by the cutter. See **sketch 17A.**

End mills

It is here that unforeseen problems are likely to surface. With the mill/drills, frequently supplied with a drill chuck and a number of end mills, it would be reasonable for the uninitiated to believe that they had the required items to proceed.

With the cutters mounted in the chuck and the workpiece mounted on the table by some means, the first lesson is about to be learned. It will soon be found that the machine appears to be cutting down-hill. Even worse, if you have been used to placing the drill chuck in the drilling machine relying on its morse taper only, and have done likewise in the milling machine, you will probably have the chuck fall out on the machine table, maybe with a broken cutter.

The difference between the milling operation and what would appear at first to be the very similar drilling operation is that, when drilling, the cutting action is continuous and the force is in the direction which forces the taper into the bore (except at the point when the drill breaks through). for milling the cutting action is intermittent, and the forces act both against the side of the bore and due to the spiral cutter also tending to pull the taper out of its bore.

The sideways force together with the intermittent action has the effect of vibrating the taper out of its socket. For this reason it is essential that the draw bar which screws into the small end of the taper is fitted and lightly tightened to prevent this occurrence.

Even with the drill chuck captive using the draw bar, the problems have not been fully resolved. For if anything other than very light cuts are taken, the inadequate grip of the drill chuck will permit the cutter to be gradually drawn out of the chuck, due to the spiral action of the cutter.

This will result in a sloping surface and there is unfortunately no other course of action that to obtain (purchase or make) a proper milling cutter chuck. If no other lesson is learned from this article, this fact is essential knowledge.

The only possibility of managing with a drill chuck is if the mill chosen is one of the very small types, typical of those added to the smaller lathes, and only the very small (¼ in. shank) cutters are to be used. Even in these circumstances it is probably not a good method to adopt.

End mills come in a range of differing types though in the main the variations are slight. More will be said about this subject in the final part of this article relating to the actual milling procedures.

It is essential to realise, as the question of chucks is to be discussed, that two basic types of shank occur. These are those with plain shanks and a second type that have a short threaded end. These can be seen in the photograph illustrating the differing types of end mills.

The cutters are invaluable for slitting operations and, whilst much of what will be done could be achieved with a hacksaw, this approach will never result in the precision and resulting good appearance of using a slitting saw.

(*For more details of slitting saw, see the article elsewhere in this issue on slitting saws and making suitable arbors for these. Ed.*)

Milling cutter holding

There are basically two forms of cutter to be held – those with shanks and those like discs which are held using the central hole.

End mill chucks

These come in two basic types each with subtle variations from differing manufacturers. A third type is not really a chuck but just a holder. Each type has its own distinct advantages and disadvantages. All three types are shown in simplified form in **sketches 18, 19 and 20.**

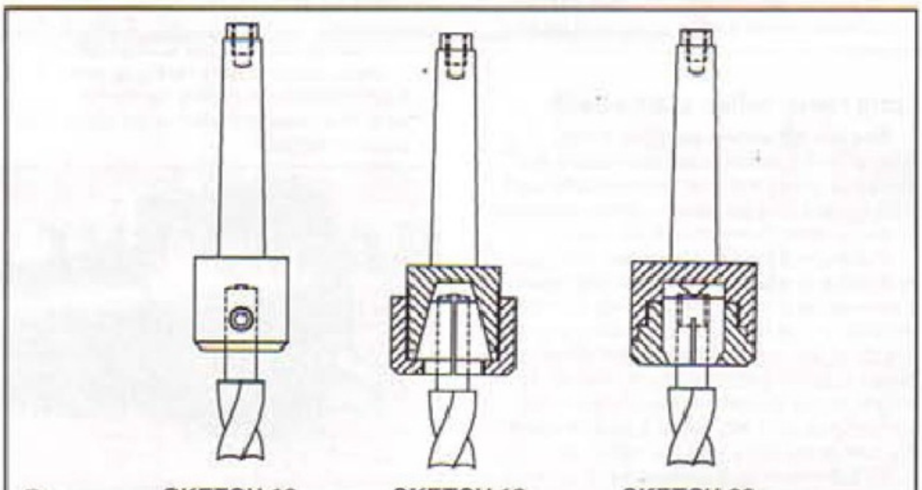
Holder

The item shown in **sketch 18** is the simplest form and is really just a holder. One end has a taper to suit the machine to which it is to be fitted, whilst the other end is bored for the shank of the cutter to be held. The cutter is then secured by means of a grub screw from the side.

The shanks of end mills to BS122 Pt 4 have a tolerance of +0.00025 – 0.0005 inch so with, say, the bore made to +0.0003 to +0.0005 inch, concentricity should be within 0.0005 in. – that is ignoring any errors due to the taper and its socket; this is probably comparable to that achieved by the collet chucks for which no value is available. (*Does any reader have a value for this? Ed.*)

This type of arrangement has the advantage of considerably reduced cost, particularly if, say, only two shank sizes are purchased probably ¼ and ½ inch diameter, though as the smallest cutter with a ½ inch shank is 5/16 dia, a ⅜ inch wide slot would have to be produced using a ¼ inch cutter. Even so, if a ⅜ inch holder were purchased the cost would still only be about 40% the cost of the cheapest chuck, bar one.

The one known cheaper milling chuck is that made by A. Marks of Laughton



© SKETCH 18. SKETCH 19. SKETCH 20.

Disc type cutters

Not including slitting saws which are really a version of this type of cutter, and apart from a few very special types such as tee slot cutters, the only frequently found version of this type of cutter in the home workshop will be the gear wheel cutter.

This cannot be considered an operation for the beginner. As a result, other than to say that the method of holding these in the machine will be very similar to that about to be detailed for slitting saws, the subject will not be expanded upon here.

Slitting saws

Slitting saws are very much like circular saws except that there is no set placed on the individual teeth to give clearance. The saw is intended to cut a slot in width, equal to the saw's material thickness.

Sheffield (0909 563940) (see trade pages). In this case the three holders would be about 60% the cost of the chuck.

A well known supplier of end mill holders and many other items such as slitting saw arbors and fly cutters is Arrand Engineering of Oakham, Tel: 066477 566.

The disadvantages of end mill holders are that a number of holders have to be available, and the whole item has to be removed from the machine and replaced if a cutter with a different diameter shank is to be used.

A small 1/4 " shank cutter fitted into a non-split collet for use in a normal milling machine cutter shank.

A flat will have to be ground on the shank of the cutter, except for the ⅜ inch types where the flat will already be made. How secure this arrangement is for the larger sizes is unknown to me; perhaps some reader who has experience of these could write to the editor to expand on this subject.

Long taper collet, plain shank

Sketch 19 shows a typical collet arrangement which does not require the threaded shank but can work equally well with cutters that do (most cutters available to the amateur have this these days).

The main difference between this type and those in **sketch 20** is that the taper is shallower and much longer. One slot is slit through to the bore and over the complete length of the collet. As a result the collet closes equally onto the shank over its full length. It can therefore provide a much tighter grip, and will be able to withstand the forces trying to pull the cutter out.

To achieve this, spanners have to be used and, in view of this long and also shallow taper, the collet can become captive in the body. To overcome this, in addition to the closing ring, some form of assisted removal is also required.

In one type, Clare Collets, the removal is cleverly achieved by the use of two threads. One is used to hold the collet to the ring and is a slightly finer pitch than the other which is used to close the collet to the body. This has the effect of jacking out the collet when opening. A design for this type was published in the Oct/Nov '91 issue of *MEW*.

Threaded collet

The system shown in **sketch 20** works by a quite different method. It is frequently described as a Clarkson Collet but is made by a number of suppliers. In this arrangement the thread on the cutter shank is used as follows.

The collet has a mating thread at the base of its bore into which the cutter is screwed. The collet assembly has some method of preventing the collet rotating and also the base of the holder against which the cutter shank rests is solid. Rather than a flat base, some systems have a centre point which engages the centre mark in the end of the shank, thus assisting in maintaining concentricity. The closing ring includes the taper which mates with the corresponding taper on the collet.

This arrangement works on the principle that the closing ring is tightened only slightly, and the cutter turned until it bottoms onto the bore of the main body, this as a result of its being threaded into the collet. Now if the cutter attempts to turn under the load of the cutting action, it will still remain in contact with the base, and its position will not change. The rotation will have drawn the collet forward in the assembly, thereby tightening it further.

Some systems have the thread in a separate ring behind the collet but the principle of operation is the same.

Like the Clare collet system these collets are very expensive and also have the disadvantage of not being suitable for cutters without threaded shanks, this only being a problem with the smaller ¼ inch diameter cutters. In the case of these ¼ in shank cutters a non-slotted collet can be used. This is fitted with a grub screw which grips onto the flat that is standard on this type of cutter.

Whilst having the disadvantage of requiring threaded shank cutters, these are very easy to obtain being almost the standard for present day cutters. The system does have the benefit of being very easy to use as no spanner is required to close the collet and only rarely to open it.

A simple version of this for home construction was included in the June/July 91 issue of *MEW*.

QUICK TIP

When using the roller filing rest to file, say, the winding square on a clock arbor, it is sometimes handy to have a shoulder to rest the file against. Some of the commercial watchmaker's filing rests used single flanged rollers for this reason, but a similar effect could be obtained by shortening the rolling slightly and fitting a very large diameter washer against one end of the rollers.

Mr Whatmore

Holders for disc type cutters

As was referred to in the first part of this series, this type of cutter is really intended to be used on a horizontal milling machine. To recap, in this method the cutter is held on an arbor which is supported and driven at one end, whilst its other end is supported by another bearing.

In practice this bearing can be moved along the length of the arbor to bring it as close to the cutter as the size of cutter and shape of part being machined will permit. With this approach the cutter can be very adequately supported and quite heavy cuts taken.

When being used on a vertical mill this outrigger bearing will not be possible. Because of this the range of possibilities for using this type of cutter is limited to the use of only smaller diameters and widths.

The arbor for mounting these cutter will also require to have a minimum overhang and is known as a 'stub mandrel'. The permissible overhang will, of course, depend on the type of cutter being used. As the load placed on a narrow slitting saw is low compared to a wider cutter such as a gear cutter, it follows that a greater overhang can be tolerated with the slitting saw.

Small and large fly cutters

Conclusions re end mill holding

All three arrangements have their advantages and disadvantages, not least cost. Unfortunately there is no real alternative – attempting to get by with the drill chuck is bound to result in failures and, as a result, much frustration. The only way of overcoming the high cost would be to make them. This would be an interesting exercise, and could be to either of the designs given in the articles mentioned above.

Part Three

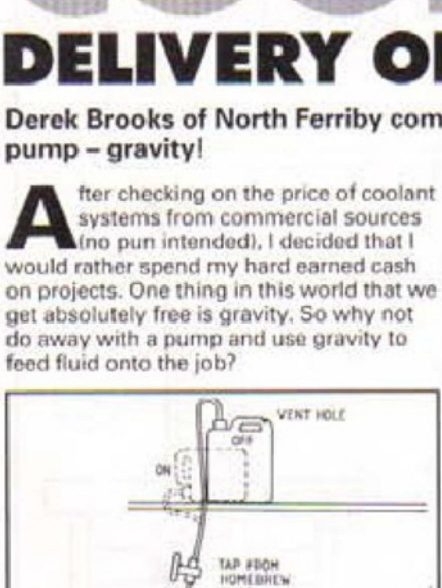
The next part of this series will deal with some advice on the actual milling operations, giving some typical examples. Also included in the issue will be a major milling project for upgrading the tilting vice supplied with most mill/drills. This will be a step-by-step article with photographic illustrations of almost all operations.

Photocopies of articles mentioned: Photocopies of past *MEW* articles mentioned in this article are available from Argus Specialist Publications, Photostat Service, each priced £1.50 inc. p&p UK, £2.00 overseas.

COOLANT DELIVERY ON THE CHEAP

Derek Brooks of North Ferriby comes up with the cheapest form of suds pump – gravity!

After checking on the price of coolant systems from commercial sources (no pun intended), I decided that I would rather spend my hard earned cash on projects. One thing in this world that we get absolutely free is gravity. So why not do away with a pump and use gravity to feed fluid onto the job?



GRAVITY FED SUDS

To do this place a one gallon bottle of suds on a high shelf above the lathe or milling machine. Connect a pipe into the filler cap. Follow this with a plastic tap obtainable from a home brew shop then more pipe to a poppet type nozzle fixed to the lathe saddle with a small plate. The bottle needs venting. To do this pierce a small hole in the handle on the opposite side of the bottle to the filler cap.

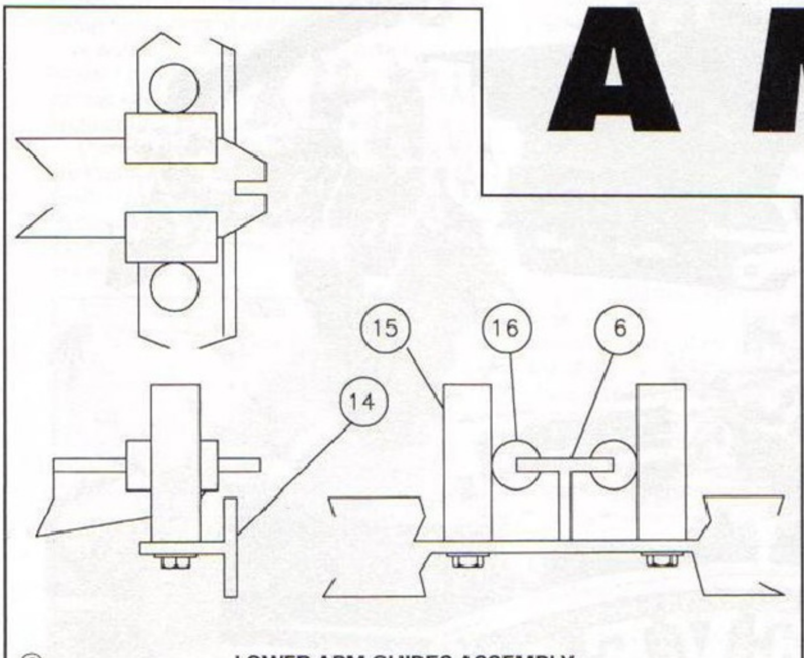
When not in use the bottle stands vertical on the shelf and of course no liquid can flow. When required the bottle is placed on its side with the filler cap at the bottom and the vent at the top. Coolant flow is adjusted by the tap. Once it has been set it does not need to be altered as you stop the flow by merely standing a the bottle back upright. The used coolant is collected in another bottle inside the cabinet or under the bench. A filter made of nylon stocking is placed in the neck. When the top bottle is empty simply exchange the bottles. I have been using this method for several years. The only real expense is the nozzle, tap and a bit of pipe, less than a fiver and to do the job you would have needed a nozzle anyway.

If your machine does not have a tray it would be an easy thing to bend up from alloy sheet. If you have never used coolant before you will have the pleasure of hearing tools singing like the birds.

Postscript

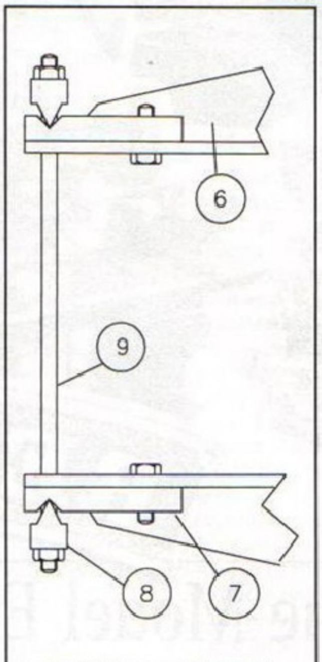
Mr Brook does appear from his photograph to have the benefit of plenty of headroom in his workshop. If this is available, there would seem to be some scope here for a single system supplying all the machines in a workshop. This could be achieved using the small pipe and fittings sold at garden centres for automatic watering systems. Ed.

A MEDIUM-

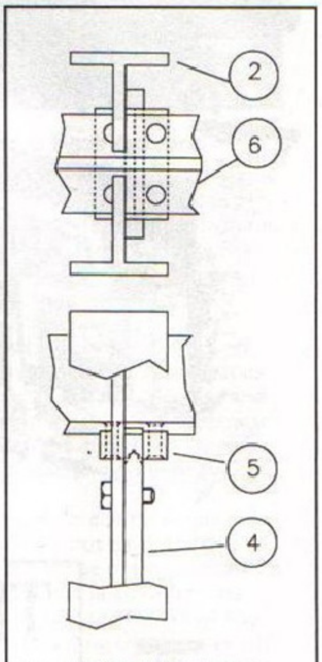


LOWER ARM GUIDES ASSEMBLY

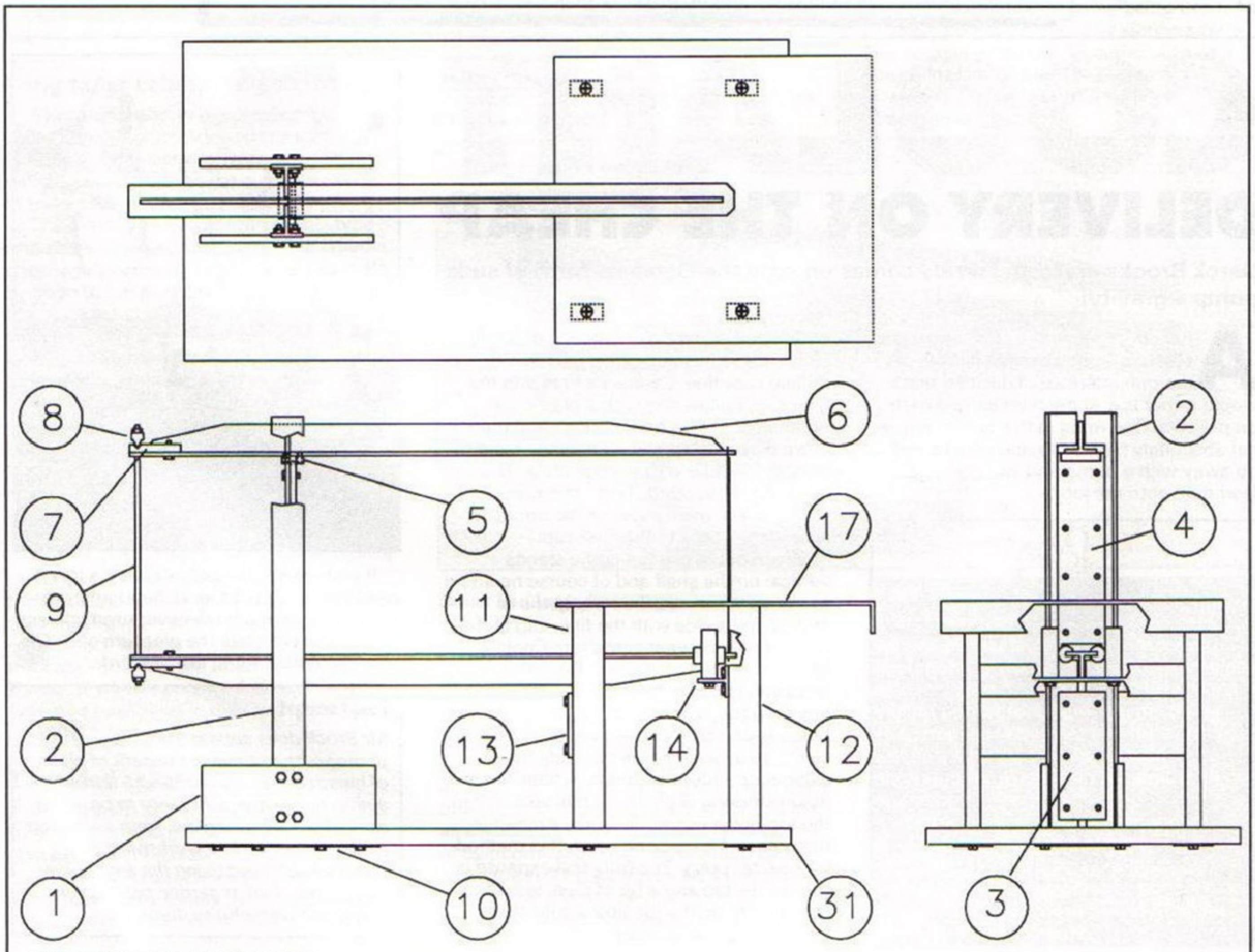
This medium duty fret saw, will prove useful for anyone intending to carry out intricate wood or light metal work. The prototype used a second-hand sewing machine motor and assorted aluminium scraps.



TENSION ASSEMBLY

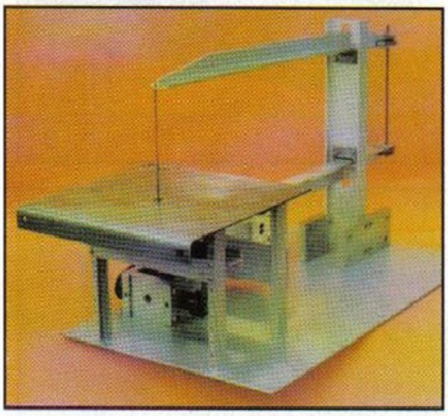


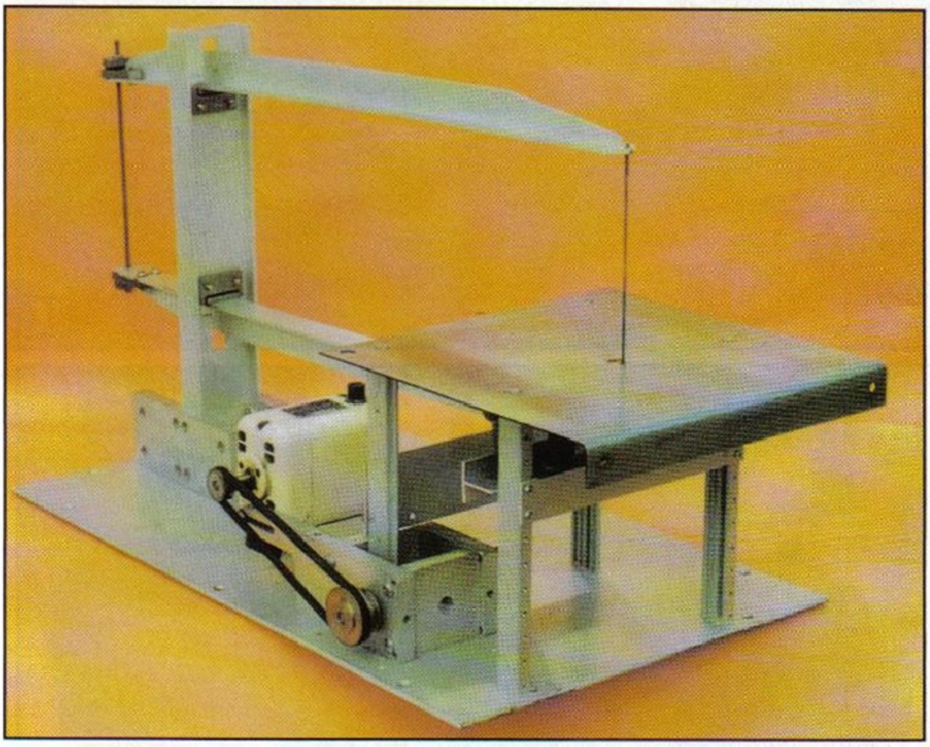
PIVOT ASSEMBLY



GENERAL ARRANGEMENT

-DUTY FRET SAW



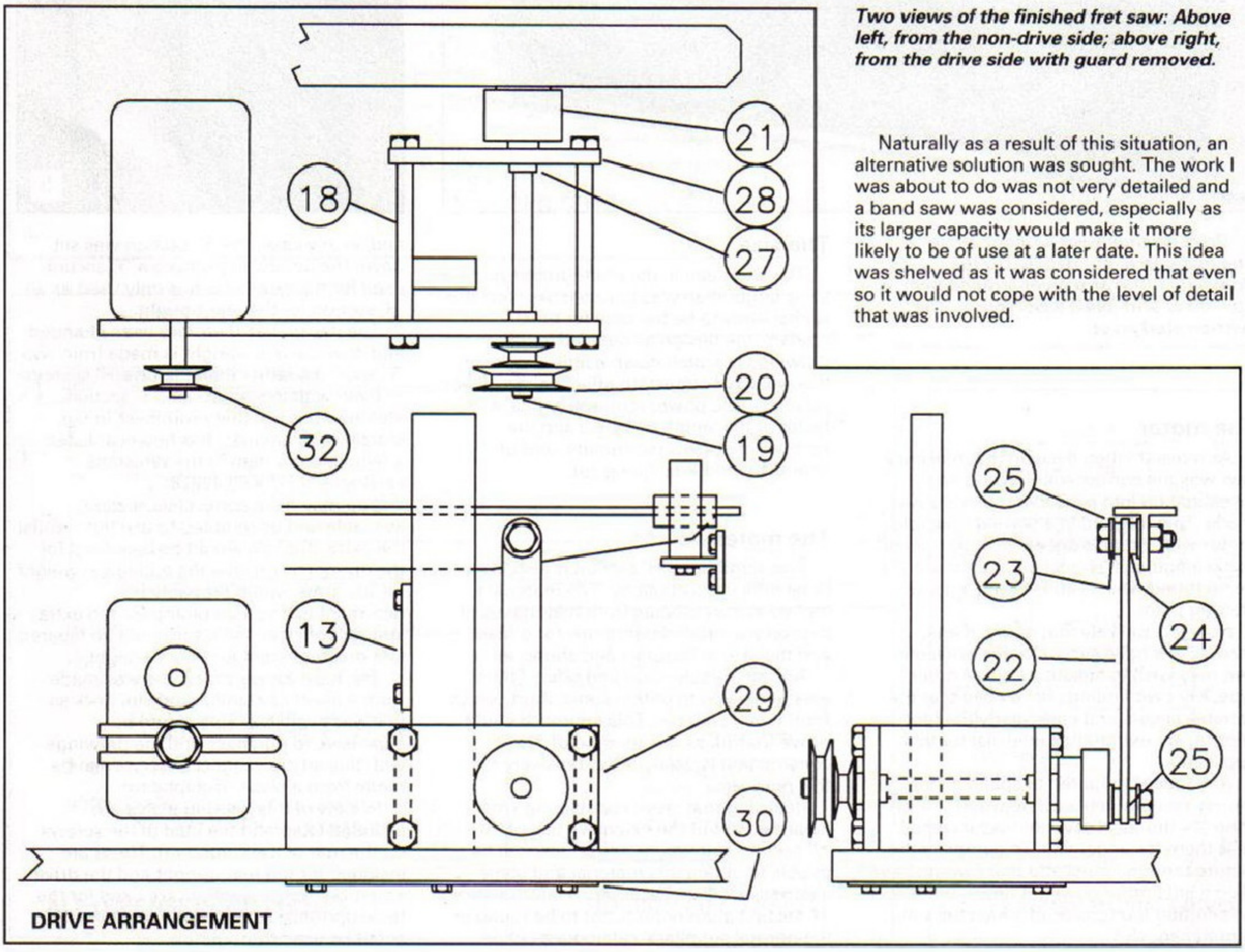


Two views of the finished fret saw: Above left, from the non-drive side; above right, from the drive side with guard removed.

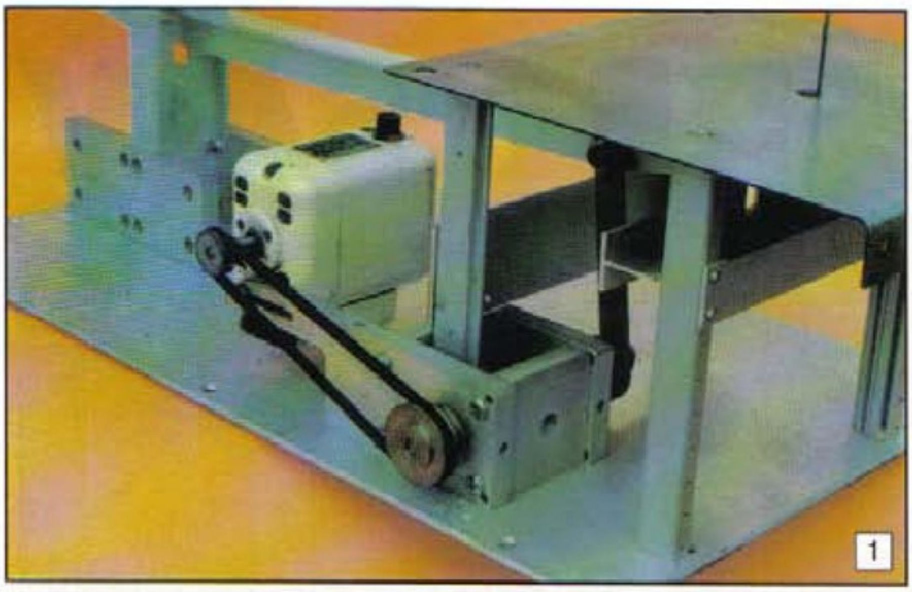
The desire to do some woodwork modelling led me to realise that for this to be a practical proposition a motorised fret saw would be a necessity.

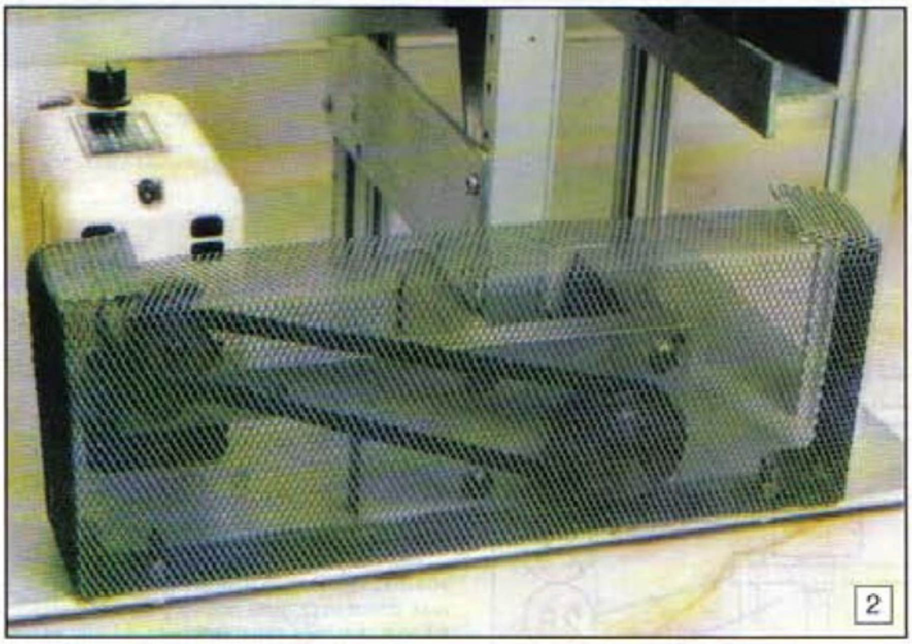
Those available were investigated, and small ones found not to be as expensive as anticipated; even so they did appear to be a little on the small side. Also as its use looked like being very limited, perhaps the one project only that I had in front of me at the time, any expense seemed difficult to justify.

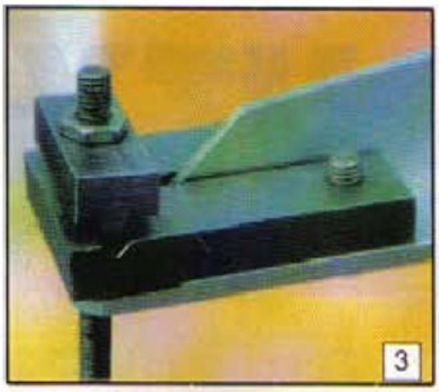
Naturally as a result of this situation, an alternative solution was sought. The work I was about to do was not very detailed and a band saw was considered, especially as its larger capacity would make it more likely to be of use at a later date. This idea was shelved as it was considered that even so it would not cope with the level of detail that was involved.

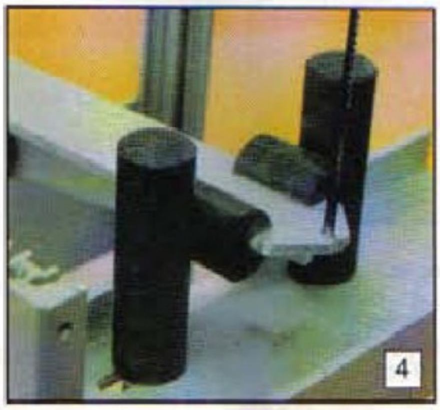


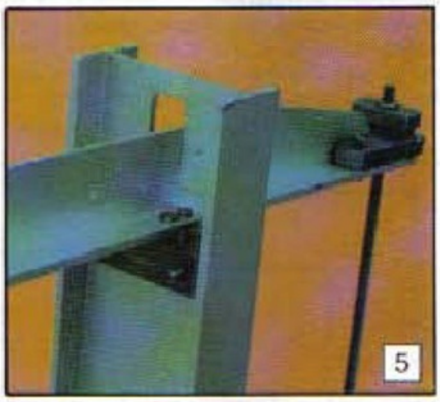
DRIVE ARRANGEMENT











1. Drive arrangement without guard. 2. The belt guard, not detailed in the drawing. 3. Top arm pivot arrangement. 4. The lower arm guide assembly. 5. The tension stud pivot.

The motor

As a result I then decided that making a saw was the correct solution and an investigation into available materials was made. This resulted in a sewing machine motor with variable speed foot control and some lengths of 'H' section aluminium being found which I considered a good starting point.

Now it is unlikely that many, if any, readers will have such a motor available and may wish to substitute some other type. My own findings have been that the variable speed, and particularly the foot control, are extremely beneficial for this application.

Any reader prepared to spend a little money could purchase a new motor and control – our local sewing machine shop sells them for under £30. To complete the picture though I must add that I would have liked a little more power at times, but then I *was* cutting four pieces of ¾ inch thick oak simultaneously!

The size

The saw seen in the photographs proved to be larger than was required. As I feel this is also likely to be the case for most readers, the design as detailed in the drawings is scaled down a little. However, this will have almost no effect on the power required. The power required will be a factor of the length of stroke and the number of strokes per minute, and of course the material being cut.

The materials

The aluminium 'H' section is also likely to be difficult to come by. The material I had was short off-cuts from material used to produce internal partitions, for offices and the like, in factories and shops, etc.

A local friendly shop and office fitters may allow you to obtain some short pieces from their scrap bin. This approach could prove fruitful, as this method of construction is used very extensively for this purpose.

Realising that, even considering what I have said about the extensive use of this 'H' section aluminium, most I feel will be unable to obtain this material and some alternative will be necessary. Unfortunately, 'H' section aluminium is not to be found in the normal suppliers' catalogues either and, in any case, the 'H' section was slit down the middle to produce a 'T' section used for the arms and was only used as an 'H' section for the rear upright.

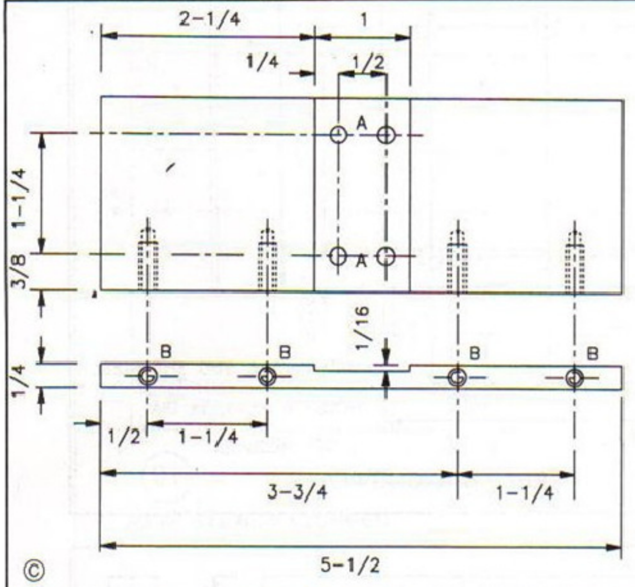
The design has therefore been changed and now the rear upright is made from two 'T' sections, rather than the one 'H' section.

Even with this approach, 'T' section aluminium is not that prominent in the suppliers catalogues; it is however listed as a regular stock item in the Whistons catalogue (Tel. 0663 42028).

You may have some steel section available and be tempted to use this. Whilst the extra strength would be beneficial for the upright, I consider the additional weight for the arms would probably be detrimental. If you do plump for the extra strength of steel, the arms could be tapered to a greater extent to reduce weight.

The base for the prototype was made from a sheet of aluminium ⅜ in. thick as this was available. This would be expensive to purchase and the drawings with this article suggest the base can be made from a piece of chipboard.

In view of this backing plates are included to spread the load of the screws on the rear of the chipboard. These are included for the rear upright and the drive assembly. Large washers are used for the table uprights. Alternatively large washers could be used throughout.



MATERIAL 2 X 1/4 ALUMINIUM.

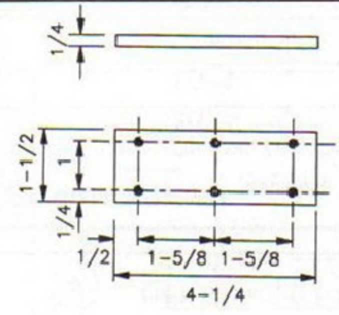
HOLES A. 4 X 11/64 DIA.
B. 4 X M4 X 1/2 DEEP

2 OFF REQUIRED.

UPRIGHT SUPPORTS

1

©



MATERIAL 1-1/2 X 1/4 BRIGHT MILD STEEL.

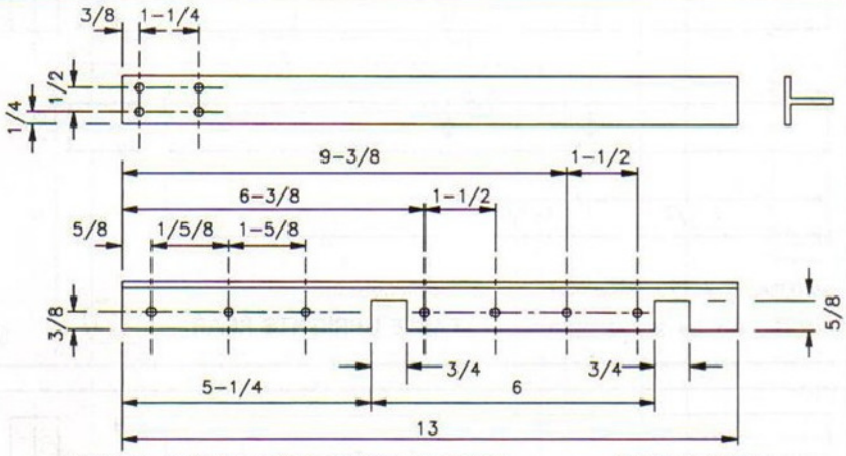
HOLES 6 X M4.

UPRIGHT STRAP

1 OFF REQUIRED.

3

©



MATERIAL 1 X 1 X 1/8 T SECTION ALUMINIUM.

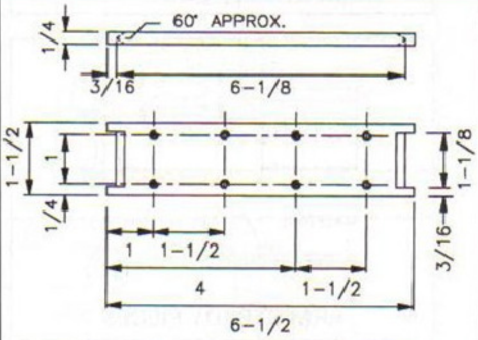
2 OFF REQUIRED

HOLES 11 OFF 11/64 DIA.

UPRIGHTS

2

©



MATERIAL 1-1/2 X 1/4 BRIGHT MILD STEEL.

HOLES 8 X M4.

