

No.55

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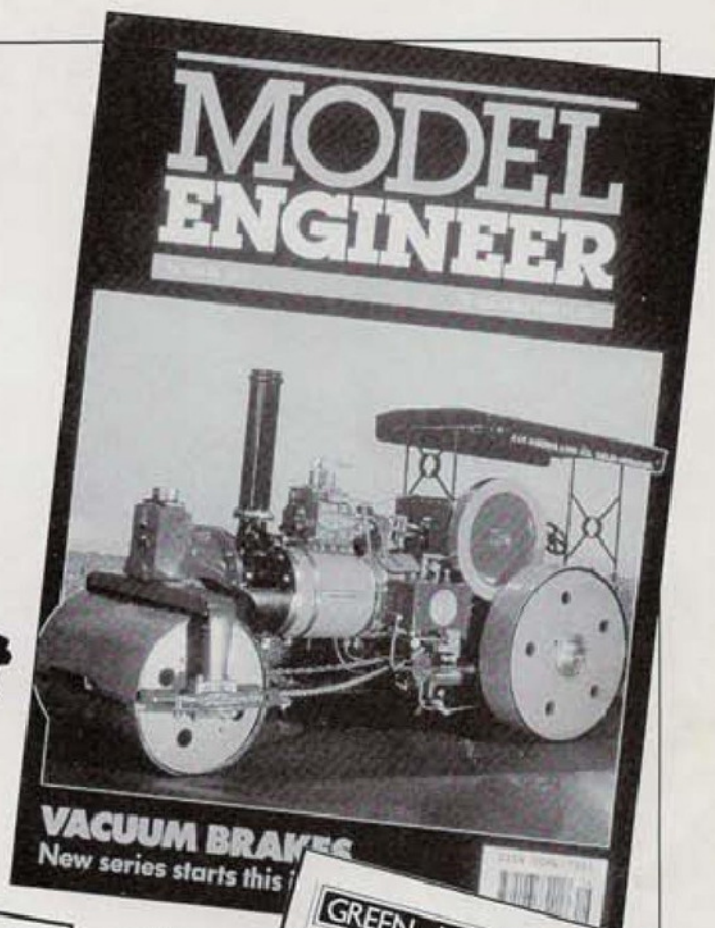
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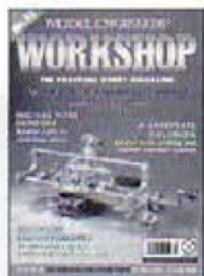
**SOMETHING
TO LOOK
FORWARD
TO...**
...every fortnight



There's something to anticipate twice every month in fascinating Model Engineer magazine! Whether your interests lie in live steam locomotive models, traction engines, internal combustion motors or stationary engines, world famous M.E. will inspire, instruct, advise and encourage. Model Engineer is published on the first and third Fridays each month and costs just £1.40 from all good newsagents; alternatively, you may care to ensure your regular copies through an annual subscription - a mere £33.60 for UK readers (overseas rates and airmail details on request).

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Nexus Special Interests
Nexus House, Azalea Drive,
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Tel: 01322 660070
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EDITORIAL

Editor
Geoff Sheppard
Group Editor
Ted Jolliffe

PRODUCTION

Designer
Rachel White
Copy Control Manager
Carrie Degan
Printed By
St. Ives plc (Andover)
Origination by
Derek Croxson Ltd.

SALES

UK Sales Manager
John Furlong
Classified Sales Executive
Sharon Hope
Northern Area Office
Carrington Business Park,
Manchester Road, Carrington,
Manchester M31 4YR
Tel: 0161-776 4460
Fax: 0161-777 6524

MANAGEMENT

Group Managing Director
Tony DeBell
Divisional Managing Editor
Dawn Frosdick-Hopley
Divisional Sales Manager
Roy Kemp
Group Marketing Manager
Aileen O'Connor
Group Circulation Manager
William Pearson

SUBSCRIPTIONS

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Editor: Geoff Sheppard

Nexus Special Interests, Nexus House, Azalea Drive,
Swanley, Kent BR8 8HY tel. 01322 660070 fax. 01322 667633

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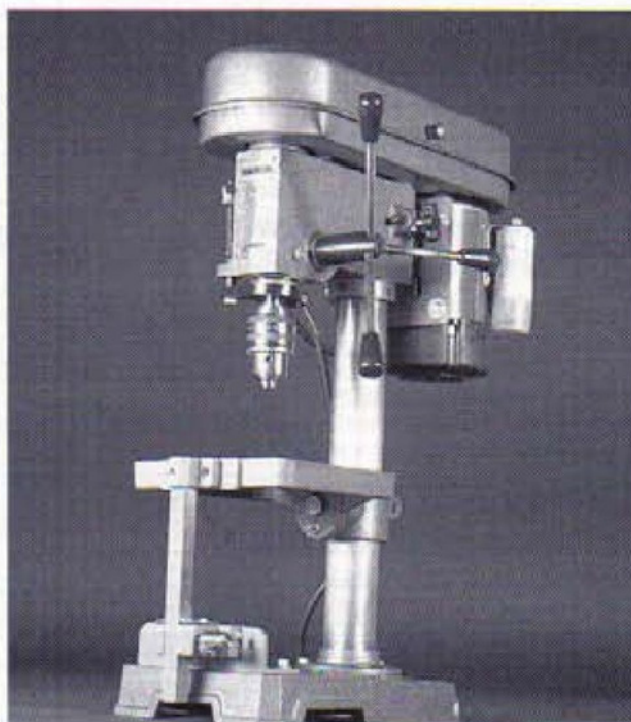
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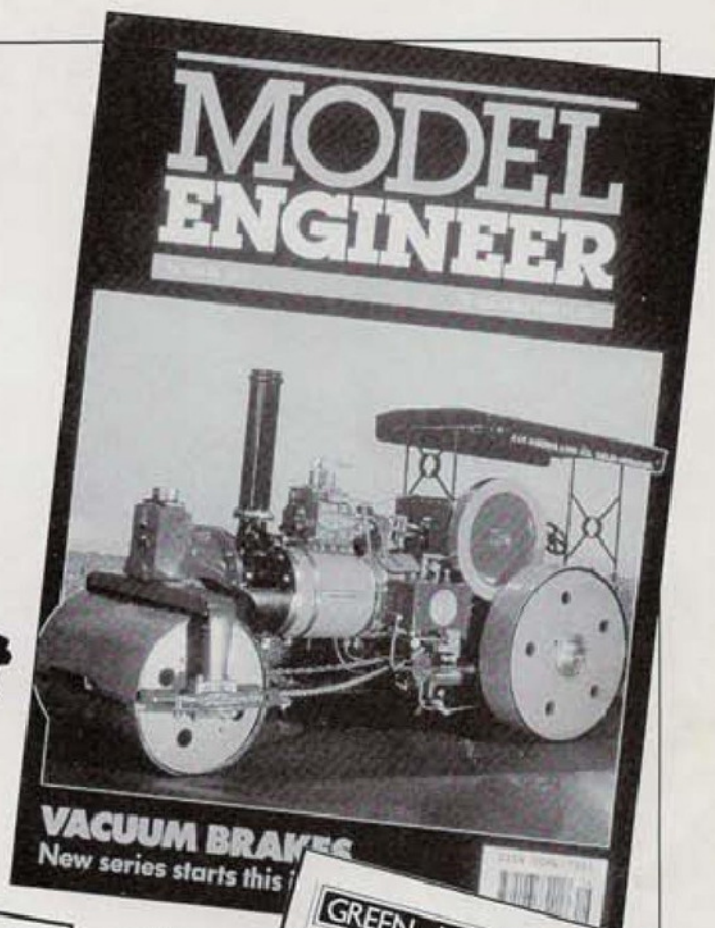
On the cover

*This elegant
ornamental turning
slide rest won a
Silver medal for its
builder, Nicholas
Edwards at the 65th
Model Engineer
Exhibition in
January 1996. The
Society of
Ornamental Turners
will be
demonstrating their
skills at the 68th
Exhibition which
opens at Olympia on
December 29th.
John Edwards
introduces the art
and science on
page 35.*



*Len
Walker's
modified
drilling
machine
will also
be on
display at
Olympia.
Another
of Len's
useful
tools is
described
on pages
16 and 17.*

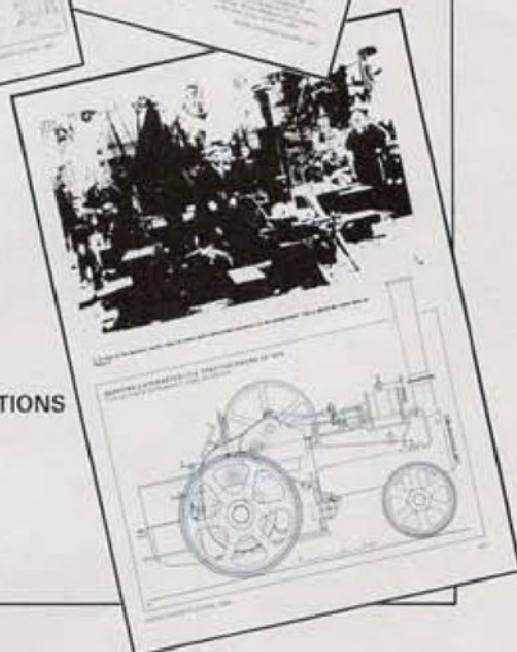
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ON THE EDITOR'S BENCH



I have to start these notes with an apology. Issue 54 contained an article by David Machin on additions to the Quorn tool and cutter grinder which included modifications to the spiral head which facilitates the restoration of centre drills. Unfortunately, the gremlins took a hand at a late stage of the production process and managed to insert the wrong images in some of the drawing panels on page 48 of that issue.

As readers will probably be aware, there are a number of agencies involved in the production of a magazine such as this and, these days, the transmission of material across the interfaces is mainly by electronic means. Being aware that small inconsistencies and mis-matches can occur at these boundaries, I try to check personally at as many points as possible, but there is a stage after which it is no longer practical for me to confirm that all is well. Inevitably, on very rare occasions, something will go awry at this point, and this is what happened. We are all still mystified, but will try to increase our vigilance in order to prevent a repeat of the problem.

I must therefore offer apologies to David and to any reader who has been inconvenienced by the error. We have repeated page 48 on page 62 of this issue with (hopefully) the correct drawings this time.

Also in this issue, I have included two articles, one by Paul Boothby and the other by Robert Newman which, although they describe items which are relatively simple in themselves, are very detailed in their presentation. This has been done deliberately to meet a number of requests from newcomers to our hobby who have little or no experience of planning the sequence of tasks involved in the manufacture of a project. Paul Boothby's contribution on the construction of a pair of tube benders is in fact laid out in a simplified form of 'operation sheet' order.

It is sometimes surprising how many people do not appreciate that much time

and effort and perhaps material can be saved by sitting down and thinking a manufacturing sequence through before attempting to cut metal. The projects dealt with in the home

workshop are seldom designed with interchangeability in mind, one part often needing to be made to fit to another. The drawings therefore do not feature manufacturing tolerances of the sort which would be encountered in industry, so a different form of process planning is advantageous. For instance, if a shaft on one component has to be a good running fit in the bore of another, which should be made first? Is it easier to turn an outside diameter to fit a previously machined bore or vice versa? Perhaps experienced machinists would have no difficulty with either option, but the beginner would not.

With the onset of colder weather, some may not find the workshop quite so welcoming, so the fireside sometimes wins. I find that the flickering box in the corner of the lounge seldom holds my attention for long, so this is the time when, with pencil and notepad, components are 'machined' on paper. One of the areas in which this can be of benefit is in work holding. How many times have we thought 'It would be easy to machine if only I could get hold of it'? One of the letters in Scribe a Line touches on this topic. Thinking through the sequence of operations in advance often suggests that a different approach would make things much easier, so don't be over-eager to grip that precious casting in the four jaw chuck and knock lumps off it. A much-missed fellow club member used to describe this precipitate form of machining as 'Chuck in three jaw, Chuck in four jaw, Chuck in scrap box'! I try to heed his words.

Another matter raised by the less experienced is the availability of practical training in machining techniques. Although there are a few so-called evening classes still in existence, many of these now seem to operate as informal clubs, where participants are expected to take their work with them and just get on with it. Often, the 'person in charge' is a storeman who will provide the necessary tools then switch off the lights at the end of the session. On very rare occasions is there anyone in attendance who is qualified to give practical instruction. Although there are training courses available at some colleges, these are usually aimed at industrial trainees and take place during the working day. The fees for such courses are likely to be substantial and more than the hobby machinist would wish to pay. Some clubs and societies have well equipped workshops where beginners are welcomed and provided with some basic instruction. Those within reach of such facilities can consider themselves fortunate. We have, on occasions, been sent information on affordable courses of professional instruction which we have been pleased to publish. If any reader is aware of more, then I would be pleased to receive details.

The 68th Model Engineer Exhibition at The International Model Show

By the time that this issue is published, we shall be close to the opening of the Olympia Exhibition. Although this is being written before the entries in the Competition and Loan sections have been processed, I hope that we shall be able to study some interesting items. I know that Peter Rawlinson is planning to enter the CNC milling machine which we are currently describing.

The 'village' area in which the centenary of Model Engineer magazine was celebrated last year is to be repeated, though in a less enclosed form. This time the emphasis is on the club exhibits and demonstrations of practical skills. As usual, the Society of Model and Experimental Engineers stand will be a major feature, with the workshop set up to provide a venue for the demonstration of a variety of techniques. Experienced model engineers will be present and willing to discuss relevant topics with any visitor. The ever popular hot air engine display will have its own area on this occasion, and the Gas Turbine Builders Association will also be within the village. The Society of Ornamental Turners plan to exhibit some of their fascinating equipment and a selection of the beautiful objects which can be produced by those proficient in its use.

Regular demonstration runs of a wide range of internal combustion engines are scheduled, though the gas turbines may again have to perform in the aircraft display area in the National Hall.

The model engineering trade is well represented, so visitors should take the opportunity to stock up with tools and materials. I know that most of the companies present are only too happy to take orders in advance, for collection from their stands. Give them a call.

As in previous years, I hope to be at Olympia for much of the time, and able to meet many of our contributors and readers. To those I am unable to greet in person, I would like to take this opportunity to say that I wish them a Happy Christmas and all success in 1999.

D.E (Laurie) Lawrence

Regrettably, I have to end these notes with some sad news. 'Laurie' Lawrence, the previous editor of Model Engineer died a few days ago after a long illness. He took over the editorial chair in August 1979 and guided the magazine for just five years before being succeeded by the current editor, Ted Jolliffe. He continued to contribute material to both 'M.E.' and the SMEE Journal.

We were pleased that he was able to put in a brief appearance at SMEE100 and to enjoy the display. It proved to be the last time that most of us had the opportunity to exchange a few words with him.

When he was active, he visited many of the societies around the country and made many friends. He will be widely missed.

A FACEPLATE BALANCING FIXTURE

Setting components accurately on a faceplate can be a frustrating business. Harold Hall describes a fixture which will facilitate this task and also allow the unit to be balanced before transferring it to the lathe mandrel

Having completed the description of the dividing head I now turn to the faceplate balancing fixture. This was made simultaneously with the dividing head because of the similarity of some parts. However, this would not be the way to describe them as many readers will not make both. Even so, to avoid repetition, I will only deal with aspects that differ markedly. Anyone making the balancing fixture, would benefit from reading the article on the dividing head, in particular with regard to the spindle.

The Design

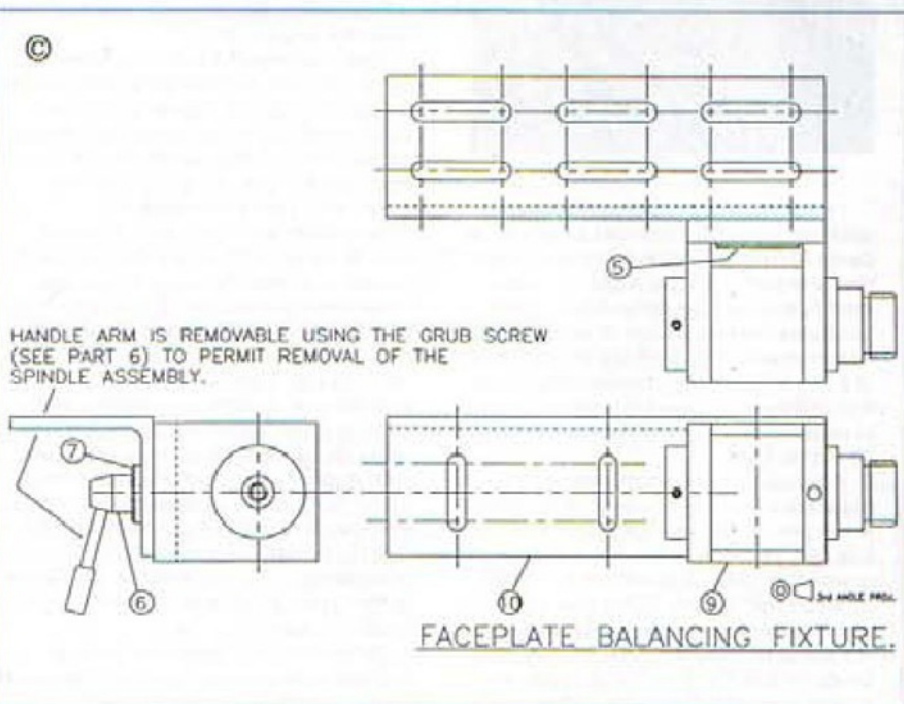
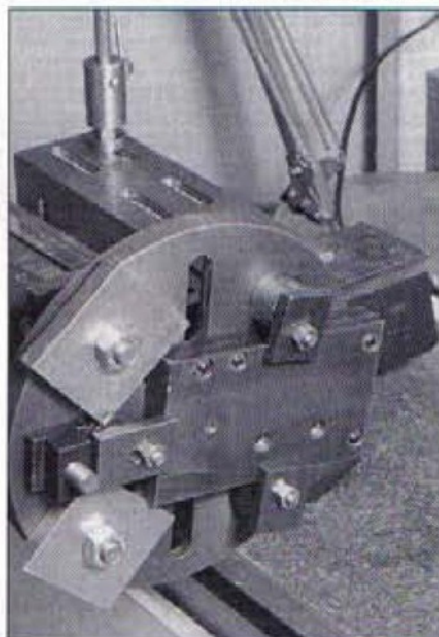
The principle closely follows designs published in the past. That is, a unit mounted in the bench vice incorporating a spindle for mounting the faceplate both in the horizontal and vertical planes and having facilities for mounting a DTI. The workpiece can be positioned and clamped more easily when the unit is in the horizontal plane as the part will sit on the faceplate without the need for it to be held in place. Positioning can then be aided by a DTI, or other indicating device (Photo. 1).

Once the workpiece is positioned and secured, the faceplate can be moved to the vertical plane and the assembly balanced

1. With the axis of the fixture vertical, the workpiece can be centred with the aid of a dial indicator. Gravity is now an asset, not a liability!



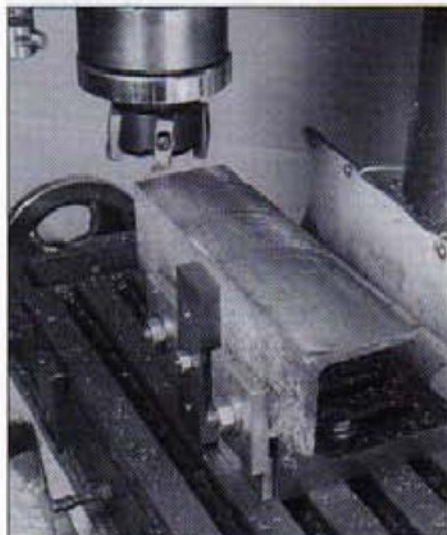
2. Turned through 90 deg., the fixture is then used to help find the best position for balance weights.



(Photo. 2). Comparing this to carrying out the operation on the lathe, there are no belts that have to be cleared and the bearing arrangement is freer, making it possible to more easily achieve a better balance. This will reduce vibration and make it possible to run the lathe at a higher speed if required.

My first intention was to machine a length of angle iron to provide the mounting for the spindle assembly, and on which could be stood a magnetic base to carry the DTI. Having machined the angle I realised that I had gained a long angle plate which would also be useful elsewhere. Because of this I also machined slots into the angle so increasing its usefulness as an angle plate. The slots would also permit the direct mounting of a DTI mounting arm, rather than requiring the use of a magnetic base.

The spindle assembly is the most unusual aspect of the design as it includes home-made rolling bearings. I decided that the spindle should include a Morse taper to match that of the lathe spindle. Although I could not think of an immediate use for this feature, I felt it should be included just in case. To accommodate the Morse taper, the spindle would require an



3. Machining the first face of the angle.

outside diameter of 25mm, involving the use of large rolling bearings. With angular contact bearings costing in the region of £25 for a pair, many potential constructors may be deterred, though in all probability radial bearings would suffice, in which case the cost would be reduced to around £12.

Whilst I would have gone along with this, it seemed worth investigating whether a cheaper method could be used. With this in mind, I decided to attempt to include my own home-made rolling bearings. For these, 4mm balls were

purchased from the local cycle repair shop at a cost of £1, and the design shown evolved. Not only did this save money but, as no races are involved, the whole assembly is much more compact.

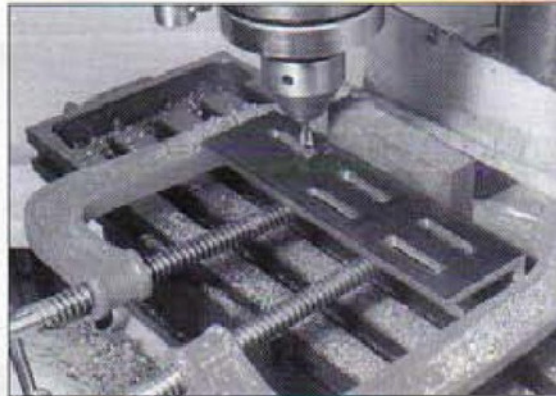
The idea was 100% successful; as an indication of this, with the faceplate horizontal it runs for around 1 minute if given a light spin. I also believe that, just possibly, the unit could occasionally double as a drilling spindle.

Manufacture

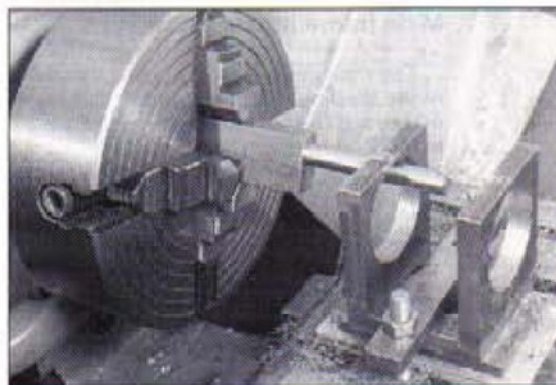
The angle (Item 10)

The angle was made from an old fence post and was quite rusty, needing more metal to be removed than I would have liked. The first side was machined as shown in **Photo 3**, followed by the second side in a similar manner. In this case though, the angle was mounted off its previously machined surface rather than off the inside face, which ensured that the two faces were at 90 deg. The ends and the long edges were also machined, only the two inside faces being left unmachined.

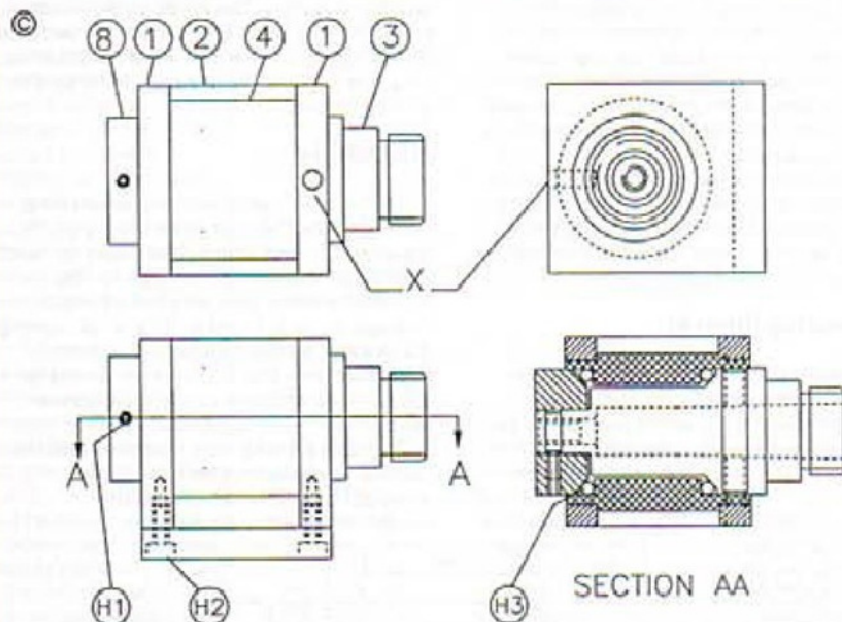
It was at this point that I realised I had the makings of a useful long angle plate and decided to add the slots. **Photo 4** shows them being machined. If this is printed in colour it will be seen that the face is covered in marking blue. When machining features into components that do not require a high degree of accuracy, I mark out the edges of slots, recesses, steps and the like with the height gauge and machine up to these marks, also



4. Machining the slots in the angle, enabling it to be used elsewhere as a long angle plate.



5. Boring the large holes in the frame.



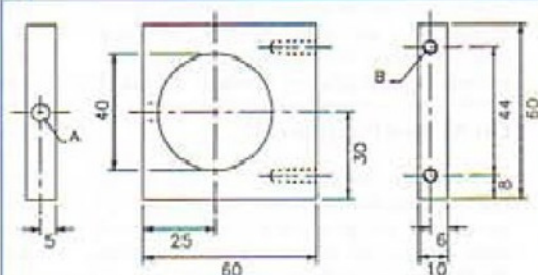
- H1. M4 X 6 SOCKET GRUB SCREW. 2 OFF.
H2. M5 X 12 SOCKET CAP SCREW. 4 OFF.
H3. 4mm (5/32") BALL BEARING. 56 OFF.

X. DRILL HOLE THROUGH THREE PARTS 1, 3 AND 4 AFTER ASSEMBLY. IT WILL BE NECESSARY TO LOCK THE SPINDLE BY SOME MEANS TO PREVENT IT ROTATING

SPINDLE ASSEMBLY

3rd ANGLE PROJ.

8.

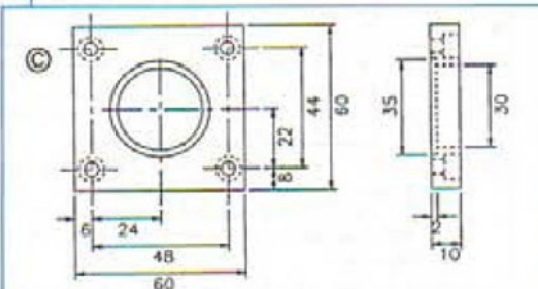


- HOLE SIZES.
A. 5.1 DRILL AFTER ASSEMBLY.
REQUIRED IN ONE END PLATE ONLY.
SEE ASSEMBLY DRAWING.
B. M5 X 10 DEEP. 2 OFF.

MATL. 60 X 10 MILD STEEL.
QTY. 2 OFF. SEE NOTE RE HOLE A

END PLATES

1

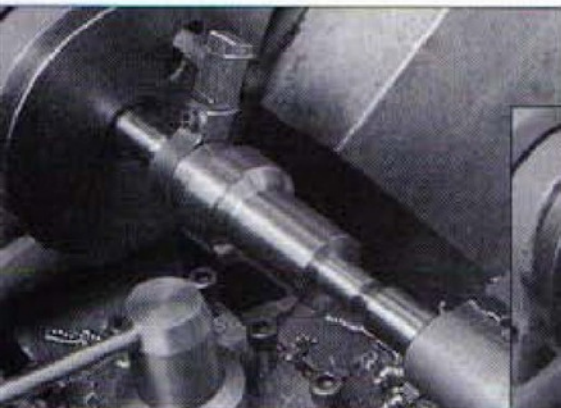


- HOLE SIZES.
A. 5.5. C.BORE 9 dia. X 5 DEEP 4 OFF.

MATL. 60 X 10 MILD STEEL.
QTY. 1 OFF.

BASE PLATE

2



6. and 7. Machining the spindle between centres to ensure concentricity.



8. Boring the second end of the outer bearing whilst mounted on a stub mandrel.

setting the table stops where appropriate. This is much easier than getting involved with edge finders and working out leadscrew dial readings.

Main frame (Items 1 and 2)

The main frame is a simplified version of the dividing head main frame and the machining follows closely the principles mentioned in that article. The one exception is that the two larger holes were finished bored as shown in **Photo. 5**. This required packing under the frame to bring it to the correct height for boring.

Spindle (Item 3)

The essential requirements for the spindle are concentricity between the faceplate mounting, the angled bearing surface and the 14mm diameter portion on which the end bearing fits. It is therefore vital that these surfaces are machined whilst the spindle is mounted between centres. The methods of setting up and machining the faceplate thread and the Morse taper are as those for the dividing head. Some of the between centres machining is shown in **Photos. 6 and 7**.

Outer bearing (Item 4)

The main requirements for this are that the two bearing outer diameters are concentric and that the shoulders of each bore are parallel to each other. To this end, the following method was used:-

The piece of steel was mounted in the chuck and, after facing the end, was drilled through 8.5mm diameter, followed by boring to 28mm diameter, 30mm deep.

The purpose of this was to take the head of a screw which would secure it to a stub mandrel during a later operation. The part was then reversed in the chuck and the other end bored as per drawing, 40mm diameter by 16mm deep, the outer surface then being reduced to 46mm diameter for a length of 10mm.

It was then removed from the lathe and a piece of steel mounted in the chuck to make a stub mandrel, the end being faced and then drilled and tapped M8. The outer diameter was turned to a very close fit in the 40mm diameter bore and to a length of about 18mm.

The bearing was now placed on the stub mandrel and held in position with the M8 screw, the inside diameter of the bearing now running true, as was the base of the bore. The 40mm diameter by 9mm deep bore was then produced, thus ensuring that it was true with the first bore. **Photo. 8** shows this operation. The second 10mm length machined to 46mm diameter is a nominal dimension, the length being turned such that the 50mm dia. section was a slightly tight fit between the end plates of the main frame, the latter having been assembled so that it could be used as a gauge.

Finally, the bearing was returned to the chuck and the 30mm through bore made. This is clearance for the 28mm diameter spindle, so dimension and concentricity are relatively unimportant.

End bearing (Item 8)

A length of 40mm diameter steel was mounted in the chuck with sufficient length protruding to permit the part to be

machined and parted off in the one visit to the lathe. The essential

features are that the bore is a very close fit on the 14mm diameter spigot on the end of the spindle, and that the 45 deg. angle is turned at the same setting, so as to ensure concentricity.

The outside diameter is dimensioned as 40mm, equal to the diameter of the stock material specified. However, the outside diameter was skimmed, ensuring that it had adequate clearance in the 40mm bore of the outer bearing. The turned finish also looked better than that of the stock bar. After parting off, the outer end was faced to complete the turning operations on this part.

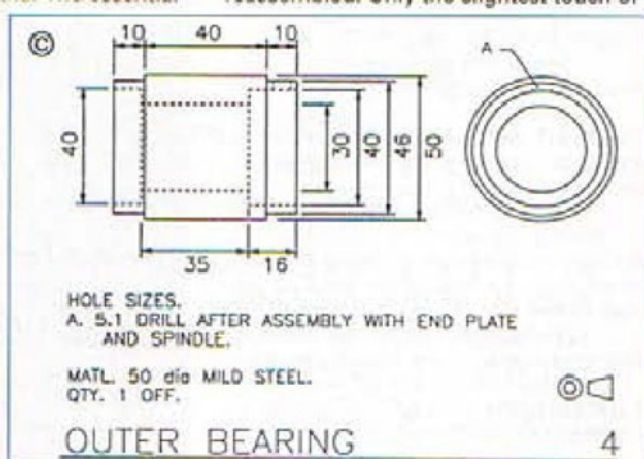
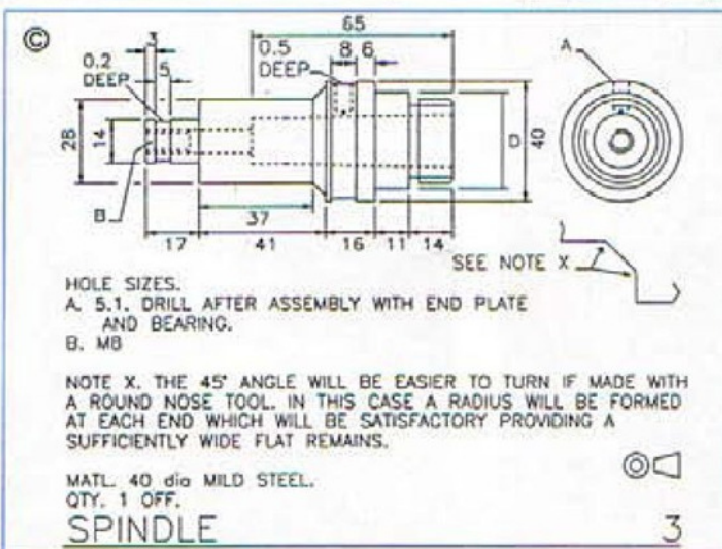
Remaining parts

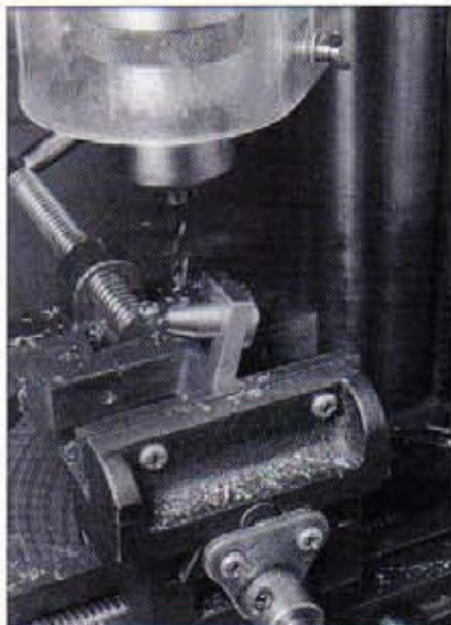
The remaining parts need very little comment as they are all very straightforward. Just one point is perhaps worth a mention. The main portion of the clamp handle (Item 6) requires a hole to be drilled into it for the arm. **Photo. 9** shows how this part can be securely held for the drilling operation.

Assembly

The unit was provisionally assembled. Having made the outer bearing a tight fit between the end plates, there was no need to provide additional fixing for it. The 5.1mm diameter hole was then drilled through parts 1, 3 and 4. This is for locking the spindle by the insertion of a short 5mm diameter bar, the purpose being to assist in the removal of the faceplate or chuck.

The spindle was then removed and the bearing surfaces and ball bearings thoroughly cleaned and the parts reassembled. Only the slightest touch of





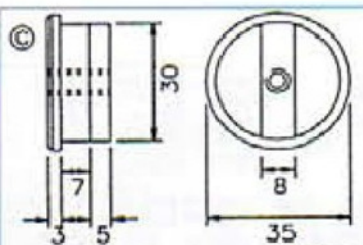
9. Bolting the central boss of the handle to a small plate enables it to be easily held for drilling.

thin oil was used and the end bearing adjusted to take out any end play.

On assembly I immediately found that the spindle ran very freely, so I was pleased with the result. It did though become a little stiff occasionally, but it did not seem to be a serious problem as, after a turn or two, the spindle once again became free. Even though it was only a slight inconvenience, I felt that I would like to know the reason, if only to improve my understanding. After much thought I began to feel that, just possibly, the balls, not being precision types, would differ in diameter and may cause the unit to tighten up when they arrived at a given point, probably where they coincided with a possible lack of concentricity in other parts.

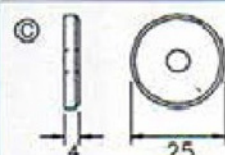
I dismantled the assembly so as to measure the ball diameters, and found that they varied by about 0.015mm. It was at this point though that I noticed a spot on the 40mm diameter of the spindle where it appeared to be rubbing on the inside diameter of the outer bearing. I had made the 40mm diameters of the spindle and the end bearing quite close fits in the outer bearing, the idea being that this would help to prevent the entry of swarf and the like.

What was happening was that, with the variation in ball sizes, the spindle was being forced off centre. In theory, if the parts were truly concentric and circular, the rubbing should be continuous through the full 360 deg. rotation. Obviously, even with my best intentions, there were very slight errors of concentricity and/or being truly circular, causing contact between spindle and outer bearing to occur intermittently when the errors coincided with the larger balls being in a certain position. I reduced



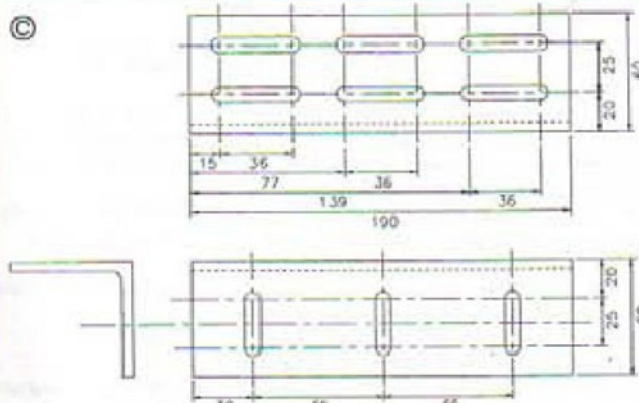
HOLE. M6
MATL 35 dia. MILD STEEL.
QTY. 1 OFF.

5.
CLAMP PLATE



HOLE. 6
MATL 25 dia. MILD STEEL.
QTY. 1 OFF.

7.
CLAMP WASHER



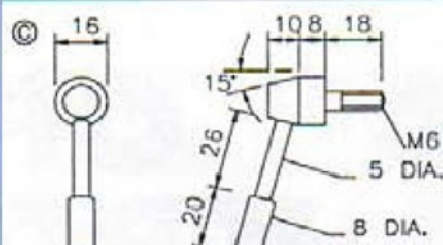
MATL 60 X 60 X 6 (2-1/2" X 2-1/2" X 1/4") ANGLE IRON.
MACHINE TWO OUTER FACES. SLOTS 6 WIDE
ANGLE

the 40mm diameters of the spindle and the end bearing very slightly and the problem was totally eliminated.

I have gone into detail on this problem to prevent others from falling into the same trap. Having solved the problem, the arrangement now works better than I had ever thought possible. Certainly there would seem to be no point in going to the expense of purchasing commercial bearings for something which will get only limited light duty use.

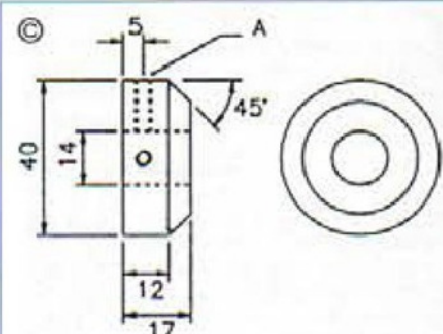
In use

Having the faceplate horizontal whilst fitting the component most certainly makes this operation much easier. The real benefit becomes obvious though when the assembly is returned to the lathe and it is found that the use of higher speeds is made possible by the improved level of



MATL 16 dia. MILD STEEL.
8 dia. MILD STEEL.
H1 M3 X 5 SOCKET GRUB SCREW.
QTY. 1 OFF.

6.
CLAMP HANDLE.



HOLE. A. M4. 2 OFF.
MATL 40 dia. MILD STEEL.
QTY. 1 OFF.

8.
END BEARING

balance which can be achieved.

Two down

With the dividing head and the balancing fixture completed, I will continue the series with a smaller project, the special quadrant for the Series Seven lathe. This was used whilst making the worm for the dividing head. I will also include details of the counterbores and the die head chaser holder, both made and used when constructing the dividing head.

Postscript on the Dividing Head

Whilst cutting a worm gear for a future project, I suddenly realised that I had mistakenly made the worm gear for my dividing head with a 20 deg. pressure angle, rather than the 14 1/2 deg. pressure angle required to suit a Myford changewheel. Although the 20 deg. PA worm will work well enough at the light duty to which it will be subjected, I feel that I should correct the instructions given on page 40 of Issue 54. The cutting tool tip width should be 0.042in. (not 0.028in.) and the internal angle should be 29 deg. (not 40 deg.). Apologies to anyone who may have been inconvenienced by this error.

AN OFF-SET MICROMETER

If a commercial micrometer head comes to hand, a couple of hours work will produce a useful measuring instrument. Len Walker gives step by step instructions on how to achieve accuracy



This is a less common type of micrometer, basically designed to measure work in progress - say on a lathe faceplate or on a milling machine table - without having to remove the job. This eliminates having to re-set work, often the most time consuming part of the process.

It can also be adapted, using your own special anvils, to measure such things as tube wall thickness or awkward recesses. It is simply a standard 0 - 1in. micrometer head, mounted in a frame. With the head set to zero, the measuring anvil is exactly flush with the hardened wear strip attached to the frame. The thickness of this strip can be easily adjusted (by surface grinding), to give the required degree of accuracy on assembly.

I used a standard Moore & Wright 0 - 1in. micrometer head, (as usual, because it was there), but the simple basic design could be adapted without difficulty to suit any other make.

The first step is to accurately measure the distance from the micrometer head mounting face to the measuring tip. This can be obtained by using a dial (or vernier) caliper gauge with a 'step' measuring facility. On mine, this dimension was exactly 2.000 in., as shown on the G.A. I think that other makes are all made to some 'standard' recognisable figure for ease of installation into fixtures.

This dimension on 'our' instrument is the sum of the height of Detail 2 (frame) and the thickness of Detail 4 (hardened wear strip). Either can be varied to give an accurate assembly. Aim to leave Detail 4 just a few thou. plus - this will provide an easy means of adjustment on final assembly. Perhaps a few words to go with the 'music' will help.

Detail. 2

Make from 2in. x 3/4in. bright mild steel, or better still use black hot rolled mild steel, as the first essential is a stable, stress relieved frame. If bright steel is used, as I expect most of us will have to, rough out slightly oversize, then stress relieve by thoroughly soaking at red heat, then allowing to cool slowly. This should not be necessary if black hot rolled M. S. is available as the stresses are relieved

during manufacture. (Lovely stuff!)

Grind both sides of the frame parallel, then grind the top and bottom faces square and parallel, to suit your assembly. To ensure that these faces are truly square clamp the frame to an accurate angle plate, using the 7/8in. dia. hole. Surface grind the long top face first to correct any distortion, then the bottom face, but leave say 0.015in. plus at this stage.

