No.53

MODEL ENGINEERS'

WORKSHOP

THE PRACTICAL HOBBY MAGAZINE

A FABRICATED DIVIDING HEAD

No castings required

SOLDERING ALUMINIUM

Low temperature technique

CNC MILL

Three axis machine for home construction

A GLASS ENGRAVING LATHE

Rescued and restored

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Tel: 01322 660070
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EDITORIAL

Editor
Geoff Sheppard

Group Editor
Ted Jolliffe

PRODUCTION

Designer
Mathew Deaves

Copy Control Manager
Carrie Dogan

Printed By
St. Ives plc (Andover)

Origination by
Derek Croxson Ltd.

SALES

Display Sales Executive
John Furlong

Classified Sales Executive
Sharon Hope

Northern Area Manager
Denise Barrow
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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MODEL ENGINEERS' WORKSHOP OCTOBER '98

CONTENTS

Issue No. 53

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

SUBSCRIPTIONS AND BACK ISSUES HOTLINES:
ORDERS:
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On the cover

This copper wheel glass engraving lathe was rescued by Alan Bourne just as it was due to go in the skip. He has now restored it and presented it to the Museum of The British Glass Industry. The story starts on page 18

His Royal Highness The Duke of Gloucester is seen in conversation with Ron Manning of the Chingford and District Model Engineering club while touring the SMEE 100 Exhibition (Photo by Mike Chrisp)

ON THE EDITOR'S BENCH

In this issue we conclude the short constructional series on the Quick-Step mill and start one on Peter Rawlinson's CNC milling machine. Both items have generated an enormous amount of interest, with material suppliers receiving a significant number of enquiries, even though the latter unit has, as yet only been described in general terms in the introductory article published in Issue 52.

I usually try to avoid having to split articles for publication into instalments because of the normal eight weekly publishing cycle, which can make things drag out over rather a long period. In this case, however, both contributions were rather large, mainly due to the number of drawings involved, and would have completely overwhelmed a single issue. As it happens, we are now into the period of the year when we have the 'extra' issue, and have a run of three magazines at four weekly intervals, so I thought that this would be a convenient time to publish them. With so many components to be made in each case, I feel that it would be a very swift worker who would be held up for a lack of instructions.

One of John Payne's Quick-Steps was on display in the tools and equipment section at SMEE 100, together with some of the examples of work it is able to produce. Many visitors were seen to be studying them closely. Peter Rawlinson's machine has also begun to become productive, with the added CNC dividing head facilitating the manufacture of components which would be very difficult and time consuming, if not impossible, to produce with accuracy in the home workshop in any other way. I have asked him to let me have photographs of some examples as soon as possible.

SMEE 100

Mentioning the Uxbridge gathering, I have included a couple of pages of photographs in this issue, showing just a few of the highlights, with an emphasis on the tools and workshop equipment on display. I feel that the readers who attended will agree with me that it was quite an outstanding event, with the opportunity to see items which are not normally available for viewing by the public. Also not to be missed was the chance to meet so many readers of this magazine, because although I was primarily there as a SMEE member, helping as a steward, it was inevitable that I would be wearing two hats for part of the time. Particularly pleasurable were the meetings with readers from overseas who had made a special effort to be at this unique event. I can now put a few more faces to names.

The 68th Model Engineer Exhibition and the International Model Show

Included in this issue are further details of the exhibition to be held at Olympia at the turn of the year. This will be the last one to be held at this venue, and I hope to be soon in a position to give details of the location and timing of the 69th Exhibition, but contractual details had not been finalised at the time of going to press.

As far as this one is concerned, there is just a short while left to make an entry in the Competition and Loan sections, but by completing the entry form (or a photocopy) and sending it to the Swanley address quoted, you will ensure that your exhibit is registered. We have included an extract from the competition class lists, detailing those in which readers of M.E.W. and Model Engineer are likely to have most interest. The full list of classes is in the Competitors' Handbook which again is available from Swanley.

Not mentioned in the abbreviated list are, apart from the Duke of Edinburgh Trophy, the special awards which have been donated over the years by 'friends of the exhibition' for presentation in recognition of particularly meritorious work in specified categories. These trophies and prizes are presented in addition to the usual medals and certificates awarded in each class. Of particular interest to the readers of this magazine are the Bowyer-Lowe Trophy, donated by the late Mr. A. E. Bowyer-Lowe to be awarded for the best example of craftsmanship and design in the Tools and Workshop Appliances class (Class A5), and The John Gray Memorial Trophy, donated by the family of the late John Gray for the best exhibit in Class A5 by an entrant under 25 years old in the year of entry.

It would be pleasing to see a bumper entry in Class A5 this year, as I know that there are some pieces of workshop equipment of the highest quality out there, and they deserve to be seen and admired by all.

I am aware that many people who make such items do so to provide themselves with an aid to making some other piece of model engineering, and do not consider that the tool is in the 'concourse' category, and would have no chance of winning an award. They may be underestimating their abilities, because ingenuity of design can play a large part in the scoring, but such items are always welcome in the 'Loan' section, where they may studied by others faced with similar tasks, perhaps solving a problem which has been puzzling a fellow model engineer for months. Don't say "Oh!, no one would be interested in that." It is often such a device which generates the most comment.

Tom Walshaw (Tubal Cain)

Since Tom's death, many people who have admired his work and appreciated his advice have asked if there is some tangible way in which he could be remembered. Responding to a wish expressed in his will, his family have decided that the most fitting memorial would be a donation to the Woodland Trust.

Tom was a keen conservationist and the Woodland Trust have agreed to set up a memorial fund in Tom's name and that all donations will be used to forward the work of their Cumbria branch.

Contributions should be sent to Miss Jane Gooderson, Commemorative Administrator, The Woodland Trust, Autumn Park, Dysart Road, Grantham, Lincolnshire NG31 6LL.

Brooklands Museum

As the motor racing season draws to a close, I have the opportunity of assisting in the organisation of a straight line sprint which takes place on the now disused runway of the old Vickers airfield located within the Brooklands complex. This gives me the chance to take another look at the wonderful museum which has been established in the redundant buildings. Bringing together a display of artefacts from the earliest days of both motoring and aviation, this is very much a living museum, with restoration projects being carried out in the full view of visitors. The people involved are always willing to describe what is going on and to explain the significance of the exhibit in question.

Not only cars and aircraft are being refurbished. The buildings used by the old constructors, tuners and sales organisations are being lovingly repaired and redecorated, so that turning a corner behind the old clubhouse takes one straight back into the 1930s. Unfortunately, only fragments of the banked track and the Campbell circuit remain, but the Test Hill (1 in 8 if my memory serves me correctly) stands as if ready to provide a challenge to the next series of products from the motor industry.

A small room, once used by Malcolm Campbell as a sales office now contains, just as found, the contents of a workshop of an engineer who used to fettle cars of the 1920s and 30s. It looked awfully familiar!

As I studied one exhibit, I overheard a visitor saying "If it's anything mechanical, even if its only a nut and bolt, then I'm interested in it". I concur with his view, and commend a visit to Brooklands to anyone who is of a like mind.

CLOCK BUSHING TOOL

David Penney of Chesterfield combined the best features of a number of designs to produce this handy aid to clock repair

During the time I spent at the training college on a clock and watch course, most if not all the clocks that I had to repair needed attention to the pivot holes in the plate. This was dealt with in a number of ways; the first was to ream out the worn hole with a taper reamer to a size that would take a ready-manufactured bush. This was done by very careful reaming and, when the right size was found, the reamer was marked with ink or tape so the same size could be found again. This was all right if you had a steady hand and you did not want the reamer for a larger size hole. A further disadvantage with this method was that sometimes the hole became elongated and, if this happened, it was difficult to find the centre.

The next method was by means of a purpose built bushing tool, on which the clock plate was placed so that the hole could be reamed and bushed in one operation. This was much better, but there were still some problems.

The college had two bushing tools, made by different manufacturers. They employed the same principles but they both had their problems, so the next step was to produce one which incorporated all the good points and which could also be used as a light tapping machine.

The manufacture of the machine is not too difficult, the hardest part being the cutters, so I will start with these. All the cutters are made from 1/4in. dia. silver steel, turned down to the following sizes:-

0.197, 0.247, 0.297, 0.347, 0.447, 0.547, 0.597mm.

These sizes are 0.003mm smaller than the commercially made bushes produced by Bergeon for the clock trade.

Reamers

I started by making up a small jig to hold the reamer blanks, so that they could be held in the milling machine in order to have the small flat milled on the end. Then, into the lathe to turn the reamer diameters. I first turned the large diameters so that if I got it wrong, I could go to the next size down. When all the reamers had been turned to size, the 2 deg. tapers were machined, making sure that about 3/8in. of full diameter was left at the top. A little less than half of the tapered part of the reamer was now cut away, the large ones being filed or milled before grinding.

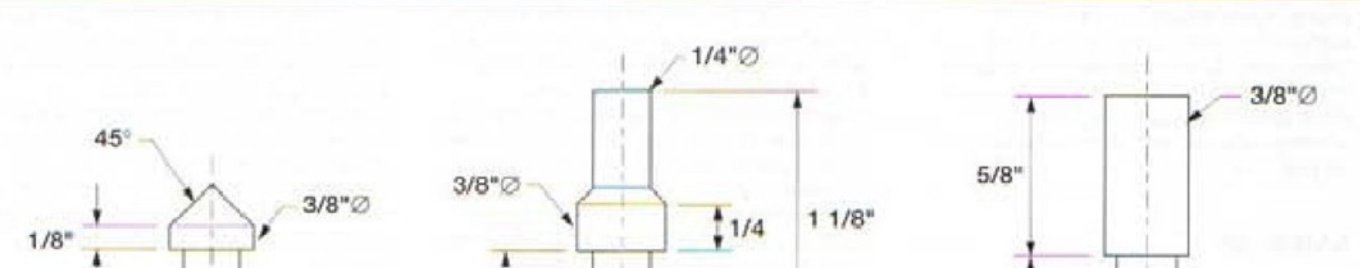
This grinding was done in the lathe, first locking the head before setting the holding jig in the chuck, making sure that the cutter was located in the jig with the flat on the cutter at 90 deg. to the lathe bed. A milling spindle equipped with a cup grinding wheel was fastened to the cross slide, and by operating the cross slide and saddle, the remaining metal was removed to leave exactly half the diameter. When all the reamers had been finish turned and ground, the size of each was stamped on to the holding flat before it was hardened and tempered. If the builder is put off by this operation, the reamers can be obtained commercially.

Column

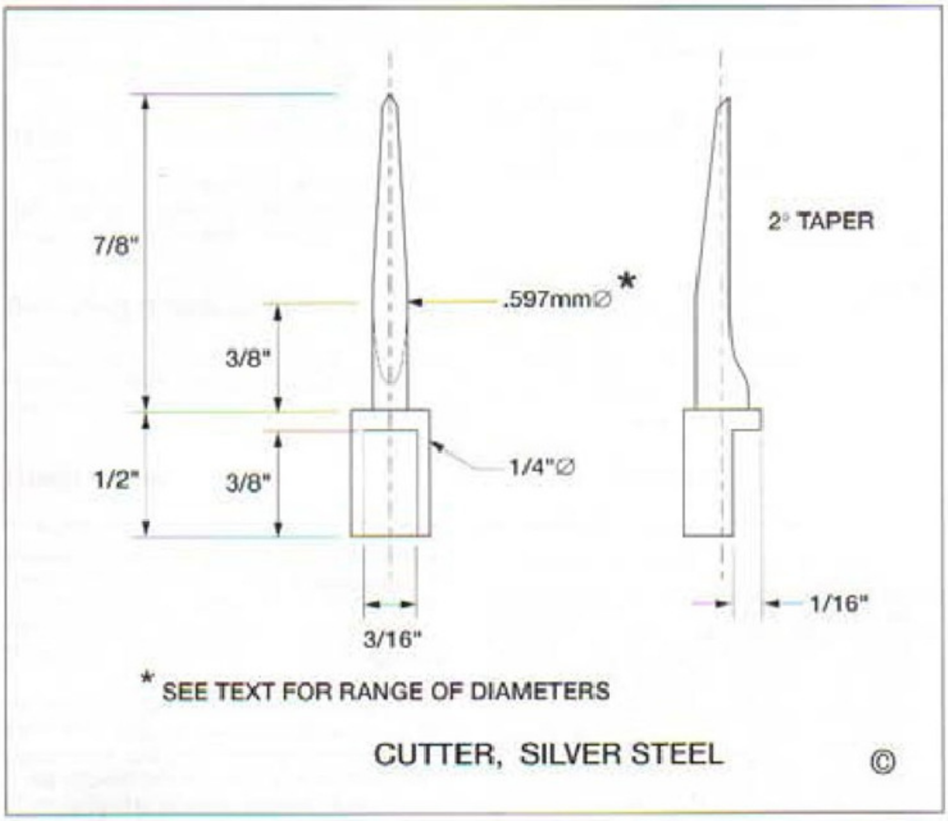
This is made from 1in. dia. bright mild steel, 12in. long, with a 1/8in. x 1/8in. keyway cut along its length. This allows the head to be raised or lowered without the centre setting being disturbed.

Base plate

After marking out and drilling the four 5/16in. holding-down screw holes, the locations of the centres of the lower column support and the anvil support bush were determined, but no holes drilled at this stage. By scribing a circle of the same diameter as the flange of the lower column support at its location at the rear



CENTRE, B.M.S. | BUSH INSTALLER (SMALL), B.M.S. | BUSH INSTALLER (LARGE), B.M.S.



CUTTER, SILVER STEEL

of the plate, it was possible to locate the flange for drilling at a later stage.

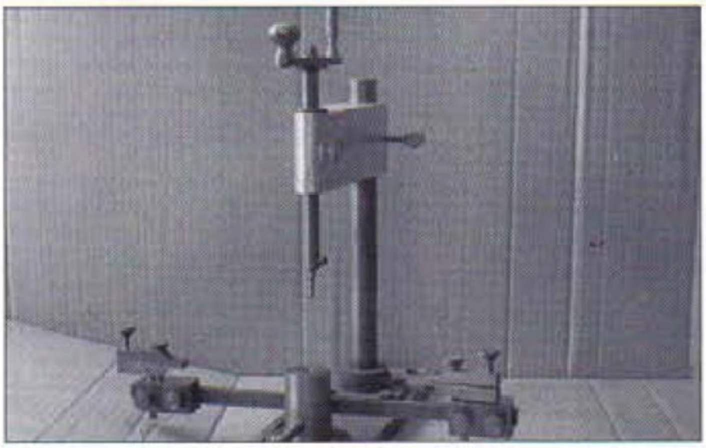
Lower column support

With the bright mild steel bar turned down to the dimensions shown on the drawing, the 1/4in. BSW hole was drilled and tapped to accept the retaining grub screw. The 1in. dia centre hole was bored to a good fit on the column then the four 1/4in. dia holes marked and drilled in the flange. These could then be transferred to the base plate. A small flat, not shown on the drawing was machined at the bottom of the column, so that the grub screw would hold it in the correct orientation on the base.

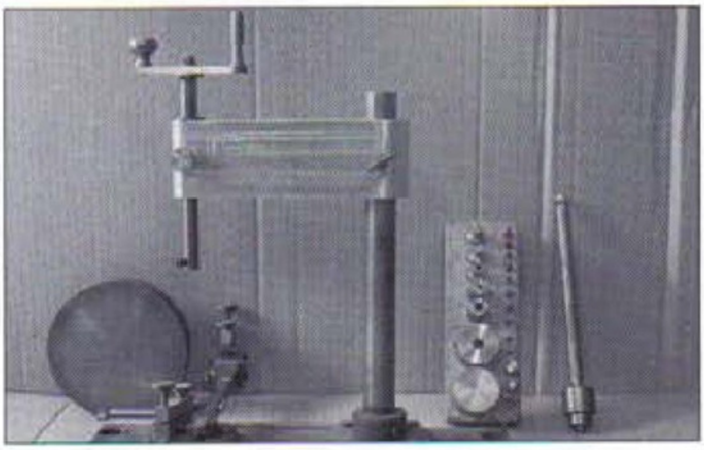
Anvil support bush

This is much the same as the column support, but has a 3/8in. centre hole and a 5/16in. x 1/2in. deep recess cut at the rear, with two 2 BA holes tapped in its face. These are to hold the support bar. The holes were drilled using the bar as a jig.

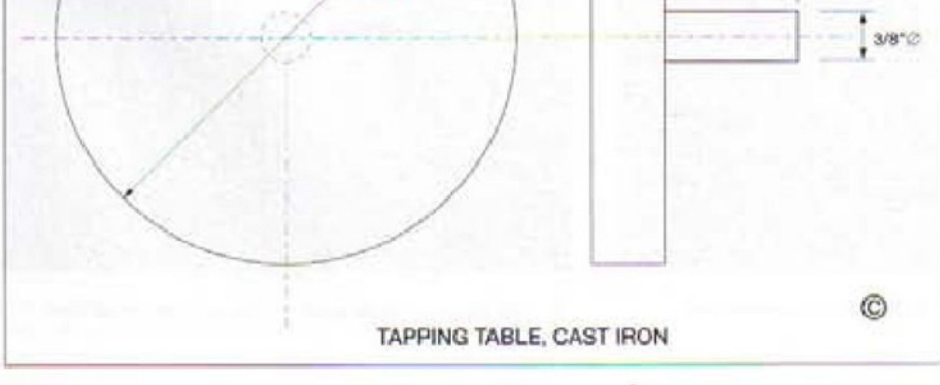
Do not be tempted to fit this bush to the base plate at this stage because it must be located in perfect alignment with the main arm.



1. The completed bushing tool shown with the large anvil and the clamps in place



2. A good depth of throat allows the largest clock plates to be accommodated without difficulty



TAPPING TABLE, CAST IRON

Anvil lock screw

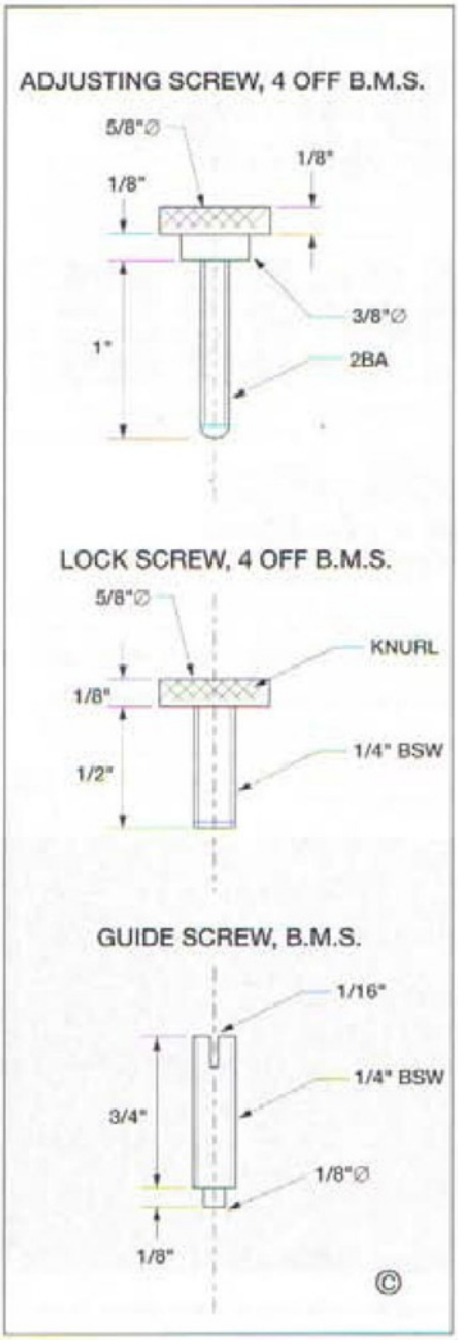
This item is only necessary if the machine is to be used, in conjunction with the cast table, as a tapping device.

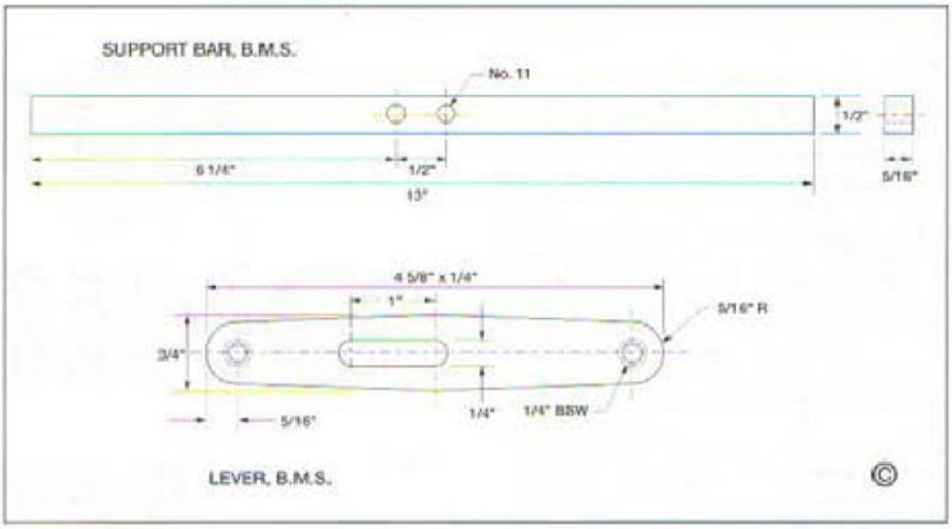
Main arm

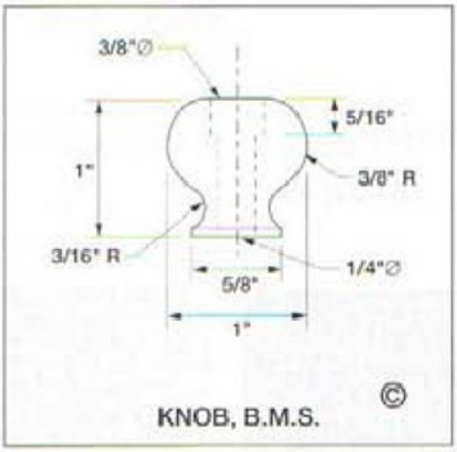
The arm is made of aluminium. The 1in. dia. hole was first drilled and then bored out in the milling machine, then the 1/2in. dia. hole is drilled and reamed in the same machine. The waste material on the sides was milled and filed away to the dimensions shown on the drawing. The two 1/4in. BSW holes at the rear are for the lock screw and guide screw; that at the front is used to lock the drive rod.

Drive rods

Made from 1/2in. dia. silver steel, 7 1/2 in. long, these have a 1/4in. square and







a short length of $\frac{1}{4}$in. BSW thread machined at one end. The square gives the lever a positive drive and the thread accommodates a retaining nut. The lower end of one rod has a $\frac{1}{4}$in. dia. reamed hole for the cutters, with a 4 BA grub screw for retention. The second rod has a $\frac{1}{4}$in. UNF thread to take a small drill chuck.

If the machine is only to be used for bushing, the second rod will not be required.

Slide body

I first made the back plate because this can be then be clamped to the slide body and used as a jig for the four 4 BA retaining bolts. Next, all the other holes were drilled and tapped and the body then placed in the miller for the slot to be machined. This slot can be made a little over-size to allow free movement on the support bar.

Clamp

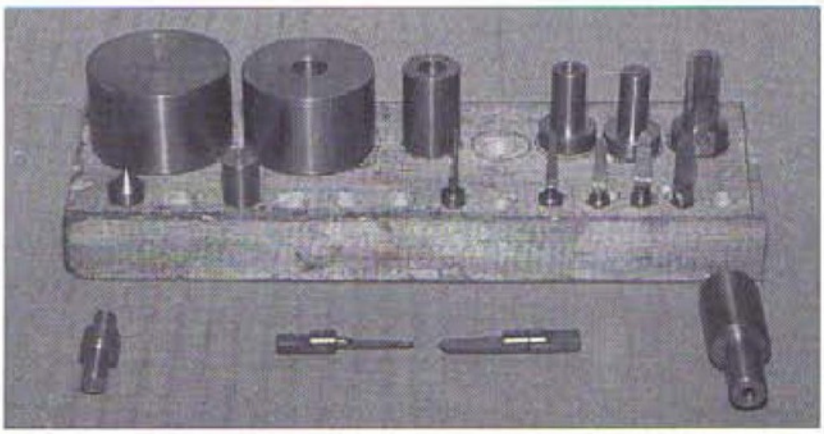
The lower clamp of each pair is similar to the upper, except for the $\frac{1}{4}$in. dia. hole which takes the support rod. The rear clamp screw hole is only drilled $\frac{3}{16}$in. deep to act as a retainer. The support rod is kept in place by a $\frac{3}{32}$in. roll pin. It will be found that the clamps can moved in all directions when clamping a clock plate in position, thus having the advantage of being able to hold the plate in different positions when there is something fastened to it that cannot be removed (e.g. a riveted pillar).

Support bar

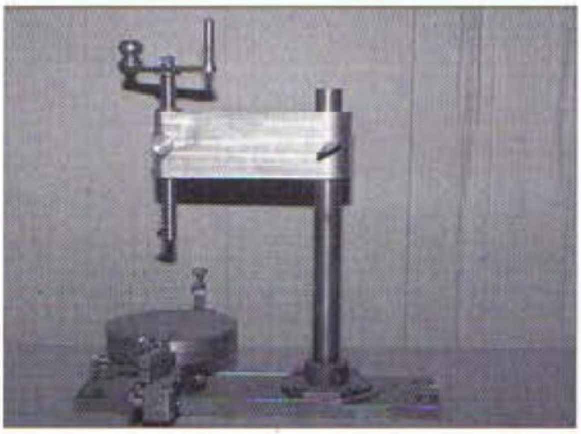
After marking out and drilling the two No. 11 holes in the $\frac{1}{2}$in. side of the bar, their locations were transferred to the anvil support bush before opening them out to 2 BA clearance. With the holes in the bush drilled and tapped, the assembly could be put together with 2 BA screws. The ends of the bar may be drilled $\frac{3}{32}$in. to take roll pins which will stop the slides dropping off the ends.

Lever

The $\frac{1}{4}$in. x 1in. slot in the centre of the lever provides the facility of



3. A wide range of tooling can be made to suit individual requirements



4. The tapping table adds to the versatility of the machine leverage adjustment, this option being an advantage if the device is to be used for tapping.

Knob

Just a nice little turning job. Note the 3/8in. dia. counterbore at the top to take the head of a 1/4in. dia. Allen screw.

Adjusting & lock screws

These can be made to any shape to suit individual tastes. The essential dimensions are shown on the drawings.

Guide screw

This is made from an Allen grub screw or by cutting down a 1/4in. BSW bolt. When fitted with a lock nut it can be adjusted to give the right amount of clearance to allow the arm to be moved freely up and down the column, but to remain in line.

Anvils

It is suggested that one of each of those shown will be required, but it may be found necessary to make others for special jobs. The one shown at the right hand side of the drawing is used for support when access is very limited.

Centre & bush installers

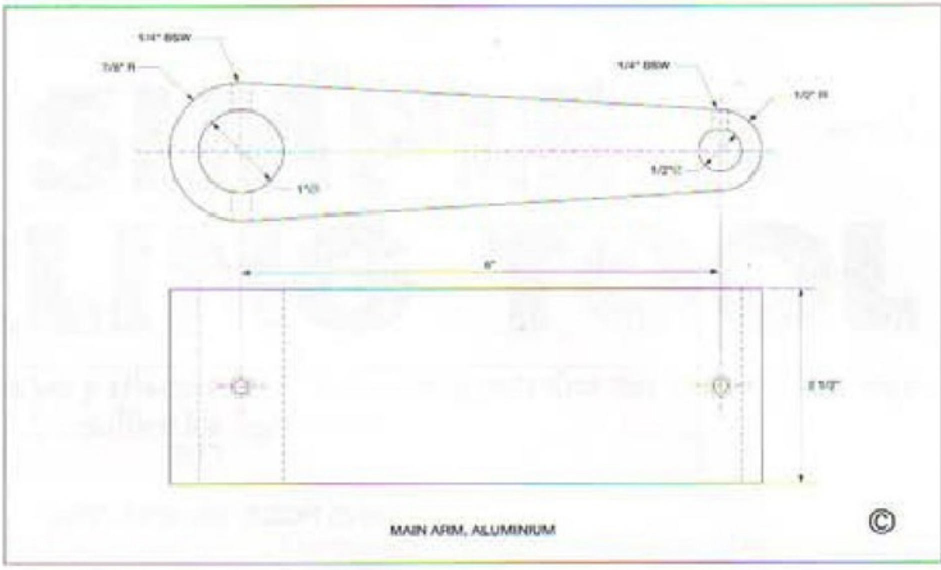
The centre is made of 3/8in. dia. bright mild steel, with a 45 deg. portion turned on one end and the other reduced to 1/4in. dia. for 1/2in. to fit into the drive rod. The two bush installers may be made from silver steel then hardened and tempered if it were found necessary.

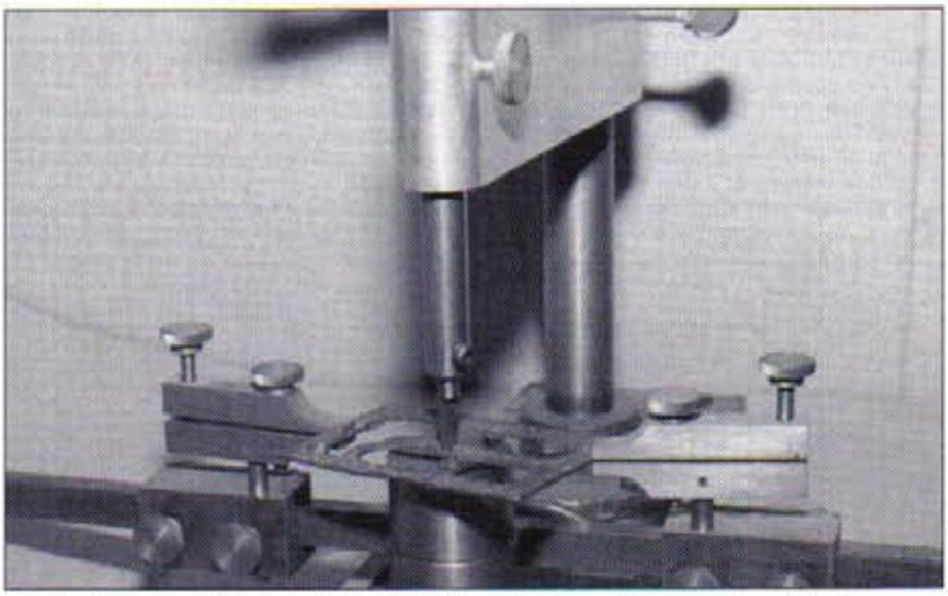
Assembly

When assembling the parts, the drive rod was fitted to the main arm with the large bush installer fitted to the lower end. The anvil support bush was placed on the base and the position adjusted so that the installer located in the central hole. It was now a matter of making sure that the support bar was at 90 deg. to the base and that all was centralised before clamping the anvil support bush in position. The holes could then be drilled and tapped in the Base Plate. This procedure made sure that everything lined up correctly.

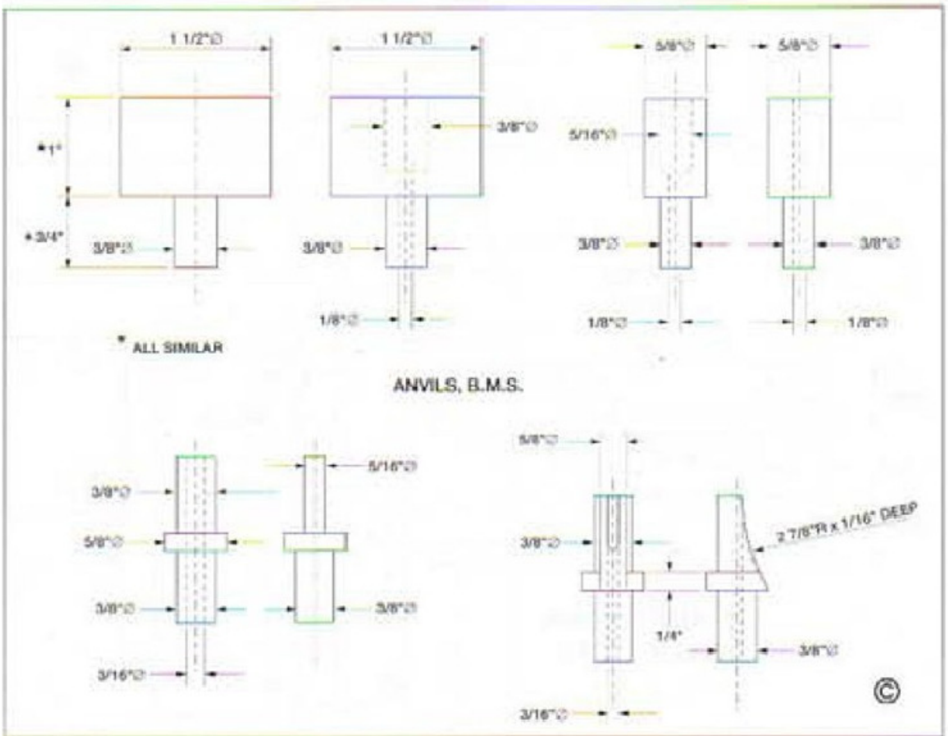
If you are left handed, the 1/4in. BSW hole at the front of the main arm can be moved to the other side simply by turning the arm over. A light spring and a couple of washers placed on the drive rod between the arm and the lever make sure that the tool is lifted clear of the work to facilitate tool changing.

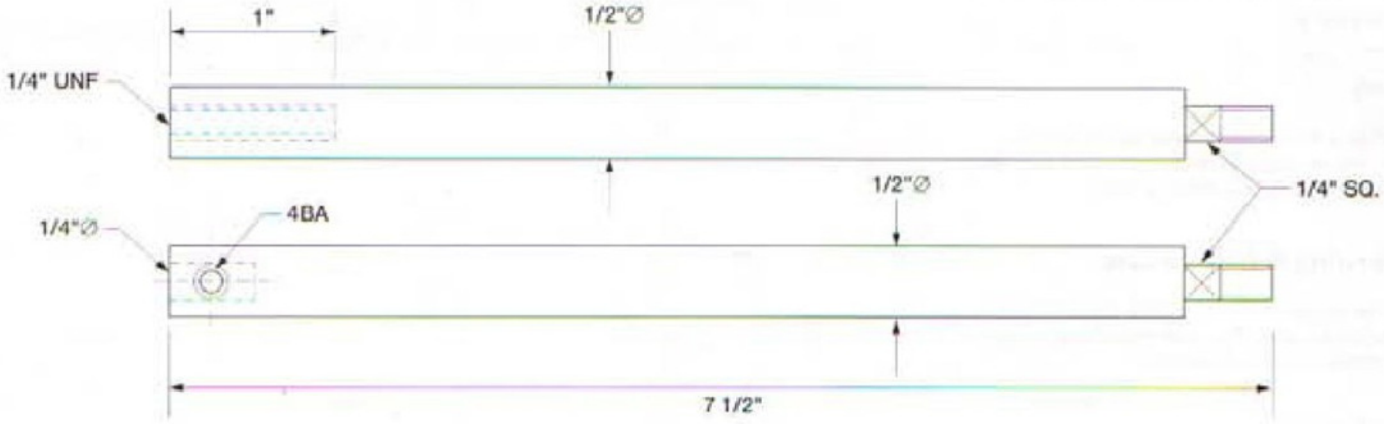
It will be found that some of the items described in the text do not correspond with those shown in the photos. This is because the photos were taken before the modifications were carried out (i.e. the 1/8in. x 1/8in. slot in the column).



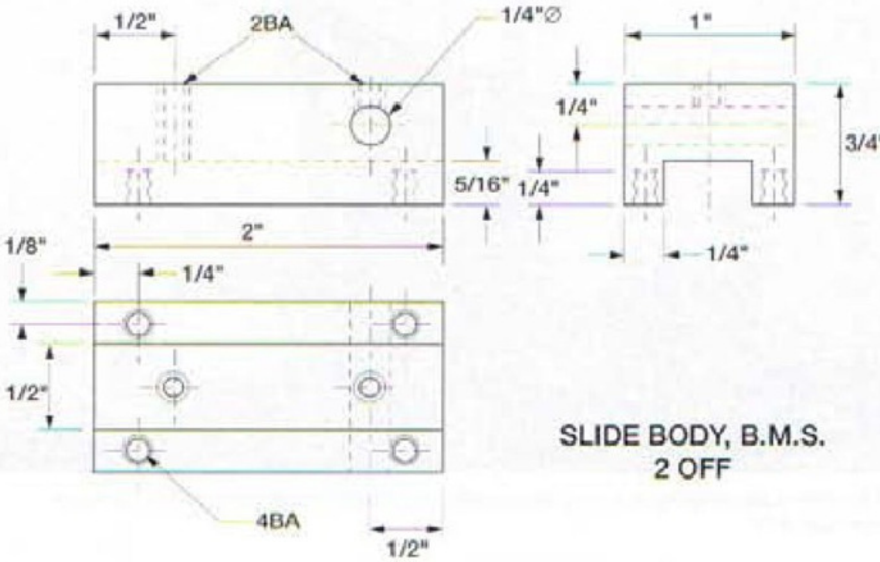


5. The clamp assemblies are fully adjustable, allowing a wide range of work to be accommodated



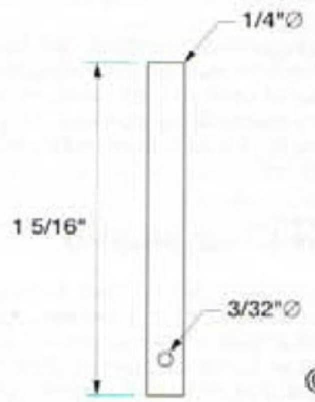


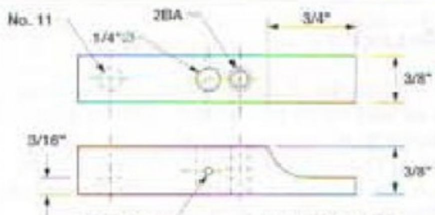
DRIVE RODS, SILVER STEEL



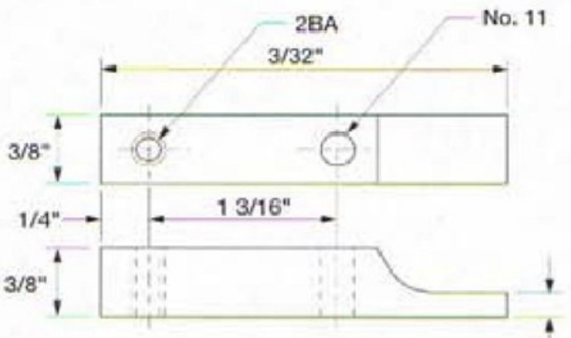
SLIDE BODY, B.M.S. 2 OFF

CLAMP SUPPORT, ROD B.M.S.