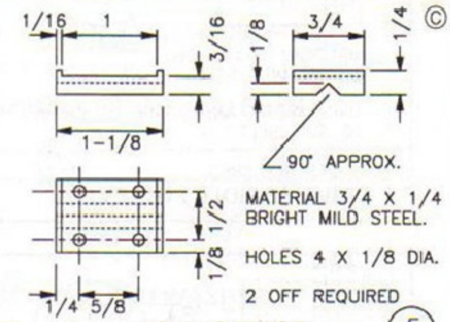
FIXED PIVOT

4

1 OFF REQUIRED.

©

©



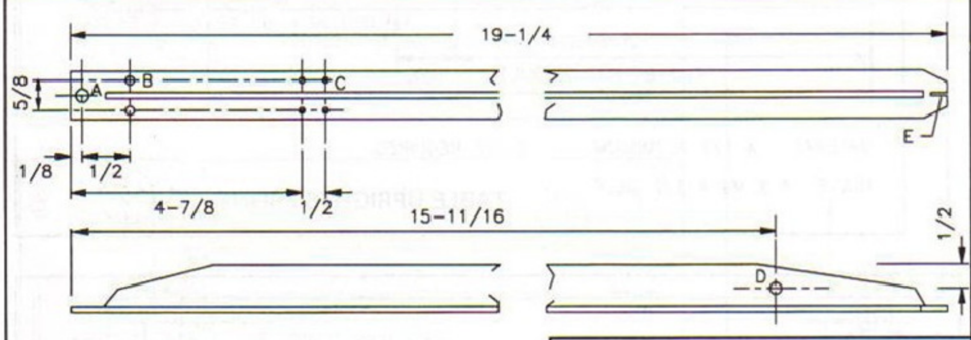
MATERIAL 3/4 X 1/4 BRIGHT MILD STEEL.

HOLES 4 X 1/8 DIA.

2 OFF REQUIRED

MOVING PIVOT

5



MATERIAL 1 X 1 X 1/8 T SECTION ALUMINIUM.

HOLES. A 3/16 DIA.
B 2 X 11/64 DIA.
C 4 X 1/8 DIA.
D 13/64 DIA. ONE ARM ONLY.
E SLOT 3/16 LONG X 1/32 WIDE.

2 OFF REQUIRED.

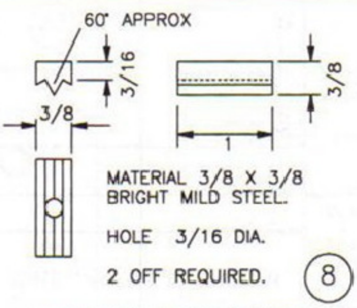
NOTE. SHAPE GENERALLY AS SHOWN WHERE NOT DIMENSIONED.

ARMS

6

ALL DIMENSIONS IN INCHES.

©



MATERIAL 3/8 X 3/8 BRIGHT MILD STEEL.

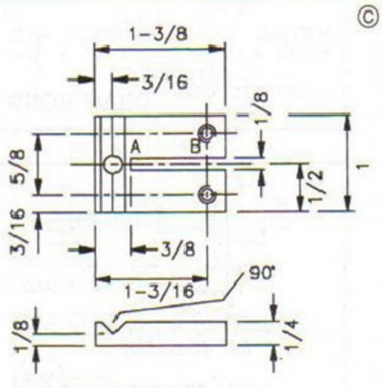
HOLE 3/16 DIA.

2 OFF REQUIRED.

8

TENSION FIXED PIVOT

©



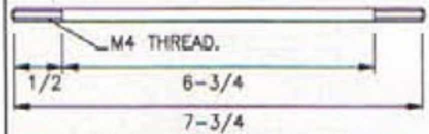
MATERIAL 1 X 1/4 BRIGHT MILD STEEL.

HOLES. A. 3/16 DIA.
B. 2 X M4

2 OFF REQUIRED.

7

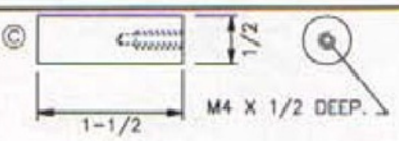
TENSION MOVING PIVOT



MATERIAL 5/32 DIA BRIGHT MILD STEEL.

1 OFF REQUIRED.

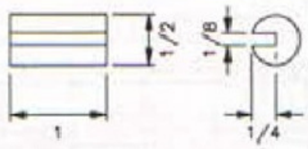
TENSION STUD (9)



MATERIAL 1/2 DIA NYLON 66.

2 OFF REQUIRED.

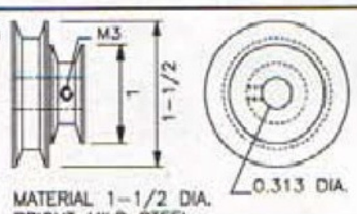
ARM STEADY POST (15)



MATERIAL 1/2 DIA NYLON 66.

2 OFF REQUIRED.

ARM STEADY PIECES (16)

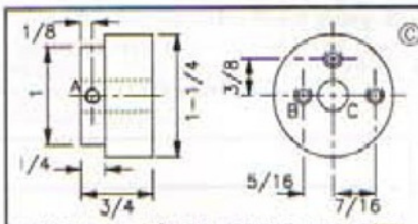


MATERIAL 1-1/2 DIA. BRIGHT MILD STEEL.

MAKE WIDTH, AND SHAPE OF GROVE, TO SUIT BELT.

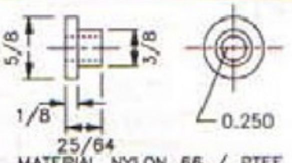
1 OFF REQUIRED.

DRIVE SPINDLE PULLEY (20)



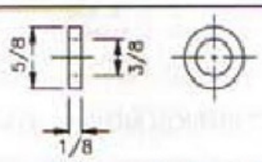
MATERIAL 1-1/4 DIA. BRIGHT MILD STEEL
HOLES A. M3. B. 3 X M5 X 3/8 DEEP
C. 5/16 DIA.
1 OFF REQUIRED.

DRIVE BOSS (21)



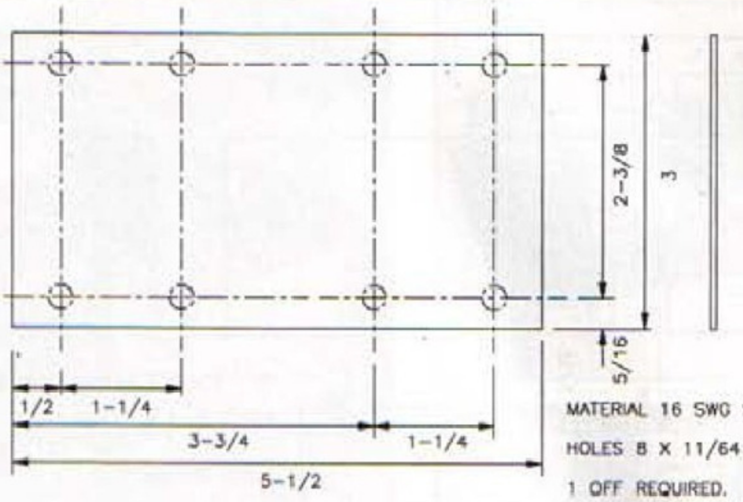
MATERIAL NYLON 66 / PTFE
2 OFF REQUIRED.

LINK BEARING (23)



MATERIAL NYLON 66 / PTFE
2 OFF REQUIRED.

BEARING BUSH (24)

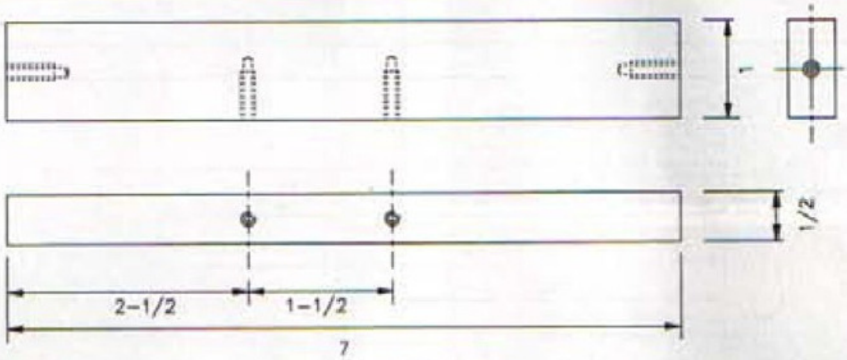


MATERIAL 16 SWG SHT STEEL

HOLES 8 X 11/64 DIA.

1 OFF REQUIRED.

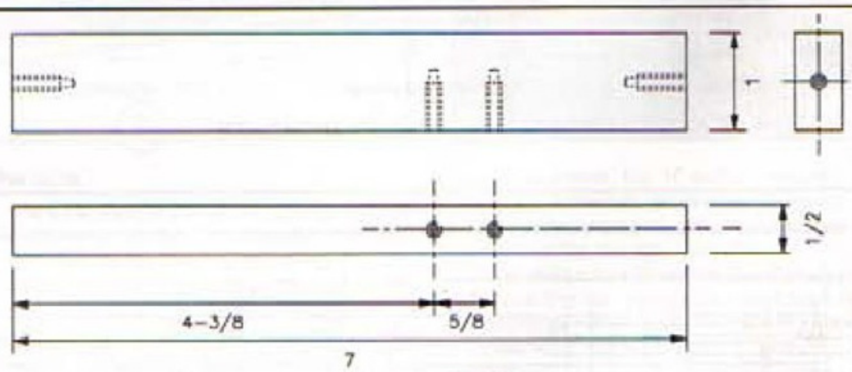
REAR BACKING PLATE (10)



MATERIAL 1 X 1/2 ALUMINIUM. 2 OFF REQUIRED.

HOLES 4 X M4 X 1/2 DEEP.

TABLE UPRIGHTS REAR (11)



MATERIAL 1 X 1/2 ALUMINIUM. 2 OFF REQUIRED.

HOLES 4 X M4 X 1/2 DEEP.

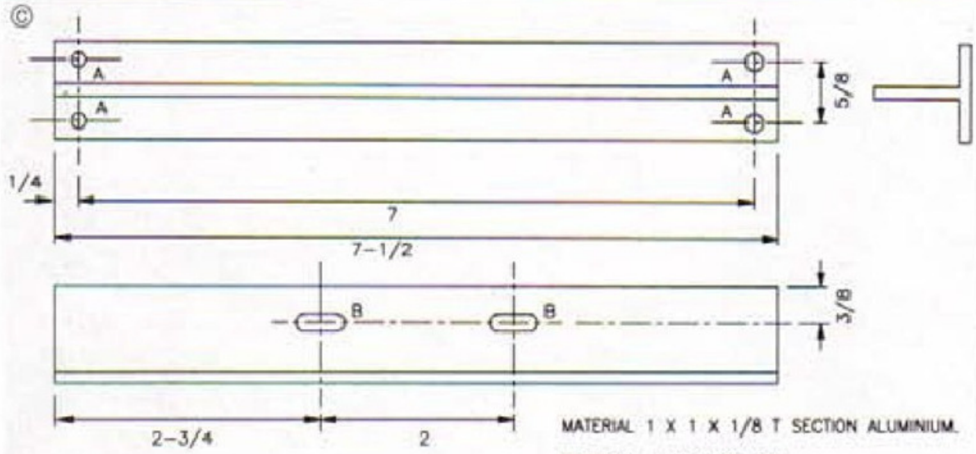
TABLE UPRIGHTS FRONT (12)

MATERIAL 16 SWG SHT STEEL.

HOLES 4 X 11/64 DIA.

1 OFF REQUIRED.

TABLE UPRIGHT STRAP (13)

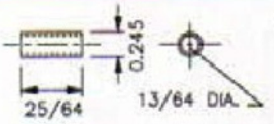


MATERIAL 1 X 1 X 1/8 T SECTION ALUMINIUM.

HOLES A. 4 X 11/64 DIA.
B. 2 SLOTS 3/16 X 3/8.

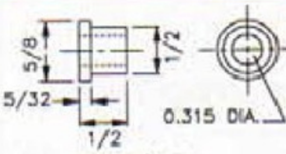
1 OFF REQUIRED.

ARM STEADY CARRIER



MATERIAL 5/16 DIA B M S.
2 OFF REQUIRED. (26)

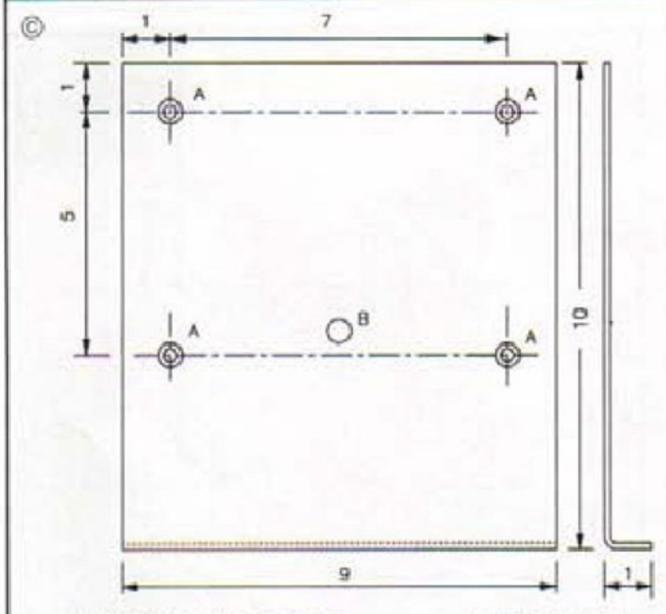
LINK BEARING PIN



MATERIAL 5/8 DIA.
NYLON / PTFE.

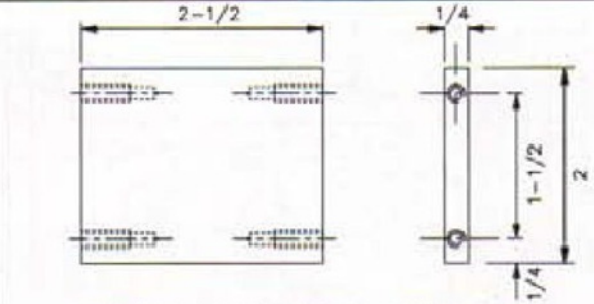
2 OFF REQUIRED. (27)

DRIVE BEARING



MATERIAL 16 SWG SHT STEEL. 1 OFF REQUIRED.
HOLES A. 11/64 DIA. CSK FOR M4.
B. 1/4 DIA. POSITION TO SUIT ON FINAL ASSEMBLY.

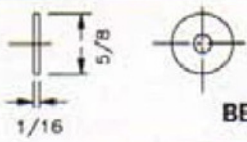
TABLE (17)



MATERIAL 2 X 1/4 ALUMINIUM. 2 OFF REQUIRED.

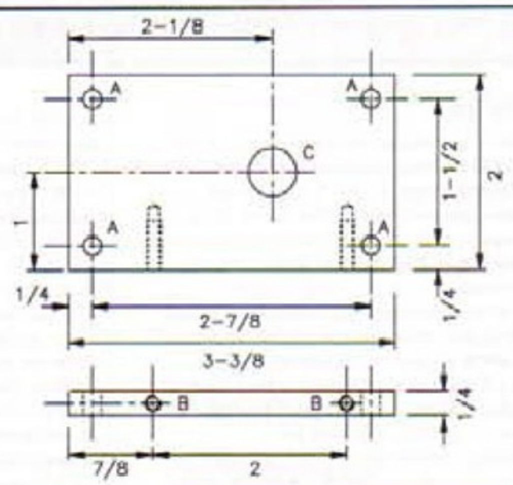
HOLES 4 X M4 X 1/2 DEEP. (18)

DRIVE ASSEMBLY FRONT AND REAR



MATERIAL 5/8 DIA. B M S.
HOLE 13/64 DIA.
4 OFF REQUIRED.

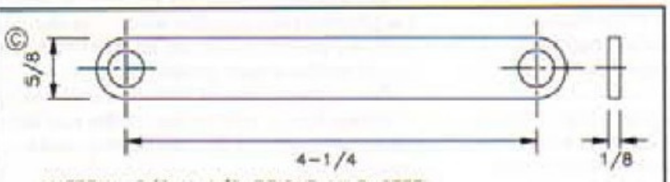
BEARING END WASHER (25)



MATERIAL 2 X 1/4 ALUMINIUM. 1 OFF REQUIRED

HOLES A. 4 X 13/64 DIA.
B. 2 X M4 X 1/2 DEEP.
C. 1/2 DIA.

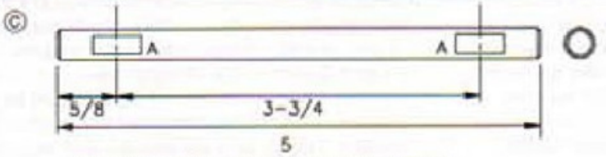
DRIVE ASSEMBLY RIGHT SIDE (28)



MATERIAL 5/8 X 1/8 BRIGHT MILD STEEL.

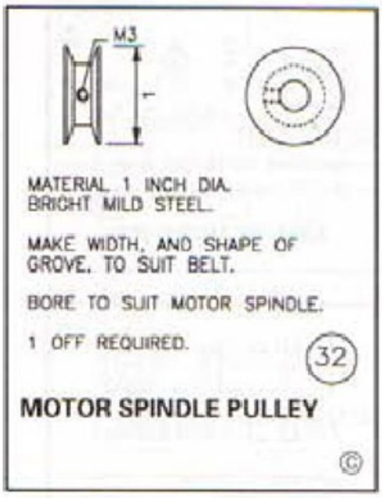
HOLES 2 X 3/8 DIA. 1 OFF REQUIRED.

LINK (22)

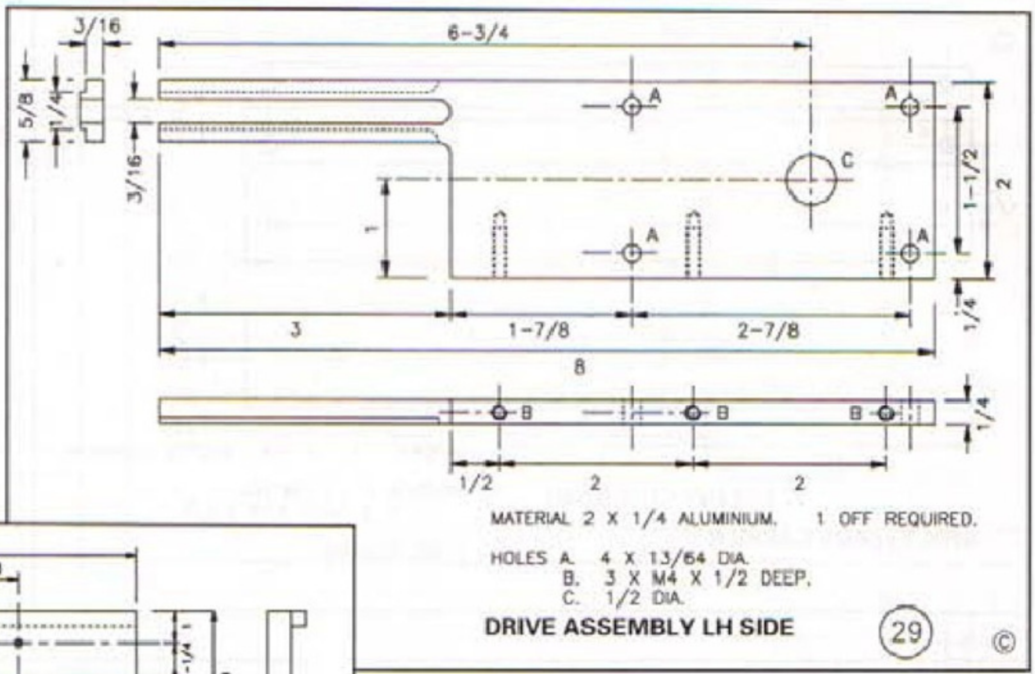


MATERIAL 5/16 DIA. BRIGHT MILD STEEL.
A. 2 FLATS 1/2 X 3/16
1 OFF REQUIRED.

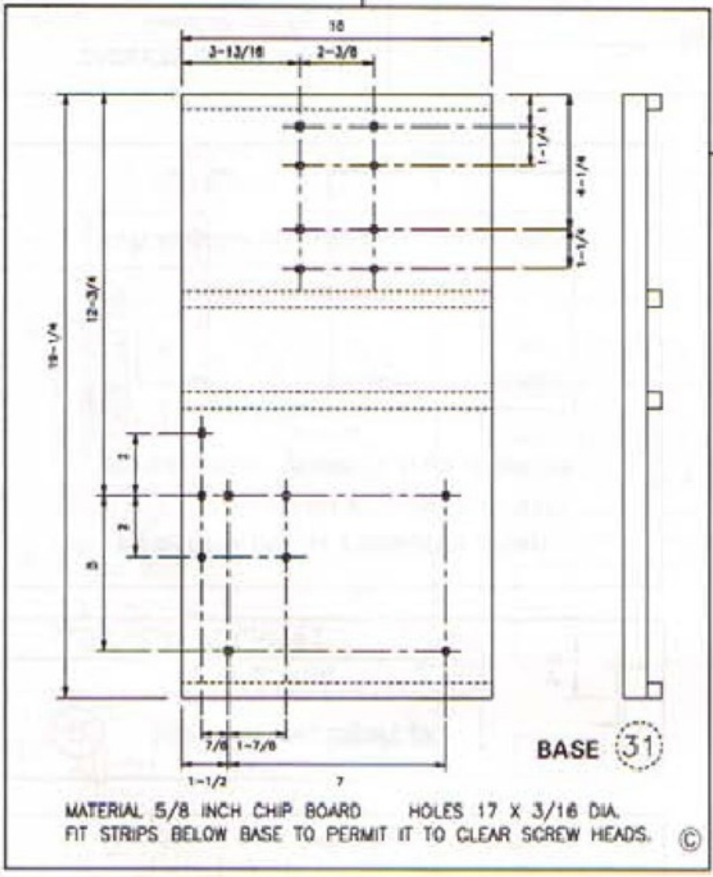
DRIVE SPINDLE (19)



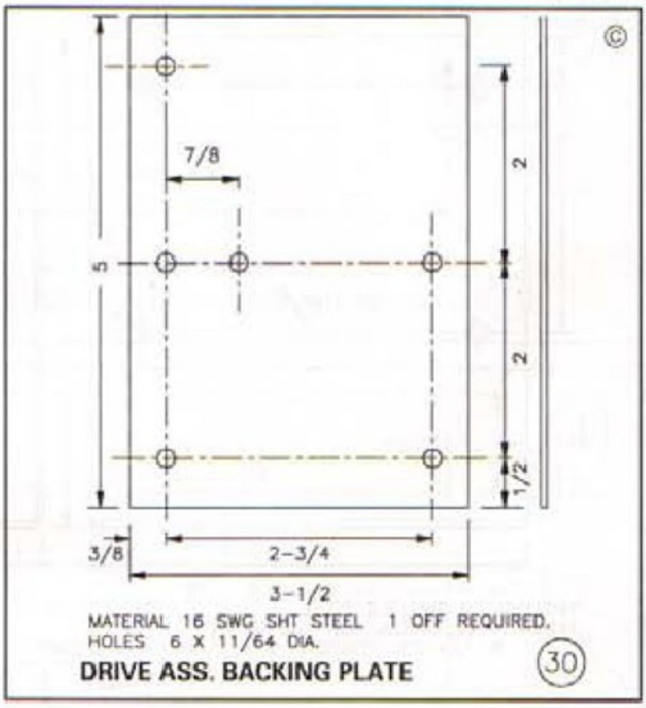
MOTOR SPINDLE PULLEY



DRIVE ASSEMBLY LH SIDE



BASE



DRIVE ASS. BACKING PLATE

The design

As the original was to be used for work which was not very detailed and also of a heavy nature, coping saw blades were used rather than the finer fret saws. Any reader wishing to use fret saws could easily adapt the blade fixings to suit this requirement.

The drive arrangement consists of a belt drive from the motor to a spindle. The saw arm is operated via a link, being driven from an off centre screw positioned on a boss at the end of the spindle. The belt used was a sewing machine belt.

The pulley on the end of the spindle, has two diameters, thus providing two speeds. The boss is provided with three different off centre positions, thus achieving three lengths of blade travel.

As the various parts in the drive assembly were also made of aluminium, this was obviously not suitable as the bearing material for the drive spindle. To keep the construction as simple as is possible, the bearings for the spindle, and also those in the ends of the link, are bushes made from graphite filled nylon. If this is not available standard Nylon 66 would suit.

Better still would be to use PTFE and, if no suitable material is available, and some has to be purchased, then without doubt PTFE should be obtained. This and Nylon 66 are readily available from a number of suppliers, including Whistons.

When machining PTFE do take care to avoid overheating it as a result of too high a speed and/or too heavy a cut. If its temperature exceeds 270 deg. C it will give off a gas which will be very unpleasant if inhaled. Also refrain from smoking, in case any particles are drawn into the burning tobacco.

If it is anticipated that the saw will be used extensively, then it could be considered a good idea to incorporate ball races.

The original has been used at slowest speed, and shortest blade travel, this giving the greatest power at the blade. For lighter work the saw could be set for either a faster speed and/or longer stroke.

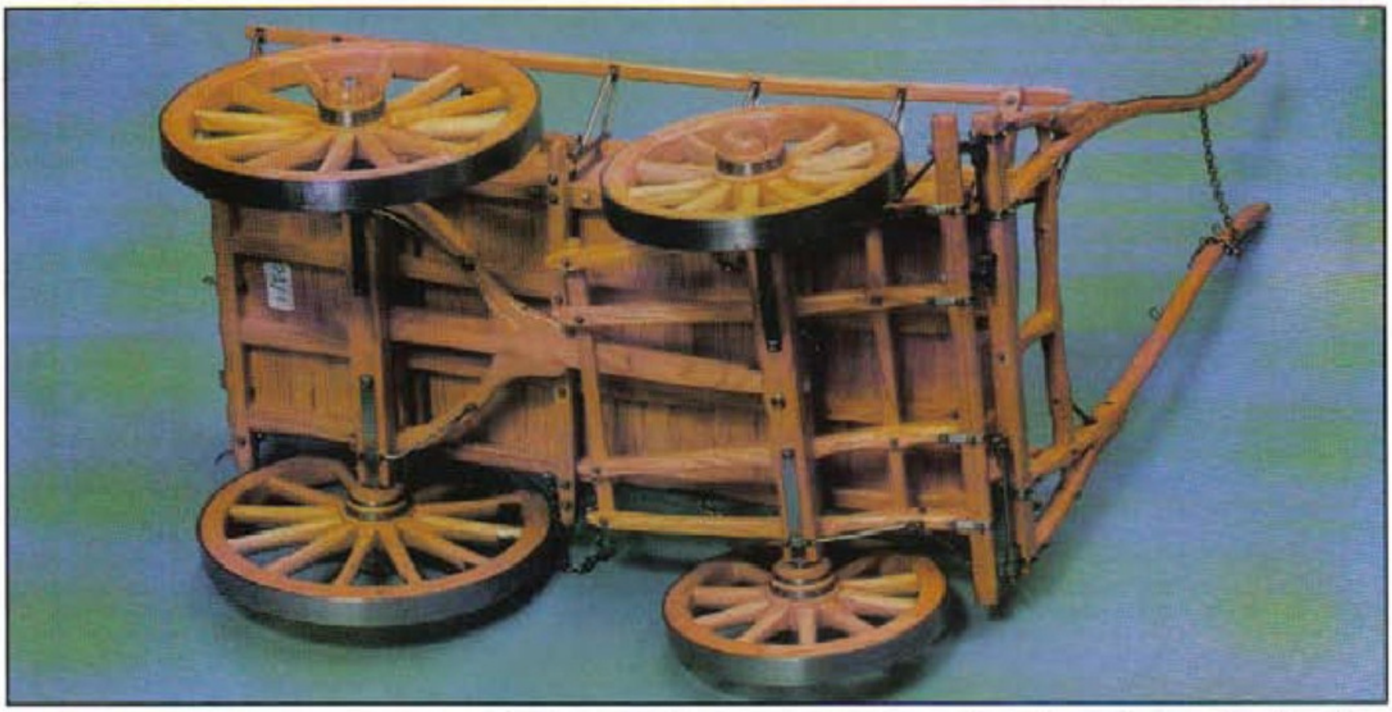
Due to the length of the arms and the relatively light construction, deflection of the arms to the left and the right is quite easy.

To eliminate this the lower arm is restrained from sideways movement by two nylon posts, one on either side. These posts are mounted with slots so as to permit adjustment, thus enabling sideways movement of the arm to be eliminated. To improve the operation of this, the sides of the arm are also faced with nylon, as can be seen clearly in the photograph.

As the upper arm cannot be steadied in this way, some movement will still exist on this arm. The slightly smaller all round dimensions and more robust 'T' section, will make the assembly more rigid, which will improve this condition.

To minimise the effect of the upper arm

The reason for making the fret saw in the first place; the editor's charming model farm wagon.



moving, the table is positioned at its lower possible level, thus making sure that the cut taken is at the most stable part of the blade. The arms pivot on a knife edge, mounted on the rear upright, with a vee groove on the arm. These are in the form of bright mild steel add-on components, rather than 'V' grooves being cut into the aluminium arms direct, which would be too soft for the purpose.

Tension of the blade is created by a stud with nuts to pull the arms together at the rear end; this is also pivoted with a knife edge into a 'V' groove. If very extensive use of the saw is envisaged, then making these pivot components out of gauge plate and hardened may be beneficial. The arrangement of these can be seen in the photographs.

The work table stands on four uprights which also carry a support angle for the nylon posts mentioned above. The posts have cross straps fitted for added stability. The rear left hand post is fixed to the drive assembly for additional support.

Manufacture

Manufacture of the saw should present very little problem to the average home machinist and, as the drawings are fully detailed, only limited comment is being made on the subject.

The moving pivot **item 5** should be drilled and then the holes transferred to the arms **item 6**. The method of fixing these two parts together is by riveting using 1/16 in. bright mild steel pins 3/16 in. long – lightly riveted on both sides.

In numerous places the holes in one part are required to line up with those in another. These are mostly for parts being screwed together where the clearance over the screw will permit a degree of error. Even so it is probably easier, at least in some cases, to drill part A and then to use this to drill part B, as in the above case.

The arm steady pieces are slotted along their length for fixing to the lower arm. Fix using two-part quick setting resin adhesive.

If making the various bearings from nylon, take note that it was found that the thermal expansion of this material is greater than that for other materials. The result of this was that, when in continuous use, the bearings tended to seize. This was overcome by increasing the clearance to about two thou.

The work table **item 17** is drawn with a return on the front edge; this serves little purpose other than appearance. The table will be strong enough without this return and as sheet metal bending is difficult without the required tools, this could be omitted if it proved to be a problem.

QUICK TIPS

Grind the shank of a suitably large broken drill to produce a tapered file-tang shape. Fitted with a file handle and resharpened, they make ideal tools for de-burring drilled holes.

W. Brian Taylor

MAKING A SMALL FOUR JAW CHUCK

In this another article by Mr Loader of Harlow, he describes a 3- ¼in. four jaw chuck of slightly unorthodox construction. This enables it to be made on a small lathe only, In Mr Loaders case a Unimat 3. The drawings for this chuck are our free pull-out plain in this issue.

I wonder if those who are thinking about buying or replacing a lathe, ever consider having a four jawed chuck instead of the normal three jawed one. Not a self-centering one, they are a bit limited and cannot be off-set or precisely true. Perhaps the thought of lining up each time is a bit daunting. It need not be, because there aren't many jobs which take more than a few minutes to set running true enough for most purposes.

When my wife bought me my Unimat 3 several years ago, it had the standard equipment and I was glad enough to accept it. I suspect that this is the reason why purchasers don't think of an alternative, because a three jawed chuck is standard. So we get conditioned to thinking that it is the only way to buy a lathe, with a three jawed chuck as the main holding device.

Having done just that, I was quite happy for a long time but I did think from time to time that a four jawed chuck would be a useful accessory. I also thought about the £80 or so it would cost and that, in turn, led to other ideas and one or two sketches on scrap paper. The sketches became a little more tidy and the ideas grew into a project.

1: ***The starting point, the machined cast iron disc and the almost useable backplate.***

Along the way I dismissed some ideas which were not very practical and chose a conventional design which tied in with bits and pieces I had, including an almost ready backplate and a cast iron disc in the rough, about 1 in. thick and 4 in. diameter.

I intended to do everything on the Unimat and it was only the preliminary hacking down of the cast iron disc for the body which I didn't. Had I been forced to, I would have done that too on the Unimat, probably by drilling and tapping it and bolting it to the face plate. Instead, I did it at the company I worked part-time at, where the people I worked for couldn't have been kinder and let me use the Harrison M300 which I worked on. It had rock-solid bearings, two axis digital read-out and all the trimmings. It made light work of the disc.

Those less lucky than me could perhaps borrow the larger lathe of a friend, or go to the local college for a term's model engineering: there must be many jobs outside the range of a small lathe which could be done at the same place.

Hand on heart, everything else has been done on my Unimat with the standard accessories and a 2 in. angle plate. Some of the set-ups are a bit improvised, but that's all part of the fun.

The size I chose was 3 ¼ in. which seemed to be the right size for the Unimat, it could be scaled up for a larger lathe without too many problems.

I have used imperial units except where I have had to do otherwise and all the dimensions on the drawings are nominal; common sense will determine if there is a need to be careful. **Photograph 1** shows the starting point, the body disc as it came off the Harrison M300, and the almost ready-made backplate.

Backplate

I started with the backplate because it was the one thing which needed hardly any work. I skimmed the face level, opened out the hole, tapped it M14 x 1, screwed it to the lathe spindle and skimmed it true. A look at the assembly drawing, **Fig. 1**, shows how it has to do several jobs; locate the chuck body, locate and clamp the front plates, hold the screw retainers and clamp the bearing block. **Fig. 4** shows the backplate. Mine was made from cast iron, I think it may have been a cylinder cover and it had holes ready drilled in four positions just right, so I opened them up to No. 19, which clears 4mm. I used 4mm. cap head screws because I had some and the taps too. 2BA would do just as well. The other holes were left till later. If no cast iron is available, mild steel makes a good alternative.

Drilling methods

I used three methods for drilling. For accuracy and alignment, the component was clamped to the cross slide, packed up to correct height, lined up and drilled from the headstock. This was also the way the larger drilling jobs were done. For shallow or small holes and hand-held work, the faceplate was screwed to the tailstock and used as a drilling pad. Where the work had to be clamped or the drill reach a long way, the 2 in. angle plate was clamped to the cross slide, lined up and the work clamped to it. For locating centres I used a ground 60 degree included point made from a broken end mill and accurately ground on a cylindrical grinder, when I had access to such machines. It picks up a centre punched or centre drilled hole, or the junction of two scribed lines.

Preliminary drilling

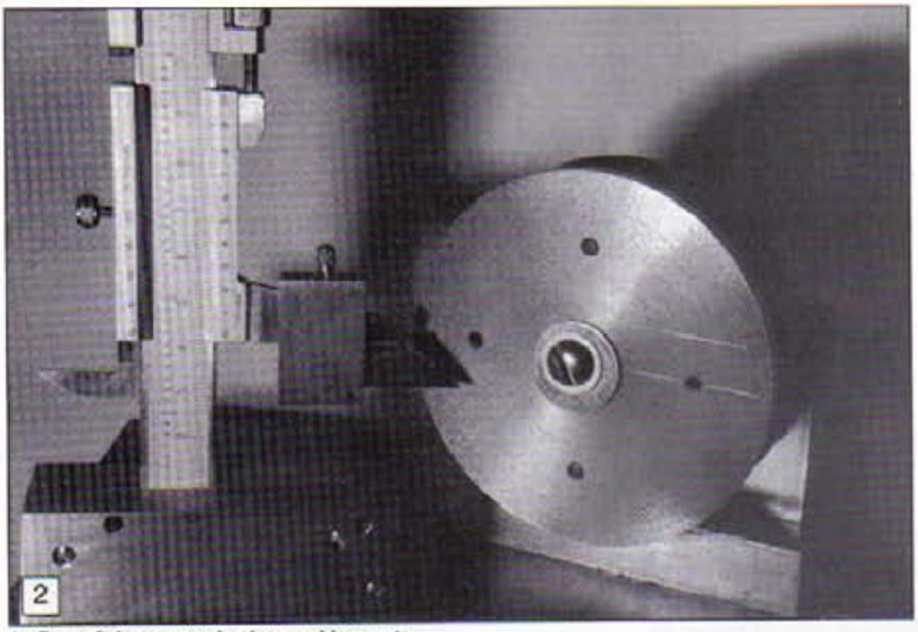
Nothing much can be done till the back plate is clamped to the body, so I assembled the backplate in the recess in the body, spotted through the No. 19 holes, took the backplate off and drilled where I'd spotted. I used No. 20 so that there was a bit extra clearance in the body. For all the drilling, I used a series of drills to make life easier for the lathe, starting with one about 3/32in. and working up. When the drilling was finished I centre punched lightly on the backplate and the body, so that I'd have a guide for lining up.

Front plate

This was a disc of cast iron but could be mild steel. It is made as one thing and cut into four sections as shown in **Fig. 3.** Separating into four is only done after all the drilling, tapping and reaming has been done.

I made it 5/32in. thick, because it tied in with the cutters I had. It could be a bit thicker, but no smaller than 1/8in. because of the thickness for the threads and dowels to register. Also, if it isn't 5/32in. it will land you with a major re-design job, as it would change some of the important dimensions. If it is made from sheet, cut it roughly circular, drill a 3/8in. or 10mm. hole in the centre and turn it on a bolt used as a mandrel, to about 1/32in. over the 3 ¼in. finished diameter.

To drill it, I clamped the backplate to it as accurately as possible, spotted through with the No. 19 drill, followed with the 4mm tapping drill, a No. 30, and tapped the holes. I left the two clamped together while tapping, so that the clearance hole helped



2: *One of the stages in the marking out.*

to guide the tap.

With the 4mm holes tapped, the backplate, body and frontplate can be clamped together. So the next thing I did was to screw it on to the lathe spindle and bore out the centre of the frontplate to 25/32in. It gave an idea of what the finished chuck would look like, spinning at more or less full size and bulk. It was quite happy so far.

To mark out the dowel holes and the other threaded holes marked B, C and D in **Fig. 3**, I put a centre punched plug in the hole in the frontplate and marked the pitch circles with dividers. The spacings can be picked up by lining up with the 4mm tapped holes, and the others by trial and error with dividers. It can be worked out by trig., but trial and error is often quicker.

The rest of the marking out I did by clamping the assembly to the 2 in. angle plate, through the centre hole and one of the clearance holes in the angle plate. There are four of these in each face, drilled 9/32in. so that a 1/4in. bolt clears nicely. My 8 in. by 6 in. surface plate made a good datum to work from, but don't get too excited if you haven't got one, use a piece of thick glass, a marble cheese board or anything flat enough.

The 2 in. angle plate is ground on the sides as well as the faces, so once clamped it can be turned 90 degrees without unclamping. I marked the centre lines for the jaw slots in the body and the guide lines for cutting the front plate into four. **Photograph 2** shows some of the marking out.

All the hole positions were centre punched and the drilling was done with the angle plate clamped to the cross slide and the body assembly clamped to that. The dowel holes were drilled No. 33 (0.113 in.) and the 2BA ones marked B on **Fig. 3** were drilled the same and left till later.

It took a long time, cranking the saddle to and fro, and clamping and unclamping for each hole position but I had to do it that way because the tailstock travel isn't enough to get the depth. I was tempted to take it to work and do it in a fraction of the time, but I kept faith and resisted.

Drilling completed, I reamed the dowel holes, those marked C and D on **Figs. 2 and 3**, by hand with everything still fastened together with the 4mm. I reamed till the reamer poked through about 1 1/2 to 2 diameters. With temporary dowels in place, I took off the backplate and reclamped body and frontplate together to drill the holes marked B in **Figs. 2 and 3.** They were drilled No. 25 right through, then I took off the front plate, opened up the body holes to No. 12 and countersunk them till a 2BA screw was just under flush in the body.

I clamped the front plate to the body again, with a couple of dowels to line up, and tapped the 2BA holes. The clearance holes kept the tap reasonably upright.

The eight dowels needed were made from 1/8in. silver steel and made 1/32in. shorter than the whole assembly, so that they would be just under flush when pressed in.

When everything was screwed and dowelled together and checked, the assembly was screwed to the lathe spindle and the outside diameter skimmed till body and front plate were flush. Sighting rings were machined in the front plate at 5mm. spacings with a Vee tool, these don't take much doing and are extremely useful for roughly setting work up.

Body machining

This was the big job and the whole thing would stand or fall by it. The 5/16in. slot for the jaws to run in were made by first drilling holes and then cutting out to slots. The hole positions were partly marked out from previous marking out and only needed the height from the back surface. I marked and centre punched them and checked very carefully with a scale reader. This is a clever little gadget which my daughter and son-in-law sent me from America. It is a magnifying lens on a stand which is set at the focal length from the base. It is extremely useful for all sorts of checking jobs.