The next step is to ream a mounting hole for your micrometer head, absolutely square to the top and bottom faces. With limited equipment, this is probably most readily achieved by clamping the frame, packed up to centre height, to the cross-slide. Set the long face 'square' to the lathe spindle - using a dial test indicator swung from the chuck, using the largest radius possible to ensure accuracy.

Drill, bore and ream to suit your micrometer head, noting that a maximum 0.005in. chamfer is called for to allow the head to fully seat on assembly.

Drill and tap 4mm for the grub screw, then file a neat 1/32in. chamfer on the edges as shown, and complete with the 1/8in. and 3/16in. chamfers. The positions of the two 4mm tapped holes for the capscrews are transferred from the hardened Detail 4. Tap as shown, then counterbore the first threads - this face must be flat.

Detail 4

Use 3/4in. x 1/4in. gauge plate, filed to size, making sure that the ends are square, adding the 1/32in. chamfers where indicated.

Mark off, drill and counterbore as shown. This will leave about 0.023in. 'spare' clearance for the capscrew heads, which will provide a little latitude for fine tuning on final assembly. Obviously, the heads must still be below flush.

Harden and grind flat and parallel, leaving a few thou. plus at this stage.

Detail 6

This is simply a brass pad which is used to prevent damage to the head mounting stem. Don't forget it!

Final Assembly and accurate 'zero' setting

This can be done in two easy stages:-

Stage 1

With the micrometer head and the wear strip fitted to the frame, turn the micrometer head back to zero, then onwards another 0.005 (i.e. set on the 20 thou. line on the thimble). Lay a straight edge along the wear strip and the measuring tip and, using feelers, determine the amount to be removed from the bottom face of the frame to give a flush condition at this stage.

Remove the head and wear strip, and grind the bottom edge of the frame to suit the 'flush' requirement.

This initial stage leaves Detail 4 approximately 0.005 plus when the micrometer head is returned to a normal zero reading.

Stage 2 Final accurate setting

Hold the assembled head firmly down on a surface plate and offer a 0.500in. test diameter under the measuring tip. If the micrometer has to be wound down (say +0.005) before contact is made, it will be necessary to reduce the thickness of Detail 4 by 0.005in. on the surface grinder (in other words reduce the wear strip by the 'plus' amount indicated).

A CNC MILLING MACHINE

Part 3 of the description of Peter Rawlinson's machine covers the remaining mechanical components and their assembly. As before, Figure, Item and Photograph numbers follow on from the previous instalment

The components which comprise the machine spindle, its housing and drive have been redesigned since building the prototype, as have those of the CNC Z axis leadscrew and drive system. It was found difficult to maintain accuracy with the original design, and the new arrangement allows the parts to be machined in smaller groups.

Figure 7 is a General Arrangement of the CNC Z axis assembly showing the bearing positions and the Item Numbers of the parts.

Spindle drive motor mounting

Item 76 is the spindle drive motor mounting plate which is designed to give a small amount of adjustment to the motor drive belt tension. It is designed for use with a Parvalux PM6D motor (Item 75) and is likely to need modifying to suit other sizes or makes of motor. The top bearing mounting plate (Item 77) will, however be common and is quite straightforward, but do make sure that the bearing bore is square to the plate.

Both this and the lower bearing mounting plate (Item 78) are attached to the rear support plate (Item 79), which is mounted on the front part of the turret head rotator (Item 68 -see previous article). The spacers (Item 80) complete the motor mounting assembly. Together with the gusset plates (Items 81 and 82), these parts form a very stiff box shaped recess which holds the CNC Z axis sub assembly. The rectangular hole in the left hand gusset is to accommodate the Z axis leadscrew drive. The parts will have to be assembled in a specific order, which I am sure will become apparent on study of the drawings. Although I have detailed all the side holes for the gusset bolts, I would suggest that only the holes in the gusset plates be drilled tapping size and then all parts put together, clamped and spotted through, as very slight errors can make life very difficult.

Spindle support frame assembly

The CNC Z axis support frame (Item 83) is cut from a single piece of

aluminium, but could be fabricated. My original machine had a movement along this axis of 20mm, but as I found this a little restricting, I have increased this by 10mm. The components as drawn are therefore proportioned to provide a movement of 30mm.

There is a large amount of metal to be removed when making this part from solid and, when doing this, I prefer to use a ripper cutter. These are more expensive, but as they are usually made of a cobalt steel, they last much longer than standard cutters. I have not include a photograph of hacking out the material, but Photo. 23 shows the use of a button to mark out the radii on the arms. I would also point out the use of the Quick Release Vice Jaws described in MEW No. 48. It is necessary that the accuracy of this piece be of the highest order, especially the positioning and alignment of the holes which support the slide rods (Item 84).

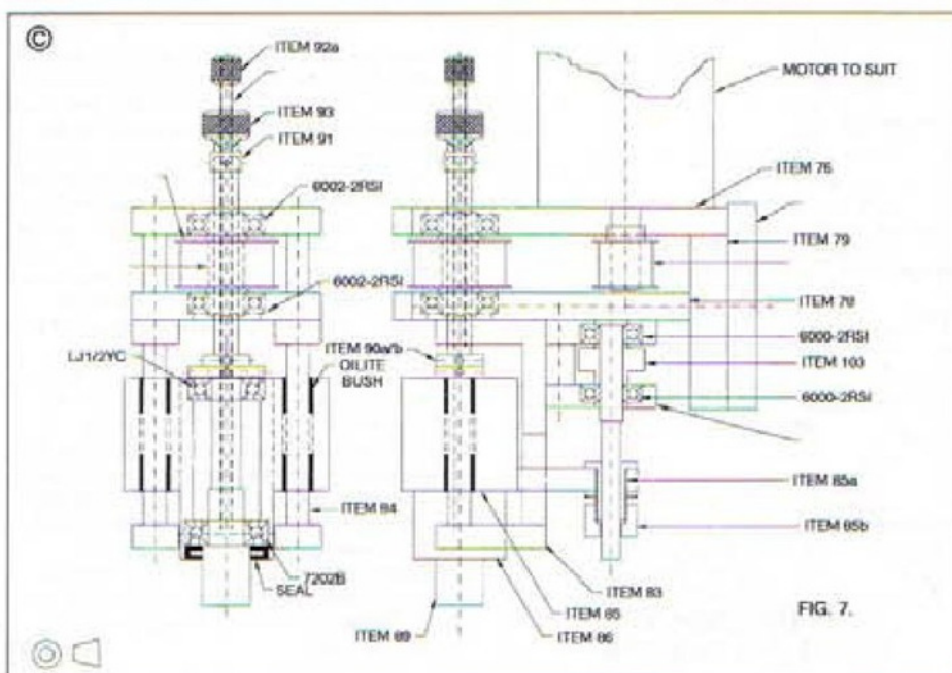
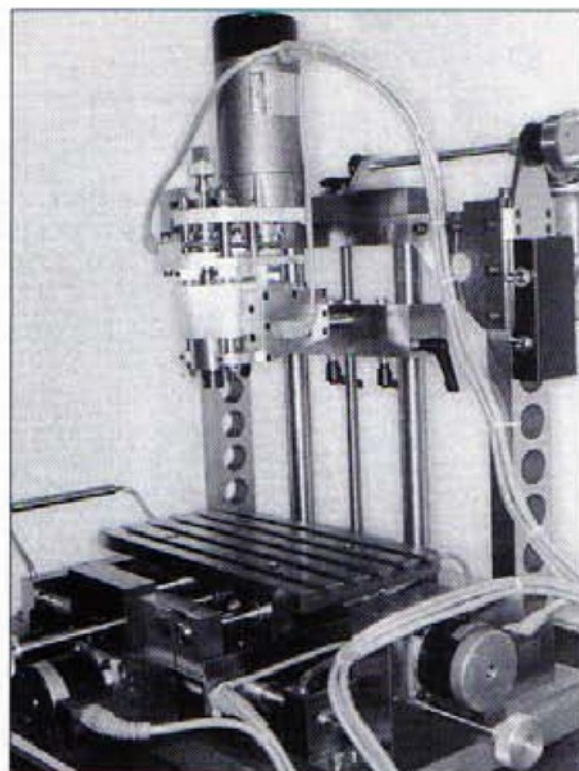
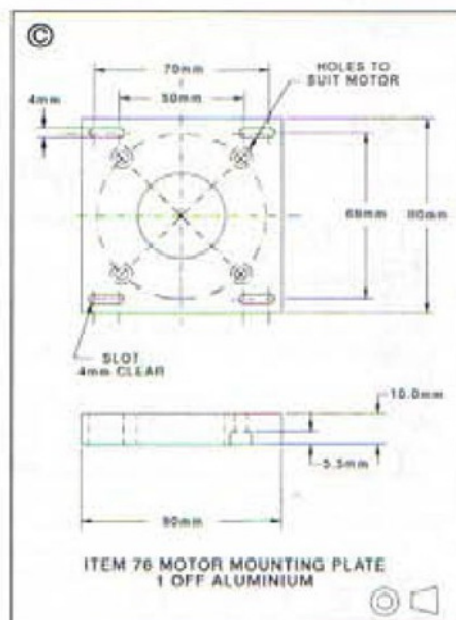
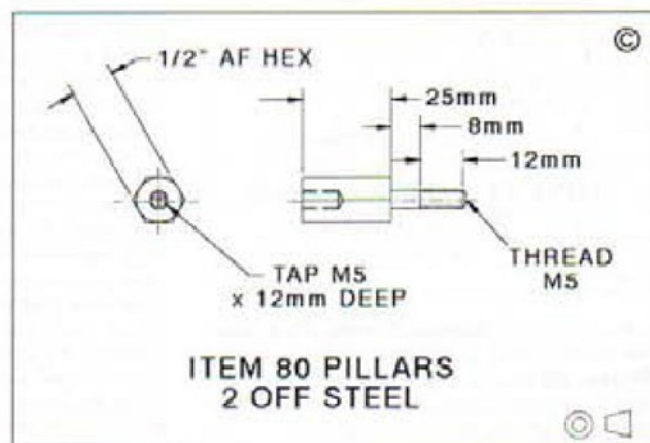
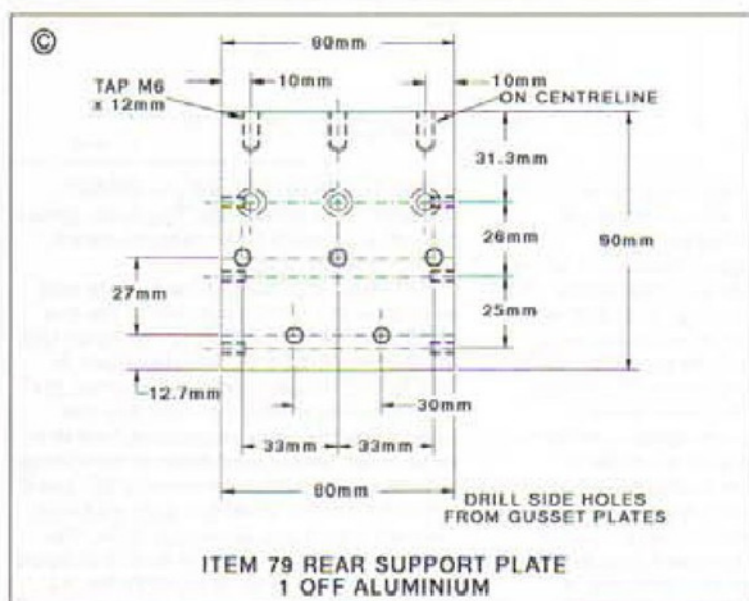
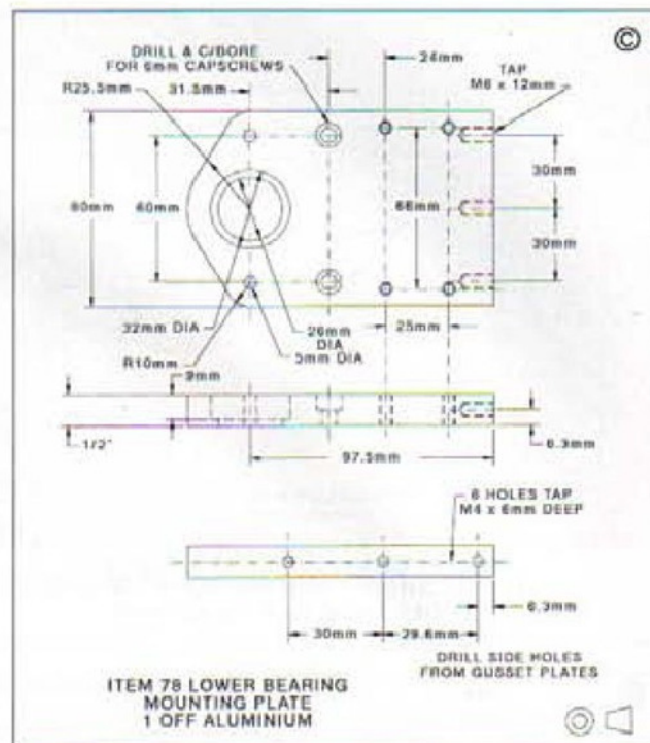
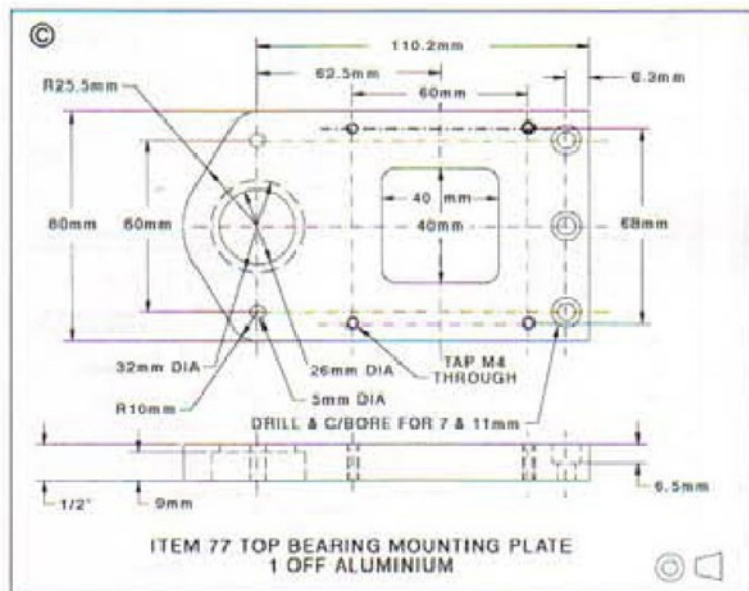
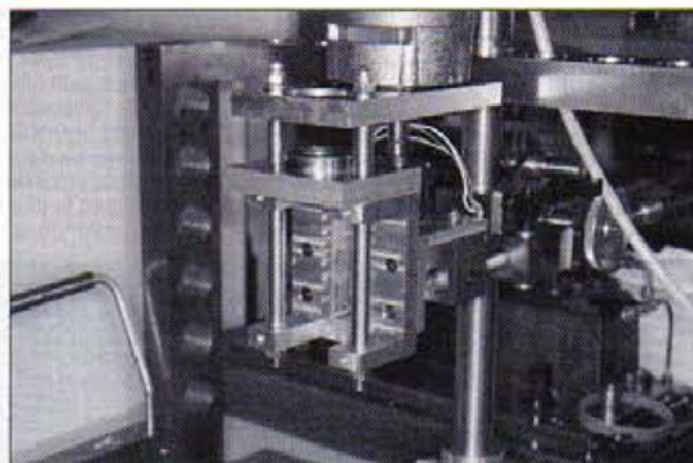


FIG. 7.





23. Using a button to mark out the radii on the arms of the partly machined Z axis support frame



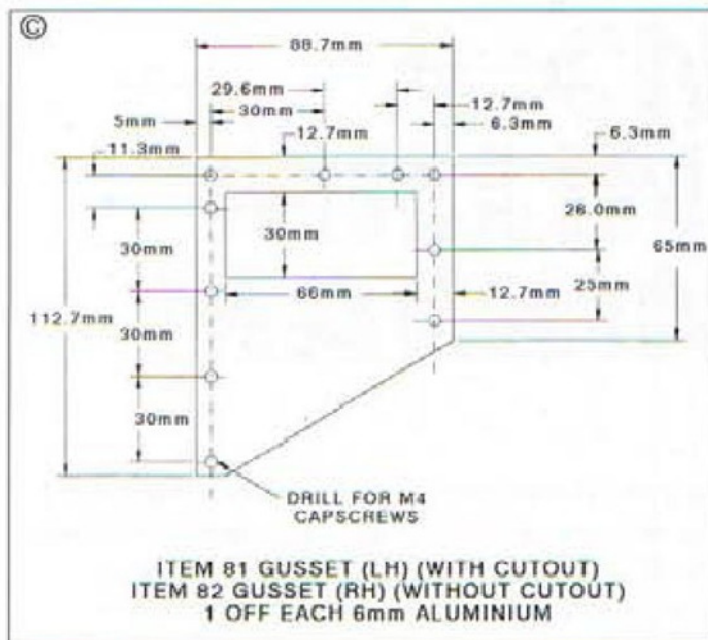
24. The Z axis support frame of the earlier version of the machine.

Photo 24 shows these components on an earlier version of the turret which had different mounting arrangements and also just a single bar for the main vertical slide, since changed to the twin arrangement. It will be seen that in this version, the slide rods pass through holes bored through the frame, but in view of the difficulties involved

in keeping all the holes in the correct relationship, the published design uses bolts engaging in tapped holes in the slide rods. A small measure of adjustment will therefore be available, but the length of the rods must be carefully controlled to ensure that they will be nipped firmly between the arms of the frame.

Quill holder

We now come to Item 85, which I have called the quill holder, into which the bearing barrel (Item 86) is either press fitted or Loctited. I suppose that this assembly could also be made from one piece, but I don't think that the additional

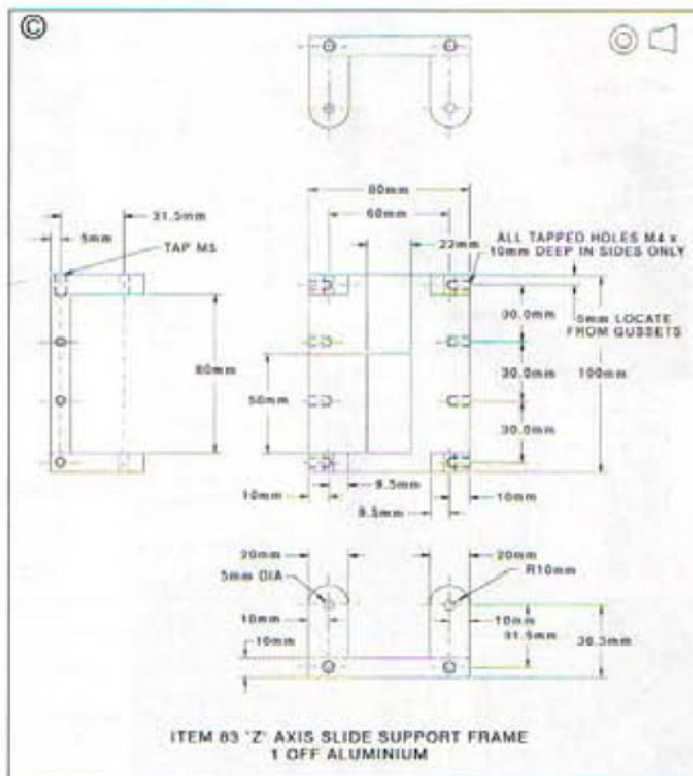


complication is justified. **Photo. 25** shows the holder being machined to shape, while **Photo. 26** shows the finished part. It must again be emphasised that the machining of this part must be of the highest accuracy, in order to maintain the three main holes in alignment.

The spindle

The main shaft or spindle (Item 89) was designed to suit collets which I had to hand, but I have recently discovered that this pattern is now very expensive (over £42 each new). I therefore suggest that the

spindle should be made to accept the same type of collets as will be specified for use on the dividing head. These are 'E' type single angle collets from the ECX 20 system which have the advantage that each can accommodate a range of 0.5mm on bores under 3mm and 1mm on larger bores. The revised design is shown as Item 89A and it will now be seen that, as no draw bar is required, there is no need to drill through. This type of collet also requires a closing ring (Item 89B) which conventionally incorporates a lip, the purpose of which is to ensure that the grip of the collet is relaxed when the ring is unscrewed. Unfortunately, this feature is not terribly easy to machine, so it has been omitted from my design. I can report, however, that I have never had any difficulty in releasing a cutter from the chuck. If you wish to see the design of a closing ring which incorporates the lip, look at the one which John Payne has specified for the Quick-Step mill, illustrated on page 55 of Issue 53. These closing rings can also be purchased in the finished condition, but it would then be necessary to ensure that the spindle nose thread was a match. A further point is that this collet configuration does take up more space,

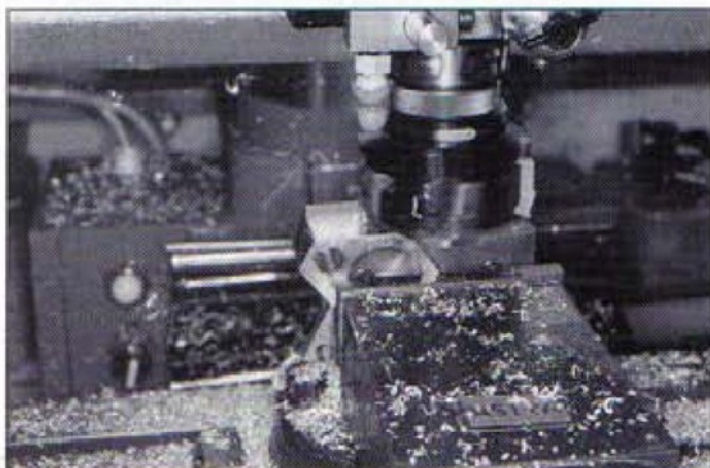


but the height of the gantry could be increased to compensate. The other option would be, of course, to make ones own collets (**Photo. 27**)

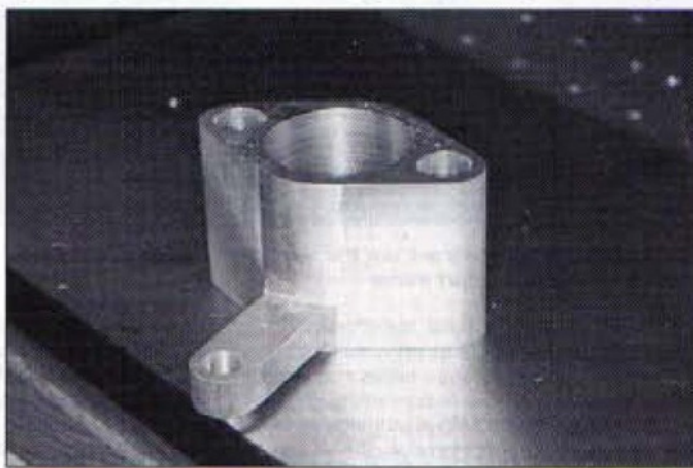
My original version of the spindle was machined in a similar manner to the one which I made for the milling machine right angle drive unit previously described. It was turned between centres or rather, the front was first machined, including the collet bore, then a piece of steel, held in a lathe collet, was turned down to be a snug fit in the bore. Without removing this piece of steel from the lathe, the shaft was then locked onto it and allowed to cure. The procedure is then the same as that covered in the article on page 19 of MEW No. 51.

With the outer surface finished, the shaft was drilled through 5mm for the draw bar, and here I used the tailstock drill shown in **Photo. 28** and covered in detail in MEW No.46. A centre location will still be required to support the shaft when machining the two keyways, so it would be a good idea to open up the centre before drilling.

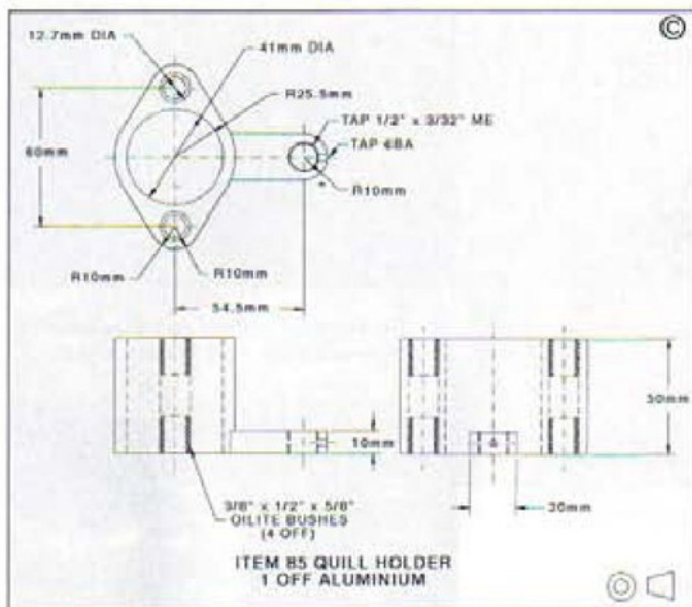
The mill is set up and here I have used an indexing device, although a dividing



25. Machining the quill holder



26. The completed quill holder

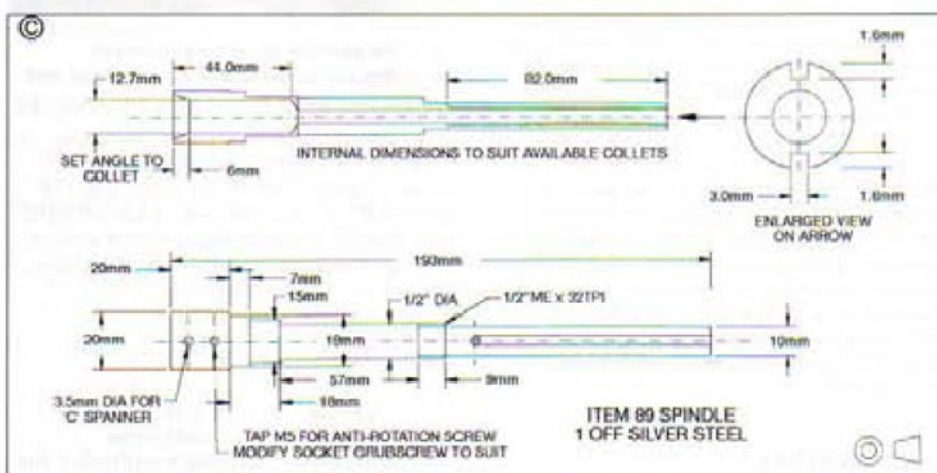


27. Collets to fit the original pattern spindle



head would do as well. You will note (Photo. 29) that this has already been packed up to exactly the same height as my dividing head tailstock and, in this way they are all interchangeable. The shaft is held in a collet or on a centre, then the cutter centred over it, again in my case by using the centring device. **Photo 29** shows the cutting of the first keyway, the shaft then being turned through 180 deg. for the second.

As the spindle ends up with rather a thin wall section, I thought it advisable to fit the cap (Item 91) which will resist the loads imposed by the draw bar pull nut (Item 93) and stop any tendency for the spindle to split (Photo. 30).



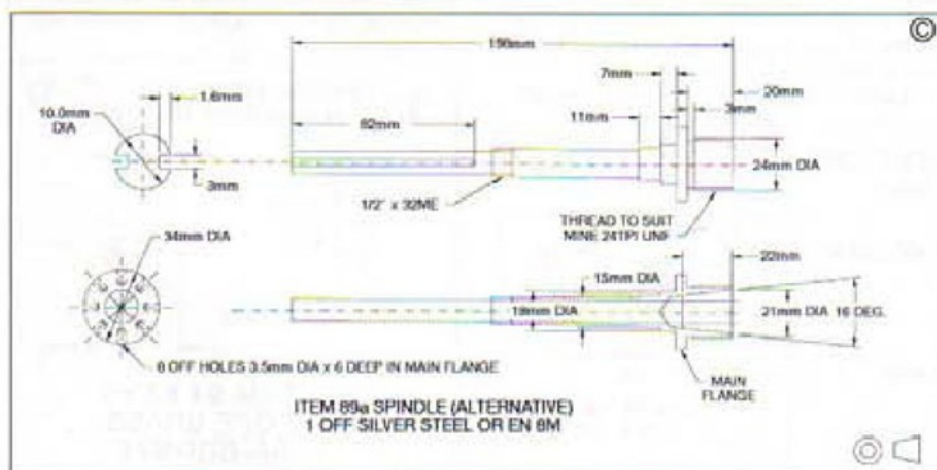
Spindle drive assembly

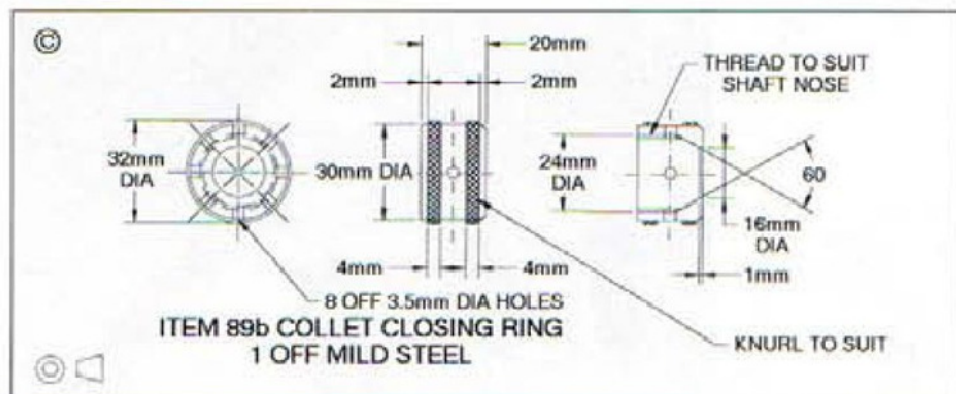
This part of the head took some time to design, as broaching facilities to form the housing for the keys were not available. The design used has, so far, worked well, with no problems whatsoever.

The spindle drive keys and their carrier are shown as Items 94 and 95. The latter part is made from silver steel, 15mm dia. and must be drilled and bored accurately to allow the shaft to slide through. It is then held in a dividing head or indexing fixture and accurately aligned with the table travel. Again I used the centring device to align the slot drill (Photo. 31). A 6mm wide slot was cut first, the job then being rotated for the second 6mm slot. After changing the cutter, the 3mm section was completed in this one before another 180 deg. rotation (Photo. 32).

The keys can be made from brass, but if something tougher is thought necessary, then phosphor bronze would be ideal. I suggest that a piece of 1/4in. square material be held in the mill vice and a small cutter used to machine an inverted 'T' shape, the stalk of which will be a snug fit in the slot of the carrier (do both keys at the same time.) Cut to length and file the ends to suit.

Hold in the mill vice, this time by the stalk of the 'T' and machine down to 3.95mm. Remove, deburr, and fit into the carrier, clamping lightly in place. If all is correct a nice sliding fit on the shaft will have been produced; if not adjust as required. The outer profile will then have to be created, so





that the assembly will fit into the bored and reamed pulley (Item 97). I did this by Loctiting the keys in place and holding the assembly in a collet. The protruding portion of the keys was then carefully turned away, then the assembly finally finished off using a file until a good fit in the pulley was achieved. The latter was then secured in position with the grub screws.

Z axis leadscrew and motor mounting

The components which form the mounting for the CNC Z axis leadscrew and the stepper motor form a sub-assembly (Item 100) which incorporates a small amount of adjustment. I found it virtually impossible to make six separate parts, all of which would line up perfectly, so the unit was redesigned to solve the problem (see Figure 7).

It is best constructed by first machining all parts to size externally and then bolting them together. This sub-assembly is then lined up on the mill table and clamped down on parallels. If you do not own any purpose-made parallels, bright steel bar can be perfectly adequate as long as you use adjacent pieces from the same bar length to limit any discrepancies. Check them with a micrometer.

The sub-assembly is, of course, now upside down, but this does not matter. Drill and counterbore the fixing holes, then bore the 38mm and 22mm dia. holes. Next bore the lower (nearest the machine table) bearing recess, the upper recess being bored using a tool in the boring head which will cut on the upward movement of the head. If you do not feel confident about doing this (it is common practice, but I believe in making life easy and, after all, this is only a hobby), then there is just sufficient room to fit a bearing retaining ring using 6 BA countersunk screws, so bore the 'top' straight through.

Finally, mill the slots for the motor adjustment. It will be noticed that the holes

and counterbores for the 6mm dia. holding bolts are oversize, to give adjustment. It is therefore necessary that the counterbores be flat bottomed.

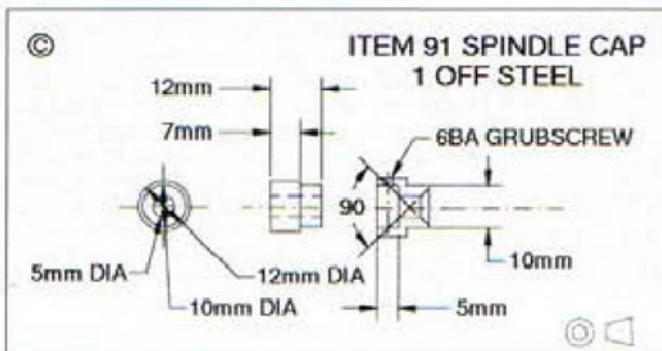
Z axis leadscrew and drive

I would suggest that the CNC Z axis leadscrew (Item 103) is first screwcut between centres then finished using a button die. I have used a standard M8 thread, but any thread of this diameter may be used. The 10mm dia. sections are machined to fit the support bearings and the 12mm dia. portion is to suit the 32 tooth pulley which may be a press fit or Loctited in place. The leadscrew drive components (Items 105, 106 and 107) are all fairly simple, but do need to be concentric. Their location can be seen in **Photo. 33**, which shows the underside of the head. The stepper motor will need an additional conduit box of the type shown as Items 32a and 38a in Part 1.

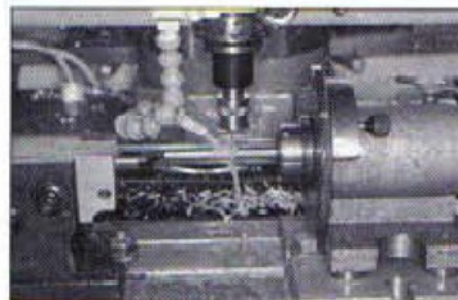
The nut is required to be of the anti-backlash variety, and the parts for this are shown as Items 109A and 109B, the former being screwed into its location in Item 84 from the top and locked in place with the grub screw. The lower part is screwed on to this and eased off until the lead screw will enter both. Any clearance on the thread of the lead screw is then taken up and the second part locked. This unit will require some running in, which is easily carried out using an old fashioned geared hand drill clamped in the bench vice. With the leadscrew in the chuck and the nut held in the hand, any stiffness can be easily assessed and adjustments made accordingly.

Limit switches

The question of limit switches again arises. I have included a system on the Z axis of my machine, but it is not connected as there is no specific input to the Interface, although I believe that such switches can be



28. The tailstock drilling unit was used to make the draw bar hole in the spindle



29. Milling the first keyway in the spindle

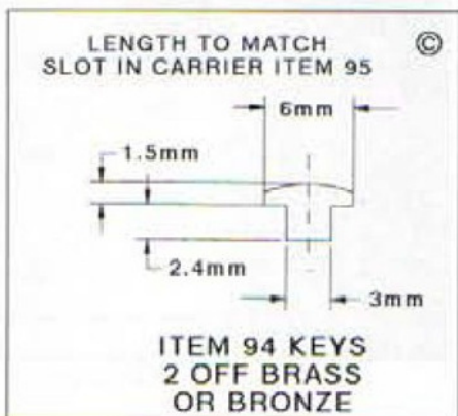


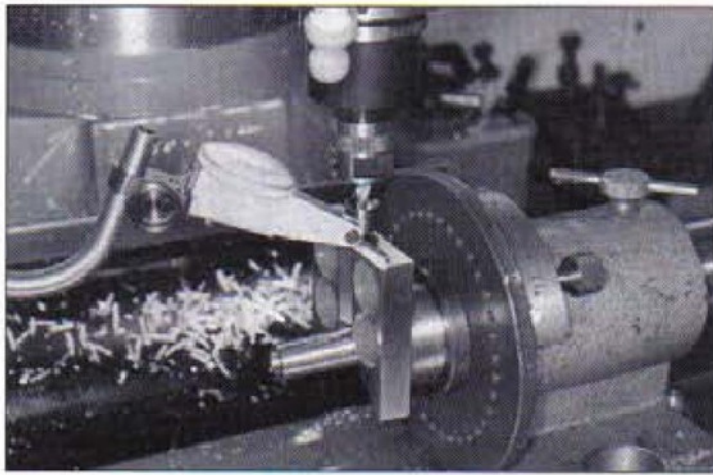
30. The spindle drive arrangement showing the collet draw bar, pull nut and cap on the spindle

used in a general limit system. They may be incorporated to the builder's requirements, and if not connected to the electronic system could be wired to pilot lamps of some sort, which would then give a warning. **Photo. 34** shows the set-up on my machine.

Assembly

Most of the assembly is straightforward and needs little comment. I have already mentioned the adjustment of the X and Y leadscrew bearings, and the same comments will





31. Using the centring device to position the cutter over the key carrier

apply to the bearings on the Z axis leadscrew and the main spindle, the latter being most important due to the high speed of the shaft.

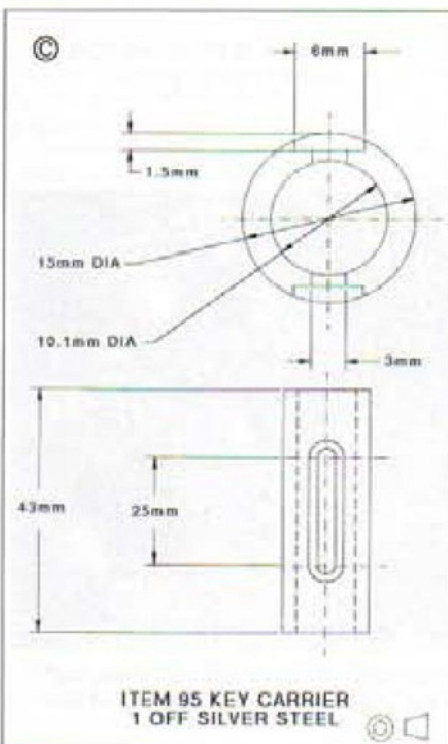
The other points to watch out for are friction or play in the slide members. The Z axis and turret Y are not as critical in this respect as these are locked up during the machining operations.

The Syncroflex belts do not want to be too tight, but conversely must have no slack, otherwise accuracy will suffer.

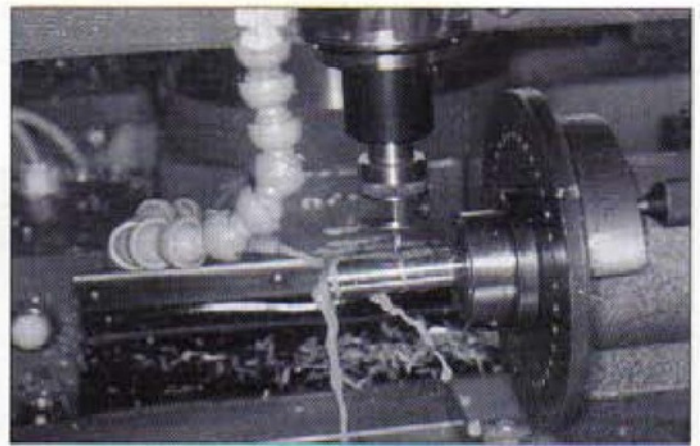
Adjust the CNC Z axis anti-backlash nuts as described above, and I would recommend that as soon as the machine is operational, a small program be written to exercise all the leadscrews and nuts. These can then be adjusted accordingly to give best performance.