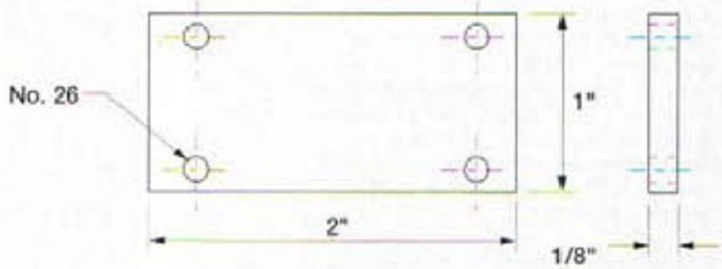




CLAMP LOWER, B.M.S. 2 OFF



CLAMP UPPER, B.M.S. 2 OFF



SLIDE BODY BACK PLATE, B.M.S.

A SIMPLE KNURLING TOOL

Simple tools can often prove to be very effective. Alan Jeeves suggests that this knurling tool may suffice for light work

Knurling tools for the lathe can be quite expensive to buy and are probably of a more sturdy structure than is required for model engineering, clock making and similar work. Here is an easily made gadget which will not break the bank and which has plenty of scope upon which improvise. The principle of its operation utilises the mechanical advantage of the lever. The general arrangement **(Fig. 1)** shows this to good effect. The knurling wheel is below the workpiece and the lever is pivoted on the fulcrum. By exerting a downward force upon the handle in the direction of the arrow, an upward force results upon the knurling wheel. Sufficient force can be applied to the handle to cause the knurling wheel to generate a pattern on the periphery of the work. The lever is a piece of whatever is handy, in this case a piece of 13mm square section mild steel. It is milled or sawn out at one end to accept a knurling wheel. This one accommodates a stock wheel obtainable from tool suppliers and is 5/8in. dia. x 3/16in. wide x 1/4in. bore. The best ones are the straight (or milled) pattern. Knurling wheels can, however, be home made from a suitable material such as silver steel. The lever should have a comfortable handle provided, as pressure is applied to it with the hand.

A pivot hole is drilled through the lever near to the wheel end. A proportion of around 4:1 is a good ratio for the lever action. The chamfer at one end of this hole **(Fig. 2)** is to clear the radius left on the pivot block **(Fig. 3)** at the junction of the spigot and the square section.

A further hole is drilled through the lever to house the pin on which the knurling wheel rotates. This pin is better made out of silver steel which has been hardened and tempered (temper to 240 deg. C), but it may also be made out of mild steel and case hardened. If it is left soft it will wear rapidly and will require continual replacement. This completed pin is oiled and then fed through the lever and the knurling wheel to be held secure by a small wire passed through the Imm dia. cross hole. The wheel should spin freely. The pivot block may be made out of the maximum size of mild steel stock which will fit into the tool post. It has a spigot turned onto one end and the lever pivots on this spigot. It will be noticed that an axial recess has been formed into the top of the spigot (simply filed in) and this acts as an effective way of preventing the lever from slipping off when in use. The pivot block is held in the tool post rather like the boring bar. This method of producing a knurl is quite successful and the equipment is easily set up. Several different sizes of knurling wheels are obtainable 'off the shelf' so, when designing your own version of this knurling tool, the class of work which it will be asked to carry out should be borne in mind.

When knurling work of smaller diameters, the piece may be seen to deflect away from the direction of the applied force. Further pressure on the lever would be wasted effort and may also cause distortion, with disastrous results, so extreme care must be taken. To get a good knurl, the wheel should be left to 'dwell' until a satisfactory result has been achieved.

*TO SUIT WIDTH OF LEVER

FIG.3 PIVOT BLOCK

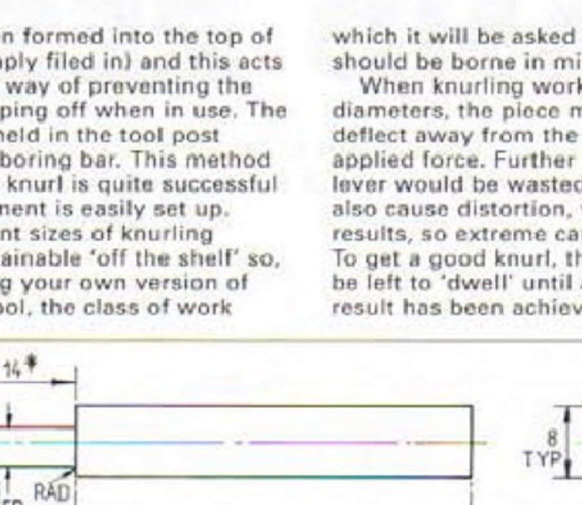


FIG.1 GENERAL ARRANGEMENT

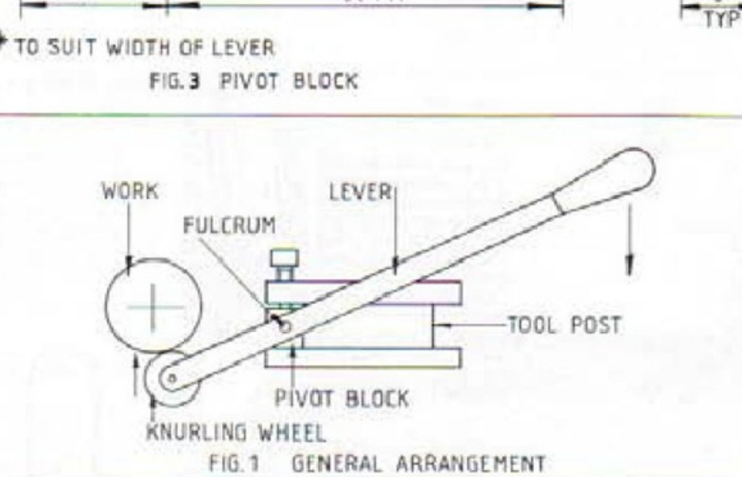
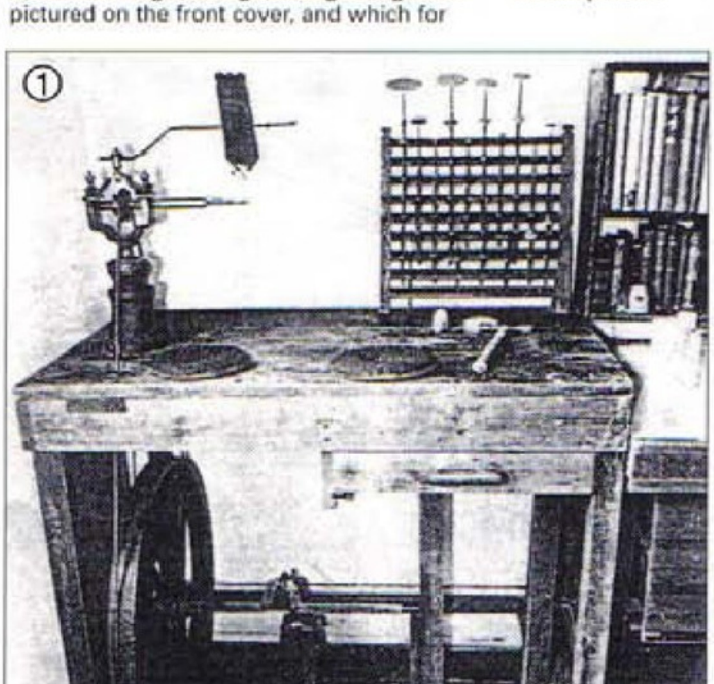


FIG.2 LEVER

A 19TH CENTURY COPPER WHEEL GLASS ENGRAVING LATHE - RESCUED AND RESTORED

Readers of M.E.W. always seem to be on the look-out for interesting pieces of workshop equipment from earlier days. Alan Bourne of Reymerston, Norfolk was just in time to prevent a family heirloom from being lost for ever.

Glass engineering isn't normally thought of as part of model engineering. Most would consider it mainly artistic; engraving, cutting, and grinding to produce results to delight the eye. But is it really like that? What about a glass presentation tankard for such things as winning IMLEC? Also, the actual work is that of a skilled craftsman. Here we look at his main tool, which is pretty much the same today as it was in years gone by. Before coming to the glass engraving lathe pictured on the front cover, and which for display purposes has been fitted with a tripod base, we need to know something about glass itself. Then, how I came by the lathe with a historical conjecture. Design and construction show that good development and thinking are by no means just activities of the late 20th century. Finally, some suggestions on setting up a workshop for practical glass engraving and a little information on where this particular lathe will be able to 'rest in peace'.

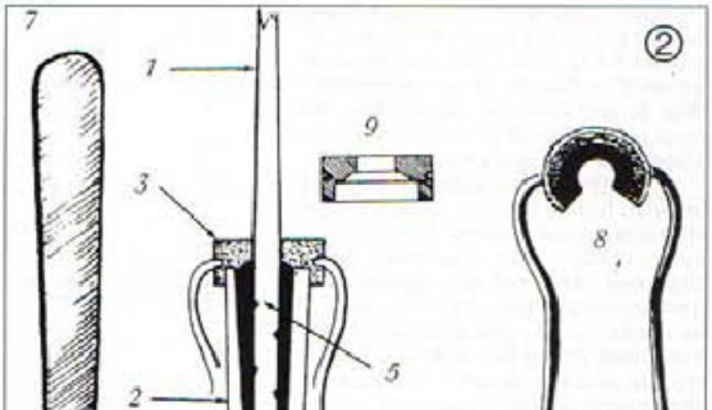


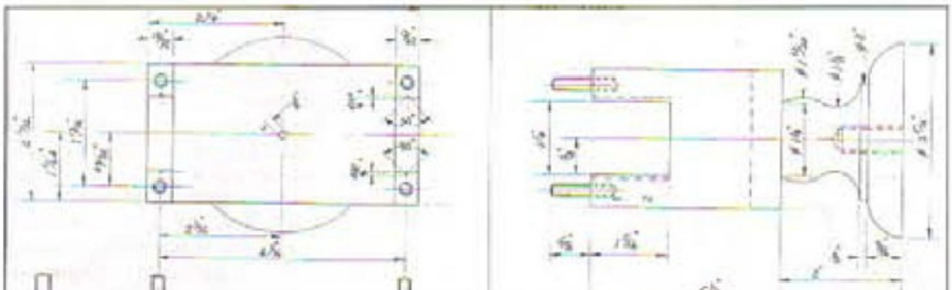
The Nature of Glass

For information on the constituents used in glass and the practises of the engraver for decorative purposes, several extracts from a specialised book on the subject have been included. The book is entitled "The Techniques of Glass Engraving" and is by Jonathan Matcham and Peter Dreiser.

At the outset, therefore, my thanks to the publishers for putting me in touch with them through Mr. Matchams daughter Julia. I am indebted to and very much appreciate being given permission to include pieces of text and illustrations from their book in the preparation of this article.

Glass of good quality is an extraordinary and beautiful material. It makes its first appearance in Mesopotamia and Egypt about 3000 BC as a siliceous glaze on steatite beads and small stones, most probably in imitation of precious stones, which implies that the late Bronze age was familiar with the fluxing power of alkalies on siliceous materials.





Through the centuries, by adding various alkali fluxes such as potassium carbonate (potash) and sodium carbonate (soda ash) to silica in the furnace or kiln, glass of widely varying qualities could be moulded. The chemistry of glass is very complex, but the principal is easy to understand. Silica is a hard glassy substance which, as natural quartz has a sharp melting point of about 1610 deg. C (2830 deg. F). Some reference sources give 1800 deg. C for pure quartz. The use of alkali additives reduces the melting point temperature and saves money in extra heating costs.

When silica with the correct proportion of alkali and limestone is heated, it reaches a plastic or fusion condition in the temperature range 1300 to 1400 deg. C. For forming or blowing, a temperature of 900 to 1000 deg. C. is normal and the material is then rather like treacle. When formed, cooling is done gradually, better termed annealing, to avoid great internal stresses, and so avoid the risk of cracking whilst engraving.

In 1674, George Ravenscroft discovered and patented the incorporation of large quantities of lead oxide with the melt, thus producing a whiter, softer and much more brilliant glass. Today, the British Standard for full lead crystal is not less than 30% lead oxide.

History and Conjecture

The lathe as 'rescued' in 1983 was as **Photo. 1** and was illustrated in the Model Engineer of 9th. May 1997. It was destined for the Council tip in less than 24 hours.

In order to put it in the Olympia Exhibition for 97/98, it was decided to make some of the missing pieces, so making the display more authentic. The centre swivel post, radius arm, splash guard and leather tongue were made to dimensions approximated from illustrations in the book. Compared to the brass of the lathe itself, which has been deliberately left unpolished, the new items are very yellow in colour.

The lathe seems certain to have been manufactured in Bohemia (was Czechoslovakia) about 150 years ago, perhaps a little less. Having only two pulleys on the mandrel does date it no later than the early second half of the 19th. century.

In 1856 John Standen of Kingswinford, being 'too old' at 48 to get a job in an iron foundry (he was a blacksmith), took his wife and family to Canada. His daughter Elisabeth (aged 9) was left in England to study her music in the care of two aunts who kept a school at Moss Grove House. Another pupil at the school was Stanley Baldwin who, in 1923 became Prime Minister of the United Kingdom. Elisabeth Standen married widower Joseph Bourne, my Grandfather, whose own glass design and decorating works was at Wordsley. Their eldest daughter Ellen married Arthur Richardson; his glass works was also at Wordsley, a family business since 1837. They had two sons Harry (Henry) and Horace.

The conjecture therefore is that the lathe, manufactured around 1856 (when the Standens sailed for Canada on 26th. April aboard the 900 ton John Howell) would, with others, have come to England and have been factored through W. Woolley of Dudley (the name stamped on the frame) to the Richardson and other works in the Stourbridge district.

It was after Harry's death that the 'rescue' was effected, the lathe being found in a margarine box, resting on a large heap on the garage floor. He must have retained the lathe when the business was sold in 1937.

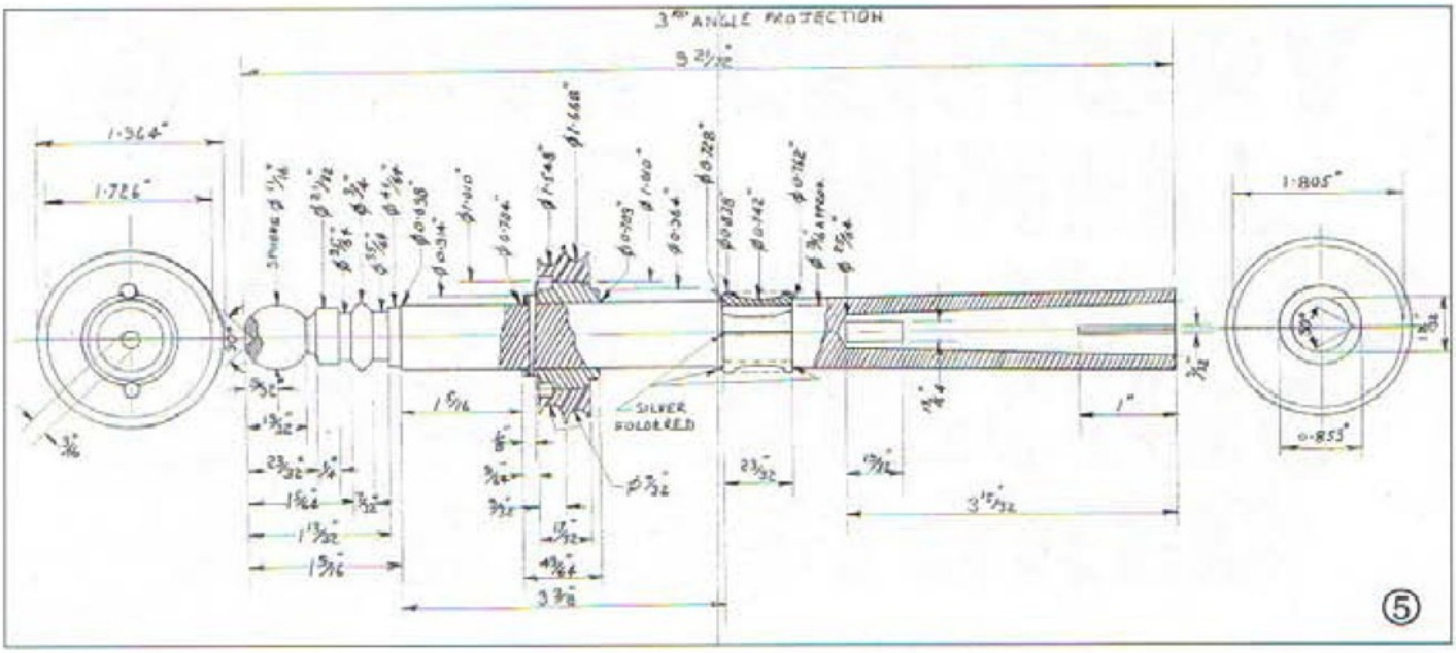
The M.E. entry generated much interest as an antique in mechanical engineering. The operation of glass engraving lathes before the turn of this century was usually by means of the foot operated treadle. **Fig. 1** is a typical example. The highest belt ratio available from the treadle would allow spindle speeds of up to perhaps 2000 r.p.m, and as when metal or wood turning, be very fatiguing to operate for long periods. The two soft pads near the front of the bench are for resting and forming a fulcrum for the elbows whilst holding the glass with the hands against the cutting wheel.

Much of the cutting and engraving is done using copper discs of varying diameter, thickness and edge profile. These are charged with abrasive compound paste. At the back of the bench is a wooden rack which might contain as many as 100 different spindles for use on the lathe.

The spindle, the business end of the lathe, is cast in lead and in situ in the mandrel which for this purpose would be mounted vertically. **Fig. 2** and the accompanying table show the tools and the method. The outer end of the spindle is usually arranged for the riveting of copper or diamond wheels, but for cork or wooden wheels the spindle end is given a tapered screw thread. In some cases, a nut may be used for stone grinding wheels.

Design and Construction

The main frame and circular base is a one piece Bohemian brass casting, with a very good surface finish. The colour has a bronze hue rather than the yellow of brass we are accustomed to in England. The upper and lower half bearing blocks are white metal (approx. 2:1 lead tin alloy) and are retained by vertical vee grooves cast as part of the frame. The frame width across the bearings is 4 $^1/_2$in., and the centre height



of the mandrel above the bench is 11 1/2in. The lathe is secured to the bench by means of a long bar with thread at each end, one end screwed into the casting, while the other, protruding through and below the bench, has a large wooden washer and forged wingnut to secure the lathe. Two other holes or slots are provided in the bench for the leather driving belt. The mandrel protrudes to the right from the frame 4 1/8in. and is taper bored similar to Morse and is 3 1/2in. deep. Unlike the Morse socket, a deep groove extends approximately 1in. into the bore, so that a mating lead key, cast on the spindle, ensures that the spindle, when replaced, is in exactly the same accurate position every time.

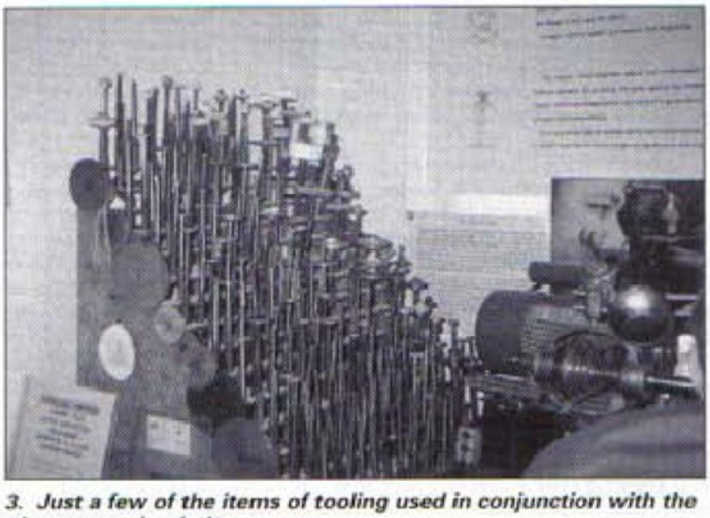
1. The glass engraving lathe as found

We come now to the mandrel - its double pulley wheel assembly and the front and rear bearings. Without doing damage to the mandrel, it is not possible to prove how the pulleys are fitted. However, it does seem that a hub sleeve is a good fit on the mandrel and has a taper pin through the diameter and cleaned off flush. The pulleys, in one piece, appear to be driven on to a shoulder and secured with blind dowels in line with the mandrel axis. The headstock and bridge castings **(Figs. 3 & 4)**, along with the mandrel **(Fig. 5)**, being fully dimensioned, give a good idea of the machine's actual size. It is important to note that the numbers 1 to 4 stamped on the main frame are repeated individually on **Figs. 6, 7, 8 & 9**, so that they are replaced in their correct positions should the lathe have been dismantled for any reason.

The front mandrel bearing **(Fig. 5)** is a bright steel ring wrapped round the mandrel in a recess 23/32in. wide. When new it was probably like the front bearing which can be seen as barrel shaped in the exploded view of **Fig. 10** (a lathe having a six step pulley on the mandrel). The ring would have been brazed or silver soldered in place. This one has a neat ring of braze at each end. When new, the joint line of both ends would also be brazed and turned to profile. Now however, due to wear as the drawing shows, there is a slight gap, not penetrated originally with the braze which has enabled the depth of recess to be gauged.

The rear bearing arrangement does, I think, show the really clever part of the design of these early lathes. Look at the rear mandrel bearing, **Fig. 5** and also that of **Fig. 10**. The bearing is vee shaped, almost like the cross section of a sporting discus. Provided that the two halves of the bearing blocks do not meet (a gap of approximately

2. Kevin Andrew at work in the Broadfield House Glass Museum



3. Just a few of the items of tooling used in conjunction with the glass engraving lathe

1/8in. is normal), we have therefore, with only a single screw adjustment, a perfect shake free journal and thrust setting. The single screw centre bearing adjustment bolt **(Fig. 11)** is drilled through, as is the upper half of each white metal bearing **(Figs. 6 & 8)** for lubrication. The square hole broached 3/4in. deep **(Fig. 11)** begs the question, Was this the beginning of 'Allen' socket heads and keys? In those days, as now, the tang of a file was square or nearly so. The 'moat' about 1 1/2in. down from the top of the pedestal is to collect oil which inevitably drains down from the bearings.

Setting up a Workshop

For the hobbyist with a home workshop and even a small lathe, the home-made lathe shown in **Fig. 12** could be a quite straightforward, no frills project, and at the same time be a way to get started in this fascinating and rewarding form of craftsmanship. The natural progression to many and varied sizes of spindles would come with increasing skill and experience. A word of warning - do NOT try it on your valuable metal lathe. Grinding glass on that lathe could 'Seriously damage it's health'.

A bench size of 72in. by 36in. is desirable, needs to be rigid and, if the lathe is motor driven, then floor or near floor level immediately underneath is the best position for the motor. A typical set-up is shown in **Fig. 13**. Good daylight lighting is best, the arrangement shown in **Fig. 14** also shows a method for artificial lighting.

The essentials of decorating glassware is cutting away glass from the original smooth surface. Glass being what it is, the job can only be done by abrasion. That abrasion can be by some form of rotary grinding or, for fine lines, drawing with a diamond or tungsten carbide point. Another possible tool could be Multicraft drill and a dental burr.

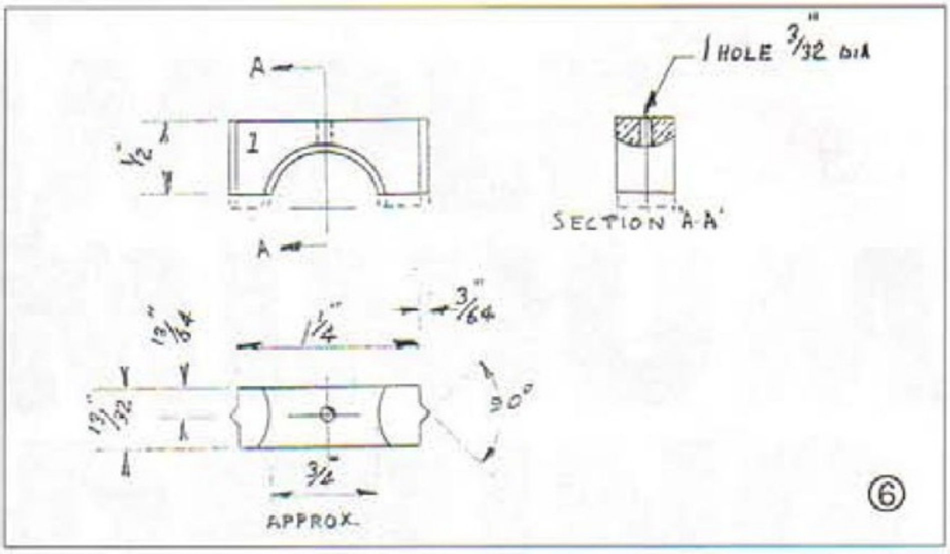
Whatever is used, the job is done wet. With a copper disc, the abrasive paste does the job. With anything else as a tool, a water drip is used for two reasons. First, no glass dust in the air. Second, it keeps the glass cool. Abrasives for grinding and polishing (corundum and carborundum) are two common ones, mixed to a paste with paraffin and light machine oil, details of which and many other aspects of the craft are fully described in the book.

A couple of paragraphs provides a good example.

"The Use of the Leather Tongue

"The value of this rather crude but effective piece of equipment can now be appreciated. The detachable leather tongue, which is ordinarily gripped between two pieces of hard 'spring' brass at the very end of the splash-guard, is positioned just forward of the top of the revolving wheel, so that the abrasive can remain as long as possible on the cutting edge. A new leather tongue should be conditioned in the oil, for the obvious reason that new absorbent leather would inhibit it's action.

"The abrasive selected from the edge of the paste pool in the dish and either fed to the wheel by a finger or offered to the wheel from the edge of the dish. The finger is the



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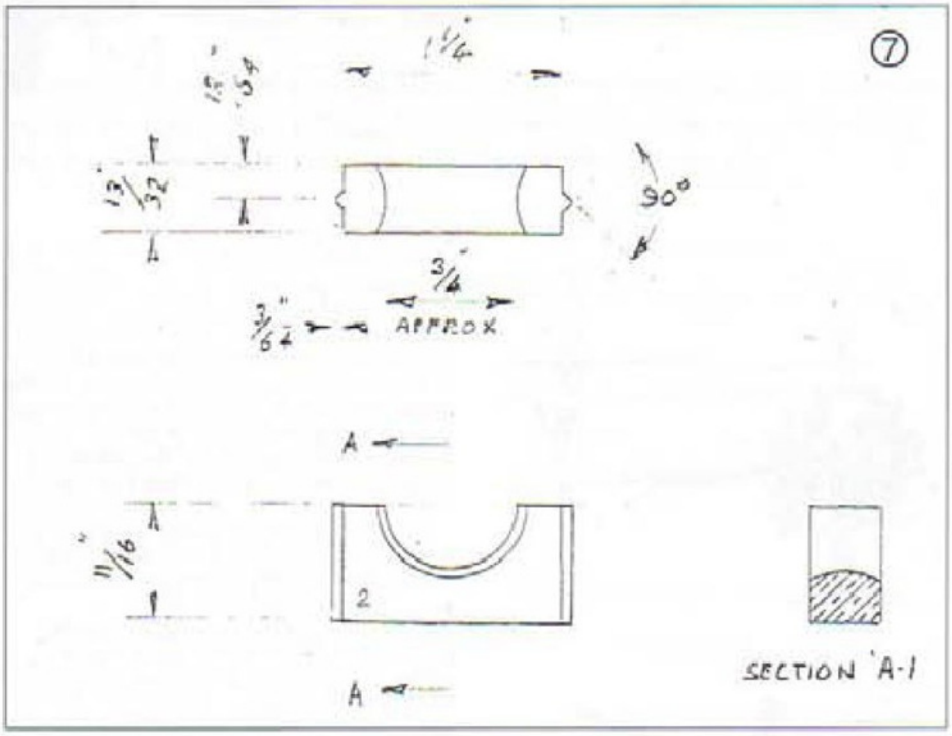

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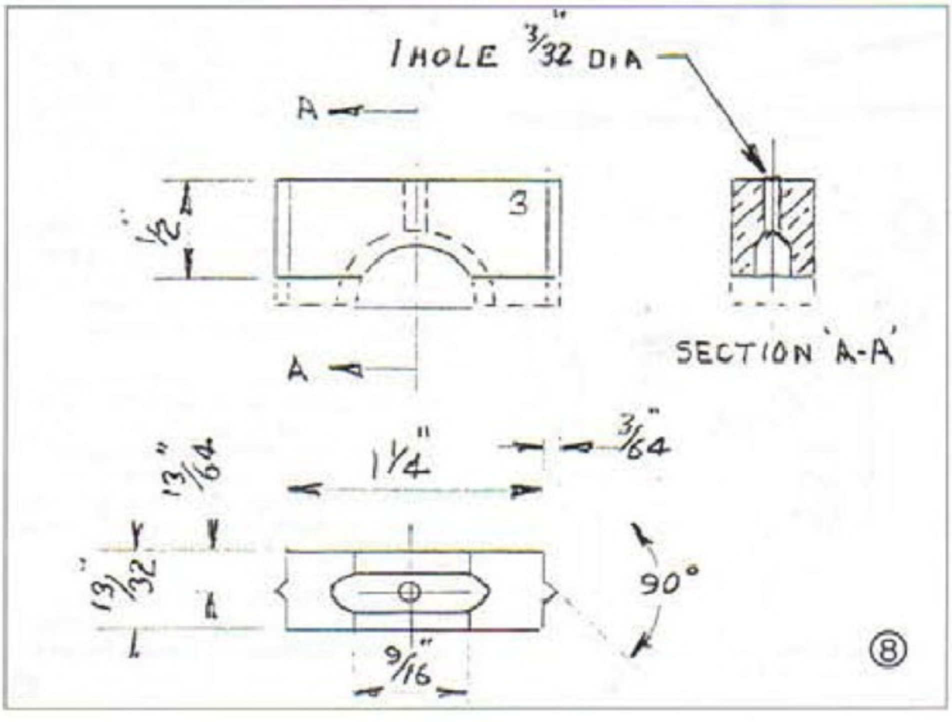

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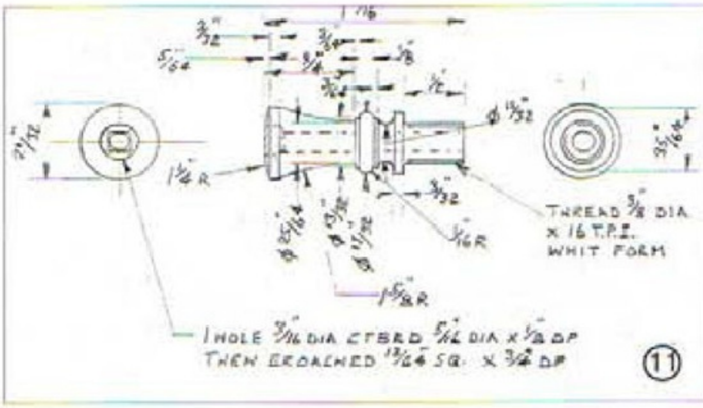
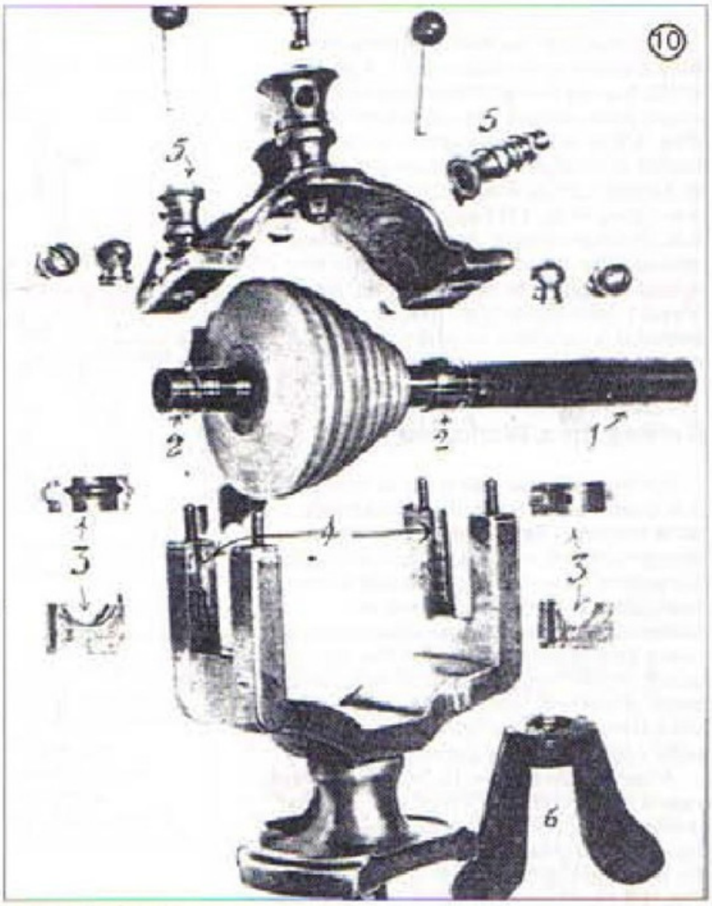
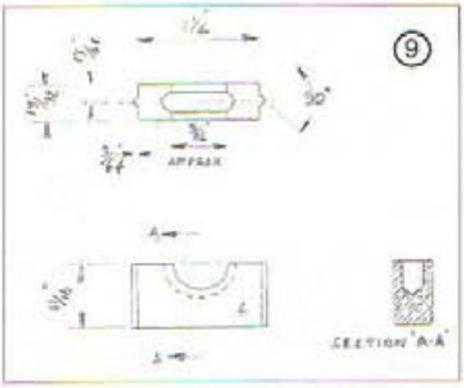






most efficient method, though it is a matter of choice and habit. As the wheel must be replenished every few seconds, or as soon as the bite of the carborundum weakens, the dip and wipe towards the bottom of the wheel becomes an automatic movement with scarcely an interruption to the concentration. At first too much or too little abrasive will be picked up -mostly too much- when the hands and glass will be plastered with oil but, with practice, enough will be picked up on the tip of the index finger to be wiped almost free by the edge of the wheel. It is a rule that each grade or type of abrasive must have it's own container and separate leather tongue." **(See Fig. 15)**.

For the purposes of historical record, a full set of detail drawings has been made. Should there be any interest, then enquiries should be made via the editor.

The book is readily available from the Public Library here in Norfolk, in fact as many as five copies seem to be distributed around the county.

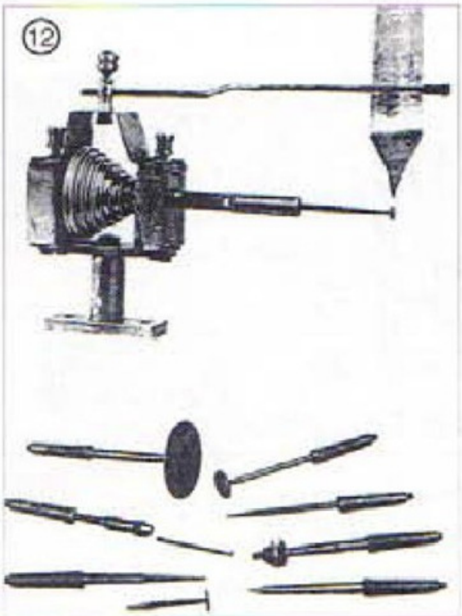
Finally, my lathe is destined very soon now to go to the Broadfield House Glass Museum (the museum of the British glass industry) which is at Kingswinford in the West Midlands. This is within five miles of where it must have done many hundreds of hours running and where, as said earlier, it may no doubt 'rest in peace'.

In conclusion, my personal thanks to Peter Dreiser for several helpful, interesting and humorous phone conversations. Also, for his reading the draft to ensure the chosen extracts from the book are acceptable.

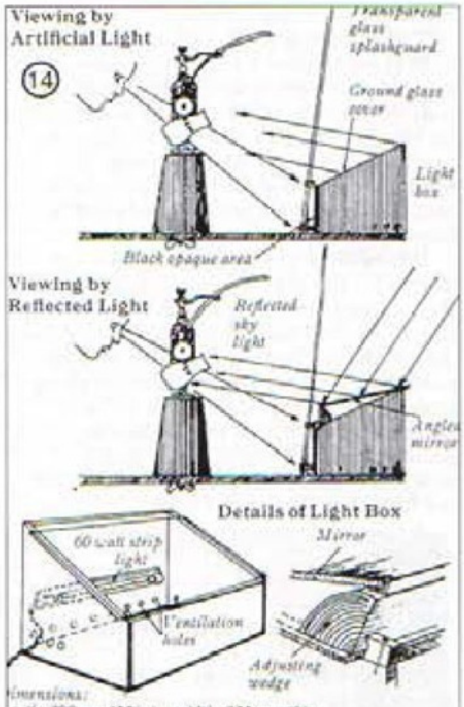
The book from the libraries is in hard back and was first published in 1982 by B. T. Batsford Ltd., 583 Fulham Road, London SW6 5BY. The ISBN No. is 0 7134 25369

The same book has recently been re-issued after four reprints of the original, but now in paperback by the same publisher at £17.99. ISBN No. 0 7134 83156

The Broadfield House Glass Museum, Kingswinford, West Midlands is open from 2.00 pm to 5.00 pm from Tuesday to Sunday.



A Typical Wheel Engraver's Work Bench Set-up



SIMPLE ALUMINIUM SOLDERING

The soldering of aluminium components was once all but an impossibility for most people. Materials introduced in recent years have made the job much easier. T.S. Christian has been experimenting with a readily available material which is effective at lower temperatures.