The 5/16in. holes were drilled by clamping the body to the cross slide, packing underneath for height and lining up with centres in the headstock and tailstock, locating in the centre punched holes.

Each hole was centre drilled and drilled out by using a sequence of drills before the final 5/16in. one. It took about 10 minutes per hole, so counting the clamping and lining up time, it was one side of a C90 tape: I like to have music while I'm working. I put the packing away where I could find it again, because I'd probably need it later for a similar process.

To save wear and tear on the Unimat, the slots were roughed out before milling by hacksawing. This was not straightforward because my vice is a 2 3/4in. one and doesn't open enough to hold 3 3/4in. I improvised by holding a 1 in. by 3/4in. bar in the vice and clamping the chuck body to that. The sawing was another long job; the other side of the tape. It may seem to be an unnecessary stage in the making, but it is easier on the machine and probably quicker in the end. Confucius, that often quoted philosopher, had an expression for it: "foolish man wears out machine, wise man roughs out with hacksaw first."

The milling was no trouble once it was set up. An 8mm diameter bar with a centre drilled hole at one end was held in the chuck, passing through the 5/16in. holes and located in the centre by the tailstock. The 8mm bar took up the amount the drill had drilled oversize and the body was clamped to the angle plate resting on the cross slide, so that when it was rotated 90 degrees it

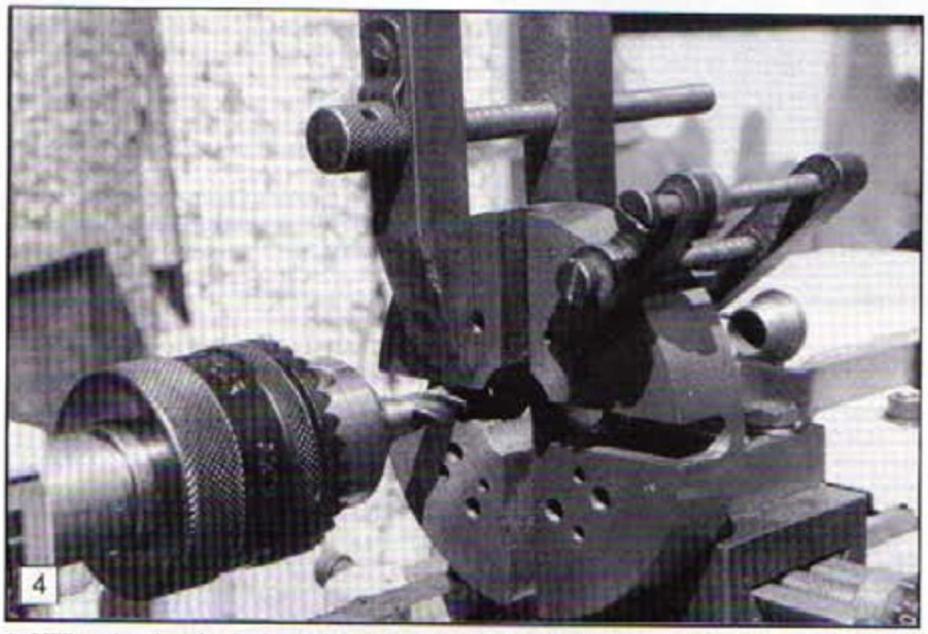
3: *Clamping the body to the angle plate so that the 5/16in. holes are in line. When the angle plate is turned and clamped, the body can have its slots cut.*

was in position ready for the milling to be done. **Photograph 3** shows the body being clamped to the angle plate before rotating or clamping it to the cross slide.

I used a 5/16in. end mill for finishing the slots, holding it in a 1/2in. capacity Black & Decker chuck which I have made an adaptor for to fit it on the headstock, or the tailstock. It took six or eight cuts to machine out each slot. **Photograph 4** shows the last one having its final skim.

Jaws

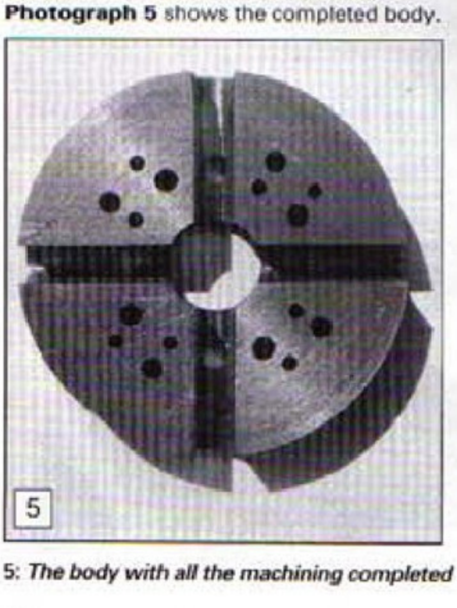
I chose to make the jaw threads 5/16in. BSF because I had four cap head screws that size and they are made from high tensile steel which would do nicely. I also thought that I had the taps. Luckily, when I found I hadn't, I had good friends who lent me a set. The idea jaw material would have been 5/16in. or 8mm. It is not an ideal world, and the material I had was some 3/8in. mild steel which I had to file down to 0.317 in.



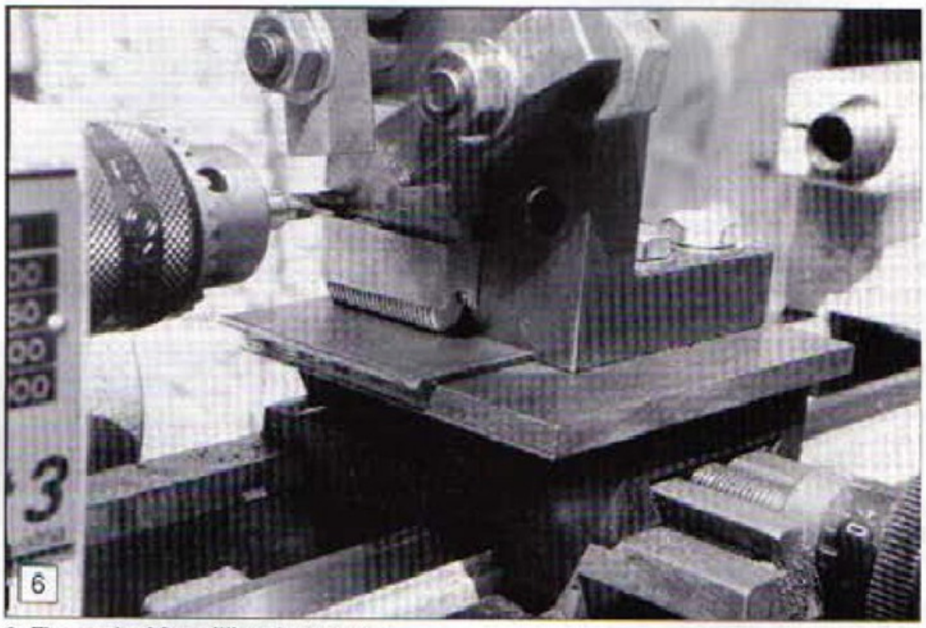
4: Milling the slots in the body, by making sure the body is hard up to the cross slide front aligns it.

Apart from taking a long time, the milling was uneventful but too noisy to play a tape. It needs care, slow feed for the cutter, the saddle locked for each cut, and the cross slide half locked, enough to put a bit of a drag on the movement. It is most important to remember that the small lathe isn't designed to hack off lumps of cast iron in this fashion. It is doing you a favour, so don't take liberties.

When the milling was finished, I drilled the holes in the body for the screw retainers. After I'd marked and centre punched the positions I used a centre drill, but to be sure I followed the centre drill with a 3/16in. drill to keep things central in the slot. I finished off with a 1/4in. drill. **Photograph 5** shows the completed body.



5: The body with all the machining completed



6: The method for milling the jaw slots

which was what the 5/16in. cutter had made the body slots. I have got a millenicut file, but even using that it took some time so, if you have it, use stock 5/16in. or 8mm.

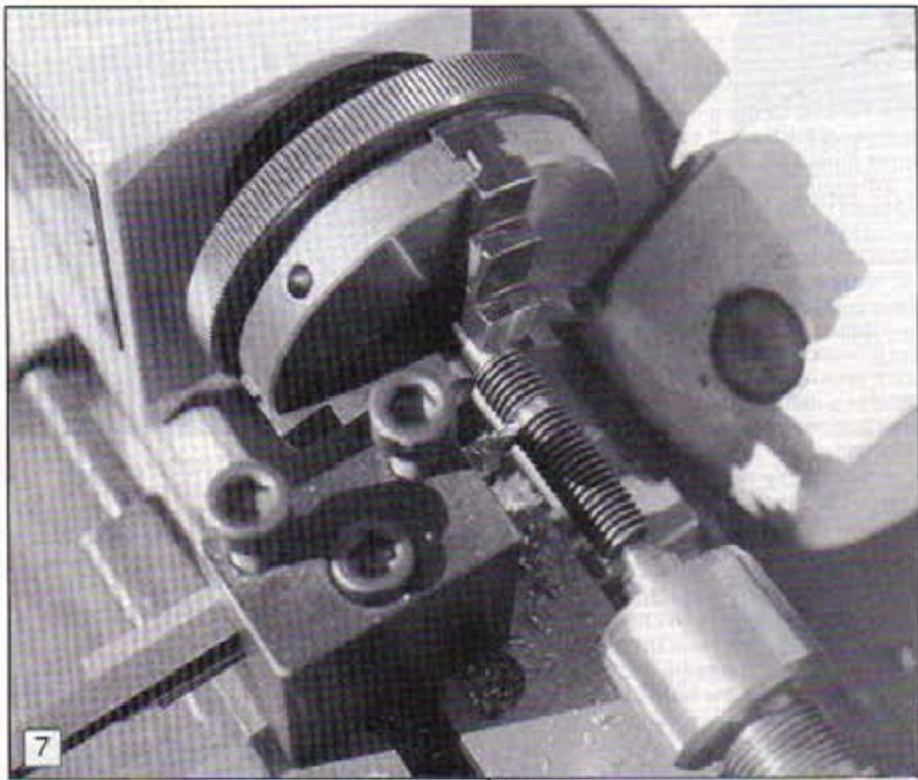
I made the jaws in pairs, so that I would only have to drill two holes and when tapped they could be split into two. It was another job to do on the cross slide, drilling from the headstock, after packing up for height and lining up square. As usual, the drilling was in easy stages, finishing with a 1/4in. The correct drill is 0.266 in. and I hadn't got one, so I relied on the tendency of the 1/4in. one to drill big. When I started the tapping it was a bit of a nerve-racking process. It isn't too bad when the taps are your own, but when they are borrowed it is another thing to cause a twitch or two. I started the taper tap true by clamping a 5/16 in. BSF nut over the hole and lining it up with a piece of 1/4in. diameter rod, before finally clamping. The taper tap went in till it started to make ominous clicking noises, then I cut with the plug till that went tight, then the taper again, and so on. When finished, the cap heads fitted a treat and I cut the rough jaws in two with a razor saw.

I milled the 5/32in. slots in the jaws for them to slide in the front plate, by clamping to the angle plate over a piece of flat plate to make a datum surface. I know the distance from the top of the cross slide to the centre line of my Unimat, it is 0.9045 in. as near as I can measure it. This made it fairly easy to work out how much packing I'd need to bring the jaw blank to the right height. **Photograph 6** will show the way it was done. Each jaw was seated on a short length of 5/16in. BSF thread located in the tapped part and stood off the datum by a packer of the calculated thickness to do the job. Jaw, threads, packer and datum must be spotless and burr free. An old toothbrush is ideal for cleaning the threads.

I used a 1/8in. three fluted end mill to rough out the slots down to 3/32in. deep, finishing to the same depth with a 5/32in. end mill. When all the slots were milled I deburred thoroughly and checked by trying the front plate in them. They fitted, so I put them to one side to finish off when the final fitting was done.

Jaw screws

These were the 5/16in. BSF cap heads. I cut off the heads and faced to 1 5/16in. then centred one end with a 3/16in. centre drill. The other end was turned to 1/4in. x 3/16in. as in **Fig. 5**. They were supported by a tailstock centre while I undercut them. I used a tool 0.075 in. wide because I had one that size. The undercut could be as small as 0.060 in. or as big as 0.080 in. but the screw retainer must fit. I used a speed of about 300 r.p.m., made sure that the tool was sharp, and had no problems.



7: ***Undercutting the jaw screws, note the tailstock centre to steady the work.***

Photograph 7 shows the set up.

On the subject of the jaw screws, the more observant will have noticed when comparing the detail drawing of the jaw screw with the assembly drawing, that they don't tally. When I first designed the job, I searched everywhere for 5/16in. BSF or 8mm socket screws to make the jaw screws from. I couldn't find any, even though I got an engineering supplier to enquire for me. After I'd made the ones shown on the assembly drawing, with the slot and pilot hole in them. I found some 8mm which were exactly what I needed. I am now making new jaws with 8mm threads. This is why I haven't included a drawing of the chuck key for the slotted jaw screws. If 8mm or 5/16in. BSF socket screws are available, use them, then you will only have to make a chuck key from a length of the appropriate hexagon key. If you have to make a chuck key for the slotted screws, it is like a thick screw driver with a pilot to guide it, made from silver steel, hardened and tampered, or mild steel case hardened.

Screw retainers

These are a simple little job. I used four pieces of ¼in. diameter mild steel, faced to 9/32in. long, filing the step on each side till they were an inverted T shape, with the upright of the T 0.070 in. and central. Next I filed the radius till it fitted a 7/32in. drill shank, checked that they fitted the jaw screw slot and eased them where I had to. When the fit was right, I case hardened them.

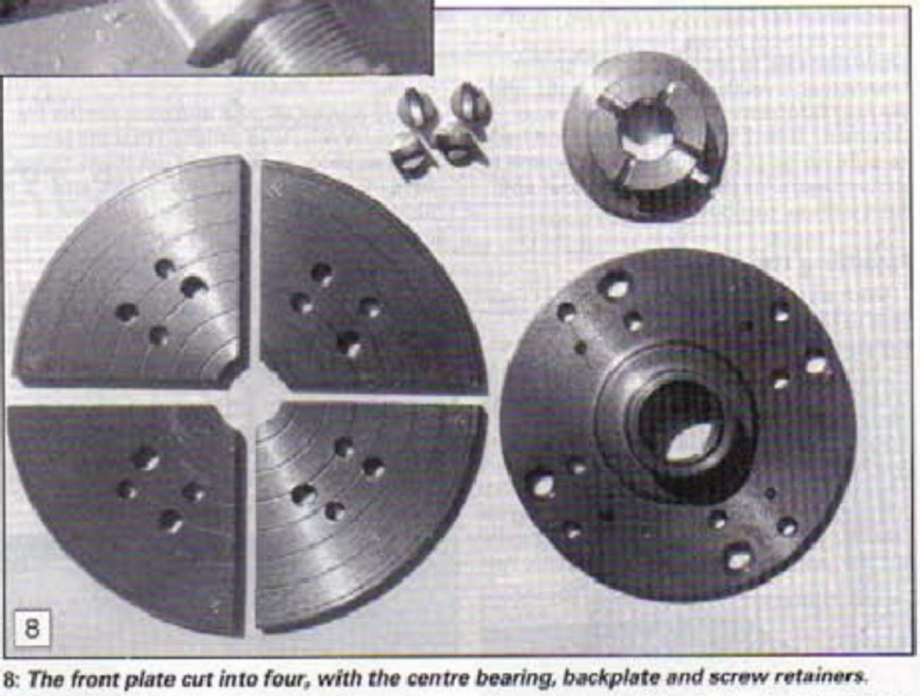
Centre bearing

Hard brass was the best material I had for this, although it could be made from bronze or cast iron. I made a mandrel to hold it on for finishing, so that I could take it off, try it, and put it back on the mandrel and know that it was running rue. It was as well that I did, because when I was roughing it out in the chuck, it spun when I got a bit excited with the depth of cut. When a job does that, it is very difficult to get it running true again, so a mandrel is the answer. Rough out how you will, but finish on a mandrel for such parts.

Photograph 8 shows the screw retainers, centre bearing, backplate and frontplate cut into the four pieces. The dimensions given for the centre bearing in common with most others are nominal, but it is important that the diameter fit the body recess with no shake and that the flange is flush or slightly under flush with the body surface.

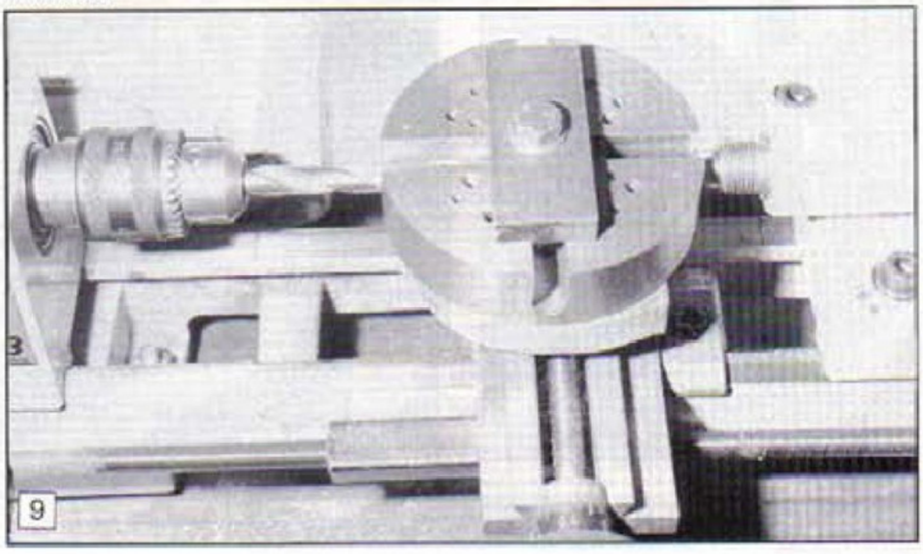
Drilling the ¼in. holes was a repeat of the 5/16in. body ones except that the drill was used for spotting. Drilling was a series again with the finishing drill a No. 1 (0.228 in.). **Photograph 9** shows the spotting procedure. I reamed the holes ¼in. to give a good finish for the screws to bear in. I marked the position with a couple of centre punch marks on the centre bearing flange and the body, after I'd assembled the bearing, jaw screws and retainers, so that if there was any error it would go back in the same place.

With everything done except for finishing the jaws and final fitting, I cut the



8: ***The front plate cut into four, with the centre bearing, backplate and screw retainers.***

9: ***Spotting the hole positions for the centre bearing. The method is similar for drilling the 5/16in. holes.***



front plate into the four sections and filed them to the marked line, or thought I did. Unfortunately, I had ignored another of the sayings of friend Confucius: "foolish man measures once and cuts once; wise man measures twice and cuts once." I don't know if it was in the marking out or in the cutting, I suspect over excited filing, but the result was that the jaw slots were far too wide. This posed a real problem, because the only material I had to make a new frontplate was a cast iron disc, like the one in **Photograph 1**, but solid except for a small hole in the middle. So I said, "my word, how unfortunate," or words to that effect, and set about cutting off a slice.

I cut carefully, rotating so that there was a good guide all round about ¼in. deep and 1/32in. from the edge. I couldn't have done more, or so I thought, but for some obscure reason of hacksawing science, it cut dish-shaped, the 1/32in. over at the periphery and well under in the middle. It should be impossible to do this and I still don't understand how I managed it. However, I said, "my word, how very, very unfortunate," and cut another disc. It took the other side of the cassette I'd played while cutting the first one; much as I like selections from the Puccini operas, I prefer to listen to them in less fraught circumstances. In time though, even the most stupid mistakes can be put right, and the new frontplate cut straight, and was skimmed, drilled, tapped, reamed and had its sighting rings machined on. This time I allowed extra for the cutting into four and did it without trouble.

Finishing the jaws

With all the machining jobs done, it was time to finish off the odds and ends. So that the jaws would close down enough to be useful, the first ¼in. of thread was hacksawed and filed off to clear the centre bearing. Next the jaws were fitted to the slots without the screws in, to check that they slid nicely. It took a bit of de-burring and fine filing where there were shiny interference marks but it didn't take long.

When everything worked as it should, I put the jaw screws and the retainers in. At this stage it may be necessary to reduce the depth of thread in contact with the screws. Although the drawing shows the jaws with half the depth of thread, it can be less. As long as there is enough to locate and move the jaws, it can be a help to take some thread off, if it will improve the fit.

When the jaws fitted, the chuck was screwed to the lathe spindle and the jaw surfaces skimmed level, **Photograph 10** shows this being done. With the jaws level, the horizontal lines can be marked out for the steps. I did this using the chuck surface as a datum. The verticals were marked and the intersections centre punched. The jaws were taken out for this and the front face used as a datum. I drilled relief holes at the intersections, any size between 1/16in. and 5/64in. will do.

After roughly cutting out the steps, I assembled the jaws again and skimmed the steps level and as far as possible into the relief holes. I had to set the jaws fairly true to do this, but it saved a bit of filing and gave a good idea of how useful the sighting rings were. Then I finished the horizontal faces right into the reliefs, filed the vertical ones the same and filed the 45 degree chamfer at the front of the jaws. This chamfer could be machined by setting up the jaws on the cross slide and using a high speed steel countersink as a milling cutter.

I de-burred all over and took out the file marks. When I was satisfied that the jaws were as smooth as I could get them, I case hardened them. I used "Kasenite" and although it is only a surface treatment, it does get the surface very hard.

Finally, I cleaned all the parts, made a quick chuck key, as I described earlier, and tried the finished article out. **Photograph 11** shows the finished chuck and **Photograph 12** being used for a typical four jawed chuck job. It has since proved very useful for facing the new 8mm threaded jaws to length and holding them for drilling the tapping holes. It adjusts easily and as long as it is not overtightened or expected to do too much, it will do anything a chuck of that size would be expected to do.

It took about a year to make, but there are other calls on my time and I did make the odd mistake. For those who, like me, have a small lathe and would like a four jawed chuck, my advice is to have a go. It isn't as difficult as it looks. It has also proved again what a splendid and versatile little machine my Unimat is.

11: *The finished chuck.*

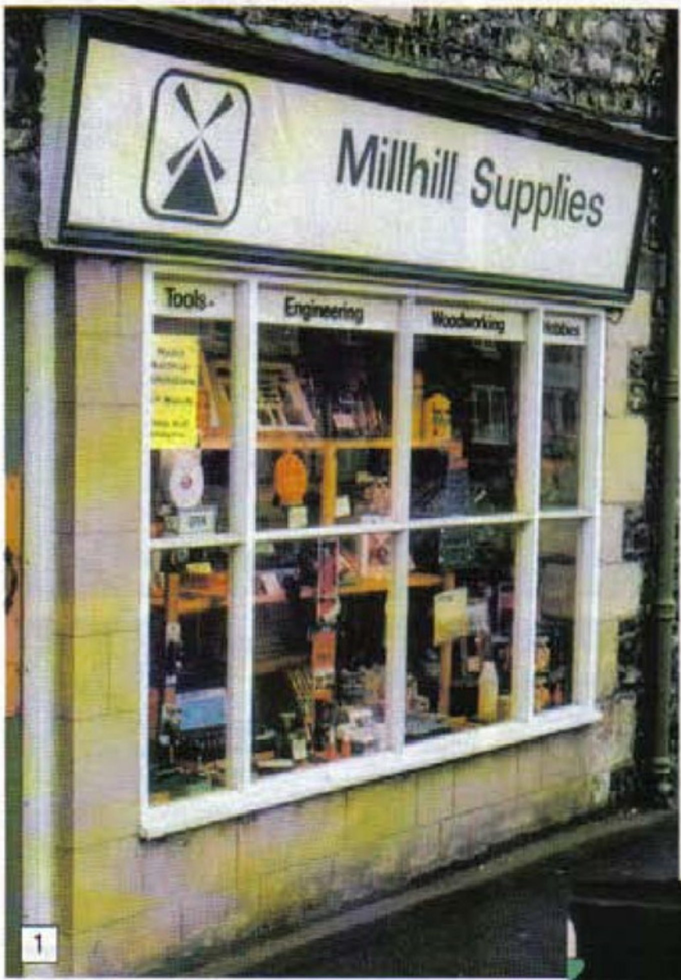
QUICK TIP

One of the banes of the turner's life is that of having exactly the right thickness of packing to hand when needing to pack up a lathe tool, or mount a job on the cross slide etc. for boring.

Many domestic throw-outs are superb for this, cans for example are of high grade tin-plate, and come in a variation of sizes. After you have emptied the contents of a four pack, the aluminium cans can be recycled as packings, use the painted bits, tops and bottoms may vary. Biscuit tins are another good source, and scraps of sheet steel are easy to acquire. Snip up a few for lathe tools and keep a few in sheet form to be cut to size, as required, for larger jobs.

10: ***Skimming the fronts of the jaws level.***

12: ***A suitable four jawed chuck job to try it out on.***



A VISIT TO MILLHILL SUPPLIES

Situated in an attractive Oxfordshire village, with other attractions nearby, this shop is a must if one wants to see a wide range of tooling and equipment suited to the needs of the model engineer, workshop enthusiast and woodworker

A visit to Millhill Supplies will take you into the typical Oxfordshire village of Crowmarsh Gifford, complete with its stone walled buildings. Millhill Supplies are to be found in just such premises, but on entry, apart from the wooden beams to the ceilings, what you find will be far from olde world.

Millhill Supplies are suppliers of small tools for those with metalworking interests, they also supply smaller machines such as the Hobbymat MD65 and the expanding range of machines from Draper Tools Limited, typically their MD350 mill/drill.

1: What the visitor sees, one of the two shop windows. 2: Part of the Draper Tools display, a circular saw, bandsaw and drilling machine. 3: Just part of the recently installed stock of woodworking tools and equipment. 4: Well finished, these Sealey Bench Grinders form an attractive display.

5: Amongst a vast range of hand tools, springbow callipers, dividers etc. in various sizes will fill the needs of many hobbyists. 6: Picador products are widely used in model and experimental engineering, Millhill feature this display of these in their shop. 7: Another permanent display is this from Britool. 8: A huge range of drills is carried, loose as well as these boxed sets. 9: A quality dividing/indexing unit, part of the vast range of tooling. 10: Another of the regular displays, this from Loc-line. 11: A wide range of books related to our hobby are carried in stock, this is but part of the selection.

Cutting tools

A complete range of small cutting tools is stocked. This includes taps and dies for all the common thread forms, including the older ones such as British Standard Whitworth. many are available in both carbon and high speed steels. Drills are available and individually in imperial, number, letter, and metric sizes, some also as stub drills, also a wide range of drill sets.

No raw materials are stocked except silver steel in 12 inch lengths. A wide range of BA screws, nuts and washers are also stocked and also to be seen are gas appliances from the popular range supplied by Primus-Sievert AB.

New catalogue

The above is but a very brief indication of the range of items stocked, other products can be observed in the photographs, but you'll need a catalogue to fully appreciate the extent of their range. New catalogues are issued three to four times a year, the latest of which has just been published. This can be had free of charge by applying to Millhill Supplies (please mention *Model Engineers' Workshop* magazine if you write or phone).

Orders are stored on computer using a program specially developed for them; there are now 10,500 customers listed on this, many from overseas. Orders received in the morning post will be despatched during the day subject to stock – and there is plenty of that! Urgent phoned orders can be dealt with till quite late in the day, as the post office is just next door. Credit cards are taken, as are orders for export.

Quality products

One's first impression on entry is that of quality products, an impression which still remains with closer examination. Most products are of well known origin with such manufacturers as Mitutoyo, Britool, Arrand, Eclipse, Dormer and many other well known names.

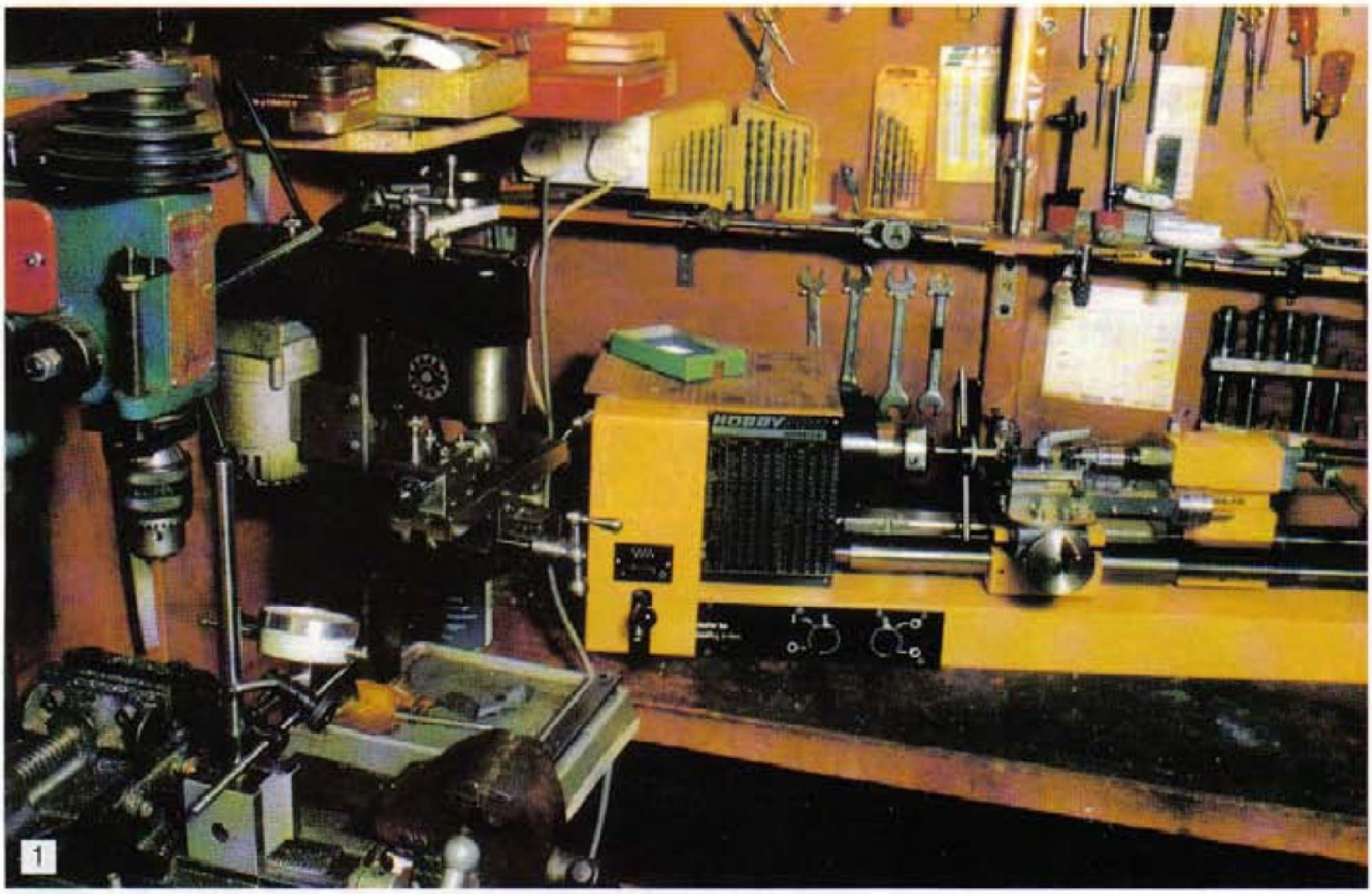
Millhill also stock some items from suppliers of economy products, but only if the quality comes up to their demanding requirements. This means they are well above average for products frequently seen from such locations. Examples of this are some rather nice four jaw chucks from Poland.

The range is always being expanded and is now also moving into products aimed at the woodworker. It is also hoped to expand the premises in the near future.

Make a visit

For those living within travelling distance it's a nice place to visit, only a few hundred yards from the river Thames where you can deposit the family (on the bank, that is) whilst you browse around the shop, and parking is easy.

Opening times are from 9 till 5 Monday to Friday and 9 till 1 on Saturday. The shop is in Crowmarsh Gifford on the A4130, a few hundred yards from its turning off the A423. It is on the outskirts of Wallingford, Oxfordshire. The catalogue includes a map indicating the area. The address is- Millhill Supplies, 66 The Street, Crowmarsh Gifford, Wallingford, Oxfordshire. OX10 8ES. Tel: 0491 38653



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WORKSHOP VISIT

The tiniest workshop we have yet seen is that belonging to Chris Ford. Measuring a mere 4 x 4 feet it houses a good collection of tools and Chris produces a vast amount of work from such tiny premises

The Kennel

Without doubt the first impression of anyone visiting the workshop of Chris Ford will be its small size, affectionately known as the kennel (the shed, not Chris) by his family and friends. Chris spent many years as a machine tool service engineer for Alfred Herbert, visiting countries all over the world in his duties for this company.

He left this type of employment a few years back to run his own business in a different field altogether. He did though retain his interest in metalworking in the course of his hobby. It would be unreasonable of any visitor to Chris's workshop to go away complaining about the size of their own workshop – having seen his, being only four feet square!

His machines

Photograph 1 shows the rear of the workshop having his Hobbymat MD 65, and the left side with the milling machine and a bench drill. The right hand side contains shallow storage shelving which could not be photographed without removing the door – these pictures had to be shot from outside.

To keep the left hand side bench as shallow as is possible, a Cowells milling machine was chosen; it can be seen in **photograph 2**.

The requirement for a small drilling machine also presented a space problem

2

due to its depth. This was largely overcome as can be seen in **photograph 3**, taken with the guard removed. In this case the motor has been pivoted from its normal position behind the column to the left hand side. This largely eliminates the space taken up by the motor behind the column.

3

A bar behind the machine, just visible in the photograph, maintains the motor in this position and belt tension.

A bench vice can be seen mounted between the milling machine and the drilling machine, highlighting the requirement for maximum use of the space available. The rear bench is the deepest (probably about 15 inches) and, as the lathe is not fixed to it,space for bench work can be made by moving the lathe to the rear.

QUICK TIP

All model engineers as well as full size ones are familiar with the green slimy hand cleaner that it widely available in motoring and DIY outlets. The same manufacturer also produces other hand cleaners that contain small polystyrene granules. The (painlessly) scour out dirt from our wrinkled hides and appear to wash off more easily. I would, as they say, use no other. Try specialist cleaning or industrial supplies companies for these products which are available in 500g drums. (see trade pages)

John Jennings

Even the door is pressed into service as a metal store as is seen in **photograph 4**. This is, no doubt, left open when working in the better weather as there is no window in the workshop – this would only take up valuable wall space ...

The building

The shed is of conventional construction but has been lined with polythene sheeting to help keep out moisture. Chris states he has no problem with condensation and rust – I do hope though that this is still the case as much of the photography had to be taken with door open and from outside, whilst it was raining. Fortunately, the umbrella provided by Chris was appropriately advertising Kodak!

The inside is then lined over the polythene sheeting with hardboard. The hardboard provides a good surface for fixing various methods of storing tools and materials. **Photograph 5** shows a typical example of this. Observant readers will see in this photograph, standing on the electric socket, some miniature figures, also some Meccano strips used to make one of the metal storage racks.

Tin plate toys

These give a clue to Chris's main interest being the restoration of tin plate toys, and also Meccano. Before anyone dismisses this as low level engineering, this is not the case as many of the more detailed toys contained some intricate parts, and were far from mere tin plate.

As with many collector's items, the question of whether to restore or not is a matter for the expert. But typically, if an item is in good to very good condition and is still in its original packing it is best left alone. On the other hand these were intended as toys and were used as such, the result of which is that there are many to be found (though less as time passes) in very poor and frequently incomplete condition.

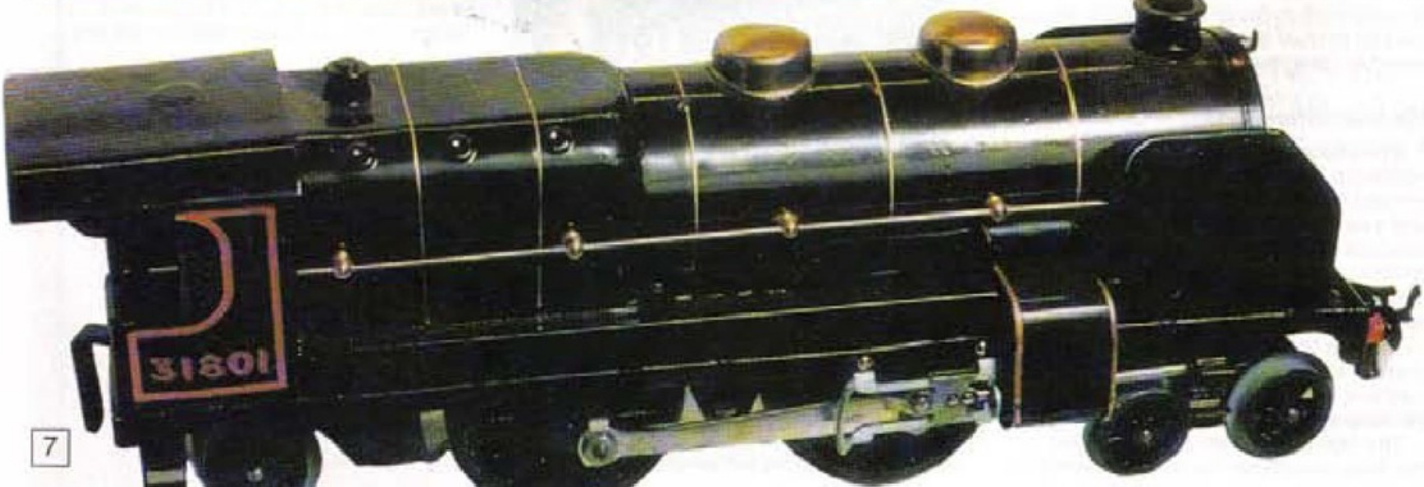
Restored toys will never be as valuable as originals in good condition, but they will be worth more than a pound or two. A visit to a car boot sale or similar may provide something to get started with. **Photograph 6** shows a typical shell prepared for restoration whilst **number 7** shows a similar engine after restoration. This was originally received in a similar condition.

5

6

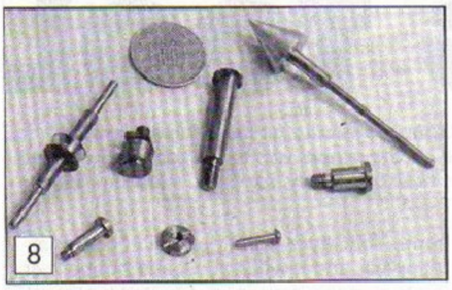
The H.R.C.A.

Chris belongs to the Hornby Railway Collectors Association which has some 2000 plus members worldwide; its recent AGM had 500 members attending so it can be seen that it has an enthusiastic



7

membership. Restoring such items covers many disciplines and so members tend to specialise in given skills; they then sell their expertise to others in the Association. Typically, one produces the special colour paints, another the transfers for the lining and lettering, others the tinplate items.

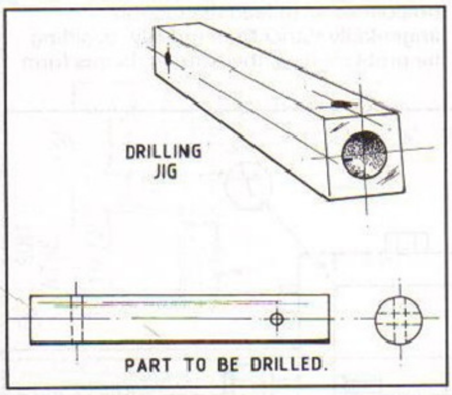


8

Chris specialises in turned and milled components, for which he has a list of some 30 standard parts, and will also make specials. These are all small components and a typical selection of these can be seen in **photograph 8**. The association publishes a list annually of members' services on offer and, as a result, he supplies some 1000 to 2000 parts per year which go worldwide.

Improving production

The outcome of this service to other members is that many parts are required to be made in small batches, say 10 to 20. This is where his machine tool background begins to show, for he makes many jigs and fixtures to speed up the operation, also improving the quality of the finished product. He places much emphasis on making the parts, and the jigs themselves, with the minimum of effort.