Alignment checking

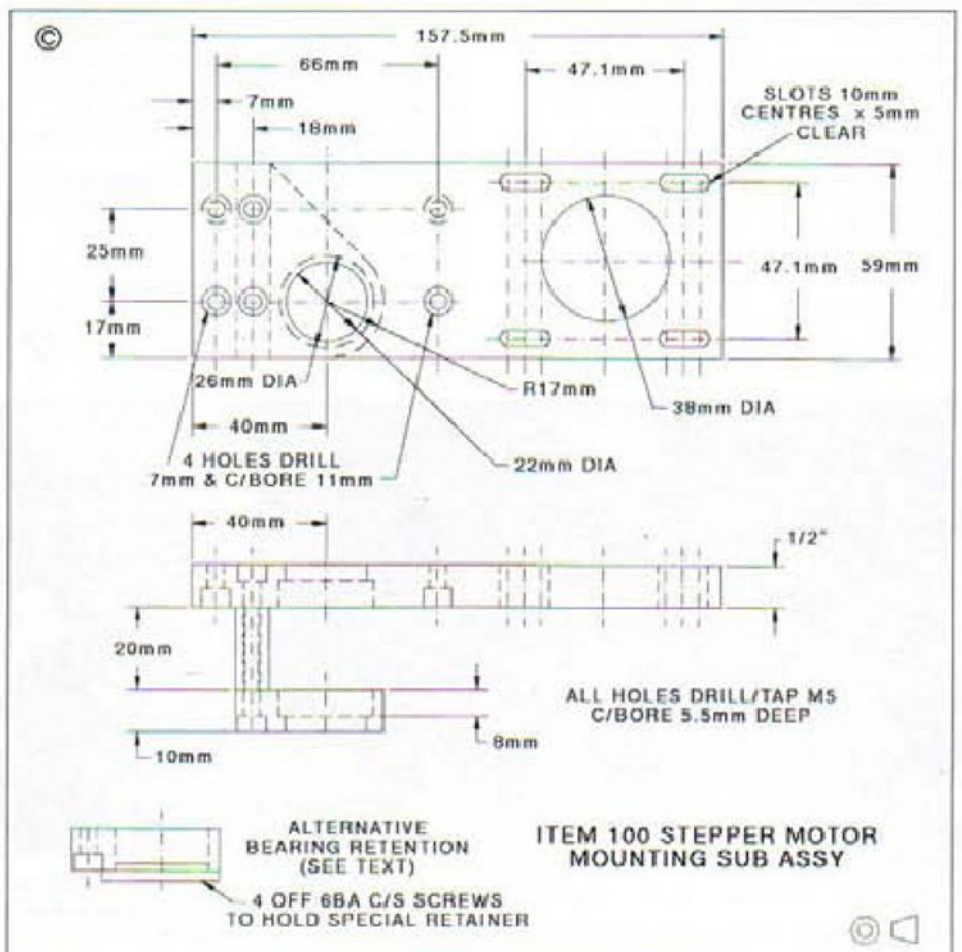
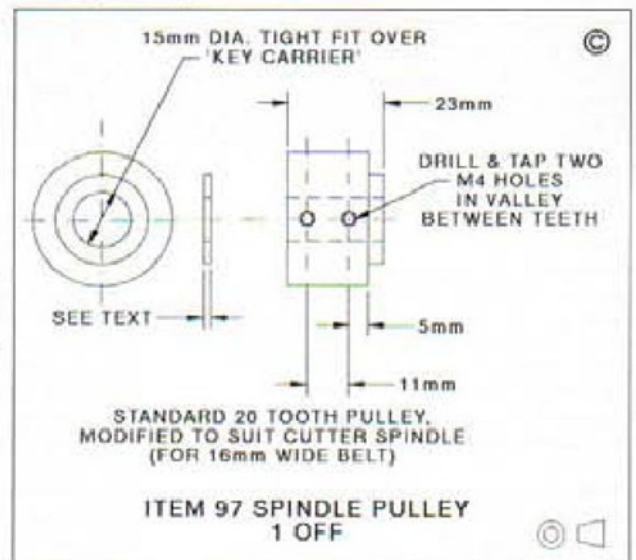
Before using the machine, it would be sensible to check that all has gone together in a way that will ensure

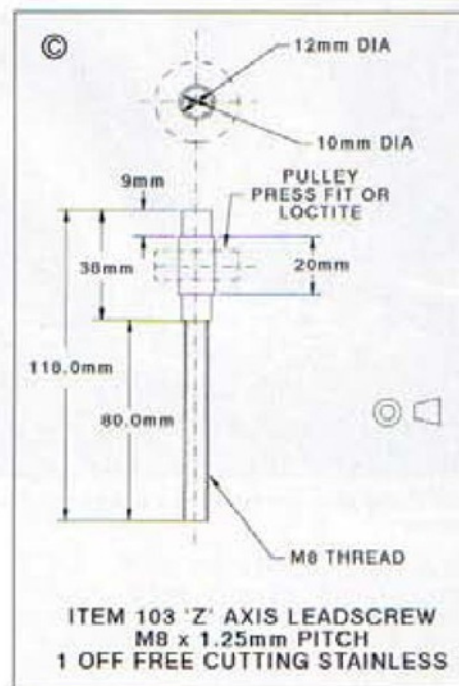
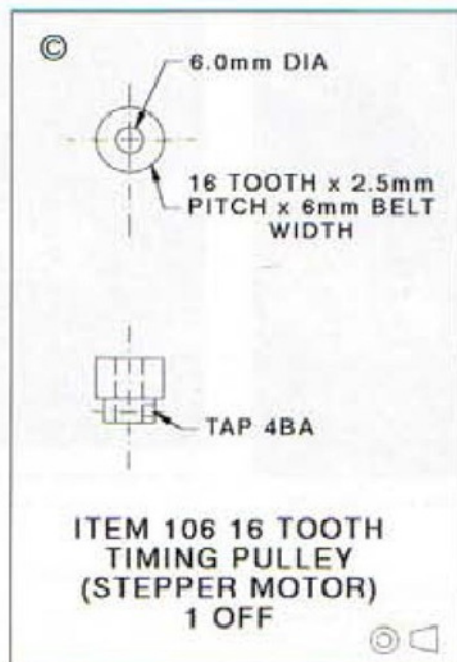
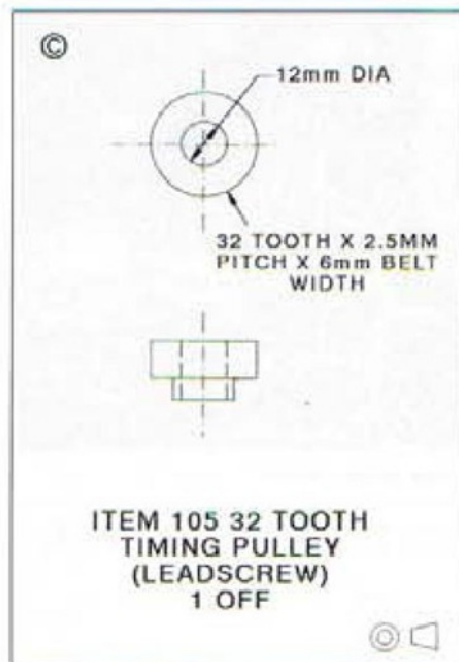


reasonable accuracy. Firstly check that the table top is parallel to the slide members. Use a dial gauge on the base and slide it along so that the stylus is on the slide bars. If you don't have one, make up an elephant's foot stylus, as this makes the job much easier. Next place the stylus on the table and run the table under the gauge. This will show if there is any taper between the sliding surface and the table top which needs correcting. These checks apply to both the X and Y axes.



32. machining the key slots in the carrier





The other setting to watch is the angle between the X and Y slides, controlled by the accuracy of the position of the plate between the two axes. If the holes in this can be drilled using the milling machine as a jig borer, then you should not be too far out and there should be some adjustment in the bolt holes. It would of course be best to fit dowels after all is correct. This check of the squareness of the X and Y axes can be carried out using a large accurate square mounted on the X slide bars and a dial gauge mounted on the table. The stylus is set on the edge of the square which is at right angles to the X axis and the variation noted as the table is moved across the Y axis slides.

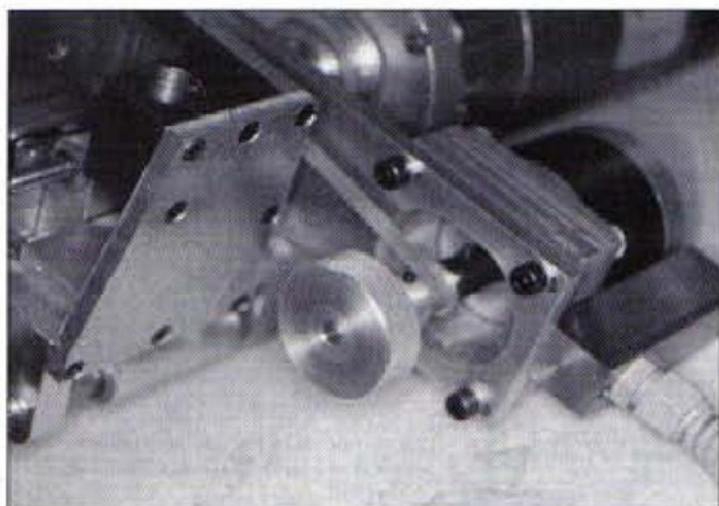
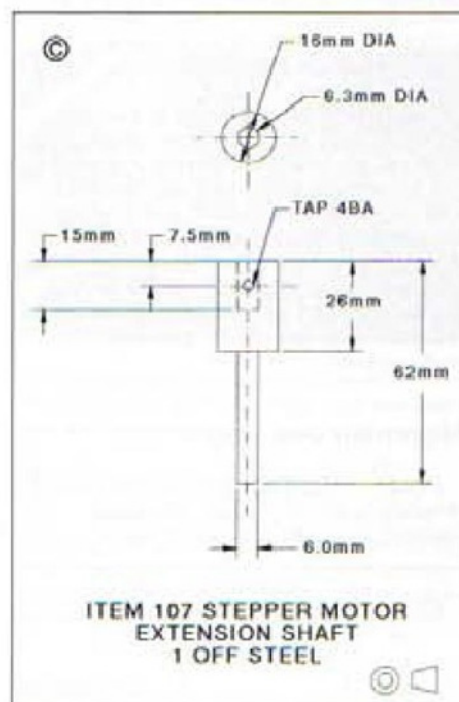
Check that the spindle is vertical in relation to the table. To accomplish this, mount a short (100mm) bar on the spindle and at right angles to it, so that it is parallel to the table. Fit on the end of this a dial gauge, with its stylus resting on the table. Rotate the spindle by hand (not forgetting to lift the stylus as it comes to the Tee slots) and check at the four 'Cardinal points of the compass' and if all readings are the

same, then all is well. If different on the X axis, adjust at the turret rotator until correct. If on the Y axis, then this will have to be carried out by using shims under the rotator.

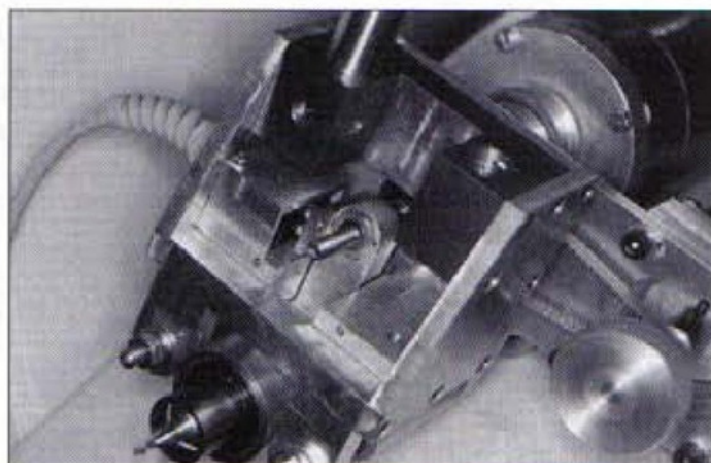
It is also important that the main Z axis vertical slides are at right angles to the table. This is ascertained using an accurate square or cylinder mounted on the table and a dial gauge mounted on the Z axis slide bar. This is traversed up the columns with the foot resting on the square. Any discrepancy in the reading must be adjusted out.

Some of these checks may find minor problems, some of which could be ignored, so it is up to the individual to decide on the level of accuracy. Remember that you are likely to want to use a series of drills of different lengths which will require the head to be moved up and down to accommodate them. The spindle will need to be at right angles to the table and the table parallel to the slides to ensure accurate results.

The next part of the description will deal with the control system and go on to give details of the CNC dividing head.



33. The leadcrew drive arrangements on the original machine



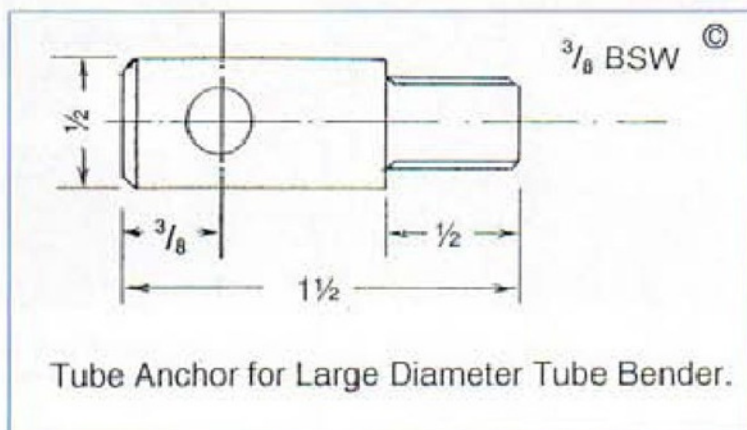
34. An underside view of the head showing spindle, leadcrew and limit switches. It was not possible to pivot the head on this version

Helical Tube Benders

1. The Large Diameter Tube Bender and typical coil formed on it



Increasingly, more complex home workshop construction projects are demanding the use of such materials as stainless steels, some of which are less than easy to handle in conventional ways. Paul Boothby describes the manufacture of two tube benders which will create helical coils in stainless steel tube.



Introduction

Have you ever tried to create a neatly bent cooling coil and failed? Because a helix is not a plane (two dimensional) curve, it is not possible to bend a tube into a helix using a conventional tube bender. A narrow tube can be bent using a suitable former into a relatively large dia. without fear of causing kinks in the tube. However, as the dia. of the helix is reduced, so the tendency for the tube to kink is increased.

In this article, two types of bender are described. One is a simple former-based design, for making 10in. dia. coils, and the other is a more robust model for bending 1in. dia. coils. Both models are intended for use with 1/4in. dia. stainless steel tube.

Large Diameter Tube Bender

To form large dia. coils (say 10in.), a simple former can be made from a 12in. length of 8in. dia. PVC or ABS water or gas pipe (Photo. 1). The wall thickness should be at least 1/2in.

Make the anchor from a 1 1/2in. length of 1/2in. round bar, as in Figure 1. Drill and tap the hole for the anchor about one in. from the end of the pipe. Cut the starting slot at the other end of the pipe, in line with the anchor hole (Figure 2). Start the slot by drilling a 1/4in. hole at the base of the slot. Next, decide whether right- or left-handed helices are required, and file a radius of about 1/2in. on the slot

accordingly. Figure 3 shows a slot for right-hand helices. Tighten and align the anchor using a tommy bar.

Using the Large Diameter Bender:

1. Using a conventional tube bender, bend the tube through 90 deg. at about 12in. from one end.

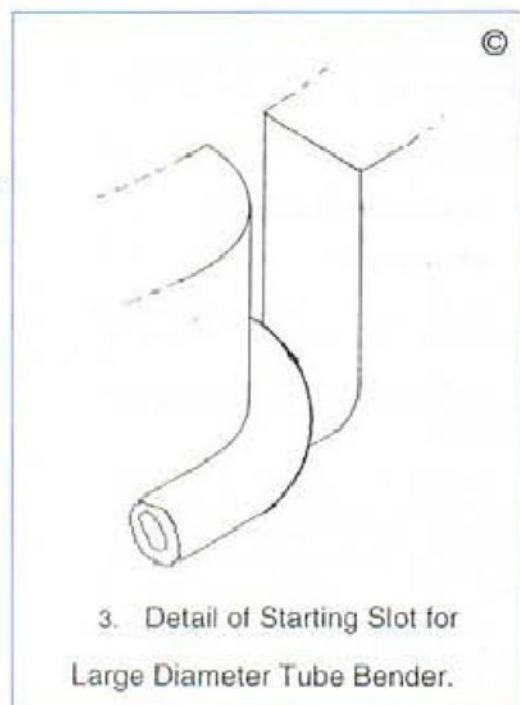
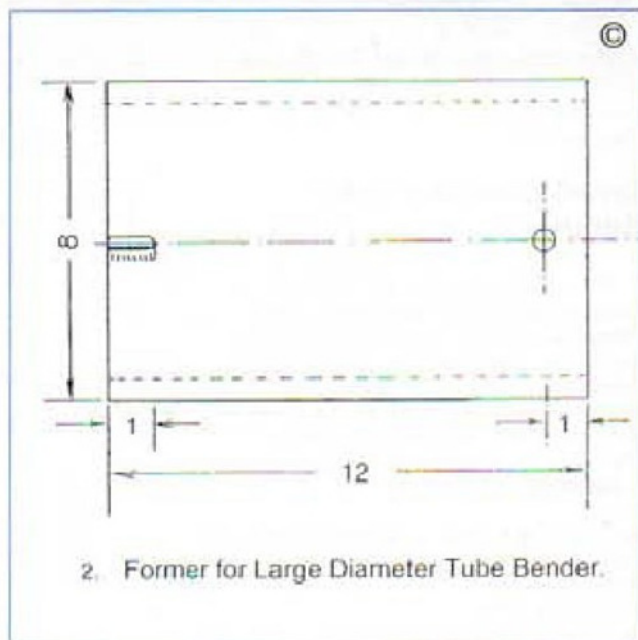
2. Bend the tube again through 90 deg. about 1/2in. from the first bend, so that the planes of the two bends are at 90 deg. apart. Note that the orientations of the bends will determine the handedness of multi-turn coils.

3. Grip the anchor end of the former horizontally in a suitable vice.

4. Fit the tube through the pipe and into the anchor hole, so that the tube fits snugly into the slot (Figure 3).

5. Wind the tube around the former until the coil is complete. TAKE CARE!!

As a guide, a 20 foot length of 1/4in. stainless steel tubing can be wrapped around an 8in. dia. former about ten times. Due to the elasticity of the steel, the coil will unwrap itself (CARE!) by about two turns, to give a coil of about eight turns with a dia. of 10in.





2. Small Diameter Helical Tube Bender

Small Diameter Tube Bender

This bender (**Photo. 2**) is capable of bending left handed and right handed helices with helix angles ranging from 0 deg. to 45 deg. The barrel can be calibrated in degrees or directly with the pitch of the coil. The bender can be made entirely on a 3 1/2 in. lathe such as a Myford ML7, using the following accessories:

- 2 x 2 x 3/8 in. angle plate, machined with parallel and square faces and edges
- Vertical slide
- Dividing head
- Dividing head spindle adapter, 1/2 in. x 26 tpi with draw bar - see appendix.
- 12 in. x 1/2 in. to 1 in. dia. PGMS bar, accurately centred at each end.
- A revolving steady will be useful.
- Holding and clamping bolts, and tee nuts.
- 1/2 in. x 26 tpi nut, made by drilling and tapping a 3/8 in. nut.

1. Tube Anchor Assembly:

Anchor Block:

1.1. Cut the anchor block from a steel bar and mill to 1/2 x 3/4 x 1 5/16 in. (**Figure 4**).

1.2. Mount on either the vertical slide or four-jaw chuck, and drill the guide hole 1/4 in. dia..

1.3. Drill and counterbore the hole for the mounting bolt. Ensure that the counterbore is deep enough so that the head of the cap screw will be clear of the guide hole.

1.4. Mount the anchor on a thick washer on the angle plate using a single 0BA capscrew through the guide hole. The

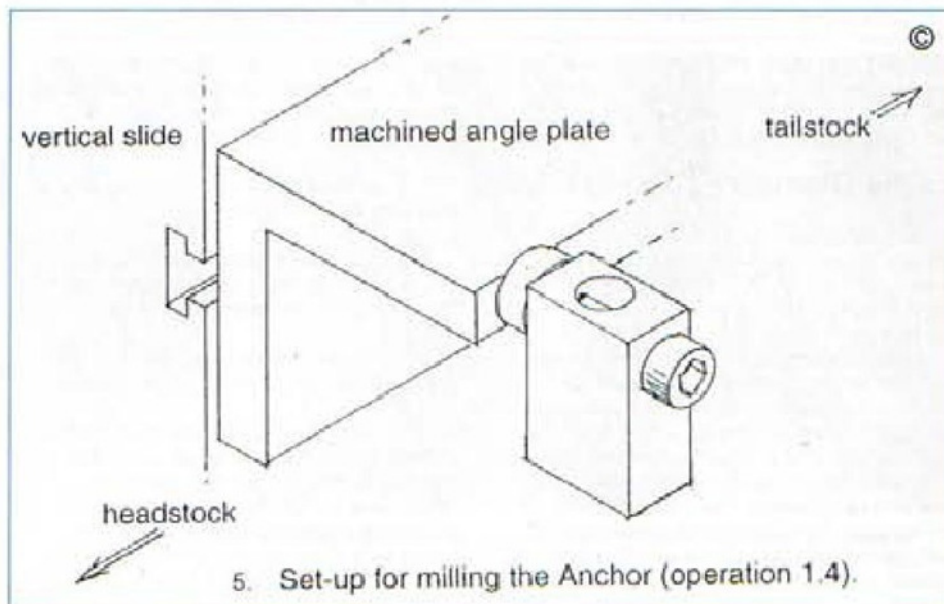
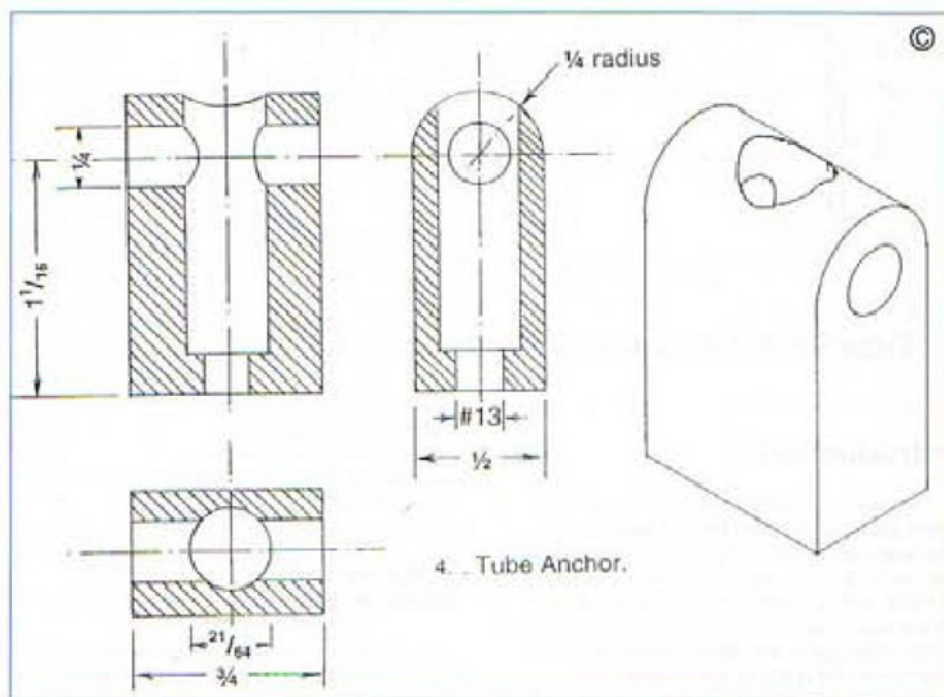
(tapped) hole used needs to be in the edge of the angle plate as shown in **Figure 5**, so as to prevent the cutter striking the plate.

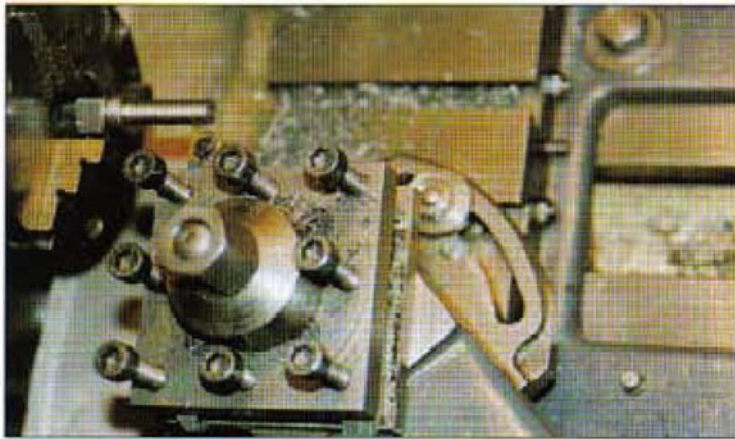
1.5. Set up the end mill flush with the face of the anchor and lock the carriage and vertical slide.

1.6. Rotate the anchor through 5 deg. and commence milling the radius. **Warning:** Before commencing to mill, check carefully that the rotation of the cutter will be such that it will tend to tighten the holding cap screw. If the job loosens it may rotate into the cutter with disastrous consequences. Take only very light cuts. Exercise extra care if there is excessive back play in the cross slide.

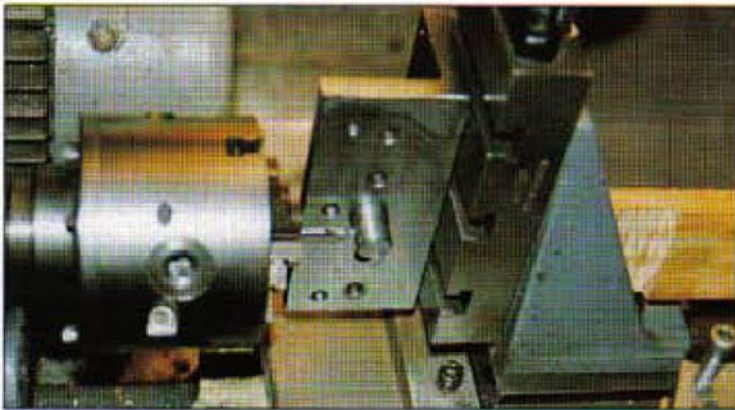
1.7 Repeat operation 1.6 until the anchor has traversed 180 deg.

1.8 Complete the radius by filing.

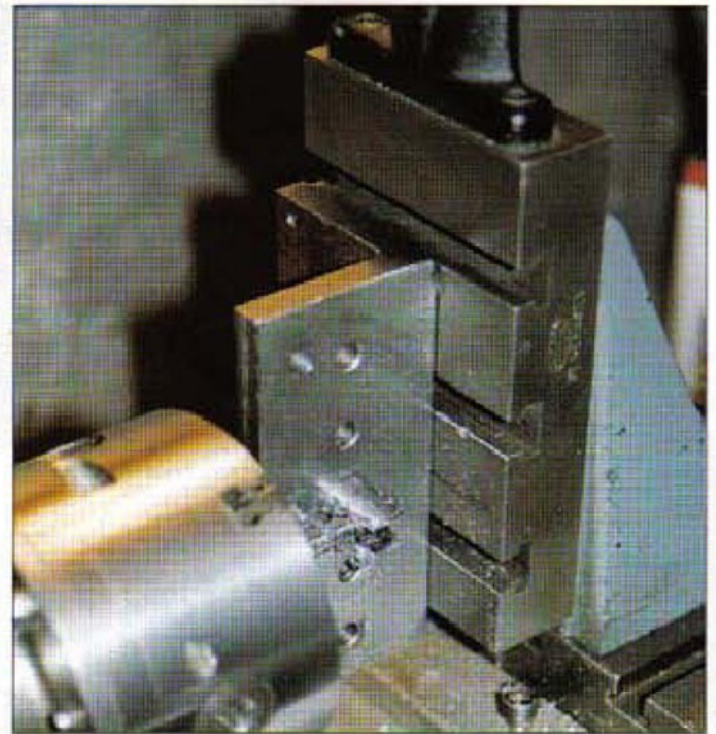




3. Cutting the OBA shoulder on the anchor bolt using a 1/2in. x 26 tpi nut in the chuck (operation 1.12)



4. Drilling the reference hole for the slot in the anchor bolt (operations 1.15 to 1.17)



5. Completing the milling of the slot in the anchor bolt (operation 1.8)

Anchor Bolt:

1.9. Make the anchor bolt from 5/8in. round bar.

1.10. Face off, and cut to 1.625in. overall length. (Figure 6).

1.11. Cut the 1/2in. dia. shoulder 0.465 in. long, then screw cut it 26 tpi.

1.12. Fit a 1/2in. x 26 tpi nut in the headstock chuck and screw into it the part-made anchor. Ensure that the assembly runs true (Photo. 3).

1.13. Cut a 1/4in. dia. shoulder 1in. long, then screw cut OBA for a length of 3/8in. (Note dia. of OBA= 0.236 in.).

1.14. Fit the vertical slide perpendicular

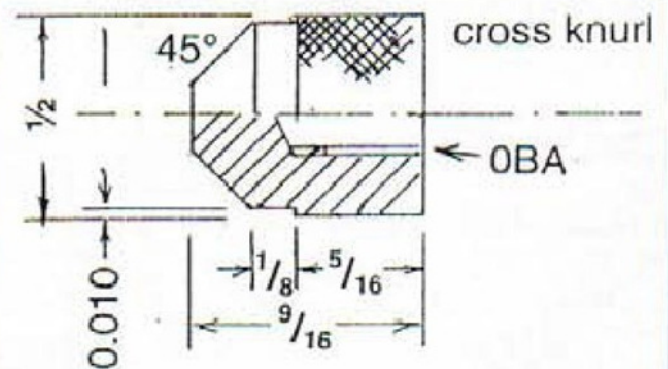
to the lathe axis and fit the angle plate vertically.

1.15. Using a nut and suitable spacer, mount the anchor bolt on the angle plate, as shown in Photo. 4.

1.16. Centre the bolt at the lathe centre height and lock the vertical slide.

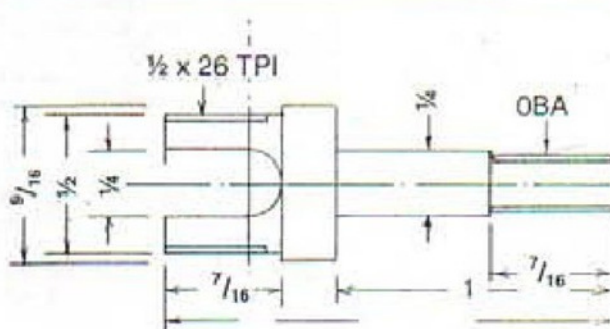
1.17. Drill through the bolt 1/8 in. from the edge of the shoulder and open out to 1.4in. dia.

1.18. Set up and mill the slot as shown in Photo. 5.

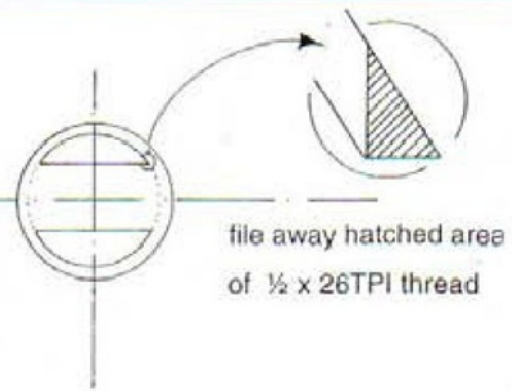


7. Clamp Nut.

1.19. File flat the sharp ends to the threads at the edges of the slot and remove all burrs from the individual threads with a fish-back needle file. (Figure 7).



6. Anchor Bolt.



file away hatched area of 1/2 x 26TPI thread



6. Turning the outer diameter of the clamp nut, held on the Dividing Head Adapter (operations 1.22 and 1.23)



7. Straddle Knurling the clamp nut (operation 1.23)

Clamp Nut:

In the prototype, both the clamp nut and the anchor nut were made in brass, as shown in the photographs, only because brass was more readily available than steel.

1.20. Face and centre a $7/8$ in. length of $3/4$ in. dia. brass bar.

1.21. Drill a pilot hole 0.600in. deep and open out to $29/64$ in. dia.. Tap the hole $1/2$ in. x 26 tpi.

1.22. Fit the Dividing Head Spindle Adapter in the lathe chuck and screw the clamp nut fully home. (Photo. 6).

1.23 Turn the diameters and chamfer as in Figure 8 and straddle knurl the raised portion. (Photo. 7).

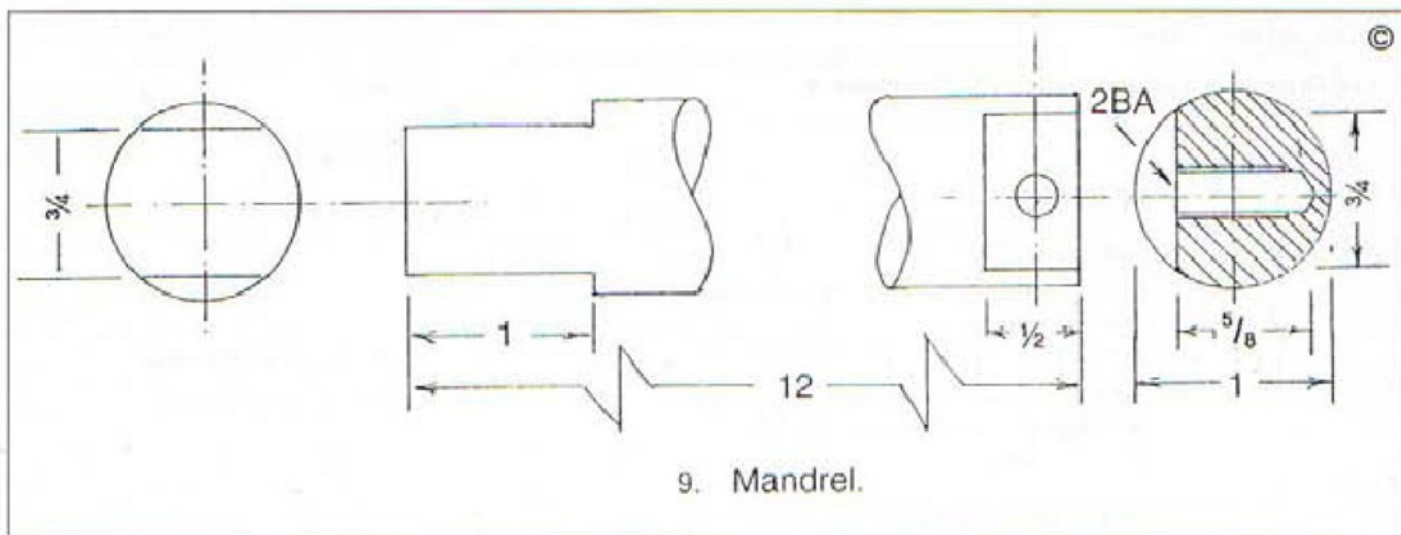
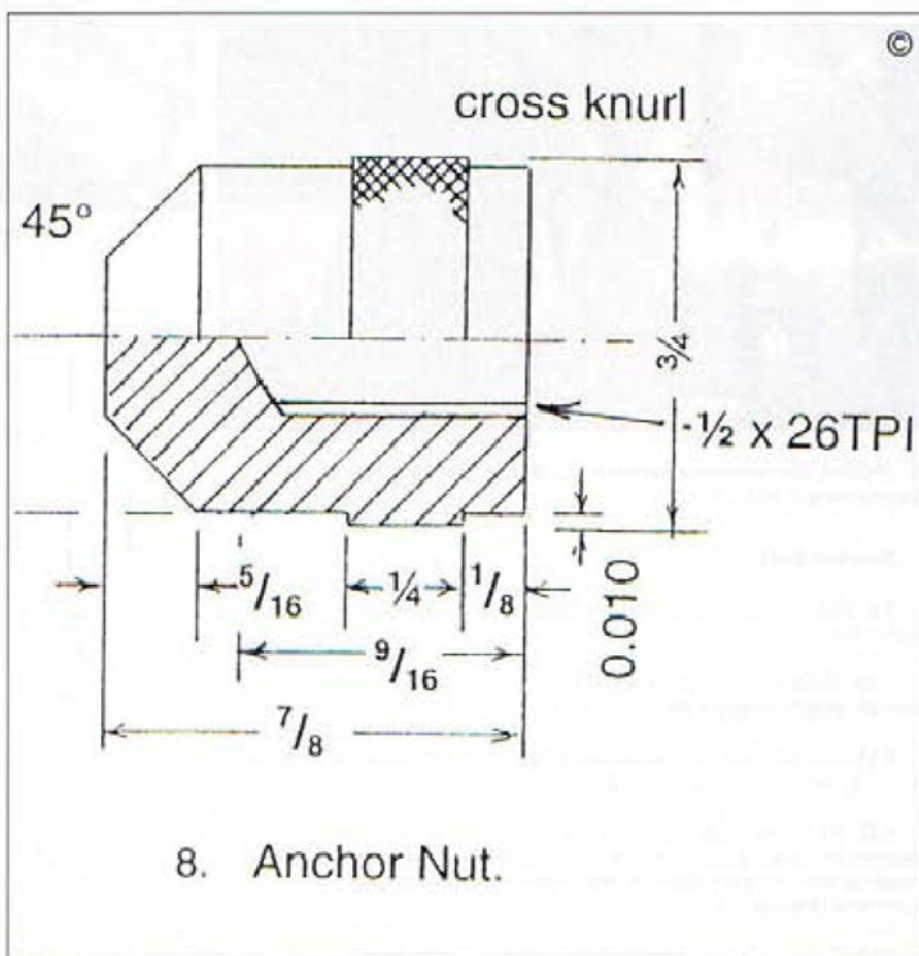
1.24. Face off to give a length of 0.80 - 0.85in.

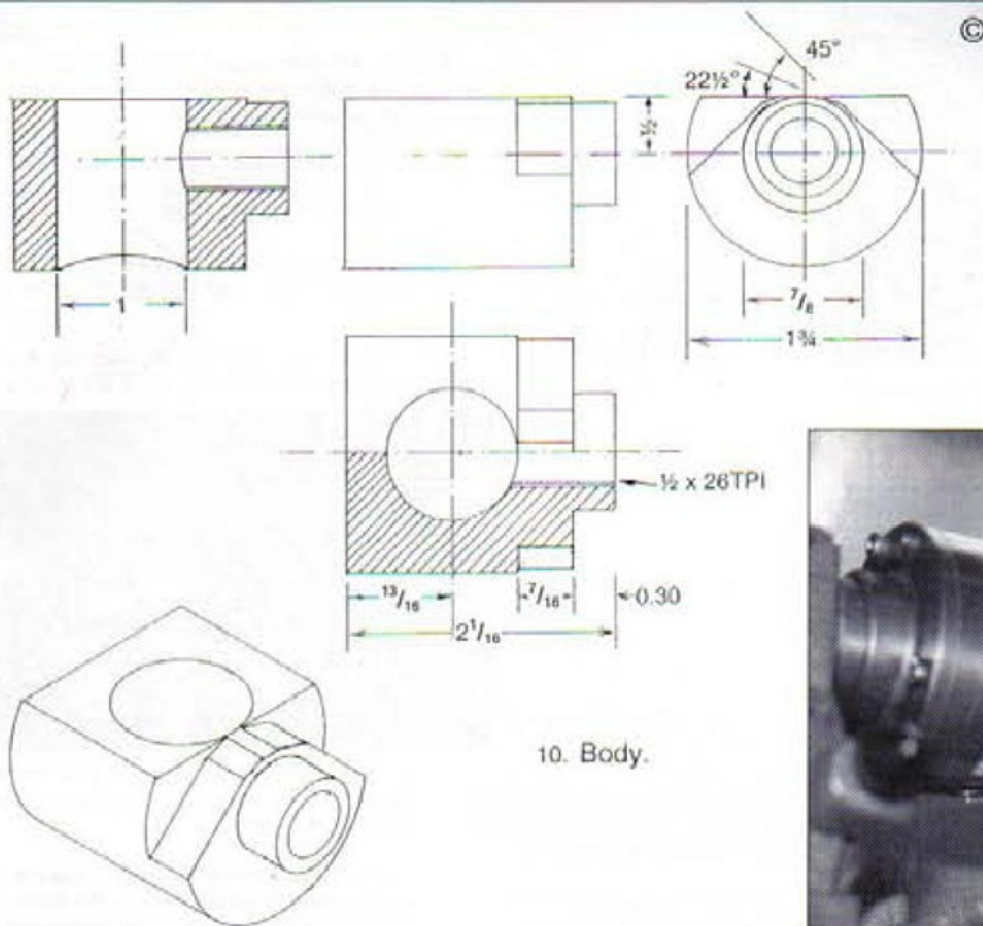
Anchor Nut:

1.25. Use $1/2$ in. dia. brass bar. Commence by drilling a hole (No. 6 drill) 0.375in. deep and tapping it 0BA.

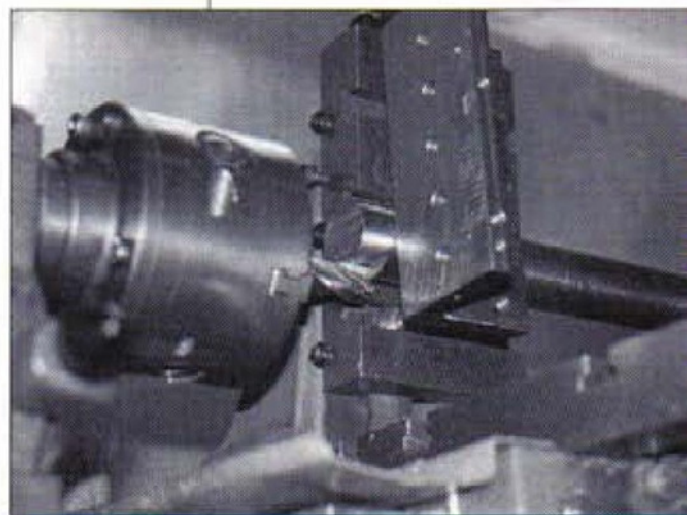
1.26. Turn the diameters as in Figure 9 and straddle knurl the raised portion.

1.27. Cut the chamfer, then part off.

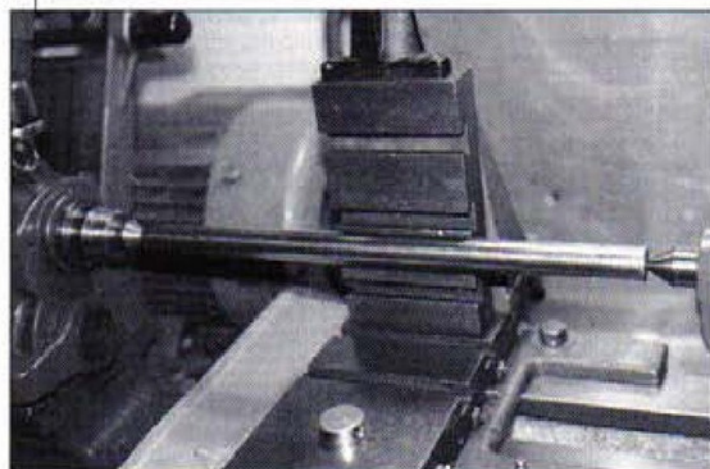




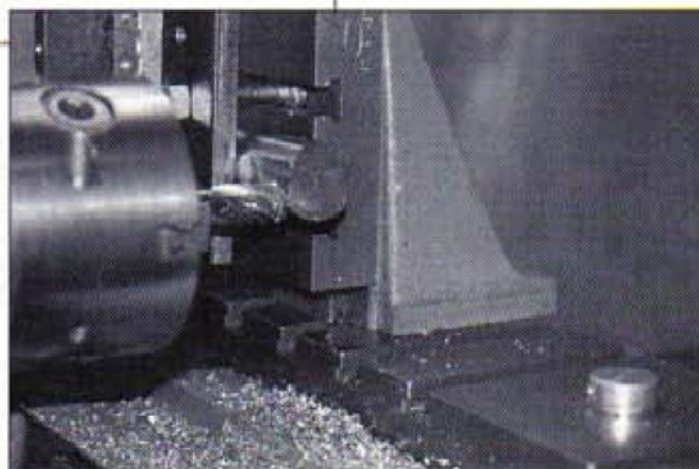
9. Milling the shoulder on the mandrel for the anchor block (operation 2.4)



10. Body.



8. Setting the vertical slide parallel to the lathe axis using the precision ground bar (operation 2.1)



10. Milling the spanner flats on the mandrel (operation 2.6)

Mandrel:

Use a 12in. length of 1in. dia. mild steel for the mandrel (**Figure 10**). Because of the size of the mandrel and the fact that milling is required at both ends, it is easier to face both ends by end milling, holding the mandrel in the vertical slide.

2.1. Fit the vertical slide parallel with the lathe axis using a 12in. length of accurately centred $\frac{3}{4}$ to 1in. round precision ground bar held between centres. (**Photo. 8**).

2.2. Mount the mandrel horizontally on the slide then end-mill both ends.

2.3. Mill a shoulder $\frac{1}{2}$ in. wide and $\frac{3}{4}$ in. across in one end of the mandrel. Make

frequent checks to ensure that the anchor block is a good fit on the shoulder. (**Photo. 9**).

2.4. Reset the vertical slide perpendicular to the lathe axis using the faceplate as a guide.

2.5. Clamp the anchor block to the mandrel and drill into the mandrel through the counterbored hole in the anchor, tapping 2BA.

2.6. Reclamp the mandrel on the slide, parallel with the boring table. At the other end of the mandrel, mill a pair of spanner flats, about 1in. wide and $\frac{3}{4}$ in. apart. (**Photo. 10**).

3. Body:

3.1. Use a 2 $\frac{1}{4}$ in. length of 1 $\frac{3}{4}$ in. dia. mild steel bar to make the body. Face one end. (**Figure 11**).