New, lead-free plumbers' solder can be used as an effective solder for aluminium and some 'light-alloy' castings. Since it works at normal soldering temperature, sheet aluminium is not unduly softened in the process and many alloy castings can be repaired without damage.

Background

My personal interest is in the restoration of professional valve equipment, and even making the occasional valve radio (!). Equipment of this type relies for its performance as much on its mechanical excellence as on its electronic design. (Shaft resolutions approaching 10 seconds of arc are achieved in some WWII test gear). Thus both restoration and construction involve mechanical engineering - often to a high standard.

Sheet aluminium is the preferred material for chassis and cases of home-constructed gear; it is easy to work and does not corrode. However, joins and seams have to be fastened by rivets or screws. Both are unsightly and are also liable to work loose, causing havoc with electrical performance. Good, reliable, earth connections are another difficult area. For these reasons, I have become a regular user of hard aluminium solders.

The hard-solder product sold under the name of 'Lumiweld' produces strong, durable joins in both sheet and cast aluminium. (This is an 'unsolicited testimonial'!). Its main disadvantage is that the high temperatures involved (around 300 deg. C) usually softens aluminium sheet and is too high for comfort for many light alloys.

A little while back, I picked up a set of small brushes on a market stall - one brass, one bristle, and one stainless - for the grand total of 99p. For some reason, I decided to try repeating the procedures for hard soldering specified for Lumiweld with some lead-free plumbers' solder. To my surprise, half-hard aluminium sheet wetted well, and a simple overlap joint was made with a good peel strength. A couple of simple boxes were made, and left on one side - joints made with some soft aluminium solders can deteriorate quickly. After several months, the joints are still strong, so a few more experiments were made to establish a reliable soldering procedure.

Recommended procedure

Anyone who has used the hard solder mentioned above will recognise these methods, and due acknowledgement is hereby made.

Equipment required

1. A supply of stainless-steel wire brushes, large and small.
2. Some lead-free plumbers' wire solder. Mine was 'made for Sainsbury's Home Base', but it all seems much the same.
3. A gas torch or blow-lamp with a clean, well-spread flame.
4. A stainless-steel scraper. I made mine from an old kitchen-knife cut to a narrow (5 mm) spade end.

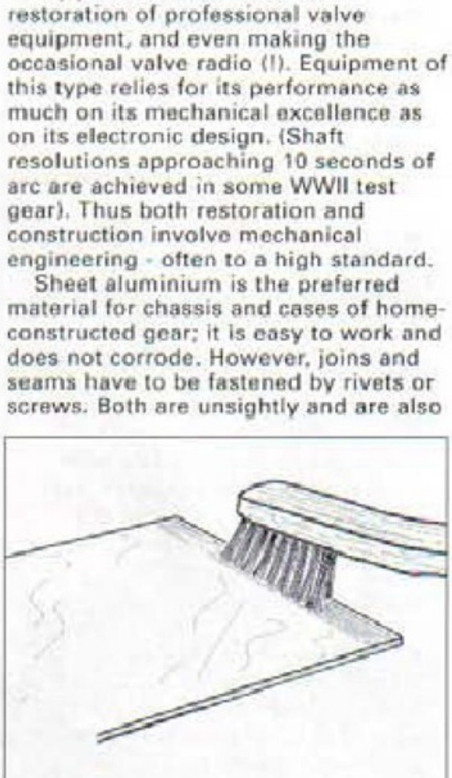


Fig. 1. Clean the area to be tinned with a stainless-steel wire brush.

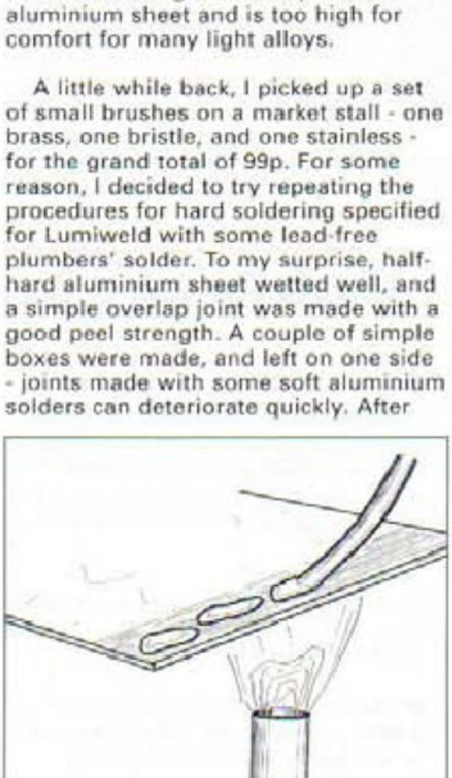


Fig. 2. Heat, and rub with lead-free solder wire. Initial tinning is often patchy.

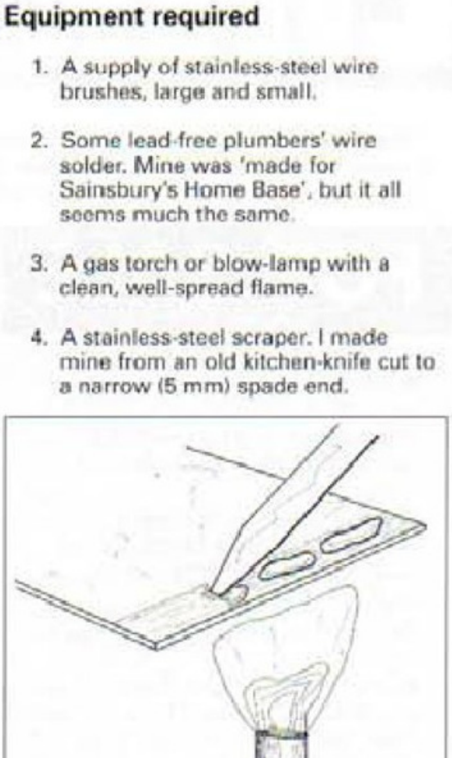


Fig. 3. Spread the solder with a stainless-steel scraper.

Method

For joining aluminium sheet to make boxes or trays, proceed as follows.

1. Ensure that the aluminium surfaces to be joined are clean - degrease, wash and rinse to remove any chemical contamination.

2. Burnish the areas to be soldered using a stainless wire brush. For most joints, a small brush is adequate **(Fig. 1)**.

3. Heat each component and tin by rubbing the solder on to the area to be tinned **(Fig. 2)**.

4. Initial tinning will be patchy. Spread the solder by scraping with the stainless-steel scraper. Do not overheat **(Fig. 3)**.

5. Place, clamp, or jig the surfaces to be joined.

6. Heat and run a fillet of solder to complete the join **(Fig. 4)**.

7. Allow to cool slowly without movement until set, then quench in clean water.

For lap or butt joins, tin as above, then arrange to press together as heat is applied.

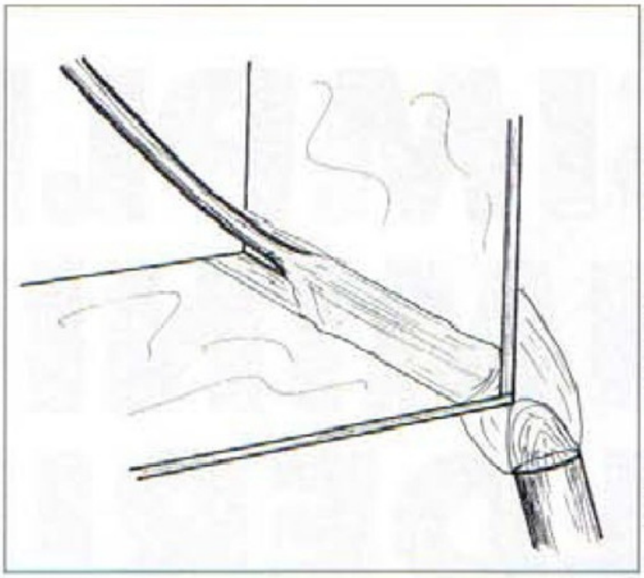


Fig. 4. Jig or clamp the parts to be joined and run a fillet of solder across the join.

Where it is possible to rub the surfaces together when the solder has melted, a stronger joint will result.

With light-alloy castings, it will be found that broken surfaces tin best if they are wire-brushed to spread the solder. Always heat such castings gently - some melt at temperatures close to that of the solder.

Notes:-

I have not found a flux that helps this process. The flux recommended for the solder seems to corrode aluminium, so preventing good wetting.

Aluminium tinned as described will bond readily to copper, brass and tinplate tinned with normal tin-lead solders. This allows tinned patches to be prepared so that earth connections may be soldered to them.

I have used a gas-heated soldering iron tinned with lead-free solder successfully for soldering aluminium. However, the high thermal conductivity of aluminium makes this useful only for small items.

It can be difficult to get a wire brush into the corners of boxes or trays. Use the scraper to prepare these areas. Run a fillet of solder down both the inside and the outside of the corner, then file and sand the outer fillet to give a 'seam-free' appearance.

Conclusions

Although the new 'green' solders are difficult to use for plumbing, and not attractive for any other purpose, their saving grace is the ability to join many aluminium alloys at low temperatures, with simple equipment and without undue softening. Joint strength is not as great as with the hard-solders mentioned, but seems adequate for non-critical, low-stress applications where joint areas are large. Well, they have to be good for something!

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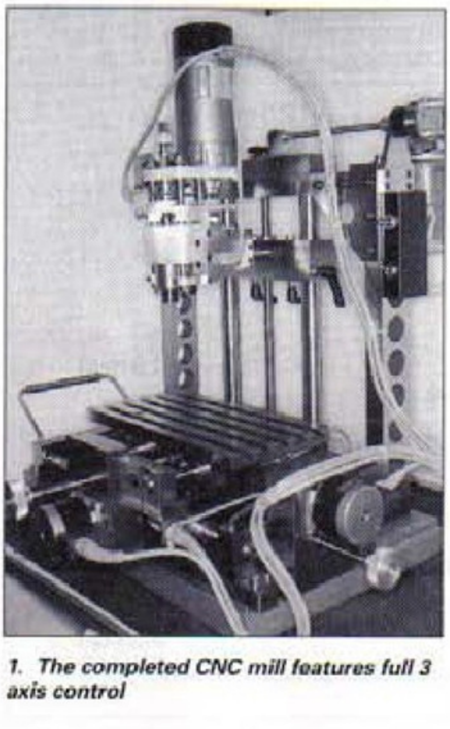
A CNC MILLING MACHINE

Peter Rawlinson starts the detailed series on building a machine which employs the 'Compucut' control system by describing the X-Y table

The article published in Issue 52 gave some idea of the construction and use of the over-all package which will be covered in the series The next group of articles will cover the construction of the CNC Mill **(Photo. 1)**, and this will be followed by one detailing the CNC Rotary Dividing Head. Readers are warned that there are a lot of parts to be made or modified (I have just completed the drawings for the Mill and Dividing Head, which cover a total of 55 A3 size sheets), but none of these is terribly complicated and all can be made in a reasonably well equipped model engineering workshop. The drawings have been checked by a number of people, but with so many involved, the odd mistake may still have slipped through, so please check as you go. I apologise in advance if you do find a problem and I would be pleased to here of them so that I may correct as necessary.

This first detailed article will concentrate on the base and the complete X-Y Table so that the builder can either construct the unit to fit his own milling machine or carry on to complete the full machine without any delays. I have designated these two approaches as Route 1 and Route 2, the former, of course, creating a two axis machine which then employs the milling machine's 'Z' axis, while the latter provides full three axis capability. **Figure 1** shows how the axes are defined and which are under numerical or manual control.



1. The completed CNC mill features full 3 axis control

To get down to the nitty-gritty of the building, let us first sort out the base.

Route 1

This will use the Sub-Base (Item 1a) only, with all parts being bolted to it. It incorporates bolting-down slots and a Tee slot key to match the milling machine.

This plate must be flat on both sides (refer to the previous article), a requirement which also applies to the main Base Plate (see below). This X-Y Table could be used with a full three axis machine at a later date by bolting the Sub-Base to the main Base Plate or by transferring the attaching components from one to the other. However, if the Sub-Base is left in place, then 25mm of 'daylight' will be lost between the table and the tool. This could be regained by adding to the length of the vertical members.

Route 2

All parts are built on to the main Base Plate (Item 1) to complete the full machine. I suggest that it is fitted with substantial rubber feet, bolted directly to the plate. All counterbores are in the under side, and tapped holes can be blind if preferred. The cut-out at the end, like that in the Sub-Base is for the Stepper Motor Drive Box and is required to have square corners.

The next parts to be machined are those

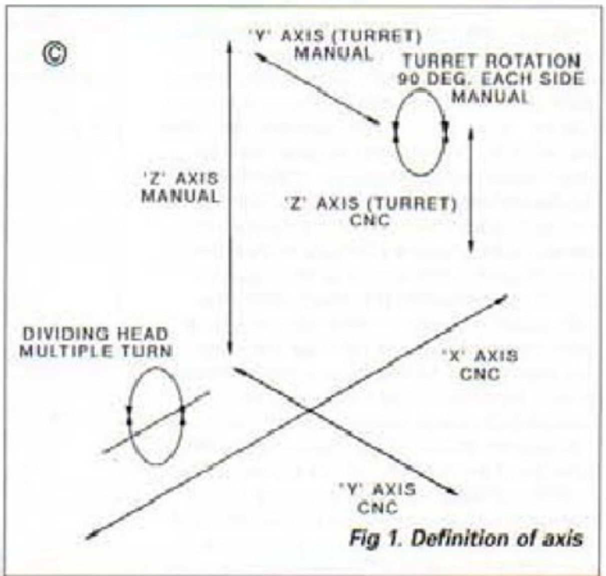
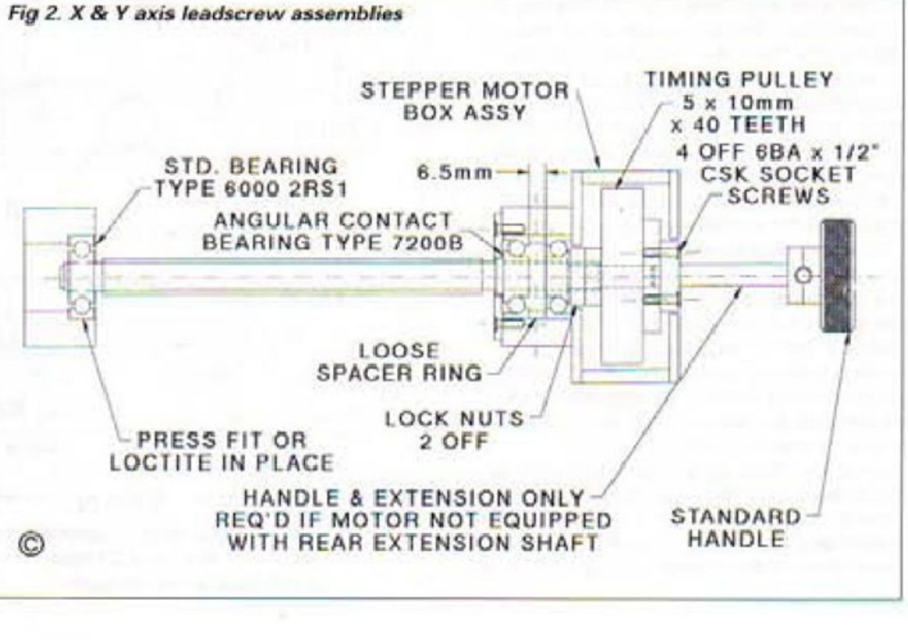


Fig 1. Definition of axis

Fig 2. X & Y axis leadscrew assemblies



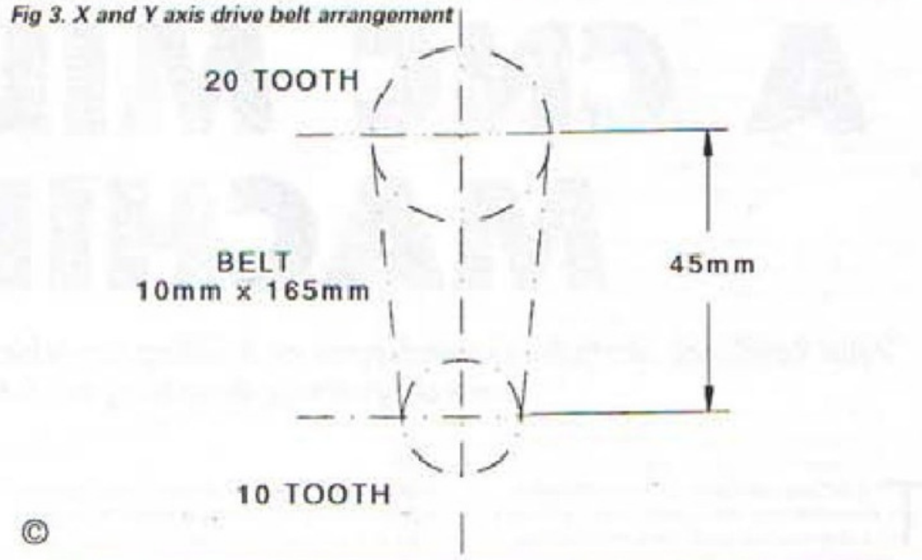
2. Machining the bearing recess in the slide bar support

that support the X axis slide. Two of these (Items 2 and 7) support the Slide Bars while the others (Items 10 and 14) are attached to the underside of the Y Axis Base Plate (Item 15). All must be accurately machined as the centres and sizes of the holes are critical to smooth sliding of the table. Within reason, the actual centre distance is not that important and can have a wide tolerance, but all parts must be the same. It is therefore recommended that a pair of measurement rods be made. Assuming the use of a milling machine, make up a substantial stop, so that the material can be positioned with repeatability. It will be noted that the holes for the slide bars and bearings are offset from the centre line by 1mm to give clearance over the Base. Mark the position of the first hole and set the piece in position, adjusting the X and Y axes until the spindle is directly centralised over the mark. Set up a dial gauge bearing against the end of the material furthest from this hole position (I recommend that the end is finely machined prior to this set up). The first hole is then drilled, bored and reamed to size. The table is then unlocked and moved until a stick gauge, equal in length to the distance between the holes, can be fitted between the dial gauge and the work piece. After being adjusted to give exactly the same dial gauge reading as before, the table is locked again and the second hole now machined. The same procedure is then used for the third hole, using a second stick gauge of an appropriate length **(Photo. 2)**.

During all of this, the table is not moved on the other axis. It is imperative that the material stop is set up with a dial gauge, as accurately as possible, to ensure that the holes are correctly positioned relative to the bolting faces of the supports. To create the corresponding offset in Items 10 and 14, a 2mm packing piece could be used, rather than disturb the table setting.

I cannot over stress the importance of the accuracy of the machining of these holes and, of course, this machining system is used over and over again for the X, Y, Z Turret Y and Turret Z Slide Bars, a total of some 14 pieces, so it is well worth setting up properly. It is of course possible to use slip gauges in place of the stick gauge, but the extra handling difficulty is not warranted. The stick gauges can be turned from 6mm dia. mild steel, polishing the ends and measuring with a vernier. I have a reasonably large milling machine which is fitted with a direct digital read out (DRO), an

Fig 3. X and Y axis drive belt arrangement



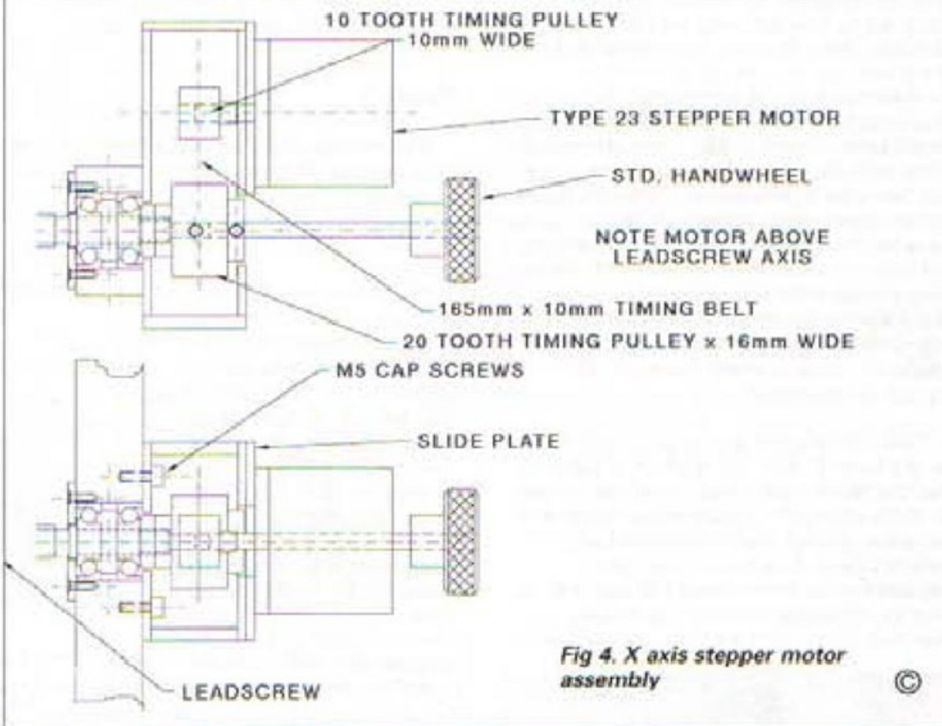
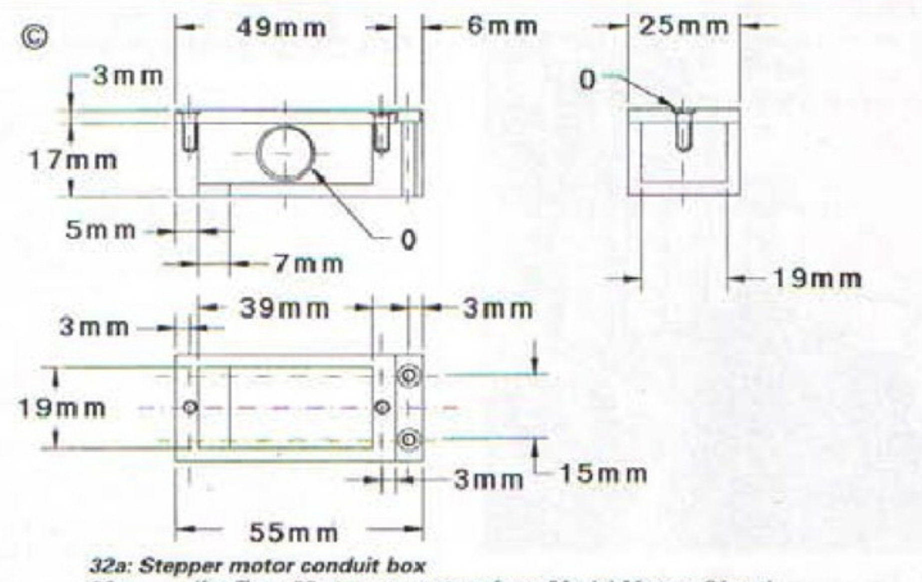
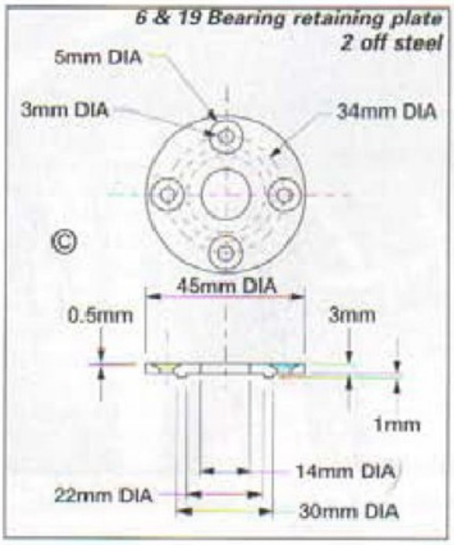


Fig 4. X axis stepper motor assembly



32a: Stepper motor conduit box
38a: (for Type 23 stepper motors from Model Motors Direct)
2 off Steel or aluminium



6 & 19 Bearing retaining plate
2 off steel

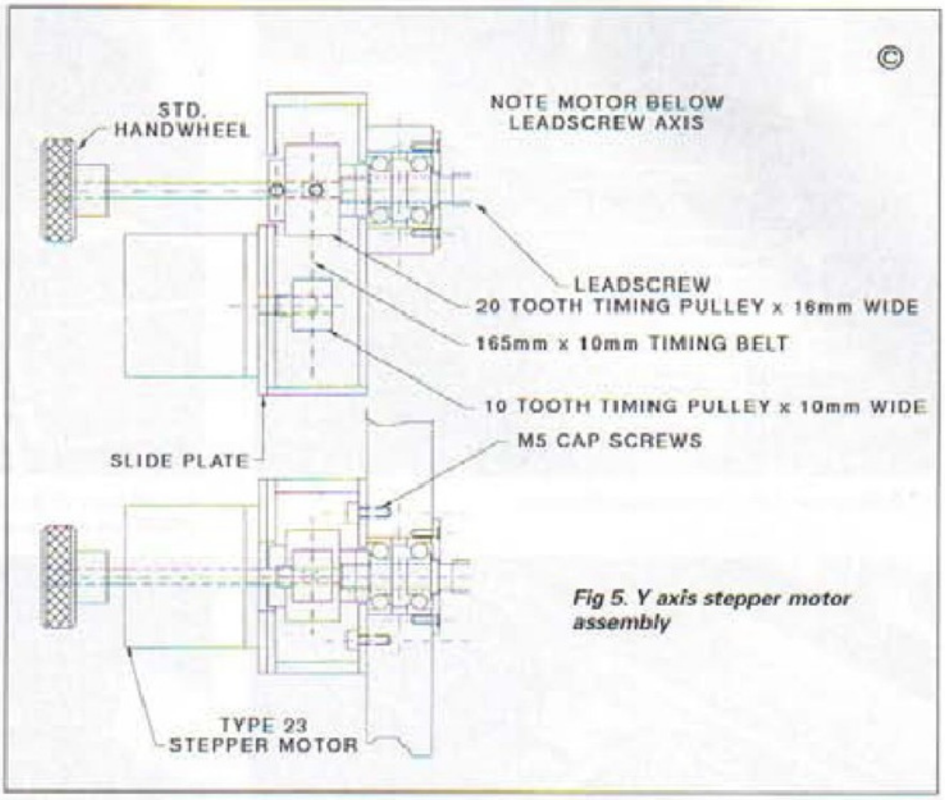


Fig 5. Y axis stepper motor assembly

attachment which can be thoroughly recommended for the considerable advantages which it can give in speed and accuracy.

Boring in the lathe

The boring of the holes may be carried out just as easily in the lathe, as long as the cross slide movement is long enough to accommodate the maximum distance between the outermost holes. I have now had the opportunity of checking with Myford and am told that they have a maximum of 6 3/8in. (162mm) movement on their cross slide which will just allow the maximum critical dimension of 160mm to be achieved if it is carefully set up.

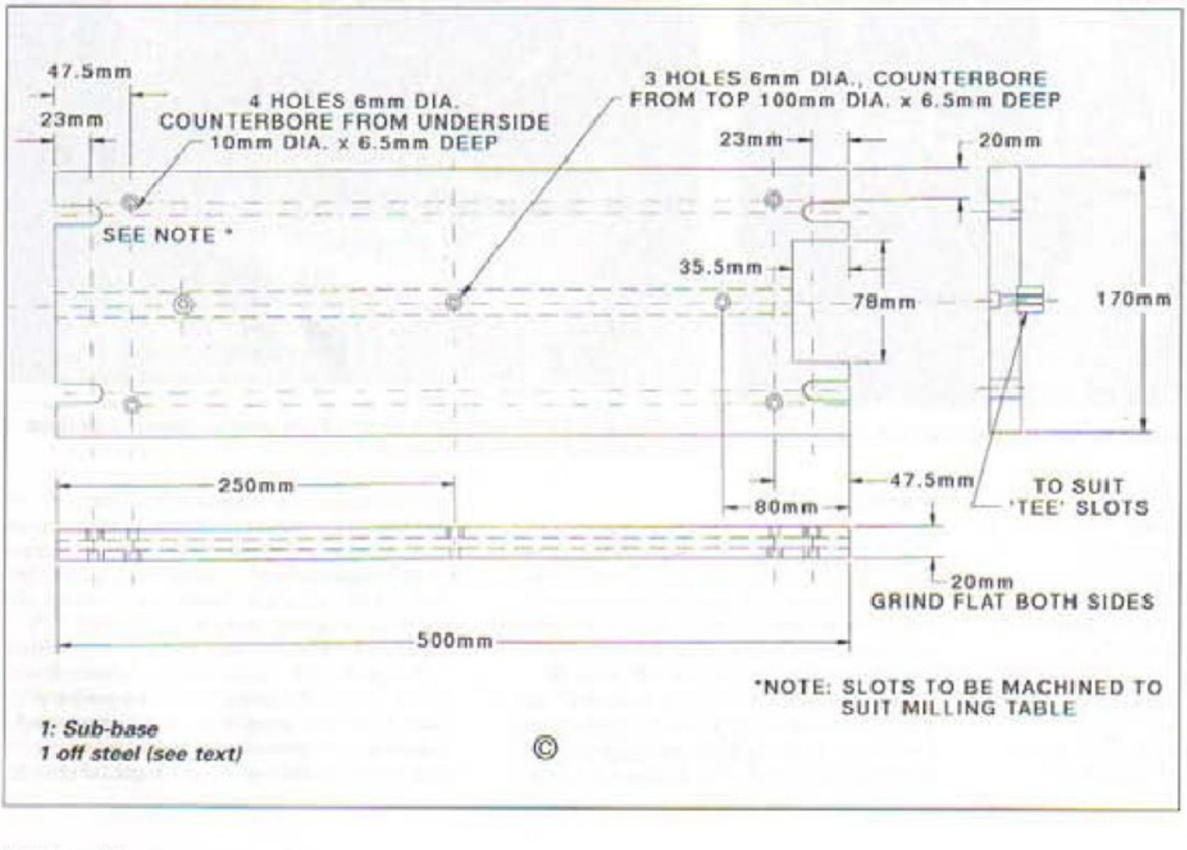
With a back stop on the cross slide, positioned at right angles to the spindle, the work is first set on packing pieces on the cross slide to bring the centre line of the holes in line with the lathe spindle, not forgetting the removable 2mm packer. The material will have to be allowed to slide along these packers and stops if the cross travel is not long enough to accommodate the movement required. All packers and stops must be adequately clamped or, better still, bolted down to the cross slide, so here it would certainly pay to make up these parts specially, with counterbored holes positioned to suit the Tee slots.

As noted, the furthest distance between holes is 160mm (Z axis). The other corresponding dimensions are 130mm (X) and 110mm (Y), with smaller distances on the other slides and, as the longest piece of material is in the order of 210mm, then the packers and stops will have to be of the order of 300mm to give adequate support.

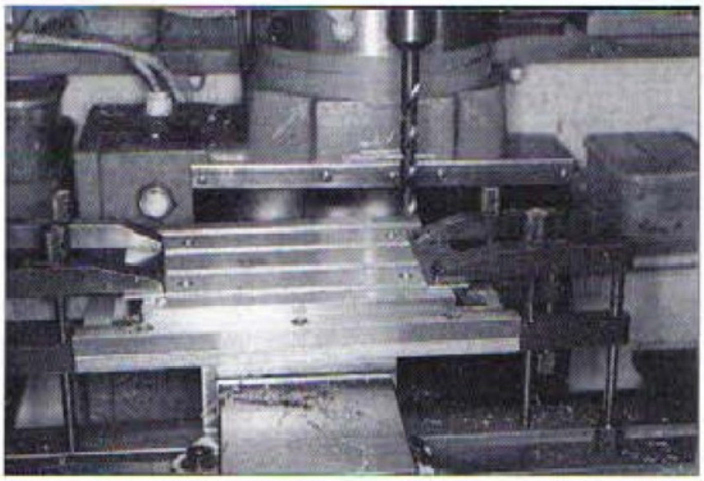
Set up for the first hole as in the milling machine procedure above, lock the cross slide and machine complete. Set a dial gauge up on the lathe bed and, using a stick gauge between the job and the dial gauge, use the cross slide to move to the next hole. It may then become a little tricky if the job has to be unclamped and slid along the cross slide to position it for the third hole. Again it would pay to make up a special bracket which bolts solidly to the saddle and supports the dial gauge in the correct position.

The drilling, boring and reaming can be simpler in the lathe as the 'daylight' is usually greater between tool and job. Do remember to lock up the cross slide at each operation and make sure that the hole is bored prior to reaming as drills can run off and boring corrects this.

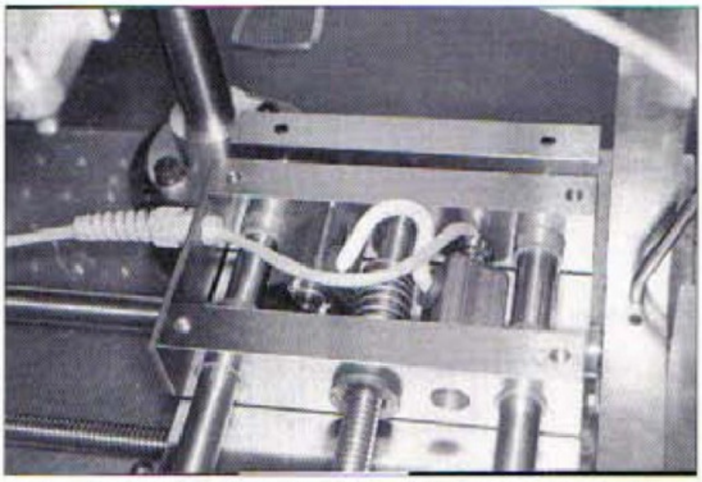
The Y Axis Base Plate (Item 15) is another of these plates which will require grinding on both faces to give flat surfaces, but here it is also necessary to make sure that the holes are both parallel



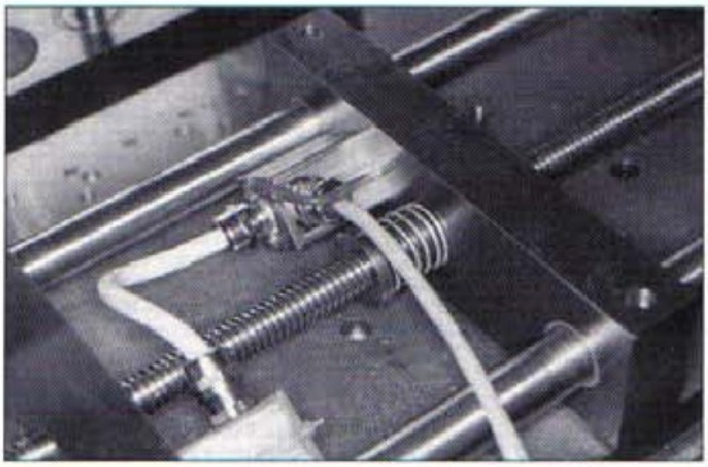
1: Sub-base
1 off steel (see text)



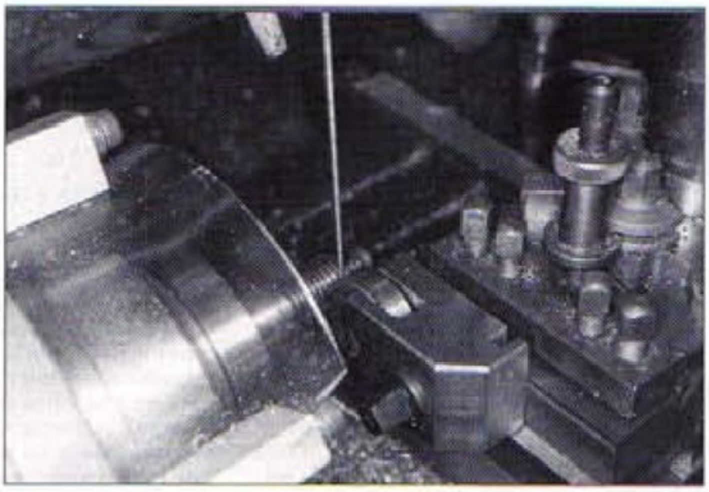
3. Drilling the holes in the machine table



4. The bars which support the Y axis table house Oilite bushes which run on the silver steel slide bars

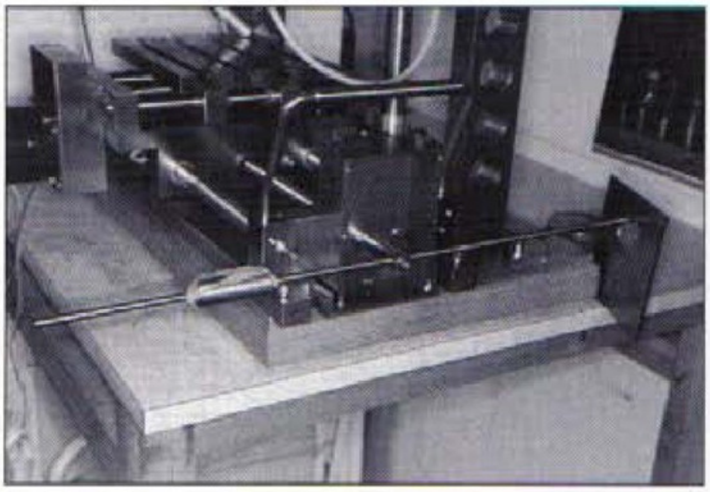


5. The leadscrew nuts are made in two pieces, with a spring between them to eliminate backlash. The limit switch arrangement is visible here



6. Winding the anti-backlash springs

7. The support of a travelling steady was needed when cutting the leadscrew thread



8. This simple rig was used to check the torque required to drive the slides via the leadscrews

and square, as these will set the X and Y axes square to each other.

Next are the Y Axis Slide Bar Supports (Items 16 and 20) and those components (Items 24 and 26) which attach to the underside of the Machine Table (Item 27). These are all very similar to those for the X axis, so the same comments and system of manufacture apply. These could however be made from 40mm x 20mm bar if the dimensions are watched.

Machine table

The next part to be covered is the Table (Item 27). This is ideally made from a piece of steel, 16mm thick, ground flat on both faces. It is shown as being 250mm x 146mm as I had a piece of this size, but could be larger or smaller as required **(Photo. 3)**.

The Tee slots are a major feature of this component, and I have used the following method of forming them before, and it works out very well. The grooves are first machined, using a ripper cutter. I find that, although the finish is not brilliant, they are much kinder on the machine, and the finish can be improved by 'shaving' with a slot drill or end mill. If you wish to adopt this method, I suggest using a 3/8in. ripper, followed by a 10mm end mill.