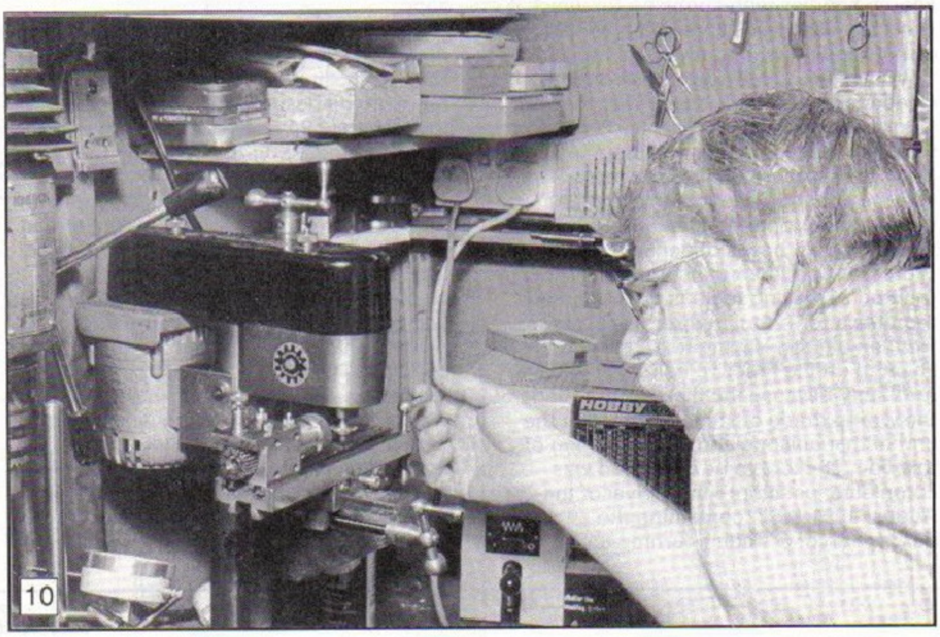
Typical example of a jig is one used for drilling a small spindle with two holes at right angles; a sketch of this is shown. After drilling the first hole, a pin is inserted through the jig and part, when the other hole is then drilled.

Close examination of **photograph 1** will show that the drilling machine is equipped with one of the economy compound slide vices. Drilling jigs are frequently mounted in this, using it to line up the spindle with the hole to be drilled. By this method the jig can be left in position and the components removed and replaced. This speeds up the operation, as there is no need to line up the drill with the jig for subsequent parts.

The stop screw is $\frac{5}{32}$in. Whit (Meccano standard). This is 32 TPI and is therefore very convenient for making adjustments when using fractional dimensions. A second hole permits it to cover a wider range of positions without the need to resort to a very long adjusting screw.

The base of the Hobbymat is cast from some non-magnetic material, and therefore even though it has a long broad flat surface behind the lathe bed, it cannot be used to mount a magnetic stand for a dial test indicator or similar. To overcome this Chris has fitted a length of steel strip to this surface which permits the stand to be used at any position along the length of the machine.

The headstock of the Hobbymat has a large flat surface on top which is useful (particularly in this size of workshop) for standing small tools, etc., ready for use. They do tend to slide off due to the shiny surface, particularly when the machine is in use. This can be overcome with a suitable size piece of corrugated card, held in position with Blue-Tak.



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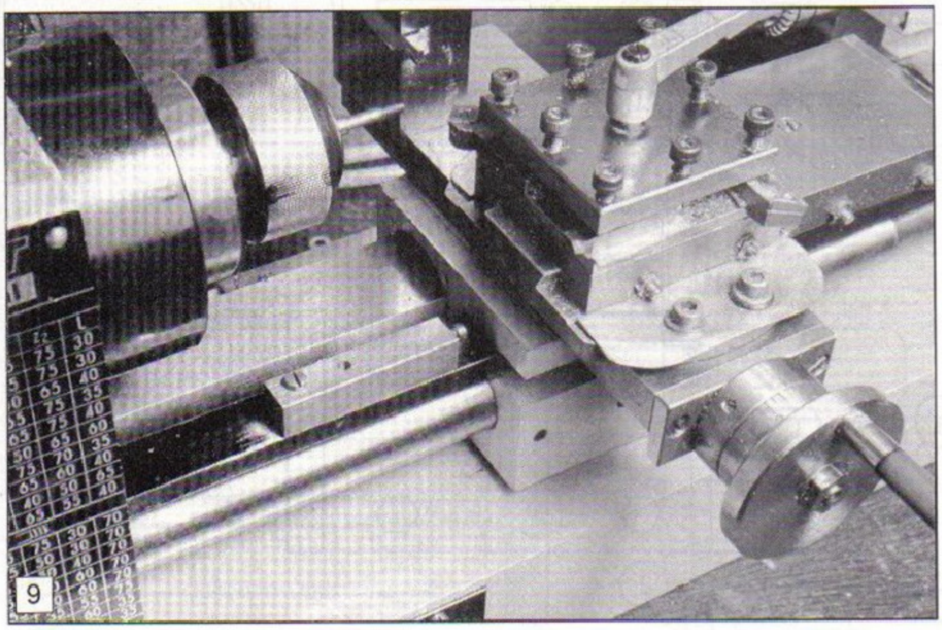
Another useful device can be seen in **photograph 9**; this is his simple saddle stop. Fitted just to the left of the saddle, it includes some interesting ideas. The unit is fitted with a single screw which permits it to be loosened and rotated through 180 degrees when not in use (just visible in the photograph), but is always rapidly available.

Chris uses predominantly collets for workholding in the lathe, but as these are expensive he makes parallel split collets for intermediate small sizes. These are made to go into his $\frac{3}{8}$ inch collet, and interestingly he makes these from PTFE. This covers, but a few, of the simple ideas to be sen in the workshop. Perhaps Chris you could provide some more for our Quick Tips.

Gear cutting

Photograph 10 shows the milling machine being set up for gear cutting using the Cowells Dividing head. This is supplied with about six gear-like dividing plates to cover a wide range of divisions. Chris uses this for making gears which he supplies to other members, as he does for the turned parts.



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Interested?

Any reader who considers they may be interested in the Hornby Railway Collectors Association should write to the Editor, *Model Engineers' Workshop*, and your request will be forwarded to the appropriate person.

AN ELEGANT BALL TURNING TOOL

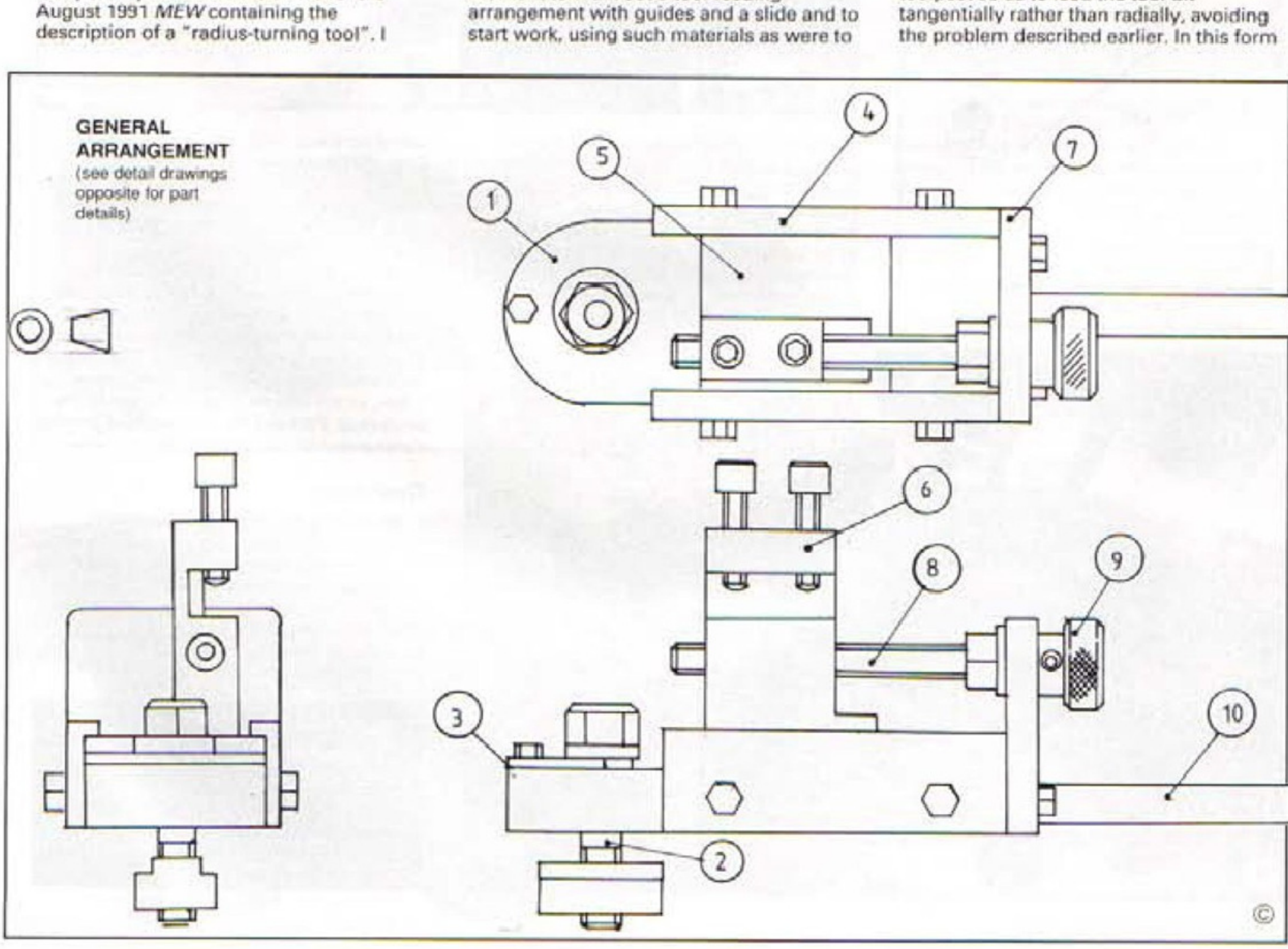
MR. G. W. H. Swallow of Dorking has produced this interesting ball turning attacment. This design makes a serious attempt to improve on the others which have been proposed over the years. It is, still very simple and will not tkae one away, for long, from the main task in hand of turning ball handles or similar.

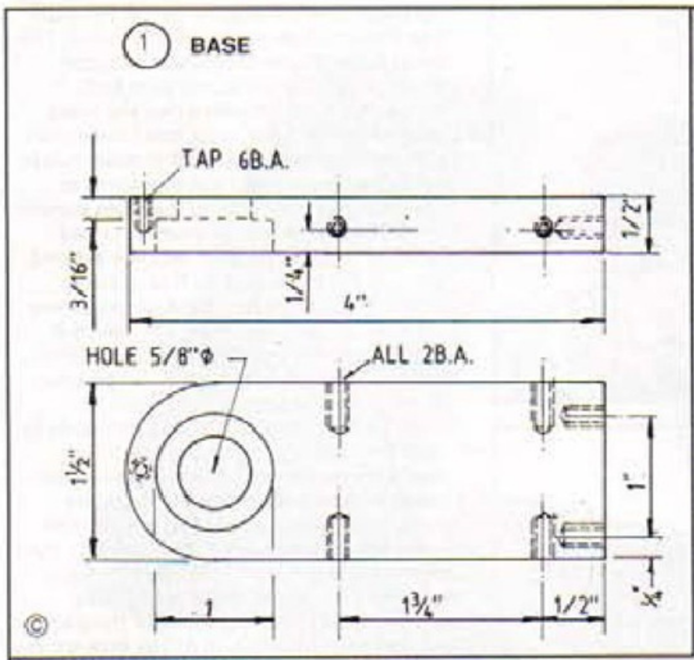
To groans of "Oh, not another ball-turning tool!", I can only say that I have not seen one exactly like this before. This is not itself a good reason for another one; a ball-turning tool is only at best needed occasionally, and the well-known handles-with-knobs-on for which it is mostly used have a Victorian appearance out of keeping with today's hi-tech.

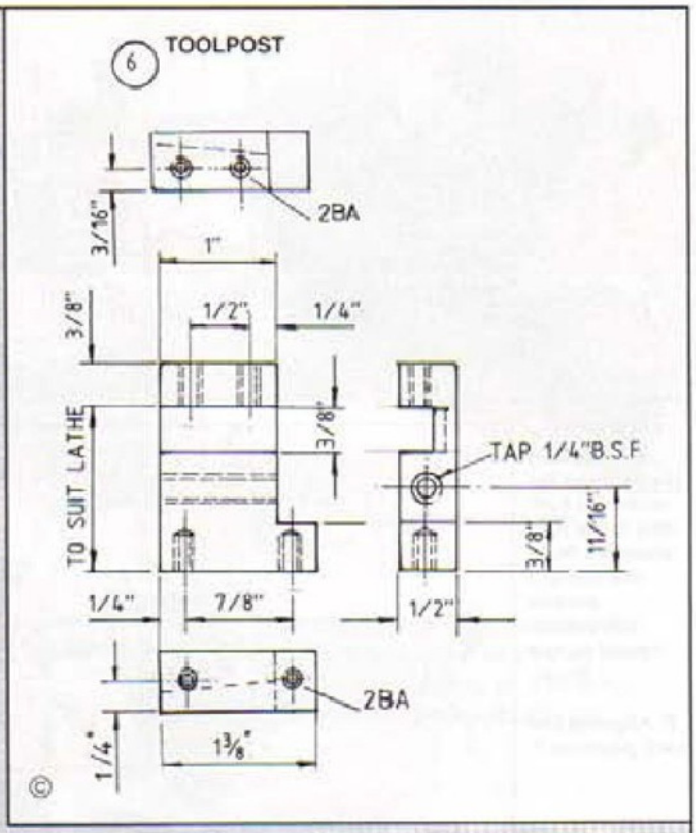
Well, this was all true until Professor Chaddock entered the scene with the Quorn cutter-grinder, which fairly bristles with ball-handles, sixteen of them in all. Besides this, there are now so many Quorns about that anyone making one without the proper handles would expect to bring down howls of derision. However, Professor Chaddock's recommended method of making them is different, and requires a form-tool in three sizes, made from an old file. Having tried this and sheared off the first two half-formed balls (probably because the blanks were made of the wrong grade of steel), I arrived at the end of that episode and the beginning of this one. The tool to be described was completed just before the arrival of the August 1991 *MEW* containing the description of a "radius-turning tool". I wrote to the Editor about this with comments from my recent experiences and he invited me to add another chapter to the saga.

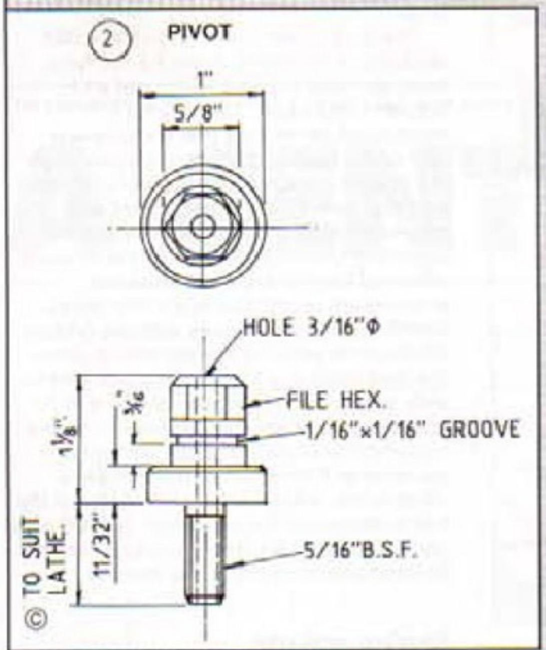
As this tool started life as an unwelcome diversion rather than as a planned project, the first inclination was to search for a ready-made design, and I vaguely knew that several had been published over the years in *Model Engineer*. Finding them was another matter, and I eventually had to retreat to the design by Edgar Westbury in his book *Lathe Accessories*, bought fifteen years earlier. This tool was a simple affair, too simple in fact, merely a steel bar pivoted at the end, with a tool fixed in place and set in line with the radius of the pivoting circle. With sixteen double-ended handles to make, the thought of feeding the tool with a delicate push from a thumb-nail was repellent even without working out how the geometry would allow it to be done. It was therefore the matter of a moment to work out a tool-feeding arrangement with guides and a slide and to start work, using such materials as were to hand. This latter point determined all that followed, and it will not escape notice that the tool in the drawings is better-looking than the one in the photographs, the actual finished tool being more a result of what happened than of any conscious design effort. The other consequence of the hurry was the use of at least one short-cut in construction that real engineers would frown upon.

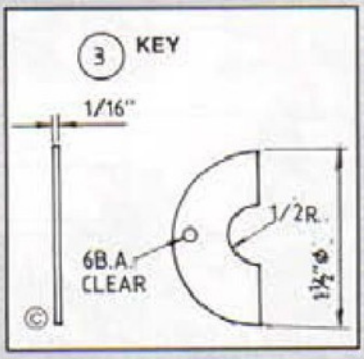
Construction of the modified version had reached an advanced stage before it was discovered that neither the original design nor this one (nor the one in *MEW*) would turn a ball! The point of the tool being radially in line with the pivot means that the inboard side of the ball cannot be turned, as the whole assembly would run into the chuck before the inside of the ball was reached. A hasty redesign had to be devised, and this redesign explains all the spare holes evident in the photographs. The slide was re-drilled to offset the toolpost so as to feed the tool-bit tangentially rather than radially, avoiding the problem described earlier. In this form

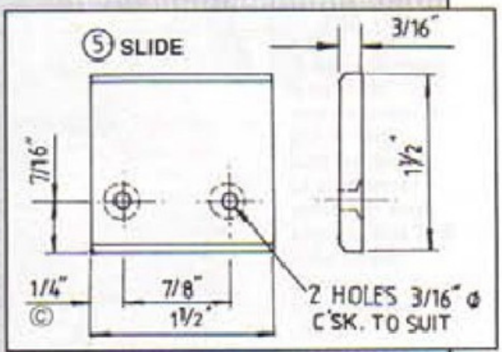


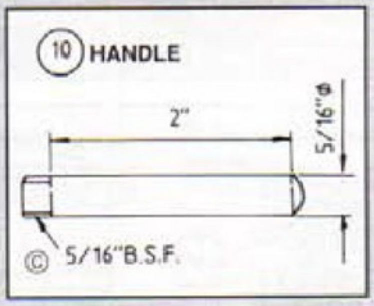

1 BASE
TAP 6B.A.
1/2"
3/16"
1/4"
4"
HOLE 5/8"Φ
ALL 2B.A.
1½"
1"
¼"
1
1¾"
1/2"
©

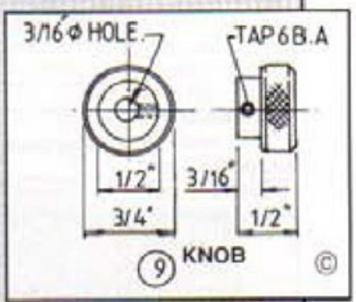

6 TOOLPOST
2BA
3/16"
1"
3/8"
1/2"
1/4"
3/8"
TO SUIT LATHE
TAP 1/4"B.S.F.
11/16"
3/8"
1/4"
7/8"
1/2"
2BA
1/4"
1⅜"
©

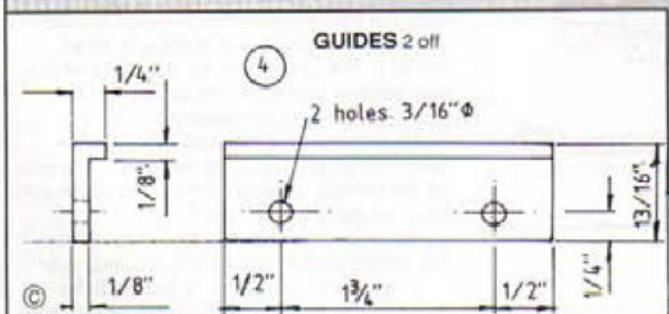

2 PIVOT
1"
5/8"
HOLE 3/16"Φ
FILE HEX.
1/16"×1/16" GROOVE
3/16
1⅛"
11/32"
TO SUIT LATHE.
5/16"B.S.F.
©

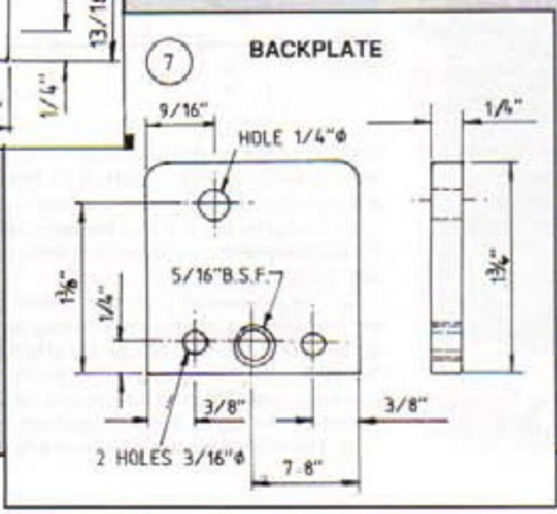

3 KEY
1/16"
1/2R.
6B.A. CLEAR
1½"Φ
©

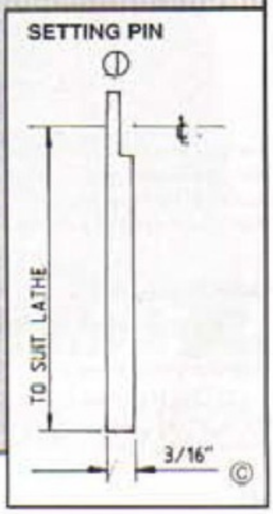

5 SLIDE
3/16"
7/16"
1½"
1/4"
7/8"
1½"
2 HOLES 3/16" Φ C'SK. TO SUIT
©

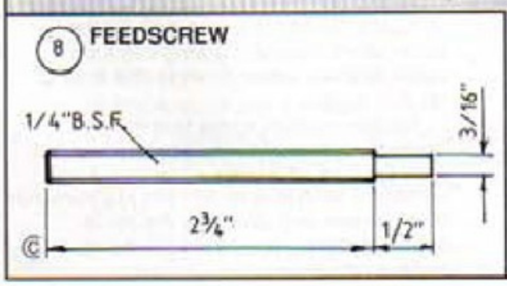

10 HANDLE
2"
5/16"Φ
5/16"B.S.F.
©

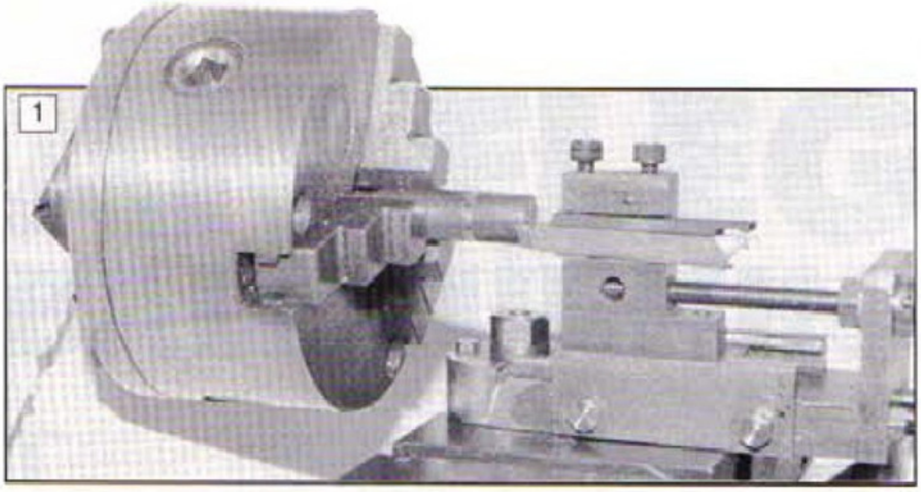

3/16Φ HOLE
TAP 6B.A
1/2"
3/16"
3/4"
1/2"
9 KNOB
©


GUIDES 2 off
4
1/4"
2 holes. 3/16"Φ
1/8"
13/16"
1/4"
1/8"
1/2"
1¾"
1/2"
©

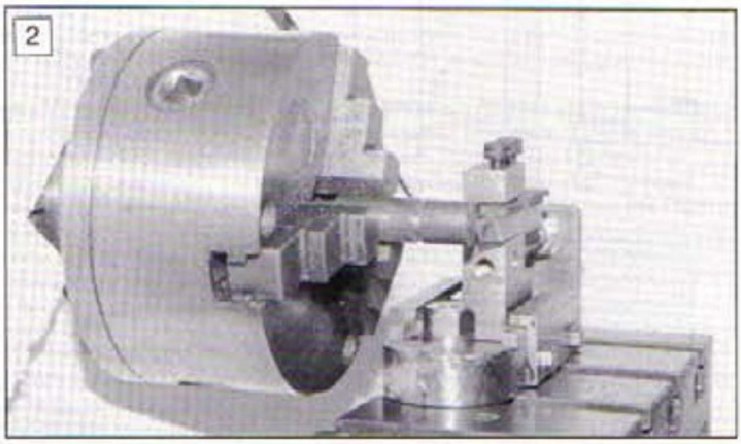

7 BACKPLATE
9/16"
HOLE 1/4"Φ
1/4"
1⅜"
1/4"
5/16"B.S.F.
1¾"
3/8"
3/8"
2 HOLES 3/16"Φ
7/8"


SETTING PIN
TO SUIT LATHE
3/16"
©

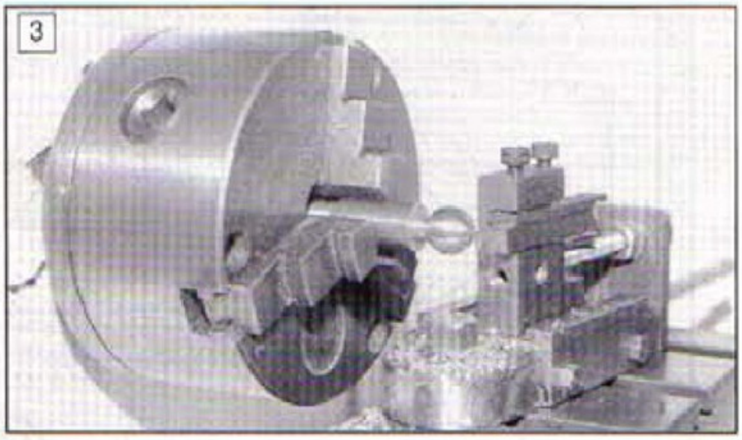

8 FEEDSCREW
1/4"B.S.F.
3/16"
2¾"
1/2"
©



1: *Setting the tool in preparation for making a ball, this is the first position. Note the run-out groove previously turned on the blank.*



2: *Aligning the tool, position 2.*



3: *A few minutes later, the ball is formed on one end of the blank, all that remains is to turn the other ball and remove the surplus material between the balls.*

4: *Some of the work in progress, from blanks to ball ended handles.*

the tool worked perfectly, and all the ball-handles were made in one afternoon, or at least the balls were; getting rid of the material between them is another story.

Construction

The construction is evident from the drawings, and it is only necessary to indicate a few points:

(1) This tool was made to fit my Portass lathe, which has a centre-height above the cross-slide of just under two inches. The position of the feed-screw and the tool-slot need to be reviewed in relation to the lathe and the materials used for the base and slide. Also, the tee-nut and bottom half of the pivot need to be made to fit the particular machine.

(2) The maximum diameter of ball that can be turned is mainly determined by the distance that the tool-bit can be offset to the left whilst still cutting at the point. However, even this maximum will be reduced if the pivot is made too high.

(3) The top edge of the slide needs to be bevelled, as the inside corner of the angle iron used to make the guides is round. The fixing holes for the guides were spotted through with the guide and slide both clamped in position with a piece of brass shim under the slide. Also, bolts were used in preference to countersunk screws in case adjustments were needed afterwards to ease the slide (i.e. by filing the holes bigger).

(4) The slot in the toolpost is slanted inwards to allow the tool-bit to be skewed to reach the pivot-centre. This not only allows the full range of sizes but emulates the form of the original design, which is best for turning inside radii. For this latter purpose, the tool-bit needs to be ground with a left-hand point.

(5) The widest part of the pivot needs to be turned so as to provide a few thou. clearance for rotation of the tool, and the base must be held without slop on the pivot by the key. The best sequence is to make the bottom half of the pivot first, then the recess and hole in the base, then the key, and then to use these last two as gauges to turn the upper end of the pivot and the parted groove in it. The hole for the setting-pin should be drilled at the same time.

The feed screw is a length of ¼in. BSF studding, shouldered down for the feed knob and held in place with a nut and washer Loctited on. The short-cut mentioned earlier was that the screwed part of the feed-screw turns in a plain hole in the back plate. This was done so that the tool-post could be spotted, drilled and tapped through the back plate to ensure exact alignment of the feed-screw. Anyone offended by this departure from real engineering might also reject the use of studding and turn a screw with the proper left-hand thread! It was intended to index the feed knob and to provide a lock for the slide but neither of these was found to be necessary. One unexpected result was the repeatability of the ball sizes without any measuring. If the point of the tool-bit is offset to the left by exactly the radius of the ball to be turned (using a scrap of BMS as a gauge), the tool-bit stops cutting when the finished size is reached. Hey presto!

Setting and use

The first requirement for the setting is to turn the ball-blank to the finished diameter and to part a groove of sufficient width down to the shank size for the point of the tool to feed into. The rest of the setting consists of three operations:

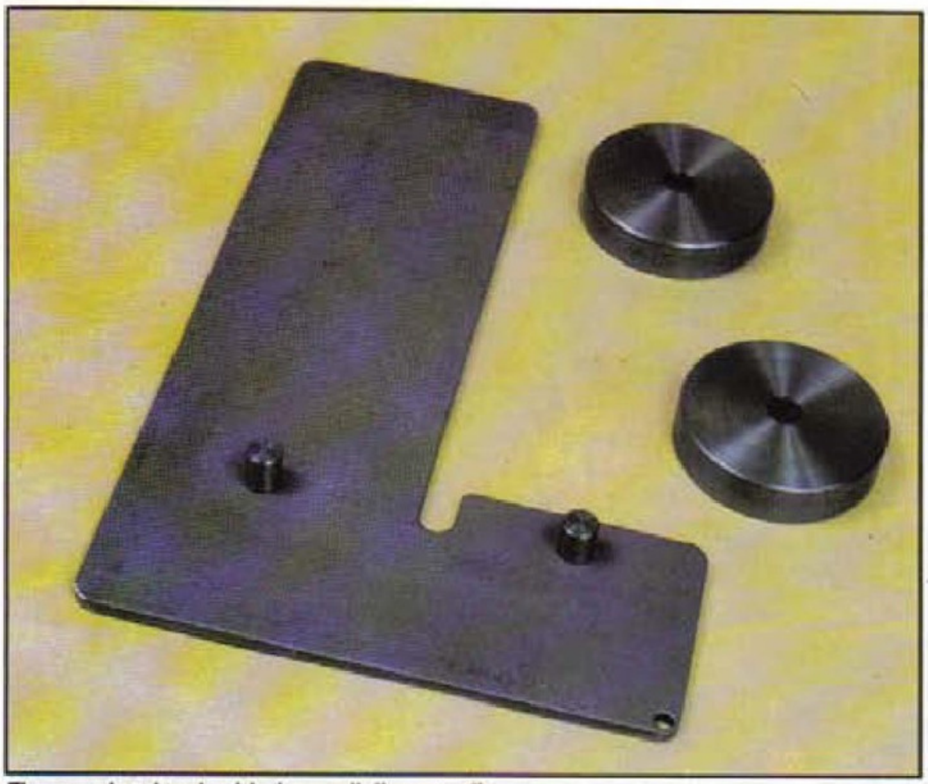
(a) After setting the tool-bit to the required offset, align the base with the axis of the lathe and wind in the cross-slide until the tool-bit touches the blank;

(b) move the cross-slide right and turn the whole tool anticlockwise 90 degrees;

(c) move the cross-slide left until the point of the tool-bit touches the end of the blank and then lock the cross-slide.

At this point the tool can be withdrawn using the feed-screw until it clears the blank when rotated. Turning can then begin. It takes longer to write this than to do it.

Finally, I should stress that nothing novel is claimed for this version of an old tool. Anyone who has ever turned a ball without a form-tool must have encountered this problem and probably the same solution. Old truths are always being rediscovered!

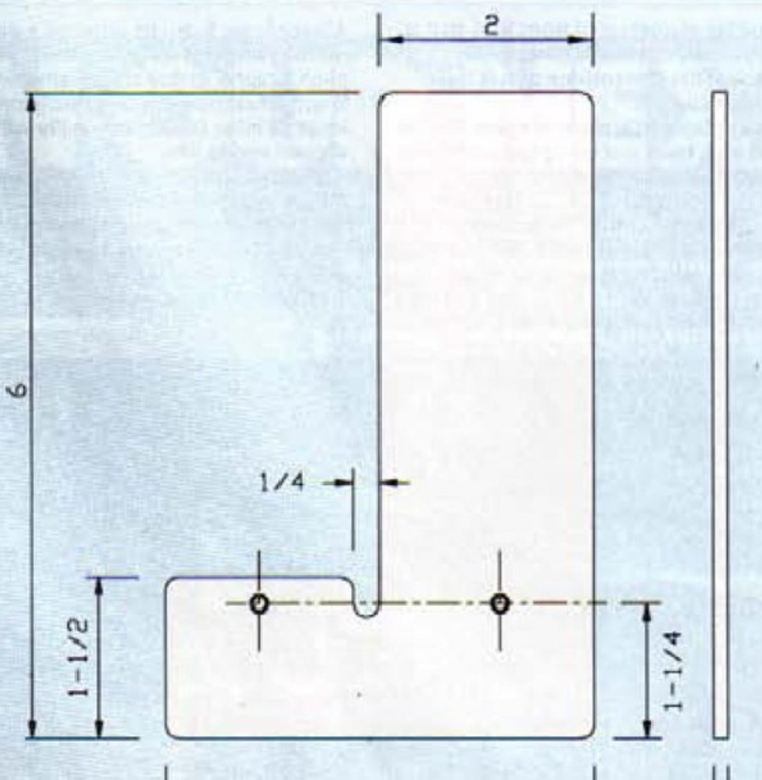


The completed tool, with the small diameter discs.

The tool set-up to deal with smaller diameters.

This simple device intended for finding the centre of circles, can also take the place of a normal square in some applications.

A CENTRE SQUARE

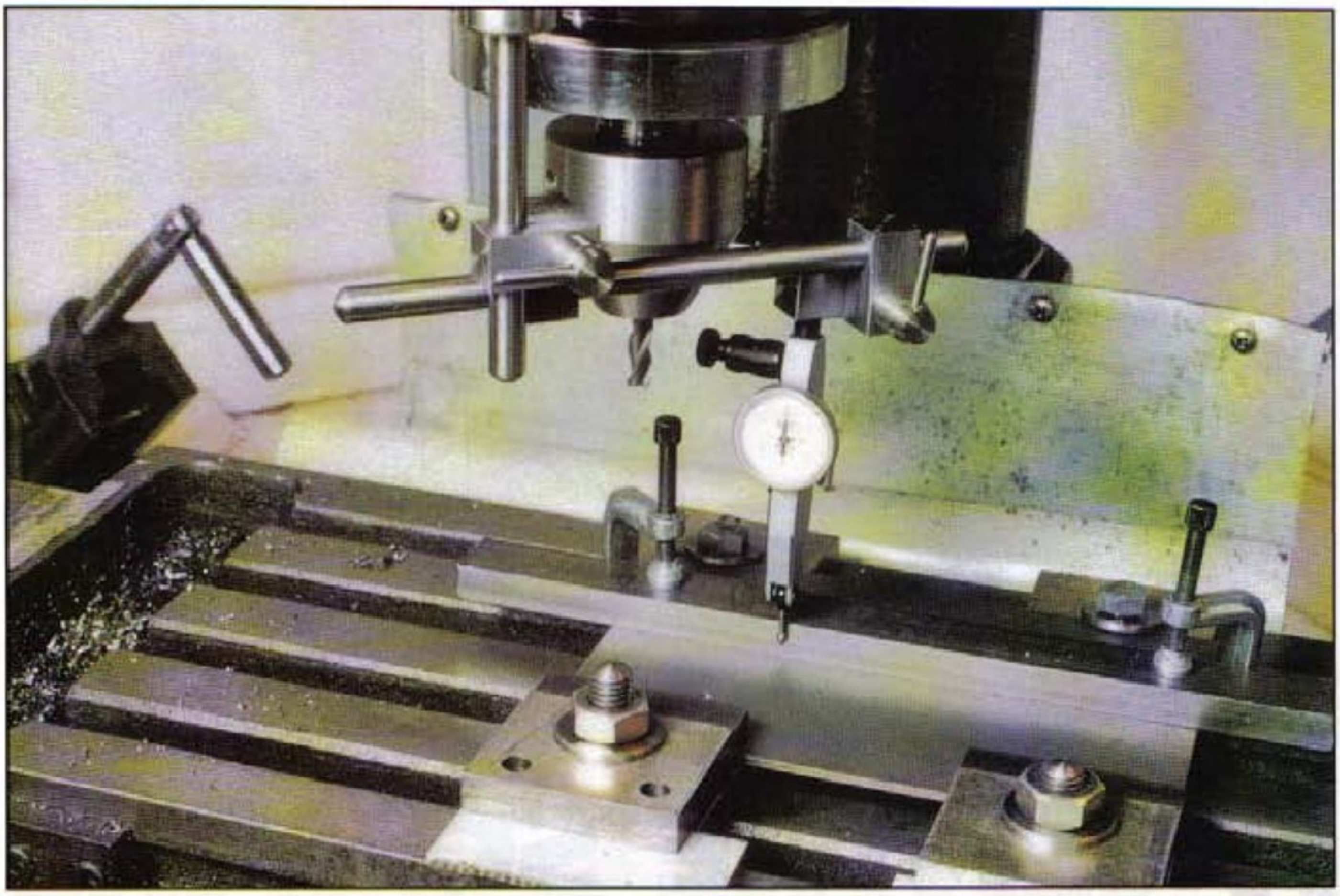


MATERIAL 14 SWG SHEET STEEL.
HOLES 1/8 dia COUNTERSINK TO 5/32 dia.
SEE OTHER DRAWING FOR POSITIONING HOLES.
MAKE 1/8 RADIUS ON ALL CORNERS
BODY

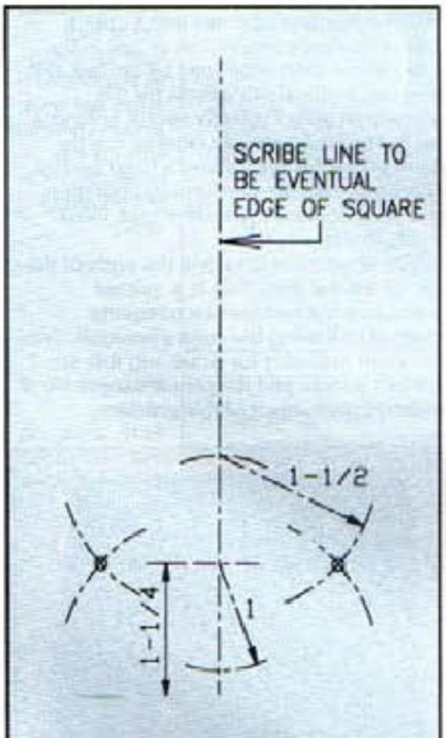
The number of times that a centre finding square will be of use in the home workshop may be limited, but they can be invaluable tools for the occasional task. Typically centre drilling a bar for turning between centres can be done on the lathe by using a fixed steady. This can be a time-consuming operation, and is, of course, dependent on a fixed steady being available.

The alternative is to drill the ends of the bar on a pillar drill. This is a quicker procedure but requires an adequate method of finding the centre position. Two common methods for achieving this are the bell punch, and the centre square which is the subject of this article.

Marking out the plate, using the geometric methods described elsewhere in this issue.



Use of the milling machine to make the square; positioning the plate for shaping.



© METHOD OF MARKING OUT BODY

Both types have their advantages, the bell punch being the easier and quicker to use; the centre square though has the major advantage of being able to be made to work with much larger diameters.