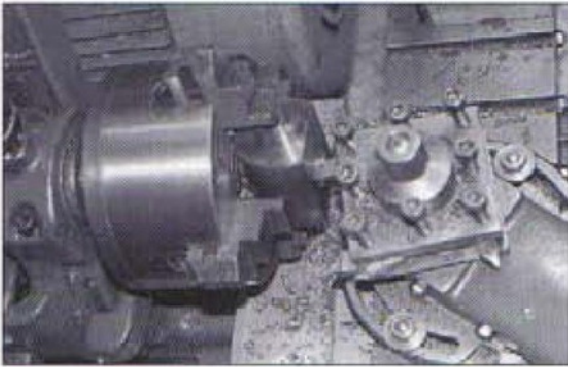
3.2. Drill into the body to a depth of about 1in. Gradually open out to $\frac{29}{64}$ in. dia. and countersink to about $\frac{1}{16}$ in.

3.3. Tap the hole $\frac{1}{2}$ in. x 26 tpi.

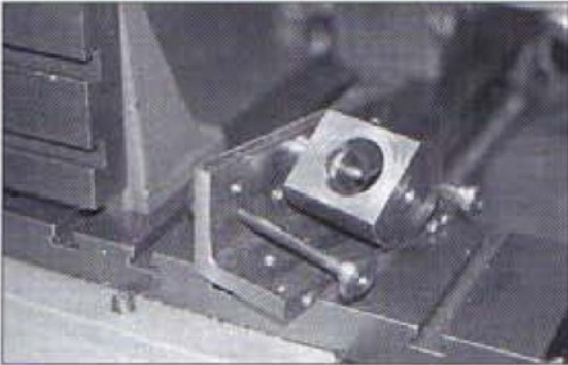
3.4. Turn the shoulder $\frac{7}{8}$ in. dia., 0.300in. deep.

3.5. Face the other end.

3.6. Mount the body sideways in the



11. Boring the mandrel hole in the body (operation 3.8)



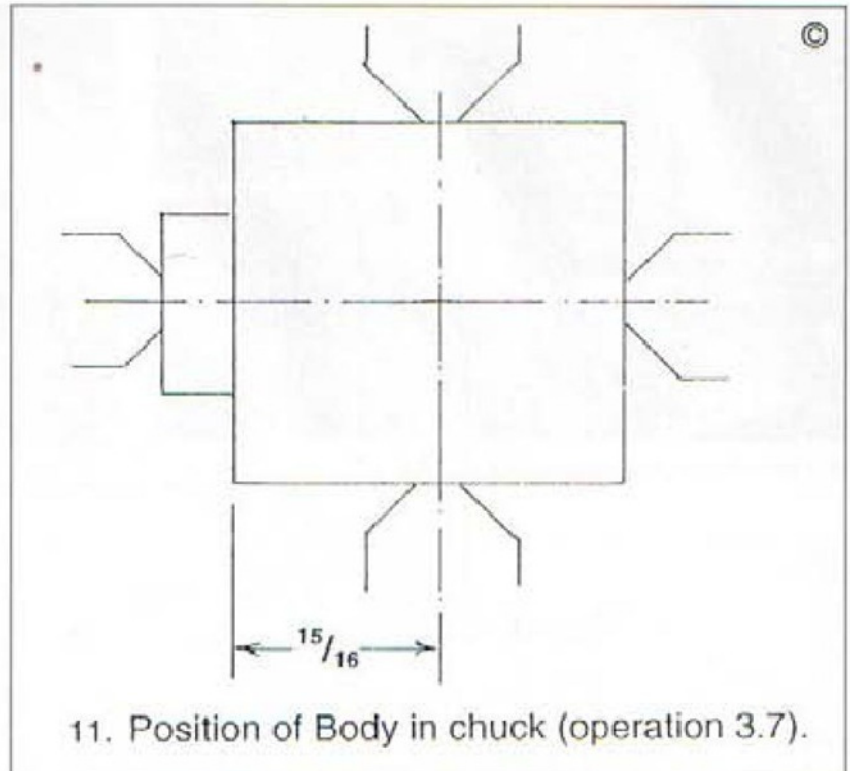
12. Method used for securing the body to the angle plate using a tee nut (operation 3.9)



13. Method of setting the body at 45 deg. to the angle plate (operation 3.10)



14. Milling the 45 deg. clearance flat on the body (operation 3.11). The packing piece under the body is the shell of a discarded bearing



four jaw chuck and centre it about its diameter, $\frac{7}{16}$ in. from the base of the shoulder. (Figure 11).

3.7. Face the body until $\frac{3}{8}$ in. has been removed from the diameter. This face should be $\frac{1}{2}$ in. from the centre of the body, and (theoretically) will be 1.436in. wide.

3.8. Drill through the body and bore out to give a good sliding fit to the mandrel (Photo. 11). Take care not to bore into the chuck. It will not be possible to complete the boring of the hole if the work has been set into the jaw slots of the chuck. Complete the job by filing.

3.9. Bolt the body to the angle plate as shown in Photo. 12, using a tee nut inside the 1in. hole, dropped over the $\frac{1}{2}$ in. hole. Fasten only finger tight. The hole in the angle plate needs to be near the centre of the length of the plate and $\frac{3}{8}$ in. from the edge.

3.10. Clamp a mitre square to the boring table and, using suitable temporary packing, set the angle of the body (now held on the angle plate) to 45 deg. to the boring table. (Photo. 13).

3.11. Fit a $\frac{1}{2}$ in. end mill in the headstock chuck and measure the clearance height (dimension 'BB' in Figure 12) from the underside of the cutter to the boring table surface. On the body, measure the distance from the edge of the shoulder to the edge of the mandrel hole. Calculate the packing needed to raise the body so as to cut the side of the 45 deg.

relief shoulder tangential to the 1in. mandrel hole. (Photo. 14.)

3.12. Mount the body on the packing and adjust to perpendicular to the lathe axis. Tighten the clamping bolts and mill the flat to within $\frac{1}{16}$ in. of the shoulder. (Photo. 14). Lock the carriage during each milling operation.

3.13. Repeat operations 3.10 to 3.12 on the other side of the body.

3.14. Slacken the bolts and rotate the body through about $22\frac{1}{2}$ deg. and mill a small flat between a 45 deg. flat and the vestige of the central flat.

3.15. Rotate the job through 45 deg. (by eye) and repeat operation 3.14 to cut the second small ($22\frac{1}{2}$ deg.) flat.

4. Wheel:

4.1. Use a 2 $\frac{1}{4}$ in. length of 1 $\frac{3}{4}$ in. dia. mild steel bar to make the wheel. Face both ends.

4.2. Cut the groove into the wheel according to Figure 13. On the prototype, the sides were cut using a parting tool and the curved section started with a bull-nose tool. Finish the groove using a round file. Check the profile regularly with a length of $\frac{1}{4}$ in. tube.

4.3. Drill at least $\frac{3}{4}$ in. deep and open out to $\frac{1}{2}$ in. dia.. Leave some of the pilot hole intact for future drilling (operation 5.1).

4.4. Part off and put aside. Leave the material in the chuck in readiness to make the barrel...

4.5. ...After completing the barrel, face to give a final thickness of $\frac{3}{8}$ in. and counterbore one face to a depth of $\frac{3}{32}$ in. and $\frac{7}{8}$ in. dia.

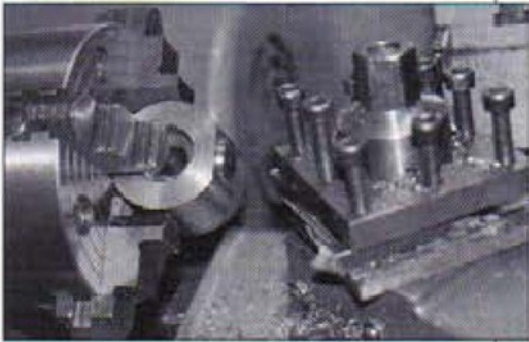
5. Barrel:

5.1. (Continuing from operation 4.4...) Drill through the workpiece and open out to $\frac{1}{2}$ in. dia. Face off.

5.2. Counterbore to 0.320 in. deep by $\frac{7}{8}$ in. dia. to be a good fit over the shoulder of the body cut in operation 3.4.

5.3. Face the opposite end and cut a shoulder 1in. dia. by $\frac{1}{8}$ in. wide. (Figure 15).

5.4. Remove the barrel from the chuck and fit on the body. Centre-punch a point



15. Turning the stub axle on the barrel (operation 5.6)

on the barrel $\frac{7}{8}$ in. from the edge of the 1in. bored hole in the body. This point will be the centre of the stub axle.

5.5. Mount the barrel in the four jaw chuck, centring the job on the punch mark made in the previous operation.

5.6. Turn the stub axle on the barrel, $\frac{3}{8}$ in. long at its centre and $\frac{1}{2}$ in. dia. Face the axle to give a length of $\frac{5}{16}$ in., so that the wheel is a good fit and also the face will be at the same height as the face on the body when the two pieces are brought together. Use the (1in.) dia. of the shoulder as a guide (Photo. 15). The length of the stub axle ($\frac{5}{16}$ in.) will give a side clearance to the wheel of $\frac{1}{32}$ in.

5.7. Drill into the stub axle $\frac{3}{8}$ in. deep and tap 2BA. Care: the hole will be very close to the counterbore (operation 5.2).

6. Wheel Retainer:

6.1. Commence by facing a $\frac{5}{8}$ in. length of 1in. steel bar and drill (No. 13) through 2BA clear. (Figure 14).

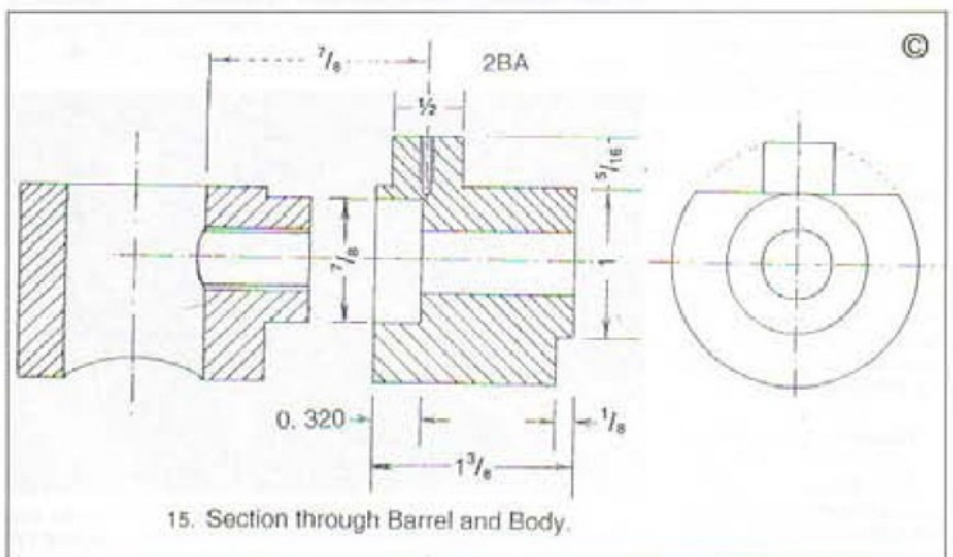
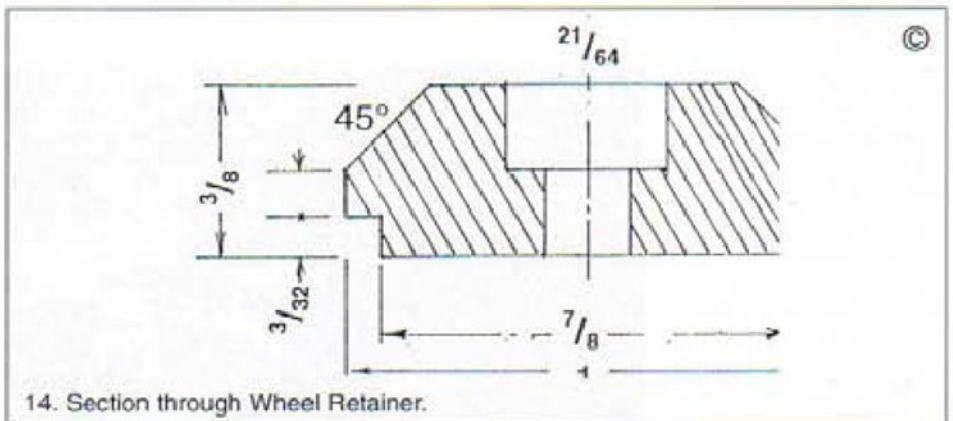
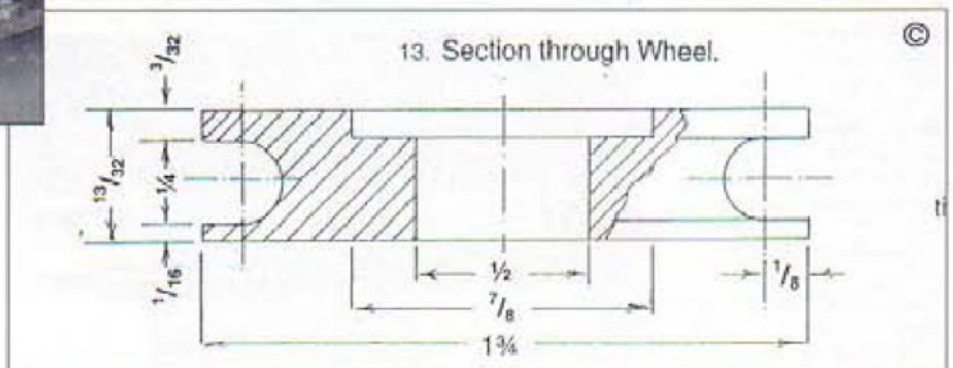
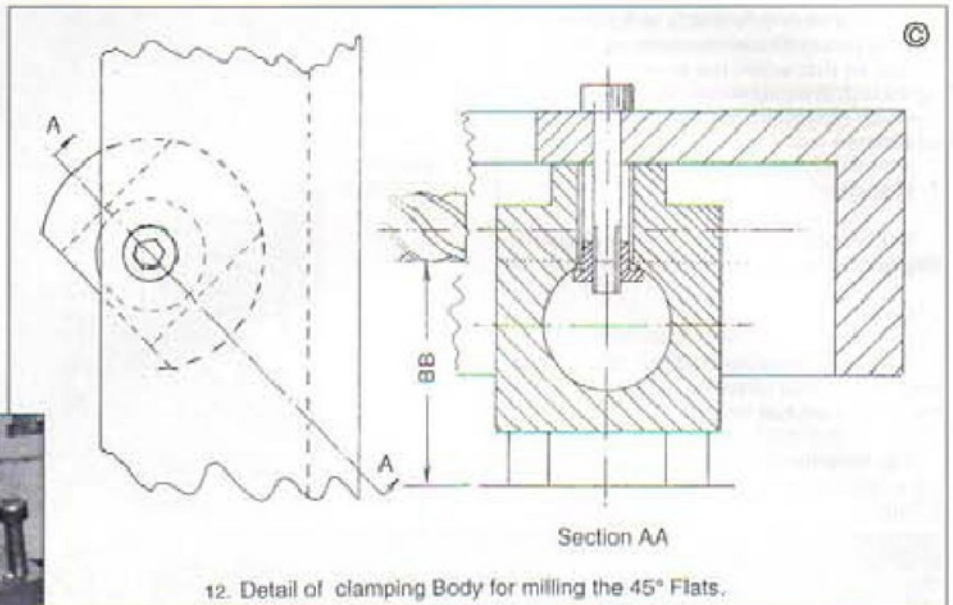
6.2. Turn a $\frac{7}{8}$ in. dia. shoulder, $\frac{3}{32}$ in. wide. Check by fitting the wheel counterbore over the shoulder, together with the barrel. The wheel should freely rotate with minimal slackness and about $\frac{1}{32}$ side play.

6.3. Reverse the job in the chuck, gripping the shoulder.

6.4. Face to give an overall thickness of $\frac{1}{2}$ in.

6.5. Counterbore the hole for the 2BA capscREW.

6.6. Cut a chamfer at 45 deg. on the face.



6.7. The stub axle needs to be very slightly proud of the counterbore of the wheel, so that when the support is fully tightened, the wheel will be free to rotate, but with the minimum of side play or wobble.

7. Handle:

The handle is made from four pieces (Figure 16 and Photo. 16):

Core:

7.1. Cut a shoulder 0.236 in. dia. x $\frac{7}{8}$ in. long at one end of an 8 in. length of $\frac{1}{2}$ in. dia. mild steel bar, and thread it 0BA.

7.2. Face the other end of the bar and cut a $\frac{1}{2}$ in. x 26 tpi thread for a length of $2\frac{1}{2}$ in.

Grip:

7.3. Cut a piece of $\frac{1}{2}$ in. (nominal) bore PVC or ABS water pipe. Face and lightly countersink each end to give a final length of $5\frac{1}{2}$ in. The easiest way to face such material is to use a revolving steady (Photo. 17). This will avoid scuff marks caused by the shoes of conventional steadies.

Handle End:

7.4. Make the handle end from aluminium, 1 in. dia. x $1\frac{1}{2}$ in. long.

7.5. Turn the shoulder for a length of $\frac{3}{4}$ in. This should be a good, tight fit in the plastic pipe.

7.6. Drill and tap 0BA x $\frac{3}{4}$ in. deep into the shoulder.

7.7. Countersink the hole.

7.8. Reverse in the chuck and face and centre the work.

Nut:

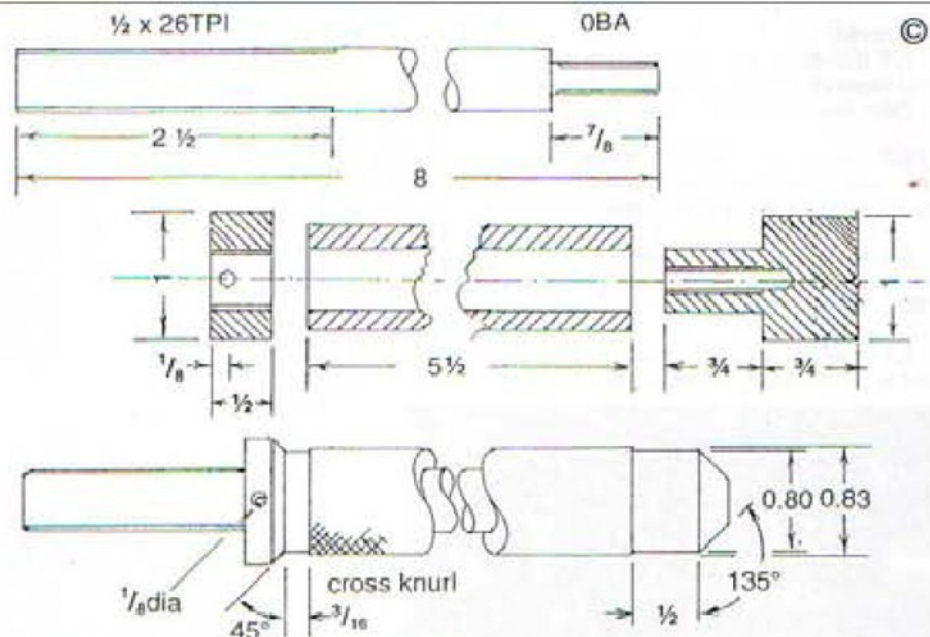
7.9. Face both ends of a 1 in. length of 1 in. dia. bar, and drill through, opening out the hole in stages to $\frac{29}{64}$ in. Tap the hole $\frac{1}{2}$ in. x 26 tpi.

7.10. Take a light cut over as much of the bar as possible.

7.11. Transfer the work and chuck to the dividing head and drill a $\frac{1}{8}$ in. dia. hole for the roll pin, through a diameter of the nut (Photo. 18).

Handle - Completion:

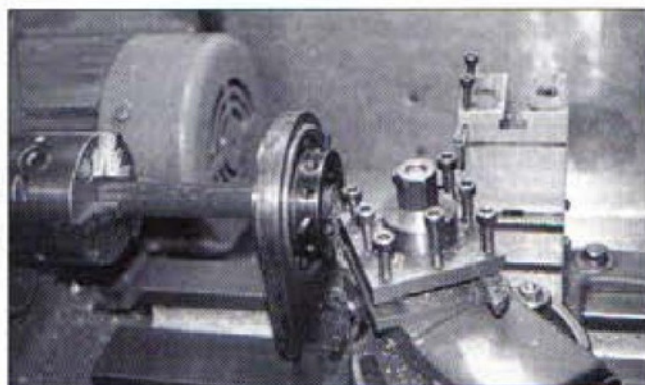
7.12. Roughen all of the unmachined length of the handle core with a coarse



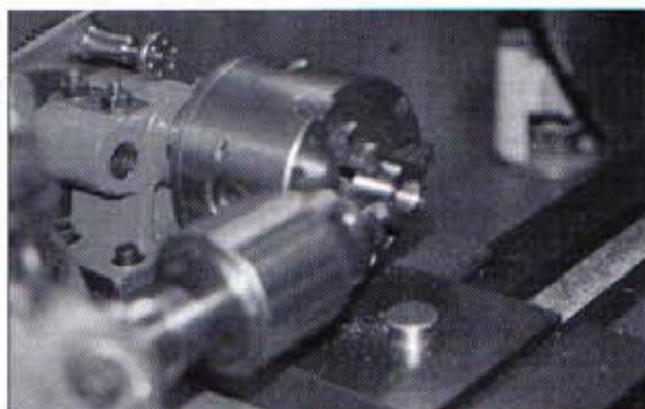
16. Handle: Components prior to assembly, and after completion.



16. The four parts of the handle



17. Facing the plastic pipe for the handle grip using a revolving steady (operation 6.3)



18. Drilling the roll pin hole in the handle nut (operation 6.11)

file. Check that all pieces of the handle will fit, but don't tighten. Disassemble and degrease.

7.13. Smear the 0BA thread with 'Loctite' or similar. Screw the handle end on to the handle core and tighten with a pipe wrench and vice. At this stage, any scarring or bruising of the core or the end is immaterial, and indeed, the rougher and rustier the core is, the better, but do protect the $\frac{1}{2}$ in. thread!

7.14. Smear liberally PVC pipe welding cement over the unmachined part of the core with and 'screw' the pipe along the core to the shoulder of the end, where excess cement will have accumulated. Smear cement over the shoulder of the nut.

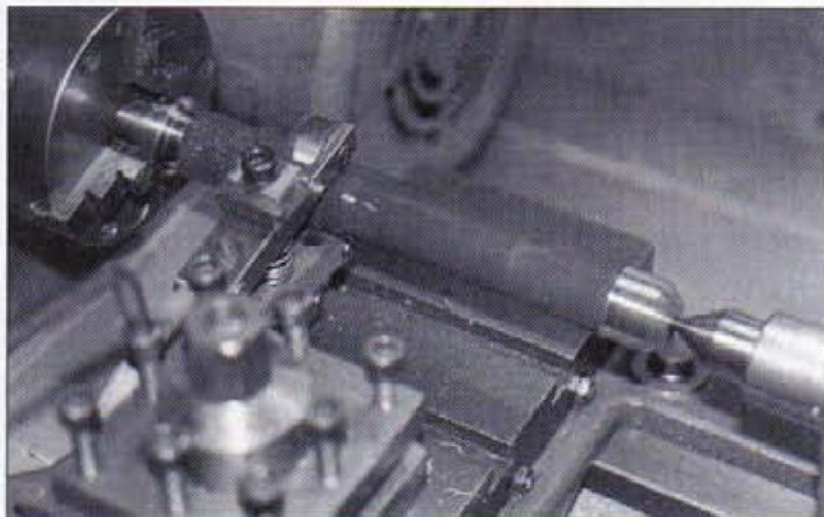
7.14. Smear the last $\frac{1}{2}$ in. of the exposed ($\frac{1}{2}$ x 26 tpi) thread of the core with 'Loctite' or similar. Fit and tighten the nut against the handle end.

7.16. Mount the nut in the four jaw chuck and support the other end with the tailstock centre.

7.17 Turn down the handle end and the nut until their diameters are slightly less than that of the pipe.

7.18. Take a very light skim at slow speed and fine feed with a very sharp tool along the entire length of the plastics pipe.

7.19. Cut a cross knurl using a straddle knurling tool over the full length of the pipe. Use a fine feed and the fastest of the back-geared speeds (about 150rpm). Exercise care when applying load to the knurling tool: PVC is considerably softer than steel, and hence it is easy to exert too great a load on the knurl wheels. Much heat is produced when knurling, and excess force will drive the wheels into the melting plastic, causing it to 'snow-plough' up in front. Use plenty of coolant. (Photo. 19).



7.20. Complete machining the handle by cutting the chamfers on the nut and handle end.

7.21. Ensure the handle assembly has not loosened, and tighten if necessary. Drill $\frac{1}{8}$ in. into the tommy bar hole, completely through the core and nut. Drive a $\frac{1}{8}$ in. roll pin into the hole.

8. Graduation of the barrel and body:

On the prototype, two sets of graduations were made: -45 deg. - 0 - +45 deg. (helix angle) and -4in. - 0 - +4in. (pitch).

8.1. Set up the dividing head on the cross-slide and fit a dividing plate with a 60-hole circle. The accuracy required does not indicate the use of the micro device.

8.2. Fit an engraving tool in a suitable carrier mounted in both the headstock chuck and the tailstock (drill) chuck. Lock the headstock and the tailstock. **Photo. 20** shows the set-up. Ideally the tool should be able to engrave lines 0.002 in. wide and 0.004 in. deep (Ref. 1).

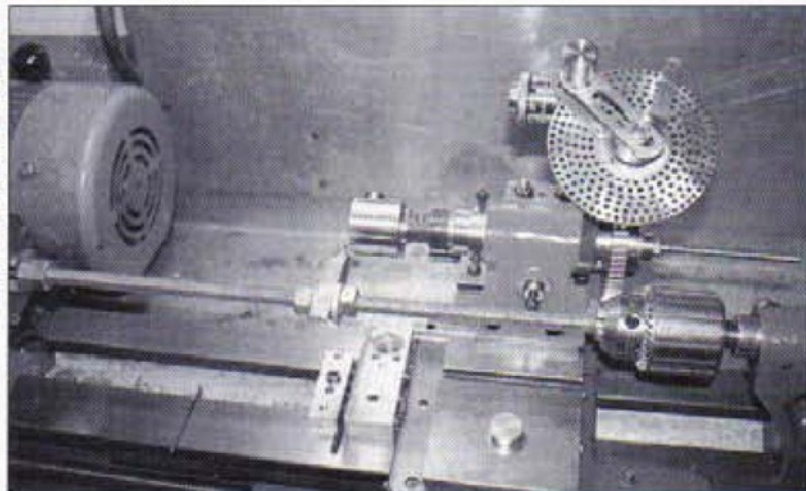
8.3. Replace the handle of the tube bender with the Dividing Head Spindle Adapter, and tighten to finger-tightness.

8.4. Set the body and barrel to zero helix angle by fitting a length of $\frac{1}{4}$ in. round bar or tube in the anchor bolt slot and through the hole formed by the wheel and the mandrel. Adjust the position of the body so that the angle between the mandrel and the tube is 90 deg.. Tighten the Dividing Head Spindle Adapter to lock the relative positions of the body and barrel.

8.5. Fit the Dividing Head Spindle Adapter (now carrying the body and barrel) into the hollow mandrel of the dividing head and tighten the draw bar. Centralise the adapter using the grub screws.

8.6. Rotate the assembly until the edge of the 45 deg. flat on the body comes into line with the scribing tool, and stop when the graduating tool is about $\frac{1}{16}$ in. beyond the flat.

20.
Engraving the barrel.
Note the use of the carriage stop and drills to obtain consistent graduations (operation 8.3)



8.7. Engrave a line $\frac{1}{4}$ in. long on both the barrel and the body. This line will be the zero helix angle datum line. Use drills and a carriage stop to assist in engraving lines of the required lengths (Ref. 1.).

8.8. Remount the barrel on the adapter but without the body, using the $\frac{1}{2}$ in. x 26 tpi nut described in the accessory list. (**Photo. 20**). Realign the engraved zero line and the engraving tool.

8.9. Move the dividing head through 50 holes (=5 deg.) and engrave a line $\frac{3}{32}$ in. long on the barrel.

8.10. Move the dividing head a further 50 holes and engrave a line $\frac{5}{32}$ in. long on the barrel.

8.11. Repeat operations 8.9 and 8.10 until ten lines have been engraved, i.e. alternating their lengths between $\frac{3}{32}$ and $\frac{5}{32}$ in.

8.12. Advance the dividing head through 270 deg. and repeat operations 8.9 and 8.10 until a further nine lines have been engraved, bringing the engraving tool up to 5 deg. short of the zero helix angle line.

8.13. The graduations of the pitch scale follow a tangent relationship, as shown in Table 1.

8.14. Measure the distance between the graduation nearest the flat on the barrel

and transfer it to the opposite side using a pencil or very fine spirit marker.

8.15. Rotate the dividing head until the tool lines up with the pencil mark and engrave a line $\frac{1}{4}$ in. long on the barrel. This line will represent the 4in. pitch line, the last one in Table 1.

8.16. Advance the dividing head by 18 holes, and engrave a line $\frac{3}{32}$ in. long ($3\frac{3}{4}$ in. pitch line).

8.17. Continue up the table, advancing by the number of holes shown. Use $\frac{1}{4}$ in. lines for the whole inches; $\frac{5}{32}$ in. for the halves, and $\frac{3}{32}$ in. for the quarters. For the zero pitch line engrave a $\frac{1}{4}$ in. line on both the barrel and the body. Engrave this line on the body later.

8.18. Continue the engraving, starting at the top of the table working downwards. The end result should be a scale which is compressed at the ends and expanded in the middle, with the centre line somewhere just below the 45 deg. flat on the body.

Using the Small Diameter Bender:

1. Decide either the pitch or the helix angle and the handedness of the coil to be made. Adjust the barrel and body accordingly and tighten the handle. Fit the anchor bolt in the correct way for the handedness of the coil. Replace the anchor nut but leave it loose.

2. Grip the mandrel in the vice using the spanner flats, and remove the clamp nut.

3. Run a length of $\frac{1}{4}$ in. OD tube between the wheel and the mandrel and through the slot in the anchor bolt.

4. Replace the clamp nut, tighten both nuts, then wind the handle around the mandrel to form the coil.

Warning: There is no room for errors! Once the coil is formed, it is impossible to unbend it to any degree, and the formed coil prevents the body being wound backward up the mandrel. Further, stainless steel work-hardens very easily.

5. At the desired length, remove the clamp nut and slacken the handle right off

so as to free the wheel from the coiled tube.

6. Remove the body assembly from the mandrel and ease off the coil. It will be found that unlike in the case of the large diameter bender, very little residual 'spring' will be present in the coil.

Appendix

Dividing Head Adapter:

The dividing head used in this project was of the G H Thomas design, and the spindle adapter was made to fit this head (**Figure 17**). It is a simple turning job using a 6in. length of 1in. dia. mild steel bar. However, it is important that all diameters and the thread are coaxial. This is achieved by turning between centres (**Photo. 22**) as follows:

A.1. Face and centre both ends of the bar.

A.2. Transfer the work, still in the chuck, to the dividing head, and drill and tap the 0BA hole.

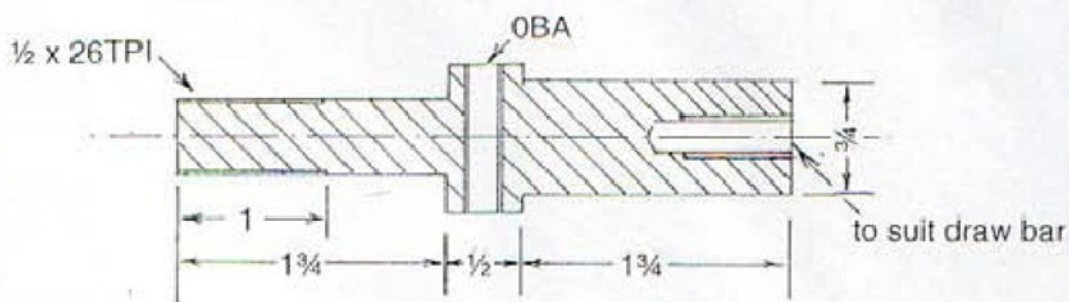
A.3. Fit a 60mm cap screw with locknut into the tapped hole and mount in the lathe between centres. Use a 80mm cap screw as a driver and wire the two screws together.

A.4. Turn the 0.750in. dia. shoulder to give a good sliding fit, with the very minimum of side play, in the dividing head mandrel.

A.5. Reverse the job between centres, cut the 1/2in. shoulder and cut the 26 tpi thread.

References

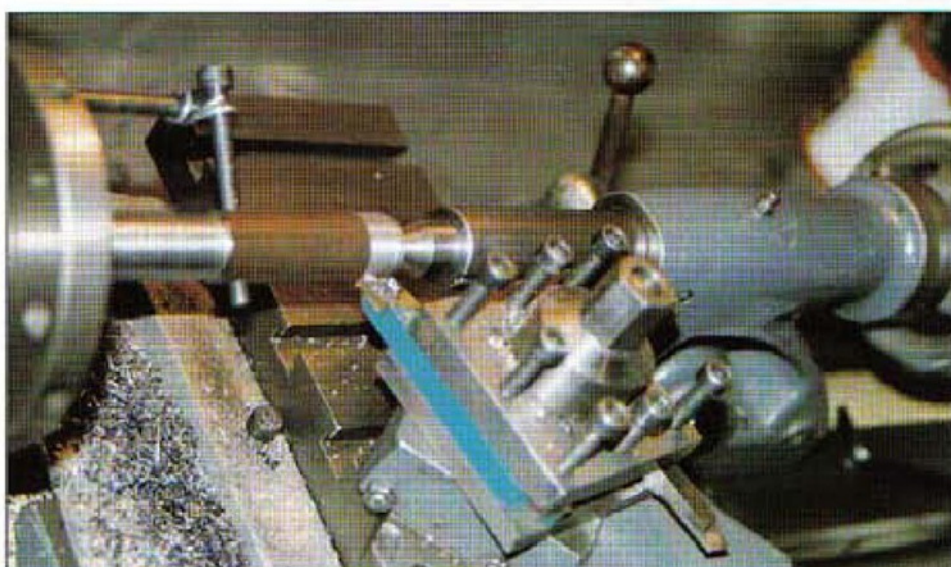
1. Dividing and Graduating - G. H. Thomas (TEE Publishing)



17. Dividing Head Adapter.

TABLE 1

Pitch inch	Helix angle deg.	Dividing head, 60 hole plate			
		Increments holes	from start		
			total holes	revs	holes
0.00	0.00	0	0	0	0
0.25	3.64	36	36	0	36
0.50	7.26	36	72	1	13
0.75	10.81	36	108	1	48
1.00	14.29	35	143	2	23
1.25	17.66	34	177	2	57
1.50	20.91	32	209	3	29
1.75	24.02	31	240	4	0
2.00	26.99	30	270	4	30
2.25	29.81	28	298	4	58
2.50	32.48	27	325	5	25
2.75	35.00	25	350	5	50
3.00	37.38	24	374	6	14
3.25	39.61	22	396	6	36
3.50	41.71	21	417	6	57
3.75	43.68	20	437	7	17
4.00	45.53	18	455	7	35



21 Turning the Dividing Head Adapter between centres. Note the cap screws used as the driver and carrier (operation A3)

QUICK TIPS

Lathe cover

Putting on a lathe cover and storing it when it's off is a bit of a bore. Fix a window blind which has a spring return above the lathe. To cover, just pull it out and fix to a knob on the apron. It retracts, neatly furled, out of the way.

John Gozzard

TURNING FOR Society Of Ornamental Turners PLEASURE

Wherever they are displayed, the items produced by the ornamental turning fraternity always evoke admiration and comment. This year, The Society of Ornamental Turners celebrate their 50th. anniversary and we were invited to join a gathering held at Baden-Powell House in West London to mark the occasion. For those unfamiliar with the science and art, their Treasurer, John Edwards, has put together these introductory notes and we add a few photographs of typical workpieces made by John and of some of the fascinating devices which he used to create them



1. This Pepper and Salt, typical examples of ornamental turning, are in African blackwood



2. Decorated boxes are also a favourite subject, this octagonal example also being in blackwood



4. Another tazza, this time in mopane

Plain turning is a process which produces a workpiece, a transverse section through any part of which comprises a plain circle. Ornamental or Complex turning is carried out on a lathe with attachments which convert that plain circular section into variants of outline. These range from a simple series of cuts taken at intervals around the work (so producing grooves or bumps on the surface), to non-circular movements whereby the whole of the circular shape is removed to give a completely different form. Such shapes are achieved by various methods, the principal ones being:-

Cutting with a fixed or revolving cutter while the work is rotated on a non-radial path, e.g. eccentrically, elliptically, epicyclically or following a path determined by a template or reciprocating device.

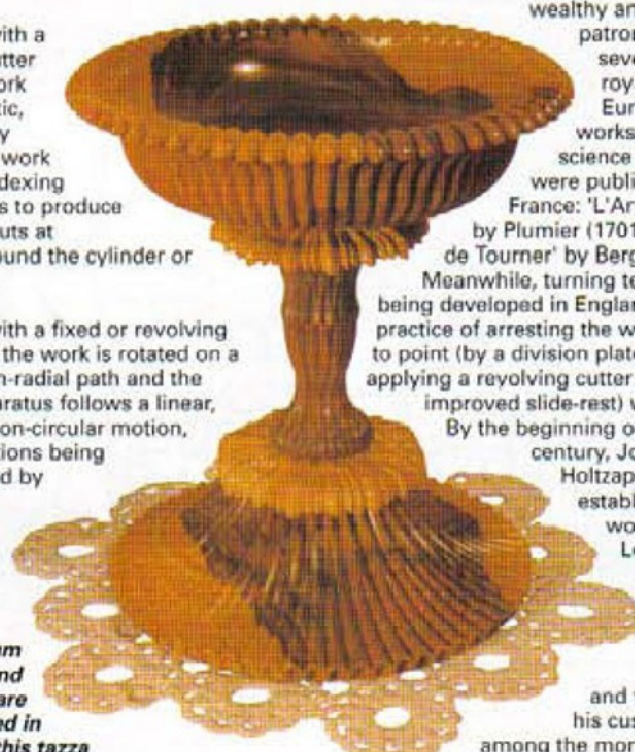
Cutting with a revolving cutter while the work remains static, then partially rotating the work (using an indexing device) so as to produce a series of cuts at intervals around the cylinder or surface.

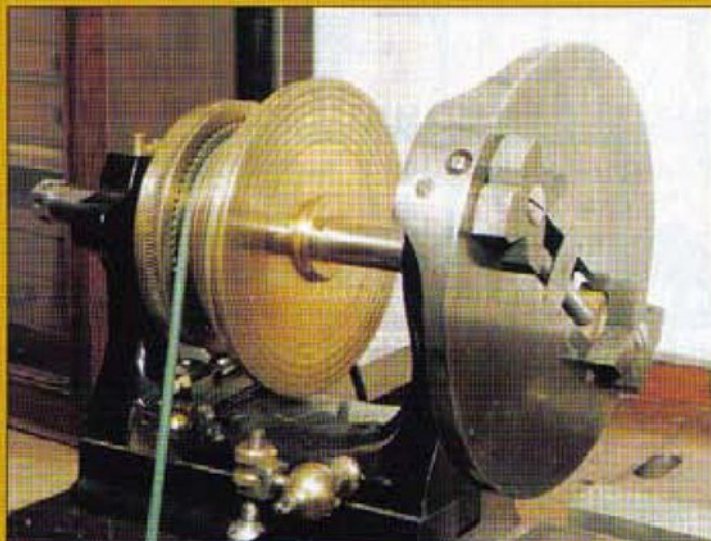
Cutting with a fixed or revolving cutter while the work is rotated on a radial or non-radial path and the cutting apparatus follows a linear, circular or non-circular motion, the two motions being synchronised by gearing.

Ornamental turning is believed to have originated in Bavaria early in the 15th. century when it consisted mostly of rose-work, being done by using a cam or template (called a rosette) mounted on the lathe spindle and allowing the headstock to rock under tension of a spring or weight, to follow the contour on the edge of the rosette. The spindle was also allowed to slide to and fro endwise under tension of another spring, to follow the contour on the face of the rosette. Thus, as the work was rotated, it rocked and traversed so that the cutting tool produced wavy lines upon the surface. Cutting tools were generally hand-held before the end of the 18th century, the slide-rest, although invented c. 1480, was not in general use until much later. It is clear from surviving examples of their work that the skill of the early turners was highly developed

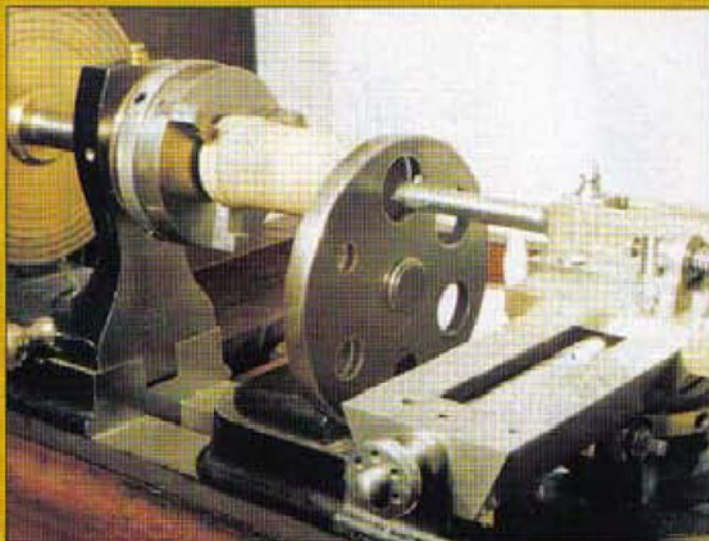
In response to growing interest by wealthy and great patrons, including several of the royal families of Europe, two great works on the art and science of turning were published in France: 'L'Art du Tourneur' by Plumier (1701) and 'Manual de Tournier' by Bergeron (1796). Meanwhile, turning technology was being developed in England where the practice of arresting the work from point to point (by a division plate) and applying a revolving cutter (held in an improved slide-rest) was employed. By the beginning of the 19th. century, John Jacob Holtzapffel had established his workshop in London and built a reputation as a maker of high-class lathes and tools. Many of his customers were among the monarchs and

3. Lignum Vitae and boxwood are combined in this tazza

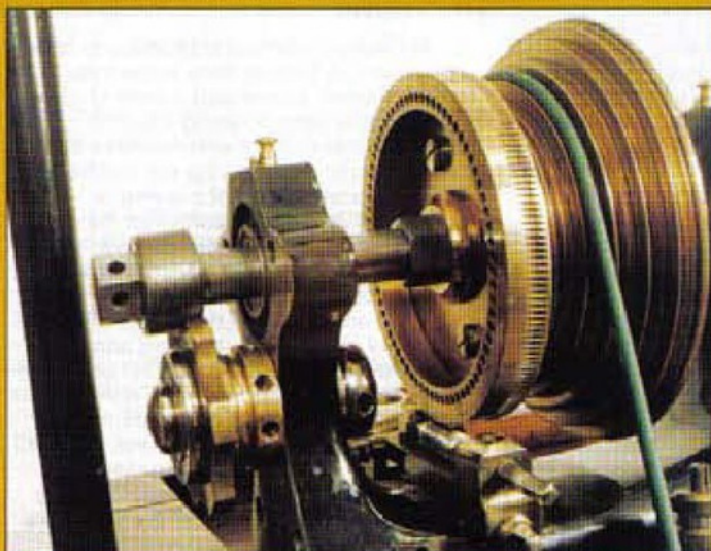




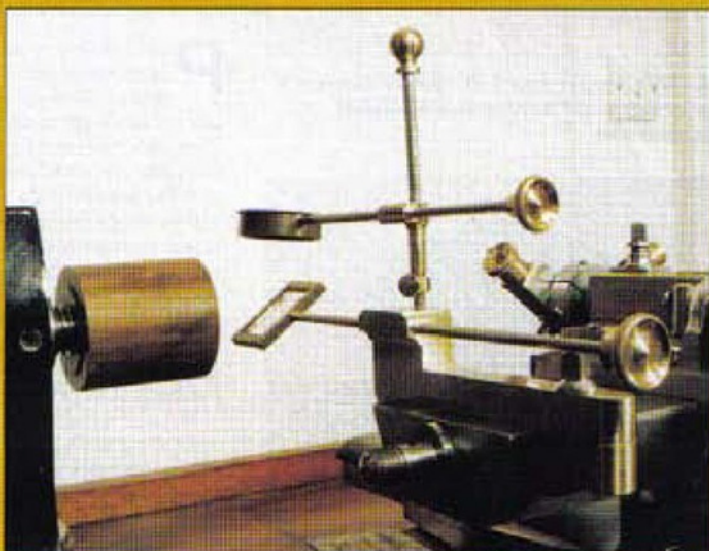
5. The headstock of John's 1892 Holtzapffel ornamental turning lathe equipped with a two jaw universal chuck.