To cut the Tee, I have used a Woodruff cutter of 3/4in. dia. which has a thickness of 3/16in. This is successful as long as the swarf is cleared continuously, either by using a long haired brush (which soon gets short) or a strong jet of coolant, the latter being preferred as it displaces the finer particles.

The Tee nuts (Item 28) are for this size of slot and simplicity itself to make, as they can be made on the lathe and need not see a milling machine. They are made by turning down a piece of 3/4in. x 3/4in. square bar and drilling and tapping the hole, finally parting off. It may be necessary to clean down the outer edges if the Woodruff cutter has cut small, but is still an easier way of making Tee nuts.

The Slide Bars (Items 9 and 23) are all from standard ground Silver Steel **(Photo. 4)**. It will however be noticed that the 18mm. dia and the 25mm dia. versions are longer than the standard 13in. bars generally available, but this can be easily obtained by special order from any good tool stockists, in 1m. or 2m. lengths. The material is used in the purchased condition, with just the ends machined square.

Leadscrew nuts (Items 12 and 12a).

These can be made from either phosphor bronze or Nylatron, which is a Nylon type material, impregnated with molybdenum disulphide which acts as a lubricant. Do not make the length of thread longer than that shown on the drawing as it is not necessary and difficulty could be experienced when threading. Because we are using a spring system to take up the backlash **(Photo 5)**, the thread length could easily be reduced to 10 to 12mm. The nuts should be made before the lead screws, and are made in pairs, with a 'dog clutch' between the halves. There must be no movement within the 'clutch' as any clearance would appear as backlash.

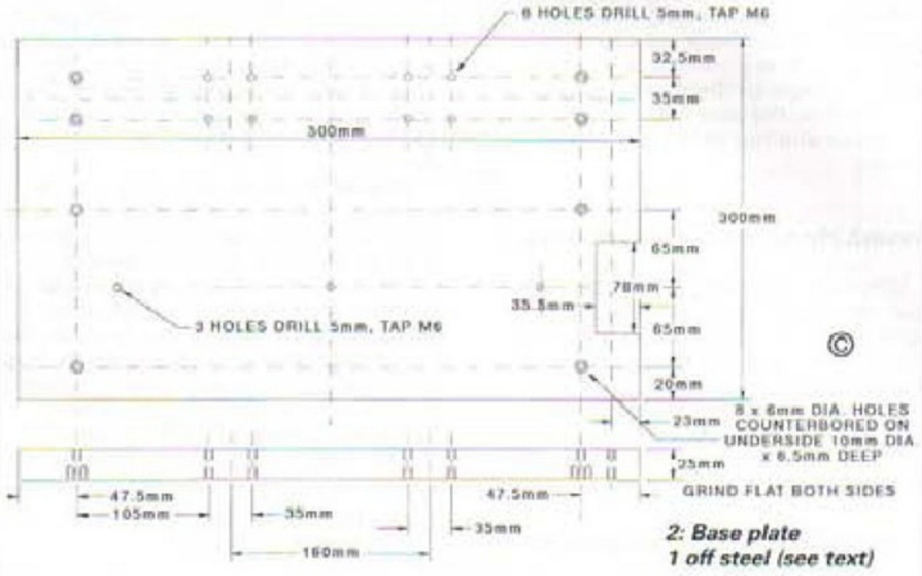
The portion of the nut containing the female half of the clutch also requires drilling and tapping for fixing screws.

No ready-made springs (Item 13) were available at the time, so an exercise was undertaken to wind my own, using 1.5mm dia. piano wire from the local model shop. This was wound around a threaded mandrel, using a roller mounted in the lathe tool post **(Photo. 6)**. This was quite successful, but I had to experiment to obtain the correct pitch and diameter.

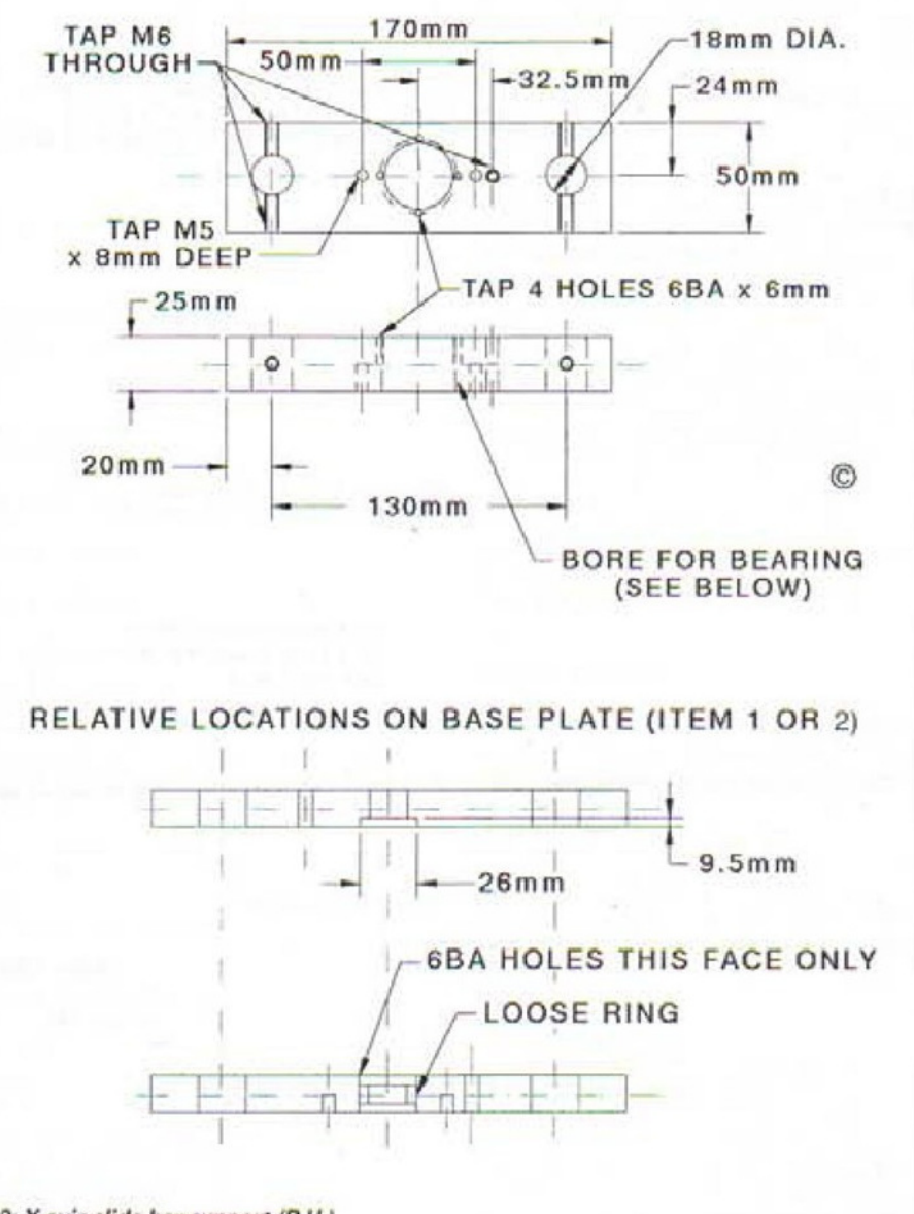
Leadscrews

We then come to the leadscrews (Items 29 and 35 and Figure 2). Both the X and Y axis screws are the same, except for length, and I decided to screw cut my own **(Photo. 7)**. They can be bought, but for this machine they would cost in the order of £200. By D.I.Y. methods, the cost, including an Acme tap, is about £50. If two or three people worked together, this could be reduced considerably as the cost of the tap is of the order of £25.

For these leadscrews I used free cutting stainless steel, and purchased one carbide tip of 1/2in. x 10 TPI Acme form. This tip has now cut four leadscrews plus a sample piece without mishap and still has three good cutting edges, so it was a very worthwhile



2: Base plate
1 off steel (see text)



3: X axis slide bar support (R.H.)
7: X axis slide bar support (L.H.)
1 off each steel

acquisition. You will note the use of a travelling steady to support the material during threading and also that the top slide has been rotated to an angle of 14.5 deg., which is half the included angle of the Acme Thread. In this manner, the tool is only cutting on two faces and not being pushed into a wedge.

Assembly of table components

When all these parts have been completed, the assembly can commence (if it has not already). The slides are straightforward and the bushes (Items 11 and 25) are either used as purchased or modified, as shown.

These bushes should be a press fit into their housings, using a smooth mandrel of a diameter a few tenths of a thou. larger than the required bore size. Use Loctite if necessary, but make sure you do not get it onto the inner bore. If everything has gone well, by tipping the base to an angle of about 15 deg., the table should slide down the rods.

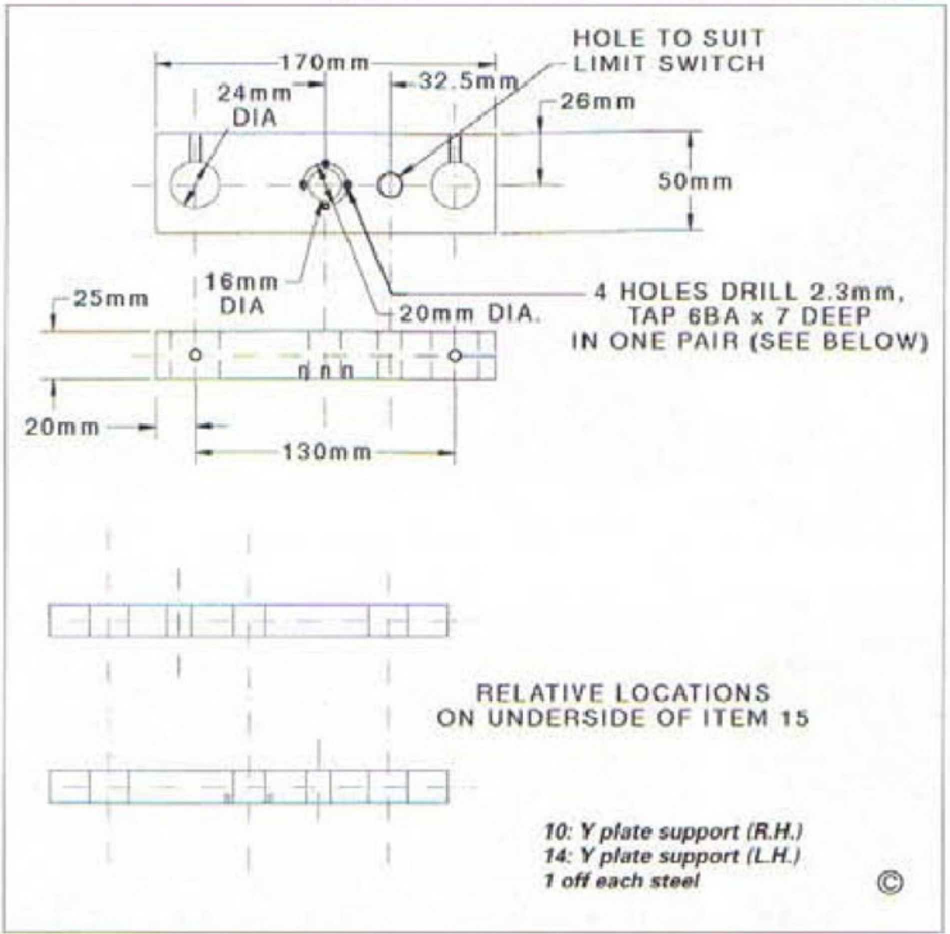
Figure 2 shows the set-up of the bearings for the X and Y leadscrews. This set-up is a standard type where no play is required, and uses angular contact bearings (used to be known as Dynamo Bearings). Using these, all adjustment is made at one end, the far end being used only as a support. It is necessary to have the Stepper Motor Box Assembly (Item 32) made and fitted, as this is part of the bearing housing. However, if a standard type hand milling machine is wanted, then it is a simple matter to fit a second bearing retainer in its place.

When fitting these parts it is important to make sure that the bearing spacer rings (Items 4 and 18) are parallel and the bearings 'nipped up' to remove any play, but to leave the shaft free to rotate. When fitting the spring on the nuts, it should be as fully compressed as possible, as it is the spring force which opposes the loads generated by the cutting tool. If this force is exceeded by the tool, then the clearance in the thread is allowed to come into effect and the play then becomes apparent.

At this point it is a good idea to check that friction within the slide assemblies has been reduced to an acceptable level. I devised some simple torque checking equipment **(Photo. 8)** which consists of length of 6mm dia. round bar which will can be mounted on the end of the leadscrew in such a way that it is balanced. Weights which can be slid up and down the rod are held in place by an elastic band. The torque required to rotate the leadscrew is checked before the motor is fitted. Mine, at this stage was measured at 19 ounce inches which seemed to be acceptable. Although it has not been checked recently, I would feel that this is now lower, as a short program has been devised to run in the leadscrews.

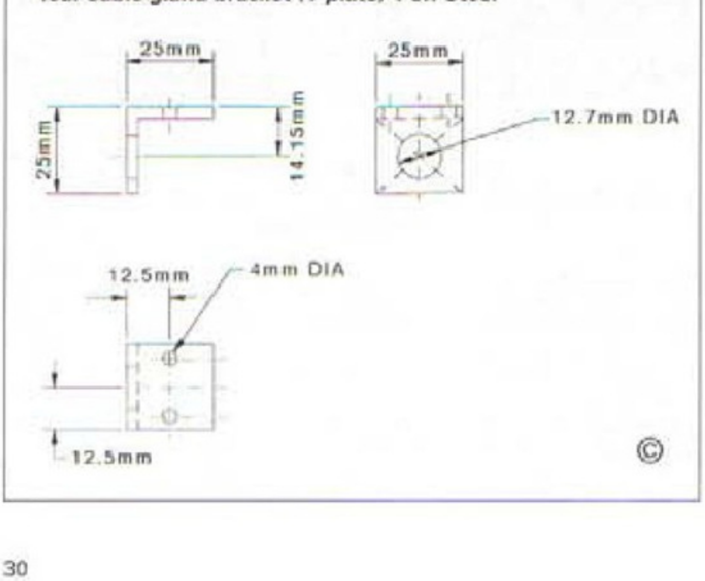
Limit switches

Photos. 4 and 5 show the limit switch system in position in my own machine. This is not fully detailed, as the parts used were to hand and had been gathering dust for 10 to 15 years, so the chance of obtaining exact replicas is small. However, they are based on small micro switches which are mounted in short (30mm) lengths of 25 x 25mm hollow square section, which are fixed in place by two long 6BA studs. As can be seen, little room is available, but glands are incorporated to stop the ingress of foreign matter. These limit switches are triggered by the head of a screw mounted on the outer support bar, working through a hole in the support bar.

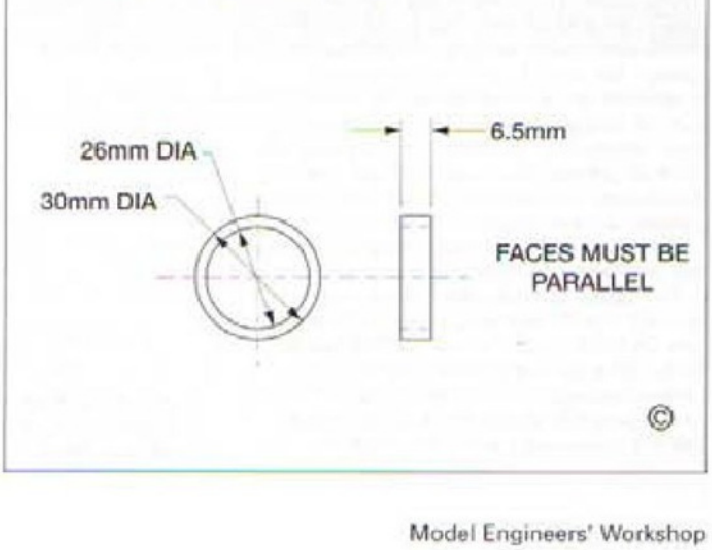


10: Y plate support (R.H.)
14: Y plate support (L.H.)
1 off each steel

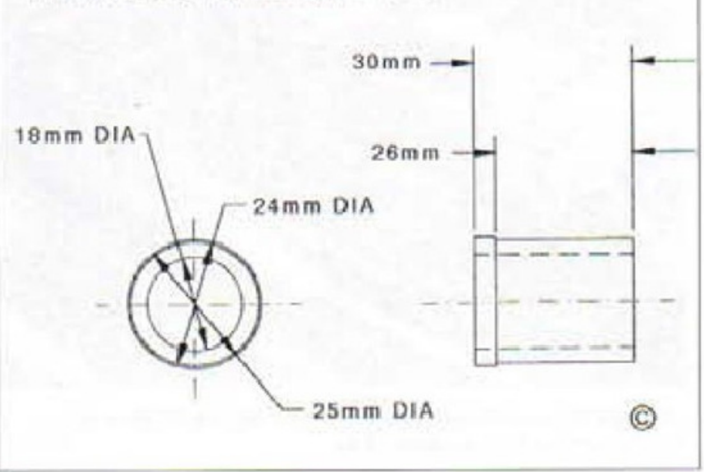
15a: Cable gland bracket (Y plate) 1 off Steel



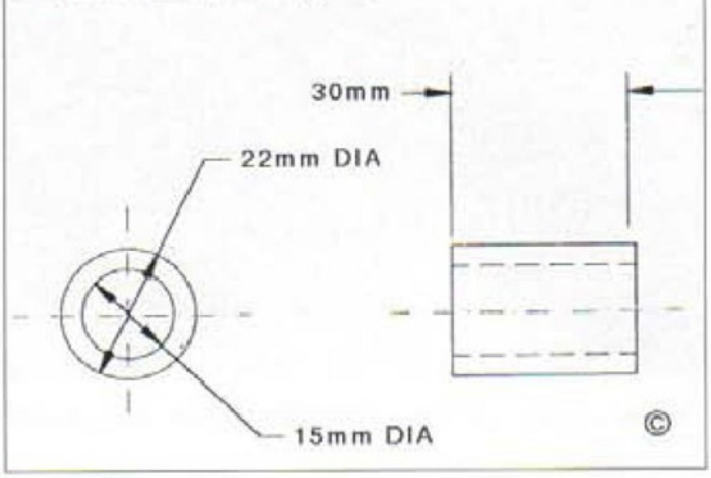
5 & 18: Loose spacer ring 2 off Steel



11: Oilite bushes (Y plate supports) 4 off

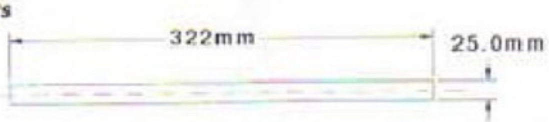


25: Oilite bushes (Table supports) 4 off



9: X axis slide bars
2 off Silver steel

23: Y axis slide bars
2 off Silver steel



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Parts List for the X-Y Table only

(Certain Items of the same specification are required for other parts of the machine. Builders may wish to purchase these as one order, so these are indicated as 'Total of x required')

Angular contact bearings	7200B	4 off. Items 4 & 17 Total of 6 required
Ball race	6000-2RS1	2 off. Items 8 & 21
Oilite bushes	18 x 25 x 30mm	4 off. Item 11
Oilite bushes	15 x 22 x 30mm	4 off. Item 25
Timing pulley	10 tooth x 10mm	2 off. Items 30 & 36
Stepper motors	5v. 200 step (Model Motors Direct)	2 off. Items 32 & 38 Total of 4 required
Timing pulley	10 tooth x 16mm	2 off. Items 33 & 39 Total of 5 required
Timing belt	10mm x 165mm	2 off. Items 34 & 40
Screened cable	8 way	4m Total of 8m required
Screened cable	4 way	4m Total of 8m required
Gland (cable support)	PG7	4 off
Limit switch	to suit (see text)	2 off.

Kits of parts:- Wren Engineering, 58 Kingswood Avenue,
Belvedere, Kent DA17 5HG
Tel. 0181 3120413 Fax. 0181 3120414

Stepper motors:- Model Motors Direct, Hillside House, Baltonsborough, nr. Glastonbury, Somerset BA6 8QJ Tel. 01458 850061 Fax. 01458 851048

Drive belt and timing pulleys.

Figure 3 shows the drive belt arrangement used on the machine. The X and Y drives both started out at a 4:1 ratio, but after some development have ended up at 2:l. The modifications which have to be made to the 20 tooth and 10 tooth pulleys are shown on the drawings, and the finished parts, together with a drive belt, can be seen in **Photo. 9**.

Stepper motors and motor boxes

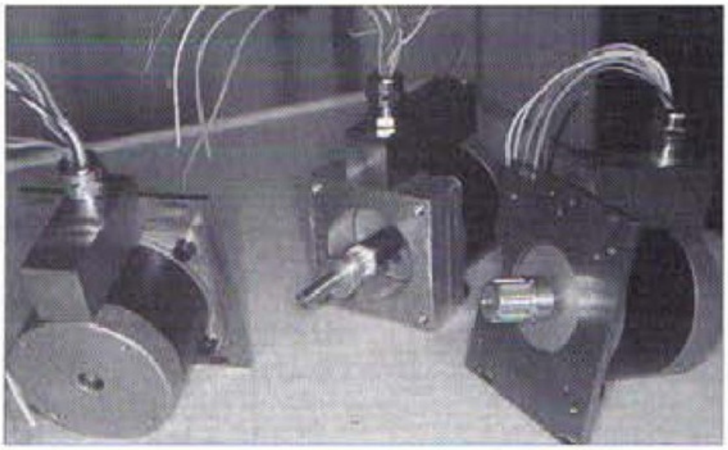
Figures 4 and 5 show the layout of the stepper motor and motor box assemblies. Note that one motor (X axis) is located above and the other below the relevant leadscrew. The motor boxes are used to contain the timing pulley system and to support and give adjustment to the stepper motors **(Photo. 10)**. The boxes are made from mild steel or any other suitable material to hand. Nothing is crucial, and if a hand machine is wanted, they can be dispensed with, but as mentioned, extra bearing retainers will be required.

Conduit boxes

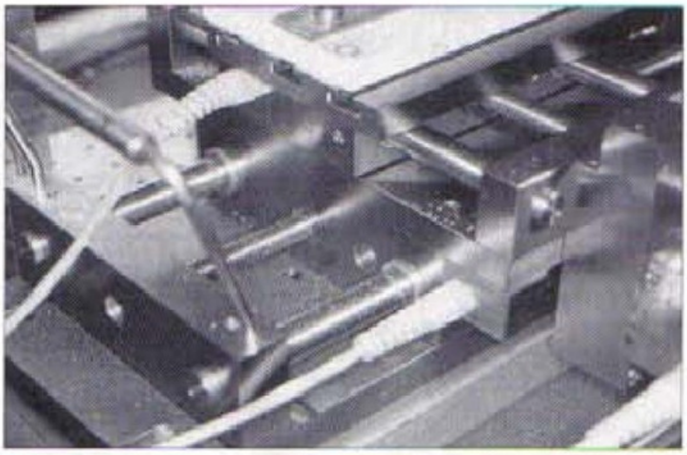
These units, although by no means essential, do protect the motor cable connections from the ingress of metal particles and, if used, coolant. Due to the different motor configurations available on the market, it may be necessary to build your boxes with an amalgamation of the designs shown, so that all requirements are satisfied. They can be seen fitted to the motors in **Photo. 10**.

Swarf tray

This is not an essential item, but well worth making to save the slides and leadscrews from damage by metal particles. It also makes clearing up the swarf a lot easier. **Photo. 11** shows how easy it was for swarf to get down among the 'works' before the tray was fitted.

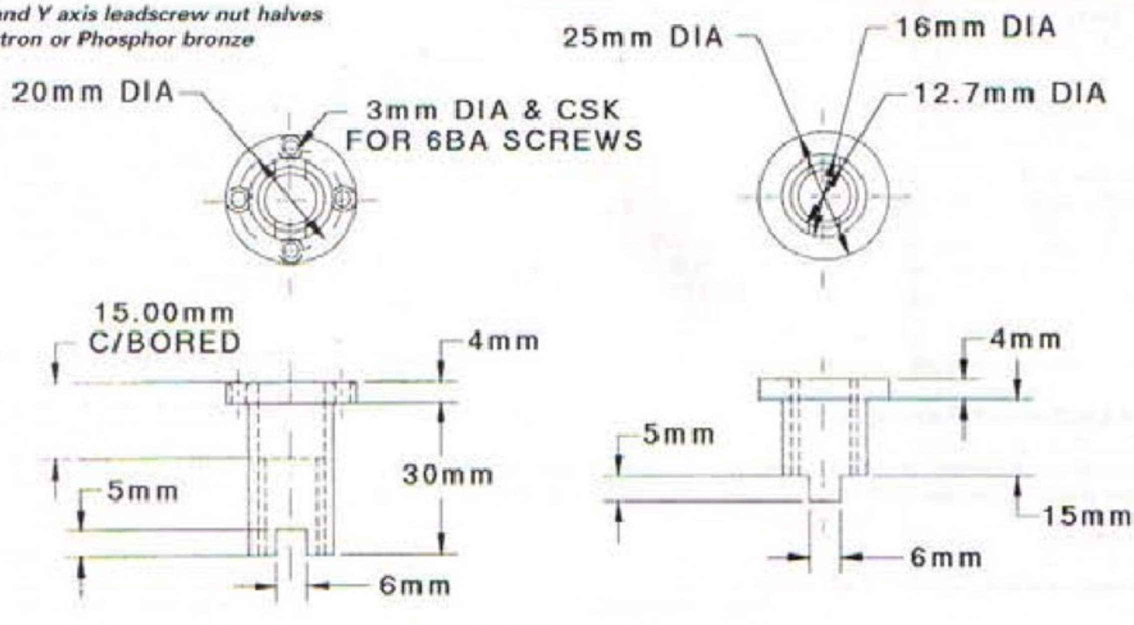


10. *Stepper motors on their mounting plates, with conduit boxes fitted*



11. *Debris can be prevented from reaching the slides and leadscrews by fitting a swarf tray*

12&12a: X and Y axis leadscrew nut halves
2 sets Nylatron or Phosphor bronze



Note: Item 13 X and Y axis lead screw nut springs (not shown)
2 off 16mm bore x 16 swg x 25mm long Piano wire

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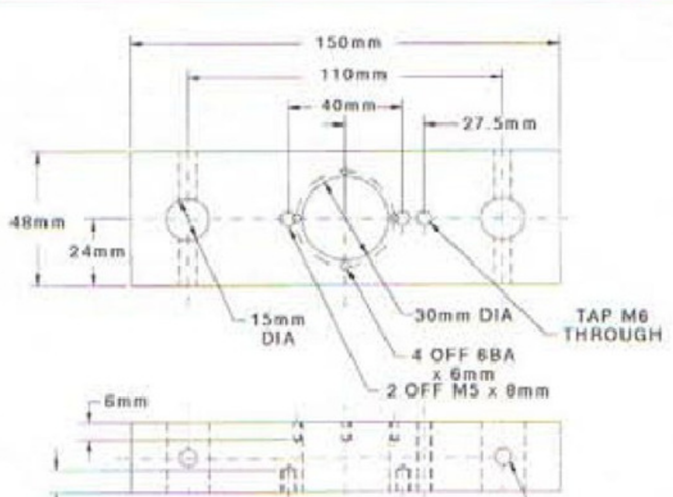

1 OFF AS DRAWN (16)
1 OFF WITHOUT M5 & 6BA HOLES (20)

16: Y axis slide bar support (front)
20: Y axis slide bar support (rear)
1 off each Steel

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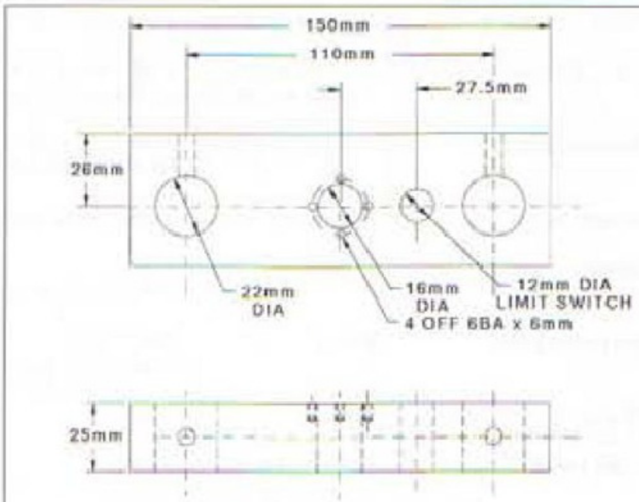

1 OFF AS DRAWN (24)
1 OFF WITHOUT 6BA HOLES (26)

24: Table support bar (front)
26: Table support bar (rear)
1 off each steel

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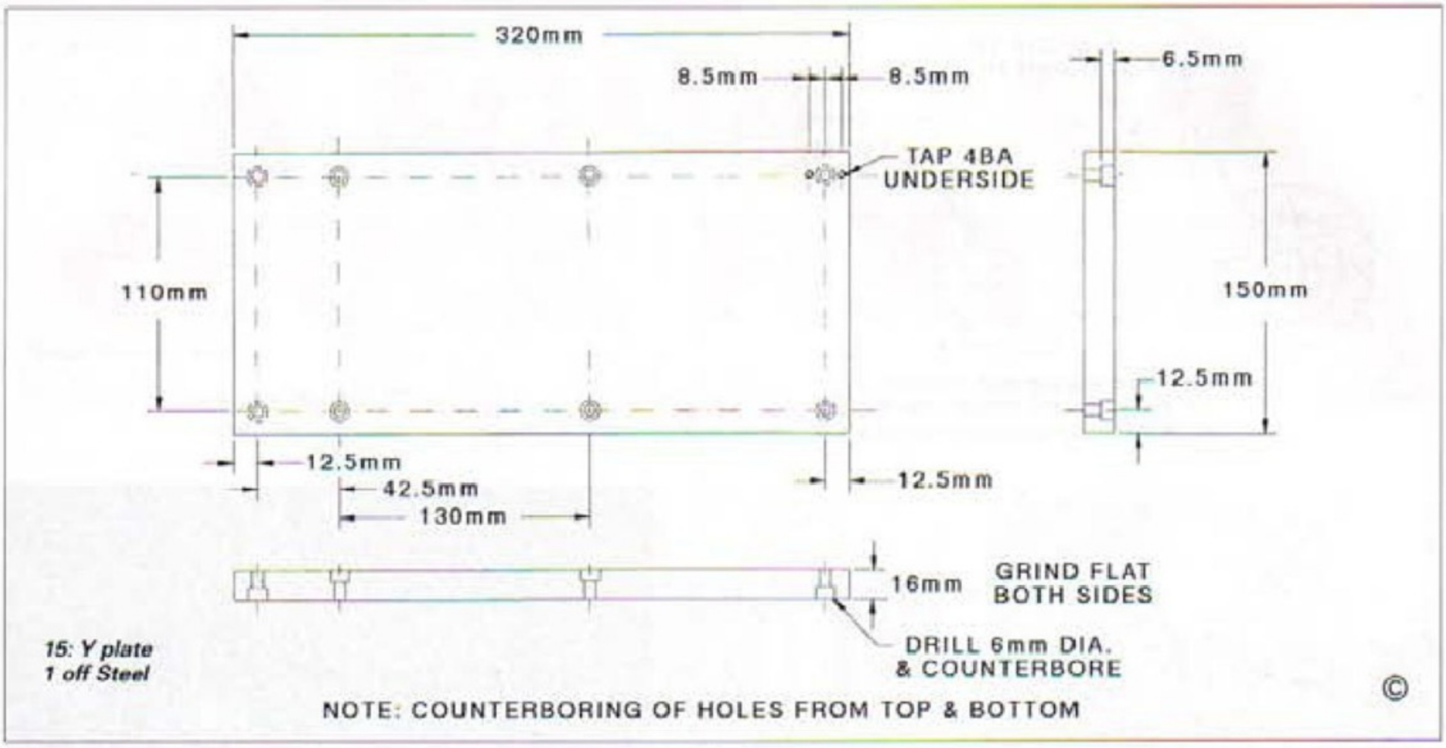
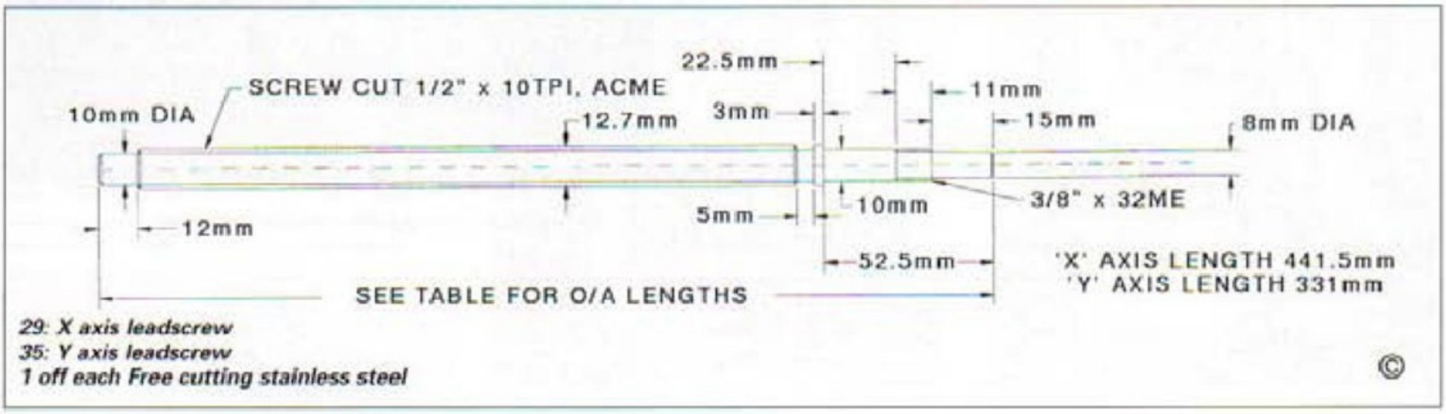
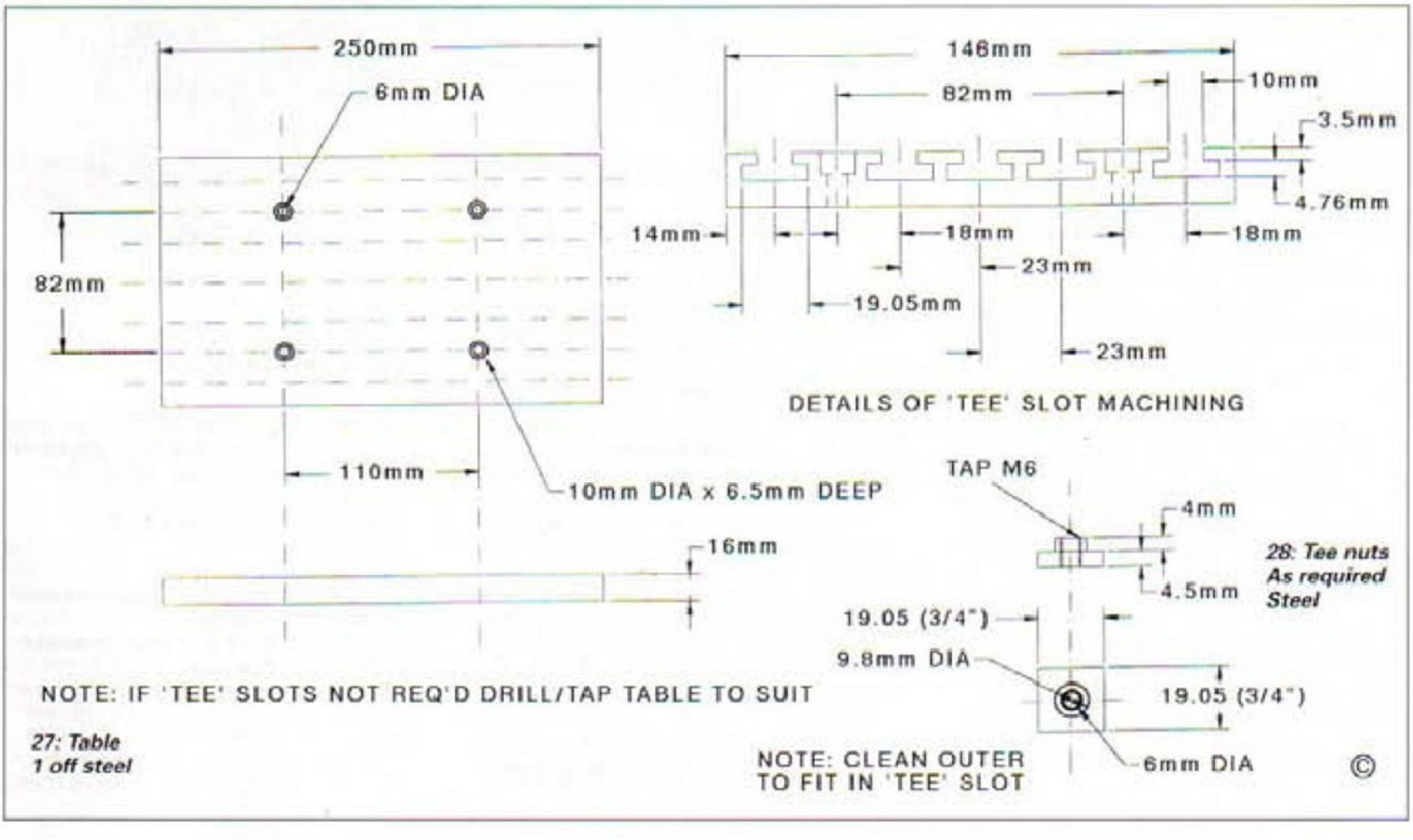


15: Y plate
1 off Steel

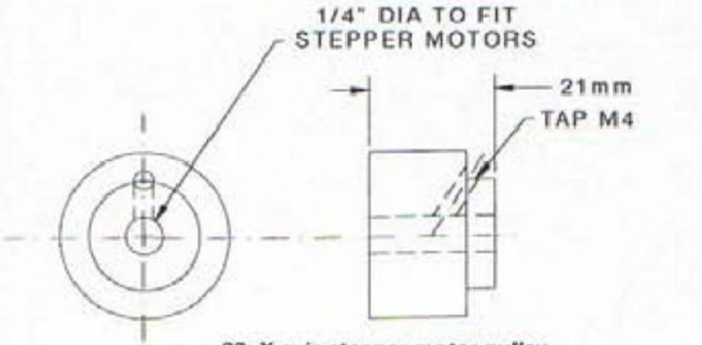


29: X axis leadscrew
35: Y axis leadscrew
1 off each Free cutting stainless steel