Making the centre square

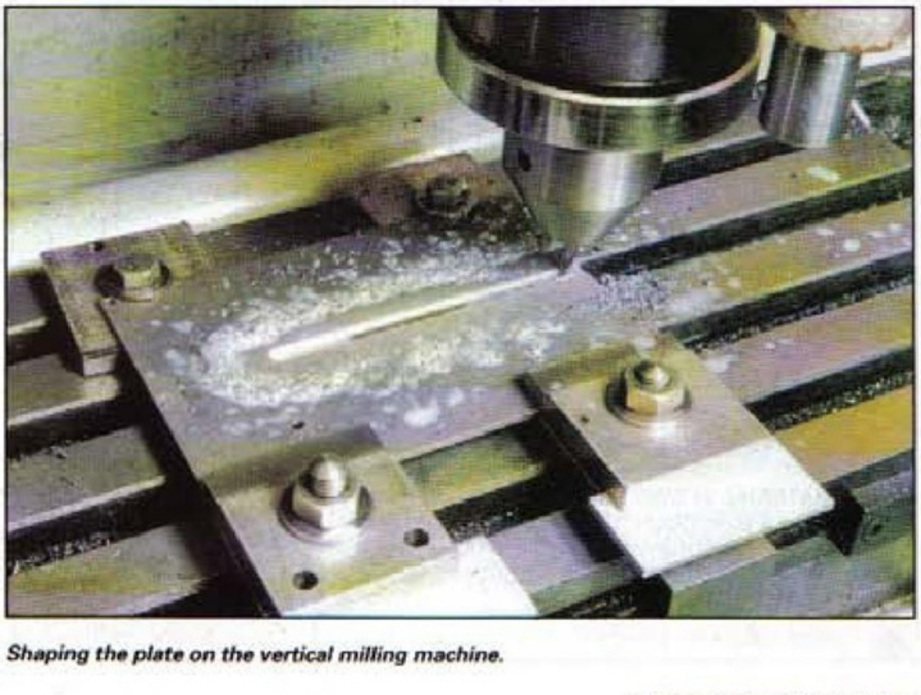
The dimensions quoted in this article originate from a piece of metal already available to the dimensions of 4 in. x 6 in., and enables diameters of from ¾ in. to 8 ½ in. to be accommodated. Readers can easily adapt the dimensions to suit their own circumstances.

Having obtained a piece of sheet steel of suitable size, mark out using the procedure indicated. (*See also the article on Workshop Geometry. Ed.*). Do take care with these operations as the accuracy of the square will depend very largely on this.

The plate must now be cut to shape. This can be done with a band saw and then carefully finished off using a file.

Alternatively it can be done on a vertical milling machine, as indicated in the photographs. In this case, clamp on a length of rectangular bar, positioning this so as its edge coincides exactly with the scribed centre line.

Position the plate on the mill such that the bar is running parallel to the table travel. Do this using a dial test indicator. The photograph shows a typical way of doing this. Follow this by using a small say ¼ in. diameter, end mill to create the shape of the finished square.

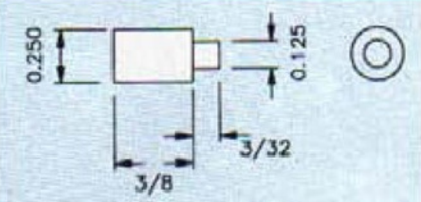


Shaping the plate on the vertical milling machine.

An alternative approach for those using a mill to shape the plate, would be to position the two holes using the leadscrew dials. This would avoid the earlier marking out operations.

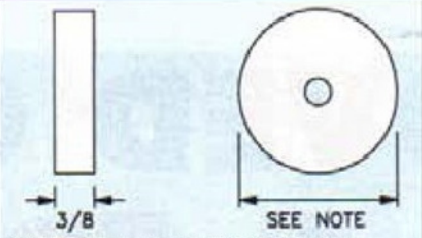
Now drill and slightly countersink the two holes, finish with a reamer to give an accurate diameter hole. If a reamer is not available then the pins can be turned to suit the diameter of the drilled hole, whatever this turns out to be.

Accuracy of the device will also depend on the concentricity of the turned parts, and also that they are made identical diameters. For this reason it is suggested that the $\frac{1}{4}$ in. diameter pins are turned from $\frac{5}{16}$ diameter stock. These should be a close fit in the holes in the 'small diameter' discs. Fit the pins by riveting and finish off flush.



MATERIAL $\frac{5}{16}$ BRIGHT MILD STEEL QUANTITY 2 OFF.
PINS. ©

Without the additional discs the square will work down to 2 in.; this is unlikely to be small enough and so the discs are essential. These discs must be concentric and of the same diameter, though the actual outside diameter is unimportant.



MATERIAL 1- $\frac{1}{2}$ dia. BRIGHT MILD STEEL QUANTITY 2 OFF.
HOLE REAM $\frac{1}{4}$ DIA.
REDUCE OUTER DIAMETER JUST SUFFICIENT TO ENSURE CONCENTRICITY WITH HOLE. BOTH DISCS MUST BE SAME DIAMETER.
SMALL DIAMETER DISCS. ©

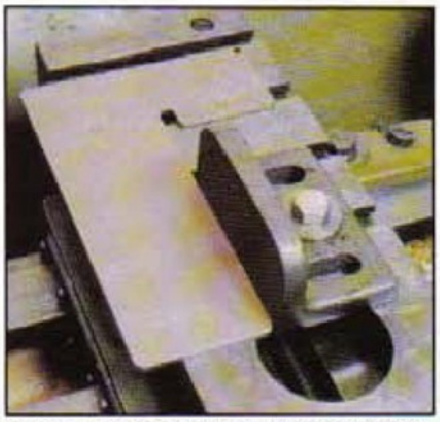
Testing for accuracy

Having completed the square it is essential to test this for accuracy. To use the device it would be normal to place it against the circle to be centred and to scribe a line, a second line would then be scribed at 90 deg., where these cross should be the centre of the circle.

To prove this will be the case, test by scribing three lines at 60 deg. and 120 deg., if these cross at the same point all is well. If a small triangle is formed then an error is present. Carefully analyse the result to determine if a little more taken off the blade will eliminate or add to the error.

These tests should be carried out without the added discs, for if these have been made concentric and of equal diameter, they will not effect the accuracy in any way.

If removing metal from the blade edge will improve the situation, an appropriate amount can be removed. Do test at both small and large diameters before making any adjustment. In any case, if an error exists then the centre can always be found by scribing three lines. The required centre will be in the middle of the small triangle created.



Using the centre finder as a normal square for positioning an angle plate on the lathe cross slide.

Other uses

There may be, on occasions, situations where the device can beneficially be used in place of a normal square. Typically from a narrow slot where the bed of a normal square would be too large, but that the two pins could enter. Also, due to there being pins on both sides of the square's edge, it may be able to locate off short edges where a normal square would not locate with a positive feel.

IN OUR NEXT ISSUE!

Coming up in the August/September issue will be:

A novel garden gate. try out your new found welding skills.

A four jaw chuck. larger and more conventional than that in this issue.

Turning ball handles. making use of the attachment in this issue.

Back to college. A look at model engineering courses.

Some ideas for the Hobbymat md65.

Stand for a mill/drill. Some more welding practice.

Improving a Milling Vice.

An article on welding with particular emphasis on mig welding.

AND MUCH MORE.
August/September issue on sale July 7th

Contents may be changed

IMPROVED CHUCK BOARDS

Above: *The two chuck boards with chucks waiting to be carried to the lathe, note how the handles restrain the chucks' movement. The gap-filler piece can be seen in the foreground.*

The board in position on the lathe with the gap-filler piece also in place.

With the board in place, notice how the chuck is exactly in position for screwing on.

In this short article we offer a simple device which will considerably ease the process of fitting and removing large chucks from the lathe mandrel

A request from a disabled reader regarding purchasing a smaller lathe arose because of his finding difficulty in fixing and removing the chuck from his lathe mandrel.

The need

This led me to consider that, even for myself, fitting the larger chucks was not an operation that I was at home with. With this in mind I began to understand the problem that would be experienced by, say, one

The trough being made; test this frequently against the chuck as the trough is extended.

who was suffering the effects of some debilitating condition to the hands.

The problem that I experienced was that of holding the heavy (in my case six inch four jaw) chuck in position, as well as rotating it to mate with the threaded mandrel.

The solution

Most will be aware of the use of a chuck board to protect the bed against damage. Whilst this is a very simple item to make from a few pieces of wood, I was surprised to see this available in the Myford catalogue. This device protects the bed should the chuck slip when fitting or removing. It also permits the chuck to be fitted or removed in two stages. To benefit in this way, first bring the chuck to the lathe and rest it on the board, then lift the chuck into position for screwing on to the lathe mandrel.

It was when considering this operation that the idea for a much improved chuck board dawned on me. The principle is for the board to be thick enough for a circular trough to be made in the top surface of the base, this being the same radius as the chuck for which it is to be used. The thickness of the base and depth of the trough being such that the chuck sits exactly (whatever that means) at the required height for the chuck to be screwed on and off.

With this arrangement the chuck can be screwed on and off, without having to take its weight whilst carrying out the operation. Having now made two (one even for a four inch three jaw chuck) I can confirm that the principle works far better than anticipated, and is well worth considering for the larger sizes, even by those who are fully able.

With the chuck firmly in place on the trough (about ½ inch deep will achieve this) the chuck still has to be lifted from the lathe.

To further improve the ability of this simple accessory, carrying handles have been included made from heavy gauge wire (coat hangers). These can best be understood by referring to the photographs; each half is made to a width, such that the one side rests against the rear of the chuck, and the other rests against the front face or just in front of the first step of the jaws.

With each handle made to this width the chuck will be prevented from passing between either side and rolling off the board. Also with both handles being behind and in front of the chuck, neither will it be able to slide along the trough and off the end of the board.

The chuck can now be carried very safely from the lathe, whilst still on its own board; it can be returned in a similar manner. The chuck can be stored still standing on its own board, which will further ease the situation as at no point is it removed from the chuck board other than at the lathe.

For those for whom even lifting the chuck to and from the lathe is a problem, a very simple block and tackle on runners mounted on the workshop ceiling could be considered.

The Myford Series Seven lathe for which the prototype was made is a gap bed lathe; this means that, with the chuck resting on the board before screwing into position, the board will tilt and the object of the board will be defeated. To overcome this on a gap bed lathe a suitable packing block will be required, equal to the depth of the gap; this requires to be quite precise.

This cannot be fitted to the board, as it would then not be possible to remove the board after fitting the chuck to the lathe mandrel. Also, if this were overcome, it would still make it difficult to store the chuck in position on the board when not in use.

Manufacture

If being made for a gap bed lathe, first make the packing piece to fill the gap; only the height of the item is critical, the width and depth can be somewhat smaller than the space available.

The process of making the chuck board needs very little explanation, only making the trough presents any real need for care. Cut the piece for the base and the two pieces to locate either side of the lathe bed. If possible choose a knot-free piece of wood, as the presence of knots will make it much more difficult to chisel out the trough.

Fix the two guide pieces using panel pins – a little suitable adhesive would also be a good idea. Ensure the guide pieces are positioned so that the assembly is a close fit on the bed without excessive movement. This will help to ensure that the unit functions correctly.

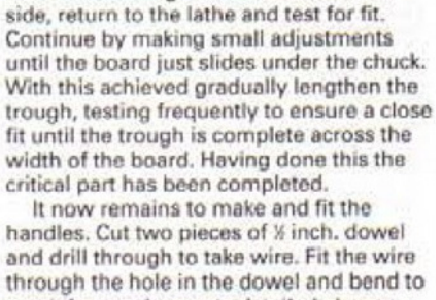
Having made the base thus far, leave the adhesive to set. Now, with the chuck fitted and the jaws suitably positioned, place the board up to the chuck body. Follow this by marking the end of the board with the outline of the chuck; do this using a pencil from underneath the chuck.

Remove the board from the lathe and, using a set square, mark the top of the board with two lines to indicate the edges of the trough. Fix the board firmly to the bench and commence to produce the trough using a wood chisel.

Initially make the trough, say, ½ inch wide and starting a little on the shallow side, return to the lathe and test for fit. Continue by making small adjustments until the board just slides under the chuck. With this achieved gradually lengthen the trough, testing frequently to ensure a close fit until the trough is complete across the width of the board. Having done this the critical part has been completed.

It now remains to make and fit the handles. Cut two pieces of ½ inch. dowel and drill through to take wire. Fit the wire through the hole in the dowel and bend to meet the requirements detailed above – this so as to ensure the chuck can be removed from the lathe whilst still on the board without the possibility of it falling off.

Position the screw eyes also to achieve this aim but positioned such that they do not obstruct the chuck from being slid along the length of the board.



Testing the trough against the chuck.

At the ends of the wire bend a length of ¾ inch through 90 degrees. This will permit the wire to be easily inserted into the screw eyes after which it can then be bent the full 180 degrees to make the handle captive.

With the construction now complete some slight adjustment to the shape of the wire handle may be preferable to obtain maximum security.

It can be seen from the photograph that, in the case of the smaller chuck, the base has been made from five pieces to avoid the requirement for a thicker piece of wood.

With the width of wood as seen in the photographs, it is required to slide the chuck along the trough to bring it in contact with the lathe nose.

To eliminate this operation, choose a narrower pieces of the wood such that, with the board slid into position, the chuck is just in contact with the lathe nose. This will make the process of fitting and removing a chuck even easier. it will also have the added benefit of taking up less shelf space.

MUSEUMS OF INTEREST

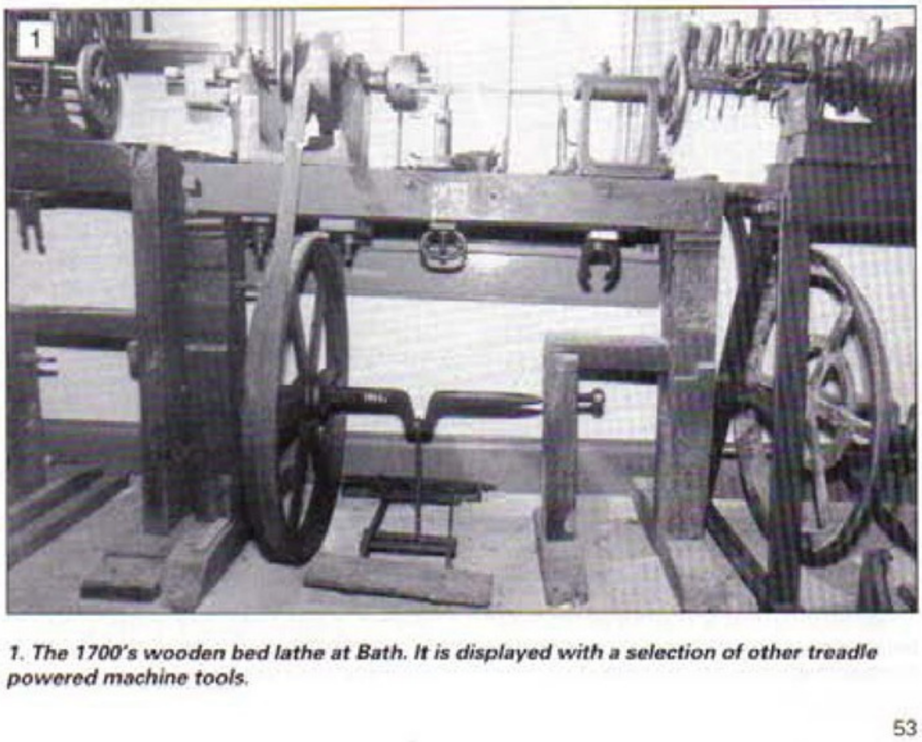
Are you at all curious about the development of machine tools? If so this brief listing of museums containing interesting artefacts from the earlier days of workshop practice should whet your appetite. There are many others, please let us know your favourite.

The interest shown in the history of machine tools by our readers came to light as a result of comments made in answers to the recent *MEW* questionnaire. This, whilst not totally unexpected, was surprising considering the number of people who made this request without any form of prompting in the questions posed.

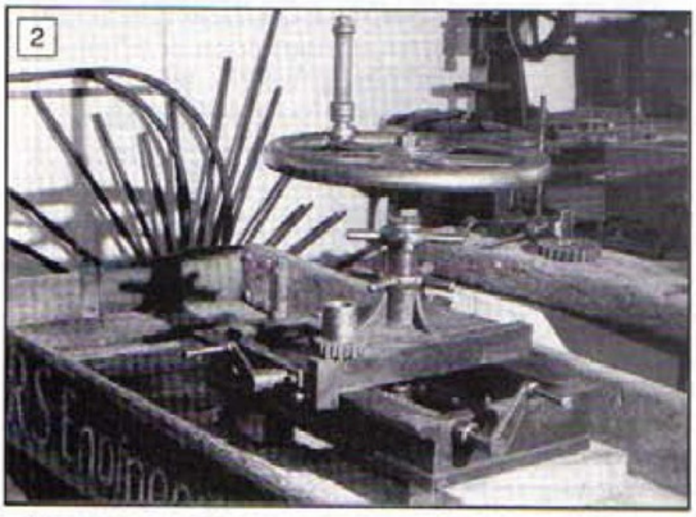
As a result of this, regular readers will remember my request for help from readers in locating interesting displays of old machine tools. Following this request, a good number of letters have been received suggesting worthwhile places to visit. It had been my intention of obtaining from the recommended locations, brief details of the extent of the machine tools on display.

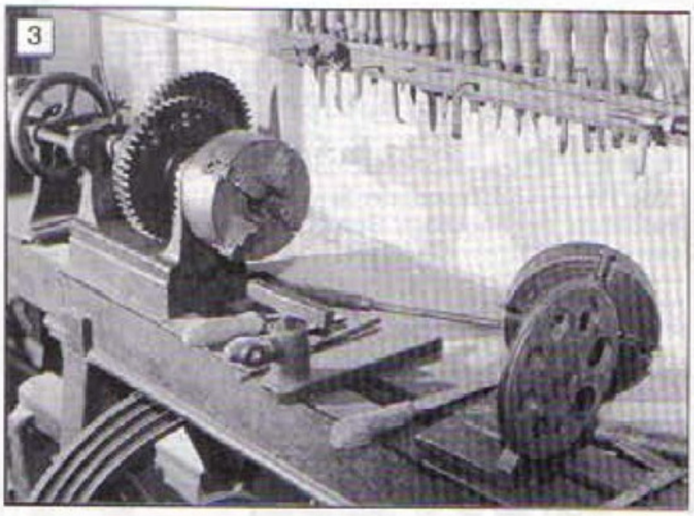
Due perhaps to my inexperience, I greatly underestimated the workload and difficulty in compiling such a report. I have though decided to publish it in a less complete state than I had originally wished. This has been done as I consider the information would be most beneficial at this time, it could be of use to readers as they travel to different parts of the country during their summer holidays.

On this basis any decision to delay



1. The 1700's wooden bed lathe at Bath. It is displayed with a selection of other treadle powered machine tools.





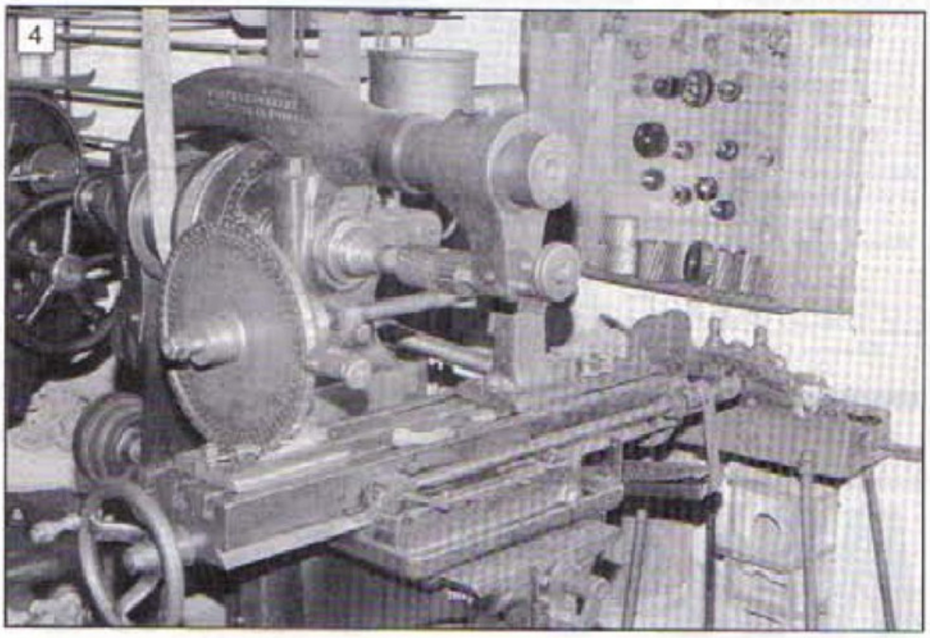
publication would probably have to be till the same time next year, and this I did not want to do. I do hope that readers will still find the article both useful and interesting.

Published list

Those readers with a more than passing interest in museums displaying items of industrial and scientific interest (or any other subject) would be well advised to obtain a copy of *Museums and Galleries in Great Britain and Ireland*. This book is published by British Leisure Publications, East Grinstead House, East Grinstead, West Sussex RH19 1XA, Tel. 0342 326972. The book should be obtained from good book shops, typically W.H. Smiths, price £6.40.

The book lists over 1300 museums and galleries, which are listed in order of location, making it easy to ascertain there are interesting displays in a particular area you are visiting. There is a subject index with listings under very many headings, the section for science and industry includes around 250 museums. There is an alphabetical index and also a military museum listing.

The book is published annually and for most entries includes dates and time of opening, also brief description of each museum's main attractions and facilities.



2. A portable hand powered re-facing machine. A specialist milling machine used on site for re-facing steam portfaces etc. Also in the Bath Museum, as are the remainder of the photos in this article. 3. A back geared plain lathe. The holes in the tool rest suggest that it may have been used for spinning as well as more usual functions. 4. An elderly horizontal milling machine, set up for straddle milling a workpiece, which itself is to be indexed.

Readers' Suggestions

Suggestions have been made by readers relating to quite a number of museums, and the major ones have been approached for brief details to publish. Unfortunately not all have responded and will not be included in this article, see conclusions at the end.

Three museums have been mentioned by a number of readers and are almost certainly very worthwhile visiting. These are those at Manchester, Birmingham and Ironbridge.

The following comments regarding individual museums are either mine or taken from the details provided by the museum itself.

Museum of Science and Industry, Birmingham

Newhall Street, Birmingham B3 1RZ, Tel. 021 235 1661.

Admission free. Times Mon to Sat 9.30 to 5.00, Sun 2.00 to 5.00.

We do have a large number of machine tools on display, with probably an equal number in storage awaiting their turn.

Machine tools is a rather vague term so it is difficult to be specific. The collection ranges from glass bottle making machines to wire curtain hook benders and from bread wrapping machines to Extrusion Presses, through medallion copying machines, looms and pen nib die stamps. If one is restricting the subject to the area of lathes, milling/grinding machines, and similar engineering tools, then we have a wide variety, from early screwcutting lathes, through engine turning machines up to C.N.C. machines, with about 50 different models on display. Examples are the pre-1850 Faceplate lathe built at the Soho Manufactory, which could turn/cut up to 26 feet diameter, over a length of 12 feet and the c. 1830 Planing machine, with a hand cut driving screw.

Additionally, there is a replica Victorian workshop containing a number of belt driven machines, although this area of the Museum is about to undergo some remedial display work and is only a static display. It is hoped that the running of these machines will be reinstated soon.

The Ironbridge Gorge Museum

This group is a number of very interesting museums spread over an area of a few miles and is in fact a World Heritage Site.

Information. Visitor Information Service, Ironbridge, Telford, Shropshire. Tel. 095245 3522 weekdays, 09245 2751/2166 weekends.

The Blists Hill Museum is the largest of the museums, the following lists but a few of the interests which make up a complete small town from the past.

Blists Hill is the next best thing to time travel. A town on a 50-acre site above the Ironbridge Gorge takes visitors back to the turn of the century. Blists Hill is no museum in the ordinary sense of the word. Its exhibits are buildings – some reconstructed, some original – which recreate the working and living conditions of ordinary people in the Britain of around 1900.

Blists Hill paints a living picture of a small community typical of those times. It has its butcher, baker and candlestick maker. It has its pub and foundry, its carpenter's shop and its coal mine, its school and sweet shop, its ironworks and canal. The little town even has its own bank, where visitors can change their decimal coinage into the pennies, half-pennies and farthings of yesterday – and then spend them in the shops.

Visitors to Blists Hill enjoy an experience of times gone by. The stories surrounding the various buildings are not told by labels and explanatory panels. Instead, visitors will meet shopkeepers, craftsmen and workers in late Victorian costume, all going about their daily business, who will be pleased to talk about their work and demonstrate their skills.

Tinsmith's and Plumber's Workshop

This workshop, tucked away down Canal Street, is housed in part of the old brick and tile works. All kinds of household items are made by hand and sold here, including pastry cutters, measuring jugs and candle holders. The fittings were brought to Blists Hill from a workshop at Bedworth near Coventry.

Foundry

Small foundries such as this existed in most market towns in late nineteenth century Britain. It is important to remember that such foundries made castings (i.e. items made by pouring molten metal into moulds), everything from cast-iron statues to doorstops. The differences between cast-iron and wrought-iron will become clear when you visit Blists Hill's ironworks. Here at the Foundry, iron, melted in the cupola furnace, is poured into sand moulds made using wooden patterns.

The machines in the Foundry's machine shop, driven by a Heath Robinson-like system of belts and shafts, are used for grinding, drilling and turning the castings. The machine shop is powered by an elegant steam engine made c. 1840 by Peel, Williams & Peel in Manchester.

The open-sided building outside the foundry has a roof supported by a framework of cast-iron, which came from Broseley.

Locksmith's shop

The intricacies of lock manufacture are explained in this shop, which is a replica, built in 1985 to house equipment from various sources. Although there were large lock-making factories in some towns, most towns gave employment to a local locksmith who made special locks and repaired old ones.

Sawmill and carpenter's workshop

In the sawmill, reconstructed in 1976-77 with equipment from various sources, you can see trees sliced into planks of varying size by a huge powered saw. The nearby yard contains an office, a crane and a timber drying shed. Stout wooden wheelbarrows are among the items made for sale in the workshop.

Ironworks

This impressive works is unique. It is the only one in the world which makes wrought-iron. It does so by 'puddling', one of the key processes of the Industrial Revolution. The various parts of the works have all been brought to Blists Hill from elsewhere, but this kind of works was typical of the Shropshire Coalfield in the nineteenth century. The processes are best understood from the viewing platform which overlooks the entire site.

The function of the ironworks is to convert pig iron (a form of cast-iron) into commercially-saleable forms of wrought-iron. Pig iron is melted in the puddling furnace to remove the carbon it contains, converting it from its original brittle form into easily workable wrought-iron. Further impurities are expelled from the wrought-iron under a steam hammer, and it is then rolled into bar form. This is reheated and rerolled to produce a better-quality bar. The southern end of the works houses a finishing mill where wrought-iron can again be reheated and rerolled to be formed into standard sections required for construction purposes and for use by blacksmiths.

The central core of the iron-framed building housing the works is an exhibit in its own right. It was designed by Sir John Rennie, constructed at Woolwich Dockyard in 1815 and moved to Blists Hill in 1974. The equipment comes mainly from Messrs. Walmsleys' Atlas Forge, Bolton, the last works in the world to make wrought-iron, which closed in 1976.

Museum of Science and Industry, Manchester

Liverpool Road, Castlefield, Manchester, M3 4JP. Tel. 061 832 2244. Times 10.00 to 5.00 every day.

The museum was Museum of the Year 1990.

The machine tools gallery

Many of the most important early machine tools came from Manchester. The Gallery includes tools by Whitworth, Muir, Sharp Roberts and Hotzappfel and cover the years from 1822 to the First World War. Most of the machines are connected to line shafting and our Demonstrator is happy to operate them for the public.

The Prescot Museum of Clock and Watch Making

34 Church Street, Prescot, Merseyside L34 3LA. Tel. 051 430 7787. Admission free. Times Tues to Sat 10.00 to 5.00, Sun 2.00 to 5.00.

The new Prescot Museum of Clock and Watch Making is housed in an attractive eighteenth century town house in the centre of Prescot, close to the Parish Church. Prescot was the main centre of the South Lancashire watch trades in the eighteenth and nineteenth centuries and its products were famous at home and abroad.

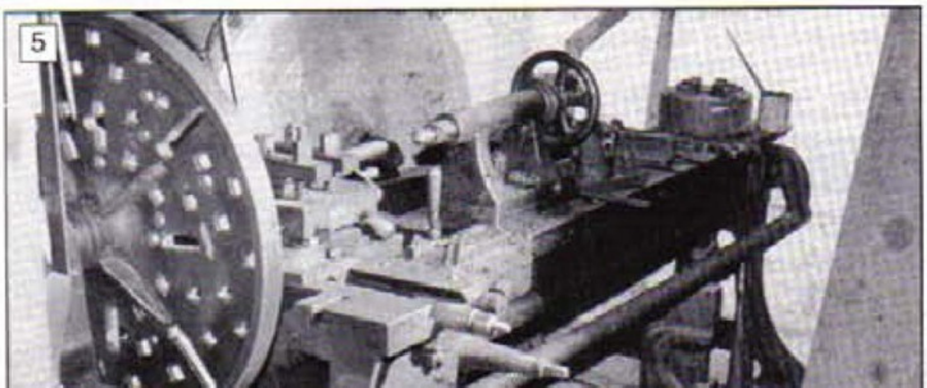
The museum displays begin with an introduction to the history of timekeeping and then explores the techniques of clock, watch and associated tool making in Prescot and South Lancashire. The social and industrial background to these trades such as the lives and working conditions of the makers is also examined.

You will see a reconstruction of part of a traditional Prescot watch maker's workshop and examples of the hand tools and machinery used to make the many intricate parts of watch movements. The establishment of the Lancashire Watch Company factory in Prescot in 1889 meant that for the first time complete watches, and later clocks, were made under one roof. The history of the factory, its aims and achievements and its effect on the town is explored alongside displays of its steam-powered machinery.

The Bridewell Museum, Norwich

Bridewell Alley, off Bedford Street, Norwich NR2 1AQ. Tel. 0603 667228. Times Mon to Sat 10.00 to 5.00.

The Bridewell Museum has a collection of material relating to Edward Hines of Griffin Engineering Works, Norwich. The firm was established in the 1860s and specialised in the manufacture of high quality ornamental turning lathes and accessories. The collection comprises examples of lathes and lathe tools, engineering drawings, plans, catalogues and a comprehensive photographic archive of production items. An ornamental turning lathe, tools, accessories and exhibition medals are on display. The greater part of this collection is currently in store, but can be viewed by appointment.



5. Massive and probably still capable of a good day's work. A screwcutting lathe belt driven from a overhead line shafting. Maker's name would appear to be Butterfield, but it is very similar to a Milnes of the same period.

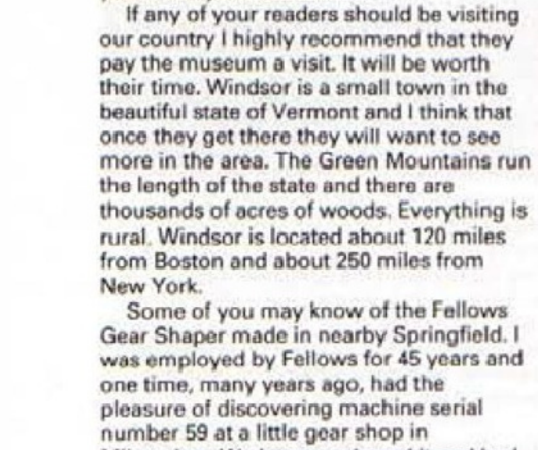
The American Precision Museum

Here I am including a letter from Robert Plummer of Illinois, U.S.A.

A museum exists here in the U.S.A. which is full of old machine tools (mostly American made by perhaps also some British) and hand tools. The name is American Precision Museum, Windsor, Vermont 05089. The man in charge is Mr E. Battison. I am sure a brochure is available and that Ed Battison will be glad to send you one if you contact him.

If any of your readers should be visiting our country I highly recommend that they pay the museum a visit. It will be worth their time. Windsor is a small town in the beautiful state of Vermont and I think that once they get there they will want to see more in the area. The Green Mountains run the length of the state and there are thousands of acres of woods. Everything is rural. Windsor is located about 120 miles from Boston and about 250 miles from New York.

Some of you may know of the Fellows Gear Shaper made in nearby Springfield. I was employed by Fellows for 45 years and one time, many years ago, had the pleasure of discovering machine serial number 59 at a little gear shop in Milwaukee. We later purchased it and had it on display in our factory lobby. We later gave it to the museum where it now happily resides. We started numbering our machines with serial 50 so it is the ninth machine built by us, in 1898. The machine was purchased new by the old Jeffrey Automobile Co. of Racine, Wisconsin, which later became Nash Motors, then American Motors and finally it was merged into Chrysler Corporation.



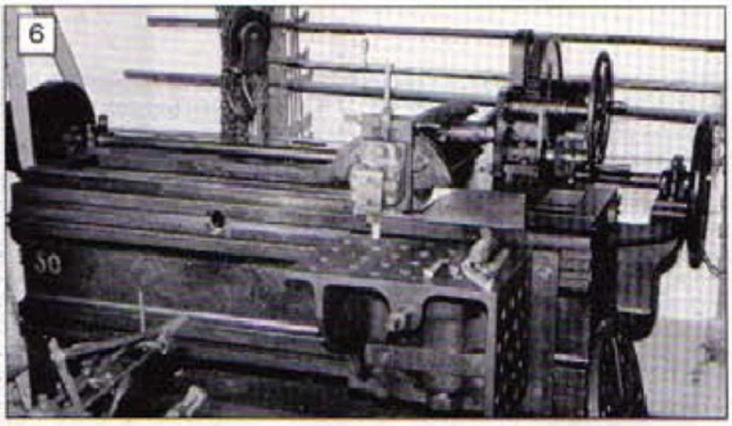
The Bath Industrial Heritage Trust

Camden Works, Julian Road, Bath BA1 2RH. Tel. 0225 318348. Times: Summer period 7 days 10.00 to 5.00, Winter Sat and Sun 10.00 to 5.00.

I would like to thank the curator of the museum and in particular Mr Dennis Paul, a friend of the museum, for their hospitality to me during my recent visit when I was able to take the photographs which accompany this article. This is indeed an intriguing place to visit.

Camden Works is an independent museum, an Educational Trust, in Bath. It has virtually all the equipment and papers – over 50000 documents – from J.B. Bowler's engineering works and mineral water factory that ran from 1872 to 1969. Pretty well all the tools were bought second or fourth hand or got from scrapyards, so much is older than the business.

6. Unfashionable nowadays, the shaper was much prized for its ability to generate plane surfaces with a single point tool. This geared head model could also be used for making dovetails. Note the overhead crane used to load the workpiece onto the moveable table.



It is a virtual treasure trove ranging from 24 in. lathes to watch-making equipment. Among six treadle lathes, including the hand tooling, is a wooden bed lathe of around 1750/1760 and an early Maudslay.

The following is an extract from the museum brochure.

At Christmas, 1872, Jonathan Burdett Bowler set up in business on his own as a Brass Founder and Engineer at the back of No. 12 Southgate Street, Bath. As early as 1864, he had advertised himself as a brass founder in the Bath Post Office Directory, but giving only his home address, 45 Villa Fields. In 1848, aged fourteen, he had been apprenticed 'in the art and business of furnishing ironmonger and brass founder' to Nathaniel George Wilcocks, who ran both a mineral water machinery factory and the City Brass Foundry and Iron Works, with workshops in Avon Street and Back Street, and a showroom at 15 Westgate Street. Bowler eventually became Wilcocks' foreman and must have acquired a great deal of experience with him, both on the mineral water machinery and on the jobbing engineering side. The firm specialised in making and repairing the equipment used by brewers, public houses and mineral water manufacturers, and combined this with a wide range of work for local tradesmen, public institutions, such as hospitals and Bath Corporation, farmers and private domestic customers. Wilcocks was a typical nineteenth century engineer, employing skilled, highly versatile men and accustomed to doing whatever the customer wanted, quickly and with a minimum of fuss.

Bowler built up his own business in the Wilcocks tradition. In 1886, the same year that he set up house at 4 Devonshire Terrace, Wellsway – where, incidentally, his great-granddaughter still lives – he moved the works to a block of three-storeyed buildings, adjoining his mineral water factory, in Corn Street. Bowler had entered the mineral water trade in February 1876 when, in partnership with Walter Edward Annely as W. Annely & Co., he had bought the manufactory of Thomas Bull in Corn Street Place. During 1877 this factory was extensively re-equipped, largely with machinery of Bowler's own manufacture or reconditioning.

When the business closed, the mineral water factory was much as it had been eighty years earlier, with the barrel for generating the carbonic acid gas, the pump for aerating the water, the wonderful collection of bottles of all types – a museum in their own right – the catalogues, price-lists and advertisements, and the little room where the ingredients were mixed, the recipes kept locked away in the office safe. The basis of most of the recipes was a mysterious liquid known as Twaddle, which consisted of a hundredweight of sugar, four ounces of refined saccharine and four pounds of tartaric acid, stirred briskly into fifty gallons of water. Everything, lemonade, ginger ale, lime juice, contained Twaddle.

In the engineering shops too, there had been little change. Everything looked as if one happened to be visiting the works on a Sunday, with the men returning to work the following morning. In one sense, it must have always had something of the atmosphere of a museum. J.B. Bowler rarely bought any new machinery and most of the machines date from the 1870's or, in one or two instances, even earlier. In the recollection of Mr Bowler's grandson, the only machine ever bought new was a small drilling-machine, installed in the first decade of the present century. It was still there when the works closed. Stored away in one corner was a portable hand-powered milling machine (seen in one of the photographs, the machine with the large handle on top), which used to be taken out to farms to reface the slide valves of steam engines.

The people at Bowler's had to be able to do anything. It was impossible for the business to employ unskilled men. The old type of versatile, broadly-trained engineer gradually died out. 'As they passed away,' says the last head of the firm, 'that was it. I never tried to get anyone else'.

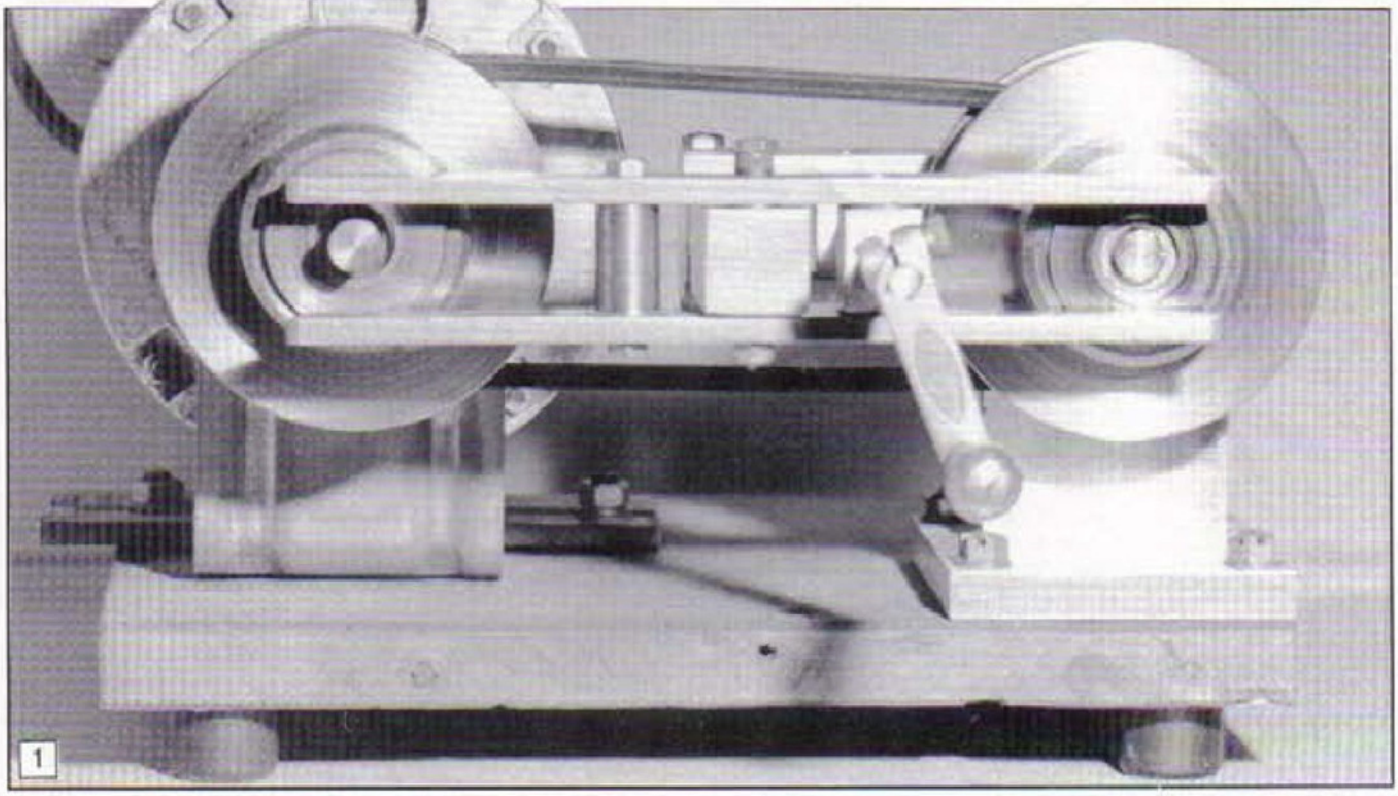
Bowler's finally closed its books and its business in 1969. The site now belongs to Bath City Council and the premises have been demolished. A car park has taken their place.