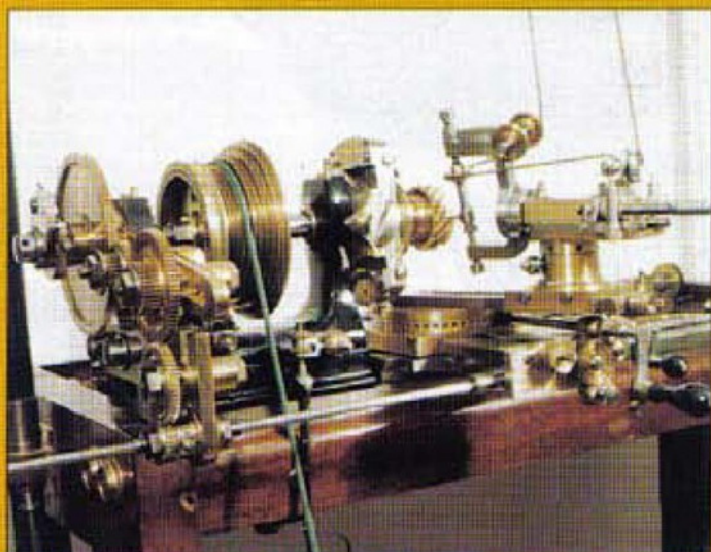
6. A form of fixed steady, known as a boring collar, is used when boring long cylinders



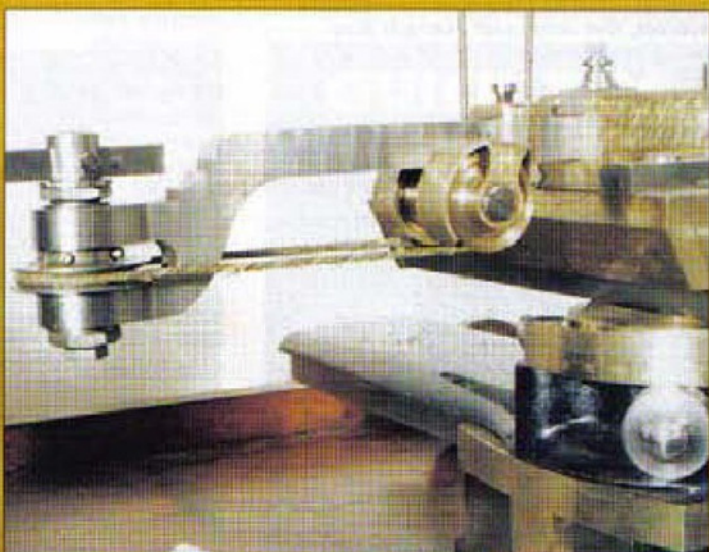
7. Another view of the Holtzapffel headstock showing how the traversing mandrel is actuated using a screw hob and star nut



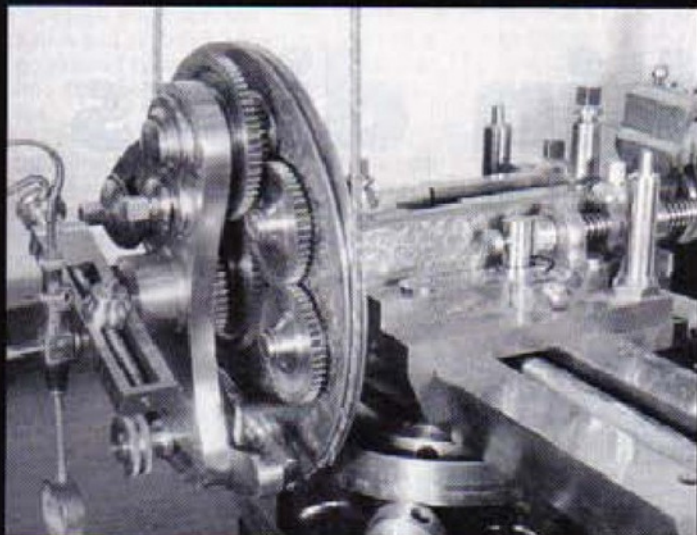
8. It is sometimes difficult to get a clear view of the working area. A mirror and a magnifier, strategically placed, can help a lot!



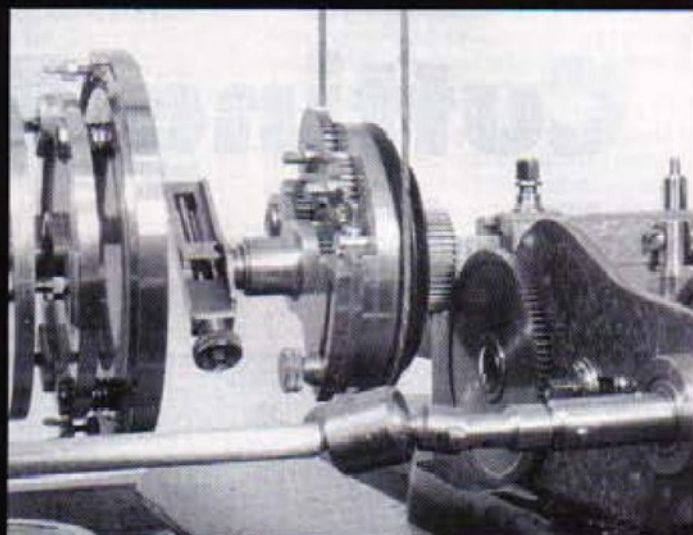
9. The spiral-spherical slide rest fitted with a Holtzapffel universal cutting frame which is set at the correct helix angle and geared to the headstock in order to cut a spiral



10. The ornamental turning slide rest equipped with a long internal cutting frame



11. This epicycloidal cutting frame, again on the ornamental turning slide rest is equipped with a diamond cutter. The pendulum bob weight maintains the cutting edge of the diamond at the correct attitude regardless of the motion of the frame



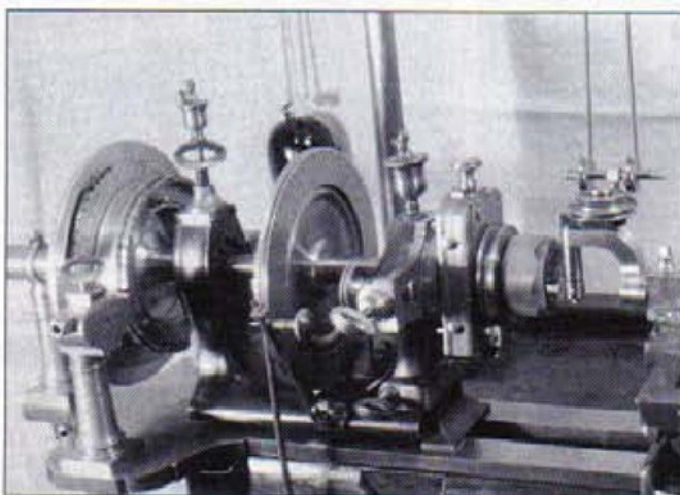
12. The rather complex chuck assembly, known as a Tympan chuck, has a sheet of paper attached to its face, and is used to verify the pattern being created by the ellipse cutting frame. The geared drive from the latter to the headstock is also evident

nobility of Europe. Other engineers copied or varied his designs and England became the world centre for ornamental turning. The Holtzapffel firm continued to make lathes until 1927, by which time they had produced a total of 2557, serially numbered, many of which were equipped for ornamental turning.

Relatively few of these mechanical marvels survive today and hardly any are complete with all their original accessories. However, the hobby is kept alive by a small band of enthusiasts, many of whom belong to the Society of Ornamental Turners, an organisation based in England, but with members world-wide. They seek to develop the knowledge of O.T. and to restore, maintain and use the old equipment or to adapt modern lathes for ornamental turning. Some are even bringing the hobby up-to-date by building computer controlled O.T. lathes.

The greatest work on ornamental turning is 'Turning and Mechanical Manipulation' by Charles & John Jacob Holtzapffel (5 vols. 1843 - 1897). Volume 5, entitled 'The Principles and Practice of Ornamental or Complex Turning' is considered to be the 'bible' of O.T., but there is much related information in the other volumes. Other useful books include 'Ornamental Turning' by J. H. Evans (1903-4), 'The Lathe & Its Uses' by J. Lukin and 'Ornamental Turning' by T. D. Walshaw (1990). Reprints of all these books are usually obtainable.

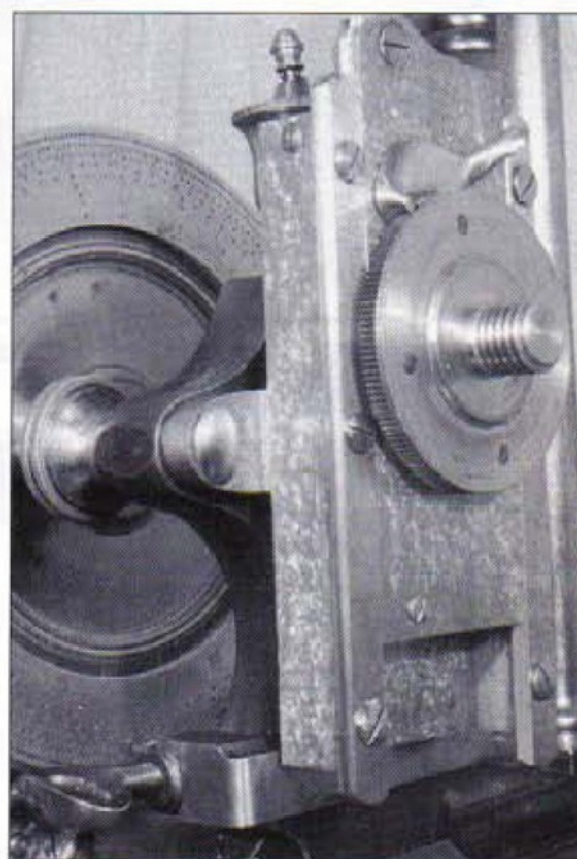
The hobby of ornamental turning declined rapidly following the invention of the motor-car which, by the end of the First World War, had become the fashionable pastime of the mechanically-minded amateur.



13. An ornamental and rose turning lathe, c.1840 by John Bower of Clerkenwell is set up for rose turning. The device behind the headstock is the rosette, from which the pattern is transferred to the workpiece

The Society of Ornamental Turners was formed in 1948 with the objects of encouraging, developing and promoting the study and practice of the art and science of ornamental turning. Its members meet quarterly in London to display examples of their work, to share their experiences and to attend a lecture or demonstration. occasional outings to places of interest are also arranged. A Bulletin containing articles on all aspects of O.T. and news of the Society is published half-yearly in March and September. Competitions are held annually for ornamental turning, plain turning, making equipment, displays at meetings, contributions to the Bulletin and for advancing the knowledge of the art.

Over many years, a close association has been formed with the Worshipful Company of Turners and several members of the Society are Freemen or Liverymen of the Worshipful Company. From time to



14. A straight line chuck fitted to the Bower lathe

time, the Worshipful Company holds competitions which include categories open to members of the Society.

As last year, the Society will be taking part in the Model Engineer Exhibition at the International Model Show, with a stand in the Club Village. Demonstrations will be given and members of the Society will be on hand to discuss O.T. with anyone who may be interested in the art and science.

John Edwards can be contacted on 01732 355 479

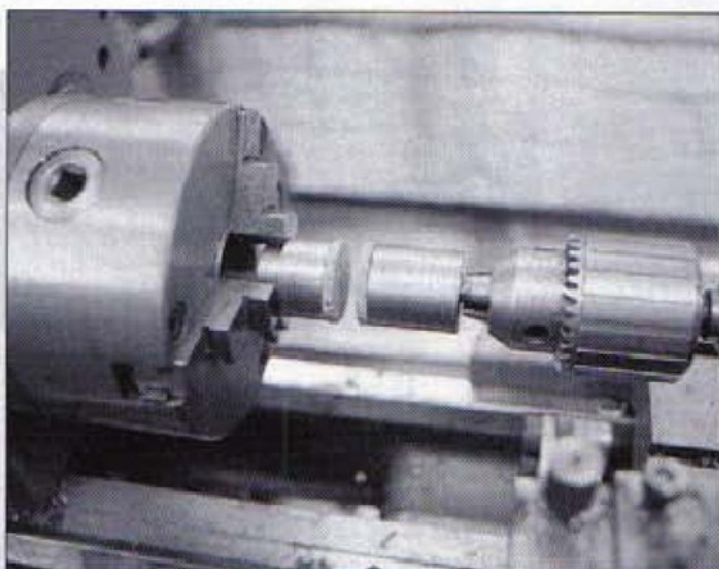


Cutting Thin discs

It often worth spending a few hours making the simplest of tools. Charles Darley of Gillingham, Kent was able to solve a couple of problems with some basic lathe work



1. The three separate parts of the disc cutter



2. The assembly set up in a Boxford ME10 lathe

During Sunday lunch my father-in-law, a keen microscopist, was discussing the problem encountered when trying to turn thin discs of Perspex and similar materials on his Cowells 90 10-200b lathe. The discs are used for the manufacture of filters, which fit in the filter ring of the substage condenser on the microscope. They need to be unmarked and of accurate diameter.

Over coffee I sketched out a few ideas and although it might be a case of re-inventing the wheel I came up with the simple construction which forms the subject of this article.

The unit consists of three parts as follows:-

A round section of 32mm dia. bar (Item 1), reduced at one end to fit the three-jaw chuck of the Cowells lathe.

A further round section of 32mm dia. bar (Item 2), drilled out $\frac{1}{4}$ in. dia. for two thirds of its length.

A piece of $\frac{1}{4}$ in. dia. bar with a small ball bearing at one end.

Discs of cork, or rubber if available, are glued with Evostick to the face sides of Item 1 and 2. In use, Item 1 is held in a three-jaw chuck. The $\frac{1}{4}$ in. diameter bar, item 3, is set into the drill chuck, which is held in the tailstock. Item 2 is slipped on to the $\frac{1}{4}$ in. dia. bar. It is important that Item 2 is able to revolve freely.

A Perspex blank, cut roughly to size, is placed between the two cork-covered surfaces and the drill chuck advanced in the tailstock until the Perspex is tightly held. By running the Cowells lathe at 500rpm and using a round nosed tool, it is possible to cleanly machine off the excess

Perspex. Discs of about 34mm dia. and upwards to about 60mm dia. can be fabricated using this simple device.

Construction of the component parts was quite straightforward and completed in about an hour.

Item 1 was manufactured from a piece of suitable round steel bar stock. It was faced at both ends to give a length of 25mm. One end was then reduced to 32mm dia. and then reversed in the chuck and the end reduced to 22mm for a length of 10mm.

Item 2 was machined from a similar piece of steel stock to a diameter of 32mm and a length of 30mm. It was centre drill along its axis and then further drilled $\frac{1}{4}$ in. to a depth of about 20mm. A piece of $\frac{1}{4}$ in. dia. bar, 50mm in length was selected to make it a close fit in the drilled $\frac{1}{4}$ in. hole. One end of the bar was drill to a depth of $\frac{3}{32}$ in. to accommodate one half of a $\frac{3}{16}$ in. ball bearing. The ball bearing was then fixed in place by the use of Loctite 601. To prevent the shoulder of the bar adjacent to the ball bearing fouling on the drilled hole, it was chamfered off.

To avoid a hydraulic lock up, a flat was filed on the $\frac{1}{4}$ in. bar for a length equal to the depth of the hole. Oil was applied and the two parts assembled.

Although use was made of the three-jaw chuck to mount Item 1 it aligned well with Item 2 and 3 in the drill chuck. Purists would no doubt recommend the use of a four-jaw chuck!

Two over sized pieces of cork were

located and glued to the faces of items 1 and 2. The tailstock was bought up and the drill chuck tightened onto the cork. A high lathe speed was selected and the cork machined off down to the diameter of the two steel sections.

Later that evening my father-in-law phoned to say that he had successfully machined several discs to exact size.

Excessive use was not expected, hence the absence of proper bearing surfaces. I told my father-in-law that I would willingly spend another hour making up a similar device should he ever wear the first one out! His immediate reaction was to present me with another problem.

Certain applications in the hobby call for a these thin filter discs to be cut with a hole dead centre and for this hole to be filled by a disc of a different colour. They need to be unmarked and have accurate fit one to another.

More sketching resulted in the design of another simple device, also consisting of three parts:-

Item 4, a round body section of 40mm. dia. bar reduced at one end to fit into a recess in Item 5, which holds a filter of 33mm, drilled through the centre for the punch, Item 6.

Item 5, a further round section of 40mm dia. bar machined out as a good fit to fit over the reduced end of Item 4 and drilled through to take the end of the punch when it has passed through Item 4.

The punch, Item 6, simply a piece of $\frac{1}{2}$ in. dia. bar machined down to $\frac{3}{8}$ in. and a cutting edge formed at the smaller end.

A filter blank that has been machined to size is laid in Item 5, which is placed on a good solid surface. Item 4 is then placed into the recess, thereby holding the disc flat.

The punch is put into the top, rested upon the filter and then given a smart tap with a hammer. It cuts the disc and the centre drops out of the end. With the first filter removed, a second disc is placed in the assembly and the process repeated. There are now available two discs with holes and two centres, which can be placed in the holes and glued with super glue.

Again, machining of the component

parts was quite straightforward and took no longer than the first set.

Item 4 was manufactured from a piece of suitable round steel bar stock, faced at both ends to give a length of 25mm. One end was reduced to 33mm dia. for about 12mm, centre drilled and then drilled through $\frac{3}{8}$ in.

Item 5 was machined from a similar piece of steel stock, overall length about 20mm, bored for a depth of about 10mm and a diameter of 33mm. It was also centre drilled and drilled through $\frac{3}{8}$ in.

Item 6 was machined from a piece of $\frac{1}{2}$ in. bar to $\frac{3}{8}$ in. for a length to fit through Item 4 and about half-way through Item 5. At the $\frac{3}{8}$ in. end, a cutting edge was formed by the use of a round file to a shape similar to that found on a normal domestic hole punch. A hardened cutting edge was considered, but not considered worthwhile in view of the limited use that it is likely to get.

Yet another phone call reported that a considerable number of discs had been cut successfully.



3. The punch and die components

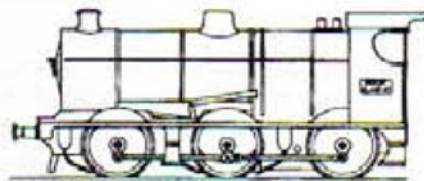


4. Test purposes only! A hole has been punched in a spare piece of filter material

Don Young's Derby 4F & 2P tender Locomotives in 3.1/2" gauge

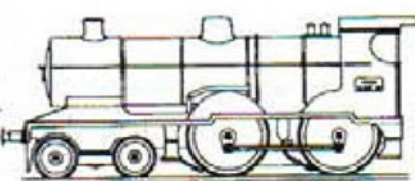
During the 1970's and 80's, there was a trend towards 5" gauge and larger locomotives. However, and perhaps surprisingly, there does seem to be a marked return to 3.1/2" gauge models. We therefore have pleasure in bringing two of the more popular Don Young designs to your notice. **DERBY 4F** was described in Model Engineer Magazine in 1975, and was intended as a beginner's engine. Don also chose to look for an alternative along the same lines, the **DERBY 2P** one with a higher speed capability, against a slight loss of tractive effort. Utilising many common components, and with a fine example by Steve Titley, of Hampshire having proved the quality of drawings, we can recommend either model for your consideration.

Two fine examples of locomotives from the HRM Range, now form a small part of the extensive Reeves range of locomotive designs.



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Send SAE
for complete
list of
castings for
these
designs.



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Magnetic vice jaw protectors from Smith Francis Tools

A range of magnetic vice jaw protectors has been added to the range of Priory workshop products available from Smith Francis Tools Ltd.

These protectors are particularly well suited for use when working with delicate materials or for the production of prototypes where surface damage or component distortion must be avoided.

An extruded aluminium section incorporates an integral magnet which holds the protectors securely to the vice jaws, but allows easy removal or replacement when required. The protectors can be supplied in 12 lengths from 75 to 180mm, together with a range of face treatments and designs to suit the workpiece being held.

TRADE COUNTER

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

For use with harder materials, there are two styles of aluminium grooved faces. These have been designed to minimise material displacement when clamping irregular shaped objects. A 90 deg. angled recess is incorporated to aid horizontal clamping and a range of both vertical and horizontal 120 deg. prisms cater the clamping of round and oval sections.

Where fine milled, ground, polished or hot materials are involved, then fibre faces and extrusions can be supplied which can withstand temperatures up to 80 deg. C without distortion. To achieve maximum grip with the minimum pressure, rubber faces can be supplied, ideal for use with thin walled tubes and profiled components in plastic and wood.

For the most delicate holding operations, felt faces are available, reducing the possibility of surface damage on very soft materials, including precious metals.

These products are available through

tool stockists, but for further information, contact Smith Francis Tools.

Smith Francis Tools Ltd, 66 Moseley Street, Birmingham B12 0RT
Tel: 0121 622 3311, Fax: 0121 666 7201

New Email address for Wren Engineering

Wren Engineering, who are supplying tools and material kits to Peter Rawlinson's designs, now have an email address to add to the contact list noted in Trade Counter in Issue 52 (see below). Wren will be displaying some of their products at the forthcoming International Model Show at Olympia.

Wren Engineering, 58 Kingswood Avenue, Belvedere, Kent DA17 5HG
Tel. 0181 3120413, Fax. 0181 3120414, email wreneng@aol.com

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Tel. 01580 766262 (Kent)

● Two petrol motor mower engines FREE to anyone who can use them. One requires new H.T. lead.
Tel. 01706 648709 (Rochdale)

● 'Model Engineer' magazines. 340 issues 1953 to 1995, £30.
Tel. 01243 863082 (daytime) (Bognor Regis)

● 'Model Engineers' Workshop' numbers 1, 3 to 52. Sell as complete batch. Offers.
Tel. John on 0181 668 2142 (London)

● Crawford Truegrip key operated collet chuck with 20 collets, metric and Imperial to 1in. Backplate fitting. Offers or swap for Meddings bench drill.
Tel. Paul on 01625 576709

● Eclipse No.653 cutting-off tool holder with Eclipse blade and wrench. Unused in box, £25. Eclipse 521R tool bit holder with Eclipse tool bit and wrench. Unused in box, £25. both plus postage.
Tel. Les Savage on 01209 831766 (Cornwall)

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● I have acquired a Coronet Minorette comprehensive woodworking machine, complete but disassembled. It has no base and I can see no obvious fixings for a stand. I would welcome advice also the loan of any material that would help me to assemble it, especially an instruction book.
Tel. Pat Twist on 01962 880475 (Winchester)

● Operating / maintenance manuals or other information relating to Victoria universal mill Model M0 Serial No. BEC 71133/117. Makers, Machine Tool Comp., London NW10. Appreciation and compensation for any information received.
Tel. John Smith 01322 348704 (Dartford, Kent)

● 'Model Engineers' Workshop' magazine (No. 2) Autumn 1990. £10 paid.
Tel. Derek Frampton on 01243 863082 (daytime) (Bognor Regis)

● Advice/information on how to dismantle and reassemble a Newall Precision Universal Tool Head No. 1-2087. Any help most appreciated.
R. Williamson, 14 Hillside Drive, Crewe, Cheshire CW1 4AT Tel. 01270 587750

● Beginner seeks bench mounted mill/drill machine; Chester Champion, Warco Minor, Westbury or similar.
Tel. 01433 630441 (Derbyshire)

● Boxford changewheels 44t and 54t.
Tel. Paul on 01625 576709

● Small tool and cutter grinder in good condition. Must be able to sharpen end mills, slot drills, side and face milling cutters.
Tel. Andy Maddox on 01234 768 484 (Bedford)

● For Myford ML10, 125mm/5in. 4 jaw independent chuck, travelling steady, fixed steady.
Roger Henstridge, 68 Solstice Rise, Amesbury, Wiltshire SP4 7NH Tel. 01980 590329

● Cash waiting to buy small Stuart Turner horizontal engine, 1/2 hp or Model 400 or 600. Also copy of any original drawings for these models.
Tel. Dave on 01235 764943 (Oxon)

● Operator's manual or any other information regarding a Smart & Brown Mark 1 lathe.
Lyndon Scott, 1636 Langworthy Street, North Vancouver, B.C., Canada V7K 1N5.
Fax. 604 984 3334 Email lynsco@axionet.com

BANDSAW IMPROVEMENTS

Philip Amos recalls some of the published modifications to the popular horizontal / vertical bandsaw and suggests further enhancements

Introduction

The Taiwanese metal cutting horizontal / vertical bandsaw has been on the market for at least 20 years and seems to have been sold all over the world. It is an inexpensive, but very capable piece of kit, but it is built to a price and it shows. It is described in some detail in Reference 1. There have been a number of articles in ME and MEW (References 1 to 6) concerning ways to overcome some of its inherent limitations and means of enhancing its utility.

Issues

1. Correcting errors of design or manufacture.
2. Cutting square.
3. Workholding for horizontal cutting.
4. Workholding for vertical cutting.

Instructions

The instructions which come with this machine are much better than those generally emanating from Asian sources, but greater emphasis could be given therein to some critical points which will be addressed below. But if all else fails read the instructions.

Corrections

(i) In my machine the bearing in the end of the body casting which carries the screw for the moving jaw of the vice was drilled at an incorrect height so that the vice screw was not parallel to the machined surface on which the vice jaw moves. Furthermore, the draft and rough surface of the end of the casting did not allow a positive positioning of that end of the screw, with consequent unsatisfactory vice clamping (See Drawing 1). This bearing hole was drilled out oversize (19mm diameter) and a brass bush Loctited (680) in place. When set, the bearing hole was redrilled 12.7mm diameter at the correct height. With the ends of the bush being perpendicular to its axis, the end of the screw was now located in a positive fashion.

This operation required complete dismantling of the saw head and legs from the main casting in order to effect the required drilling operations.

(ii) As received, the moving vice jaw and the angling vice jaw were held down on the machined face of the base casting by ordinary hex head screws and washers. One goes into a threaded hole in the casting, one into the vice nut and one into a normal hex nut. This was inconvenient for the operation of the machine, and an alternative arrangement was devised as shown in Drawing 2. In essence there are now three long-headed hexagon screws having permanently retained loose tommy

bars. The two for the angling jaw are of sufficient height to allow the tommy bars to turn 360 deg. over the top of the jaw, but that for the moving jaw is lower to avoid fouling the bandsaw head casting, so its tommy bar movement is less.

These screws engage the tapped hole and vice nut as before, but that related to the moving end of the angling jaw engages a new shouldered nut (Drawing 2, Item 4) running in the curved slot in the base casting.

As these screws are made from hex. steel stock, they can readily be tightened with a spanner if required.

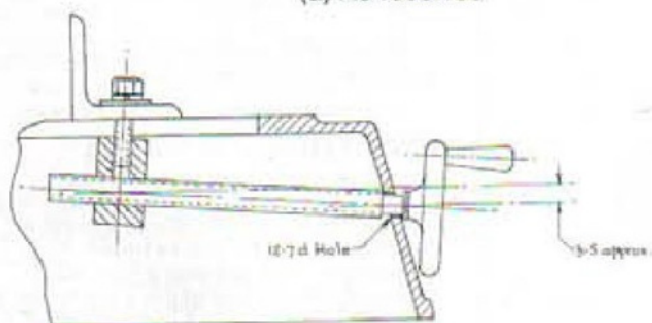
Some writers complain of inaccuracy of the scale fixed to the side of the main casting for setting the angling jaw. I do not have this problem; although the scale is shown in the instruction book, no such scale was fitted to my machine, so the machined surface of the base casting has been deeply scribed with lines accurately at 90 deg., 60 deg. and 45 deg. to the saw blade for ease of setting the angling jaw. Any other angles required are set with a protractor.

(iii) There is fitted to the machine a spring counterbalance to offset the weight of the saw head. One end of the spring attaches to a lever arm on the saw head and the other end to an eyebolt which threads into a hole in the end of a tube mounted on the side of the base casting.

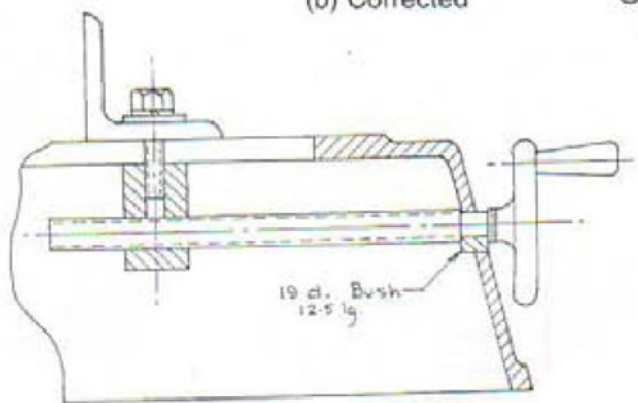
There is a bracket on the side of the base casting through which the eyebolt passes and which limits the movement of

Clamping screw
Drawing 1

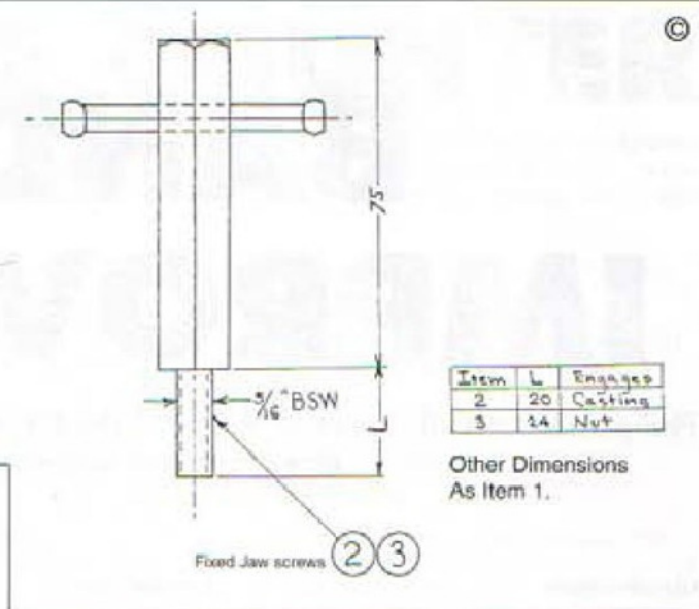
(a) As received



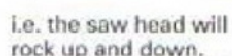
(b) Corrected



Material: Mild Steel Zinc plated



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Writers in some of the references feel that the threaded portion of the eyebolt is too short and that this makes it difficult to fit - it certainly is a bit of a struggle to get the spring end into the eye of the bolt. Likewise, the available length

case if the machine is tilted back so as to engage its wheels with the floor in order to manoeuvre it around the workshop. Several writers have referred to this problem, and E. F. Wale in Reference 2 has made his machine a fixture on a large plywood base to overcome it.

As I need to be able to move my machine because of limited workshop space, I have shaped a piece wood blockboard 750 x 307 x 22mm thick to fit inside the bottom of the legs, to which it is attached by eight round head zinc plated steel woodscrews 10G x 25mm long (**see Drawing 3**). This renders the whole thing stiff and stable, particularly when being moved in a tilted position.

the tube against the pull of the spring. The tube is fitted with a rubber sleeve at its outer end to facilitate turning, so as to move the eyebolt in or out of the threaded hole in the tube end, thus increasing or decreasing the tension in the spring.

Without the counterbalance, the weight of the saw head, measured by spring balance at its outer end, is 8 kg. With $\frac{1}{2}$ in. length of the eyebolt engaged it is 3 kg. With the end of the eyebolt end of thread just visible it is 1 kg and with the eyebolt screwed in as far as it will go it is 0 kg -

really only allows a range of loading on the saw head from 0 to about 2.5 to 3 kg, but really this is probably enough as greater pressure (e.g. leaning on the saw head) seems to stall the blade, causing it to slip on the drive wheel. I have therefore not altered the counterbalance arrangement on my machine.

(iv) The legs of the machine (called floor stands in the instruction leaflet) are very flimsy and render the whole machine somewhat unstable. This is especially the

©



There are five separate matters to be attended to in order to achieve this end.

(i) Getting the blade to track properly on its wheels, with the blade rear just touching the wheel flange, and tightened until it does not slip on the wheels.

- (ii) Adjusting the side roller guides so that the blade can just be pushed between them by hand.

- (iii) Adjusting the blade guide assemblies so that the rear rollers just touch the blade rear.

(iv) Adjusting the blade guide assemblies so that the blade is at right angles to the machined surface of the base casting when fully down at the completion of a horizontal cut.

(v) Adjusting the mitring vice jaw to be at right angles to the blade.

Blade Tightness & Tracking

At the top of the saw head casting there is a plastic knob which adjusts tension in the saw blade, arranged as shown in **Drawing 4**. This operates a 3/8 in. BSW threaded rod which engages a nut which is attached to the bearing block for the top

wheel of the saw with a $\frac{5}{16}$ in. BSW hex. head screw, 30mm long. There is a compression spring surrounding this rod which acts to lock it in position. The shaft bearing block is attached with a $\frac{5}{16}$ in. BSW hex. head screw, 40mm long, to a mounting block outside the saw head casting. This mounting block has grooves cut on either side which engage two plates attached to the saw head casting, each with two $\frac{1}{4}$ in. BSW hex head screws, 13mm long. Thus the mounting block and attached bearing block can move lengthwise with respect to the saw head casting, under the control of the threaded rod. The tension of the saw blade should be tightened until it just does not slip on the driving and idler wheels. Avoid excessive tension.

In addition to the screw which holds the shaft bearing block on to the mounting block, there is a socket head grub screw $\frac{1}{4}$ in. BSW x 12mm long in the mounting block, pressing on the bearing block. If the blade tension is slackened slightly, then by adjusting this grub screw with appropriate slackening or tightening of the clamping screw, the angle of the idler wheel shaft relative to the axis of the drive wheel shaft can be varied slightly. This adjustment is used to cause the blade to track so that the back of the blade just touches the flange on the wheel rims. Screwing the grub screw inwards tilts the wheel towards the saw head casting at the top, and the blade then moves towards the flange (and conversely).

Retighten the blade tension after making the adjustment and switch on for a trial run; further adjustments may be needed to arrive at satisfactory tracking. Switch off while making adjustments and also slacken / tighten the blade tension.

Side Roller Guides

The instruction book with my machine states: "Blade Guide Bearing Adjustment - Attention: This is the most important adjustment on your saw"

The guide rollers are fixed to castings described as "blade adjustable seats" which are attached by 25mm long $\frac{5}{16}$ in. BSW hex head screws to "adjustable brackets" which in turn attach to the saw head casting (see **Drawing 5**). The "seats" should be removed, from the "brackets" to facilitate setting the guide rollers.

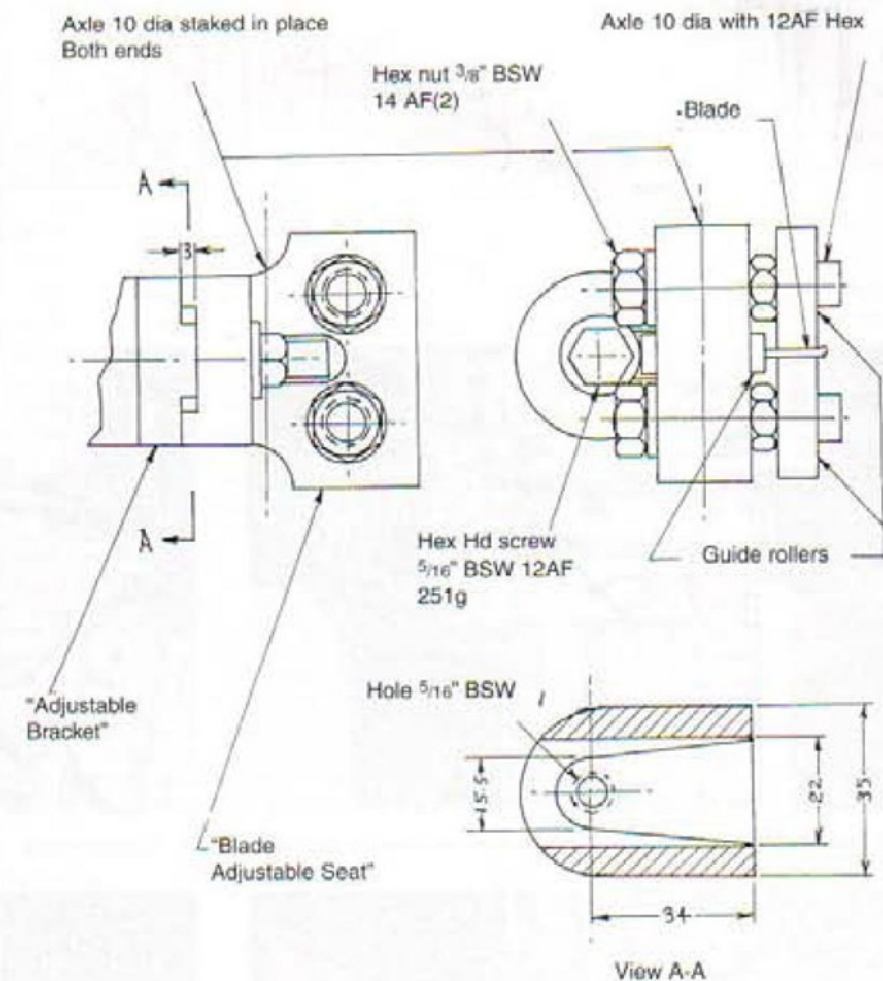
After the guide rollers are removed from the "brackets", if the saw head is lowered until the blade is in its lowest position i.e. parallel to the base casting machined surface, the plane of the blade will be found to naturally take up an attitude about 45 deg. to the plane of the machined surface (in my case 46 deg.). It is thus the function of the roller guides to twist the blade so that it becomes square to the machined surface.

With the guide rollers fitted and the "adjustable brackets" at their maximum spacing, the roller centre-to-centre distance is about 236mm and the clear space between them about 210mm (see **Drawing 6**). The minimum spacing, centre to centre, is about 136mm, with a clear space of about 110mm.

The guide rollers on the motor side of the saw are mounted on eccentric bearings, so that the gap between each pair of rollers can

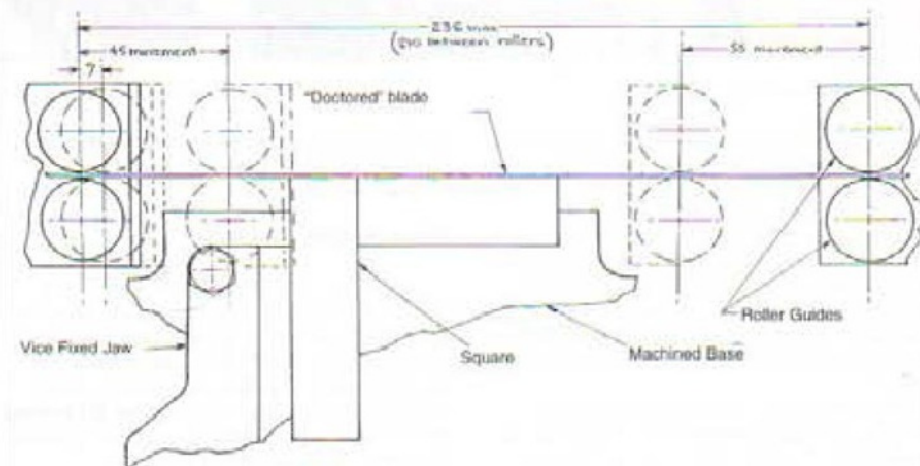
Blade Adjustment (Angular).