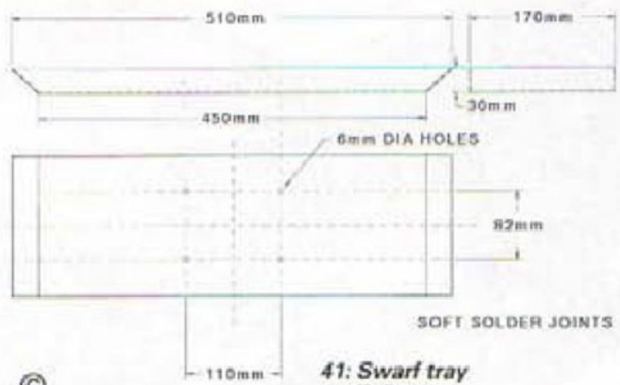


28: Tee nuts
As required
Steel

27: Table
1 off steel



33: X axis stepper motor pulley
38: Y axis stepper motor pulley
2 off 10 tooth pulleys for 10mm wide belt



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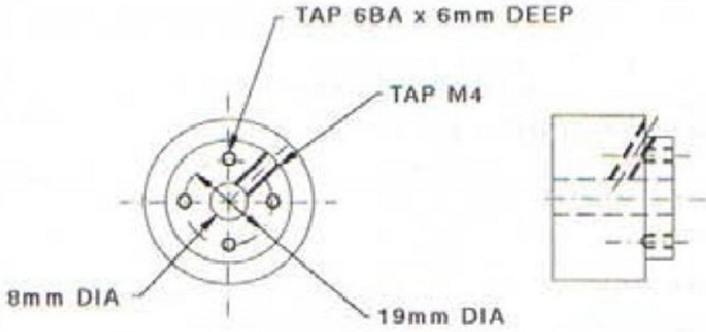
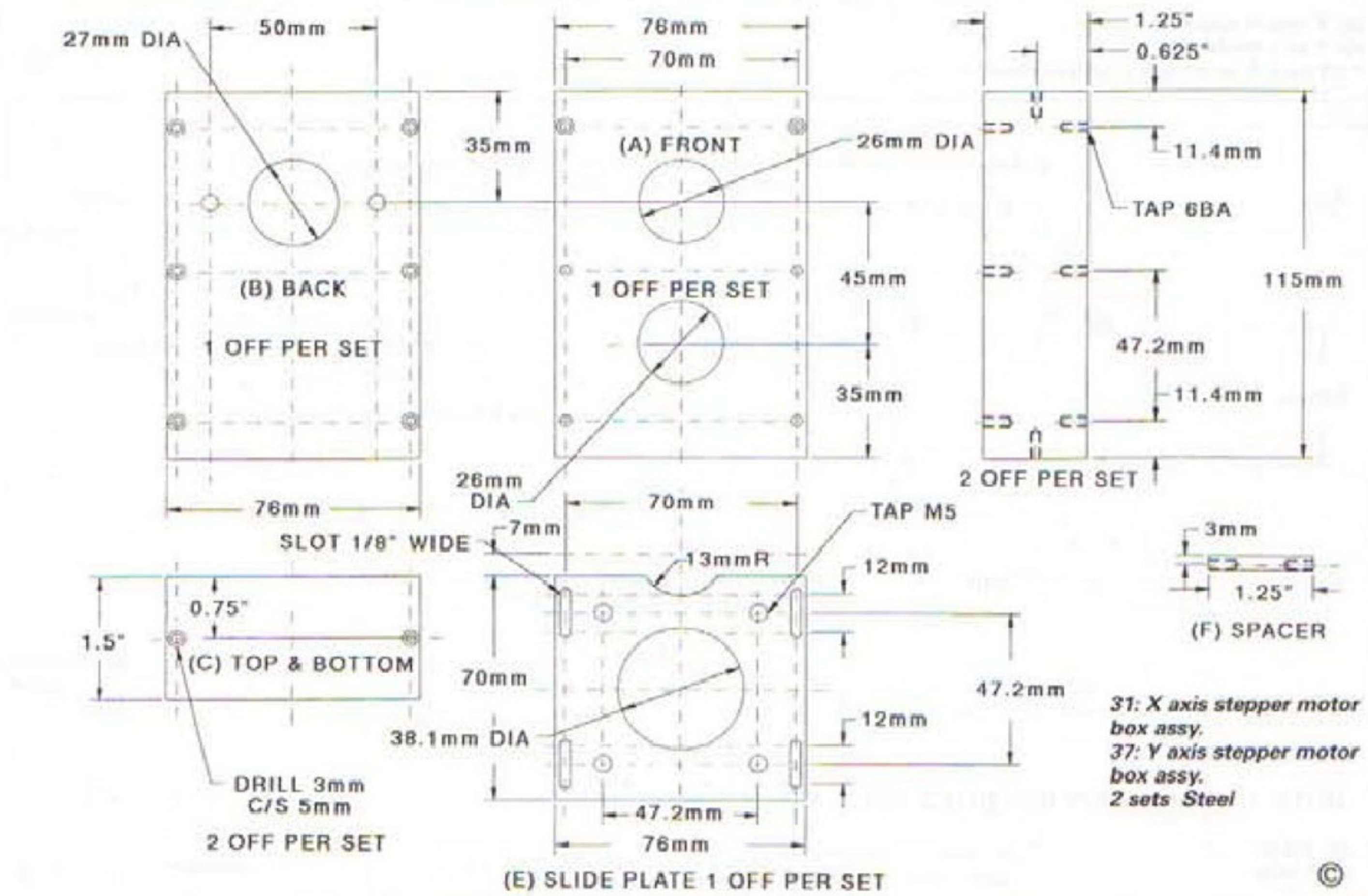
41: Swarf tray
1 off Brass



© *30: X axis leadscrew pulley*
36: Y axis lead screw pulley

9. The modified timing pulleys and a drive belt



31: X axis stepper motor box assy.
37: Y axis stepper motor box assy.
2 sets Steel

©

A FOUR JAW CHUCK FIXTURE

The basis of all successful machining is effective work holding. Keith Keen of West Sussex describes a simple adaptation of a lathe chuck that will find many uses

A few years ago I made up a simple fixture with a four jaw self centring chuck, for holding cylindrical workpieces during cross drilling or end drilling operations. The main purpose in making up the fixture was to provide myself with a quick and easy to use work-holder for the accurate cross drilling of round bars and tubes. Once I had the device, however, I quickly found that it has a number of other uses.

Fixture Use

Photo. 1 shows the fixture, which consists of an 80mm diameter self centring four jaw chuck on an L-shaped mounting base which can be bolted to a mill/drill co-ordinate table either vertically or horizontally. **Photo. 2** shows the fixture

1. The four jaw chuck fixture

being used for a cross drilling operation. **Photo. 3** shows how the fixture is first set up on the mill/drill co-ordinate table; it is aligned square to the table using a try square and bolted down, and then, using 'pointer rods' (e.g. short lengths of quarter inch diameter ground silver steel rods with tapered ends) in the four jaw chuck and the vertical drill chuck, the table is moved until the pointers line up. With the four jaw chuck axis then being in the same vertical plane as the drill chuck axis, the table is locked in its Y direction movement position.

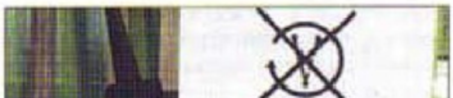
Photo. 4 shows the fixture being used for end drilling a turned workpiece. The fixture is also useful for milling work.

2. Cross drilling with the fixture

Another handy use is as a simple holder, clamped to the bench, for cutting sections of round bar and tube (this is safer for the lathe bed than using the lathe chuck) - **Photo. 5**.

Description

Figures 1 and 2 show the basic dimensions of the four jaw chuck fixture which was configured for use with my own vertical mill/drill (a Rishton VM601 with DRO). None of the dimensions are critical, and the particular mounting hole configurations shown would probably not be appropriate for other types of mill/drill. The chuck is an 80mm diameter TOS 4 jaw self centring unit with internal and external jaws. A 4 jaw chuck was chosen rather than a 3 jaw chuck, because it gives a better grip on the workpiece. The L-section chuck mount was made from aluminium alloy, so that the fixture is not heavy and is easy to manhandle while still being robust enough for light machining. It essentially consists of two plates, a vertical plate made from 4in. x ½in. flat bar, and a horizontal plate made from 2in. x 1in. flat bar. In construction, the horizontal plate was joined to the vertical plate with five steel M6 set screws in counterbored holes in the back of the vertical plate, as indicated in **Figure 2**. The



3. Alignment technique for cross drilling

hole recessing was carried out with a 16mm diameter slot drill to a depth of 6mm. For proper alignment of the fixture during use, it is essential that surfaces A, B and C are all parallel, and also that they are orthogonal to the bottom surface D. The parallel surfaces were achieved by surface milling on the plates before they were joined. After the plates were tightly fastened together (using threadlocking retainer on the screws) the bottom surface D was then surface milled flat and square to surfaces A, B and C, by clamping the L-section mount to a precision angle plate on the milling machine table, with surface D held uppermost and horizontal.

The four jaw chuck is fastened to the vertical plate of the mount with three steel M5 set screws in counterbored holes; the hole recessing here was also carried out with a 16mm diameter slot drill to a depth of 6mm. A 20mm hole in the vertical plate, along the chuck axis, allows long lengths of small diameter workpiece material to pass right through the fixture. The chuck is mounted with its jaws set in diagonal (45 deg.) planes, as shown in **Figure 2**, so that cross drilling can be carried out if required, between the chuck jaws. Also, the chuck is aligned with its 'O' marked (most accurate) key socket at the top of the fixture, where it can be easily accessed with the chuck key.

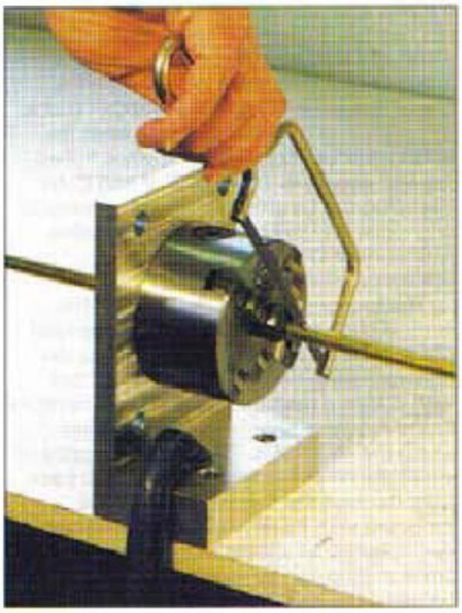
Chuck Size

I made my four jaw chuck fixture with the smallest of the self centring chucks that are available from the supplier, and I have found that this suits the range of sizes of workpieces that I most usually work on. However, larger chucks are also available, and a bigger fixture with a larger chuck might be preferred for holding larger diameter items.

Suppliers

80mm diameter 4 jaw self centring chucks are available from good tool suppliers such as Millhill Supplies, Compass House Tools and Chronos. If you have difficulty in obtaining 2in. x 1in. and 4in. x 1/2in. aluminium alloy flat bars from your local supplier, try Milton Keynes Metals.

4. End drilling with the fixture



5. The fixture used as a convenient holder for cutting round bar or tube

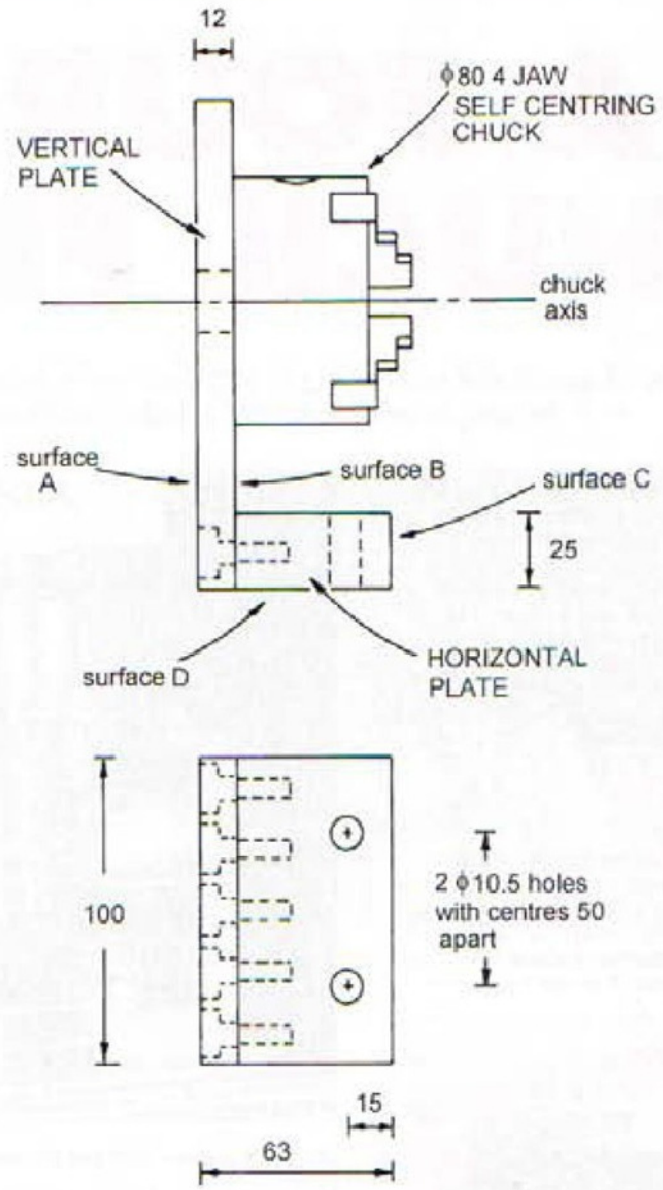


FIGURE 1. THE 4 JAW CHUCK FIXTURE - SIDE AND UNDERSIDE VIEWS

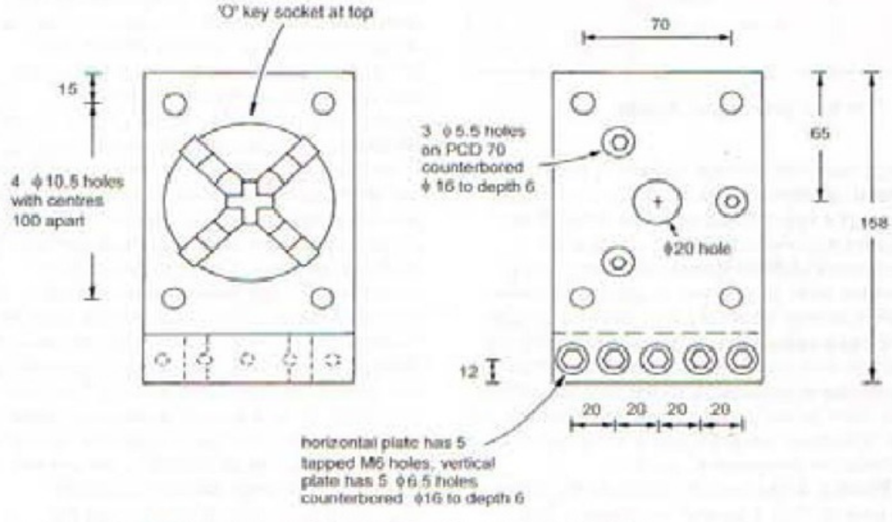


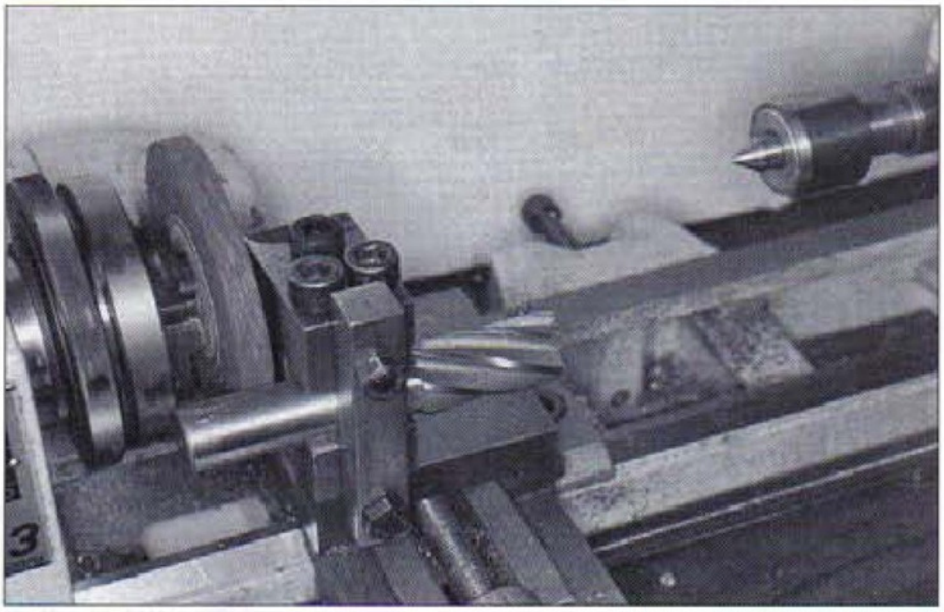
FIGURE 2. THE FOUR JAW CHUCK FIXTURE - FRONT AND BACK VIEWS

AN EXPERIMENT IN CUTTER HOLDING

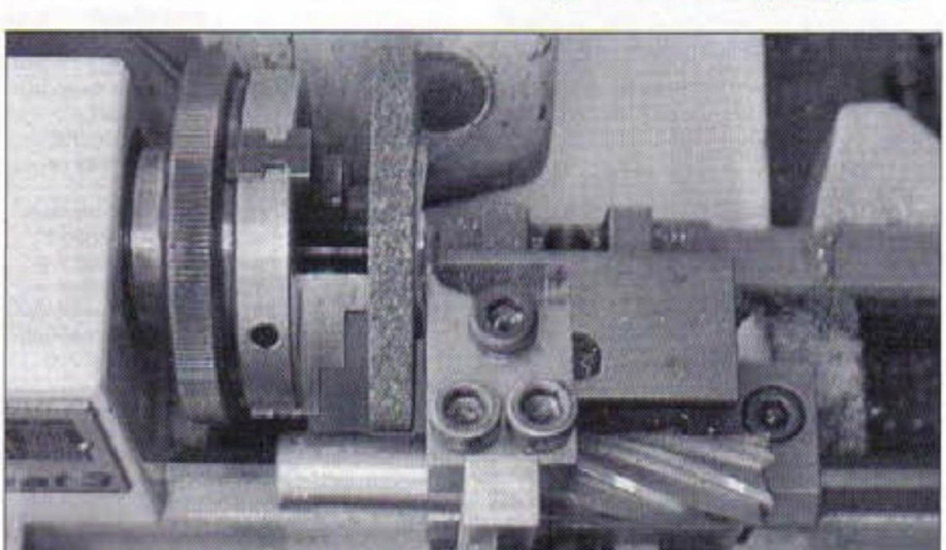
Holding an end mill or slot drill in anything other than a purpose-made chuck can be a chancy business. Bob Loader has investigated some methods which will be of interest to the users of smaller machines.

As many readers will know, my Unimat acts as a machining centre on which I carry out all my milling as well as turning. The only means of holding milling cutters available to me were the tailstock chuck for the smaller ones and a modified 1in. Jacobs chuck for which I have made an adapter. These arrangements are far from ideal because a cutter held only by friction can move radially by skidding round, or in a linear direction, which can push it back in the chuck, losing the setting. Even worse, it can sometimes, if conditions are right, 'unwind' with catastrophic results.

When discussing the problem with the editor, we suspected that there are many users of small lathes are in the same position, because commercially available milling chucks are usually much too big for these machines. He therefore asked me to have a go at solving the problem.



1. A general view of the grinding set-up

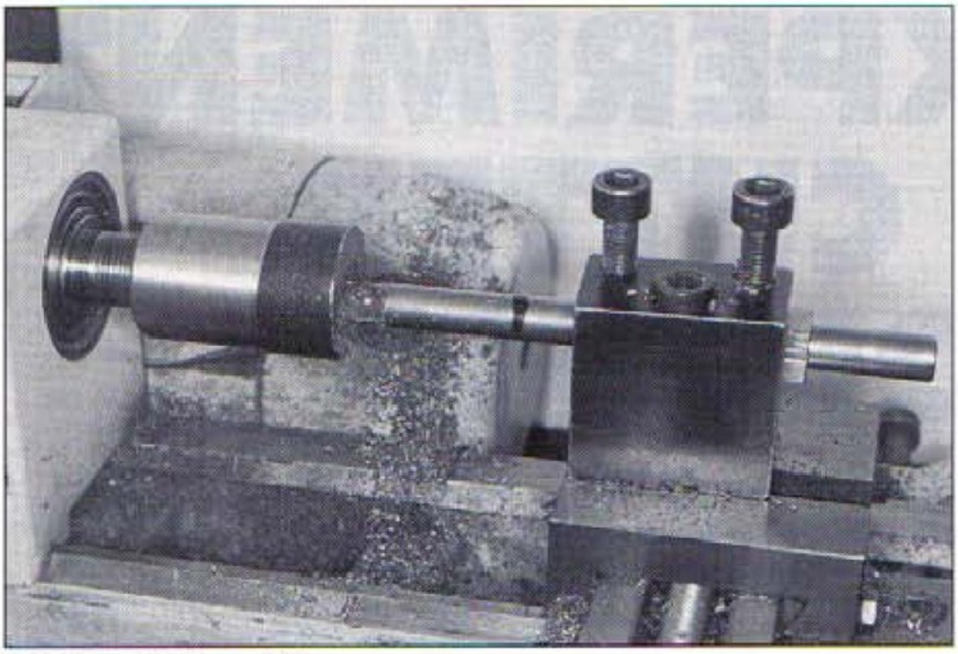


2. The grinding fixture from above

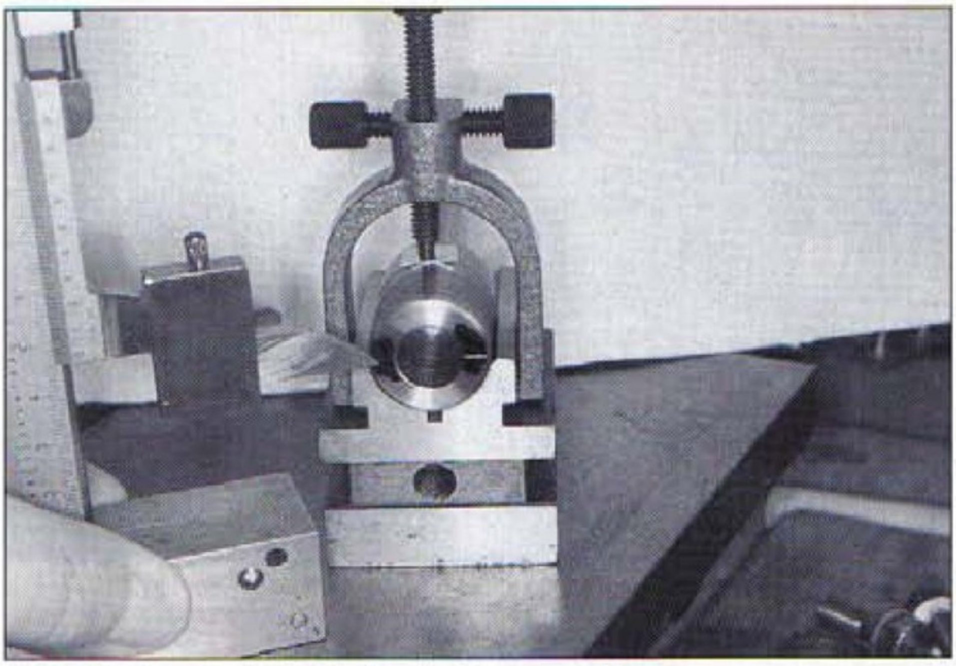
The remedy

There has to be a means of preventing the two movements. Dormer, who make the excellent mini mill cutters have got it right by grinding a recess in the cutter shank and securing it in the holder with a set screw. This is fine for cutters with 1/4in. or 6mm shanks (the two sizes they make) and, while they are reasonably priced, the holders are still quite expensive.

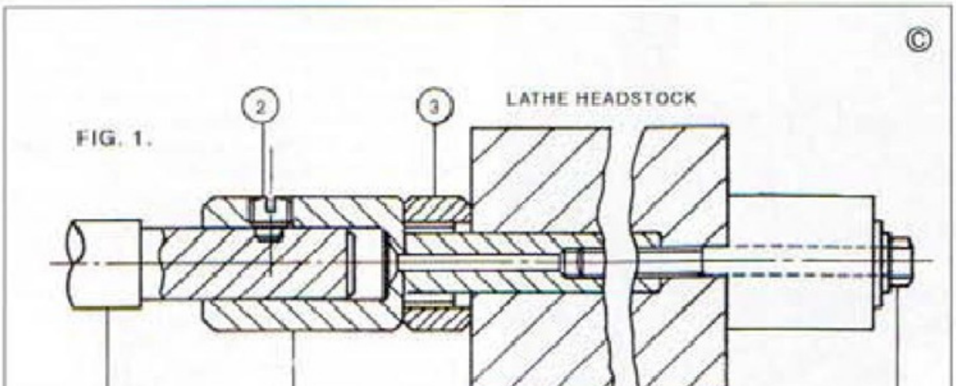
I thought that it would be a good idea to have a go at the holder first, making it for the larger end mills which I use, from 3/8in. to 9/16in. I could think about sleeving or some other method for the smaller cutters later. This was all very fine but still didn't do anything about stopping the cutter from moving under pressure. What I needed was some way of making a recess in the cutter shanks, just a small slot. The only way I could think of was grinding, but wheels of a size and shape which could be used on the Unimat aren't that easy to find. So I thought until one day, Pauline and I were looking round a shop we visit regularly. It has a section which is a cross



3. Boring out the large holder



4. Marking the centre line on the large holder



between a toolshop and an old-fashioned ironmonger and I've found many a treasure there, from a good English bench vice to a spare set of cutters for a grinding wheel dresser. In among boxes of odds and ends I found some small mounted grinding wheels of various sizes and shapes. They had 1/4in. shanks and there was one 2 1/2in. diameter and 1/4in. wide, just what I was looking for.

The set-up

Finding the right grinding wheel was one thing, setting it up quite another; **Photos. 1 and 2** give an idea of the Heath Robinson nature of the equipment. It was fixed by adapting a special tool post I'd made for larger-than-usual tools, which had some tapped holes in places which had nothing to do with tool clamping, but were useful for making sure that the end mill being worked on was pressed in to the tool post by the clamp. The rest of the clamping was done by the normal tool post bolts.

It took a long time to grind the slot, because it was plunge cutting and the Unimat doesn't like that. It was done little by little, with suitable eye protection. The saddle was locked and the cross slide stiffened by half locking. Patience is necessary; it cannot be hurried. I tried doing one cutter off-hand with no clamping. It doesn't look pretty. An occasional dressing with a diamond or dressing stick would have helped to speed the grinding process but I had mislaid all my grinding tackle. Sod's law has worked again and now I don't need it, I've found it. Now I had two cutters with slots ground in them. Time to think about the holder. Some ideas had come to me while the grinding wheel was chewing its way slowly into the cutter and I had a good idea of how I'd do it.

Cutter holder body

Mild steel was used. The largest diameter is 24mm, which can be skimmed down from 1in. or 25mm and give plenty of wall thickness for the size of cutters for which I wanted it. It was roughed out using a revolving centre in the tailstock for support; a revolving centre avoids the tiresome business of lubrication and checking the tension and tendency for solid centres to over-heat.

Once roughed out, the diameter marked ** on the drawing of Item 1 was turned to size. I had decided to make it fit inside the lathe spindle instead of screwing to the spindle end. The size of the ** diameter was 10.390mm. or 0.409in., found by measuring the shank of one of the solid centres. Remember that my holder was made for the Unimat; different machines will have different spindle bores, perhaps Morse taper ones, so they will have to be checked. Once known the diameter can be finished to size.

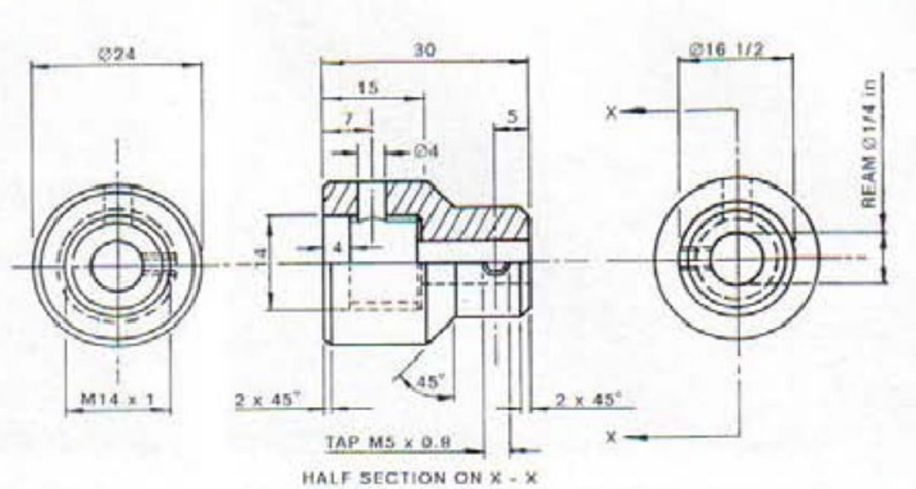
When the diameter was finished and the drilling and tapping done, I found a small snag. The diameter wouldn't go into the spindle bore any further than about 20mm. The spindle had been bored out just far enough to accept the centre and no more. As dimensioned, the holder must go in 45mm, so I had to bore out the spindle till it fitted without messing up the accuracy, a bit of a head-scratcher but all went well.

With the holder body fitted and the draw bolt pulling it back to the spindle nose, I bored out the diameter marked *, which was 1/2in. to fit the shank of the biggest cutter I intended to use. 1/2in. was the nominal diameter, the actual was nearer to 0.499. The boring out was the usual cautious caper, drilling bit by bit to just under the 1/2in. then using the boring tool which I had made to accept the small tungsten carbide tips. **Photo. 3** shows this operation under way, the grotty looking bit was what was held in the chuck and the mark on the boring bar was a guide to the depth. When the mark was reached, the rest was done to the saddle index. When the bore was right, the end mill shank, used as a gauge, bounced when pushed in and made that lovely soft cork-popping noise when it came out. To let the air out when a shank was fitted, I drilled the 4 1/2mm. hole right through.

The two 5/16in x 26 tpi holes are for the locking screws shown as Items 2a and 2b. It was the finest thread I had which would be suitable for locking. **Photo. 4** shows the marking out to get the centre line in the right place. I used two methods for the drilling. **Photo. 5** shows the normal (to me) way of drilling a round component, using a crutch centre. The same method couldn't be used to drill the other hole as it was too close to the end, so another set-up had to be used. A vee block was clamped to the cross slide and the holder body clamped to it, with a packer underneath to get the height right. With the holes drilled and tapped the holder was finished, the 24mm. diameter and the chamfers having been machined while the holder body was still in the lathe.

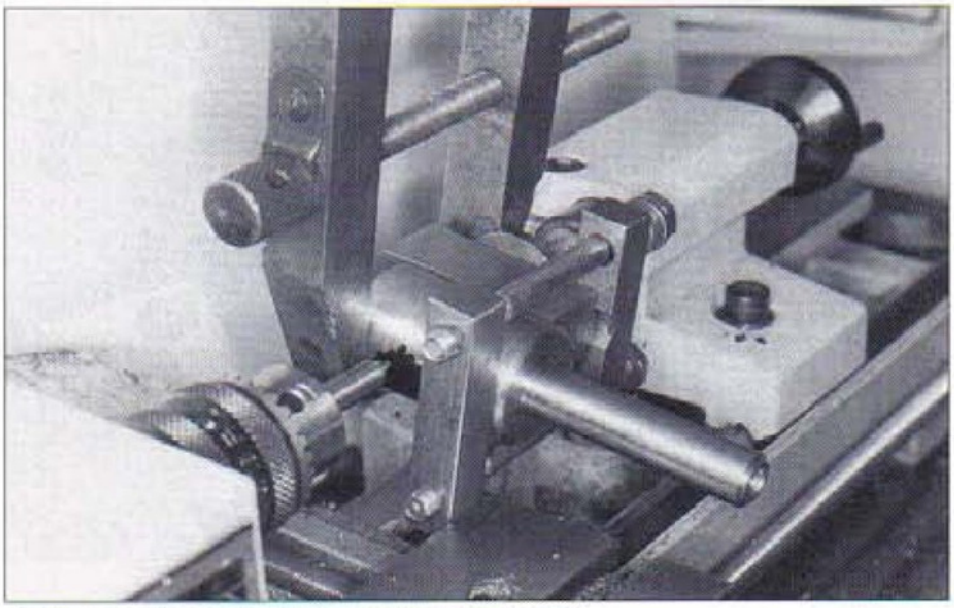
Thread protector

A look at **Photo. 3** will show why a thread protector is a good thing. It may not be so for other lathes, but the Unimat needs it. It is another easy-to-make component (Item 3). It keeps swarf out of the spindle thread as well as protecting it from bumps and bangs. When screwed on, the holder butts up to it and not to the end of the thread. It is shown in position in **Photo. 7**.



HALF SECTION ON X - X

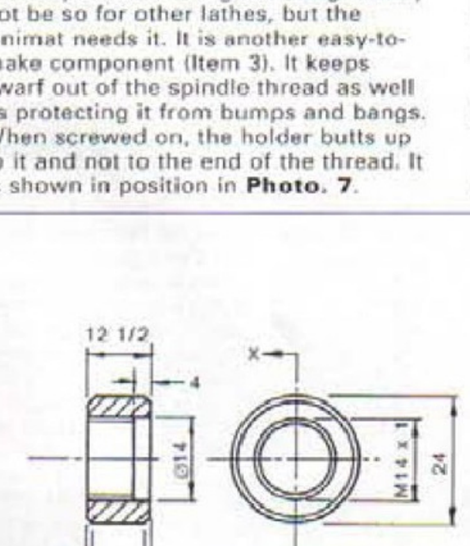
FIG. 3. SMALL CUTTER HOLDER, B.M.S.



5. Centre drilling the holder clamped to a crutch centre

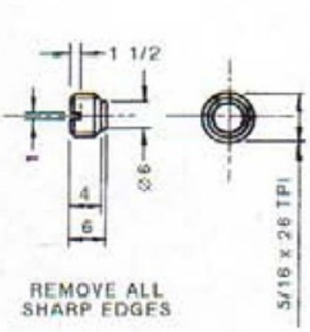
Adapter

So that I could use my 1/4in. cutters as well as the larger ones, I made an adapter, **Fig. 2**. If the diameter marked * is a good fit in the holder and it is concentric with the 1/4in. hole, all will be well. It is just a matter of machining the reamed hole and the diameter on the same setting. The 5mm hole for the locking spigot of the long locking screw was drilled using the same method as that shown in **Photo. 6**, but simpler because the adapter was screwed to the cross slide directly with a 6mm bolt as shown in the photo, once again with a bit of packing to get the height right. I used an old bolt because it would be drilled into.



SECTION ON X - X

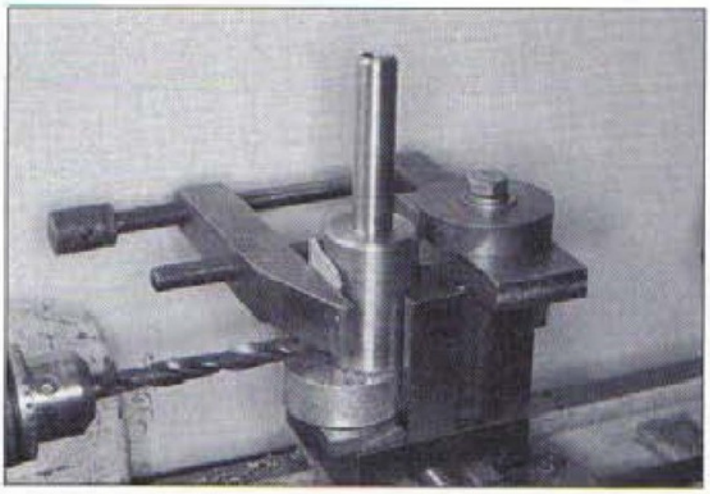
ITEM 3. THREAD PROTECTOR B.M.S.



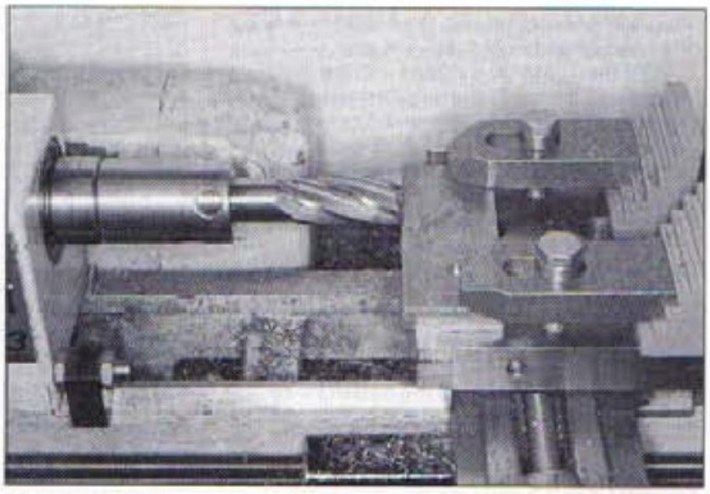
ITEM 2. SHORT LOCKING SCREW, B.M.S.

Locking screws

There are two of these; the short one locks the larger cutters and the long one the 1/4in. ones via the adapter. I used some steel of unknown specification which I knew was quite a bit tougher than mild steel, which is why the drawings don't specify the material. If in doubt, find an old 5/16in. cap head which has a plain portion and use that. The screwdriver slot was cut with a hacksaw and the ends of the spigots were chamfered.