The contents, however, belong to a Trust formed specially to conserve and display them. In 1978 they were moved into their present home, the Bath Industrial Heritage Centre at Camden Works, which was built in 1777 as a Real Tennis court. The Bowler Collection is presented now as closely as possible to the layout in Corn Street in an attempt to recreate something of the atmosphere of the original premises.

Other permanent exhibitions at the Centre feature the Bath Stone industry and Cabinet-making. Changing exhibits explore aspects of Bath's industrial and social history which have hitherto gone unremarked in the city of Beau Nash, the Woods and Jane Austen.

Conclusions

I do hope the above will be beneficial to readers of this magazine. Also I have a number of museums listed as suggested by readers for which I have been unable to get further details. If feedback received regarding this article leads me to consider it worthwhile, I will include the list in the next issue with the limited details that I have.

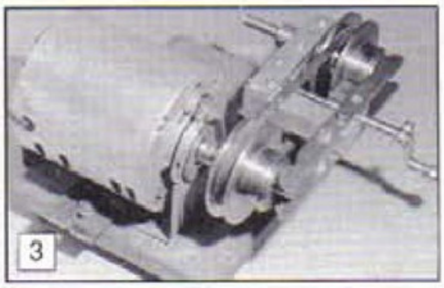


1

MECHANICAL VARIABLE SPEED DRIVE

The gradual introduction of electronic variable speed drives into the home workshop is not without its drawbacks. Amongst these are the complex electronics and a more expensive and complex motor (if D. C.). These may be acceptable to the electronically biased home machinist but, for the engineer who wants to stay with mechanics, this excellent mechanical variable speed drive by Mr A Longworth of Gainsborough is ideal.

2



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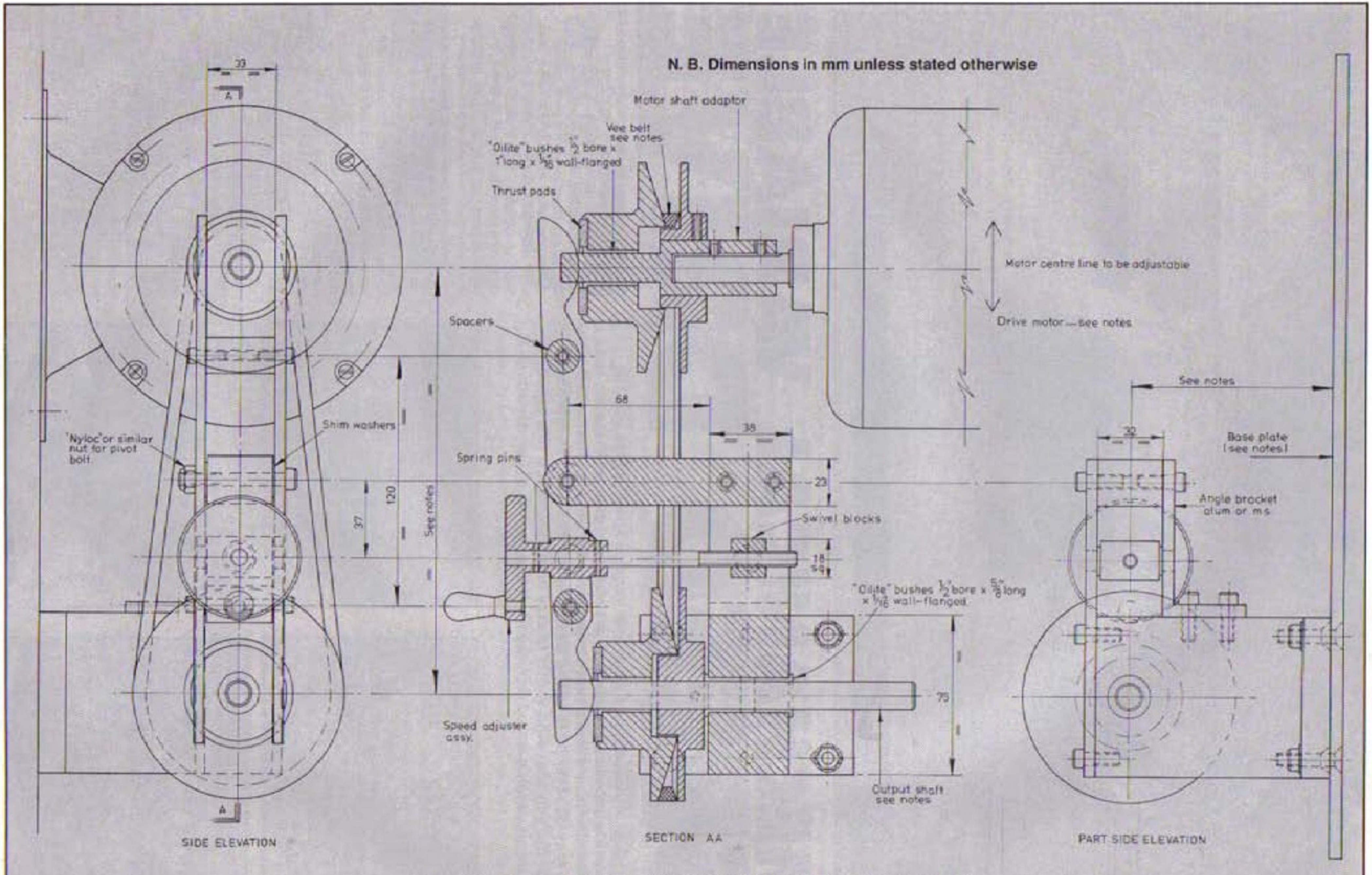
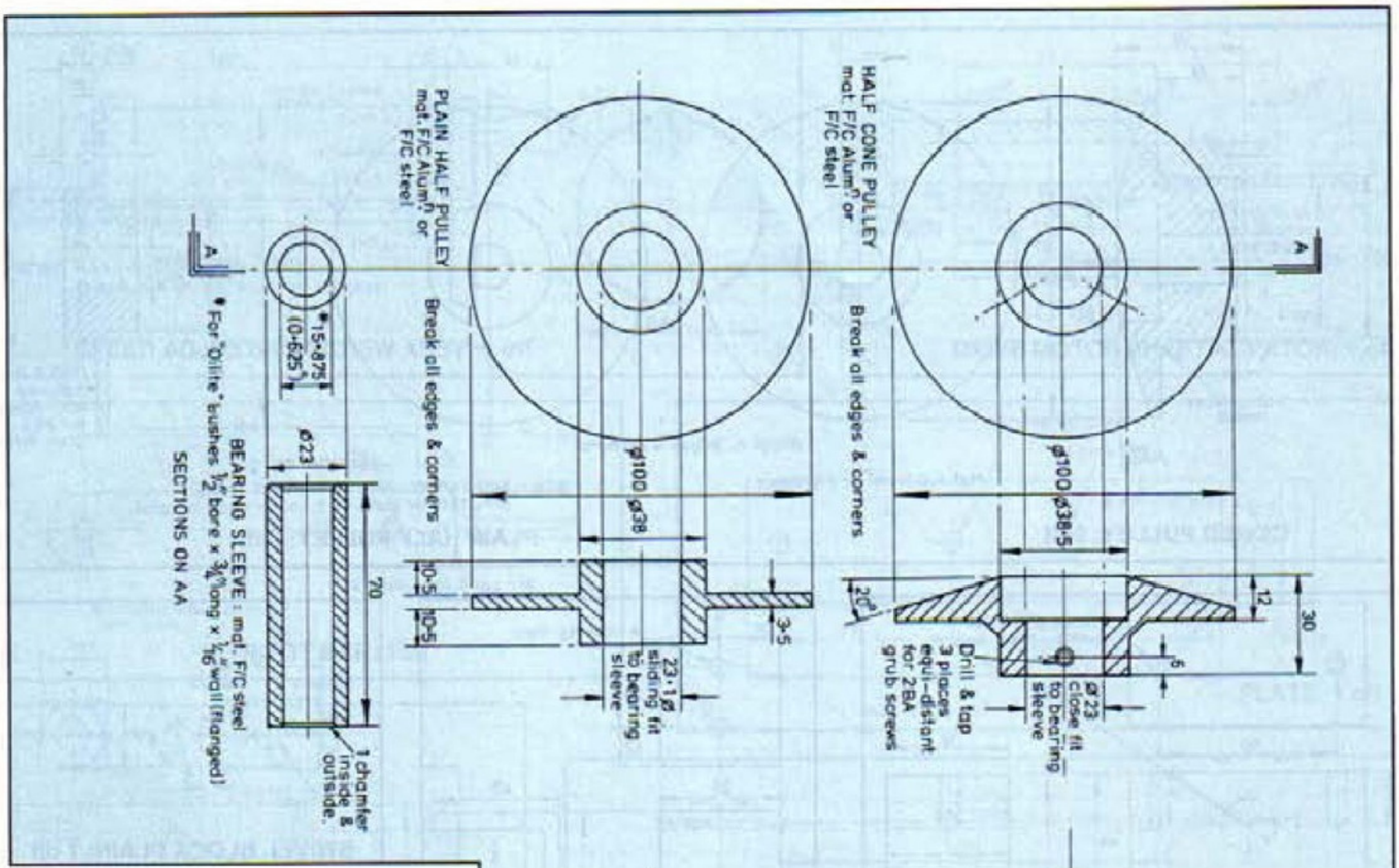
My interest in machine drives stems from quietly desiring those machines which are always well outside the range of my finances. Struggling, together with a great many model engineers, with old and rather basic tools and slowly improving them or building my own and, it must be admitted, deriving a lot of pleasure in so doing, it would appear that the majority of machine tools aimed at the home workshop have not greatly improved in the last 50 years. In fact, in many aspects, the design of these machines is inferior to pre-war machines.

The area of least development would appear to be in the drives for equipment such as drilling machines, light lathes, small bandsaws, etc. In recent years, electronic speed control has been developed but this requires motors which are considerably more expensive than the simple induction motor, the "workhorse" of most home shop machines. The actual electronic controllers, unfortunately, add to the cost and can be expensive to repair or replace.

Various forms of mechanical infinitely variable drives have been developed over the years, and are widely used in industry and operate at high efficiencies. These industrial drives require high precision components working in oil baths and are, of course, designed for hard continuous service. However, for the home workshop, something simpler is required and the Variable Cone Pulley is simple and yet extremely efficient.



GENERAL ARRANGEMENT OF INFINITELY VARIABLE SPEED ADJUSTER



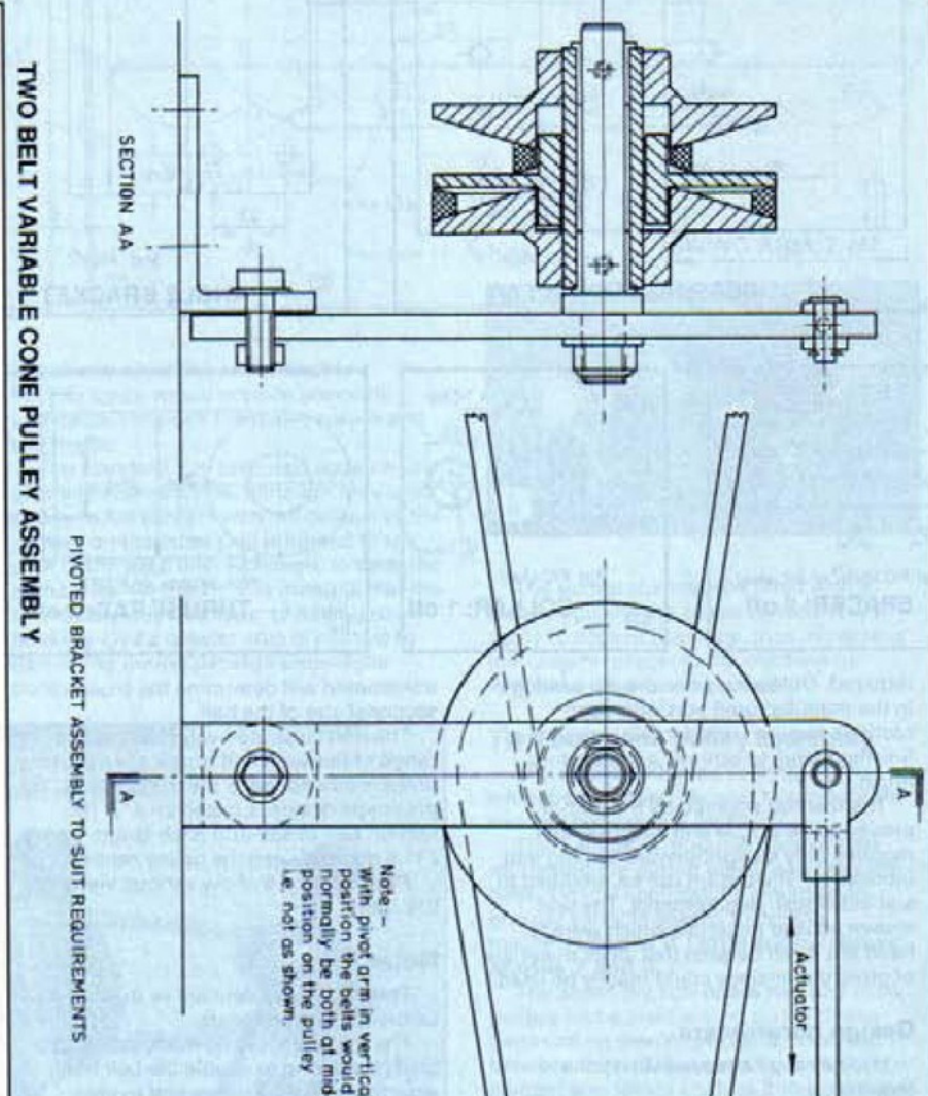
The modification version described in the text and drawings is relatively simple to build and adapt to existing belt-driven machines, and I have no doubt that readers will further develop and improve the idea. One addition I intend to carry out at some time is the inclusion of a linear scale to indicate the speed range positions. I have not as yet investigated the possibility of renting an accurate Tachometer to obtain the scale positions. Renting would seem to be a sensible option as this is an instrument which would not be used on a regular basis.

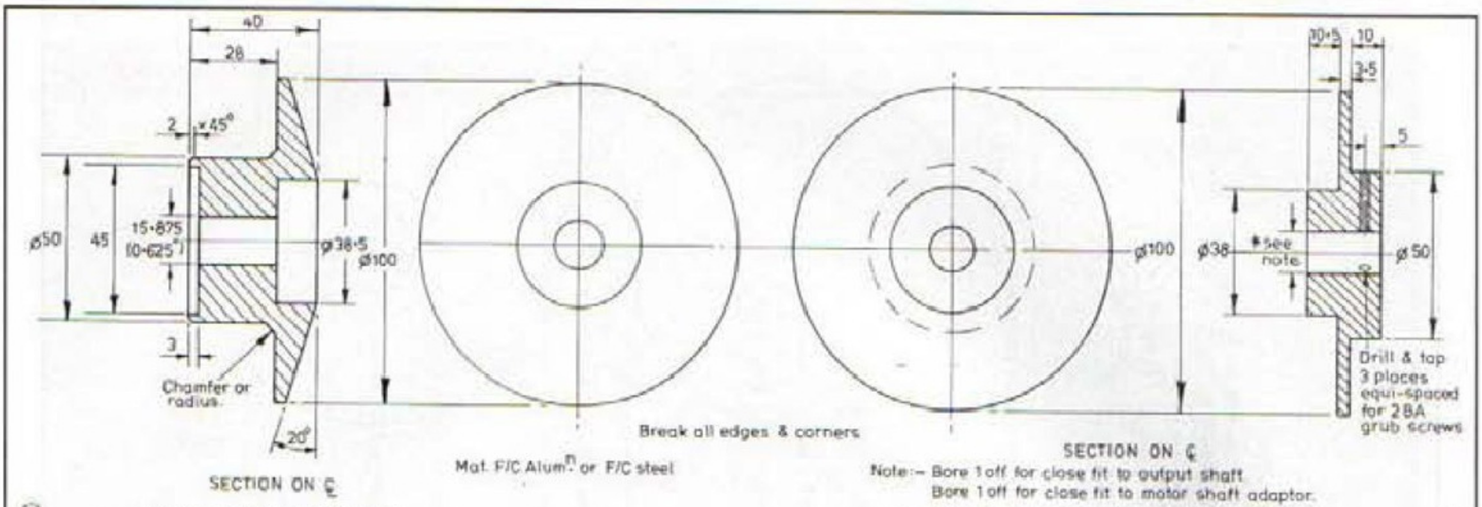
The method adopted to overcome the problem of inter-locking castellations in the half cones, i.e. to have one plain half cone and one plain disc applies particularly to the use of small section Vee belts and relatively small pulleys. It will be appreciated that the small section Vee belt will conform more readily to the smaller diameters enabling worthwhile ratios to be obtained.

Infinitely variable speed controllers

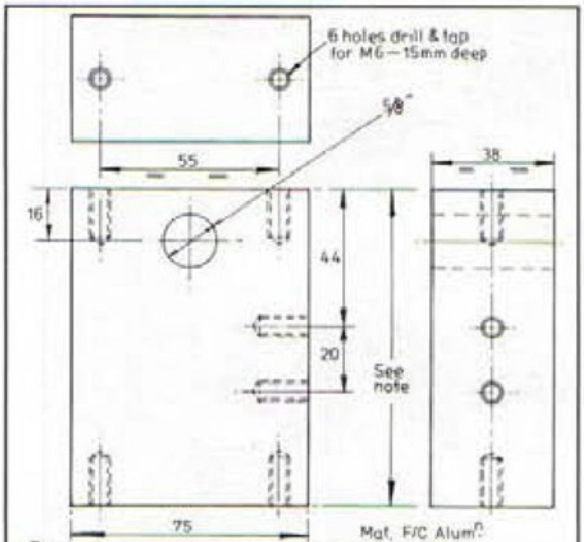
The Variable Cone Pulley (VCP) method of speed control is long-established and proven, and relatively simple to operate. It eliminates the time-consuming process of belt changing which involves switching off the machine and thereby interrupting work-in-progress. Belt change drives and gear drives are also limited to fixed steps in speed variations and are almost always a compromise, rarely producing the ideal speed for the job in hand. Stepless Speed Control is obviously desirable and the VCP is a simple and efficient way of obtaining this.

The model engineer wishing to make his own VCP is faced with a problem in that the conventional expanding pulley usually consists of mating halves with inter-locking castellations formed in the cone faces. These normally require castings to be made for which accurate patterns are

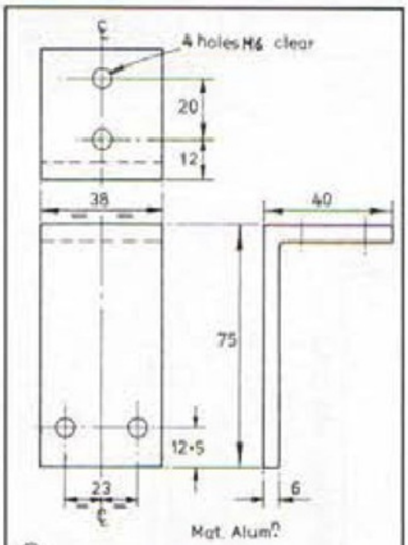




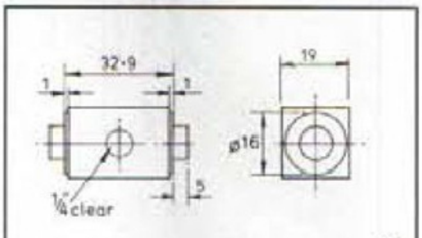
CONED PULLEY: 2off **PLAIN HALF PULLEY: 2off**



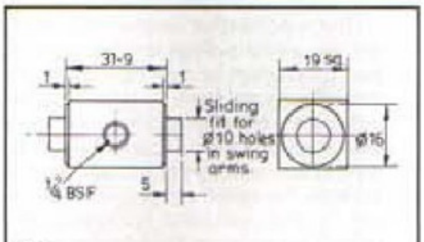
BEARING BLOCK: 1 off



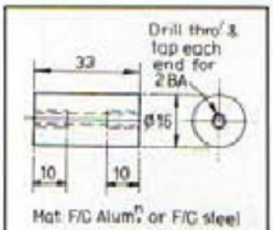
ANGLE BRACKET



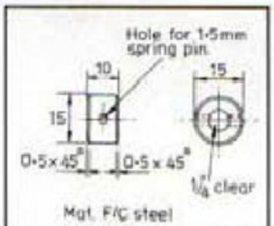
SWIVEL BLOCK PLAIN: 1 off



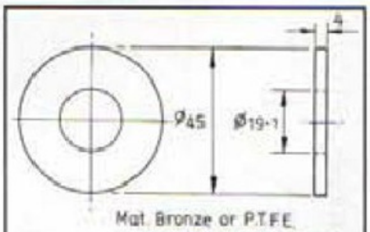
SWIVEL BLOCK TAPPED: 1 off



SPACER: 2 off



COLLAR: 1 off



THRUST PAD: 2 off

required. Unlike the pressure die-castings in the manufactured versions, sand castings require considerable amounts of finishing work to achieve a satisfactory finish.

The method adopted by the author proved to be simple and effective, and requires only straightforward turning and fabrication. The design can be modified to suit individual requirements. The unit shown utilised materials which were to hand but it will be seen that stock materials of other dimensions could readily be used.

Design parameters

(a) The range of speed variations required.

(b) The centre distance between the drive motor and the output shaft.

(c) (a) and (b) will determine the length of Vee belt required.

(d) The amount of power which is to be transmitted will determine the cross-sectional size of the belt.

The unit illustrated will give a speed range of between half motor speed to two times motor speed to the output shaft. The prototype design is based on a 'Z' (M) section belt of 580 mm pitch length giving 211.5 mm between the pulley centres.

Photos 1 to 5 show various views of this unit.

Notes

The base is not detailed as this can be tailored to requirements.

The motor should be made adjustable on its mounting to enable the belt to be assembled to the pulleys and to give adequate tension to the belt.

Alignment of the pulleys is facilitated by slotting the holes in the bearing block foot.

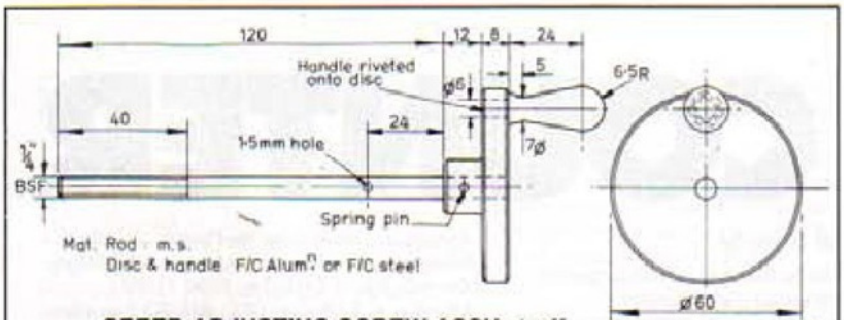
The contact arcs of the swing arms need to be truly parallel on assembly and have a smooth and burr-free finish in contact with the thrust pads assembled to the coned half-pulleys.

A drop of light oil with eliminate any noise.

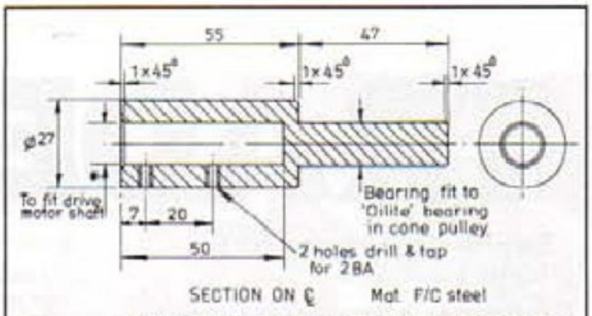
The speed adjuster assembly of the prototype used a handle which was available but a simple alternative can be constructed, as suggested in the drawings or to suit individual choice. The screw thread was ¼ in. BSF but any other fine thread could be used.

The height of the bearing block shaft centre line is shown to be the same as the motor centre line height above the base but this is not essential.

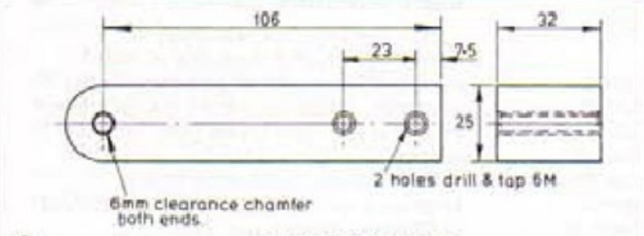
Again, the bearings used and described were to hand but, of course, could be of other sizes, as could the shaft sizes.



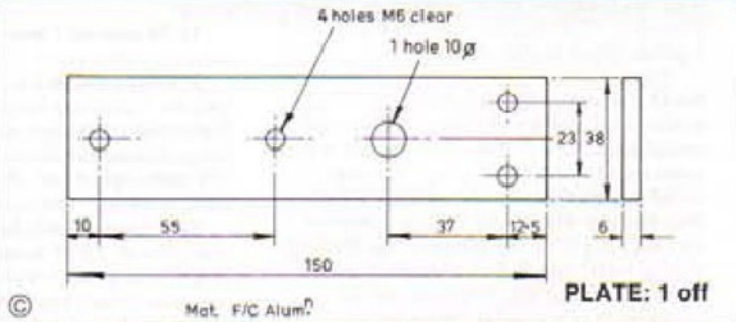
SPEED ADJUSTING SCREW ASSY: 1 off ©



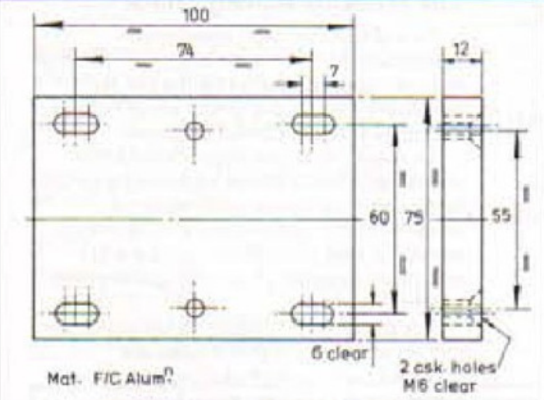
© **DRIVE MOTOR SHAFT ADPATOR: 1 off**



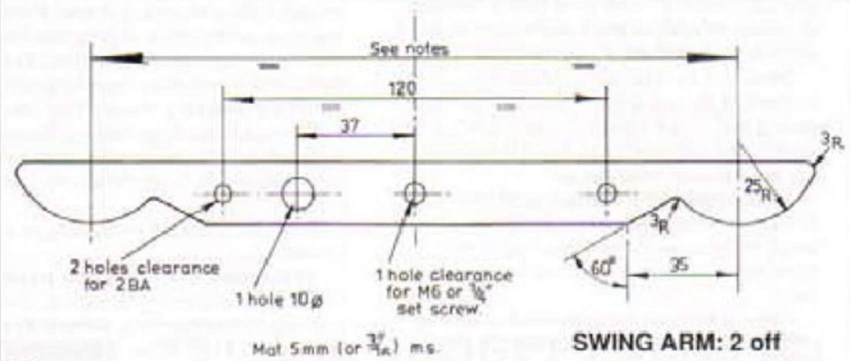
© **PIVOT BAR: 1off**



© **PLATE: 1 off**



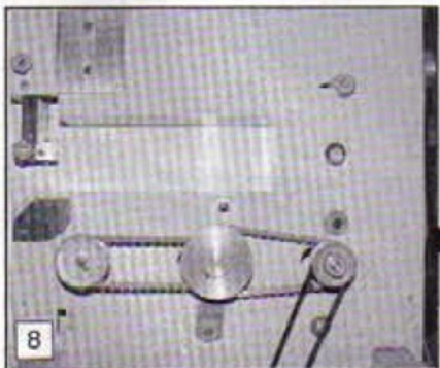
© **BEARING BLOCK FOOT: 1 off**



© **SWING ARM: 2 off**

Note that bearings were fitted to the coned half-pulleys although these do not rotate on the shafts but only slide during speed adjustment. The bearings were fitted to avoid any chance of a binding but are not strictly essential, and probably a P.T.F.E. spray would provide adequate lubrication between the pulley halves and the shafts.

The standard Vee belt used appears to give adequate traction, although only one side is in full contact with the pulleys as the contact on the other side is limited to the area of the pitch line. Although, to date, the author has not tried it, it is possible that the round polyurethane type of belting could possibly give a greater area of contact by deforming during passage around the pulleys.



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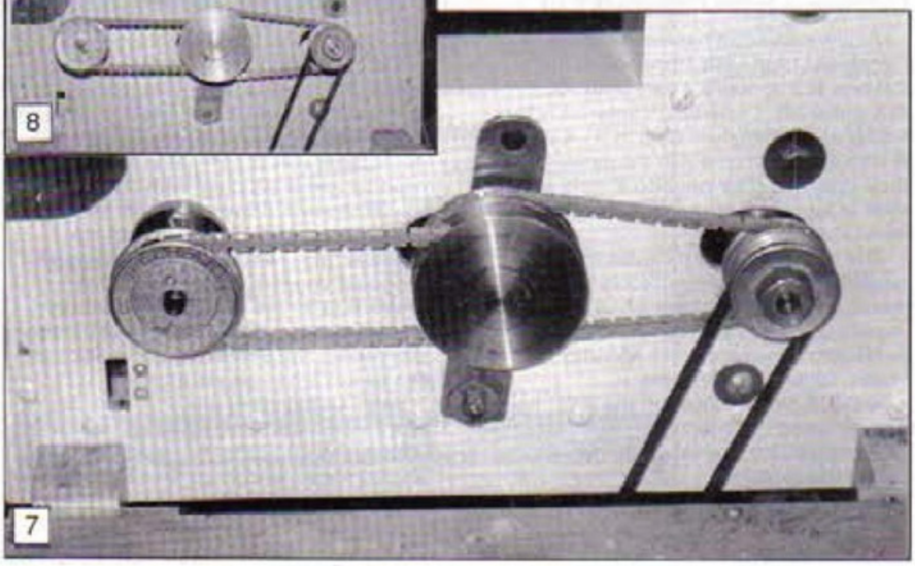

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The output shaft can be fitted with a stepped pulley, the speed variations will apply to each of the steps, thus increasing the range available to the machine to which the drive is connected.

Two belt cone pulley assembly

The method adopted to produce the simplified VCP can be used to produce the two belt cone pulley assembly.

This version is mounted between the motor and the output pulley and uses two belts. Typical applications would be to provide variable speeds to drilling machines **photo 6**, lathes and bandsaws **photos 7 and 8.**

The assembly comprises two half cone pulleys and a plain sliding pulley (these parts can be seen in **photo 9**) mounted between them. This assembly is fitted to a pivoted arm which enables it to be moved towards or away from the input and output shafts. Moving it towards the input shaft will cause a decrease in the output shaft speed and conversely an increase when moved away from the input shaft.

TRADE COUNTER

New items of interest for the home machinist.

VERTICAL ALIGNMENT DEVICE

N.S. and A. Hemingway have recently introduced a device which they call a vertical alignment device for use with the Unimat 3, Toyo ML210 and Emco Compact 5 lathes. Their leaflet states:

"From many reports received there is no doubt that with one exception, the vertical drilling and milling attachment is a most useful accessory. This one exception is that upon raising or lowering the head the radial position above the column is lost. We offer our Alignment Device complete and ready to fit to the column. The Drilling/Milling head may now be raised and lowered without loss of radial setting.

We include a special clamp handle which can be positioned to best suit the user. A quick half turn is all that is needed to clamp or release the head allowing easy and free movement along the column.

Should it be desired to rotate the alignment device around the column then easing the single clamp screw found in each of the two plates holding the guide bar is all that is necessary.

Thus none of the versatility of the drilling/milling head is lost by fitting this latest accessory. Where applicable the parts are supplied in a colour to suit the lathe.

Other items for the Unimat 3, some of which are also recently introduced are, A Bed Stop, Slow Speed Drive, Tailstock Lever Feed attachment and a Four Tool Turret".

For details of these and other items available write to

N S & A Hemingway, 30 Links View, Half Acre, Rochdale, Lancs. OL11 4DD, Tel. 0706 45404.

Anti Condensation Heaters

Many of the correspondents relating to the "Keeping rust at bay" article have referred to low output anti-condensation heaters.

A range of low power industrial heaters are marketed by Electromail. These are intended for use in small enclosures but could be used also for localised heating as suggested by a number of readers in our follow up item in the last issue.

These range from 20 watts to 100 watts and have a cross section of 70mm x 65mm and are from 61mm long at 20 watts to 183mm long for the 100 watt unit.

The prices are from around £10.00 + VAT + p&p to £15.00 + VAT + p&p (P&P is £2.85).

The catalogue for this company is in two volumes and costs £6.00. It has a total of 28000+ parts listed and 1500 pages, many in colour. This is split with 1200 pages of electrical and electronic components and 300+ hardware and tools.

The address once again is Electromail, PO Box 33, Corby, Northants. NN17 9EL, Tel. 0536 204555.

Overseas readers should refer to the editorial in the Feb/Mar issue regarding overseas suppliers of materials.

Sources of Supply

I would like to thank numerous readers who have provided the following information, too many to detail in the space available. These are in reply to requests for materials and tool suppliers in previous issues.

1). **Stainless steel angle.** No reply, any suggestions.

2) **Silver steel.** Square and long lengths. Compass House Tools, High St., Rotherfield, East Sussex TN6 3LH (limited range in square). Blackgates Engineering, 209 Wakefield Road, Drighlington, Nr. Bradford BD11 1EB (¼ inch square).

Pillar Engineering Supplies have 16 branches in the Midlands and Southern England and can supply silver steel in 13 inch and longer lengths, also gauge plate in square section. No minimum order charge (bars cannot be cut to length required though). No delivery charges. Pillar also supply a wide range of engineering requirements including cutting tools, hand tools, machine tools, fasteners, cleaning materials and very many other items.

Contact Pillar Engineering Supplies, 26 Aston Road, Waterlooville, Hants. PO7 7UZ, Tel. 0705 254341, for details of nearest branch.

See also the item re catalogue from Flapstock.

3) **Solidox solid oxygen pellets.** Welding Engineering Supplies, Unit 2, Barking Industrial Park, Alfreds Way, Barking LG11 0TJ, Tel. 081-591 5777.

Some New Requirements

1) SRBP/F (Synthetic Resin Bonded Paper/Fabric) and similar, frequently known as Paxolin, Tufnol etc.

2) Ebonite.

3) Stainless Steel, square and hexagon sections.

4) Soft Iron for electro magnets.

5) Second hand electric motors. Other than Harrison Electrical, see trade pages this issue. Also see Scribe a Line.

6) A company who will sharpen milling cutters and the like.

Can anyone help with information on sources of supply for these?

Catalogue from Flapstock Ltd

A new catalogue has been issued by Flapstock Ltd of Little Horwood, Milton Keynes, this contains a very wide range of raw materials. Of particular interest is the listing of square silver steel in ¼ , ⅜ , ½ and ⅝ inch sizes. Whilst not in the catalogue, they state that they can also supply silver steel in lengths longer than the normal 13 inch.

The catalogue also includes a wide range of cutting tools and tools and materials for casting such items as Jewellery, model cars and many others.

Flapstock is open 9 till 5 Monday to Friday, callers are welcome.

Little Horwood is just off the A421 half way between Bletchley and Buckingham. The catalogue contains a map with more detailed instructions.

Send for a catalogue, mentioning *Model Engineers' Workshop* to- Flapstock Ltd, Shucklow Building, Little Horwood, Milton Keynes, MK17 OPT. Tel. 0296 713631 Monday to Friday or 0831 836052 Saturday Sales Office.

Electric Motors

Harrison Electrical specialise in supplying new and secondhand electric motors to the model engineer and home machinist. These include AC and DC, direct drive and with gear boxes fitted for lower speeds.

Write for list, mentioning *Model Engineers' Workshop* to Harrison Electrical, 17 Chigwell Road, South Woodford, London, Tel. 081-989 5873.

The Modeloy Milling Chuck

This chuck has been developed specifically for the model engineer. Most of the milling encountered by the model engineers entrails the use of small cutters and quite often in confined spaces.

To meet the above requirements the chuck has a No. 2 Morse taper and a small body and nose cap to give maximum visibility to the cutter, minimum restriction when working in confined spaces and minimum overhang from the spindle nose bearing.

The dangers of holding hardened cutter shanks in lathe and drill chucks are obviated by the automatic locking of the cutter into the milling chuck body.

The chuck comes complete with three collets of ¼ in., ⅜ in. and ½ in. capacity, to accept standard threaded shank cutters and a spanner to fit the nose cap, the No. 2 Morse taper will fit both lathe and milling machine and is supplied with the standard ⅜ in. Whitworth drawbar thread. Metric (6mm, 10mm and 12 mm) collets are available.

Should you require an alternative thread, e.g. for the Mk 1 Dore Westbury milling machine, please specify at the time of ordering. No. 3 Morse taper shank may also be available, please enquire.

Send for details of this and other items, such as Fly cutters, Mini mill (¼ in. shank) holders and End mills etc. to A. Marks, 3 Old Hall Close, Laughton, Sheffield S31 7YZ, Tel. 0909 563940.

Continued Expansion at Machine Mart

Machine Mart have continued to expand their High Street retail business with the opening of a new superstore in Peterborough.

The new store, No. 25 in the developing nationwide chain, is located in Millfield, Peterborough and boasts 5000 sq. ft. of bright uncluttered shop floor space. All products from the Machine Mart catalogue are displayed and available at the store which carries over 1300 different items in stock at any time.

In keeping with normal Machine Mart policy a full after sales and parts service is available at the store in the event of any product difficulties.

A free copy of the full colour 116 page catalogue is available from Machine Mart on 0602 411200.

Contect Duck Oil and Tufagena Hand Cleaner from Deb Group

1) Contect Duck Oil. This is a multi purpose service spray widely used throughout the industrial and automotive trades. It lubricates, use it as a light lubricating oil to improve efficiency and dramatically reduce friction.

Penetrates, low viscosity Contect penetrates tight tolerances to release seized components.

Displaces, Contect contains special additives to rapidly displace water from metals and electrical circuits.

Inhibits, Contect forms a film inhibiting corrosion on most metal surfaces.

Cleaner, Contects' light solvency action cleans and protects electrical and metal components.

Silicon free, means that the Contect film can be quickly and easily removed from surfaces by means of solvent or detergent degreasers, making the product ideal for use in paint or spray shops.

Compatible, Contect is compatible with a wide range of surfaces, including plastics, glass, paints, metal and most rubbers.