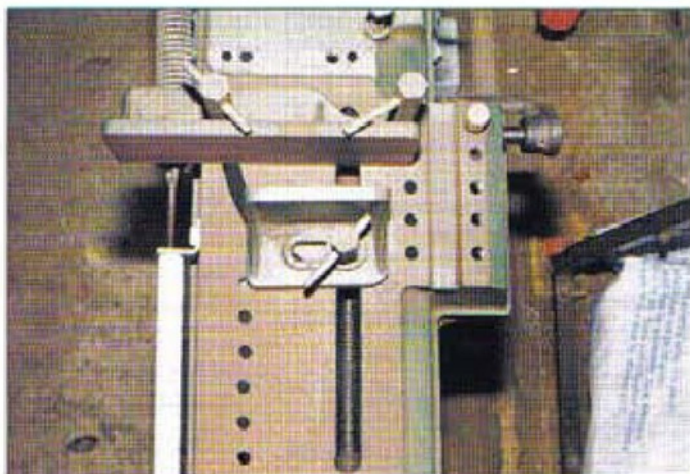
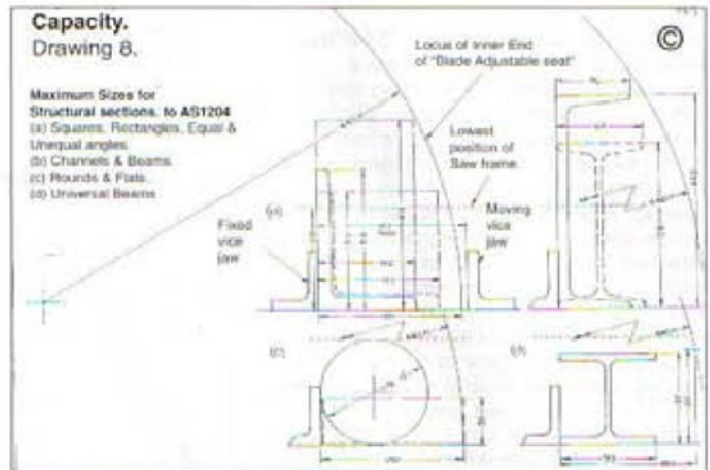
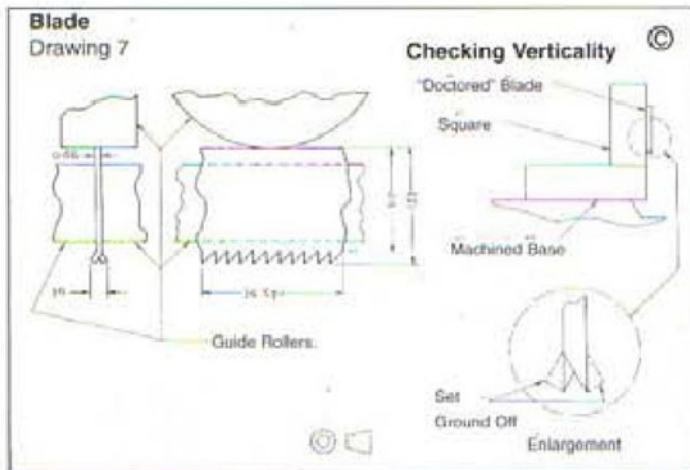
Drawing 5.



Adjustment of Vice Fixed Jaw.

Drawing 6.

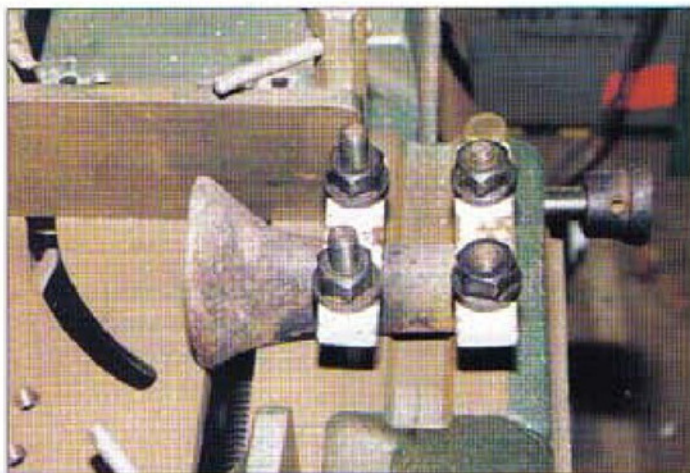




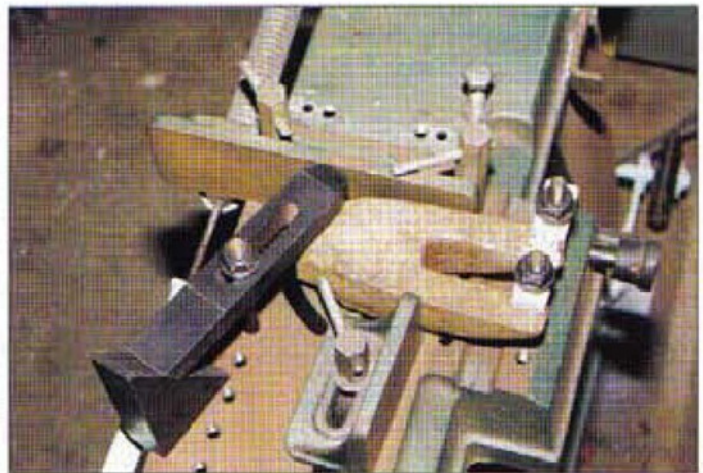
1. Pattern of clamping holes and length stop with clamp screw



2. Clamped slab



3. Clamped casting



4. Clamped forging

be adjusted by loosening the outer locknut (14mm AF) and rotating the inner hex (12mm AF) behind the bearing. The instruction book states that the correct adjustment is achieved by rotating the bearing shaft until the rollers grip the blade tightly and then backing off until the blade can be pushed between the rollers by hand. Elsewhere it states the clearance between blade and rollers should be from zero to 0.025mm.

Blade thickness as supplied is 0.65mm (24 BG). The gap between the rollers can be varied from 0.72 to 1.59mm, as measured with feeler gauges. Thus the minimum clearance available is 0.72mm minus 0.65 or 0.06mm, which is about twice the

maximum recommended in the instruction book, but it seems to work all right!

Rear Roller Guides

The rear rollers are held in a fixed position in the "seats" by their axles, so that the back of the blade can only penetrate between the side rollers to a depth where the set of the teeth does not touch the side rollers (**see Drawing 7**). However, the "seats" can be moved forward and backward on the "brackets", so that the rear rollers can be brought (just) into contact with the rear of the blade.

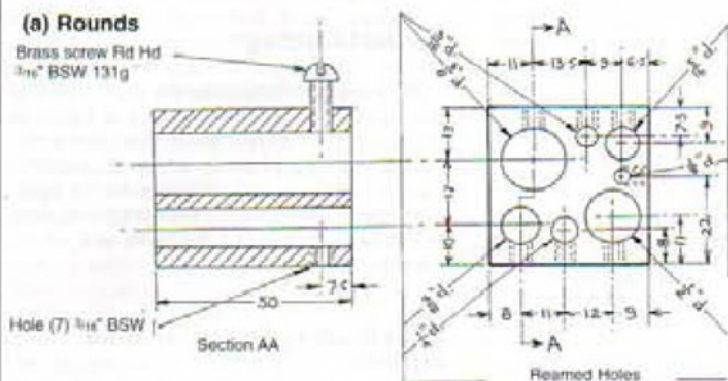
Squaring Blade to Base Casting

The design of the joint between the "seat" and the "bracket" is a curious one. The "seat" has a parallel sided groove which mates with a tongue on the "bracket". The tongue is tapered in plan, being almost as wide as the groove at its lower end but much narrower at the upper end (**see Drawing 5**). Thus the "seat" can be clamped to the "bracket", but can be rotated in plan to some degree when the clamping pressure is reduced sufficiently.

On my machine, the tapered tongue at the idler wheel end is more or less symmetrically disposed with respect to a vertical plane at right angles to the

Drawing 9. Material: Mild Steel & Brass

Brass screw Rd Hd
1/16" BSW 131g



Technical drawing of a rectangular plate with dimensions and assembly details.

Dimensions:

- Overall height: 35"
- Overall width: 33"
- Distance from top and bottom edges to the first hole: 10"
- Distance from left and right edges to the first hole: 10"
- Distance from top and bottom edges to the second hole: 10"
- Distance between the centers of the two holes: 33"

Hole (4) $\frac{1}{4}$ " BSW

Hole (4) $\frac{1}{4}$ " BSW

Hole (4) $\frac{1}{4}$ " BSW

Hole (4) $\frac{1}{4}$ " BSW

Brass screw (3) RdHd $\frac{1}{4}$ " BSW 25g

Brass screw (3) RdHd $\frac{1}{4}$ " BSW 25g

Screw $\frac{1}{4}$ " BSW Csk Slt 251g (4)

The blade was held on a board with two toolmakers clamps so that about 250mm of its length was flat and accessible. It was ground with a small diameter grinding wheel (point) in a pistol drill at 2700 rpm. This 'doctored' blade was then used to align the blade guides so that the blade was perpendicular to the machined base.

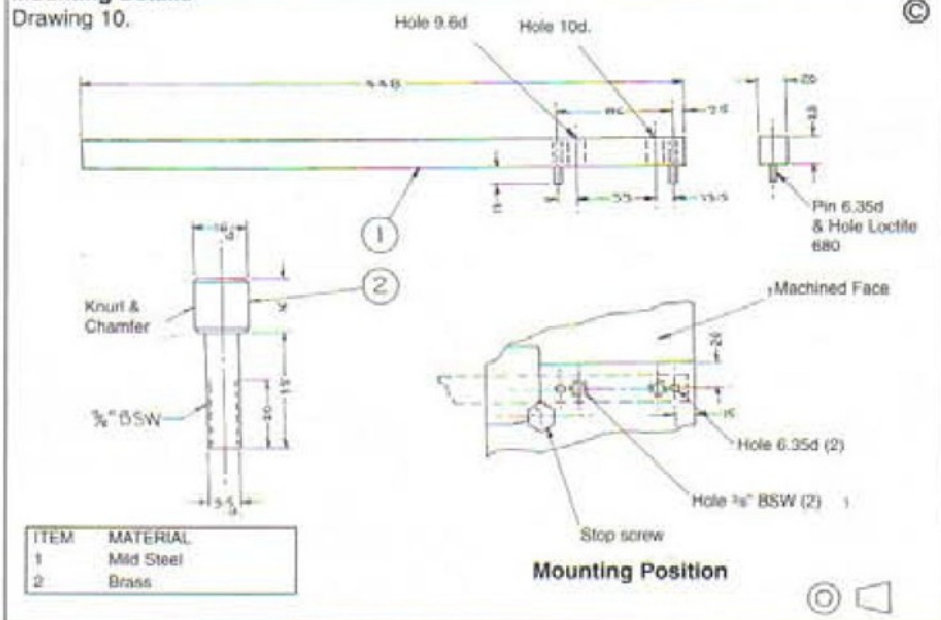
With the 'doctored' blade still in position, a try square on the machined surface of the base, with one side in contact with the saw blade was used to accurately align the mitring vice jaw at right angles to the saw blade. The jaw was then clamped in this position with its own screws (see **Drawing 6**).

Lighter loading seems to result in squarer cutting, as there is apparently less tendency for the blade to wander. So, if a really square cut is required, it is probably better to use minimum loading despite the cutting process taking longer to effect.

According to my instruction leaflet this is 112.5mm for rounds and 100 x 150mm for rectangular stock. The maximum for rounds is determined by being able to effectively hold the material in the vice, the jaws of which are 62mm high, so that half the stated 112.5 = 56.25mm seems appropriate. This is for cutting at 90 deg. to the blade. At

Also from figure (d) of Drawing 8, it will be seen that for a block 100mm high, the maximum width which can be accommodated is 140mm not 150mm. This width can be extended by repositioning the fixed vice jaw as suggested in Reference 6. This can extend the width accommodated by a maximum of 55mm and is then limited by the outer face of the inner "blade adjustable seat". However, Drawing 8 shows how various larger structural sections can be fitted in the envelope if the lowest position of the saw frame is ignored. These are the largest Australian Standard sizes that will so fit; other national standards may differ slightly. As the saw frame leaves a clear vertical space of 70mm

Drawing 10.



For lengths longer than 70mm it is

additional clamping in addition to the vice for secure cutting.

With the auxiliary table described below, the maximum thickness which can be cut is 188mm, extending no more than 70mm to the 'spring side' of the machine. Probably such dimensions are only relevant for light materials such as plastics, as large weights would tend to collapse the table and overturn the machine.

There are several ways in which a workpiece can be held, of which the simplest is the use of the vice provided as part of the machine. If the length of the workpiece fully fills the width of the vice jaws, then it can be suitably positioned, tightened in place and cut. If the workpiece is shorter and only fills half or less of the width of the vice jaws, it will be necessary to provide packing at the opposite end of the jaws of dimension equal to that of the workpiece to achieve satisfactory clamping. This is particularly the case when the vice is angled - i.e. other than 90 deg. to the saw blade.

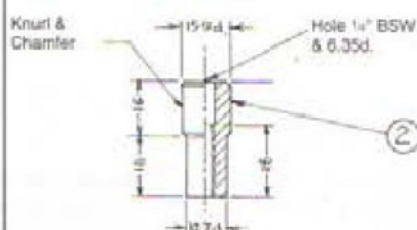
Some shapes - especially castings and forgings - may not be easily clamped in the vice, and to deal with these on my machine, there is now a pattern of 3/16 in. BSW tapped holes in the machined face of the base casting, so that the universal clamping kit (normally used with the drill/mill) can hold the workpiece in place as desired - see **Photos. 1, 2, 3 & 4.**

For very short pieces of rod or bar, there are now provided a couple of ancillary fixtures to be used in the vice, as shown in **Drawing 9**. One (**Drawing 9a and Photo. 5**) is for stock diameters of rod, and the other (**Drawing 9b and Photo. 6**) is for flats. Provided that about 10mm length can be held in the fixture, successful cutting can be achieved.

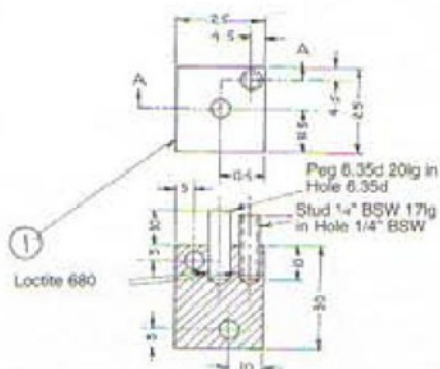
On the 'motor side' of the base casting is fitted a length stop which consists of a bar with a casting which can be positioned to reach over the base casting to cope with cutting off short lengths, or alternatively reversed for more convenient positioning outboard for longer items. On receipt, the bar is retained by a 3/4 in. BSW socket setscrew, but as the socket gets filled up with sawing effluent, it resists entry of its key. This setscrew has therefore been replaced by a brass knurled head screw (see **Drawing 16 Item 5 and Photo 1**). In the very few cases where this screw forms an obstruction to the task, it can easily be removed and replaced.

The auxiliary table provided with the machine to allow it to be used as a conventional vertical blade bandsaw is primitive in the extreme. However, mine has been used for about 20 years for a number of tasks and has proved most useful. Inspired by Reference 2 and annoyed by the inadequacies of the 'bought' arrangement, a more satisfactory

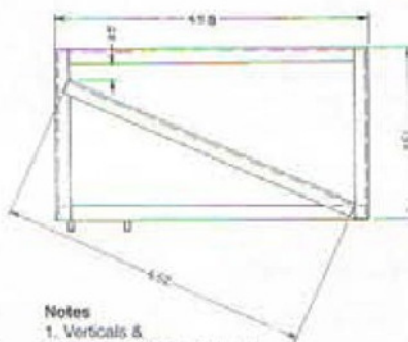
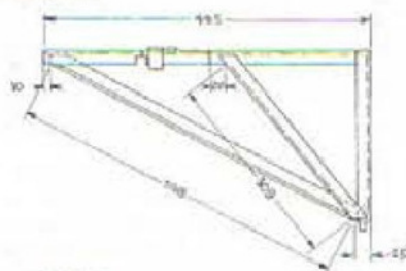
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ITEM	MATERIAL
1	Mild Steel
2	Brass



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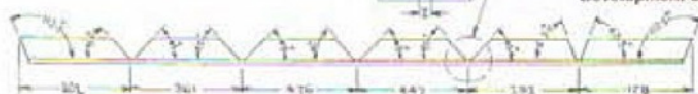
Side Braces
Scale: Half Full size

Nirvana

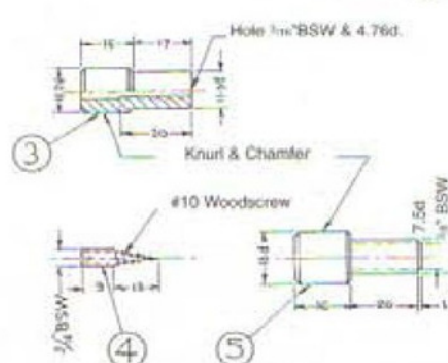
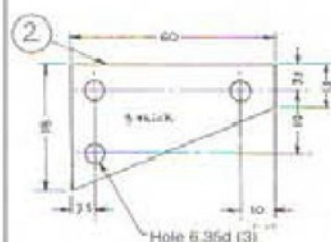
1. Verticals & Front Brace ends cut square
2. Parts welded to 3 on outer faces

Enlargement

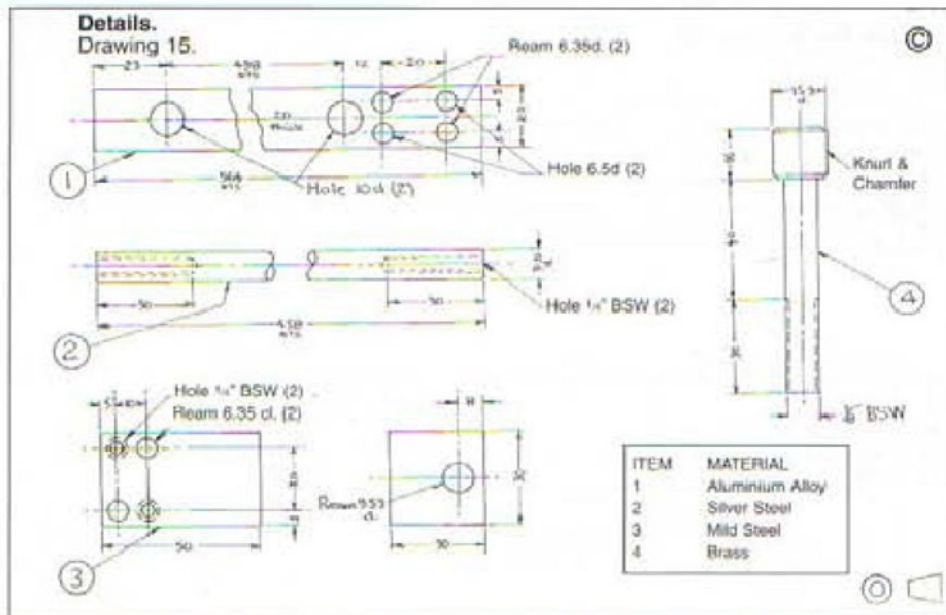
Development of Frame top



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ITEM	MATERIAL
1,2,4	Mild Steel
3,5	Brass



5. Cutting fixture for short rounds

saw blade. The bar was clamped to the main casting and the guide pin holes extended through that casting.

III. Guide pins were Loctited (680) into the bar. When set, the bar was replaced on the casting and the screw holes extended through the casting (tapping size). These holes were then tapped $\frac{3}{16}$ in. BSW and the holes in the bar opened out to 9.6 and 10mm diameter to allow easy insertion of mounting screws.

IV. A piece of timber was clamped vertically in the machine vice and another piece clamped to it horizontally at a height equal to that of the top of the "blade guard" when the "adjustable bracket" was in its lowest position (see Photo. 7).

7). This second piece of timber was also set horizontal in the transverse direction (see Photo. 8).

V. Using a square to identify the relative position of blade and timber, a cardboard template was produced and used to check the dimensions of the 'spring side' of the table (see Photos. 9 & 10).

VI. The mounting block (Drawing 11 Item 1 and Photo. 11) was made, but with only the mounting holes drilled tapping size. It was fitted to the saw head casting so as to avoid the fillets in the corners and at a height equal to that of the "blade guard" as in IV above.

This position was also checked with a rule and level. It was held with a toolmaker's clamp while two tapping size mounting holes were drilled in the saw head casting. These were then tapped $\frac{3}{16}$ in. BSW and those in the mounting block opened out to 4.76mm diameter. The block was secured in position with two

$\frac{3}{16}$ in. BSW round head steel screws, 40mm long.

VII. The angle for the top frame was notched as shown in the Drawing 12 development, folded in the bench vice and the corners hammered square. The joint was then tacked, welded and ground flush.

VIII. The table top was cut 481 x 452mm (to match the frame overall dimensions), the sloping side marked from the cardboard template and cut out with a sabre saw (jigsaw) with a metal cutting blade to minimise chipping of its laminate faces.

IX. The centres of the 15 top securing screws were marked out, drilled 4.76mm diameter and countersunk to a depth such that the screw heads were below the table top surface.

X. The table top was clamped to the angle frame at opposite corners and holes drilled through, 4.76mm diameter at the other two corners. The top was then bolted to the frame, the clamps removed and the other 13 holes drilled through. The remaining screws and nuts were fitted. Later, on final assembly, these nuts were secured on the screws with Loctite (222).

XI. The two vertical angles were tack welded to the main bar.



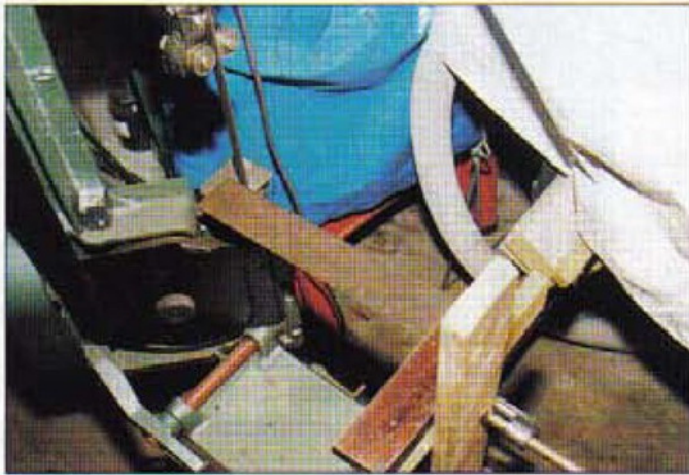
6. Cutting fixture for short flats



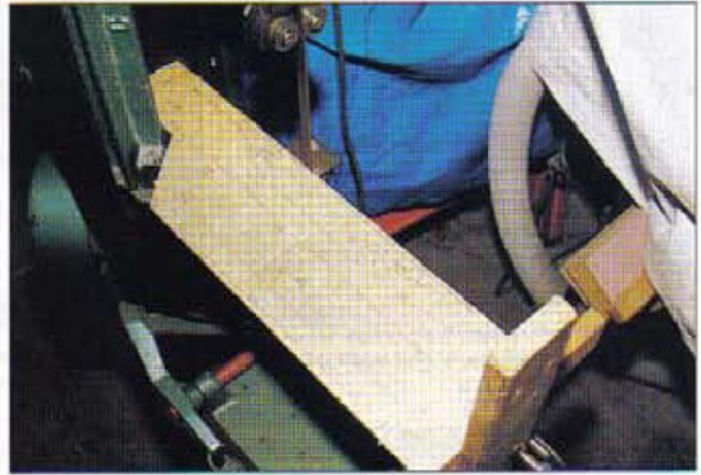
7. Setting timber piece level with blade guard



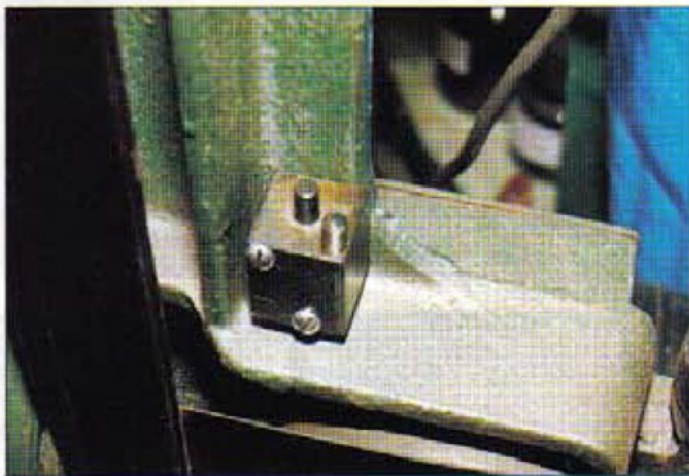
8. Setting timber piece level side-to-side



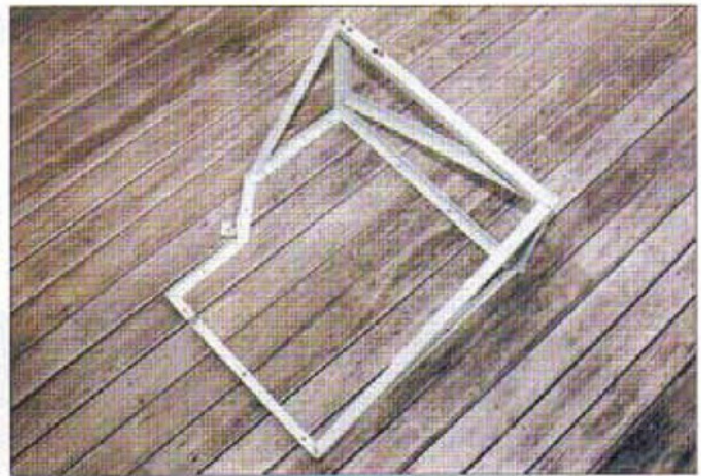
9. Noting blade sideways position relative to timber cross piece



10. Cardboard template for table side



11. Mounting block in position on saw head



12. Table frame completed

XII. The saw blade was removed and the table top/frame positioned, resting on the "blade guard" and levelled in both directions, and then clamped to the vertical angles with toolmaker's clamps. The rear mounting angle bracket was made to **Drawing 13** and clamped to the angle frame, so that it was resting on the mounting block (**Drawing 11, Item 1**).

XIII. The top/frame was removed from the machine and the top then removed from the frame. The vertical angles were tackwelded to the frame, as was the rear mounting bracket.

XIV. The frame was replaced on the machine and the front-to-rear brace angles were clamped in place. The frame was removed and these brace angles were tack welded in place (**see Drawing 12**).

XV. Again the frame was replaced on the machine and the cross brace angle clamped in place. The frame was removed and the angle tacked in position (**again see Drawing 12**).

XVI. With the frame again in place, holes for the guide pin and clamp stud in the mounting block (**Drawing 11, Item 1**) were spotted through the holes in the rear mounting angle bracket. The block was removed and these holes were drilled and tapped in the drill/mill, after which the guide pin and stud were Loctited (680) in

place and the block returned to the saw head (**see Photo. 11**).

XVII. The frame was replaced and pushed around slightly so that it would fit easily on to the mounting guide pins and could be held down with its clamp screws and nut. It was then removed and each joint welded in turn, being replaced for checking after each weld was completed. Finally, all welds were ground flush where necessary (**see Photo. 12**).

XVIII. The top was again bolted to the frame and a try-square used to mark where the saw blade would penetrate the table. This position was joined by pencil mark to the rear of the table which was then removed from the machine and two lagging screws (**Drawing 16, Item 4**) were run into its underside for attachment (with brass knurled nuts - **Drawing 16, Item 3**) of a bracing angle across the yet-to-be-cut access for the saw blade.

XIX. With this bracing angle removed, the access cut was then made through the frame and the table top. In the vicinity of the blade, this cut was opened out to 5mm wide and 20mm long, to ensure blade clearance (**see Photos. 13 & 14**).

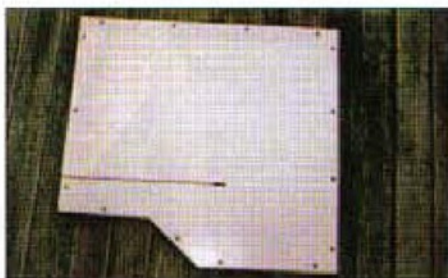
XX. The table was removed, the 'doctored' blade fitted, the table replaced and the bracing angle reattached to the underside of the table. The saw was then run to ensure it cleared the table

satisfactorily.

XXI. The guide fence was made to **Drawing 14**. Considerable care was taken to ensure that the fence itself was accurately at 90 deg. to the guide rod. The guide block (**Drawing 15, Item 3**) was then dowelled to the fence proper to preserve this relationship.

XXII. A steel rule was held against the 'doctored' blade (with a paperclip) to define the orientation of the blade, and the table marked in pencil (**see Photo. 15**). Parallel pencil lines were marked on the table at both ends of the fence transverse travel.

XXIII. The guide rod mounting brackets were attached to the ends of the guide rod and clamped to the frame with toolmaker's clamps. A 0.5mm shim was placed under the fence to ensure clearance from the table (**see Photo. 16**). The fence and guide rod were manipulated until the fence aligned with the parallel-to-blade marks and could be slid freely from end to end of its travel (**see Photo. 17**). At this stage, the bracket mounting holes were drilled in the frame, tapping size for 1/4in. BSW. The fence and guide details were removed, the holes in the frame tapped and those in the mounting brackets opened out to 6.35mm diameter. The brackets were attached to the frame with 10mm long 1/4in. BSW mushroom head steel screws, with Loctite



13. Table top completed

(242) on the threads. The fence was checked for alignment and ease of movement.

This completed the table and fence construction and they were now available for use.

Stowage

In my home workshop, as in most, space is at a premium, so storage of a bulky item like the auxiliary table becomes a bit of a problem, especially as it is desirable for it to be readily accessible if it is to be convenient to use. It has been found that it will fit fairly well between the legs of the bandsaw (see **Photos. 18 & 19**). Because my workshop is only about 150m from the sea, rusting of ferrous parts is always a problem. Thus the fence assembly and its guide rod are removed by undoing the capscrews in the ends of the rod, and these items are stored in a cut down mailing cylinder, which effectively excludes air circulation. This cylinder can also fit between the band saw legs (see **Photo. 18**).

Conclusion

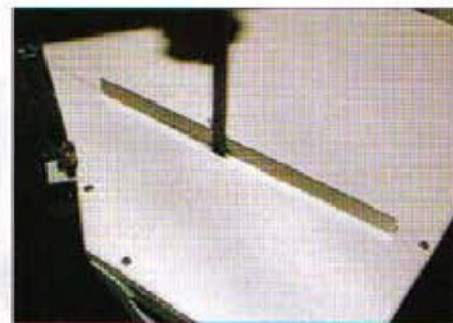
The improvements to my bandsaw have involved quite a lot of time and effort, but the results have made it a much more useful asset in the home workshop.

References

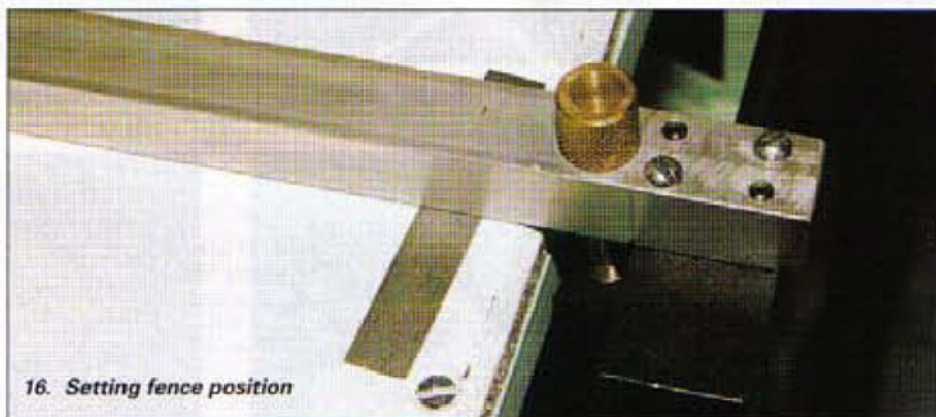
1. The Clark Bandsaw Reviewed - MEW 16 Apr/May 93 pages 57-59.
2. A Silk Purse - E. F. Wale - ME, 17 Jan 92 pages 79-80
21 Feb 92 pages 205-206
20 Mar 92 pages 332-333
17 Apr 92 pages 445-446
17 Aug 92 page 164
3. Bits and Bobs for a Universal Bandsaw - R. W. Clark - MEW 24, Jul/Aug 94 pages 22-25
4. Universal Bandsaw Modifications - G. Roberts / J. Vickers / B. Cocksedge - MEW 39, Dec 96 pages 26-29.
5. A Bandsaw Damper - S. Curtis - MEW 50, May 98 pages 51-55
6. Improvements to the Dual Purpose Bandsaw - A. Hussey - ME, 3 Jul 98 pages 39-40



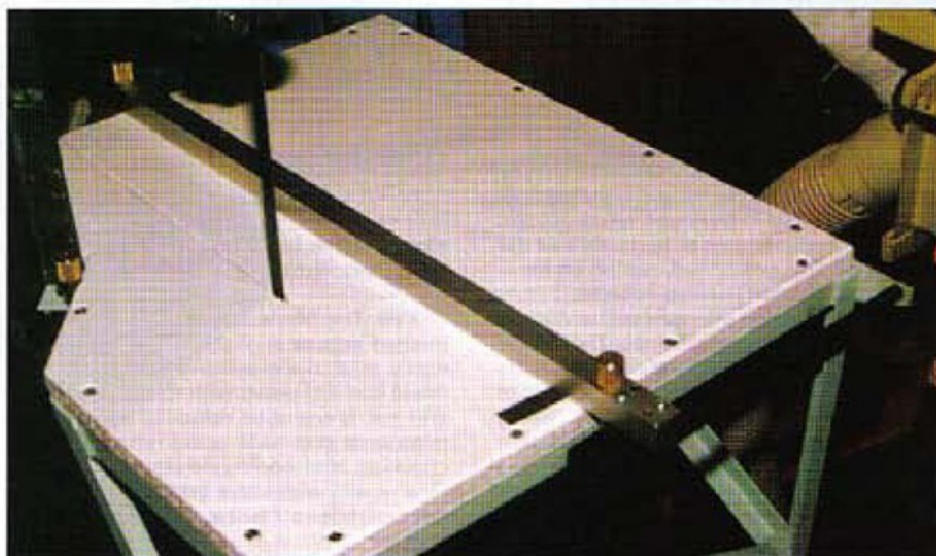
14. Table assembled with bracing angle across blade access slot



15. Checking blade orientation



16. Setting fence position



17. Fence assembly completed



18. Table and fence tube stowage



19. Table stowage



1.. With the light source on the camera, some areas are highlighted while others are in deep shadow



2. A diffused light source and reflectors transform the picture

SPREADING THE LIGHT

Professional photographer Ivan Trobe adds to Bob Loader's hints on how to obtain better workshop photographs with some suggestions on the subject of lighting

I have so very frequently admired the skill shown in the construction and the detailed drawings sent in by the many contributors to M.E.W. and have been equally depressed by the photographs that they have supplied as illustrations. Often it is impossible to see what is being illustrated.

In the September issue (No. 52) I was heartened to see Bob Loader endeavouring to improve the standard of photography with his article. Because I ran my own commercial photographic studio for nearly 40 years, I feel I am sufficiently qualified to offer a few hopefully useful comments and suggestions.

Firstly, I would not recommend using flash-light for any photography of shiny metal, particularly if that flash is not a combination of flash and modelling light, as is normal in most professional studios. This is because without a modelling light it is well nigh impossible to predict the result.

Photographing machined or shiny metal is similar in principle to photographing a mirror; you can only photograph the image that is being reflected by the mirror (or any shiny metal object). One method is to arrange for the light source to be in such a position that its light is reflected from the object being photographed towards the camera. As this will usually create strong reflected highlights, there are two possible alternatives. The first can be to place a large sheet of diffusing material such as tracing paper or other translucent material between the light source and the object. The second method is to use white card to reflect light onto the surface of the object and illuminate the white card. Several pieces of card can be used from a variety of directions. The major advantage being that the effects can be seen in the camera before the photograph is taken.

The successful photograph is a

combination of well chosen viewpoint, carefully controlled lighting, correct focus and exposure. Lighting is certainly not the poor relation that it is often regarded as.

So, what camera?

It is difficult to recommend a particular type of camera, as this can be a very personal choice, but the basic requirements are as follows:

- The facility to focus the camera close-up.
- The ability to be able to choose and use small apertures, of say f16 or even f22, in order to ensure sharp focus over the subject area (depth of field).

It follows that, as small apertures are required for adequate 'depth of field', it will be necessary to hold the camera completely still for longer shutter speeds, in order to obtain correct exposure.

I am assuming that anyone interested in this article will not have access to a professional studio camera, and with very few exceptions will be wishing to use a 35mm camera. My recommendations therefore would be a 35mm single lens reflex camera with the ability to close focus (macro-focussing), or to accept extension tubes between lens and camera body.

An additional asset would be a camera with automatic exposure control, with the proviso that the photographer must be able to choose small apertures (aperture priority). Automatic exposure control has an additional advantage when doing extreme close-up photography, but that is probably a bit too advanced at this stage. It should also be pointed out that expensive, large aperture lenses (f1.8, f2.8



3. The set-up used to provide the illumination for Photo. 2. Nothing here would be beyond the ingenuity of any home workshop enthusiast!

etc.) are no asset to close-up photography and are quite possibly of inferior quality to much cheaper lenses at the apertures required for this sort of work.

It would be fairly simple for most engineers to make a means of sturdy support for the camera in order to do 'time exposures' at small apertures, and could be quite an interesting project in itself. Of course, a cable release should also be a must.

Light source

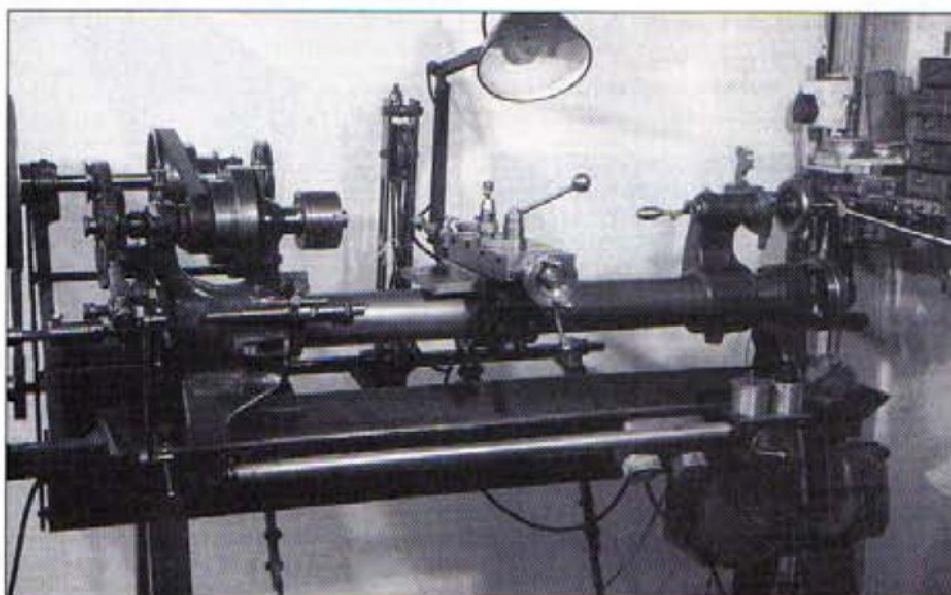
A great deal of very good photography can be achieved using only one light source with a decent reflector, suitably diffused with tracing paper, together with judiciously placed white reflectors (preferably out of view of the camera!) It could easily follow that many engineers would get the bug for photography and we would see a 'Great Leap Forward' in the standard of illustrations.

As an example of what can be achieved with this simple equipment, I have taken two photographs of the same subject, one of which employed lighting from the camera and the other lighting through tracing paper with reflectors. The third photograph illustrates the set-up, demonstrating the positioning of the trace and reflectors.



60 YEARS WITH A 4in. ROUND BED DRUMMOND LATHE

It is obvious from correspondence and queries that many home workshops house machine tools now well past the first flush of youth, but that the majority of these have been modified and improved over the years, so that they are still capable of giving good service. John Frazer of Balleymena, Co. Antrim has a round bed Drummond which is a prime example.



1. A front view of the 4in. round bed Drummond lathe showing some of the modifications, including the stop for the slide rest and the motor controls.

While the 4in. Drummond lathe has been out of production for many years, it would appear from fairly frequent references to it that, not only does the memory linger on, but that quite a few of the breed still continue in service. I therefore think it may be of interest to some readers to learn of the development of one such machine over a period of more than 50 years, and of how it has been modified to meet my particular requirements.

I purchased Lathe No. 3600M from the local cycle shop which was going out of business in 1939 or '40 for the princely sum of £10. For a further £2 (which I didn't have!) I could have had the home-built petrol engine which the previous owner, a clever and competent mechanic, had made to drive it. It was generally in good condition and came with three and four jaw chucks (the former rather the worse for wear) faceplate, complete set of change wheels, an angle bracket for the boring table and an

apparatus which I have never seen elsewhere, which consists of the necessary clamps, stanchions and bearings to support a wooden roller forming part of some sort of overhead or guide pulley system. Although this is obviously an original fitting, I have never seen it described in any Drummond literature (nor, I may say, have I had occasion to use it).

The lathe was initially set up in treadle form but was little used during the war years, as my attention, as a young engineer, was directed elsewhere. However, on return from the Royal Navy in 1946, it was set up in the garage with an overhead motor driven countershaft and put to work. Since then its development has been somewhat spasmodic, but nevertheless continuous.

As it would be tedious to give a blow by blow account of progress, I shall not attempt to do so, but must mention one major upheaval which occurred about twenty-five years ago when a friend visiting my workshop said, "I see you've got one of

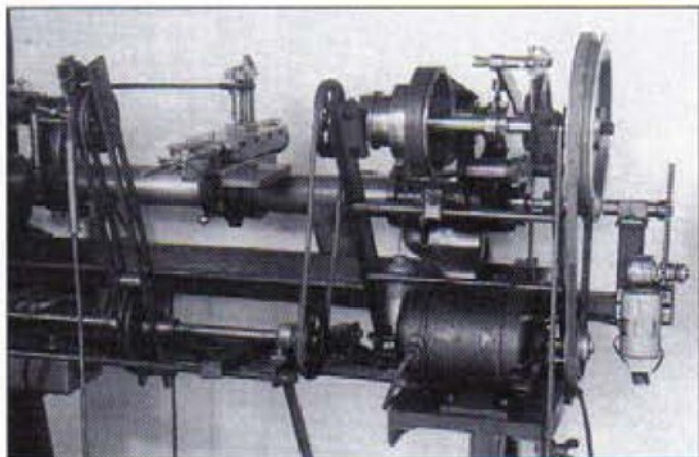
those old Drummonds: would you like another?". I had little difficulty in making an appropriate reply, and thus found myself the possessor of Lathe No. 06052 complete with Buck & Ryan nameplate and, *mirabile dictu*, one of the rare long beds which will accommodate up to 21in. between centres. This bed still had the original machining marks on it, though the lathe as a whole was inferior to my original one. A suitable marriage was arranged between the best components of both, and the remains built up into useable form and passed elsewhere for further service. In the rebuild it was necessary to make up a new pair of legs and a chip tray, as the originals were required for the remains. The legs were welded up from rectangular hollow section material to give a slightly higher floor to centre height, and a pattern made up and casting obtained for the chip tray. This could, undoubtedly, have been made up more readily and cheaply by fabrication from steel plate but, on aesthetic as well as grounds of rigidity, the casting was chosen.