6. The other method of drilling using a vee block and parallel clamp.



7. Testing the holder with the large cutter

8. Finish turning one of the sleeved cutters between centres

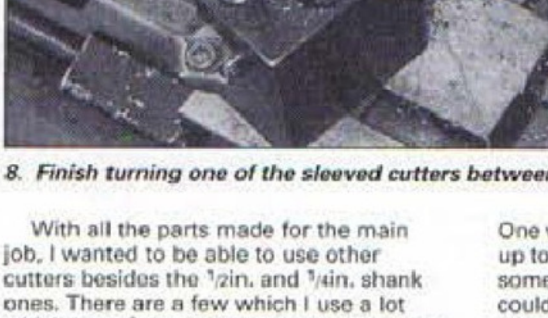
With all the parts made for the main job, I wanted to be able to use other cutters besides the 1/2in. and 1/4in. shank ones. There are a few which I use a lot which have 3/8in. shanks, so the next thing was to find a way of using them.

I thought of grinding a slot in all the cutters with 3/8in. shanks and making another adapter, but it seemed preferable to think of a method which was independent of the grinding business, so that anyone could do the job without having to grind the cutter. One way would be to sleeve the diameter up to a bit over the holder bore and fix it in some way. The fixing is the problem. It could be silver soldered, something I have done more than once; the temperature needed to silver solder has no appreciable affect on the hardness of high speed steel, especially if the cutting part is buried in wet sand. I couldn't try this on my cutters because I haven't a heat source which will get hot enough. I had flights of fancy, such as putting the cutter in the freezer, with the chef's permission of course, to see if it could be shrunk by the low temperature. Even with the fast freeze on, there was no significant reduction.

There is, however, a really easy way of sleeving up, as long as it is done accurately. The method is to make the sleeve an interference fit on the cutter shank and press it on, using a bench vice or, if available, a mandrel press. The only difficulty is making the hole in the sleeve to the right size, so that the fit is truly an interference fit. For the size I was interested in, a difference of between 0.0005 and 0.001in. is enough and the easiest way is to use a hand reamer and make use of its taper. This taper is for about a quarter of the length, so if the reamer was taken through a sleeve until the end was just level with the end of the sleeve, it would press on a treat.

I was lucky that I have a selection of 'D' bits of various sizes and there was one which measured 0.3735in. as near as I could measure it. The cutter shanks, nominally 3/8in. all measured 0.3745in., giving a difference of about 0.001in., just right to have a go with. Well, I had a go and it worked all right. The pressing was done in my bench vice, a 3in. one. A bigger one would be better, and don't use one of those pathetic things sold in car maintenance shops, it will probably come in half with the pressure it has to put up with. Use a good English made one and it will stand the extra leverage; it may have to, when a tube has to be used over the handle to give a bit more pressure. Not too long a tube though, or it could put too much strain on the vice. I did three 3/8in. shank cutters with very little trouble and some extra leverage from a short length of tube slipped over the vice handle, which extended it from 5in. to 12in. The first couple of millimetres or so can be scraped out from the sleeve with a three square scraper, just enough to give it a start. A smear of

FIG. 2. ©

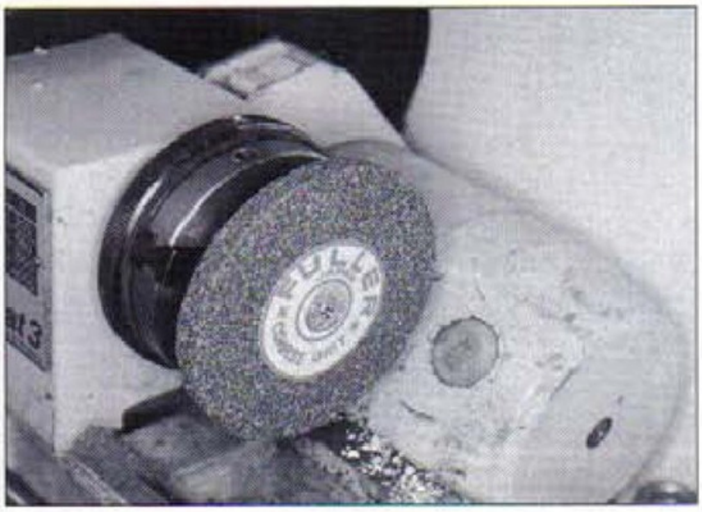


ADAPTER. B.M.S.

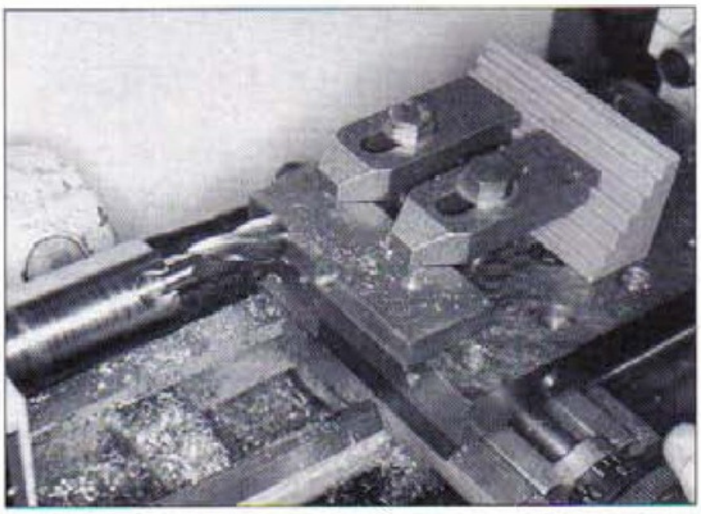
©

CHAMFER ALL EDGES

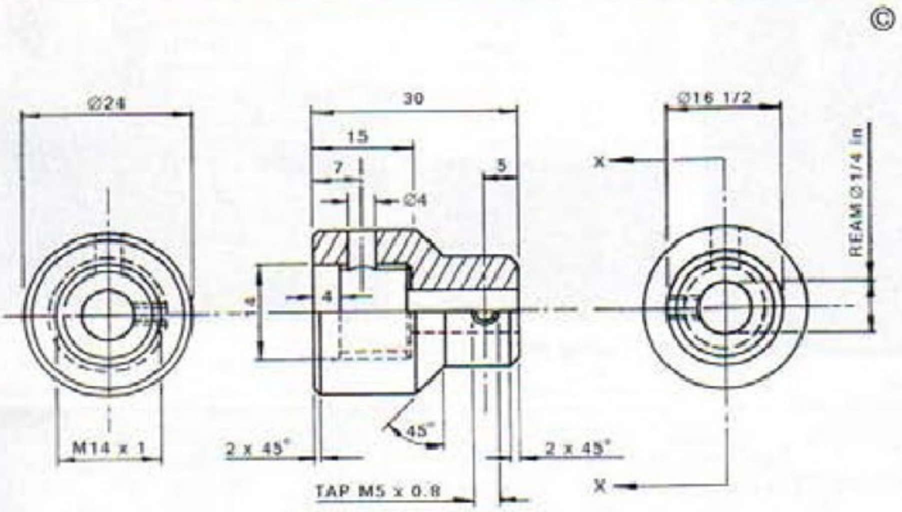
ITEM 2b. LONG LOCKING SCREW B.M.S.



9. The grinding wheel used to grind the slots in the cutters

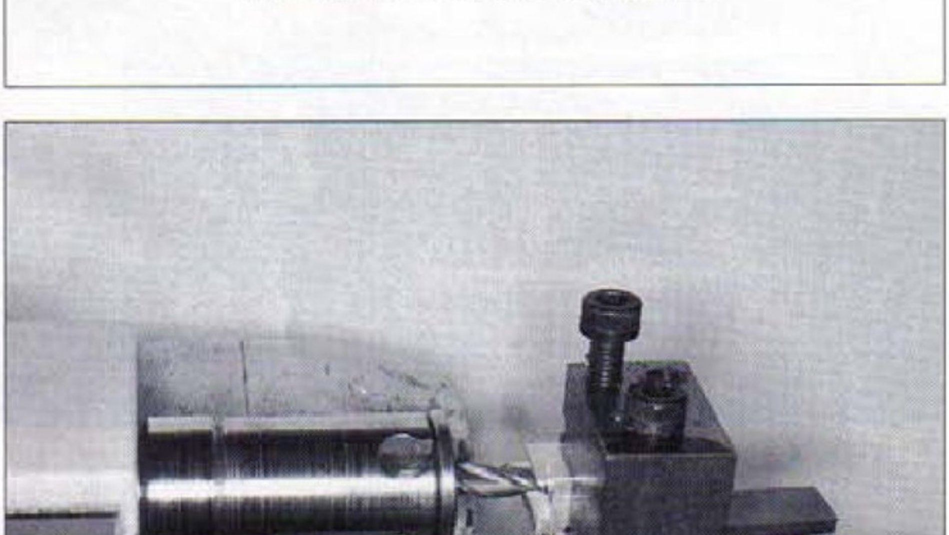


10. Testing one of the cutters with a pressed-on sleeve



HALF SECTION ON X - X

FIG. 3. SMALL CUTTER HOLDER, B.M.S.



11. The holder with the adapter for using ¹/₄in. cutters

oil helps too and it is vital that the pressing is started off squarely. I protected the cutter teeth with a piece of aluminium alloy between teeth and vice jaw; the other end shouldn't need any protection.

End mills are machined between centres and I made use of the centres for the next part of the job, turning down the enlarged shank till it was a good fit in the cutter holder **(Photo. 8)**. This left the slot to fit the clamping screw, a few minutes work with a file.

Should the cutter be a slot drill, or lack the centre at one end, the turning can be done in a four jawed chuck, using a split bush to hold the cutting length and setting it true with a wobble bar.

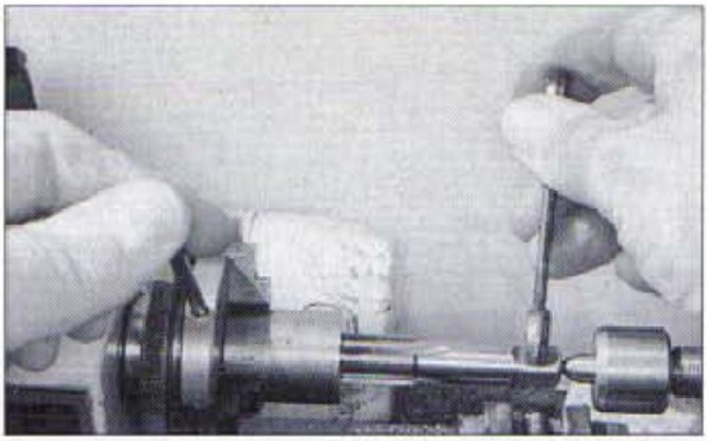
Testing

The first test was done using the largest cutter I had modified, the ⁹/₁₆in. one. I set up a piece of 6mm mild steel **(Photo. 7)**, and had a go at it. There was a bit of vibration, as there always is when I'm milling with a large (to the Unimat) cutter. The machine slowed and stopped a few times, but that was something else which I found out about and have since corrected. It is another story, not without interest, but not relevant to this one.

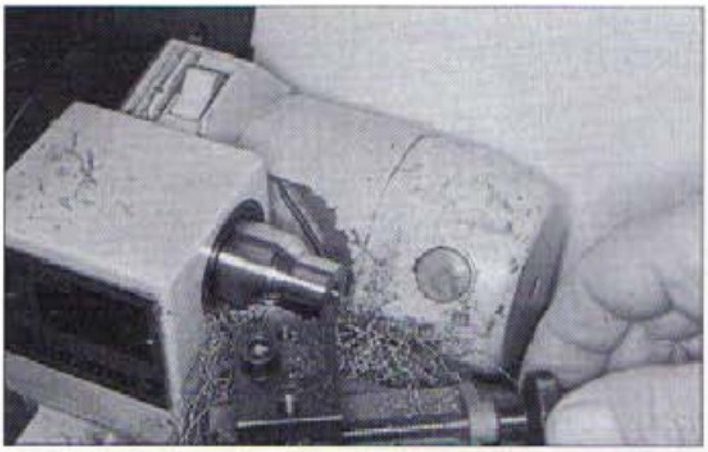
An afterthought

I thought it would be nice to make a small cutter holder for the mini mills, so I made the one shown in **Fig. 3**. It was a quick job and as long as the M14 thread and the ¹/₄in. reamed hole are concentric, there is not much that can go wrong. The best way of making sure is to cut the thread first, using the tailstock centre, as in the photo., to keep it true. The blank can then be threaded on to the headstock and the rest of the machining done on that setting. It is less trouble to make than the adapter and it works a treat.

I put a tommy bar hole in the small cutter holder, something which could have been done to the thread protector, just in case they got stuck. It didn't need to be done for the other components. When the small holder was tested it worked perfectly.

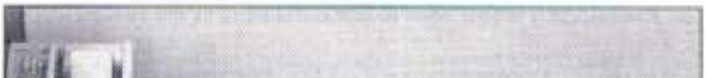


12. Keeping the tap straight and square while cutting the thread in the small holder



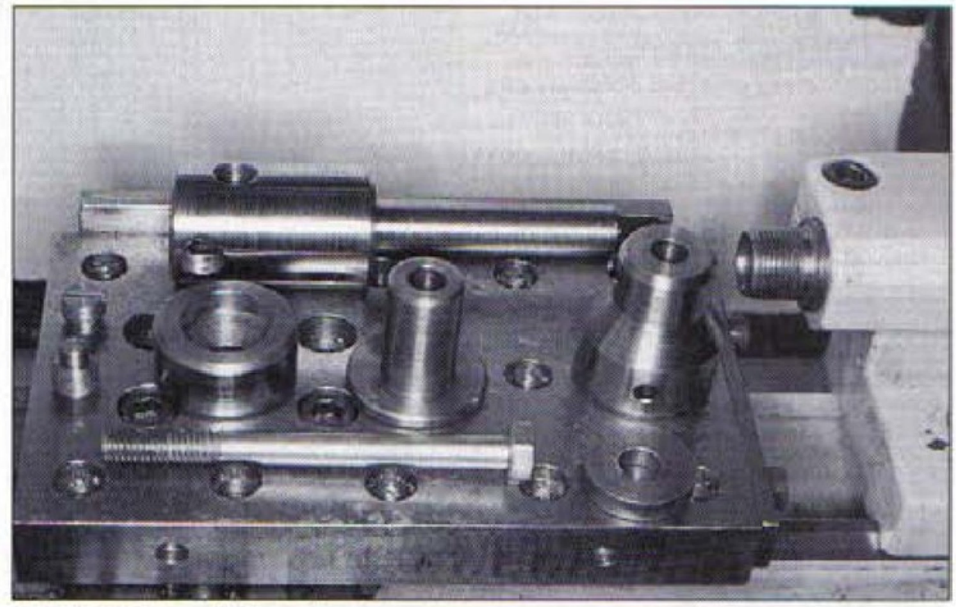
13. Turning the large chamfer on the small holder

14. Drilling a tommy bar hole in the small holder



15. Testing the small holder

16. Three of the modified cutters; left to right, an off-hand ground one, a pressed-on shank and a machine ground one



17. All the bits and pieces

Testing the sleeved cutters

Once I'd found out what ailed the lathe and put it right, I set up the large cutter holder with one of the sleeved cutters. I wanted to see if the pressed-on sleeve would stand up to some graunching. I gave it a right hammering, with no problems. That proved the method, so I was well pleased.

The attachments can be made quickly and the materials are mostly the sort of thing to be found in the scrap box. Remember that the cutter holders are designed for the Unimat and would not be suitable for other machines without modifying to suit. It is my solution to an aggravating problem. I hope it may help others who have the cutters but only a Jacobs chuck to hold them with.

Sources

It is easy to get the mini mills; the magazine advertises several suppliers. The grinding wheel is a different thing and the best places to look would be old-fashioned ironmongers. **Photo. 9** shows the wheel and the main label, the back just has the maximum speed of 3450 r.p.m. printed on it. There were both coarse and fine grit wheels; I chose coarse so that there was a chance that it would be more free-cutting than a fine one.

A FAILED ATTEMPT

The old adage 'never start something you can't stop' applies to this article. Harold Hall thought that he would improve the look of the dials of his milling machine and ended up adding significantly to the capability of his workshop. Here he summarises the train of events and describes the basis of a fully equipped dividing head. The remaining components of this and the other projects will follow in subsequent articles.

Having attempted to improve the appearance of the micrometer dials on my milling machine, I failed so badly that the only course of action was to recalibrate them.

This I thought I would carry out on my Myford Super Seven using a 40 tooth gear mounted on the changewheel end of the spindle and a forked detent to give the 80 divisions required. Even though I have seen the method adopted on Series 7 lathes, I was not happy with the limited methods of fitting the detent on the Super Seven. It was decided therefore to make a dividing head which could be mounted on the lathe bed, allowing the dial lines to be cut using the top slide. The head would also be usable on the milling machine table.

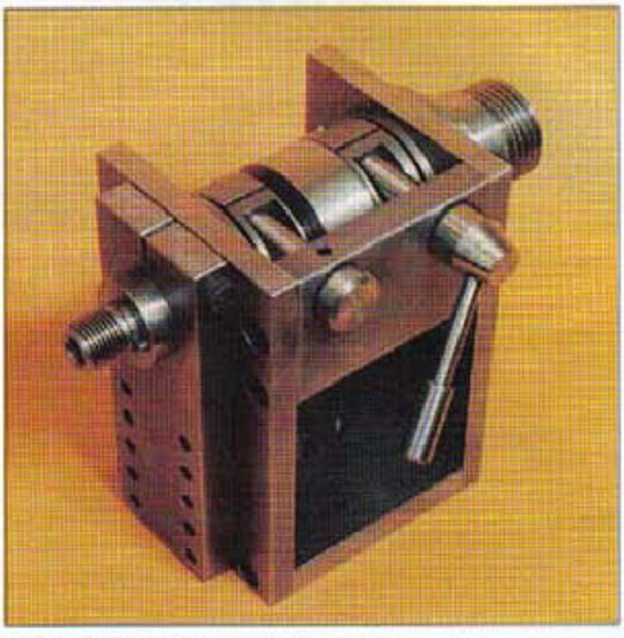
As the idea took shape, I decided that its spindle should replicate the chuck fixing and Morse taper of the lathe spindle. Centre height should match that of the lathe, enabling the tailstock to be used if required. Matching the centre height would require a special boring bar.

Tools require tools

The dividing head would use the 20 DP gears supplied by Myford, so a 20 DP worm would be required. Having equipped the lathe with a quick change gearbox, DP, Metric and other special pitches could only be produced using a special quadrant. Buying the quadrant was difficult to justify, so making one had to be the way forward.

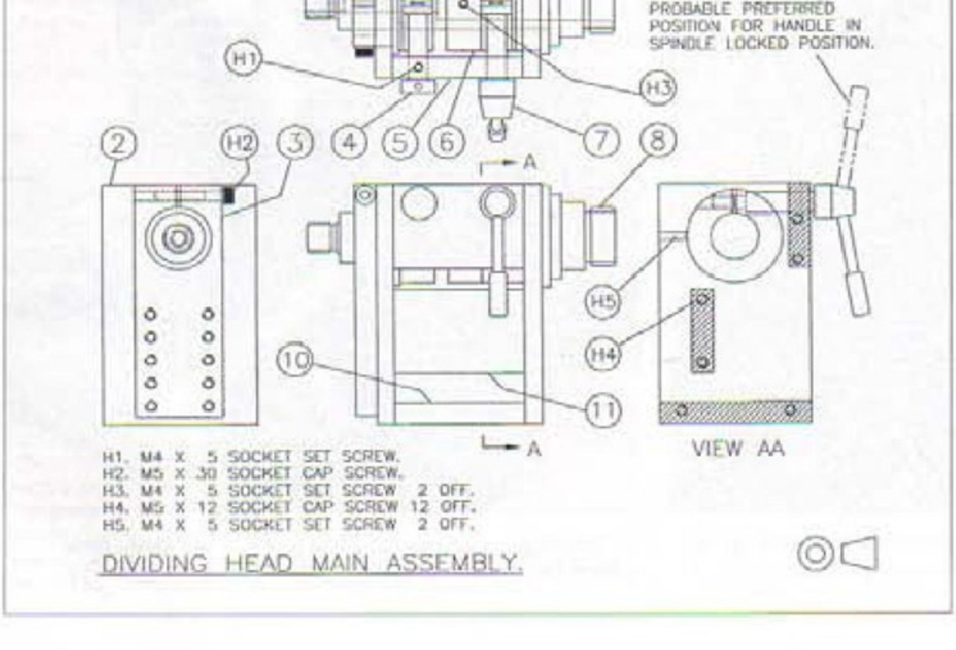
My five minute attempt to improve my milling machine dials was already developing into a time consuming event. Still, making tools has always been my first activity and some useful items of equipment would now materialise. Certainly, the dividing head would open up new possibilities.

The design I had in mind would necessitate the boring of some large holes, a task that would have to be done with the job mounted on the faceplate. I had always intended to produce a faceplate balancing fixture and as I foresaw much of its construction being similar to parts of the dividing head, I added this to the list of items to be made.



1. The dividing head main assembly

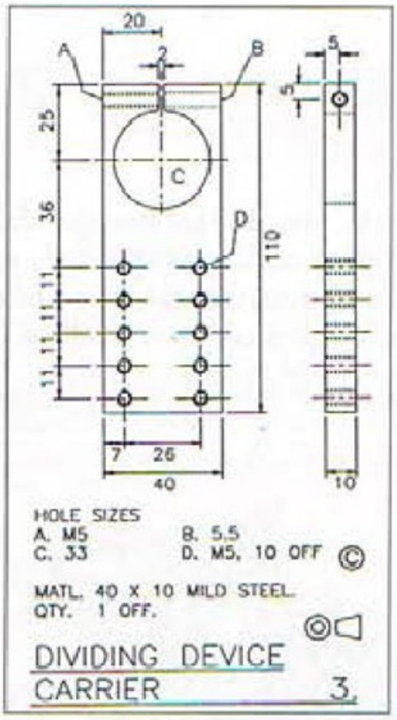
The main frame of both the dividing head and the balancing fixture would be made from flat mild steel plates, necessitating these to be held together using socket head cap screws. In the past, I had always made do with inferior methods of producing counterbores, but decided that now was the time to put that situation right. I therefore decided to make a range of counterbores to suit cap head screws from M3 through to M8, yet another task to add to the list.

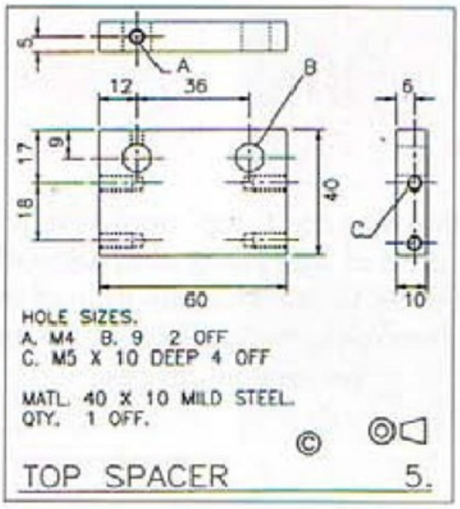


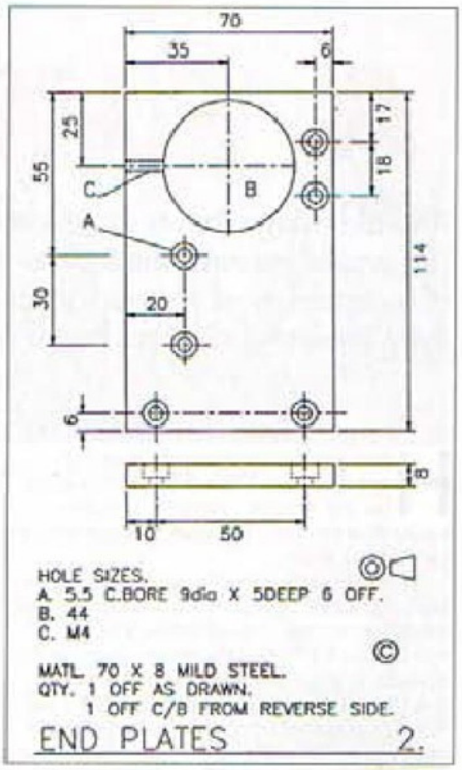
At this point in the deliberations I met with Geoff Walker who we featured in issue 17 **(Ref. 1)** and was reminded of the division line cutting tool that he had made. A number of photographs were included in the article, but no drawings. This led me to decide that I should make such a tool, to my own design, rather than use the top slide of the lathe. Having completed the design, it had a requirement for a deep recess to be made. When milling slots, I set the table stops to delineate the ends, thus avoiding the need to count leadscrew turns and work to dial readings. With a recess, I decided that to have stops available on both the X and Y axes would make this task much easier. You've guessed it. Y axis stops were added to the list.

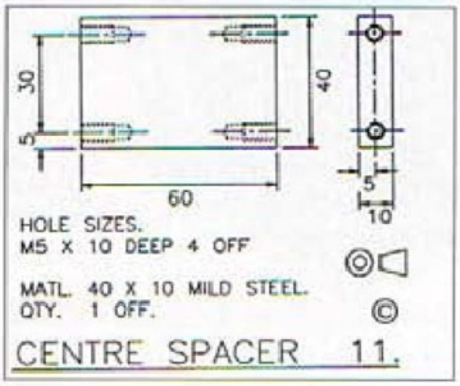
Unfortunately, the Y axis stop I developed was not compatible with the apron I had fitted in front of the table (see Issue 9, page 29) to protect the lower slide. Being reluctant to forgo this protection, an alternative method would have to be developed.

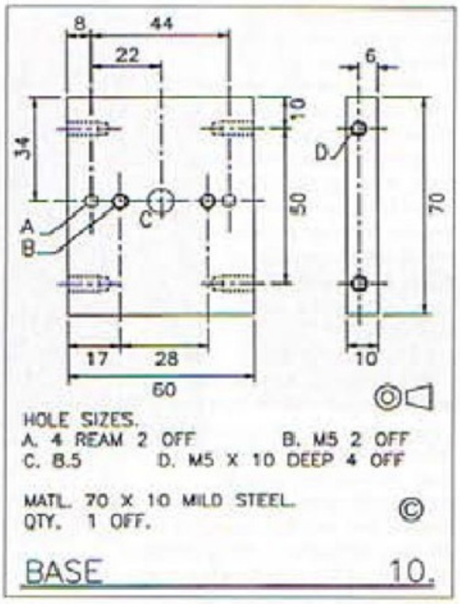
If you have kept up with this long list of items to be made you will have arrived at the following. A. Dividing head. B. Faceplate balancing fixture. C. Line cutting tool. D.





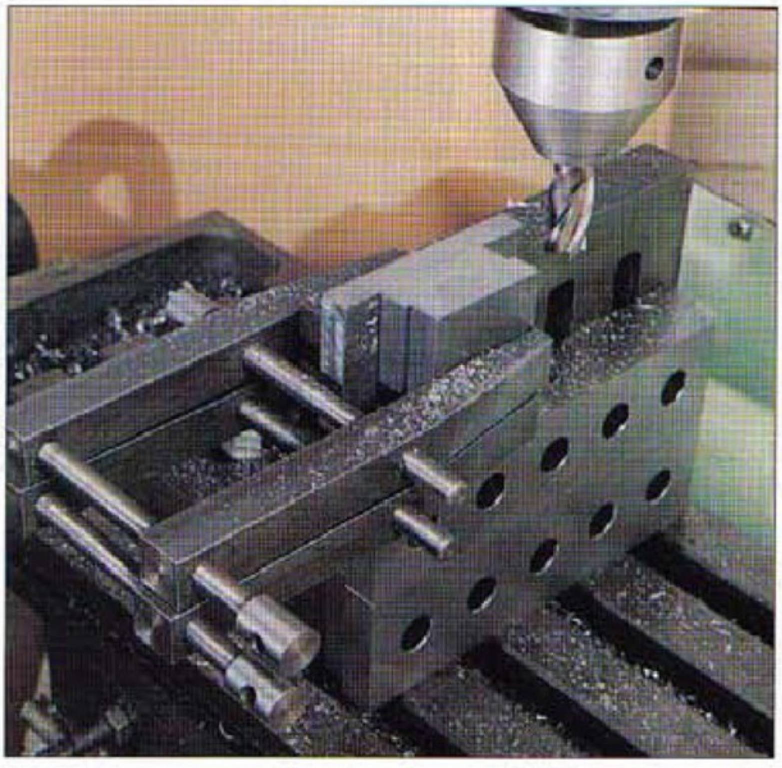




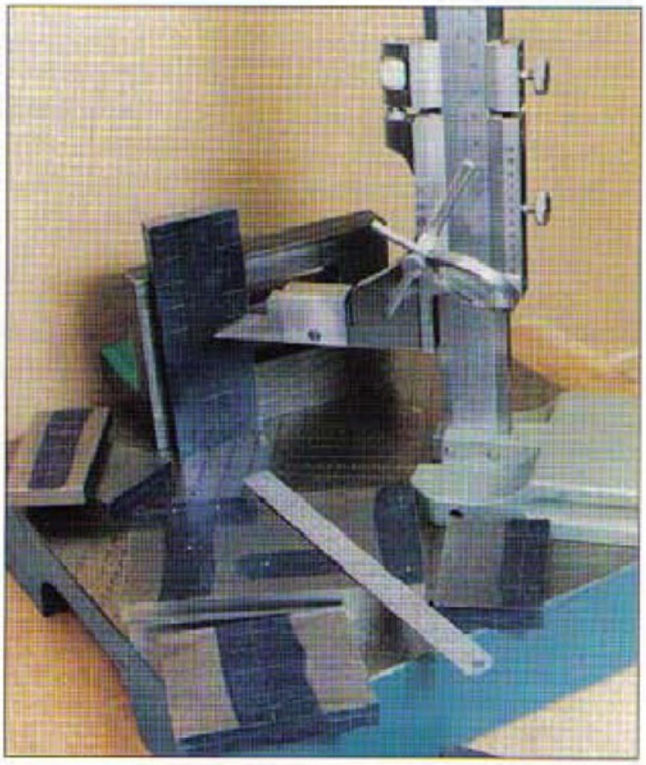


Super Seven changewheel quadrant. E. Y Axis table stops. F. Milling machine slide protection apron. G. Counterbores for Metric cap screws. H. Special boring bar. Also, not yet mentioned, I. Holder for die head chaser. Eventually however, the boring bar was not made, an existing simpler item being pressed into service. I could have also added a rotary table, as a curved slot was included in the special quadrant, but decided to call a halt at this point.

Having now more time available for workshop activities, I was able to approach this series of tooling with less pressure to



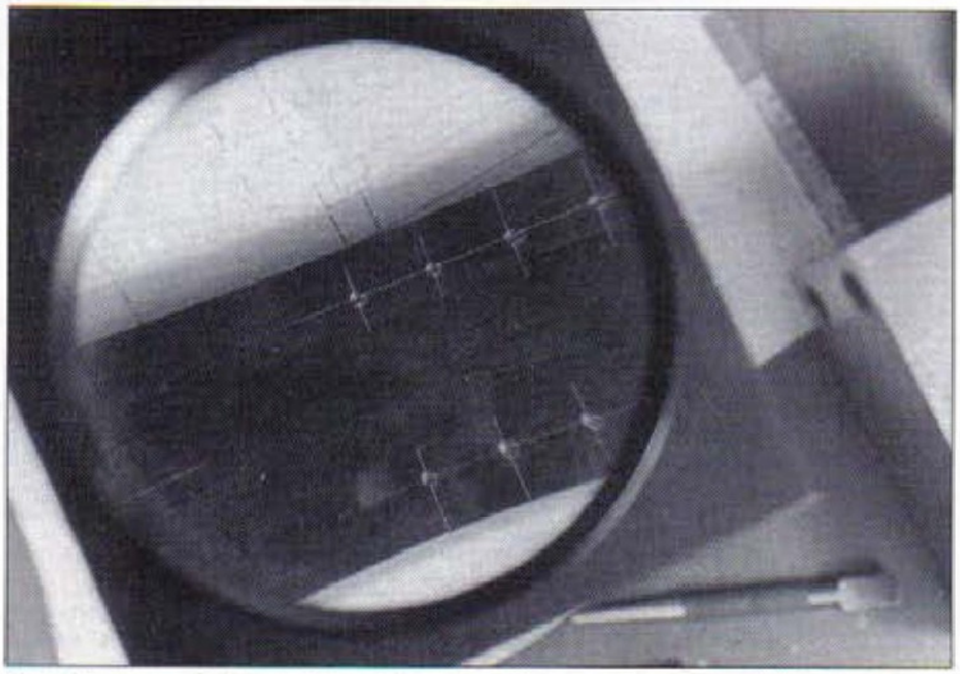
2. To ensure that the parts that control the width of the main frame are exactly the same size, they are machined at the same time



3. Marking out all the flat plate parts at the same time makes for efficient use of time, and improves accuracy get the each task complete. As a result, the long list above was a practical route to the ultimate aim, new dials for the Hobbymat. I also decided that I would fully draw the four main items, A, B, C and D above, that is assembly and detail part drawings, and use these in the workshop, something that I have not always done in the past. The drawings with this article are the ones I used but with a few minor improvements. Another consequence of more time being available was that a better job could be made of each item than may have been the case in the past. In all this was a very satisfying period of workshop activity.

After completion of the tooling, new dials were made for my Hobbymat milling machine, being much improved on those originally fitted. I do now also have some very useful additional items of workshop equipment as a result of the exercise.

The major items above I intend to cover in full as a short series of articles. Simpler items will be covered, at convenient points in the series, with a basic drawing and maybe a photograph or two.



4. Using a powerful magnifier to check centre punching of the various flat plates before drilling

THE DIVIDING HEAD

The design

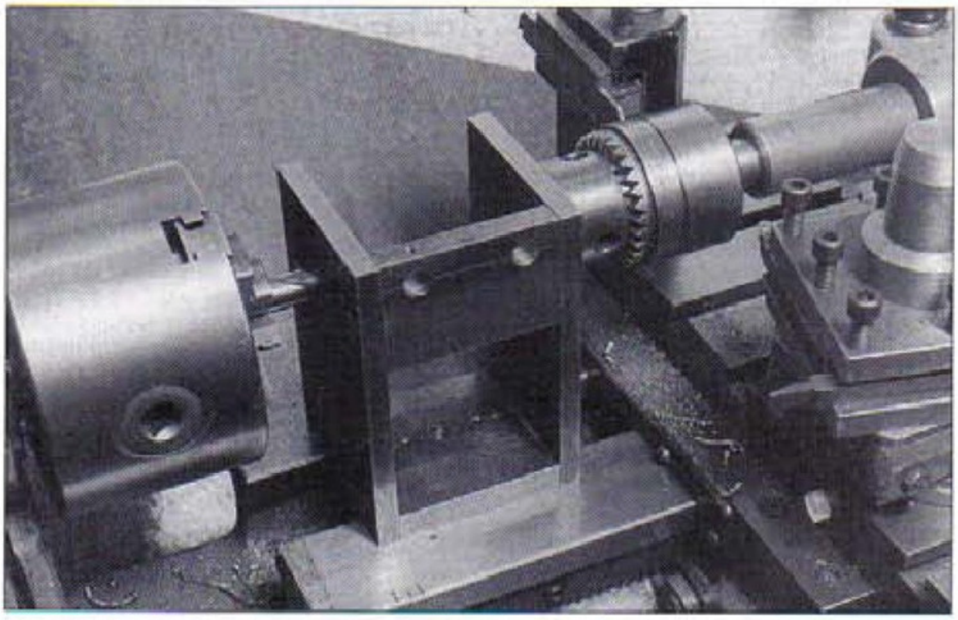
This should be adaptable, allowing three methods of dividing, and also be usable on both the lathe and the milling machine. To achieve this, it consists of a main assembly and attachments which will provide the three methods.

These methods of dividing would be as follows:-

(i) Direct from a gear (a lathe changewheel), giving a wide range of possible divisions. The range would be enhanced by using a forked end detent, thus doubling the number of divisions available.
(ii) Using dividing plates mounted directly on the dividing head spindle. I chose not to make the plates themselves, but used those obtainable from Maidstone Engineering Services **(Ref. 2)** These are made using modern production methods and are very economical compared to dividing plates purchased in the past.
(iii) By interposing a worm and wormwheel between the dividing head spindle and the dividing plates, thus increasing the number of divisions dramatically. The gear would be one of the changewheels, usually either a 40 or 60 tooth gear. However, with adjustment being provided, other gears could also be used.

Having designed the unit with this article in mind, all three systems have been made, but no doubt, some readers will chose to limit their unit to one, perhaps two, of the methods described.

Photo. 1 and the 'Dividing head main assembly' drawing **(Figure 1)** show the basic unit. Both front and rear bearings are split, enabling the rear bearing (1) to be adjusted for zero clearance and the front bearing (9) to be locked during machining operations. At the left hand end is a plate with a series of tapped holes. This carries the parts associated with the dividing methods and, together with slots in the associated parts, permits adjustment. This adjustment is required for differing size



5. Marking out the position of the large hole in the main frame end plate

gears, the PCD of the dividing plate holes and worm and wormwheel centres.

Figure 2 illustrates the assembly which locates and fixes the unit to the bed. Item 12 is required to locate the dividing head accurately on the lathe, but would be an inconvenience when mounted elsewhere. Because of this it is removable, but must return to exactly the same position when replaced. To achieve this it is dowelled, in addition to being fixed by two screws. These are not equally spaced about the centre line, thus ensuring that it is always fitted the same way round.

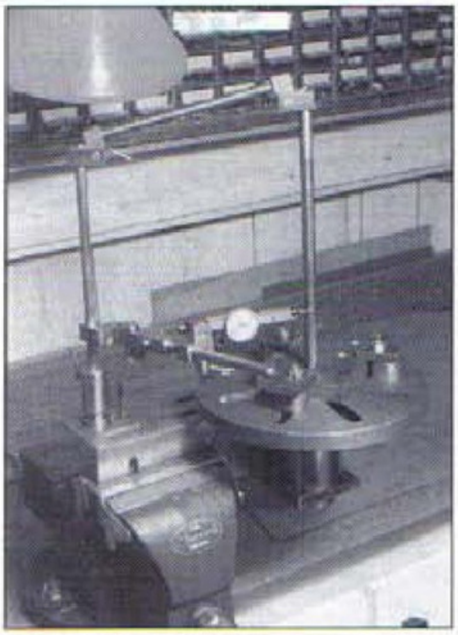
Manufacture

This is one of the more major tasks which I have undertaken in the workshop in recent years, but many of the parts were easy to make and it is a case of bulk rather than complexity. There are though some items that need particular care, especially the spindle (8) and the bearings (1 and 9). I will not therefore labour the article with manufacturing detail on every part, but concentrate on those that need special attention. I will also highlight items that will benefit from being made together rather than one at a time.