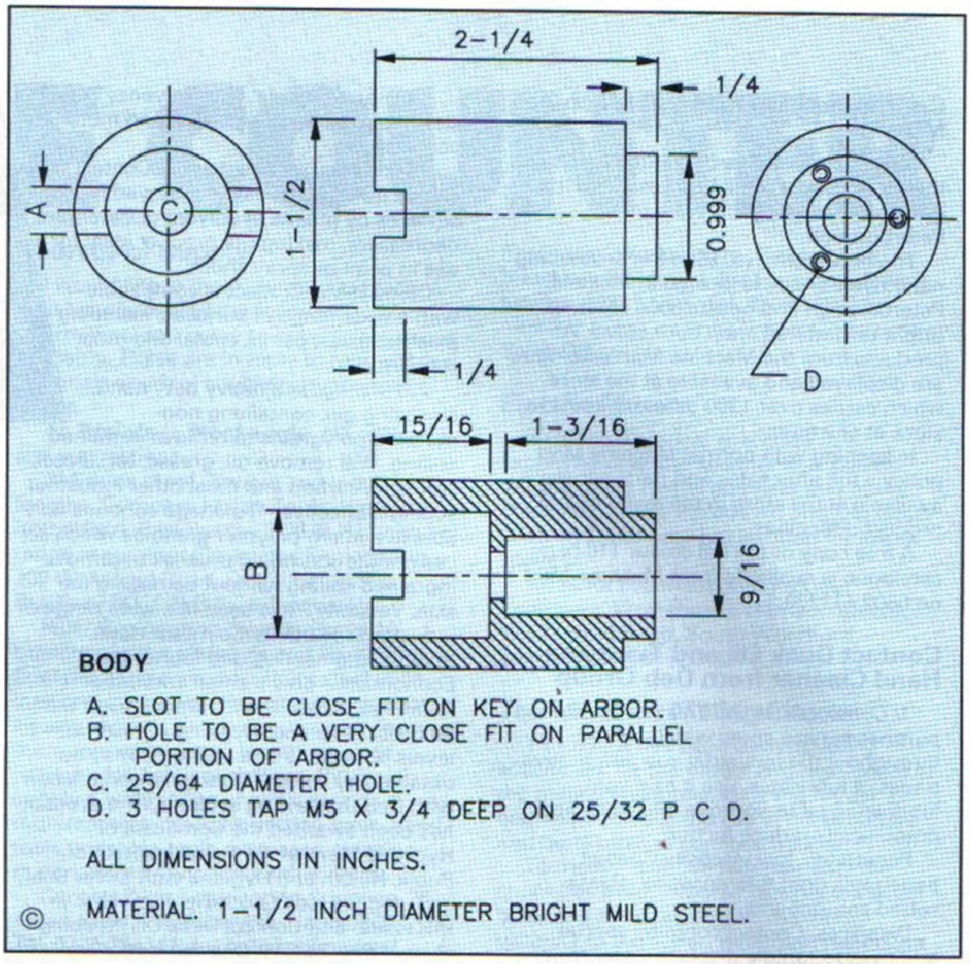
2) Tufanega is a heavy duty hand cleansing gel, containing non-abrasive polygrains to remove ingrained soiling. Will remove oil, grease, tar, diesel, creosote, carbon and most other industrial soilings. Effective – Tufanega contains non-abrasive micro-polymer granules which act like minute scrubbing brushes to remove ingrained soiling without damaging the skin. Versatile – it is used in a wide range of industries including the motor trade, mining, engineering and foundries. Economical – only a small amount of Tufanega is required to remove even the heaviest of soiling. Hygienic – maximum levels of hygiene and economy may be obtained by using Tufanega in conjunction with Deb Dispensing systems. The product has been awarded the Certificate of Hygienic Merit of the Royal Institute of Public Health and Hygiene with Silver Seal.

Tufagena (see Quick Tip elsewhere in this issue) and Contect Duck Oil *(Keeping Rust at Bay, M.E.W.* Dec/Jan issue) are produced by Deb Group Ltd., Belper, Derbyshire DE5 1JX, Tel. 0773 822712. They should be readily available from many retail outlets, in case of difficulty they can be obtained from Pillar Engineering Supplies (already mentioned in this section).

SUBSCRIPTION RATES - AN APOLOGY

I have had a lot of correspondence since the last issue, querying the subscription rates shown in the Subs. Ad. It seems that there was something of a misunderstanding, and by accident the Subscription rate for *Model Engineer* appeared instead of that for *MEW*. If you would like to take out a subscription to *MEW* the rates are:-
6 issues, UK £15.00, Europe £18.90, Middle East £19.20, Far East £31.10, Rest of World £20.30, or U. S. $38.00.
Cheques etc. payable to ASP.
Subscriptions from Argus Subscription Services, Queensway House, 2 Queensway, Redhill, Surrey, RH1 1QS. USA Subscription Agent: Wise Owl Worldwide Publications, 4314 West 28th Street, Torrance, CA 90505, USA.
Apologies for any inconvenience this may have caused.

Make these slitting saw arbors and avoid the need to produce your various slotting operations using a hack saw. The improvement in the appearance of the work completed will be very noticeable...

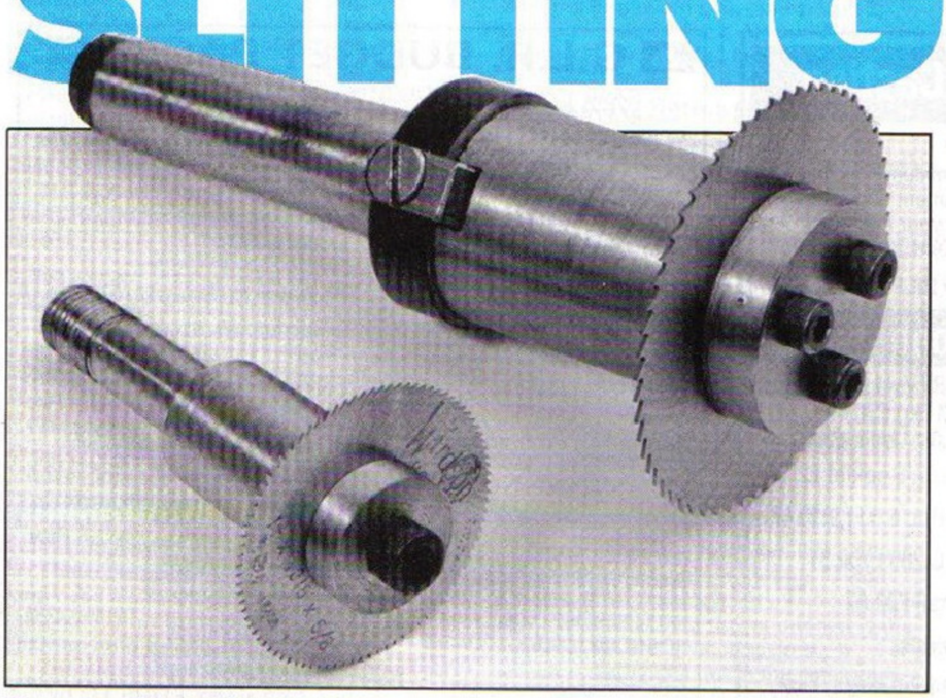


The face cutter supplied with many drill/mills now available is made up of two main parts, an arbor and the cutter itself. With the cutting head removed by the removal of the single central screw, the arbor becomes a very useful means of attaching other devices to the milling machine spindle. This can be seen in one of the photographs. One such device is a slitting saw holder.

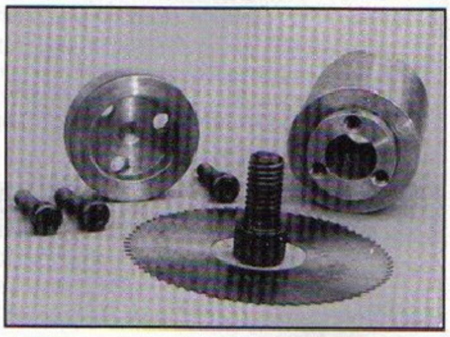
This type of cutter and all similar shape cutters are really intended for use on the horizontal milling machine. In the home workshop this type of machine is unlikely to be available, and so some method of using them on a vertical machine must be pursued.

As the narrower slitting saw presents only a very light load to the spindle, an overhanging arrangement is quite acceptable. This would be totally impracticable for wider cutters where the outer bearing of the horizontal machine is essential.

SLITTING SAW



The two carrier sizes for comparison



The parts for the larger holder

Saw sizes

Slitting saws come in a wide range of diameters, from 1¾ in. diameter up to 8 inches diameter, and probably larger. The range of widths is from around 1/64 up to ¼ inch. In the arrangement being proposed in this article, only the smaller sizes are practical, say up to 3 inches in diameter and 1/16 inch wide. With a little extra care in use, probably up to ⅛ inch wide would be quite acceptable.

Probably the most practical size is three inches diameter. This size is large enough to permit slotting of most items likely to occur in the home workshop – typical uses would be slotting collets and similar applications.

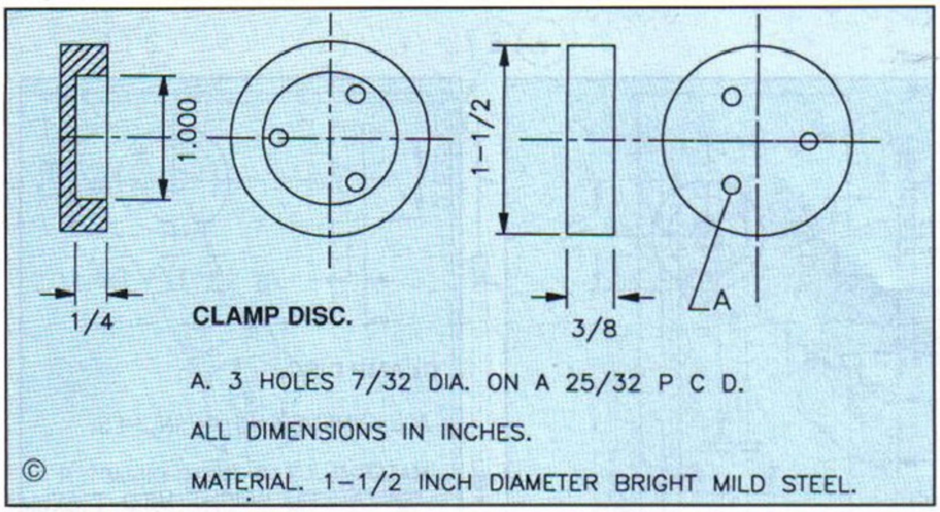
In use the thinner saws (say 0.015 in. wide) are inclined to wander and produce erratic slots. This can be overcome largely if the first approach of the saw to the work piece is done very gently. By adopting this cautious approach the initial cut is done without deflecting the saw. Once the saw has started in the correct direction it will maintain this.

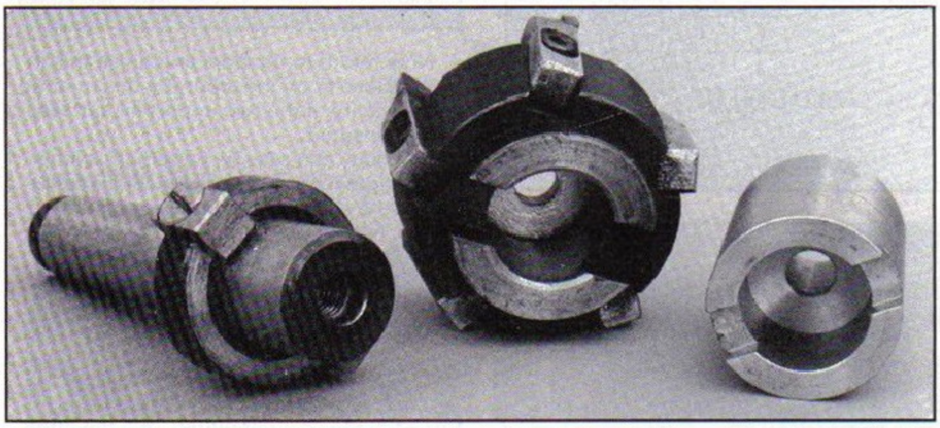
The best way to overcome this, though, is by using smaller diameter cutters. The 1¾ inch cutters are preferable in many ways, providing the limitation of their diameter can be tolerated.

The holders

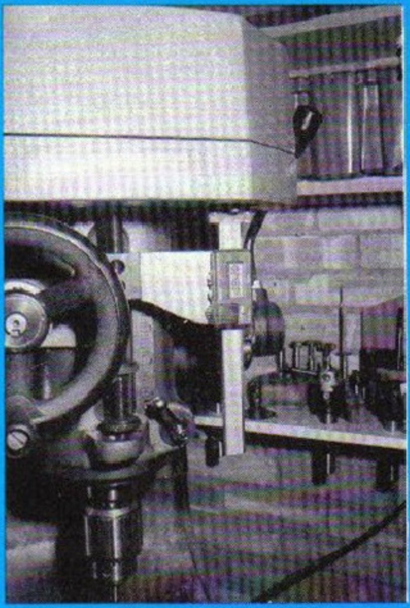
Two sizes of holder are detailed, one to suit the ⅝ inch bore of the 1¾ inch diameter saws, the other to suit the 1 inch bore of the larger sizes.

No key has been provided even though the cutters have provision for this, the reason being that the absence of the key provides a measure of safeguard should the saw seize up in the slot, as it will allow





QUICK TIP

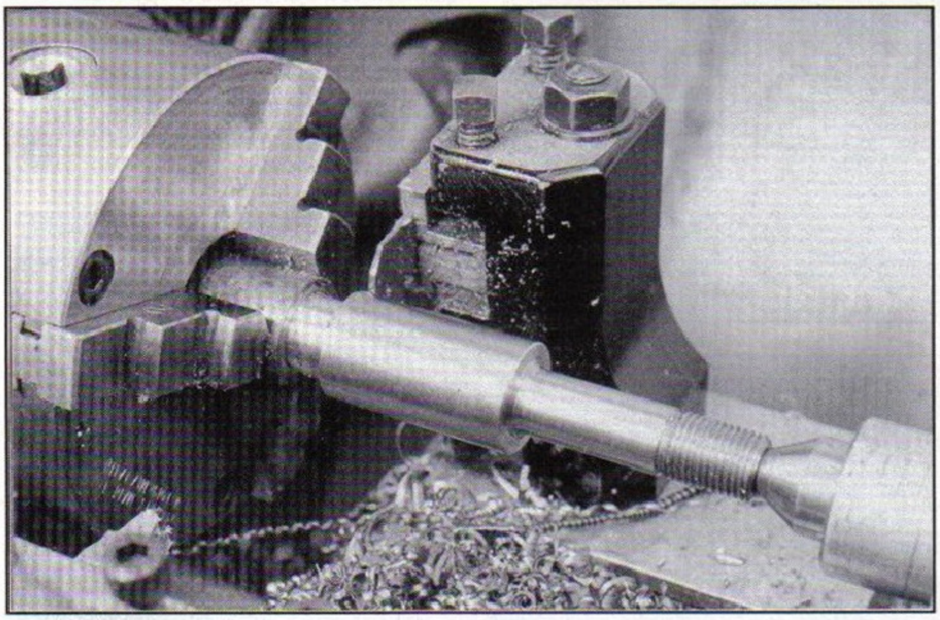


I enclose a picture of an item that has proved to be the best thing I ever did to make life easier on my mill. Easy to fit, and easy to use. If you need to drill, say 61 thou., you just bring the stationary cutter down to touch your work, hit the zero button, switch on and drill until your number comes up.

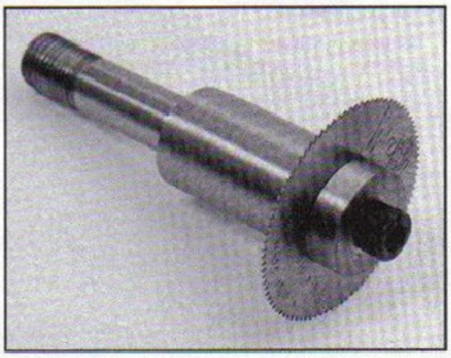
Robert Dunn

Above left, the cutter arbor and cutter, together with the body of the larger saw holder. It can be seen from this shot how the parts fit together.

CARRIER



This illustration shows the slitting saw end of the small holder being turned with the parting off tool. concentricity will be achieved by turning this at the same stage as the shank and thread.

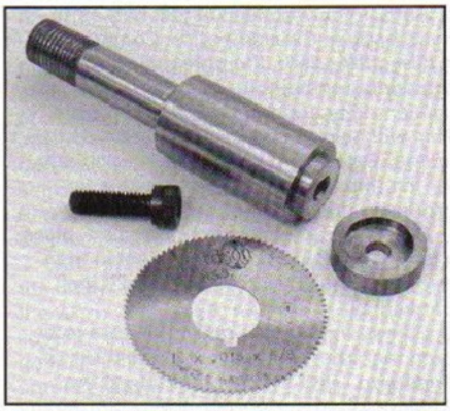


The smaller assembly ready for use; the cap screw could be replaced by a countersunk screw which would permit use in more restricted locations.

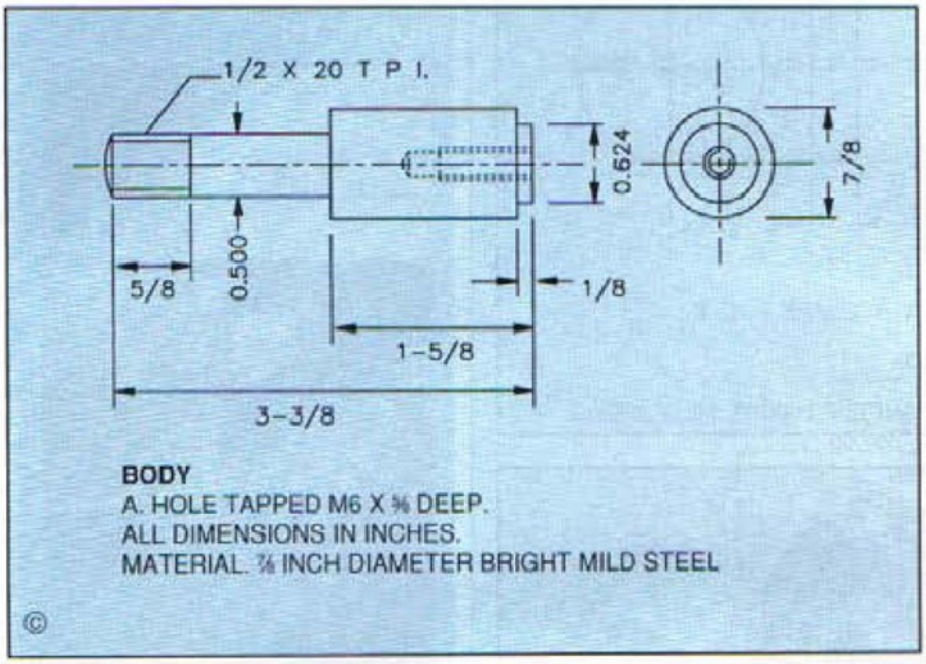
the saw to slip on the holder.

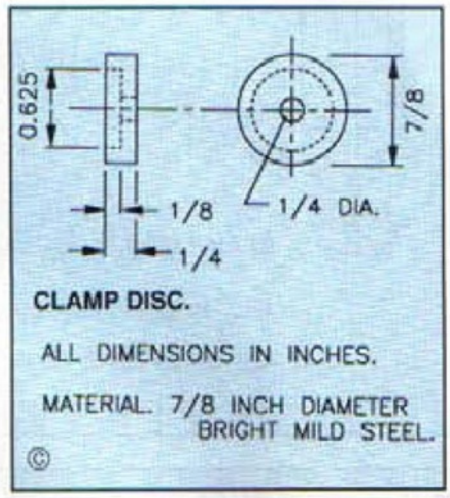
The smaller holder is complete with its own shank which can be held in the end mill chuck whilst the other is fitted to the arbor mentioned earlier.

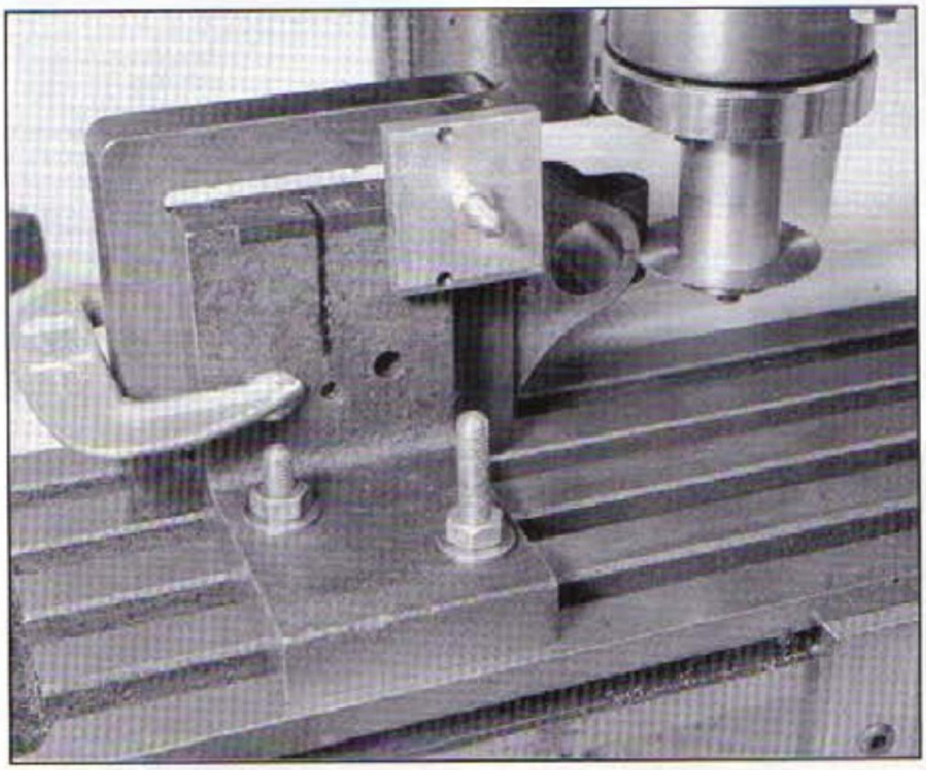
Some readers may not wish to use the arbor of their face cutter, or perhaps do not have this arrangement. In this case the holder for the larger saw could be produced in the same manner as that for the smaller. This would be perfectly acceptable as the load created by the larger saw is well within the capabilities of the smaller arrangement.



The various parts which go to make the smaller holder.







The larger assembly in use.

Construction

Both holders consist of just two parts – a main body and a clamp disc. Construction is straightforward, the only major consideration being to maintain concentricity and freedom from wobble. This will help to ensure the cutter cuts true to size. Even more important, particularly for the thinner sizes, is that the slot produced does not wander.

Considering the larger holder first, place a length of 1⅛ inch diameter steel in the three jaw chuck, and with about 2¾ inch projecting.

First commence to make the bore to fit onto the arbor, but leave it a few thou. undersize. With this done, produce the 0.999 in. diameter portion for mounting the saw; a reverse knife tool will be necessary to complete this.

Now return to the bore and finish this to a very close fit on the arbor. By this method concentricity of the two important surfaces will be ensured.

The body can now be parted off, a little over length to allow for facing. Reverse the part in the chuck, and face the outer end to length. Follow this by drilling right through to take the fixing screw, and finish the turning operations for this part by counter boring to take the head of the cap screw.

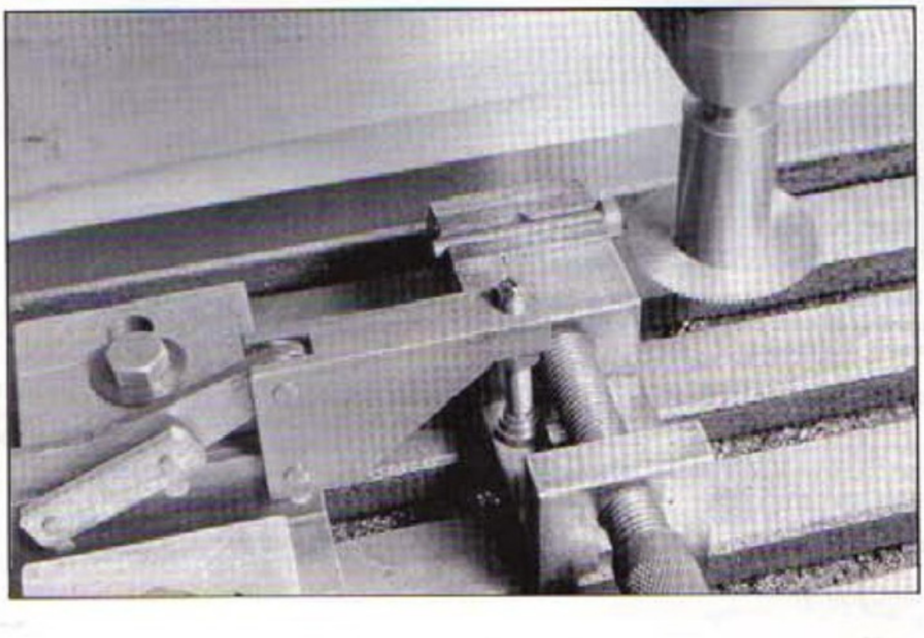
The piece of material remaining in the chuck can be used to produce the clamp disc – the turning operations for this requires no explanation. With the part turned to the shape required, drill the three holes on the PCD indicated.

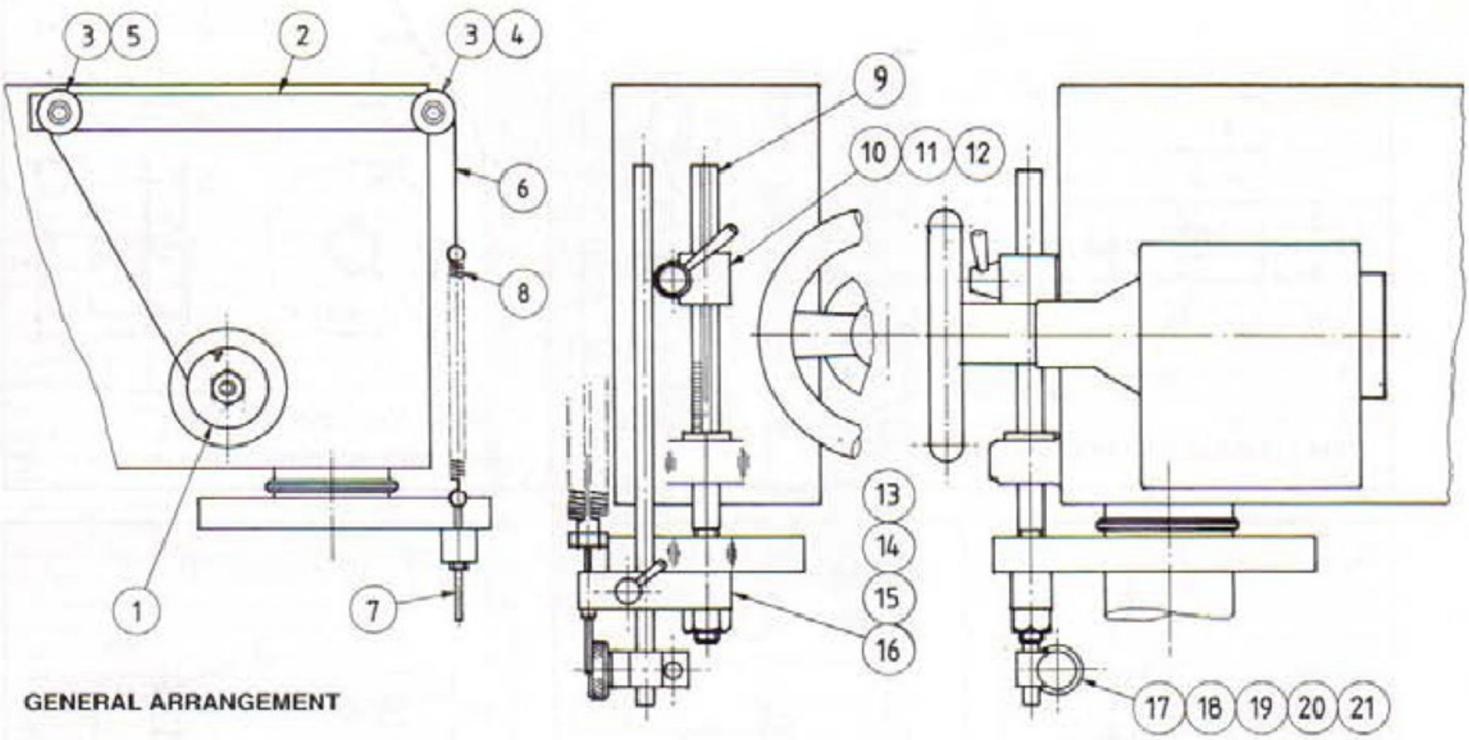
Use the clamp disc as a jig to drill the end of the body for tapping M5. It then remains only to provide the slots for the keys fitted to the arbor.

The procedure for making the smaller holder is very similar except that, instead of first turning the bore, the thread and outer diameter of the shank are turned first. Otherwise the method is almost identical.

These holders work very adequately with no sign of stress due to the overhanging arrangement. In view of this they could be increased in length by a little if it was felt that the extra reach would be beneficial.

Using the smaller saw to slot the head of a screw; this will produce a much better result than using a hand saw.

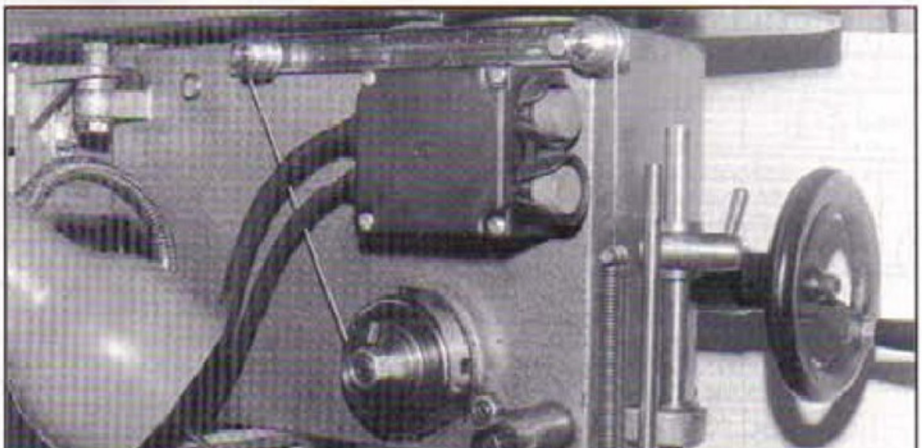




GENERAL ARRANGEMENT

MILLING MACHINE DOWNFEED MODIFICATION

This article by Mr Corps of Wedmoor, Somerset sets out to eliminate the problems frequently encountered with the down feed, found on many of the mill/drills on the market. This it achieves in a very clever manner. Also included are two other projects – an improved down feed stop, and a universal holder, this for such items as a dial test indicator or other accessory. The latter is a particularly useful item. All three items can be treated as separate projects for the reader who wishes only to carry out one of the improvements



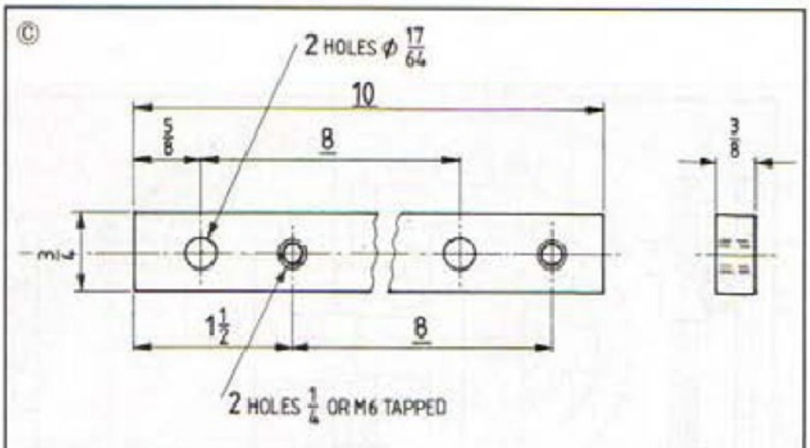
General arrangement.

Writing in "Scribe a Line", Dec/Jan issue, Mr C Clarke relates his problems with snatchy milling. Perhaps it would be helpful to some other readers to give details of a very satisfactory solution to this problem.

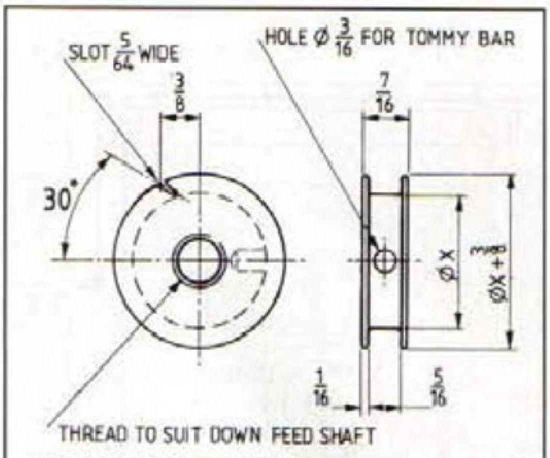
This account concerns the Naerok RDM 350 machine and although applicable to other types of mill/drill the dimensions and threads recorded may well differ elsewhere. Possibly they may differ on other machines of the same make. Certainly this individual provides a wondrous mixture of imperial and metric usages. So beware and be warned regarding the dimensions stated on the drawings. A number of reporters have paid tribute to the accuracy of these machines *taking into account their first cost*, but some deficiencies must remain for the owner to deal with. Let us look at some of these as they affect Mr Clarke's problem and as they affected the machine under review.

Last things first. After clearing up the downfeed problems in the manner to be described, residual problems indicated that the quill was not square with the milling table. The classic drilling machine test was applied (see photo) with the dial gauge set at the radius of the column base attachment screws. Thus the dial deflections indicated the precise amount of shim to be inserted at each corner. Reasonable accuracy was easily obtained by this means.

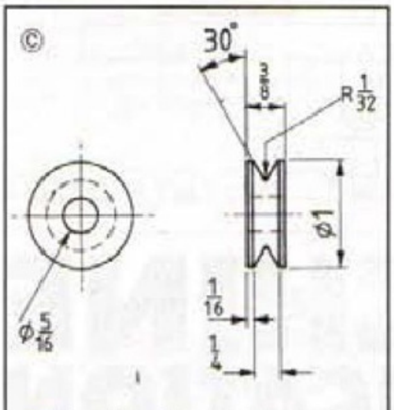
Early trials produced a huge backlash at the down-feed index traced to end play of the worm feed shaft. Removing the rear cover of the worm feed housing revealed a quite impotent ball thrust bearing. Its potency was improved by inserting a ring of 16g soft copper wire and then tightening the cover enough to produce a slight preload.



ITEM 1 SHEAVE CARRIER MILD STEEL QTY 1

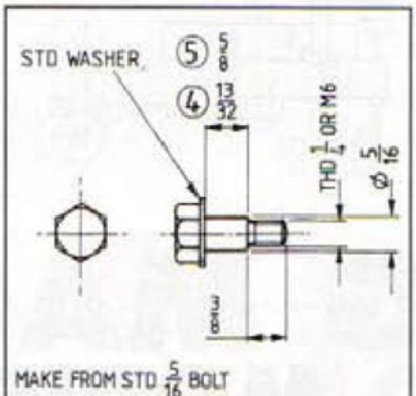


ITEM 2 WINDING DRUM MILD STEEL QTY 1 ©

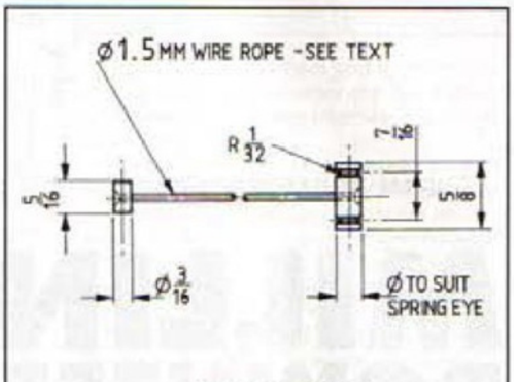


ITEM 3 SHEAVE MILD STEEL QTY 2

THIRD ANGLE

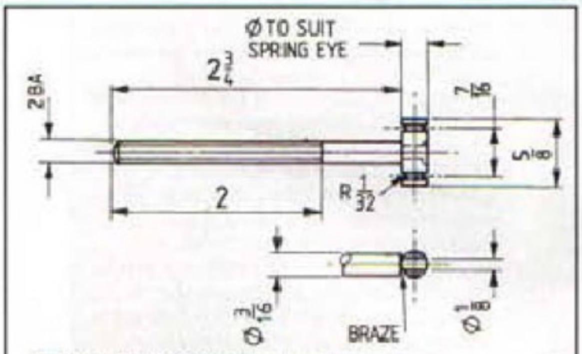


ITEM 4 STUD – FRONT
ITEM 4 STUD – REAR ©

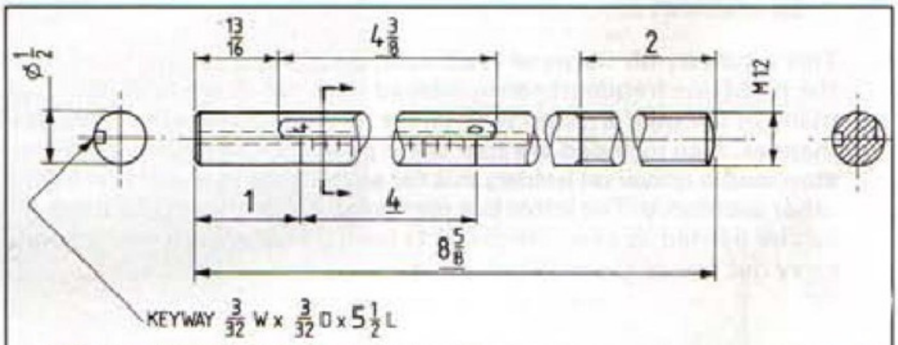


ITEM 6 CABLE

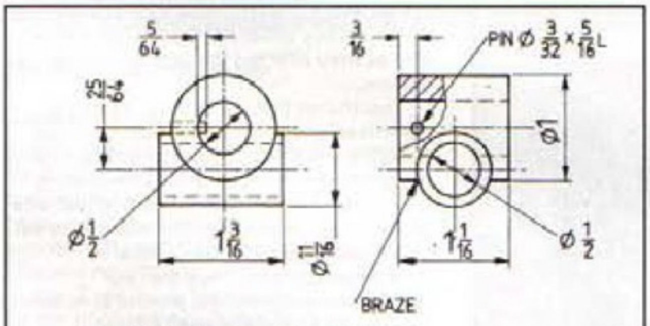
DIMENSIONS IN INCHES EXCEPT WHERE STATED ©



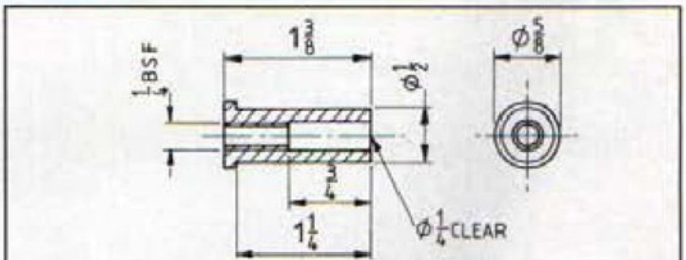
ITEM 7 TENSIONER MILD STEEL QTY 1 ©



ITEM 9 STOP COLUMN MILD STEEL QTY 1 ©

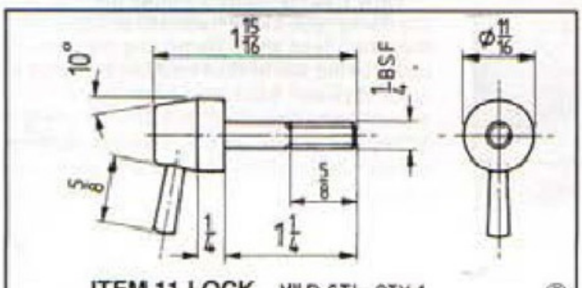


ITEM 10 BODY MILD STEEL QTY 1 ©



SEE ACCY SPINDLE COTTERS ITEM 15 ASSY STEP 2
FOR SIMILAR MACHINING

ITEM 12 COTTERS BRASS QTY 1 PAIR ©



ITEM 11 LOCK MILD STL QTY 1 ©

ITEM Nº	TYPE	ØWIRE	OD	Nº COILS	CLOSED LENGTH	FREE LENGTH
8	EXTENSION	17G ·056	·360	—	$3\frac{1}{4}$	—
16	COMPRESSION	20G ·036	·370	3	—	$\frac{5}{16}$
22	COMPRESSION	20G ·036	·370	12	—	$\frac{3}{4}$

SPRING DETAILS

Down feed

Coming now to the "meat" of this discussion, it is found that with this type of machine down-feed problems arise from backlash arising in the worm (dealt with above) and tooth clearance between the down-feed pinion and rack teeth. After dealing with the worm a residual 0.02 in., or thereabouts, of backlash remains.

My first attempt to overcome this problem was to fit a largish coil spring around the depth indicator column and compress it somewhat with the depth stop nuts. This worked for milling but was a curse for drilling as the spring had to be removed, with of course a resumption of backlash.