The making of the various modifications and the development of the additional equipment has been spread over the ensuing years, a lot of it having been done with particular ends in view. I have always found it worthwhile to tool up as well as I can for a job, rather than to improvise on a one-off basis. Thus, when a similar problem turns up again, one is ready for it without further ado or loss of valuable time. I make no claim to have thought up some of the modifications made. Many of them originated in the fertile minds of other readers of *Model Engineer*; I have endeavoured to give references where appropriate, although, in interpreting them, I have on most occasions, incorporated some of my own ideas.

Amongst the modifications made are the following:

1. Drive Arrangements

This is one of the occasions upon which I have been able to work off someone else's drawing! The two sub frames which



2. This rear view shows the countershaft drive arrangements and the motor which provides the independent drive to the leadscrew. The 'mini overhead' drive is powering the cutter frame

are hinged to a length of 2in. angle running between the legs, one carrying the countershaft and the other the motor, are straight from M.E. No. 2545 of 2-3-1950. Both sub frames are adjustable with reference to each other, and to the lathe mandrel, to allow for belt tensioning. I have retained the 1in. flat leather belt drive to the lathe itself as, not only is the belt easily thrown between steps on the cones, but it acts as a useful fail-safe device should an overload occur in operation. I now use a Nycor laminated belt.

The motor fitted is a 220V DC machine of 1/3 HP, with the connections for the field windings brought out and the series field disconnected to enable it to be supplied through rectifiers and a Zenith Variac transformer from 230V 50Hz SP supply.

The rectifiers and transformer are housed in Zenith's standard package located under the chip tray on the right hand leg, and fed through a conventional push button isolator with overloads from the 230V single phase supply.

Control of the Variac is by means of a rotating shaft made from light alloy tube with steel ends pressed and pinned in, stretching across the front of the lathe and coupled to the unit by two sprockets and a light chain (Photo. 1). This gives a very sensitive control of the lathe for such jobs as screw cutting up to a shoulder. So successful has it been that I have fitted a similar arrangement (but with different electrics) to my 7in. Edgar and Wolf Jahn lathes. Reversing is provided by a rotary switch, for the right hand, supported from the chip tray; this reverses the armature current of the motor. I can strongly recommend this type of DC drive which gives infinitely variable speed control from a creep to full speed at a touch. I have only had one failure (of the field rectifier) in the twenty-five years since installation.

2. Back Gear

This was another M. E. inspired effort (see M. E. No. 2407 of 10th July, 1947). It involved making a new and longer mandrel for the lathe from a chunk of lorry half-shaft, suitably annealed. All turning was done in the lathe itself, but the final fitting of the journals to the headstock bearings was done by careful oil stoning in a treadle lathe which happened to be

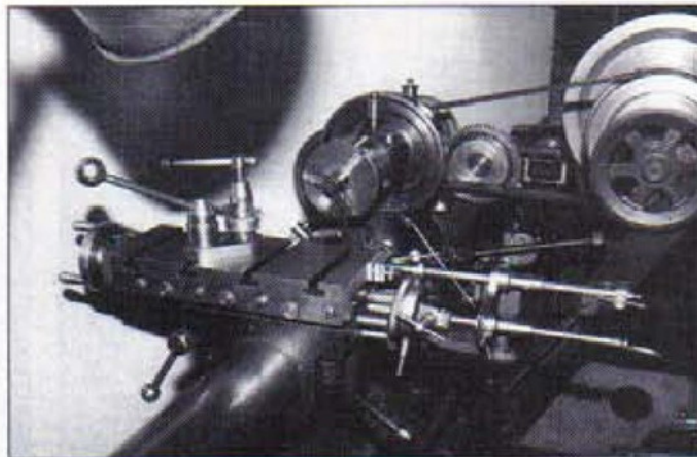
available. The mandrel was bored through with a 3/8in. hole. A pattern was made and a casting obtained for the countershaft arm which had to be put out for machining as it could not readily be accommodated in the lathe. The two pairs of gear wheels which give a 4:1 reduction were rescued from a derelict duplicating machine. The nose of the new mandrel was screwed 3/4 x 10 tpi to accept existing chuck back plates, and bored out to No. 1 MT.

3. Slow feed for Traversing the Slide Rest

An earlier attempt to provide this facility by means of a worm engaging with a change-wheel on the lead screw extension and driven by belt from the countershaft proved somewhat inflexible and has been replaced by that shown in Photo. 2. This consists of a short jackshaft with a sliding muff coupling set up in line with the lead screw extension and capable, by means of the coupling, of being locked thereto. This jackshaft is driven through a simple slipping clutch and a chain drive by a reversible variable speed motor, the controls for which may be seen above the main drive Variac. This motor is of split field construction and series connected and is not entirely satisfactory for the purpose as it has a drooping speed characteristic if the load on it increases: this is reflected in the finish on the workpiece. I intend to replace it by a compound wound DC motor and to re-work the electrical control system as necessary. The principle is, however, satisfactory. No limit switches are fitted as the carriage stop (see para. 18) can be set to ensure no over-run (inwards, anyway) at which point the slipping clutch yields, so that no damage can occur. This facility is very helpful on lengthy cuts.

4. Surfacing Feed Attachment

This is provided by a ratchet wheel fixed to the inner side of the cross-slide hand wheel, upon which acts a pawl carried by an oscillating arm depending from and centred on the cross-slide feed screw. This arm receives oscillating motion by means of a cord, guide pulley and spring combination from a small crank with



3. The lengthened cross-slide with stops, DTI and adjustable height toolpost. The large gear on the back gear countershaft is also visible

variable throw mounted on the outer end of the lathe mandrel in the position normally occupied by the driving change wheel.

This takes a minute or two to rig up, but is worthwhile on a long surfacing job. M.E. 2091 of 5/6/41 refers.

5. Indices

Both leadscrew and cross-slide screw are fitted with indices. The former, which is 10 tpi, has 100 divisions and the latter, of 12 tpi, 84 divisions, giving very nearly 1/1000in. per division (actually 0.00099).

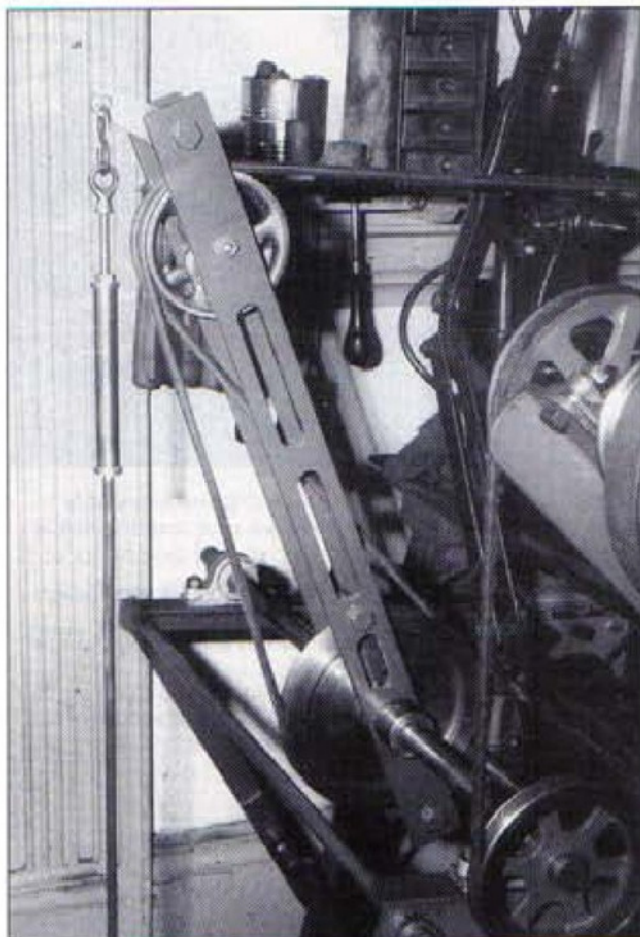
6. Tool Posts

The original Drummond open side tool post necessitates constant fiddling with pieces of packing to obtain correct operating height for the tool. I now only use it for special jobs and rely on one or other of two lantern type tool posts with screwed ring height adjustment (Photo. 3). These accept ordinary 1/4in. square HSS tool bits, and although theoretical objections may be put forward, I have always found them adequate for any ordinary requirement.

A similar boring bar tool holder with screwed height adjustment has been constructed to take a variety of boring tools and bars, similar (but more crude) and less elaborate than those described sometime ago in M.E. by George Thomas. In addition, a rear tool post with two stations, one for an inverted parting tool and the other for a 1/4in. tool bit as required, was made up and has been found of considerable value. Using it one can part off 2in. mild steel without use of back gear.

7. Cutter Frame and Drilling Spindle

These call for no special comment. The former (Photo. 2) has a spindle running on hardened and adjustable steel pivots and is bored to accept 1/4in. round tool bits, the latter has a 9/16in. carbon steel spindle running in bronze bearings. Both are constructed to be secured to the cross-



4. A close-up of the 'mini overhead'

slide, the former by a single T bolt and the latter by T bolts and strong-back, with packing as required.

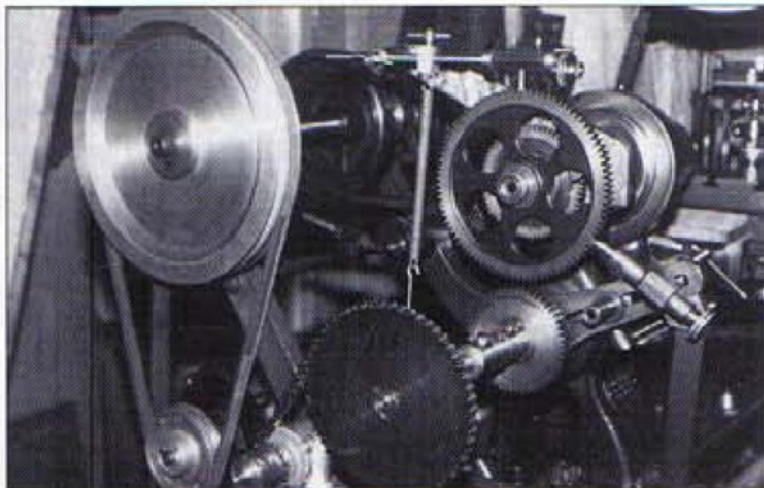
8. Drive to Cutter Frame and Drilling Spindle

I have never been particularly enamoured of the conventional overhead with its standards, arms, pulleys and what have you, all contributing to vibration and general mayhem, so I constructed a simpler and lower alternative which, so far, has proved satisfactory (Photos. 2 and 4). This consists of a sub frame hinged to the 2in. angle supporting the motor and main countershaft, which carries a length of $\frac{3}{4}$ in. shafting supported in two Oilite bearings at each end of the sub frame. On one end of this shaft is mounted a sewing machine pulley which accepts drive from a similar pulley on the end of the main countershaft, through an M section V belt. The sub frame is braced to the tie bar between the legs of the lathe by slotted struts which can be adjusted correctly to tension the driving belt previously mentioned. On the shaft is mounted what, for lack of a better term, I call the pulley carriage. This consists of two lightened lengths of 2in. x $\frac{1}{4}$ in. flat held apart by bolts and distance pieces and supported on the shaft by two bosses brazed into the flats and fitted with brass bushes. Thus the carriage can swing round the shaft and move laterally on it. In the space between the two sides of the carriage is mounted a driving pulley, a neat sliding fit on the shaft. This can be secured to the shaft in any desired lateral position by a hollow-

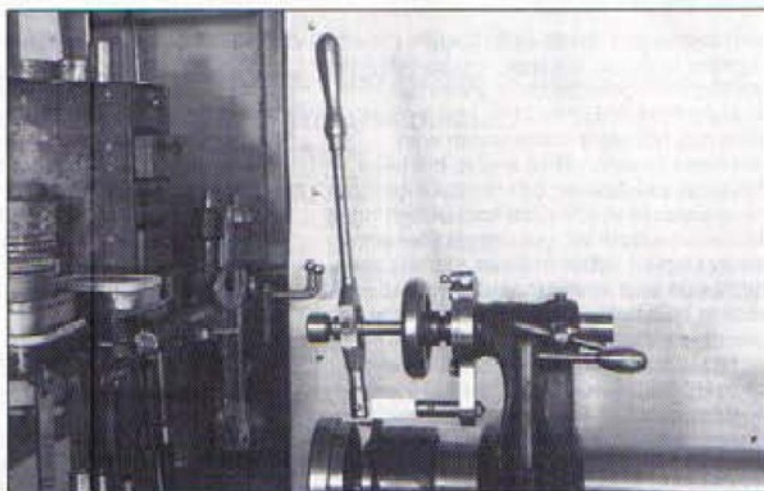
back key held captive between the sides of the carriage and lockable to the shaft by two set screws in the pulley boss, one on either side. At the upper end of the carriage is a spindle carrying two jockey pulleys and a lug to which may be attached a counter weight. The thread-up is as shown in Photo. 4, and the whole functions smoothly and without vibration. Different speeds can be obtained, not only through the variable speed drive to the main countershaft, but by playing about with the sizes of the two pulleys which transmit motion to the pulley carriage shaft. It may be argued that I cannot drive the milling spindle at right angles to the centre line of the lathe, but this can readily be accommodated by the provision of another pair of jockey pulleys mounted on and/or above the spindle itself. At any rate, I have not yet had a requirement for this configuration. Driving medium for the spindle and cutter is $\frac{1}{4}$ in. round leather belt and the length of the rod carrying the counter weight is adjustable so that, in the event of a belt breaking or coming off, it hits the floor before any damage is done to the rig itself.

9. Filing Rest

This was made up from a cutting of angle section to bolt directly to the cross-slide. Rough adjustment for height is provided by slotted holes in which the spindles of the rollers may be moved up or down and locked by a back nut. Fine



5. The headstock end of the lathe houses much of the new equipment



6. The lever feed tailstock

adjustment is provided by a 20 tpi micrometer jack screw with index, bearing on the stem of the cross-slide support. The bracket for this screw is fitted and set-screwed to the saddle of the lathe, directly under the socket for the cross-slide stem.

In use, one jacks up the cross-slide above the height required for the work in hand and then gradually lowers to bring the file into cut as required. M.E. 2090 of 29-5-41 refers.

10. Collet Chuck and Collets

This, another accessory inspired by back issues of M.E. (2609 of 24-5-51 refers) was made in a fit of enthusiasm for a particular job which I can't remember. The chuck body, machined to fit the mandrel nose, was made from a cutting of cast iron bar. The open end was taper bored to an included angle of 20 deg. and, on the outer diameter, screwed to take a steel locking ring. The collets were turned up from mild steel bar, correctly tapered to fit chuck and locking ring, bored and reamed and finally split in three parts with a slitting saw. Each collet incorporates a groove into which may be slipped a V shaped washer for ejection purposes. Collets for $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$, $\frac{1}{2}$ and $\frac{5}{8}$ in. were made, together with a number of blanks for extending the range as required, but although the whole has

proved satisfactory, I have never really made a great deal of use of it, probably because I don't find much occasion for repetition turning from bar stock.

11. Change Wheels

The lathe has a normal set of 14DP change wheels (some in duplicate), proceeding by 5 tooth increments from 20T to 60T and in addition, some useful odd-balls 26, 38, 52, 63, 66, 90 and 100T.

12. Dividing

Dividing is normally done by change wheels, either with a single wheel on the mandrel, or by a compound train using a spring-loaded detent bolted to the outer end of the change wheel arm (Photo. 5).

For divisions not obtainable in this way, there is an interpolatory micrometer detent working upon a single change wheel on the tail of the mandrel. This is based upon Holtzapffel, Vol IV p 125, and gives 533 divisions over a single 14 DP tooth. On a 100T wheel each such division accounts for 0.4 of 1 second of arc. Although no substitute for a proper dividing head, as it depends on 'chords' rather than 'arcs', it produces a reasonable result. It is, however tedious to use. (Fully described by me in ME Vol. 150 No. 3699 of 18-2-'83. For less precise requirements there is a 72 hole division plate and detent for the mandrel.

13. Cross-Slide Stops and Dial Indicator read-out

A bracket made up from cuttings of $\frac{5}{16}$ in. plate pinned and brazed together is bolted on to the rear of the boring table. This carries two bosses, one carrying the stop rod and the other carrying the dial indicator (Photo. 3). Both rods are in line with the axis of the cross-slide and are free to slide in their bosses. The dial indicator rod can be locked in its boss in any desired position by a brass-tipped lock screw. By adjusting this rod to suit the job in hand, the stem of the DTI can be made to bear on the rear face of the cross-slide and a direct reading of the cutter's position with reference to any datum obtained.

The stop rod is free to slide in its boss and is coupled to the end of the cross-slide with a form of ball joint. On the rod are two stop collars with setscrews, one on each side of the boss. These can be locked to the rod as required to provide *in* and *out* stops. The whole is made readily detachable should the cross-slide have to be set over for taper turning. The ball joint will accommodate limited adjustment of the cross-slide to secure flat facing.

14. Tailstock

This is fitted with lever operation, but retaining the original handwheel (engaged by a latch) as an alternative (Photo. 6). For this, a new barrel had to be made, 9 $\frac{3}{4}$ in. long and through-bored for an ejection rod. Mostly done by turning between centres (with, of course, exception of the boring and of machining the No. 1 Morse taper).

Design is based on an original by Duplex. There is the usual collection of die holders, centres etc. including a 2in. cone centre for tube work. There is also a 9in. ground finish 1in. OD mandrel for checking for parallelism in turning using a DTI on the carriage.

15. Fixed Steady

This was flame cut from a chunk of 1in. boiler plate and, after much labour with chisel and file, was bored and split to clamp on to the lathe bed. It will accommodate work up to 3in. diameter, and the three adjustable screws are fitted with brass pads which can be trued up when worn. I used $\frac{1}{2}$ in. Whitworth setscrews for these, but if I were to do the job again would use a finer pitch thread.

16. Travelling Steady

This was made up from odds and ends of BMS stock to bolt to the boring table, and carries two adjustable screws with brass tips to bear on the work. Using this steady it was found possible to screw cut a $\frac{3}{4}$ in. x 8 tpi square thread leadscrew 21in. overall in length in mild steel, without undue difficulty.

17. Locking Arrangement for Change Wheel Arm

In the original, this was locked in position by a setscrew with reduced end, bearing in the bottom of a groove turned in the end of the bed casting. In order to lock the arm firmly, the setscrew had to be inordinately tight and this eventually caused disaster when, as a result of over enthusiastic tightening, its point crushed in the bottom of the groove in such a way as to foul the muff coupling on the leadscrew. To effect a repair would have involved a complete dismantling of the lathe and much attendant work, so the original lock was abandoned and a simple slotted link working between pivot points attached to the arm itself and to the chip tray, was fitted. This has proved more satisfactory than the original arrangement.

18. An Inward Stop for the Carriage with Micrometric Adjustment

This is situated between the carriage and the headstock and consists of a split ring sliding on the lathe bed which can be locked in any position. It carries a protruding radial arm with a boss bored for a $\frac{1}{2}$ in. OD rod which can thus slide parallel to the axis of the bed. This rod carries a simple 40 tpi micrometer head (Photo. 1) which can be adjusted to bear on the leading face of the carriage: very useful for blind holes and holes with a change of section.

19. A Replacement Cross-Slide

The original cross-slide was found to be somewhat limited in travel and I decided, several years ago, to make a

full replacement but lengthened to extend this by some 2in. In doing so it was decided to follow the original design where possible, as the rectangular conformation with keep plates had advantages in view of my somewhat limited resources (not to mention the fact that it would be more in keeping with the rest of the machine). Accordingly, drawings were made from the original and re-dimensioned to achieve the additional 2in. travel and one or two other small changes which I thought desirable.

A start was then made with a pattern for the necessary casting for the stem / inner slide assembly and the resulting casting in iron machined up in the lathe by turning and fly-cutting. The moving slide was rather more of a problem and, for this, a slab of good quality cast iron 9in. x 4 $\frac{1}{2}$ in. x 1 $\frac{1}{2}$ in. was obtained. This was rough machined and trued up on one face, so that it could be bolted down on the table of my ancient hand planer which, some time previously, had been converted to serve in a dual role by the fitting of a leadscrew to the table and a vertical milling spindle in place of the tool box. (I will not attempt, in this article, to describe how this was done - for another day!). With this it was possible, first of all by fly-cutting, and finally by planing, to 'excavate' a slide way some 9in. long x 2 $\frac{1}{2}$ in. x $\frac{9}{16}$ in. to a satisfactory accuracy and finish.

With this accomplished, the rest was down the hill all the way - nothing more than conventional fitting and turning, although I remember problems with the leadscrew tunnel, necessitating the making and use of a special D bit. All was completed in-house, with the exception of the cutting of the four 'T' slots in the slide. I considered that it would be tempting providence to attempt them with my somewhat unpredictable plano-miller and home made cutters: they were cut for me in a friendly tool room.

The finished result can be seen in the photographs and has justified the effort in producing it. My only reservation is that I don't think I have placed the 'T' slots at their optimum spacing.

20. Locking and Clamping Arrangements

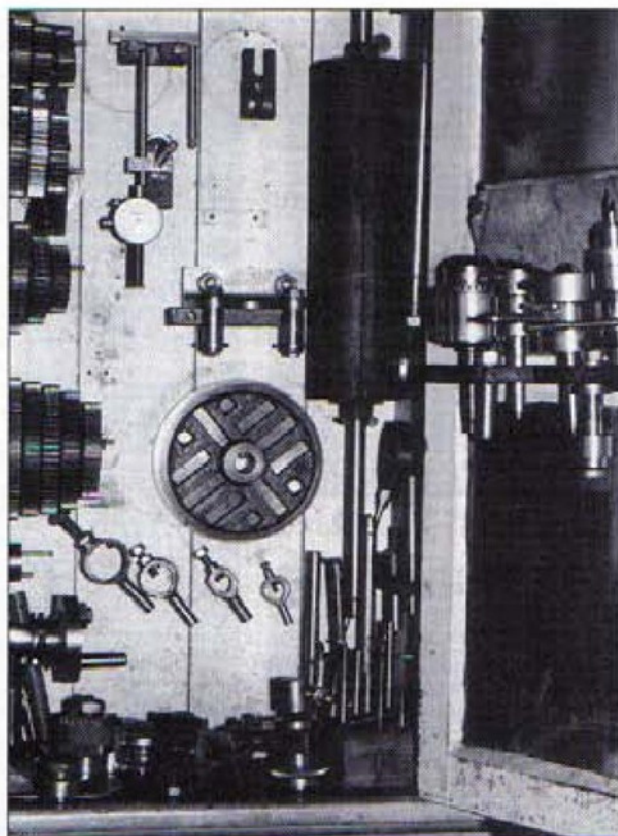
In its original form, all locking and clamping operations on the lathe were by nut and spanner. I have always found this not only frustrating but time consuming as, despite the most rigorous self-discipline, the right spanner was never to be found in its proper place when required.

Wherever possible, all such operations are now done by ball-ended levers, and spanners are now only required for exceptional operations such as setting up screw cutting trains. All these levers have been made by brazing balls of suitable size from discarded bearings on to appropriate stems. While this is, perhaps, not so elegant as a result produced by spherical turning, it provides an acceptable and much simpler substitute. If the end of the rod is cupped before brazing, the joint is virtually undetectable.

This about exhausts my list, but in addition to sorting out the sliding feed arrangements as mentioned in 3, I have it in mind to make a minimum height short top-slide to bolt down on the cross-slide, thus facilitating the production of short tapers and to permit angular advance screwcutting. I believe, however, that, as it is, the lathe can cover most of my requirements and tackle the fairly wide variety of work which finds its way into my shop. I make no claims that it is, in itself a precision tool but provided that the necessary time and care are taken, it is perfectly capable of producing precise results.

Finally, before leaving the subject, I think it might be of interest to consider the origins of the lathe's design and the reasons, not only for its longevity but why it never reappeared when Myford acquired the Drummond rights shortly after the War.

In so far as the design is concerned, it obviously originates in the highly sophisticated bar bed lathes made by The Pittler Machine Tool Company of Leipzig which were introduced in London in the mid 1890's and which were, I believe, the first such lathes to house the leadscrew within a tunnel in the bed. Drummonds simplified version was launched in 1908 and was continued without major



7. Some of the extensive range of miscellaneous accessories

change (apart from the optional longer bed) until 1940 at least: this gave it a useful life of some 32 years. Not bad

going for a simple robust design of which literally thousands must have been made.

I remember, in 1943, coming across a well-worn specimen in the Engineer's workshop of an elderly Cruiser and believe that the Admiralty was one of Drummonds major customers. When Myford acquired the Drummond rights I suspect that they did so in the knowledge that the days of the round bed design were over. It would not have made commercial sense to continue with two widely differing designs. To do so would have prejudiced the development of the more promising one of the two (the 'M' type Drummond) into the excellent lathes which they now produce.

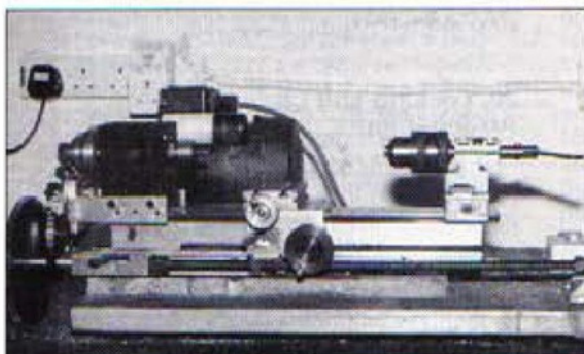
This is, in a way, a pity as the round bed design had merit. It was simple, effective and cheap. Had some detail re-design been carried out, such as the adoption as standard of the longer bed and a revision of the head stock to incorporate back gearing, together with a larger diameter mandrel, through-bored to 5/8 ID, it could still be with us and provide useful facilities at an attractive price - but this is all in the past and a matter for historians.

As far as I am concerned, the 4in. Round Bed Lathe is what I've got and in view of the foregoing, I'm unlikely to make a change!



IN OUR NEXT ISSUE

Coming up in Issue No. 56 will be



A LEADSCREW FOR THE PEATOL LATHE

A major enhancement to this popular small lathe is described by Tony Jefree

STAN BRAY ON LINE

Stan has taken to surfing the Internet and finds much to interest model engineers and other home workshop enthusiasts

MACHINE TAPERS

From Australia, regular contributor Philip Amos addresses the nature of tapers, their manufacture and their measurement

Issue on sale 19th February 1999

(Contents may be changed)

A VERSATILE CLAMP

Robert Newman gives detailed manufacturing instructions for an elegant clamping device which may be used on a range of machine tools

An acquaintance of mine possesses a large round magnetic chuck which spends most of its time on his pillar drill table. One day I watched him mark out the position for a hole to be drilled and reamed on a piece of steel which was then clamped in a vice and centred on the magnetic chuck. A switch was thrown, clamping the vice in place. He proceeded to drill and ream the hole. A simple job, simply done in double quick time. It made me green with envy. Even if events went well, I would have expected to spend at least a couple of minutes more to accomplish the same task.

Always prepared to spend as long as its needs to set up work for machining, it does seem to me that very simple tasks like the job described, take a disproportionate amount of time, especially on the drilling table; it goes against the KISS principle of which I am a disciple.

Eighteen months ago, my envy disappeared when the first model of my Versatile Clamp was finished. Inspired by a very crude and flimsy device on a woodworking tool, the clamp can be fitted to a drill table, milling table, lathe cross slide or metal cutting bandsaw in very short order. Adjustment for height, reach, position or angle of attack can all be achieved in seconds. In many cases where two clamps had been required, one Versatile Clamp sufficed. Not least of all, its grip is tenacious.

It gives me great satisfaction when I see one of these clamps installed almost permanently on my drill table, knowing that setting up and clamping times have been drastically reduced. Originally two clamps were made, a number which has since been expanded. Three is the minimum suggested number.

The body (Figure 1)

Machining was mostly done in a 6in. 4 jaw chuck, the sort of equipment that most of you will own. The body of the clamp is made from 1 1/4in. square bright mild steel (BMS). For every example made, you will need a piece 2 3/8in. long plus one piece 1/2in. long and one piece 1 1/4in. long. These two additional pieces will be used when machining each of the bodies, acting as distance pieces which help to centralise the workpiece in the chuck and also as

balance weights.

Square the metal to size, but do not use finishing techniques as it is better that the ends are left rough for gluing purposes. Finish machining of the bodies can be the last job on these components. Blue the bodies for marking, then using a surface plate and height or surface gauge, measure off all the salient points as shown in **Figure 1**. Dot the centre of the 5/8in. and 7/8in. holes, the centre of each end and the position of the anti-rotation pin. The balance pieces and the body are glued together with double sided sticky tape to allow positioning in the chuck. There are a few things you should know about this material if you have never used it before. First, be warned, it has little shear strength. Secondly it leaves a sticky residue on the metal which can be removed with paraffin or white spirit. If further sticking is to be done, these solvents must be removed using surgical spirit. The same solvent is used for degreasing. If components glued together can be held under pressure for a time, so much the better.

Remove any bluing from the ends of the body, then apply tape to the body end nearest to the 7/8in. hole position, trimming so that it does not protrude past the four sides. Lay the body on a surface plate and glue the 1/2in. spacer to the body. The plate ensures alignment of parts. The 7/8in. hole dot should now be in

1. The Versatile Clamp in operation

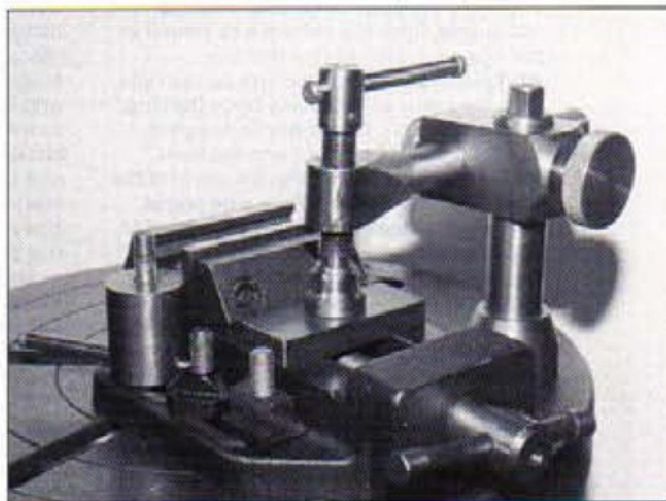
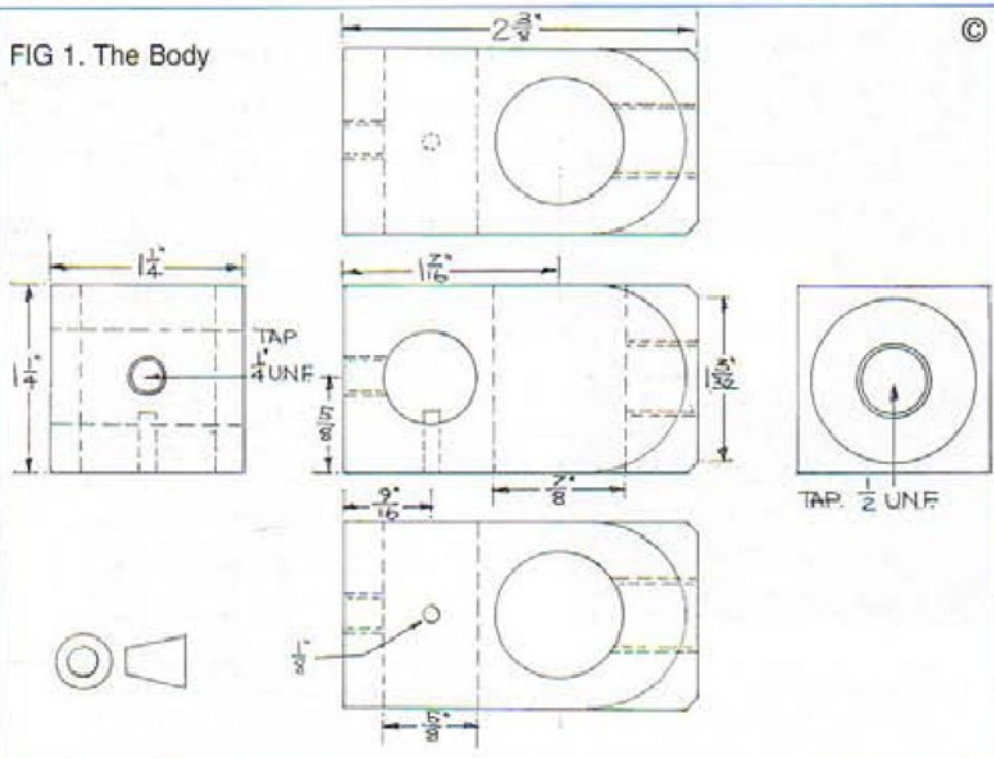
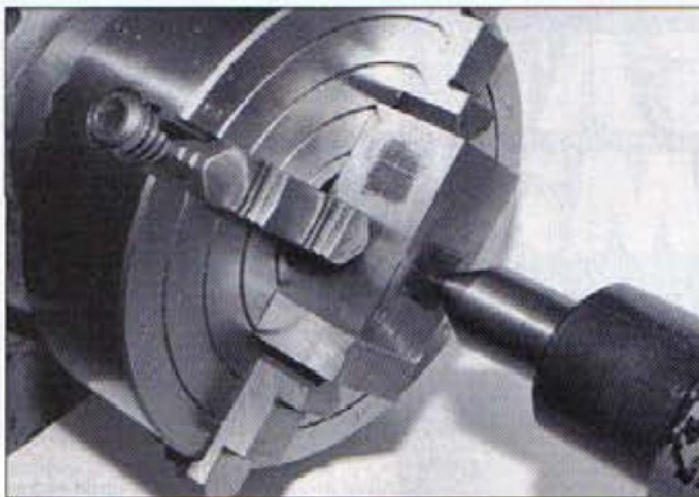
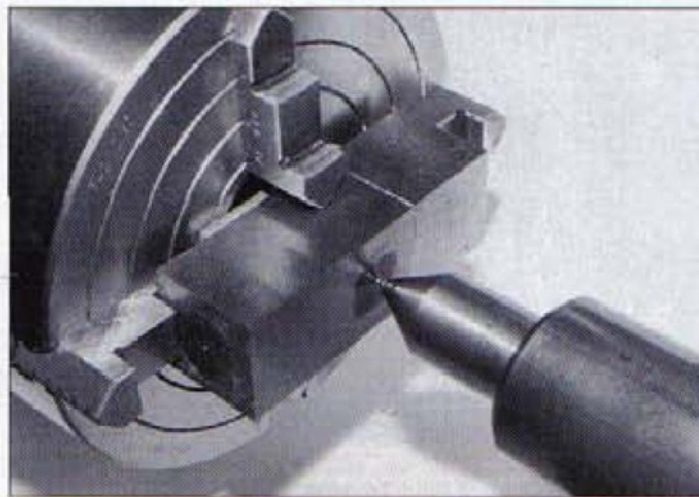


FIG 1. The Body





2. About to bore the $\frac{7}{8}$ in. hole, with the $\frac{1}{2}$ in. balance weight/packing piece in position



3. Setting up to bore the $\frac{5}{8}$ in. hole. The plywood backing piece can be clearly seen

the centre of the combined length. Fit a dead centre to the tail stock, open the chuck jaws to approximate position to accommodate the body, register the $\frac{7}{8}$ in. hole dot on the point of the dead centre and push the body in contact with the chuck face. Lock the tail stock to keep it in position. You should find that the workpiece straddles the chuck centre hole, with the metal of the chuck body backing the body length. Orient the body in the chuck so that it lies square to the jaws, then, very carefully tighten the jaws on the body, a bit at a time. If done with some sensitivity of feel, there will be no need to resort to other centring devices and you will still achieve a very acceptable accuracy. Just to be sure, withdraw the centre then return to the dot to check.

Normal $\frac{7}{8}$ in. diameter free cutting mild steel will suffice for the post, so the hole you are about to bore in the body must be a close sliding fit on this material, with a maximum clearance between the parts of around 0.0008in. Why so tight a fit you might ask? The action of tightening the

clamping screw on a component tends to cause the body to lift on the post; the tighter the fit of the post in its housing, the less likelihood there is of it 'racking'. This is possible, even with the clamping screw home tight. The tighter the fit, commensurate with the ability to slide, the more friction works for you. Aided and abetted by the clamping screw, a very firm grip is achieved. The looser the fit, the more the grip deteriorates. **Photo. 2** shows the body and spacer in the chuck and the $\frac{7}{8}$ in. hole about to be bored. Having completed the boring, remove the body from the chuck and separate it from the balance piece.

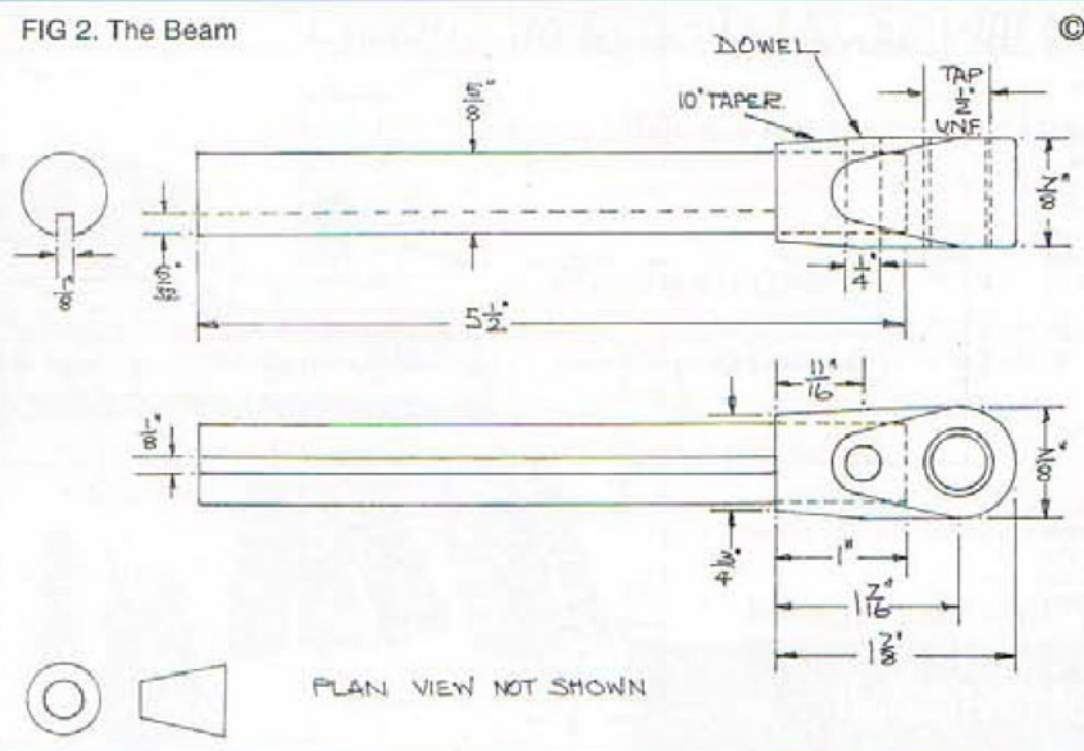
Using the surface plate, glue the $1\frac{1}{4}$ in. balance piece to the body on the end adjacent to the $\frac{5}{8}$ in. hole. The centre dot for this hole should now be in the centre of the length. If you now place the assembly in the chuck, you would find that the join of the two pieces is over the chuck centre hole, so if you attempted to bore the hole like this, irrespective of how tight the chuck grip was, the larger piece of metal

would try to tilt. Also, if we fastened the block in the chuck one pair of jaws would be extended to an unacceptable degree, so the solution is to reverse one pair of jaws and to back up the workpiece with a piece of 5mm plywood cut to 2in. x 1in. fastened centrally with double sided tape (**Photo. 3**). Again centre the body in the chuck using the dead centre. The ply is likely to hold the body just clear of the jaw step, but this is not important, the main thing being that the body is supported for most of its length. When the body has been clamped, bore the $\frac{5}{8}$ in. hole to an easy sliding fit, with no discernible slop, on the stock material which is to be used to make the beam.

When all boring is completed, return the chuck to normal configuration. The counterweight spacers will not be required again, so store them safely until you want to make more clamps. The ends of the block can now be drilled and tapped. The first two clamps I made used a $\frac{3}{8}$ in. thread in the end adjacent to the $\frac{7}{8}$ in. hole, but I always thought that this should

have been bigger. Later versions used a $\frac{1}{2}$ in. thread and were much better for it, with greater grip. While working on the ends of the body, the opportunity should be taken to finish machine them. The block is heavily chamfered at the end nearest the $\frac{7}{8}$ in. hole, to prevent damage to hands. On the first models, I left the corners on and clobbered myself a few times when tightening the clamping screw, hence the chamfer. The top-slide is set over to 45 deg. and the end machined to leave a $\frac{1}{8}$ in. land on each of the four sides. This is done immediately before or after tapping the $\frac{1}{2}$ in. thread. It is not necessary to taper the other end as the locking screw is only lightly nipped to hold the beam in place while adjustments are made, so skin damage is less likely to occur. Except for drilling for fitting the anti-rotation

FIG 2. The Beam





4. The earlier version of the clamp which features a fixed length beam with cotter clamping

to length and, as before, mark and pop centres of the thread, dowel, and beam insert. Scribe a $\frac{7}{16}$ in. radius at the position of the thread, ensuring that it is well defined. You will have noted that the thread position is in the centre of the block of metal for obvious reasons. Excess material will be removed later. Centre the block in the chuck using techniques previously described, there being no backing problems on this occasion. Drill and tap for the $\frac{1}{2}$ in. UNF thread. Remount the block in the chuck, so that the end to be

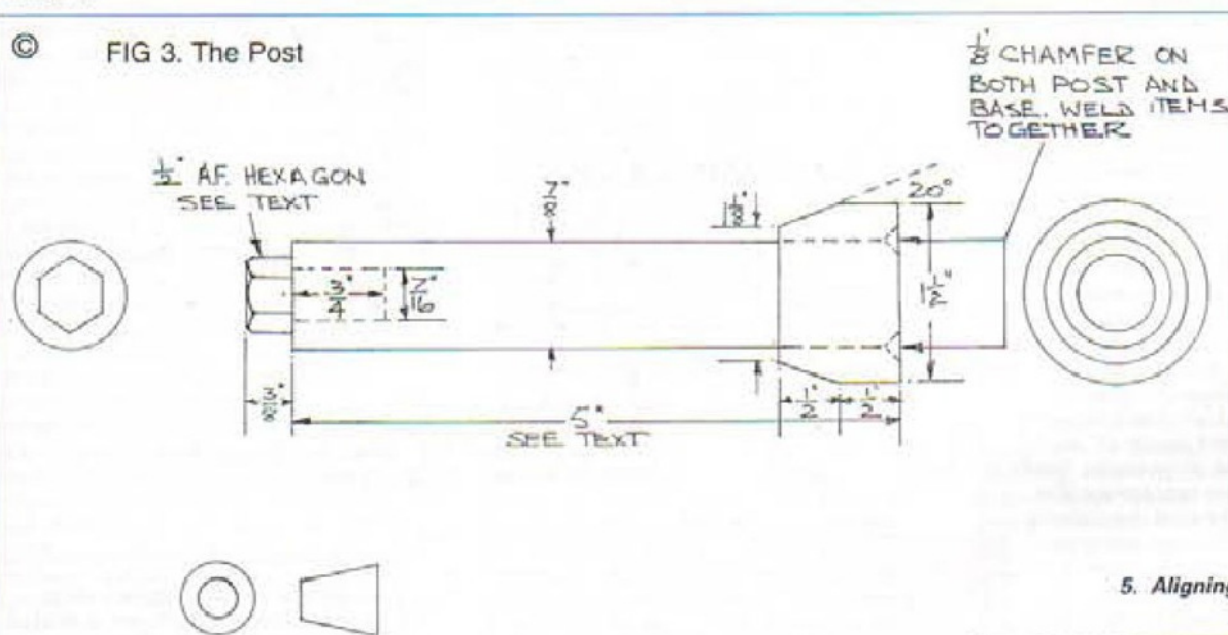
my disc sander to round off the end.