The main assembly

The Main frame (Items 2, 3, 5, 10, 11, 12 and 13)

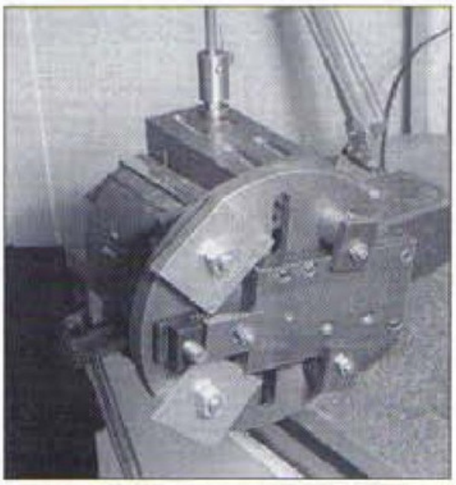
This is the logical starting point which benefits from being treated as a group rather than making the parts individually. All the parts were rough cut to length and then their ends finished on the milling machine. Dimensions are not critical, no better than +/- 0.1mm. This even applies to the 60mm



6. Using the balancing fixture (to be described in a later issue) to position the main frame end plates on the faceplate prior to preliminary boring of the large hole

dimension on parts 5, 10 and 11, but here the emphasis is on consistency. The second ends of each of the three parts were therefore machined together, as shown in **Photo. 2**.

With the parts cut to size and their edges generously deburred, it was time to mark out the hole positions. The use of a height gauge **(Photo. 3)** certainly makes the operation easier, but those who use a surface gauge will benefit even more by the 'all at one time' approach. By planning the order in which one marks out the holes, errors in setting the surface gauge, which



7. Balancing the faceplate assembly prior to it being fitted to the lathe

are inevitable compared to the height gauge, will be consistent between parts and cause no problem. Holes B on Item 2 were not marked out at this stage.

With the parts marked out, it was still important to centre punch them accurately, else any attempt for accuracy would be lost. Making a very light impression first and inspecting this with a magnifying glass **(Photo. 4)**, with subsequent correction, went a long way to providing the accuracy required.

The parts were then drilled with care and counterbored as shown. As already mentioned, I decided to make a range of counterbores specially to suit cap head screws and will very briefly detail these later in the series.

Next, the frame was assembled, complete with Item 12, to allow the position of hole B to be marked in the end plate (2). This was centre drilled as shown in **Photo. 5**, only one end required centring. The assembly was held down by hand and fed using the tailstock against the other end plate, only a small impression being required.

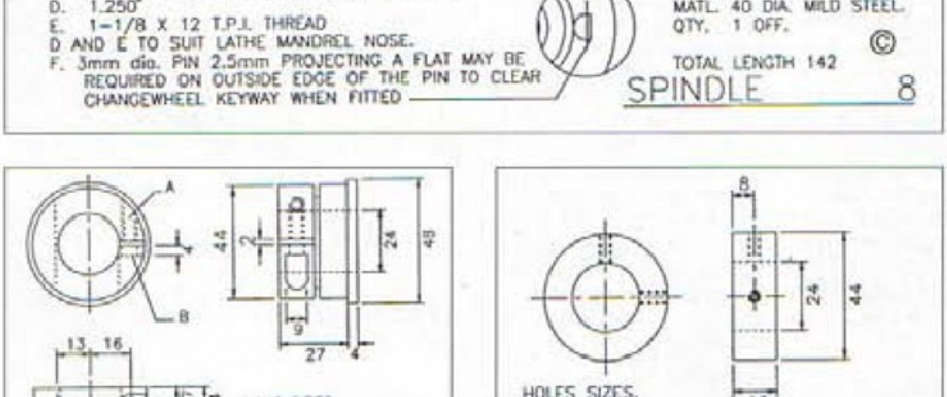
The two plates were then bolted together (hence the reason for only marking one), and set up on the faceplate ready for boring. Having already mentioned the making of a faceplate balancing fixture, this can be seen being put to use in **Photos. 6 and 7**. **Photo. 6** shows the end plates being centralised, whilst in **Photo. 7** the unit has been rotated 90 deg. for balancing.

The holes B were then bored on the lathe, but to a size a little less than that called for on the drawing. The process was most satisfying, as I initially set the speed on the slow side, as I would do for faceplate work, and found not a trace of vibration. I set the speed up two steps and even at this, vibration was almost non existent, proving the benefit of a balancing fixture.

The frame was reassembled and this time held in position using the 'Lathe bed fixing assembly' and bored as in **Photo. 8**. At first this may appear to be an impossible task. It is though a novel way of boring a hole exactly on the centre height of the lathe whilst the unit is bolted to the bed. I first saw the idea in Model Engineer, where it was being used to bore a piece of wood, the purpose being to produce a fixed steady for an item larger than could be accommodated in the standard steady.

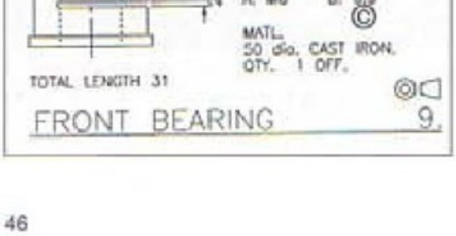
The method is to hold the boring bar in the chuck jaws with sufficient grip to allow the cutter to take a light cut, but not so tight that the tailstock cannot push the bar forward into the item being bored. My initial thoughts were to make this another item of tooling to be made, with some form of bush to protect the chuck jaws and a method of fine adjustment for setting the diameter. I decided that the use the item would get would not justify the time taken to make it, and in any case the amount of wear on the chuck jaws would be negligible.

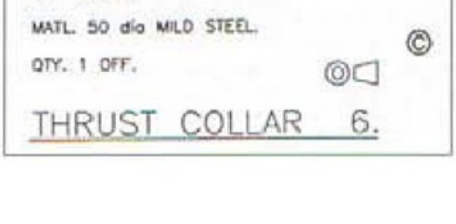
The first end was bored at one pass then the frame moved toward the tailstock and the second end plate bored, this requiring the bar to be moved through the chuck by no more than 25mm in total. The diameter was not crucial as the bearings had not been made and could more easily be made to fit the end plates.

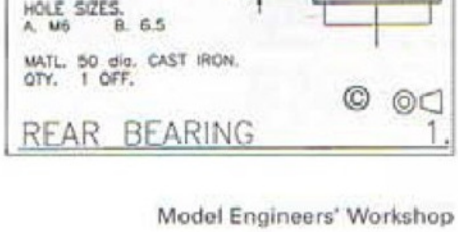


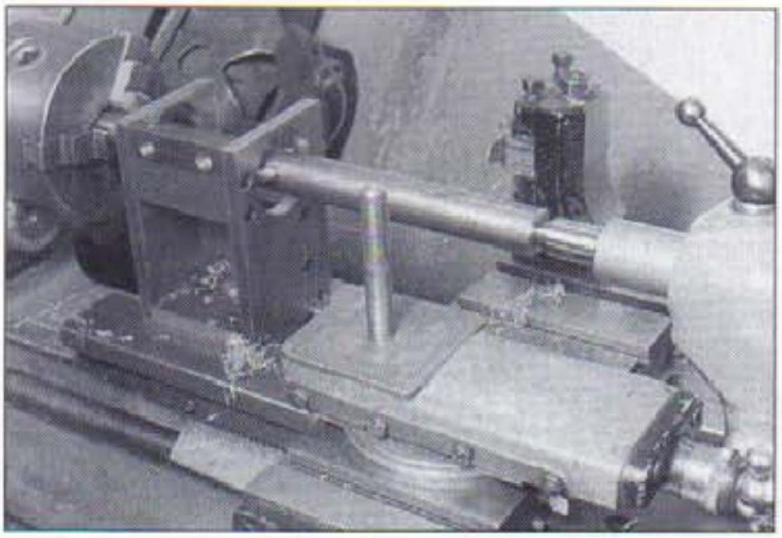
Spindle (Item 8)

The spindle is the most crucial part with concentricity being all important. As will be seen in the item on the balancing fixture, there is much in common between the spindles for the two units. Because of this I

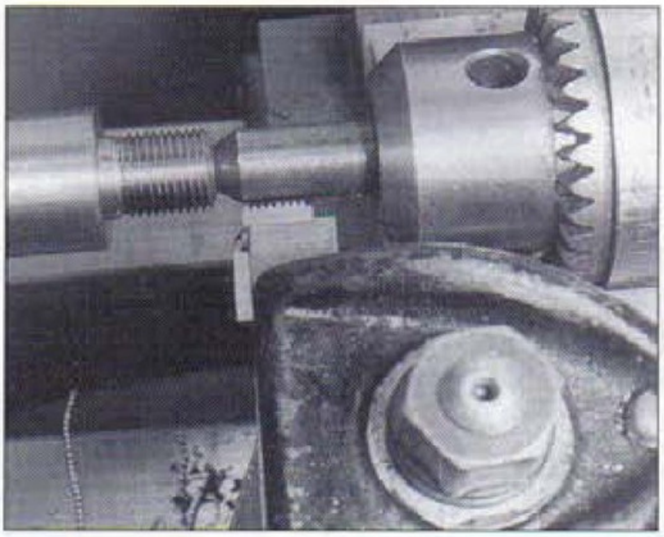








8. Final boring of the large holes in the main frame, ensuring that they are exactly on the lathes centre



9. Turning the gear/dividing plate fixing thread. Note the specially made small diameter centre held in the drill chuck

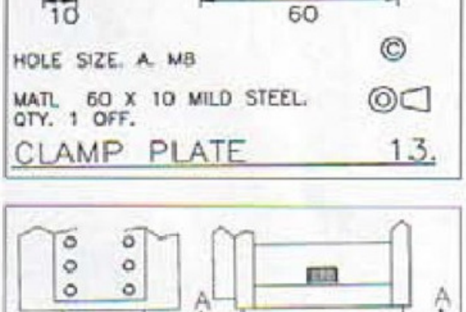
made both during the same manufacturing period, so as to avoid tool changes. The result is that I took some photographs whilst making the spindle for the dividing head and others when making the balancing fixture. As a result I do not have a full set for either, rather bad planning on my part. Anyone making either item could well look at the photos in the other article.

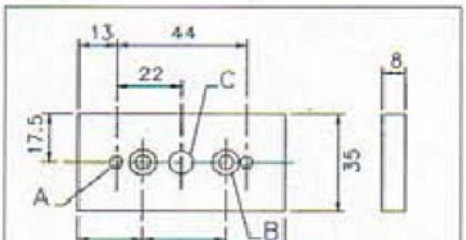
I made the spindle from two pieces (not detailed in the drawings), so as to save on material and machining time. A piece 40mm diameter and around 35mm long was bored 25mm by about 30mm deep. A further piece 25mm diameter and about 145mm long was made and the two parts glued together using a two part resin adhesive. The assembly was then centre drilled at either end but, with only 0.5mm to be removed from the 25mm diameter, this needed to be done accurately. The spindle was then turned all over whilst mounted between centres, still leaving around 0.2mm to be removed off all surfaces, outer diameters and faces. It was, of course, necessary to turn the part end on end to complete the machining, as the driving dog prevents one being able to machine it fully at one go.

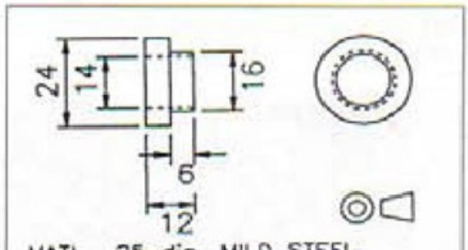
The next stage was to machine the 1 ½in. x 12 TPI thread. As concentricity of the thread with the axis of the spindle is not vital the part was held in the chuck, rather than trying to drive it with a dog. The other end was supported by the tailstock centre and the thread cut.

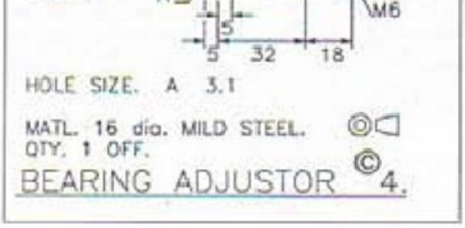
The spindle was reversed and once more mounted in the chuck, this time gripping the 1.25in. diameter chuck location. With the other end supported by a centre, the 14 x 1 thread was cut, (I did compromise and make it 14mm x 20TPI). This necessitated two other small items of tooling to be made. The standard tailstock centre had too large a diameter to permit the chaser to work down to 14mm diameter, so a centre which could be mounted in the tailstock drill chuck was made from silver steel and hardened. I had also, in the past, made do with rather poor arrangements for holding die head chasers whilst screw cutting, so decided to make a better holder. This I will also detail later in the series. In **Photo. 9**, which shows the thread being cut, the drill chuck mounted centre can be seen. The chaser holder is also in the picture, but only just.

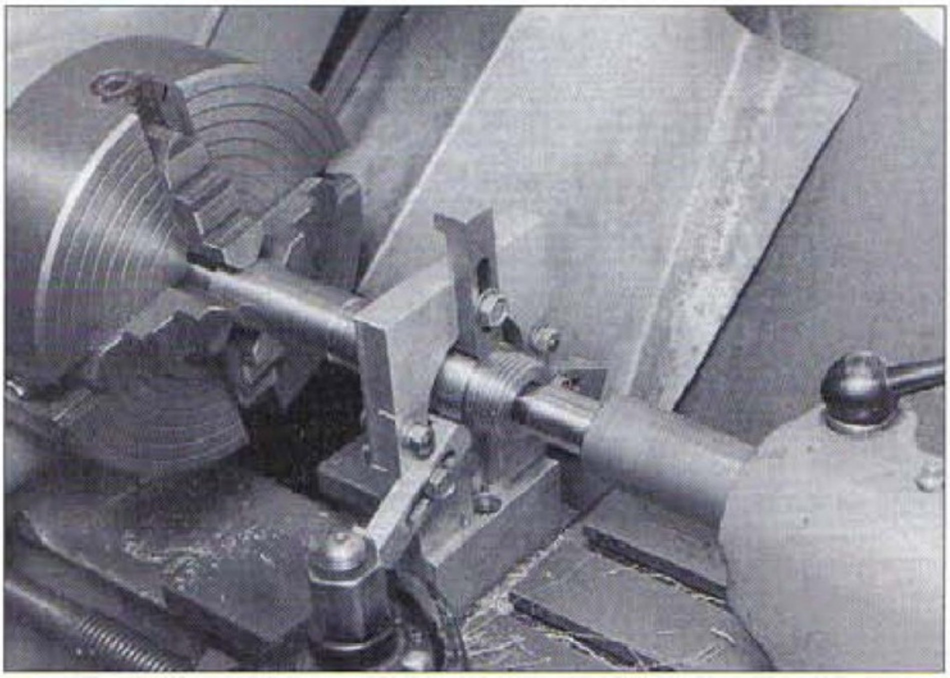
The spindle was again mounted between centres and the remainder machined to the dimensions required. This ensured that the essential diameters were all concentric, and









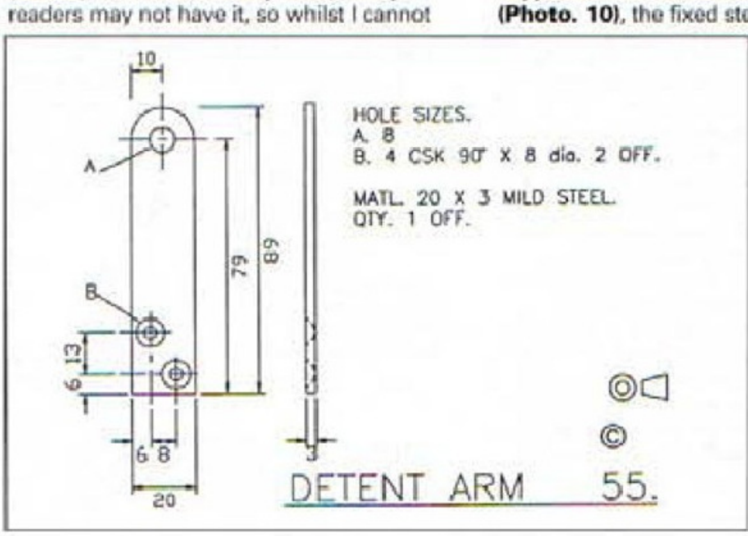


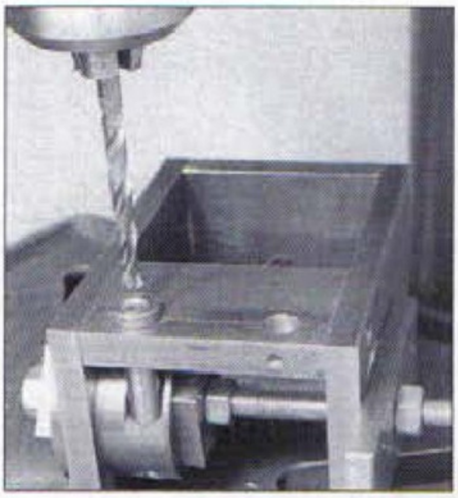
10. Setting the fixed steady prior to boring the Morse taper

that the face on which the chuck would tighten was at right angles to the axis.

It now remained to produce the Morse taper and the tapped hole at the other end, but first it was necessary to set the top slide to the required angle. The method I use is the one I devised and explained in Issue 6 **(Ref. 3)**. As this is an early issue, many readers may not have it, so whilst I cannot justify going into detail, a brief explanation of the system will be given later.

To bore the Morse taper it was necessary to hold the spindle in the four jaw chuck and to support the other end with a fixed steady. The procedure was first to get the spindle running true at the chuck end whilst supported with the tailstock centre. Next, **(Photo. 10)**, the fixed steady was fitted and set with the tailstock centre engaged, ensuring that the steady did



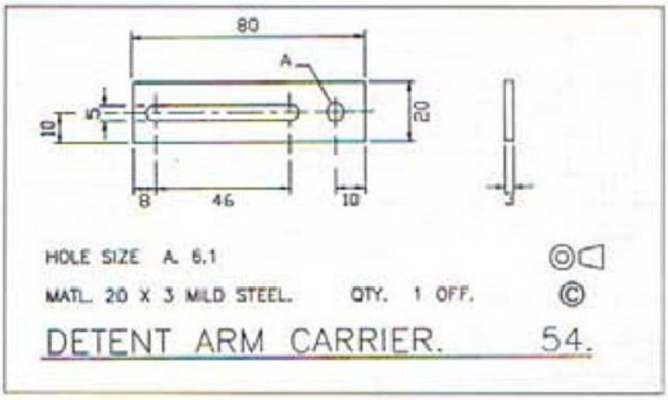


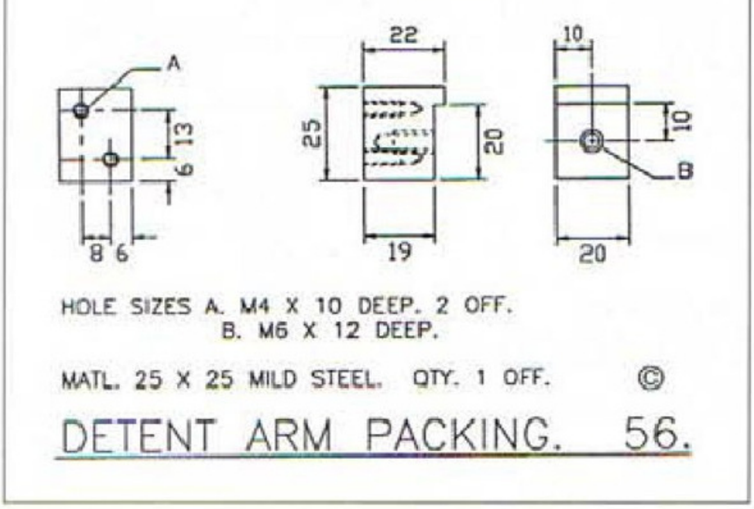
13. A purpose made drill bush assists in drilling the holes in the bearings

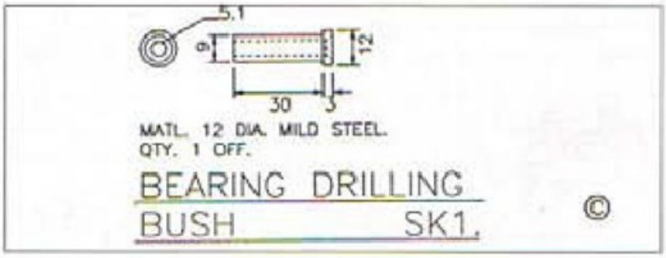
not force the spindle off axis, thereby altering the angle of the bored taper. With the centre removed, the taper was made as shown in **Photo 11**. The spindle was then reversed, still using the fixed steady, and the M8 hole produced.

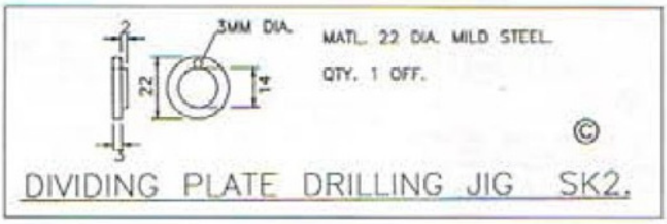
Bearings (Items 1 and 9)

For these, two pieces of cast iron were cut and their end faces machined, but leaving each a little on the long side. They were then bored 24mm diameter ensuring both were a very close sliding fit on the spindle. As the next operation was to machine the outer faces whilst the bearings were mounted on a taper stub mandrel, it was important that both internal diameters were the same to









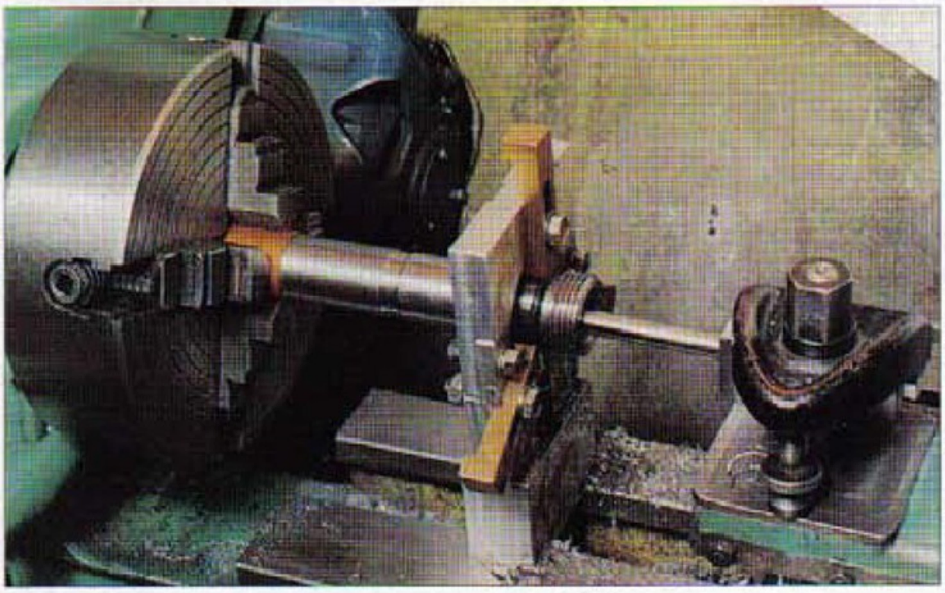
within close limits. The stub mandrel was then made, a tight fit in both bearings, and each fitted in turn. The outer diameters were turned (**Photo. 12**), the 44mm diameters being a close fit in the main frame.

There remained some minor machining work to be done on the bearings, only two points being worthy of mention. As I do not have slitting saws to cut slots in the bearings to their full depth, and I suspect this will be the case for most readers, some alternative method was necessary.

However, I find, no matter how careful I am, that slots cut with a hack saw, even though mechanically satisfactory, never appear very professional.

To overcome the problem, I first cut a slot as deep as was possible with the available slitting saw. Then, after rotating the bearing by around 30 degrees, the slot was again cut, now to what appeared to be the correct depth on one side. The process was then repeated, this time rotating the bearing the other way. The slot now appeared externally to be of the correct depth, but was short of the full depth in the centre of the bearing. This was finally achieved using a hack saw, but without the visual problems.

To assist in lining up holes A and B with holes B in the Top Spacer (Item 8), a drilling bush was made as per **Sk1**. For just two holes a simple bush from mild steel was adequate. The process is shown in **Photo. 13**.



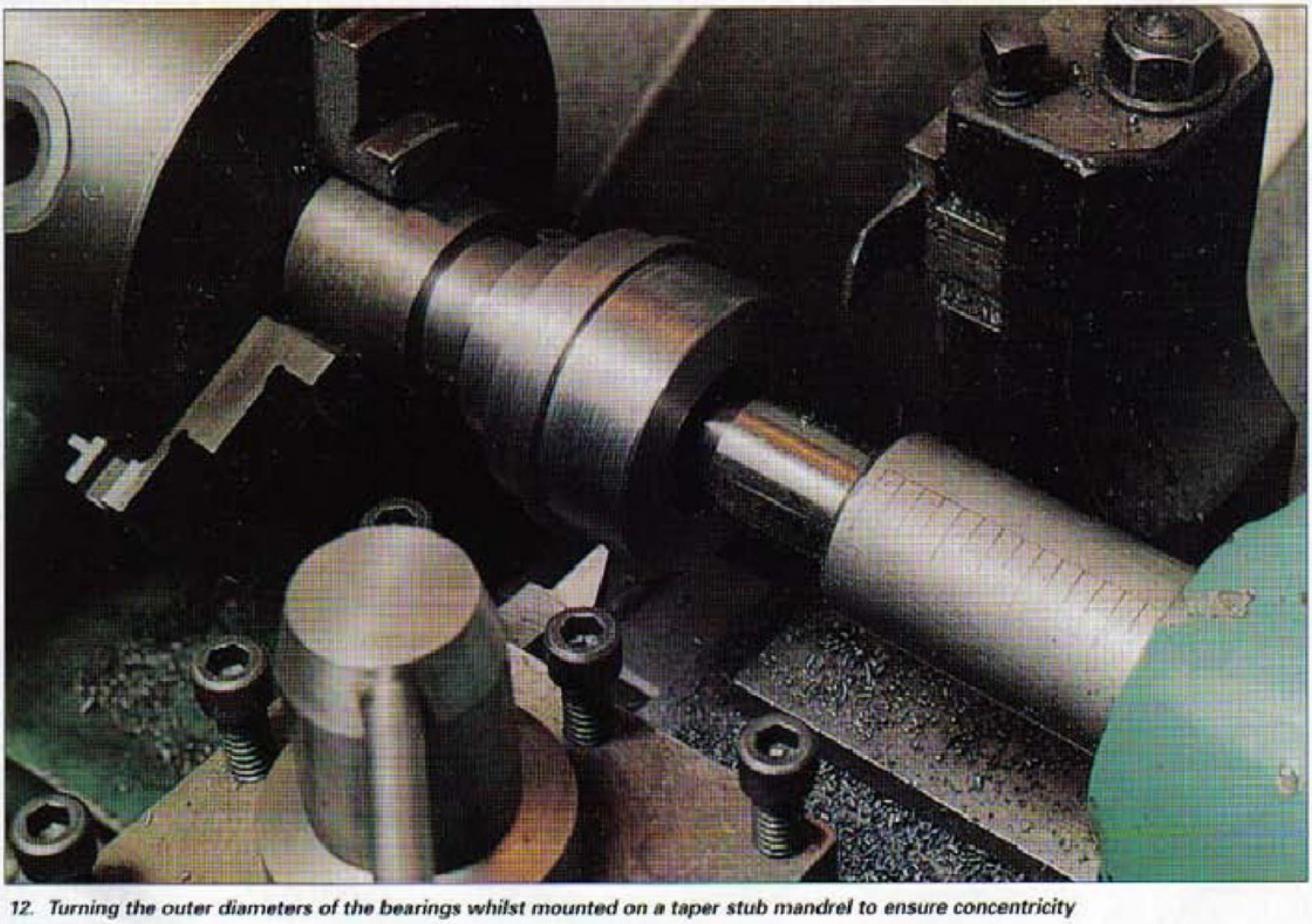
11. Boring the Morse taper

Minor items

All that remained to complete the main assembly, plus the lathe bed fixing assembly, were a few minor items. The thrust collar (Item 6) was bored to a close fit on the spindle and faced at the same setting. This ensured that the face was at right angles with the bore and would mate accurately with the front bearing when assembled. Other than that, the parts require little in the way of special consideration, other than to say that Item 12, made earlier, had to be a close sliding fit in the lathe bed.

References

1. We visit Geoff Walker's Workshop MEW Issue 17, page 56.
2. Maidstone Engineering Services, 50 Hedley Street, Maidstone, Kent, ME14 5AD.
3. Turning a Morse taper, MEW issue 6, page 28.



12. Turning the outer diameters of the bearings whilst mounted on a taper stub mandrel to ensure concentricity

SIMPLY, THE BEST

For four days at the beginning of September, The Society of Model Engineers celebrated their Centenary with a major exhibition at Brunel University, Uxbridge. In addition to models from the Society's own collection and from individual members, there were loan items from friends and supporters from across the world. A further ten Societies and the Southern Federation also presented their best work on display stands of outstanding quality. The trade were also there, with most of the 'household names' present to make it a most comprehensive exhibition, which was declared open by H.R.H. The Duke of Gloucester.

A truly international gathering of visitors enhanced an outstanding social occasion, the highlight of which was the Centenary Dinner held on the Saturday evening, over which Sir Hugh Ford presided. The formal part of this event was brought to a close by playing the record of "A Message to Model Engineers", which was recorded by Percival Marshall in the 1930s.

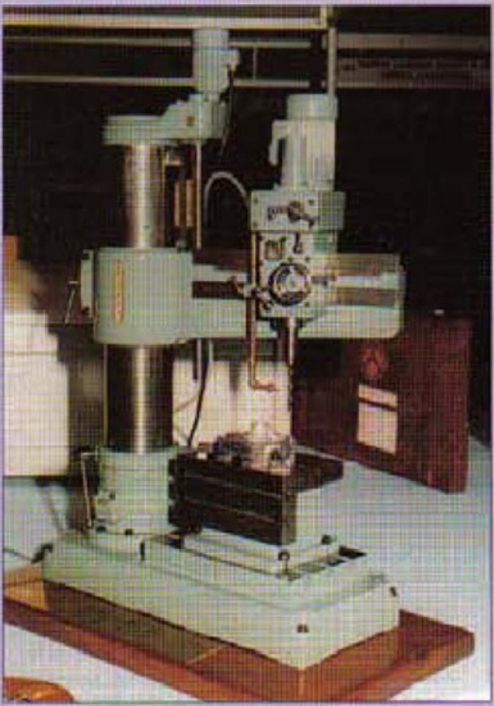
Space limitations preclude all but the briefest glimpse of what was on show, so we concentrate on the items of tooling displayed. Photos. by Mike Chrisp.

1. It is on rare occasions that we feature photographs of miniature locomotives in these pages, but this one could not be missed. H.R.H. The Duke of Gloucester is clearly delighted to have the opportunity to admire this outstanding 7 1/4in. gauge model of the British Railways Class 8P Pacific which carries the same name. The model is owned by V. Cherry

2. A collection which created much interest was the display of original George Thomas tooling items, loaned by Bob Studer

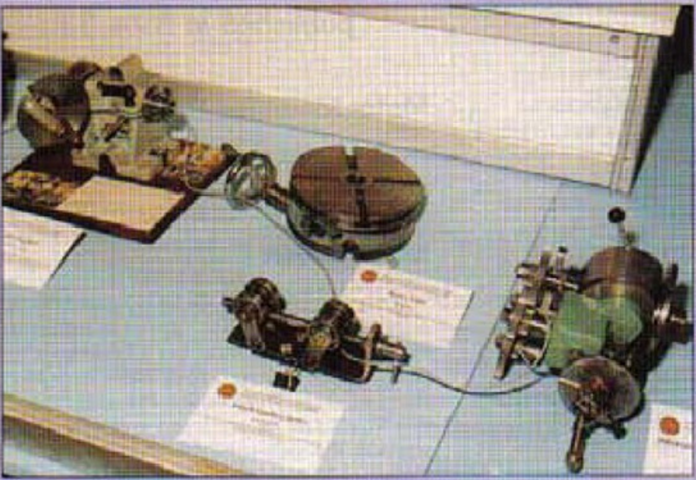
3. Always well presented, with clear descriptions of application and use, are the devices produced by Dr. Peter Clark. This 'Awkward' Chuck was just one of his contributions to the display

4. Paul Gammon constructed this interesting spring winder



5. Barry Jordan brought his complete collection of miniature machine tools, including this, as yet, unfinished model of an 'Archdale' radial drill

6. Barry Jordan's work was obviously of great interest to the Duke, who spent quite a while examining the machines and discussing them with Barry. SMEE President, Sir Hugh Ford is in the centre.



7. This varied group contains a dividing head by Peter Wardropper, a rotary table by Dennis Monk and a differential indexing head by Ivan Law. In the foreground is Tom Bartlett's chuck handling device, which he described in Issue 52

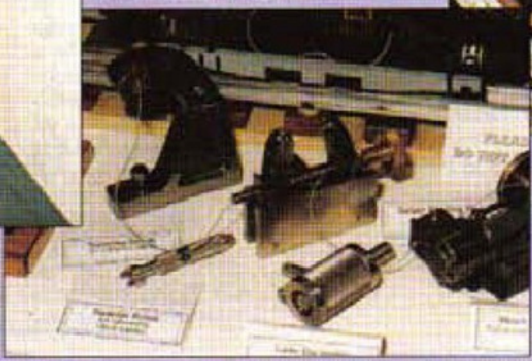
8. Somewhat bigger was the bench milling machine, also made by Tom Bartlett

9. The smaller, simpler items were not neglected. These were Brent Hudson's apprentice pieces

10. Ivan Law and the Editor admire Derek Crosland's superb Universal Grinding Centre

11. The Society stands featured some first class items of tooling, this Stent tool and cutter grinder by Roy Mosley being seen on the Peterborough stand

12. (BELOW) Another good selection of tooling, this time on the Harrow and Wembley stand



13. The Duke of Gloucester showed a keen interest in the goods displayed on the trade stands. Here, Mark Smith of Chronos stands alert, ready to deal with the royal visitor's searching queries

THE QUICK-STEP MILL - A MILLING SPINDLE FOR THE LATHE

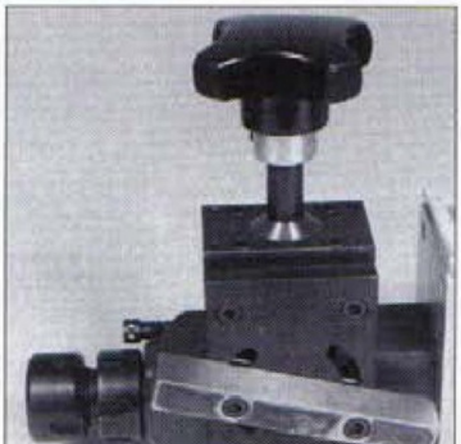
In this concluding article, John Payne describes the remaining components and the assembly procedures. Figure and photograph numbers run consecutively to those included in Part 1 which was published in Issue 52

A few components remain to be made to complete the assemblies already described, these being the collet closing ring (A34) and the items which provide the capability of mounting the unit at an angle to the horizontal. These are the Quadrant Plate (A7) and the Swivel Bar and Dowel (A38/A39). With the Clamp Bar (A22) detached from the Vertical Slide Assembly, the swivelling components can be screwed in place, then the Clamp Bar mounted on the Swivel Bar **(Photo. 9)**.

One further component which extends the capabilities of the unit is a simple Adapter Plate (A43) which allows the Quick-Step to be mounted on the lathe in a variety of locations.

The Motorising Assembly

Figure 4 and Photo. 10 give an idea of how the components of the motor drive go together. There are no particularly complicated items, but the following notes may be helpful:-



9. The swivel assembly allows the unit to be mounted at an angle, particularly useful for such operations as spiral milling

Motor Mounting Plate (A14)

No tolerances to watch but it does need to be flat.

Motor Cradle (A20)

This is difficult to make by bending up a developed strip. It is probably better to make it up from a number of parts, making the radiused back plate with two flanged ends on to which the side members can be soldered and again, making the side member that houses the switches in two parts. It will be tiresome to make.

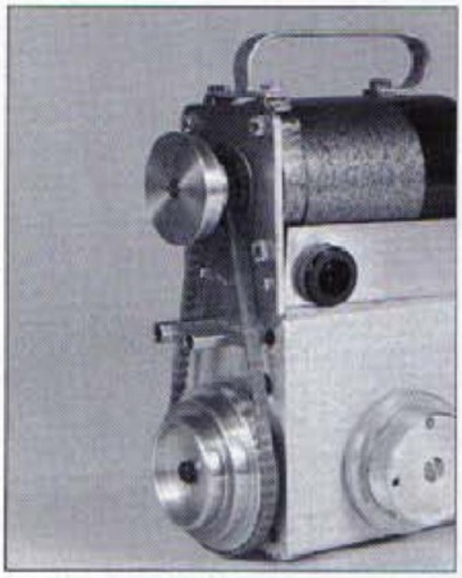
Pulleys (A17 and A17/A21M)

No difficulty here, but do make concentric and keep to the sizes given, so that the belt tension is constant on all three ratios. The 12 tooth 5mm pitch timing pulley is a proprietary item and can be obtained as part of the kit.

Assembly

1. The Vertical Slide

Fit the $^1/_4$in. dia. brass pads (A25) with the three grub screws and one $^5/_{16}$in. hex. head screw into the holes near the nose of the body (A2). The hex. head screw fits right hand side top, looking from the rear. Insert the two sliding plates (A6), packing one of them with a 2in. x 2in. piece of 0.001in.