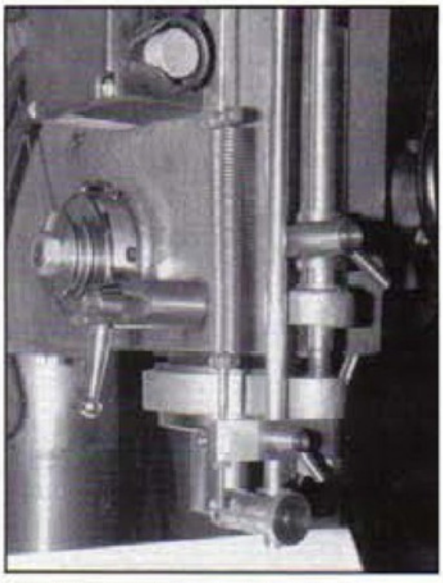
Thoughts then turned to the possible use of a counter-weight so, how much weight? Using the bathroom scales resting on the milling table, it was established with some difficulty that the quill and spindle exerted some 6 lbs. down pressure. The Autolock chuck added 2 lbs. and my GHT boring head (with Clarkson type mounting) another 1¼ lbs., a total say of 10 lbs. Add 50 per cent in order to ensure positive upward pull then a 15 lbs. weight was sought. A trial of a few cob ends of 3in. dia. bar proved that there was no place on the

"Last things first". Checking the squareness of the quill

machine to hang such a counterweight which would in any case add an undesirable extra 15 lbs. to any drilling pressure.

A loaded spring coupled through a cable to a suitable drum on the down-feed shaft was then considered, such a spring being pulled up 'by its own bootstraps' thus providing upward loading at the rack, the pinion and *maintain engagement at the worm*, without any addition to the loading caused by the machine's own spring box. And so it proved. Absolutely no backlash with 2 thou up and 2 thou down being precisely available at the feed index. Drilling operations likewise benefited.

Two springs (in parallel) are shown on the G.A., their equals may not be easy to find. My springs are from job lots obtained from J.A. Crew, the 1.5mm stainless wire rope was also obtained from this source. A single spring might well be suitable, but such was not available. A strong



Depth stop and accessory mountings.

compression spring enclosed in a tube with the wire rope passing down through its centre would provide a practical and more elegant solution.

It was found that on this machine the quill descends 4in. with one revolution of the downfeed shaft. Actually slightly less than one rev. can be made. The effective dia. of the winding drum, dimension x, is thus $4/\pi$ = 1.273 in. Before production of this drum a

replica of the thread on the shaft was made, apparently ½ in. UNF (½ in. x 20 TPI). The drum was then produced and screwcut to suit this gauge. A slot is cut in the out-facing cheek of the drum to receive the termination of the wire. The drum takes the place of the inner nut the outer locknut being applied and the assembly tightened securely using a tommy bar for the drum.

At least 1½ turns of wire wrap around the drum when fully wound and about 28 in. of wire are required in total.

The sheaves require little detailing. Mine have Oilite bushes because they happened to be available. The sheave carrier is arranged to clear the switchgear and to present the wire end at a suitable location. When drilling and tapping the head casting various odd bits of tubing were added to the industrial vacuum cleaner. These were presented to the area of the drillings from inside the casting to clear away the C.I. dust by fierce suction.

Silver soldering the terminations of the stainless wire presents a problem. It frays badly so should be silver soldered before cutting. I had several practice attempts before finding success.

At this stage a piece of angle steel could be used instead of the cross beam, the existing down-feed stop arrangements could then be retained. However once the more substantial beam was decided upon other improvements became possible. These are now reviewed.

Down feed stop

Firstly a new stop column was required using stop lock arrangements not having nutted adjustment, but having a quickly applied cotter lock. A feed-stop is worse than useless if it does not hold firmly and to this end an accurately made cotter embracing a precision ground column was used. The column was engraved with eighths, halves and inches. Numbers from 0 to 4 were stamped on a flat machined into the column. In use this feature is less than satisfactory and a piece of plastic rule has been glued to the casting to give clearer indications. It awaits the production of a cursor. A 3/16 in. keyway is required at the rear of the column, a pin pressed into the feed-stop engages this preventing rotation of the stop about the column. In making the column, cutting of the M12 (12 x 1.75mm) thread was left until last. Having centred the 'upper' end it was held in a collet in the dividing head (VDH) with tailstock support, all other operations being completed on the mill.

1. Mill a flat for the numerals. 2. Engrave the lines with a fine single tooth cutter at max. speed, using the dividing gear to graduate the line lengths and to rotate the work. 3. Locate the keyway opposite the edge of the flat adjacent to the graduations, and cut 5½ in. long using a woodruff cutter. 4. Take to the lathe, centre the 'lower' end and cut the M12 thread. My lathe is Imperial, and this material happened to be

Down-feed stop with cotters exposed.

PG EN8 (strictly without an M), resulting in a tedious screw-cutting task. The material choice was also responsible for the poor appearance of the graduations. 5. Stamp the numerals.

Had I not possessed a dividing head I would have cut the flat with the work held in the machine vice, end milled keyway (perhaps not in EN8!) and graduated in the lathe using the Radford/GHT mandrel dividing gear and a V point lathe tool. Without mandrel dividing gear perhaps the operation should be postponed!

With regard to the down-feed stop, and other cotter type fittings, all the instructions

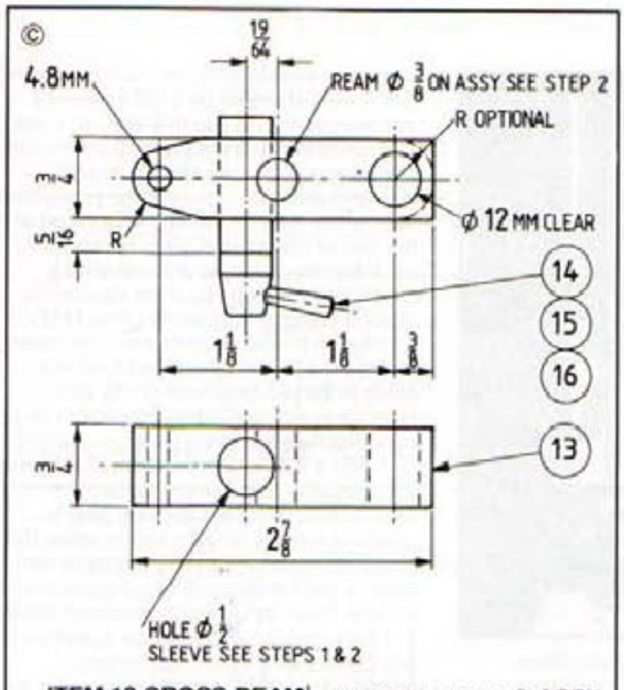
QUICK TIP

When setting up square material in a lathe 4 jaw chuck the only method you seem to mention is to centre punch the end of the stock, and put into the chuck and line up with the tailstock centre.

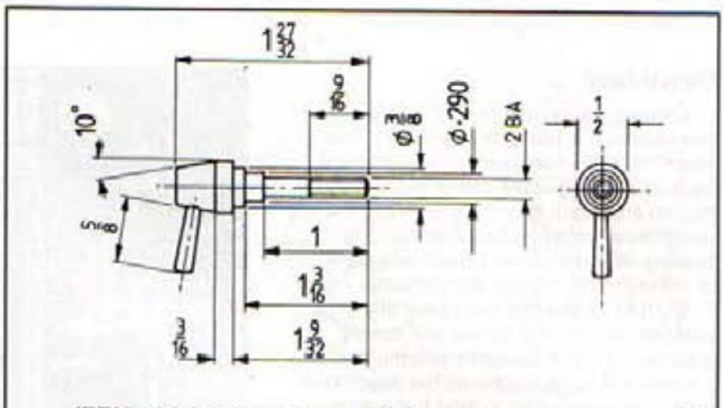
I find this method adequate for initial setting up. Where really accurate setting up is required I use a dial test indicator set up as you would for round stock, set the probe up in the centre of one flat of the stock, rock the chuck and note the lowest reading before the needle rises either side lift the probe turn the chuck 180 deg. check the reading adjust chuck jaws as necessary, lift probe turn 90 deg. rock, turn 180 deg. adjust jaws again.

With this method the stock can be set very accurately in the chuck, this method may seem obvious but I have never heard of it before.

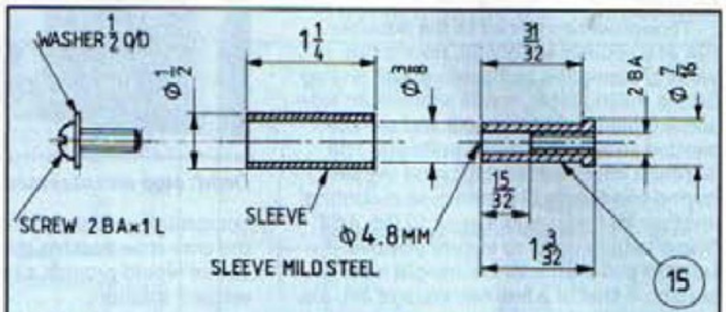
Mr. Langham



ITEM 13 CROSS BEAM MILD STEEL QTY 1 **& ASSY**

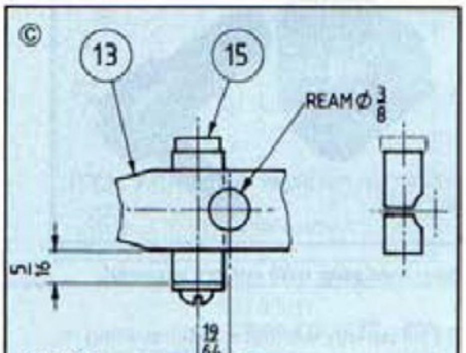


ITEM 14 LOCK MILD STEEL QTY 1



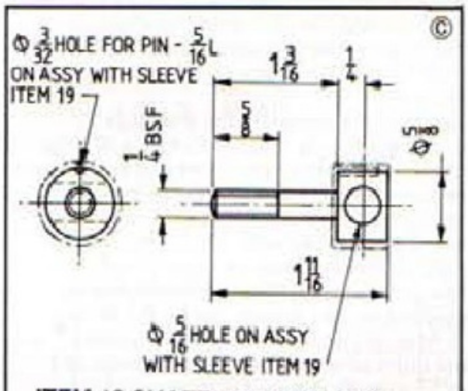
STEP 1

ITEM 15 COTTERS BRASS QTY 1 PAIR

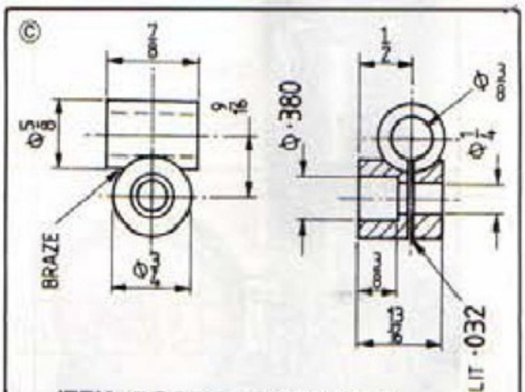


STEP 2

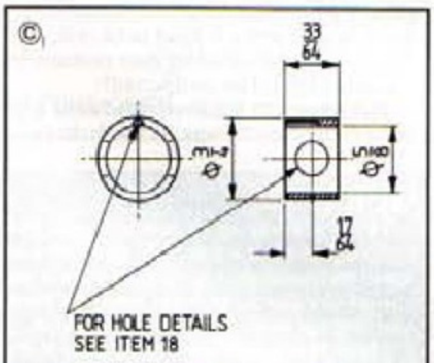
LOCTITE ASSEMBLED PARTS FROM STEP 1 IN CROSS BEAM ITEM 13
REAM Ø 3/8 HOLE
REMOVE COTTERS M/C AWAY HEAD & SLIT AS SHOWN



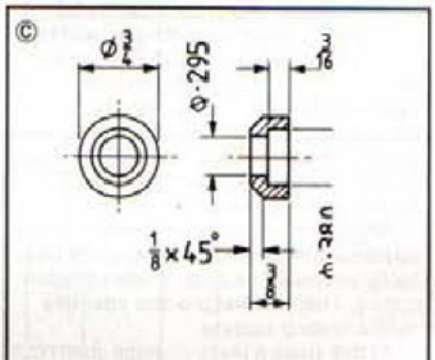
ITEM 18 SHAFT MILD STEEL QTY 1



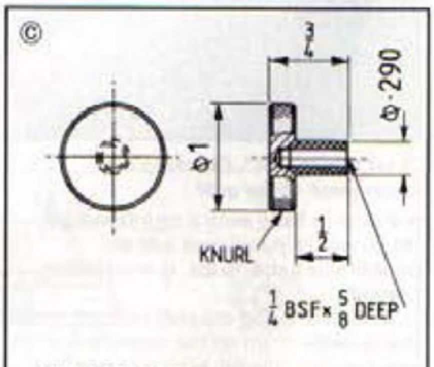
ITEM 17 BODY MILD STEEL QTY 1



ITEM 19 SLEEVE MILD STEEL QTY 1

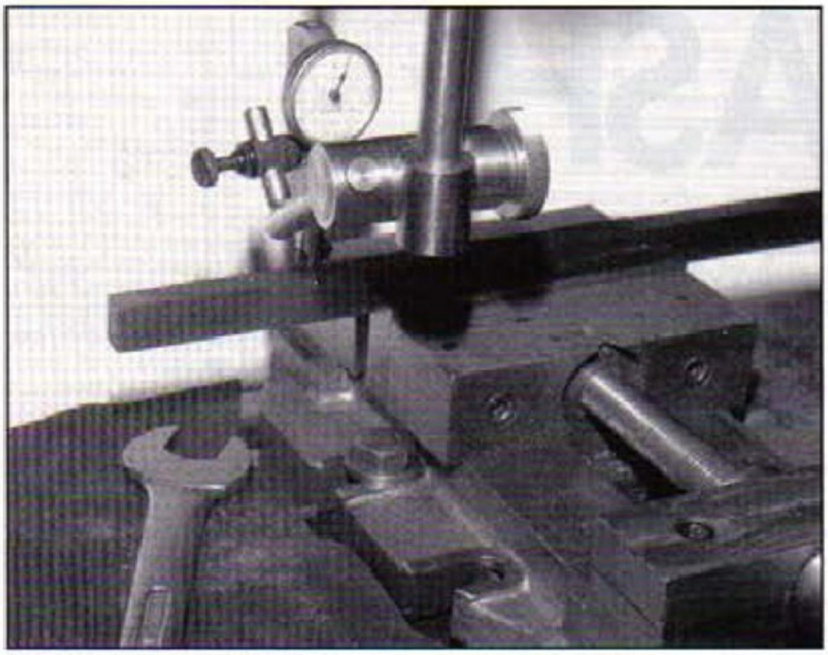


ITEM 21 COLLAR MILD STE

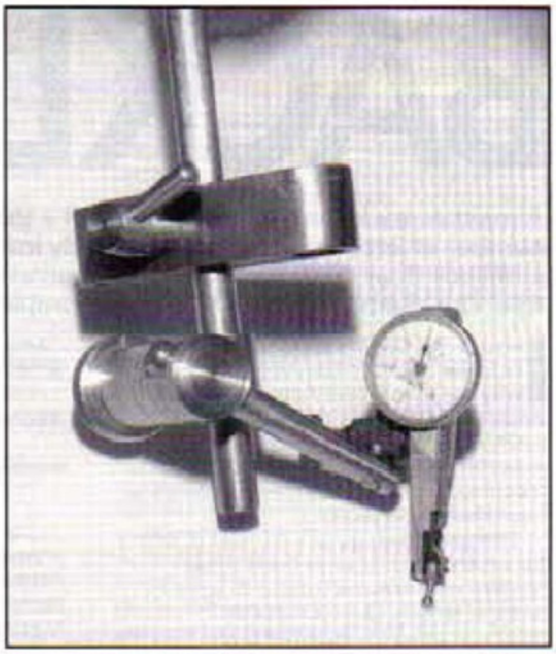


ITEM 20 KNOB MILD STEEL QTY 1

are drawn from the various writings of G.H. Thomas. Firstly it will be noted that use is made of intersecting round bars brazed together. The diameter of the cotter housing being to some degree chosen to suit an available end mill or slot drill. It is the centre distance between bars that is critical. In the case of the down-feed stop the cotter housing dia. is shown as 11/16in., chosen because I happen to have a reground end mill slightly larger than this. Now the centre distance is 25/64in., i.e. half the diameter of column plus half the diameter of the clamping screw plus 1/64 in. 1/4 in. + 1/8 in. + 1/64 in. = 25/64 in. Starting with a 1 in. bar overhanging the milling vice, one edge of this bar is located and (say) a 1/2 in. end mill is fed progressively deeper into the work feeding laterally until a point half the dia. of the mill + 1/64 in. is reached (1/2 in. – 25/64 in.). After reaching this infeed the setting is retained and the final size of end mill fed vertically to size the recess. A few small centre pops are made within the recess and the intersecting bar is turned to an easy push fit, the centre pops providing clearance for the silver solder. In cutting the bars to length some excess is left for later removal, this is required for engaging the point of the dial gauge when setting up and producing the bores. In the case of the feed stop such removal allows the floating cotter to protrude. An essential requirement for secure locking. Silver soldering is an easy task as the parts fit fairly closely, the larger piece 'embracing' the smaller. I recently read of the use of typists correction fluid as a barrier to solder, since when, like those famous little pills 'I have used no other'. Cotters are of brass, steel cotters might well bruise an unhardened shaft. The cotter blank is made



Squaring a machine vice using the new facility.



Cross beam with accessory mounting components.

with a small enlargement at the 'inner' end and are drawn into the housing with a temporary screw and washer. The following steps completed the body.

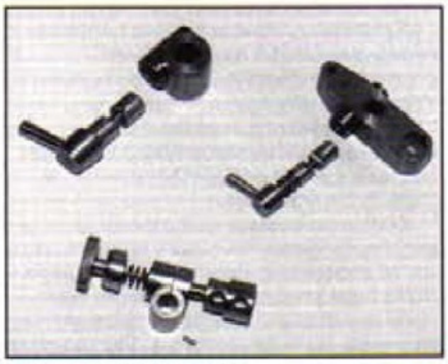
1. Set cotter housing to run true in the four jaw. Drill, bore and ream ½ inch. 2. Install cotter blank and tighten screw and washer. 3. Set main body to run true in four jaw. Drill, bore and ream ½ in. to suit column. 4. Remove cotter blank, turn off enlarged portion and saw into two parts. 5. Machine off surplus from the housing. 6. Locking handle and screw. Handle about 2 in. radius.

In drilling to depth I prefer to bring the drill point to the work and then interpose a Jo block, tool bit, drill shank or the like between the fixed and adjusting stops. On this machine the fixed stop is left 'as cast' so a proper abutment was prepared an easy fit in the fixed stop and with plenty of clearance around the stop column, and a lip of 1 in. dia. The abutment piece was well coated with Araldite under the lip and then pressed into place by down-feeding the adjusting stop (see photograph).

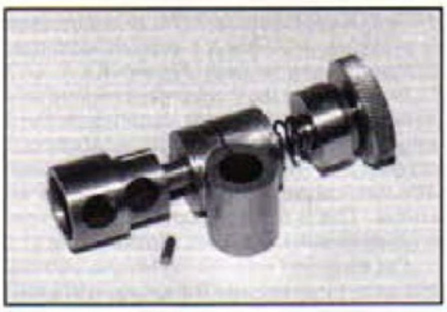
The user of a mill/drill will early need to square a vice or workpiece on the mill table, and will find no facility for presenting the dial gauge other than from a drill chuck mounted on the machine spindle. This has expensive possibilities similar to those of leaving the key in a lathe chuck!!

Here the cross beam offers a solution. A spindle specifically for mounting dial gauges, chip deflectors, cutting fluid tubes and air jets. For this spindle I have used ⅜in. PGMS but BDMS would certainly be adequate. In this case the cotters are held within a ½ in. dia. steel sleeve in order to lengthen the support and house a spring, without which the unlocked spindle could go into free-fall complete with the 'clock'. This sleeve is fitted into the cross beam with Loctite 601. Apart from its dimensions the cotter blank is prepared as previously detailed. Having made the sleeve the procedures were:

1. Mark out the relevant centres on the cross beam, observing the 19/64in. offset. 2. Drill and ream the ½in. tranverse hole in the cross beam. This was done in the milling vice with the job positioned against a



A group of components.



A "universal" clamp.

workstop, allowing sufficient overhang to clear the sleeve when the work was reset at right angles. 3. Assemble cotter blank and sleeve with temporary screw and washer, and Loctite into position. Allow setting time. 4. Reposition cross beam in machine vice against workstop. Feed milling table 19/64in., drill and ream ⅜in. hole. 5. Machine off end of cotter blank and saw through. 6. Prepare locking handle and screw with seating for the spring.

Universal clamp for accessories

Finally a 'universal' clamp was required for the attachment dial gauges etc. This is purely an enlarged version of the clamping device fitted to surface gauges for holding scribers etc. I have two of these clamps and on occasions mount two of the facilities noted. Originally made without the 5/32 in. aligning pin it was found that the 5/16 in. holes were irritatingly out of line whenever required, the cross drilling was also some thous. out. A 5/16 in. peg was put through the holes and I was just able to reach the required position with a 5/32 in. slot drill and tip of a ¼ in. centre drill, followed by the 5/32in. drilling.

Once the whole project was complete the 2 BA tensioning nut for the backlash springs was tightened until there was a positive upward snap to the quill if depressed by hand and then released. A check was then made with a dial gauge probe against the milling table, (no problem now), and the down-feed index rotated in both directions. It was found that the dial gauge exactly reflected movements either way. *No backlash whatsoever.* In the milling mode, of course, the quill lock must be engaged after each movement, and released before each adjustment. I have used the machine as a vertical borer without "snatch" problems. The feed-stop is useful where there are a number of identical pieces to be milled, but limits of the friction device used for engaging the milling mode necessitate some care in the application of feed pressure.

Materials

Tension springs: J. A. Crew
Compression springs: J. A. Crew These are job lots and may not include the required sizes.
Stainless wirerope 1.5mm: J. A. Crew
Precision ground bar: A. J. Reeves & Co.
Mild steel up to 1 in. A. J. Reeves & Co.
Larger sections and brass: K. R. Whiston & Co.

Addresses

J. A. Crew & Co., Spinney Lane, Aspley Guise, Milton Keynes, MK17 8JT. Tel. 0908 583252.
A.J. Reeves & Co. (Birmingham) Ltd., Holly Lane, Marston Green, Birmingham, B37 7AW. Tel. 021 779 6831/2/3.
K.R. Whiston Ltd., New Mills, Stockport, SK12 4PT. Tel. 0663 742028.

BACKLASH

Almost every issue we seem to set off a theme with prompts a large number of letters which are sufficiently interesting to warrant a wider audience than the editor. When such an event occurs we shall use this title. Our theme this time is drawing projections.

Included in *On The Editors Bench* for the Feb/Mar issue, I raised the question as to why the terms 'First Angle' and 'Third Angle' were used for the two common methods of drawing projection. Also expecting that the terms had some logical meaning, why were there not Second and Fourth angle projections?

This generated quite a number of letters for which I would like to thank those readers who took the trouble to write in, some at length. Quite a number misunderstood my comments and sent me explanations of the first and third angle methods.

It is not the intention in *Model Engineers' Workshop* to go into the principles of producing drawings using these systems. This was covered in an article very recently in the *Model Engineer* (photocopies of this can be obtained from Argus Publications, Photostat Service. Ask for "The Basics of Drawings" ME 3909 and 3911, cost £2.25 UK, £3.00 overseas).

It would appear that, whilst in theory second and fourth angle projections exist, they produce confusing results and are therefore not used.

The following letters are a few of those received which explain how the terms are arrived at, as well as containing other interesting information. Once again, thanks to all those readers who wrote in on the subject.

For the record it is the intention that *Model Engineers' Workshop* will standardise on Third Angle Projection. As drawings come from many sources and frequently time is in short supply, this may not always be achieved ...

Drawing Projections

● *I see from the editorial in edition No. 9 the editor has encountered the first/third angle projection problems that haunted my apprenticeship in tool/instrument making, and then my modelling interests. The editor I fear is the same vintage as myself. The added complication I recall was that First angle is also known as American projection. (Wonder what they use in Scotland?).*

The First and Third angles are right angles. Imagine an item on the drawing board in front of you. Roll it towards the right until it has turned 90 degrees. The First right angle, what you see is the left hand end of the original view. Replace it in its original position and turn it 90 degrees to its left, you see the right hand end. Try it up or down the page. In each case the 1st (right) angle position is the far end, or far side.

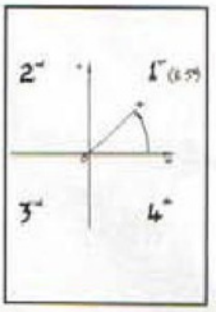
Now try the experiment again, but move it through 3 x 90 degrees angles. This third angle, albeit far away from the original view, is the accursed and peculiar "American projection" which gives the appearance of those cutout models formerly printed on Weetabix packets.
Michael Harris, Basildon

Your confession about muddling drawing projections (on the February/March Editor's Bench) stirred memories. The first drawing method that I learned was second-angle projection, the second was first-angle, and the third was third-angle. I'll come to the fourth later, as it was rather different.

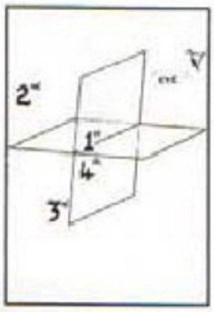
Second angle projection was once so widely used that it has even been promoted as "British Standard Projection"! Wisely, industry took no notice.

The best way to describe it is by answering your question about where the terms first-angle and third-angle derive from in the first place.

Mathematicians and engineers all love graphs. By convention (pure convention) we all put zeros in the middle of the page, make both axes positive in the top-right-hand quarter, and measure angles anti-clockwise from three-o-clock. The top-right-hand quarter is called the "first quadrant", or "first angle". The "second angle" is top-left, the "third angle" is bottom-left, the "fourth angle" bottom-right. In theory there is a "fifth angle", but it's identical with the first angle, and so forth. ***Figure 1.***



Imagine that the horizontal and vertical axes of the graph are not just lines on the page, but sheets of tracing paper sticking up out of it. Then imagine yourself looking into the first angle from the top-right-hand corner. This is the basic set-up from which all the projections derive. ***Figure 2.***



Put an object into the first angle, between your eye and the paper, and you see the object in front of the paper, and project its image away from you. This is the familiar first-angle projection technique. ***Figure 3.***

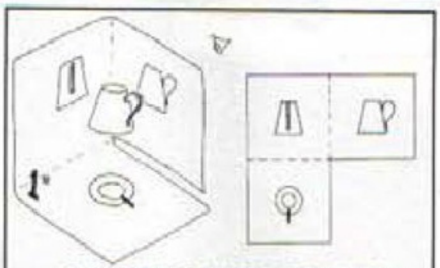


FIGURE 3 **FIRST ANGLE PROJECTION**

Similarly, put the object in the third angle, and you see the object through the paper, and project its image towards you. ***Figure 4.***

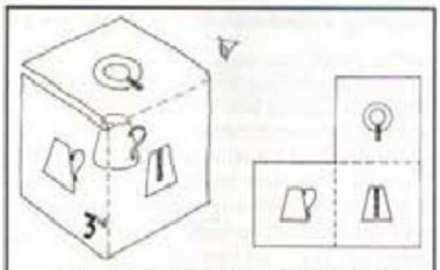


FIGURE 4 **THIRD ANGLE PROJECTION**

Indeed, a third angle drawing can be folded up to make a box which looks like the object itself when seen square-on.

Now put the object in the second angle, and you see the plan in front of the paper, like first angle, but its elevation through it, like third-angle. ***Figure 5.*** *Similarly, put it in the fourth angle, and you see the elevation in front of the paper, but the plan through it; the opposite mixture.* ***Figure 6.***

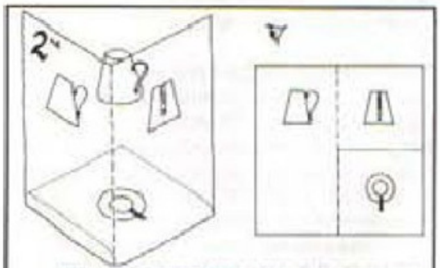


FIGURE 5 **SECOND ANGLE PROJECTION**

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FIGURE 6
FOURTH ANGLE PROJECTION

If you want to try them out, notice how the paper folds: sometimes opened out, sometimes folded up behind. The rule is always to open out the first angle.

Although all four projections are equally mathematically pure, they are not equally useable. Before discussing their merits, it's worth remarking that there are three quite distinct uses for projected drawings. One of them is the representation of component parts in such a way that they can be made: conventional Engineering Drawing. Another is the solving of three dimensional Geometric problems, either in mathematics, or within an engineering design office. As a young mechanism designer, I used to do a set of Geometrical projections to determine the lengths of links etc, and then use my results to produce a rather different set of Engineering Drawings of the individual links, for manufacture in the Works. The *third use is to picture an entire product, perhaps for a lay readership: let's call it a Pictorial General Arrangement.*

These three uses have slightly – but significantly – different needs.

For Geometric problems, any of the four projections will give the right answer, so it is simply a question of choosing the most clear. Second- and fourth- are out because (as my Figures imply) views of objects near the origin line overlap confusingly. First-angle has the edge over third- purely because it's easier to draw both the object and the projection planes at once in first-angle: for example my **Figure 3** *has come out clearer than my* **Figure 4.**

So a mathematician may well use first-angle exclusively.

For Engineering Drawing, second- and fourth- are both completely ruled out, because they depend on the subject always being the same way up. Turn the thing on its side, and plans swop places with elevations, making the drawing totally misleading. So the only options here are first- and third-, which treat all three axes exactly alike and are therefore independent of the viewpoint. Each has its nice points. When I worked in a Railway Drawing Office, (then as now, first-angle) I liked the ease of dropping plans down from elevations: gravity assisted the hand nicely. But then again, third- would have been so much more convenient for pulling off end views: the front view would sit right at the front of the locomotive, avoiding having to draw projection lines right across the whole width of a huge sheet of paper.

One meets occasional Partisans, convinced that users of the other projection are Not Real Engineers at all, but by and large engineers seem equally happy with both, while keeping a soft spot for one or the other.

For Pictorial General Arrangements, the target readership may include lay people as well as trained engineers. It seems that most people can relate to having the front view at the front, the left view at the left, and so on, just like third-angle projection. But strangely they don't seem to like having the top view at the top. Most illogical! Somehow, many folk prefer a plan to be down below the elevations: perhaps it feels natural to look down at a bird's-eye view? So the plan goes down below. Hey presto! The result is a mathematically respectable, but utterly non-standard, second-angle projection.

And it suits the draughtsman too. As I've only just remarked, it's actually easier to draw the elevations in third-angle and the plan in first-angle.

Prompted by these thoughts, I had a look through my books to see what other people get up to. Then I had a furtive snoop down at the newsagent too.

As you might well imagine, the only fourth-angle projections I could find were exercises to test understanding, in a textbook on solid geometry.

I found a staggering number of second-angle drawings. My house plans, for example. Ships, buses and lorries. And whole books full of railway vehicles: many are Victorian design plans, but many are very recent too. I found professionally draughted second-angle drawings in the current issues of Railway Modeller, Modellers' Backtrack, Narrow Gauge Gazette, *and* Continental Modeller. *Something is definitely going on here.*

The clues are that every single one of the drawings I'm referring to is a General Arrangement. All the modern ones were targeted at lay people or enthusiasts. And most of the subjects are long and thin.

Second-angle gives draughtsman and reader alike the best of both worlds. With the plans down below, like first- and the elevations near to the appropriate ends, like third-, it is both easiest to draw and easiest to understand. No doubt this is why so many railway offices were using it a century ago, a tradition apparently followed in rail magazines.

But beware! A house or a train or a ship can only ever go one way up. Never ever risk it for individual engineering components!

Virtually all the component drawings were first-angle. I have only a handful of third-angle drawings in all my many shelves. This may be a sign of my age, since Model Engineer *graciously informs me that first-angle is "seldom used in the western world nowadays, except by model engineers". Oh dear. (Incidentally, I'm 42, and not actually a model engineer.)*

Non-rail hobby magazines seem to lay views out all over the place – even overlapping to save space – purely to suit the article and the page. I found examples of woodwork, DIY, cars, fighting vehicles, boats and planes. As long as ambiguity is avoided, I suppose no harm is done.

But the biggest surprise was the lack of projections in old drawing manuals. In the books I happen to have, I cannot find any reference to standard projections earlier than the Great War, even though they were invented way back in the eighteenth century. At first I wondered whether authors simply took first-angle for granted in those days, but surely they would at least have described how to do it? Perhaps draughtsmen simply put views where most convenient, and then labelled them with suitable arrows. To support this view, South Kensington examination papers from the turn of the century give layout instructions on a view-by-view basis. Revealingly, their Examiners' Report complains that many candidates fail to line the views up, implying that they may not have been taught any form of projection at all.

It also grumbled that many candidates seemed unable to visualise the solid object being represented. This is a major problem to this day, even among engineers. My old college, when it came to choosing curriculum, made only one mandatory distinction between students' abilities. It was between those who could visualise objects from drawings and those who could not.

The complete range of tools available to the draughtsman is overwhelmingly complex – after all, there is a complex world out there to be drawn. And to make it widely understood, it has to be full of arbitrary conventions. These are not graven on tablets of stone: like any other language there has been constant change, with more yet to come. So how can we all cope?

Frankly, I think that the best tip for a beginner, whether hobbyist or student, is to concentrate on the solid object first and foremost, and let the mere drawings flow from that understanding. Use sketches, models, text, whatever helps, while learning the rules. (I've taken many a cardboard model into the Works.) And never let anyone score points off your mistakes: that's playing a pecking-order game. Who would mock a toddler for its grammar or spelling? (But of course, Mr Hall, anyone who publishes drawings is fair game!)

Just a quick tale to illustrate the point. Years ago, I ran a large Computer Aided Design installation, and came to learn my fourth method of drawing; in full 3-D on a computer screen. One of my Computer Room staff was Works trained but had never driven a drawing board. Yet he seemed to be doing a lot of furtive sketches in his own time. One day he asked how to pull what he called "flat" drawings off a 3-D one. "Cos I done me mum's new cupboard on t'computer, like, an' me owd man gonna cut out t'chipboard t'night."

How I wish I too had had the opportunity to learn drawing that way round!

Best wishes to your and your illustrious organ. Like many professional engineers I have a pipe dream of a little workshop one day, and your magazine sets me thinking cosy thoughts. Thanks.

David Halfpenny, Derby

● *Reference your comment in the Feb/Mar issue of* Model Engineers' Workshop *regarding First and Third Angle Projections, the following may be of interest.*

When I joined Rolls Royce as an Apprentice in 1952, the Drawing Training School had a device for demonstrating the Principles of First and Third Angle Projection. This device comprised three

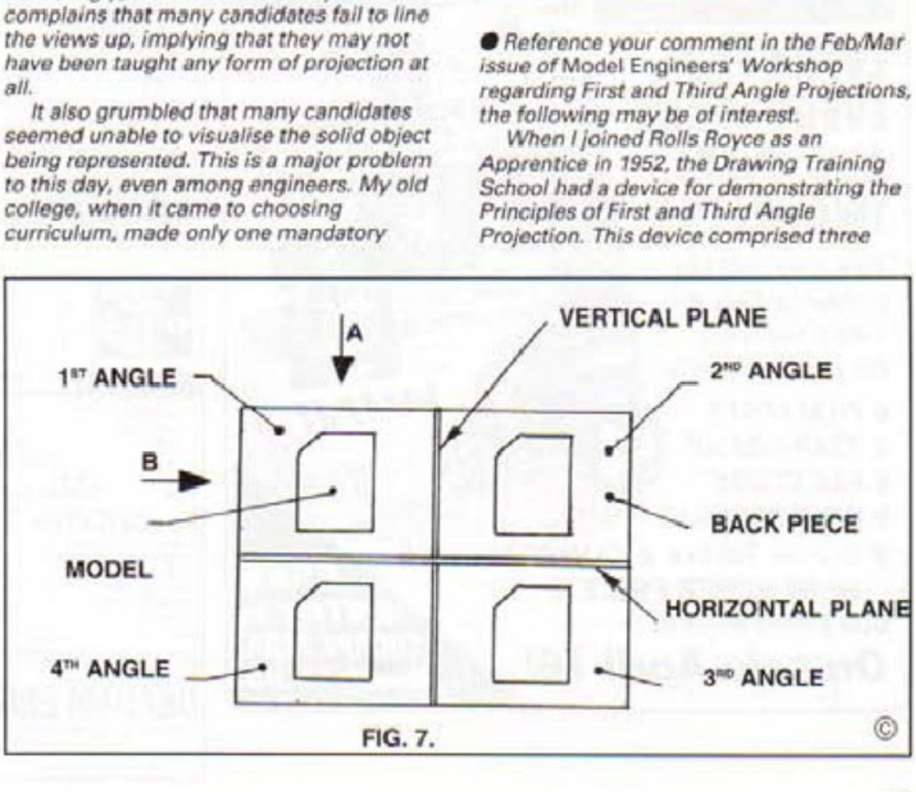

FIG. 7.

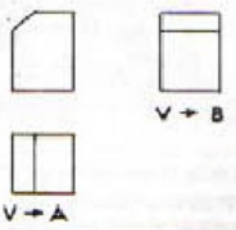

FIG 8

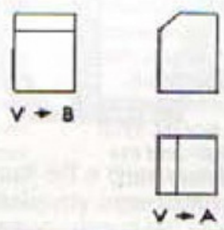

FIG 9

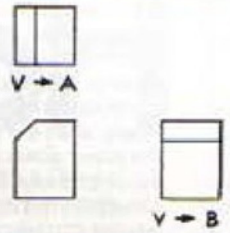

FIG 10

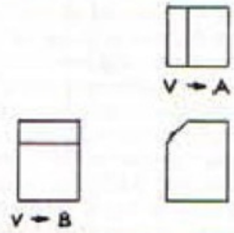

FIG 11

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pieces of plywood arranged as shown in ***Fig. 7*** *of the drawing. The back piece represents the sheet of drawing paper, and the horizontal and vertical planes were hinged so that they could be folded down onto the back piece, but were initially held in the positions shown with catches. The four spaces or boxes formed by the three planes shown are the 'Angles' in question and are numbered 1 to 4 in a clockwise direction, number 1 or the First Angle being at the top left hand position. The Third Angle is therefore at the bottom right hand position. To illustrate the rules of projection, a model is placed in the First Angle, and we now have to consider drawing the three basic view of this, i.e. a front view, a plan view when looking downwards as arrow A, and a side view looking left as arrow B. The front view is what the eye sees and is projected through the model onto the back piece (which represents the drawing sheet). Similarly, the plan view (on arrow A) is project through the model onto the horizontal plane and the side view (on arrow B) is projected through the model onto the vertical plane. If the horizontal plane is now folded down and the vertical plane folded to the right to be flat on the back piece we get in effect a three view drawing of the model in First Angle Projection* ***(Fig. 8)****.*

If the three planes are restored to their normal position, and the model placed in the second angle, the three basic views of the model can again be drawn, but now the side view is not projected through the model, but has to be projected back from the model onto the vertical plane. By folding the horizontal and vertical plane back, we get another three view drawing of the model ***(Fig. 9)*** *but if we try to read it as First Angle Projection, the side view is in the wrong place.*

If the model is place in the Third Angle, the side view is once again projected back onto the vertical plane, and now the plan view is also projected back onto the horizontal plane. When the planes are folded back, we have a three view drawing of the model in Third Angle Projection ***(Fig. 10)****.*

The whole exercise repeated with the model located in the Fourth Angle gives a three view drawing as ***Fig. 11.*** *This like the second Angle drawing* ***(Fig. 9)*** *is a mixture of First Angle and Third Angle Projection, and as such is useless as a drawing system.*

Only in the First and Third Angles are the views projected in a consistent direction, forward in First Angle and backward in Third Angle. I believe that First Angle Projection was favoured by the British, and Third by the Americans. I can think of no real advantage in using First Angle Projection, since Third Angle is a much more logical system and has the advantage of having the projected views adjacent to the face of the model being drawn. This is particularly advantageous in the case of, for instance, a long shaft with a flange and spigot diameter etc. at one end. The projection lines would be only inches long instead of feet.

A. Cowie, Withernsea