The slot in the beam now needs to be machined. As can be seen in **Photo. 5**, I used a vertical slide on the lathe, as I anticipate will most constructors. Also shown is the method used to ensure that the thread axis and the slot are directly in line with one another. Machine to a depth of $\frac{5}{32}$ in. and then remove sharp edges. Try the beam in the body to check that all is smooth, as entry must be able to be effected from both sides of the hole.

Now is the time to drill for the anti-rotation pin. First check that the dot mark is still in line with the centre of the $\frac{5}{8}$ in. hole. This is not as stupid as it sounds, as the $\frac{5}{8}$ in. hole may have been bored slightly off. Drill and ream for the pin which is made from $\frac{1}{8}$ in. silver steel. Degrease both pin and hole then assemble the beam, inserting the pin to engage with the slot. Ensure that the beam is free to move, trying it from both sides of the

block, all the time keeping the pin in the groove. In use, the ability to fit the beam from either side of the body gives 1in. of beam displacement left or right of the post without the need to move the post. If all is well glue the pin in position, otherwise rectify as necessary. If the pin is not

© FIG 3. The Post



pin, which is done later, this finishes the body.

A friend enquired as to why I did not use the cotter locking method, it being more efficient. In fact, two clamping beams of fixed length had already been made using this method for the woodworking part of my workshop (**Photo. 4**) and had proved to be ideal, but as the new bodies with $\frac{1}{2}$ in. locking knobs worked, why make things far more complicated?

The clamping beam (Figure 2)

The first two adjustable beams made used welding to attach the threaded upright to the beam. Being well out of practice at welding, my welds were poor and I was left with a great deal of filing and grinding to make the beam presentable, I was determined to find another method. As one of the new type has been used on my drill table for well over a year, gets used at least once or twice a week and shows no sign of giving up the ghost, I think I can safely say it works.

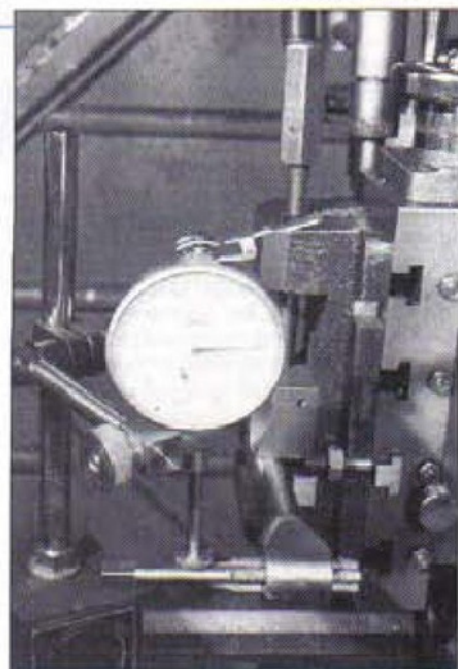
For every tool, a $2\frac{7}{8}$ in. length of $\frac{7}{8}$ in. square BMS is required. Square the ends

bored for the beam is presented, and accurately centre the block. Taking care not to break into the thread, bore to accommodate the $\frac{5}{8}$ in. diameter beam. A close sliding fit is again required, with positively no slop.

Now using the three jaw chuck, cut the necessary number of pieces of $\frac{5}{8}$ in. diameter free cutting bright mild steel (FCBMS) for the beams, finish machining to length and adding a small bevel at each end. Degrease one end of the beam and the mating hole in the block, glue the beam into the block and place aside to cure. Prepare a $\frac{1}{4}$ in. silver steel dowel, $\frac{7}{8}$ in. long for each tool. The dowel hole should be drilled and reamed in the beam when the glue has cured. After degreasing, glue the dowel in position.

The excess material can now be removed from the block and the beam prettied up a mite. Install the beam in the chuck, holding it by the diameter, with the block outwards. Set over the top-slide to 10 deg. to machine the taper, leaving a $\frac{1}{16}$ in. land at the join of the block and beam. File away any part of the dowel that might still be above the surface and round off the end to the radius previously marked. After sawing off the corners I used

5. Aligning the beam prior to cutting the groove



central to the beam hole then almost certainly you will not be able to enter the beam from both sides of the body. The beam will also not be vertical.

The posts (Figure 3)

The number to be made will depend on your own requirements. In my kit, each body is equipped with a 5in. post. There are two 6in. and two 4in. which are shared between the set. The 4in. posts are intended primarily for use on my metal bandsaw, but of course can be used anywhere. Up to now, I have never needed anything taller than the 6in.

Each post is made from two pieces, the post itself and a load spreading base. In all the tools I have made, the two items were welded together under the base, working into large chamfers on each item. Despite my remarks earlier re. welding, this is simple as the excess material can be easily machined away. Brazing also works, so I imagine would silver soldering, though a lot of heat would be required. The parts could also be glued and pinned together.

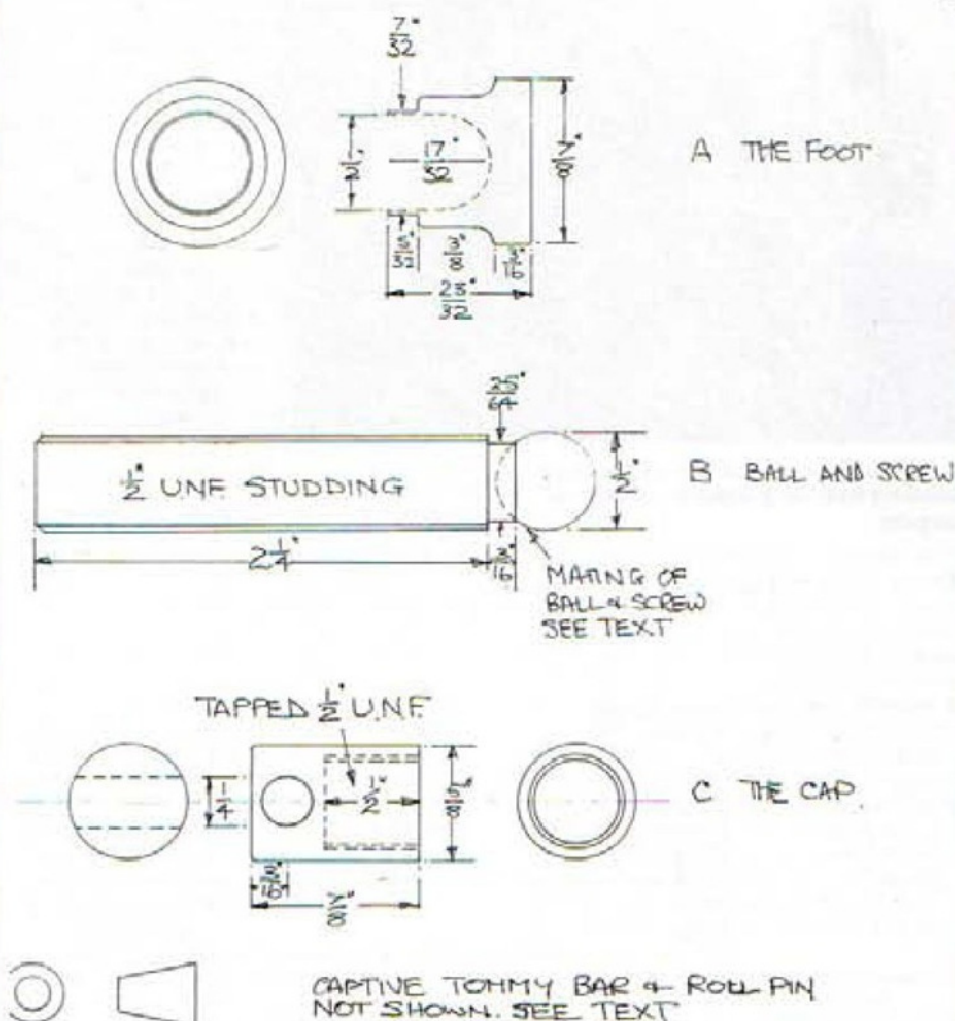
Cut the necessary number of pieces of $\frac{1}{2}$ in. and $1\frac{1}{2}$ in. diameter FCBMS and finish machine to length. Bore the $\frac{1}{2}$ in. hole a sliding fit for the post. As I do not have the grip of a gorilla, the first two models I made were drilled so that a tommy bar could be used when tightening the securing bolt. They were not very successful, as either the hole seemed to finish up in the wrong place or the bar got in the way when clamping components. Later models used an inserted hexagon. All posts, except for one 4in. have since been modified to this configuration and I would strongly suggest that you follow this course. Machine a length of $\frac{1}{2}$ in. BMS hexagon to $\frac{1}{2}$ in. diameter for a length of $\frac{1}{2}$ in. Part off to leave $\frac{1}{2}$ in. of hexagon, lightly chamfering. Bore the appropriate size hole in the end of the post, fractionally deeper than $\frac{1}{2}$ in. Degrease and glue together. When the glue has cured, drill for $\frac{1}{2}$ in. roll pin, $\frac{1}{2}$ in. long. Fasten the load spreader to the post by whichever means is available to you.

The base of the post is now drilled and tapped for the securing thread. Mine are all 8mm, as that is the size tapped into my 'T' nuts. Use whichever thread suits your equipment. All my posts are fractionally relieved on the base, to ensure even seating. The last job is to form a bevel on the top half of the base, for no other reason than it improves the look. Set the top slide over to 45 deg. and machine the taper to leave a $\frac{1}{2}$ in rim where it joins the post.

Clamping screw (Figure 4)

Because the $\frac{1}{2}$ in. ball will not pass through the tapped hole in the beam, this has to be a fabricated item. The threaded portion is made from $\frac{1}{2}$ in. UNF studding. Cut the necessary number of lengths to size and face the ends. To prevent damage to the threads from the chuck jaws, wrap thin aluminium sheet around the thread, a piece that does not quite close on itself being ideal. (drinks cans are a good source of material). Machine one end of the thread to the dimensions given in Fig 4 B, forming a seat for the ball. This is best

FIG 4.



6. The ball ended clamping screw and the foot

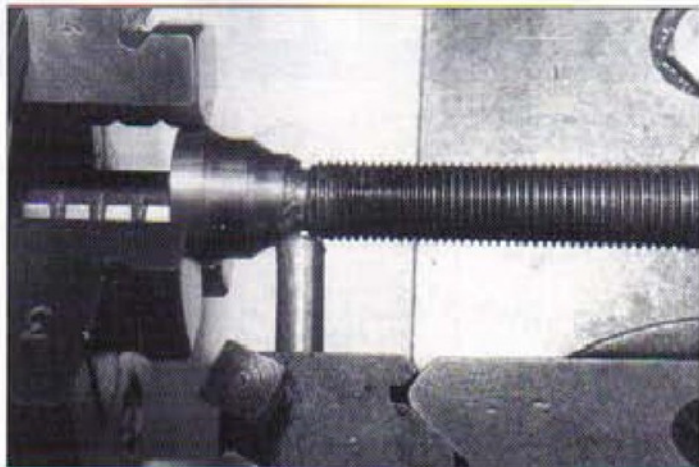
done with a $\frac{1}{2}$ in. ball nosed milling cutter, but if not available, use a drill. Thoroughly degrease both the machined end of the studding and a $\frac{1}{2}$ in. ball bearing, then do not touch these parts again with your grubby hands! For handling such items, I use large forceps which have a curved end (local fishing tackle shop).

Arrange some means of holding the studding upright for soldering. A firebrick drilled with various sized holes is my choice for this sort of operation. Normally I would now say "Silver solder the ball in place", but not this time. I have seen a very

competent model engineer (who certainly knows how to silver solder) fail to make the ball adhere at the first time of asking. He realised what had gone wrong on inspecting the joint. Exactly the same thing happened to me the first time I tried it, so I will explain how I have achieved success.

With the studding held upright, coat the ball seat with flux and place about a $\frac{1}{2}$ in. length of solder in the seat. This should be cut into very small pieces. Use $\frac{1}{2}$ in. if the seat has been drill formed. Actually, I prefer to use solder paste for this task. Apply more flux over the solder, then coat one half of the ball with flux and push it home on its seat. A short length of metal to press the ball down at a later stage will not come amiss.

The heating flame is directed at the top $\frac{1}{2}$ in. of the studding, NOT AT THE BALL and not at the joint line of the two components. When the top $\frac{1}{2}$ in. of the thread reaches the correct temperature, the ball will also have heated up by conduction. As soon as the solder is seen to flow and the two parts reach the same colour, cease heating. Allow to cool for a short while before quenching. Failure to fully heat the thread is the cause of the ball failing to adhere. If you can, soak the assembly overnight in dilute hydrochloric



7. The neck of the foot being turned over the ball

acid to remove scale.

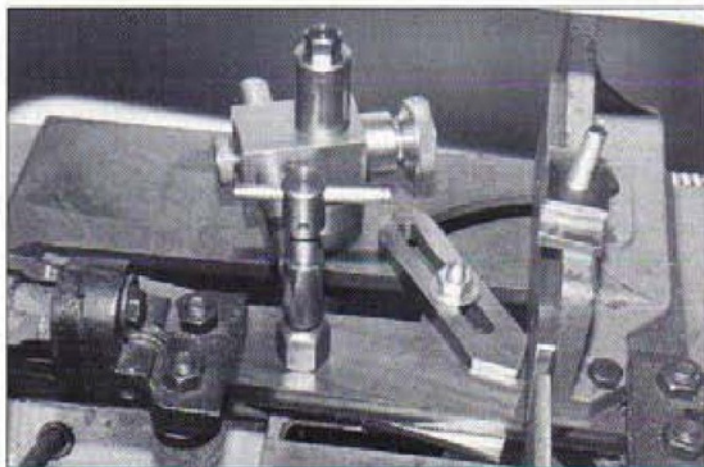
The foot is made to the dimensions shown in Fig. 4A. The ball seat being formed in the same way as that in the studding. It must be emphasised that the neck thickness should be as stated. Make it much thicker and you will have difficulty in turning the collar. You may, if you wish, reduce the thickness of metal under the ball to $\frac{1}{8}$ in. The ball should now be tried in the foot; a very smooth operation is required. Failure to achieve this may mean that, on tightening, the foot will attempt to rotate and consequently move the item being clamped. Ball end mills, worked at the correct speed and using lubricant will almost certainly produce the correct seating. If you have had to use a drill, the action is likely to feel rough. One remedy is to grip the threaded portion of the ball shaft in the tailstock and to spread a modicum of smooth grinding paste on the ball. With the foot correctly aligned in the lathe chuck, the ball is brought up to the foot and light pressure applied while running the lathe at low speed. Continually check the progress of the work, respreading the grinding paste at each inspection. When satisfied with the action, thoroughly clean the ball and seat. I should have mentioned that a couple of sheets of newspaper over the lathe ways would not come amiss and ideally, a 'slave' ball assembly should be used for the lapping. The clamping screw, complete with ball and the foot can be seen in Photo. 6.

I think that the cap requires little comment except for one thing. Use a plug tap to finish off the thread. If not available, then make the cap $\frac{1}{8}$ in. longer to ensure at least $\frac{1}{2}$ in. of thread engagement. My method of making utilitarian captive tommy bars is shown in a number of the photographs. Each consists of a 2 $\frac{1}{4}$ in. length of $\frac{1}{4}$ in. FCBMS, the ends of which are bored and threaded to take $\frac{1}{2}$ in. long 2BA screws. One of the screws is glued in position and lightly chamfered to indicate that it is fixed permanently. This is the method I use when I might want to strip the component at a later date. Assemble the cap to the thread and drill for the roll pin and tommy bar, removing the cap after drilling. Securing the foot to the ball end is simplicity itself. A short length of $\frac{3}{8}$ in. BMS with a radiused end is firmly fastened in the tool post at centre height. Set the foot in the chuck, accurately aligned, and liberally apply grease to the ball seat.

Some method of supporting the ball and threaded shaft is now needed. I used a piece of scrap brass, bored $\frac{1}{2}$ in. and held in a drill chuck. Push the ball home on to its seat and bring up the support to make sure the ball and thread do not tend to migrate to the right. The ball should be able to rotate freely. Apply grease to the thinned portion of the foot and, directing the turnover tool slightly in from the end of the neck, rotate the lathe chuck by hand while slowly advancing the cross slide to turn over the neck. All the time this is occurring, you should continuously check that the ball rotates freely. When the neck is almost touching the plain portion of the thread, stop. Withdraw the support and you should find that the ball has slight clearance but remains captive while still able to rotate. As there is little stress or friction on the collar, we can make it thin and relatively easy to turn over. It will last the life of the tool. Photo. 7 shows the operation in progress. It should be mentioned that if you have one of those single wheel knurling tools, it will make a superb turn-over tool if presented to the collar at an angle. The clamping screw can now be threaded into the beam from the slotted side, the cap is screwed on and the appropriate length roll pin driven home. Lastly, the tommy bar is fitted.

The final items to be made are the locking knobs. No drawings are provided as the construction is simple and you can make them as plain or as fancy as you please. The threaded portions at least should be made of brass or brass pads inserted with steel threads, thus preventing bruising of the post. The $\frac{1}{2}$ in. threaded knob should have a 1 $\frac{1}{4}$ in. diameter gripping section, ensuring firm clamping.

Photo. 1 shows the tool in action. On the left are the three adapters that allow the post to be secured to various pieces of machinery. The left hand adapter is the type used on the drill table and the metal bandsaw, as these tools allow access from underneath. The middle adapter is made for the drill table ($\frac{1}{2}$ in. slots), and on the right is a normal 'T' piece adapter for use on the lathe cross slide or milling table. All the threads are 8mm as mentioned earlier. It is arranged that, when fitted to any machine, the thread protrudes $\frac{1}{2}$ in. above the table surface. All threads are glued in position, no failure having yet been experienced. Photo 8 shows the Versatile



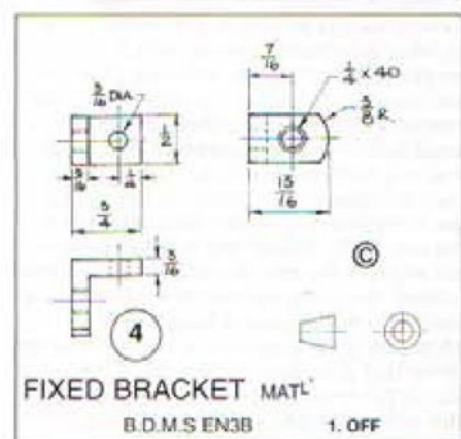
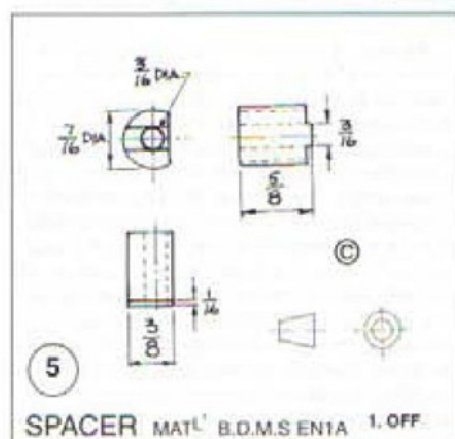
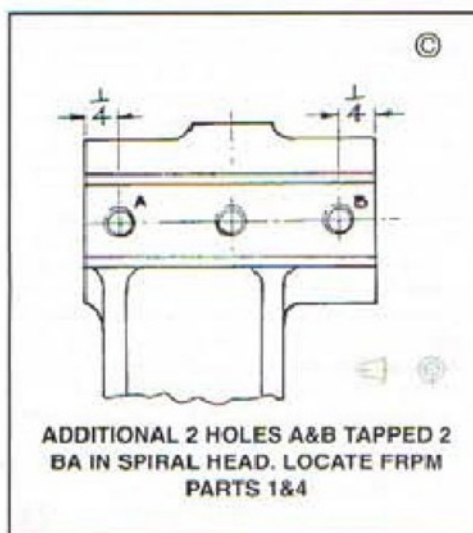
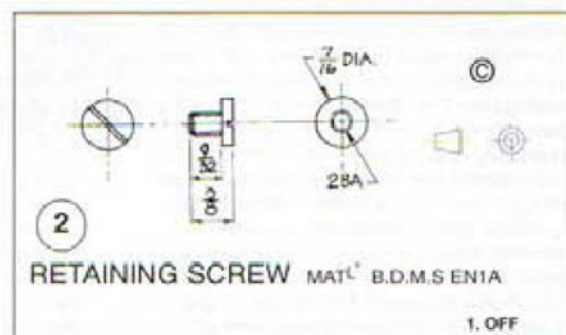
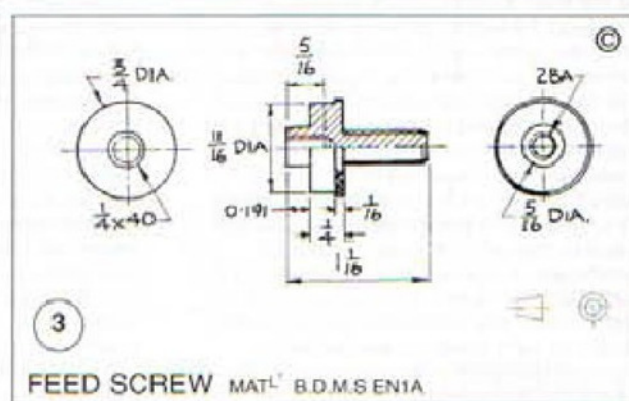
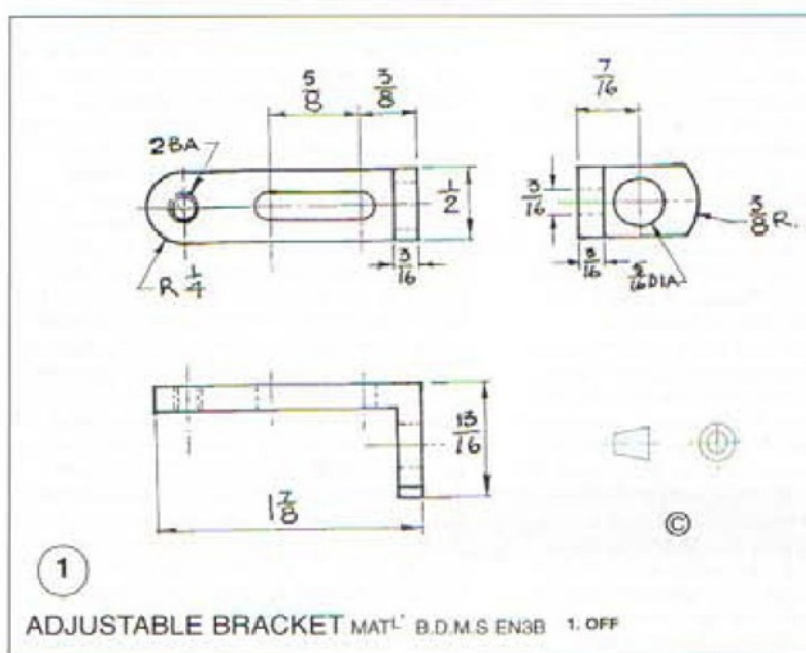
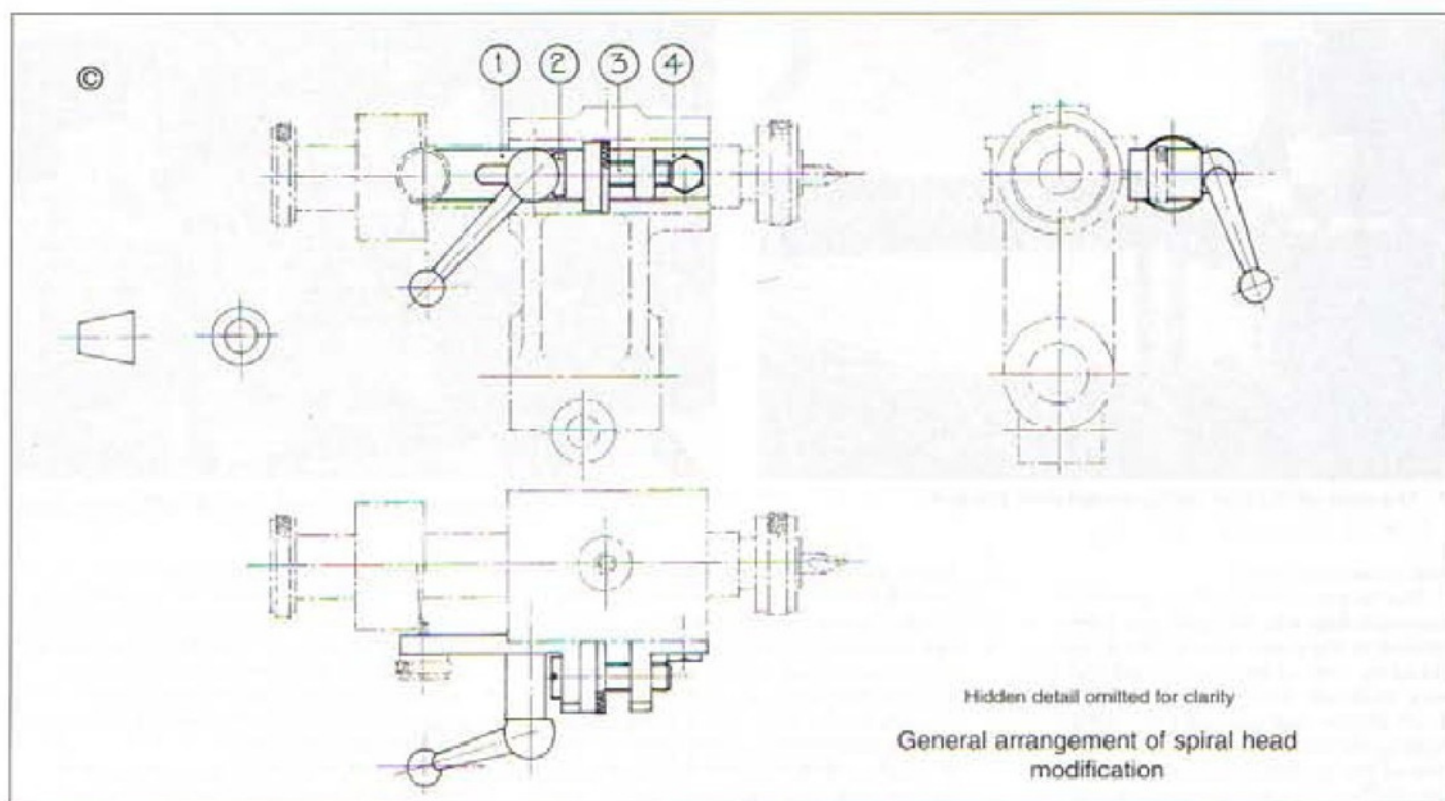
8. The clamp in use on the metal cutting bandsaw

Clamp in use on the metal cutting bandsaw (a posed shot). The rear fence is locked in position, and any metal required to be cut at an angle is simply clamped to the machine table; so much easier and quicker. The tool shown is one of the original two, made with welded threaded uprights on the beam.

Note the item occupying the central slot normally occupied by the moving fence. You may recognise this as a bridging piece, in this case pressed into service as a restraining finger to prevent the metal being worked from moving laterally. When the cut is at 45 deg. or more, it is not really needed, as long as the metal is pushed hard against the fixed fence. As I prefer to be more safe than sorry, I always fit it if circumstances suggest that I should. The item shown is 4in. long, with a 3in. x 8mm wide slot and is the largest I use. Others have lengths going down to 2 $\frac{1}{2}$ in., and are used on the pillar drill, lathe and milling table. In each case, the thread is arranged to protrude by $\frac{1}{2}$ in., thus allowing the post of a Versatile Clamp to be fixed above a finger, combining the two tools in to one. Very handy it has been in times past. For the bandsaw table, the 'T' piece is dropped into the slot from above. It is then rotated to lodge under the platform, the raised section of the 'T' being a good fit in the slot. A spare 'T' piece is shown, this one being fabricated, but normally they are milled from the solid. On the saw, conditions can be cramped, so nuts are the best locking medium. The curved slot in the platform, no longer used for its original purpose, is a further means of mounting the clamp to the table. A 'T' piece, made to fit this slot, is used with a large thick washer between post and table. For those who indulge in woodworking, the clamp, in company with prong nuts, can improve the versatility of a bench considerably. It has proved most useful on my routing bench.

The tool is not the be all and end all of clamping. It must be used with discretion. The common nut and bolt with bridging pieces can, at times, not be surpassed. After assembling the tool and trying it out, all you now have to do is sit back and await the first gripping event. (Sorry, could not resist that).

All the materials used were supplied by G.L.R. Distributors. I must say that they are a friendly and helpful bunch.



SCRIBE A LINE

Home built Air Compressors

From Patrick Butcher, Alness, Ross-shire

I was interested to read in 'Scribe a Line', Issue 53, that Mr John Noakes was having trouble finding data on National Pipe Taper Threads for use on his home made air compressor fittings.

If Mr Noakes has access to a copy of 'Machinery's Handbook', 24th Edition, on pages 1657 to 1667 he will find all the data he could possibly need on both American National Pipe Taper and British Standard Pipe Taper Threads. The tables included cover all sizes from 1/16in. to 24in. diameter in the American system and 1/16in. to 6in. diameter in the British system. The British tables also include ISO Metric sizes.

'Machinery's Handbook' is an extremely useful source of engineering data and I would recommend it to anybody who can afford it for their modelling activities. My copy cost £56 in 1996, but I wouldn't be without it now.

On another subject, would it be possible to persuade Bob Loader to write a compilation of his articles for the miniature lathe, in book form? The only books dedicated to miniature lathes that I know of are 'The Compact Lathe' by Stan Bray, and 'The Watchmaker's and Model Engineer's Lathe' by Donald De Carle. These, whilst excellent for general information, do not give any constructional articles specifically for miniature equipment. As Mr Loader appears to be the most prolific exponent of these machines at present (on the Unimat at least), a book of all his lathe based tooling could possibly be a winner. I for one would definitely buy it.

From Ray Harding, Beverley, East Yorkshire

In response to John Noakes request for information about NTP threads, I enclose photo copies of data extracted from a booklet published by Dormer Tools (Sheffield) Ltd. I have selected NPT, BSP and BSPT so that comparisons may be made.

You may recall that many years ago, NPT was known as 'BRIGGS' in the same manner as BSP was known as 'GAS'. I still have taps and dies marked 'BRIGGS' and 'GAS' in my collection dating back about 55 years!

Thanks to all those readers who have sent information on these threads. Copies have been passed to John Noakes. I would agree on the usefulness of 'Machinery's Handbook'. My copy is a bit long in the tooth now, being a 14th. Edition from 1952, but I refer to it

constantly. From time to time I see copies in second-hand book shops at quite reasonable prices, but the 'vintage' has to be watched as earlier editions are obviously lacking some of the data we need in today's changing world.

The Quick-Step Mill

From Roy Smalley, Dinnington, Sheffield

I have just finished reading the concluding article on this project in issue 53 of M.E.W., and I am impressed. You are to be congratulated, Mr. Payne, on a very neat and elegant design. I am sure this tool will be an extremely useful asset in many workshops.

Will you allow me to suggest a minor amendment? You specify a mains lead with a small three pin plug on one end and a 13A plug on the other. Such a lead is potentially dangerous, since the small plug will have exposed live pins if it is removed from its socket whilst the 13A plug is energised. I realise that you never intend to do this, but accidents do happen - the plug vibrates out; the machine stops for no apparent reason, and you wish to investigate with a voltmeter; another person (your grandchild?) pulls out the plug. There are a number of possible scenarios, but they all can lead to a very unfortunate conclusion.

It would be better to have the mains lead permanently connected to the machine, but if a removable lead is required, the mains lead should terminate in a line socket and the machine should have a chassis-mounted plug. Then if the lead is unplugged, there are no live pins exposed, only recessed socket terminals. Maplin supply suitable fittings, and I am sure that other sources can be found.

Over 40 years ago, when I was a National Serviceman, I saw my first electrocution victim. He had been electrocuted by a live 230V plug on the end of a wire. I have attended several electrical fatalities since then in the course of my work, but I still remember the blue lips and the stark, staring eyes of that first young man.

Please heed my warning and modify your otherwise excellent design.

Thanks to Mr. Smalley for pointing this out and also to Mr. Clouting of Hove, who wrote in the same vein. To be fair to John Payne, the fitting on his prototype which was referred to as the 'plug' is actually a side-entry line socket, in which the live connectors are shielded within the protruding portion which enters the chassis plug

fitted to the machine. There is therefore no danger of coming into contact with live pins if the connectors should become separated. As Mr. Smalley mentions, suitable connectors are to be found in the catalogues of such companies as Maplins and Electromail, and the appropriate items are listed by Hemingway, who are supplying materials for the Quick-Step. Drawings provided by Hemingway have been annotated accordingly.

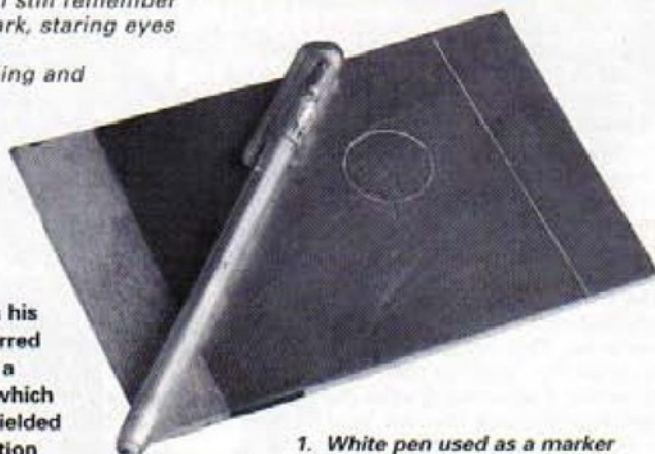
Early Myford lathe

From Trevor Gale, Rijnsburg, The Netherlands

As an ex-pat living in The Netherlands, I find it very difficult to obtain tools, especially an item such as a lathe and, where they can be found, they are typically three to five times more expensive than in Great Britain. (One extreme example would be a quote for a 125mm 4 jaw independent chuck, cast iron, no backplate, for 1712 guilders which is about £518!) Only dedicated items for brand new machines at high prices seem to be available.

This being so, a year ago I bought a lathe, second-hand, in Great Britain. I did not know its make, only that it had belonged to a chap who had passed on and that it was about 60 years old. It needed restoring, but that is mostly done now, but I spent several months finding out its identity. After many enquiries, I was referred to Myford, and there I spoke to 'John' who asked a couple of questions about my lathe and was able to tell me he thought it was a Myford ML1 (yes, one, not ten), and that very few of these were built during 1934-1935.

The only markings on the machine are 'Made In England' as part of the bed casting, and the stamp 'MA 109' on a raised rectangle at the headstock. Centre height is 8cms, and it's about 45cms between centres. The number MA 109 appears under all sorts of places, on the inside of gib strips, under the tailstock casting, etc etc.



1. White pen used as a marker (Letter from Patrick O'Keefe)

My question is: Are there any other readers with information on these early machines (Myford's information apparently only goes back as far as 1947), and does anyone know of a source of details for these machines?

In the meantime I must say that my restoration of the machine, no doubt far less complete and accurate than were my father to perform it, has nevertheless given a great deal of pleasure and interest, and also has brought back skills half-learned when I was much younger and with far less patience. The machine (and more tools made for it) is now in use.

Ways and means

From Patrick O'Keefe, Tenterden, Kent

As a genuinely amateur model engineer, with no background in professional engineering, I am often surprised to find that many modern materials or techniques are not used to assist our operations. As an instance, it is now possible to buy from most stationers or print-shops roller-ball pens in various bright colours, including white. These can be used instead of the traditional chalk or lead pencil, to temporarily mark out or spot metal items. My photograph shows such a pen and its results.

Another problem I have come against is the firm holding of awkwardly shaped castings, often needing all sorts of elaborate and specially formed packings and clamps. One such problem I solved recently by using plaster of Paris, in a fairly stiff mix, to pack out an engine cylinder in a Keats angle plate. Having used that to bore out the casting I then inserted the cylinder liner, already turned to external size, into the casting and temporarily fixed it there with a smear of instant adhesive (probably Loctite or similar would also suffice). I was then able accurately to bore out the liner, integral with the cylinder bore. A small amount of blow lamp heat will then loosen the liner and assist in removing the plaster of Paris from the casting and Keats angle plate. Another photograph shows this arrangement.

My early efforts at hack-sawing (and some subsequent ones, too!) resulted in the saw-teeth skidding across the surface of the work, sometimes seriously marking it. This was in spite of all the advice in technical books as to guidance with the thumb etc. So now, before starting sawing, I get a small triangular file, of a size to suit the work, and carefully file a small 'V' shaped nick at the back edge of the material. This should be wide enough to allow the teeth of the hacksaw blade to enter. A short backward cut or two will then deepen the slot, and normal work can follow without fear of the blade taking an erratic path of its own



2. A casting fixed in a Keats angle plate with the assistance of plaster of Paris

choosing.

Finally, against all the usual principles of filing, I have discovered a way of preventing the annoying

build up of small chips of metal clinging to the teeth of files when filing aluminium or alloys. Instead of lifting the file from the work on its backwards movement, let it slide back over the surface. This appears to clear all such chips as the filing proceeds, and saves much time and effort removing them frequently.

I assume that the far edge of the material, often with a slight burr from the action of filing, removes the chips on the backward movement. Final smoothing cuts would need to revert to the usual practice.

Re-furbished horizontal milling machine

From A. T. Booth, Nottingham

I am hoping that your readers may be able to assist me with information on my newly acquired STEDALL 'MECOL' No. 3 Horizontal Milling Machine, of which I enclose photographs taken after refurbishment. I am curious to know old it is, where it was made and the correct adjustment procedure for the spindle bearings (all the threads are Whitworth so I assume it is British made).

It is complete with the makers cabinet which contains the motor. The cabinet, main body of the machine and the access doors are all of cast iron. Table size is 15 3/4in. x 4 1/4in. The spindle has a No. 3 Morse taper. Power feed to the table is via a three step pulley on the tail end of the spindle, a countershaft, telescopic shaft and worm and wheel driving the leadscrew. It has four normal speeds plus four in back gear.

I look forward to hearing from anyone who may have a manual, brochure, or a similar machine. I can be contacted on 01155 965 4958

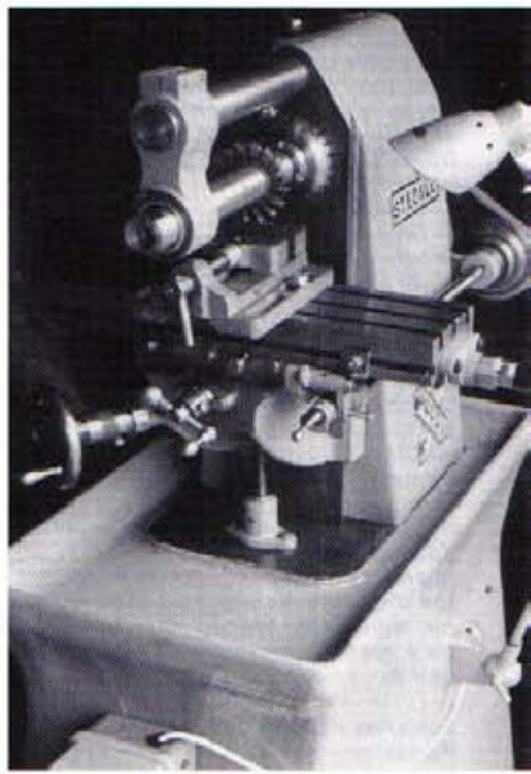
Domestic heat source

From Keith Wood, Wakefield, W.Yorks.

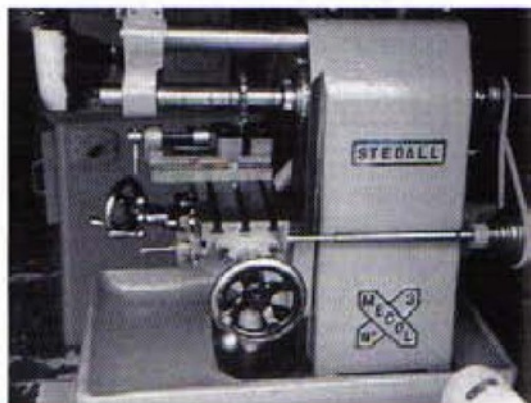
Any one lucky enough to still possess an ordinary domestic fire has a ready means of annealing even some of the more tougher steels. In the days before I invested in Quickset tooling, I used the type of toolholder which used a small HSS toolbit clamped in a mild steel holder by a square headed screw.

One day, the screw head broke off just where it entered the tool, so being unable to get any grip on the shank I decided to drill it out. It was hardened, so I left the whole thing in the remains of the domestic fire to anneal overnight and then drilled it out. It drilled very easily, no cutting fluid, but when I eventually got the HSS bit to fall out I found that I had drilled a beautifully clean 1/4in. diameter hole straight through, without noticing any change in the cutting forces required and with no damage whatever to the HSS drill I had used for the operation.

The fire will run up to a bright yellow heat using 'Homefire' smokeless fuel if the (natural) draught is left on too long. I suppose the fire may have been pretty hot when I first dropped the tool in, and I must have been lucky in keeping the drill cutting all the way through, as any hint of rubbing would almost certainly have immediately work-hardened the high speed steel.



3. Mr. Booth's Stedall 'Mecol' No. 3 horizontal milling machine



4. This view shows the drive to the table