10. The motor and belt drive assembly. The hexagon pillars both hold the motor plate in place and provide a means of attaching the belt guard

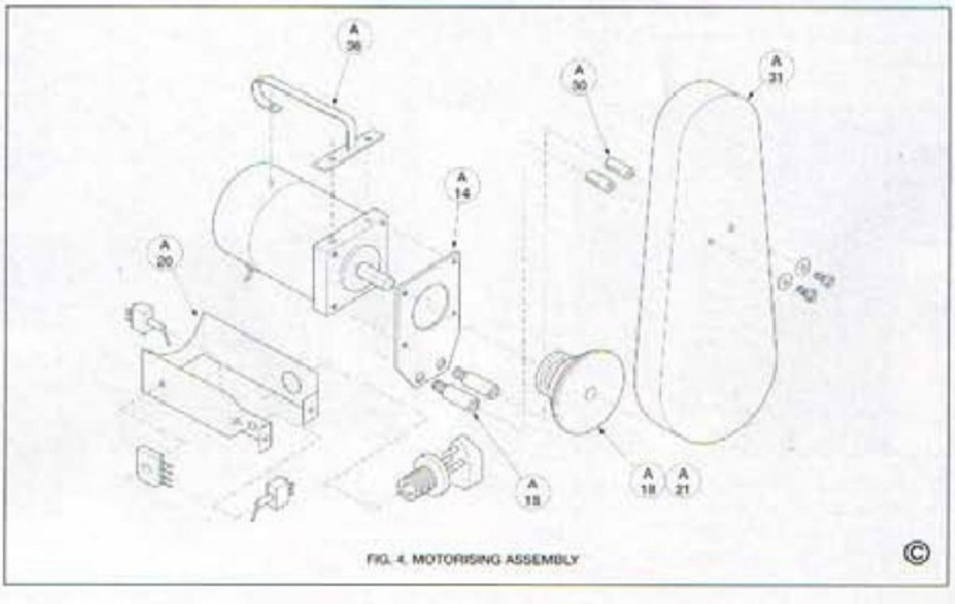


FIG. 4. MOTORISING ASSEMBLY

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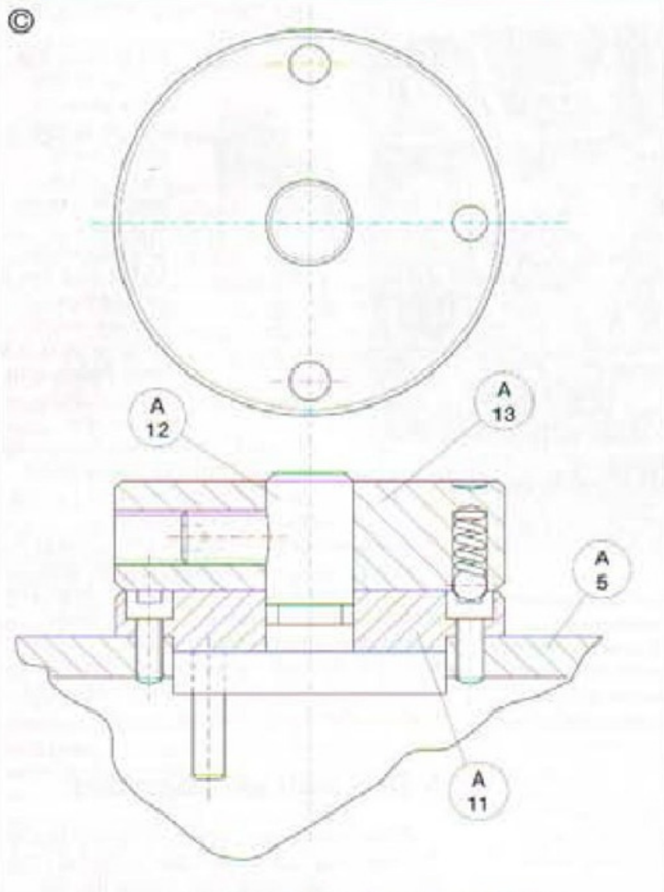
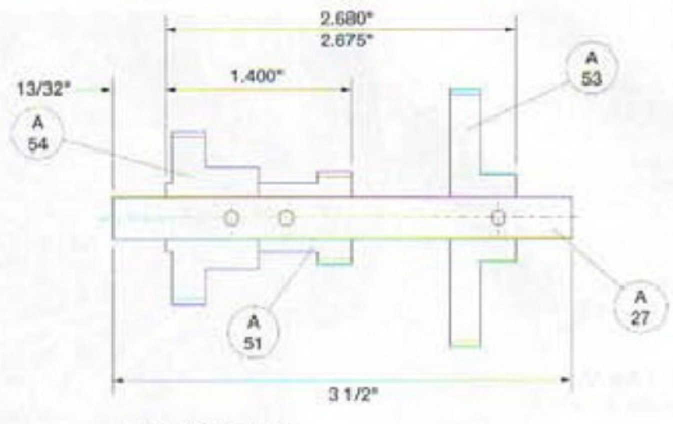


FIG. 5. GEAR CHANGE SUB ASSEMBLY



ALL SPRING PINS 2mm DIA.

FIG. 6. COUNTERSHAFT SUB ASSEMBLY

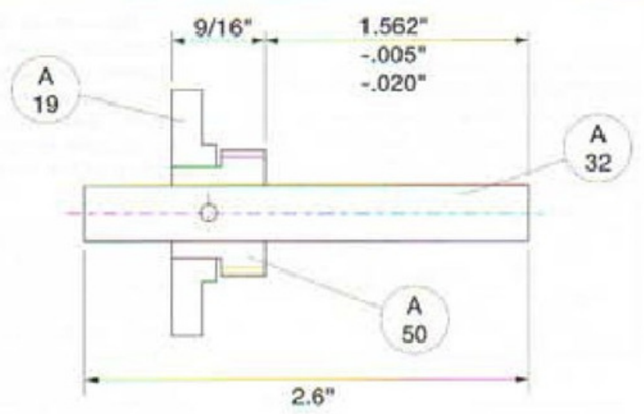


FIG. 7. INPUT SHAFT SUB ASSEMBLY

kitchen foil, setting the top edges 0.002in. - 0.005in. above the top face of the body. Lightly clamp the body with a toolmaker's clamp and gently firm up the brass pads, tightening clamp and pads.

Take the top plate (A9), blue the underside and check its seating on the slide plates, correcting the plates with a little filing or scraping to get a bed. Now clamp on the top plate, firmly and accurately located for the spotting through of the 4 5mm holes; drill these and tap them and bolt up firmly, making sure that the bolting up has no effect on the fit of the slide plates, then spot and drill 3.8, 3.9 and ream 4 for the dowels, and fit them.

Undo the clamps and the binding screws, slide the plates the other way and repeat the procedure for the bottom plate (A8).

Now make a bush bored 3/8in. BSF tapping size to fit the top plate, so that the body can be precisely drilled for the stud. Take great care to tap this hole at exactly 90 deg.

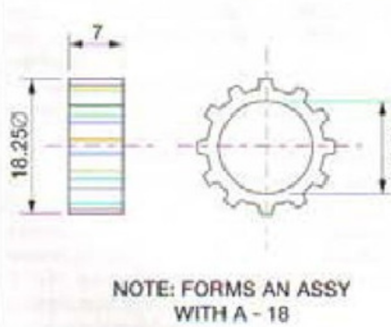
Remove the slides, marking them so that they can be refitted the same way.

2. Spindle to Body

Fit the large ballrace to the nose of the body and then the oil seal. Oil the seal and race and fit the spindle.

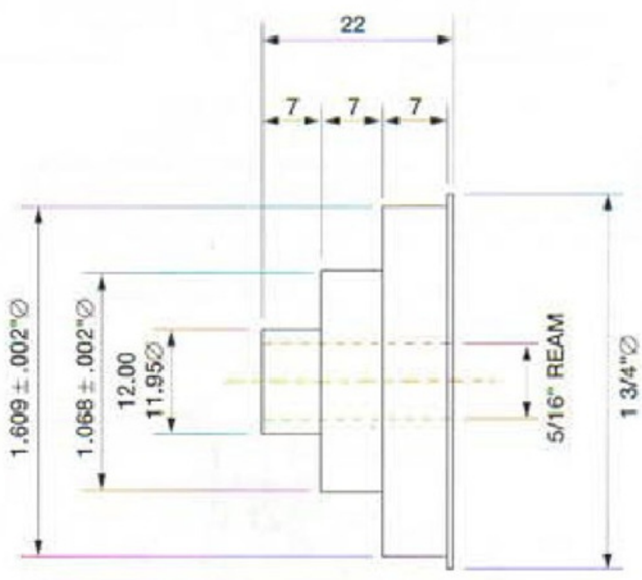
Fit the smaller race into the other end and oil it. Fit the two Bellevilles, cup to cup, and then the circlip. The Bellevilles must be clear of the outer ring of the race by at least 0.005in.; if this is not the case, remove the Bellevilles and reverse them, as often they do not assemble symmetrically. Fit the key and the 10mm

12T PROFILE TO SUIT T5 TIMING BELT



NOTE: FORMS AN ASSY WITH A - 18

A - 21 TIMING PULLEY
1 OFF ALUMINIUM ALLOY
OR EN1 A

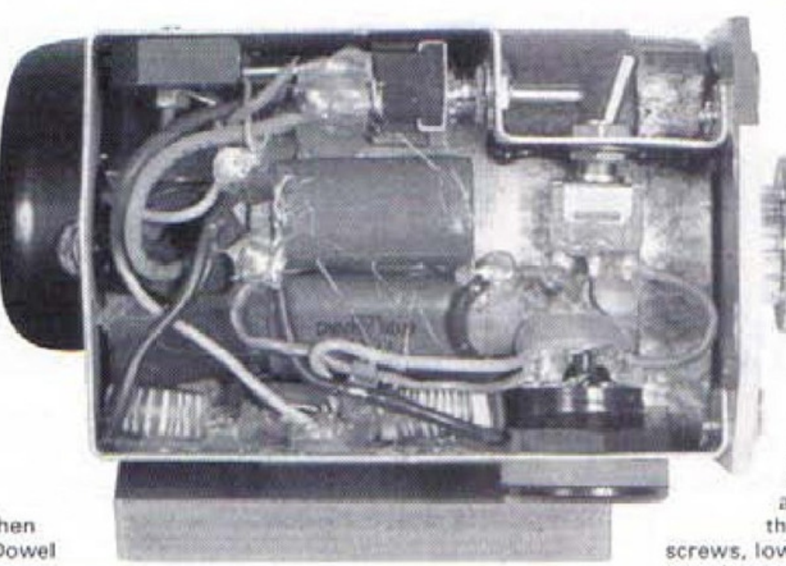


NOTE: FORMS AN ASSY WITH A - 21

A - 18 PULLEY
1 OFF ALUMINIUM ALLOY

o.d. input shaft pilot bush and make sure that the gear hub slides freely on the shaft.

Bolt on the end plate with four 5mm cap screws and the 'O'-ring after having pressed in the Glacier DU PTFE lined bearing bush. This bush is situated uppermost on the same side as the 3/8in. stud hole in the body.



3. The Vertical Slide to Body

Check that the four brass pads and the screws are still in place in the body then oil and fit the sliding plates. Dowel up and bolt the lower plate, checking that the plates slide freely in the body when there is no pressure on the brass pads.

Try the calibrated nut for fit in the top plate, ensuring that it has at least 0.0015in. end play and that it turns freely before fitting it to the plates. After dowelling and bolting, check again that the plates slide freely. Remove the top plate, Loctite the 2 1/4in. long 3/8in. x 20 TPI stud into the body and refit the top plate. If the action is stiff it will be due either to a bent stud or too little end clearance on the nut flange. Fitting the knob to the sleeve nut completes the vertical slide.

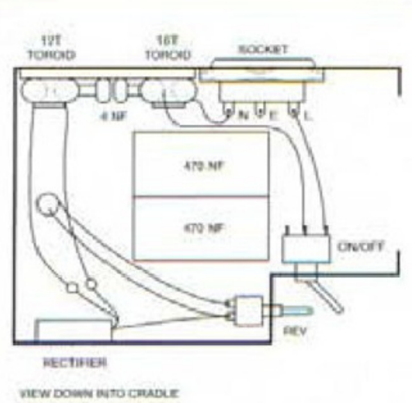
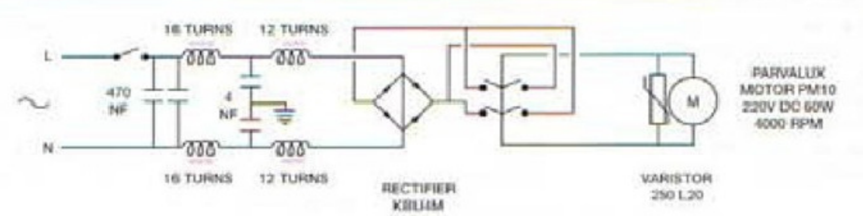


FIG. 9. LAYOUT OF COMPONENTS WITHIN MOTOR MOUNTING CRADLE ©

11. This view of the electrical components shows that the on/off and reversing switches are located in such a way that the motor cannot be reversed with the power on. The two toroids can be seen attached to the inside of the cradle wall nearest the bottom of the photo.



© FIG. 8. THEORETICAL WIRING DIAGRAM OF DRIVE MOTOR CONTROL CIRCUIT

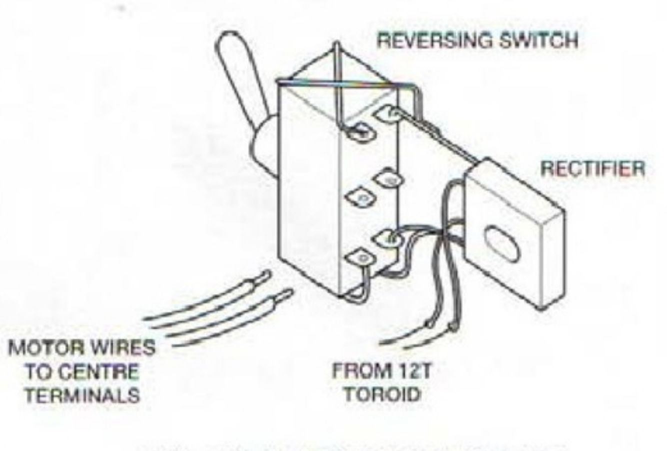


FIG. 10. REVERSING SWITCH AND RECTIFIER LAYOUT

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4. Gear Change Sub Assembly (Fig. 5)

Shorten a 16mm x 4mm dowel to 15mm and drive it into the crank (A12). This dowel must be a tight fit, so stake it in if necessary.

Fit a 3/8in. dia. 'O'-ring to the crank then oil and fit to the crank bush (A11). Fit a grub screw to the gear change knob (A13) and lay it on the bench. Fit two short springs into the 4mm holes and sit two 5/32in. balls on the springs. Insert two 3mm cap screws into the crank bush and, holding the bush by the threaded ends of these screws, lower it on to the knob. Hold together against the spring pressure and then turn until the balls engage the heads of the 3mm cap screws. Now turn the crank until the crank pin is beneath the indicator hole in the knob and in line with the 3mm screws, then tighten the grub screws.

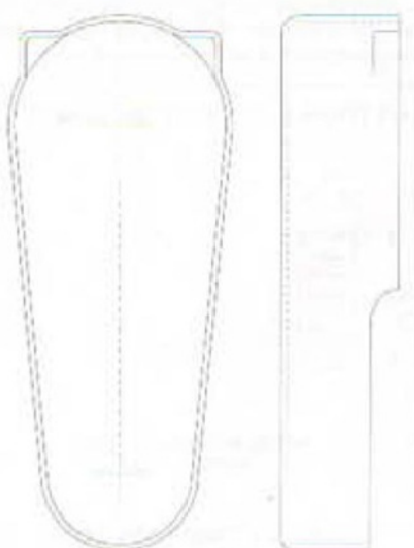
5. Gear shaft sub assemblies

Press two 4mm x 10mm dowels in to the 45T gear and Loctite this gear to its hub (on the short projection), then Loctite the 30T gear on the other end of the hub at the same time. After the Loctite has set, drill through both gears and the hub for a 2mm spring pin.

Fit the three gears to the countershaft with Loctite - the distances are shown on **Fig. 6** and pin the gears to the shaft with 2 mm spring pins, grinding the pins off flush. Do be sure that the 2mm drill cuts to size, as loose pins will come out.

Loctite and pin the drive disc and gear to the input shaft, in the position shown on **Figure 7**.

The sliding hub with its two gears is available as a machined item, No A16M. Similarly, the countershaft gears A51 and



© A - 31BELT GUARD 1 OFF VACUUM FORMED PLASTIC

A53 are combined in A35, and A19 combines the drive disc and gear A50. It is cheaper to use the combined parts.

6. Gear Box Assembly

Take the rear gearbox end plate A3, fit a ballrace (22 x 8 x 7mm) into the recess and secure with two self tappers, also fitting the oil seal on the opposite side. Press in the other 8mm Glacier DU bush and make sure that the 8mm dia. countershaft is a free fit. If it should be tight, make a hardened spindle from silver steel 8mm + .005/.008 and run this in the drill with some oil to free it up. This treatment may also be required for the bush in the other end plate and for the one in the mainshaft.

Now fit the four tie bars to the corner holes with 4 BA x 5/8in. cap screws, firmly tightened. Oil the bush and insert the countershaft (large gear end) and then fit the input shaft into the ballrace (paper down to a slide fit if necessary), not forgetting the 0.220in. wide spacer (A26).

At this stage, the other spacer (A28) can be fitted to the input shaft, followed by the large pulley (A17) which is secured to the shaft with an M5 screw and washer. If this end plate has a groove, fit the sealing ring and insert the end plate into the gearcase, ensuring that the hole in the gearcase for the gear change is in line with the input shaft and most distant from it. If you have not incorporated an 'O'-ring groove, then joint up the faces with gasket cement.

Check that the sliding gear assembly slides freely on the mainshaft and then locate in the gearcase on the drive disc and insert the other end plate, with the mainshaft engaging the sliding gear. Fit the 4 BA cap screws to the tie rods and tighten them up gently, making sure that the gears turn freely. Finally tighten the cap screws. The previously assembled gear change sub assembly can now be fitted.

Inject a light spindle oil through the filler hole, with the gear box level and inverted (about 13/16in. of oil.)

Electrical Wiring

The circuit diagram of the motor control system is shown in **Figure 8**, while the layout of the components can be seen in **Figure 9 and Photo. 11**. Although the electrics are fairly simple, if you have any doubt about your ability to handle them with safety, please consult a competent electrician. It is essential that the body of the motor and the cradle which houses the electrical components are effectively earthed.

Start with the reversing switch (Double Pole / Double Throw) by enlarging two of the outer terminals, one above the other, until the leads from the rectifier (shortened and bent as shown in **Figure 10**) will enter. Solder up the rectifier to these two terminals, then solder on to the adjacent terminals two pieces of insulated cable 2 1/8in. long. Cross them over the front of the switch and solder, as shown, to the previously soldered rectifier leads.

Prepare the motor by shortening the motor spindle to 22mm, tapping the four holes in the face M5, checking that the motor plate will slip on the spigot. The motor plate can now be fitted (the right way round!), spaced off with four 5mm washers.

Remove the plastic end cap to allow access to fit the varistor across the brushes; one of the varistor leads will have to be extended and insulated.

Remove the cable grip, shorten down to the hexagon, radius the bore and replace.

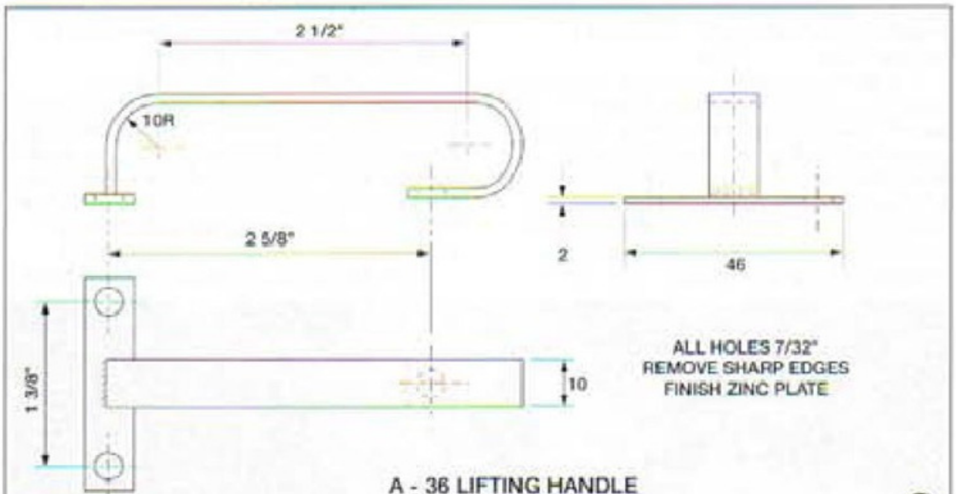
Shorten the motor leads to 2 1/4in., bare the ends for 3mm and just touch with solder to keep all the strands together. These can now be soldered to the centre terminals of the switch.

Wind the two toroids, one of them with two sets of 12 turns, using two pieces of enamelled wire 0.65mm dia. x 16in. long. The other requires two sets of 16 turns from 20in. of wire. Each toroid is wound on an iron cored ceramic ring, again available with the kit.

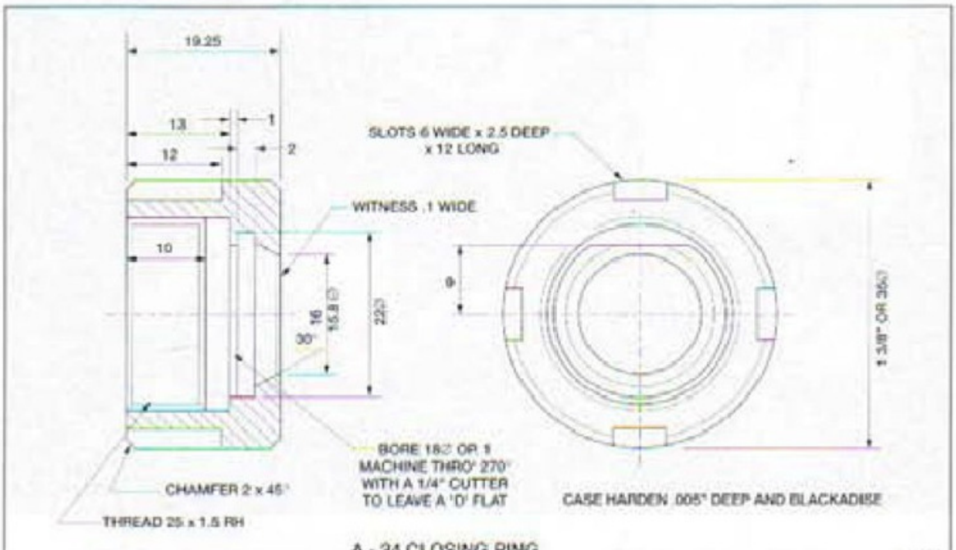
Wire these up with the two small capacitors after fitting them to the insulated strip, then glue the strip, as shown, into the motor cradle. Take the three pin socket, twist the earth tag around by 100 deg. or so and then chamfer the socket 45 deg. by this earth tag to clear the motor. Fit the socket with the spacer on the outside of the cradle, noting that a small slot will need to be filed in the spacer to accommodate a locating key. Solder the earth wire to the socket and to the small capacitors that sit between the toroids. The two terminal tags are later fitted to the motor and to the rectifier bolt.

Fit the on/off switch opposite to the

12. By careful positioning of the cable clip, the belt guard cannot be removed until the cable is unplugged. This photo shows an earlier standard, where the cable was secured with a 'P' clip fitted to one of the belt guard plug self-tappers. A cable tie may be used if preferred



A - 36 LIFTING HANDLE
1 OFF B.M.S.



A - 34 CLOSING RING
1 OFF EN32

13. The two centre finders

14. This detent assembly is designed to be attached to the Myford S7 headstock. The finger is adjusted to sit just over the division indications on the chuck backplate or indexing ring

socket, and solder a short wire from 'L' on the socket to the tag nearest to the open end of the cradle.

The cradle may now be placed in position on the motor, the reversing switch fitted to its hole, the bolt fitted to the rectifier with an earth terminal, and the other earth terminal fitted to the motor. Now fit the two self tappers to secure the cradle to the motor plate.

A little wiring remains to be done from the toroids to the rectifier and to the on/off switch and the socket. Glue the pair of 470 NF capacitors to the motor body and wire them in parallel across the A.C. input.

Coat all exposed bare wires and soldered joints with insulating varnish and cover all with a piece of polythene the shape of the motor cradle. If all has been well and properly done it will work.

It is wise to seal the motor cradle to the body to prevent the ingress of swarf. This is usually done with a small tube of silicone sealant with a fine nozzle with which a small bead of silicone is injected along the edges. At this stage, after the silicone has dried, lay the motor in position on the gear case and pencil around the motor cradle, marking the top of the gearcase to show where foam draught excluder should be stuck down to form the lower swarf seal.

Replace the motor and fix into position with the two hexagon 5mm pillars (A15) which have previously been drilled out to 5.1mm x $^{7}/_{8}$in. deep. Fit the belt, tension it (not too tight), and tighten the hex pillars.

Make two plugs 5mm dia x $^{7}/_{8}$in. plus long, with centre points machined on one end. These are then fitted into the hex. pillars with the points protruding, so that the position for the fixing holes in the plastic belt guard (A31) can be accurately marked. Drill these holes $^{1}/_{8}$in. dia. and screw on the guard plugs (A30) with self tappers.

Make up the mains lead, 2M long, with the small three pin plug on one end and a 13A plug fused 3A on the other.

Drill a 5mm hole in the belt guard between the guard plugs then fit the guard in position before fitting the small plug into the socket. Feed the cable around the guard and chalk mark the cable at the position of the 5mm hole. Remove the guard and plug to fix the cable at the chalk mark (with a nylon cable tie) to the hole in the guard.

With the guard and plug refitted (**Photo. 12**), the machine is now finished and ready for use if the lathe is fitted with headstock indexing. If it is not, then a little more work is needed to make the chuck index ring and the column and arm to carry the detent.

A no-volt release is available for those who wish to comply with the latest E. U. regulations.

15. The Quick-Step Mill is a versatile attachment for use on lathes of about 3 $^{1}/_{2}$in. centre height

Accessories

Centre Finders (A41 and A42)

The cast iron V finder (**Photo. 13**) must be set with some delicacy in the four jaw to have the shank centred and turned to 0.5in., after which the jaws can be fly cut with the job held in an inclined indexer on the vertical mill.

The scribing centre needs to be concentrically machined and later hardened.

Detent (Photo. 14)

All simple turning but take care to make the plunger a super sliding fit in the body with no play.

The column (A44/1) is secured to the Myford & Series 7 lathe by means of the Sleeve Nut (A44/2) and a stud in the tapped hole to which the lever collet chuck assembly is normally attached. A bolt could be substituted for the sleeve nut and stud.

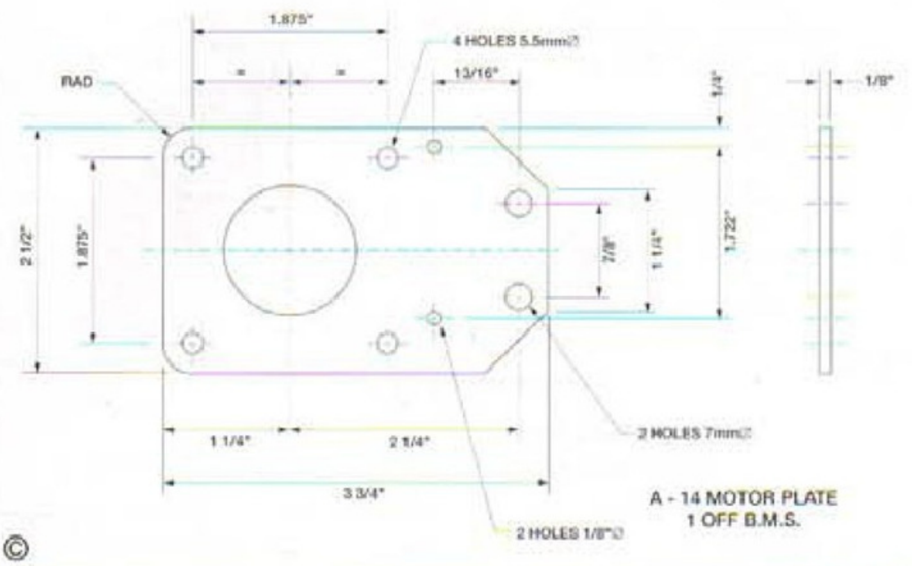
The Indicating Finger (A44/5) is curved to bring it close to the indexing ring which may be attached to the chuck backplate. Alternatively, the chuck backplate itself may be marked with indexing divisions.

Supply of components

Arrangements are being made to make available, as finished parts, some of the more difficult components such as the spindle and gears. Motor, belt and belt guard, toroid rings and other electrical components can also be supplied, as can the raw materials from which to produce the machined parts.

As mentioned in our last issue, finished machines, together with items such as collets and accessories are also available.

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



A - 14 MOTOR PLATE
1 OFF B.M.S.

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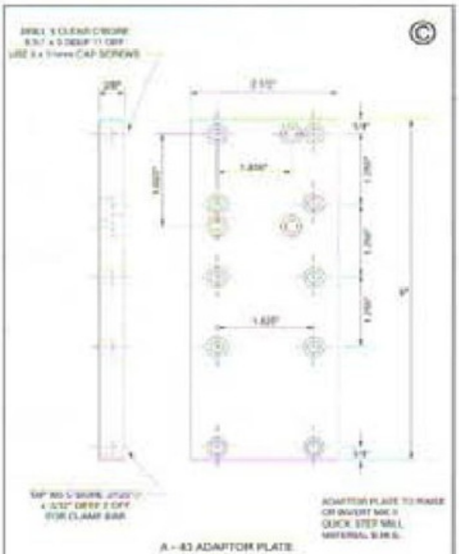

A - 43 ADAPTOR PLATE
1 OFF B.M.S.

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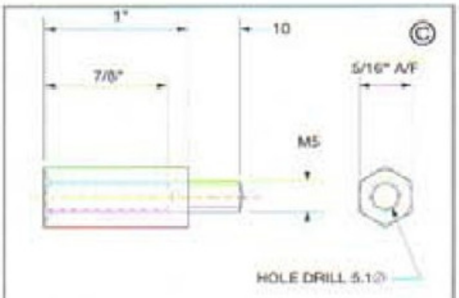

A - 15 STUD (BELT GUARD)
2 OFF BRASS

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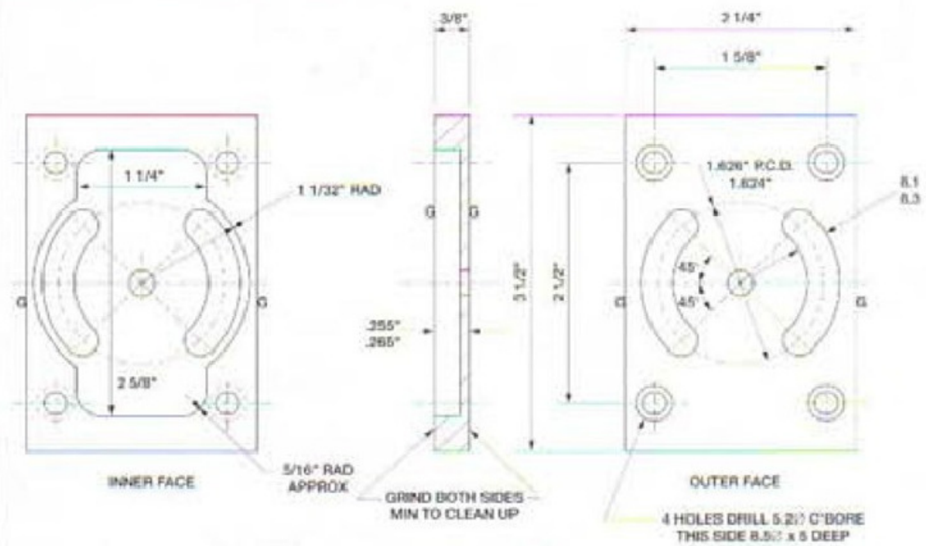

A - 7 QUADRANT PLATE
1 OFF B.M.S.

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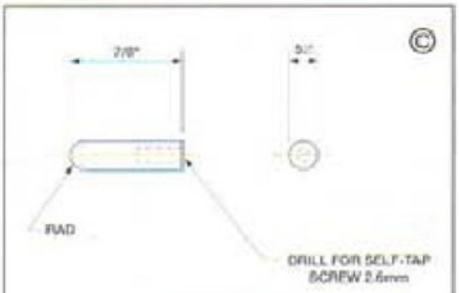

A - 30 PLUG (BELT GUARD)
2 OFF BRASS

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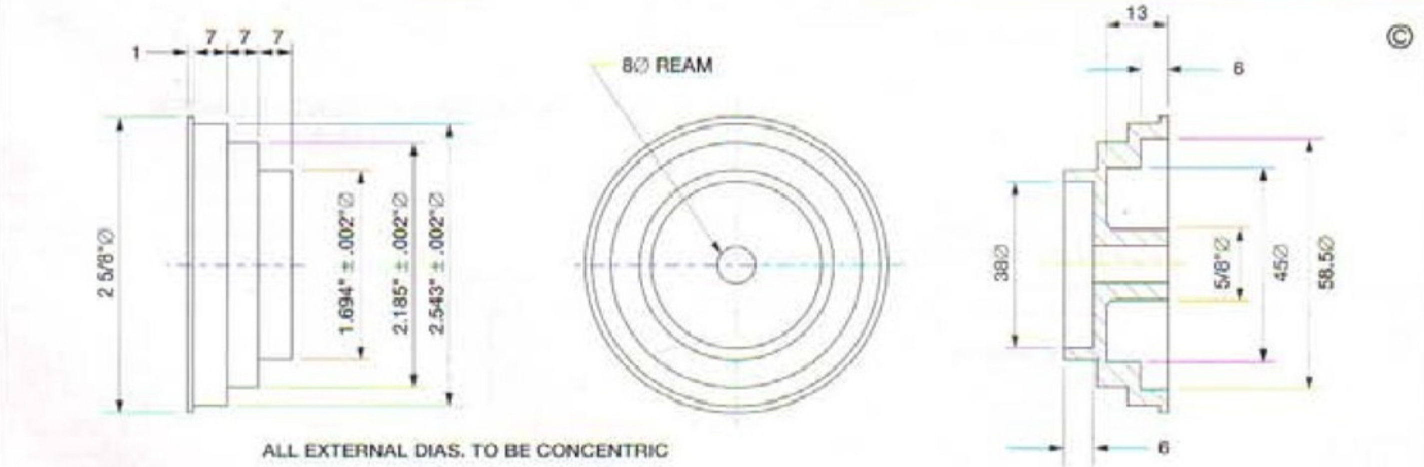

A - 17 LARGE PULLEY
1 OFF DURAL

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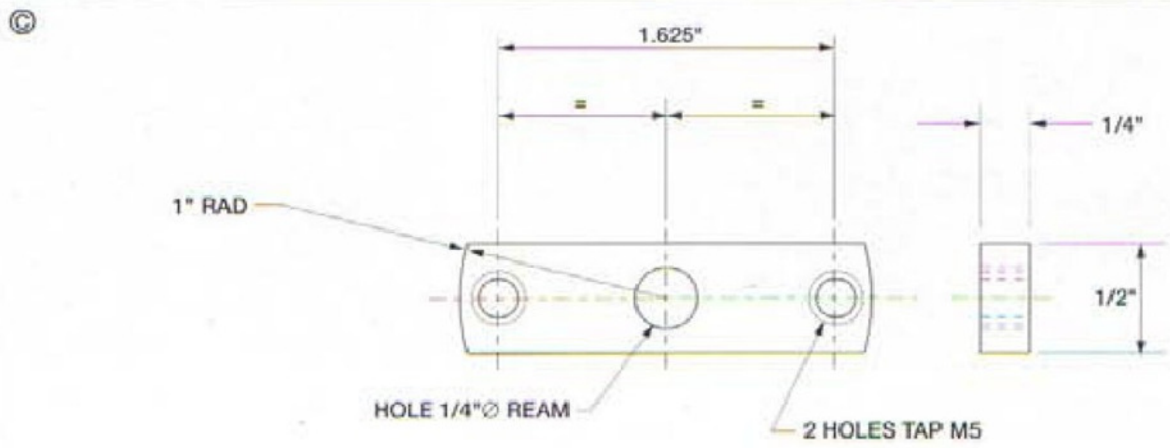
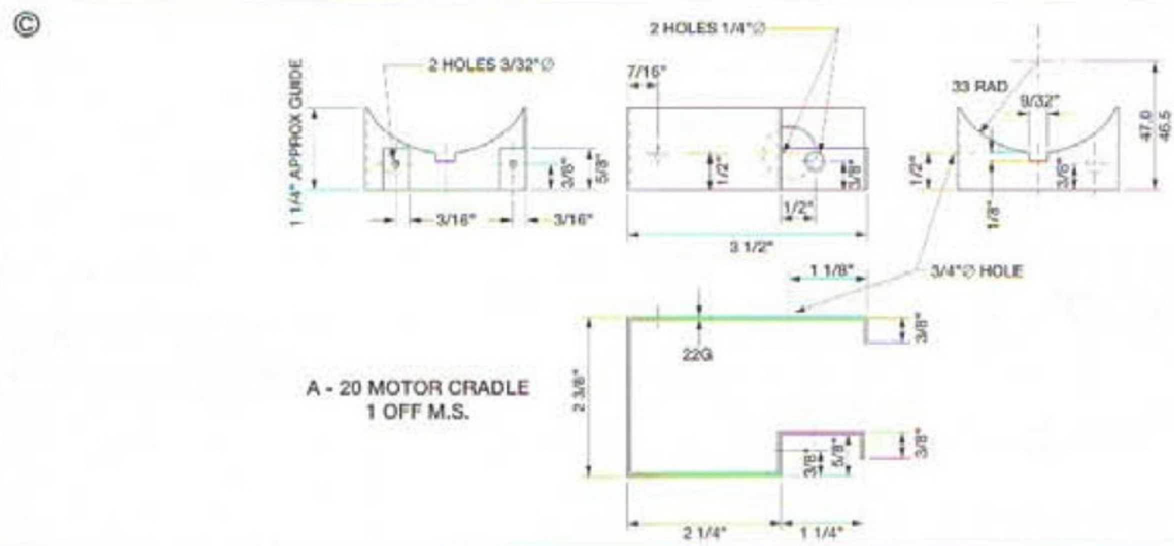
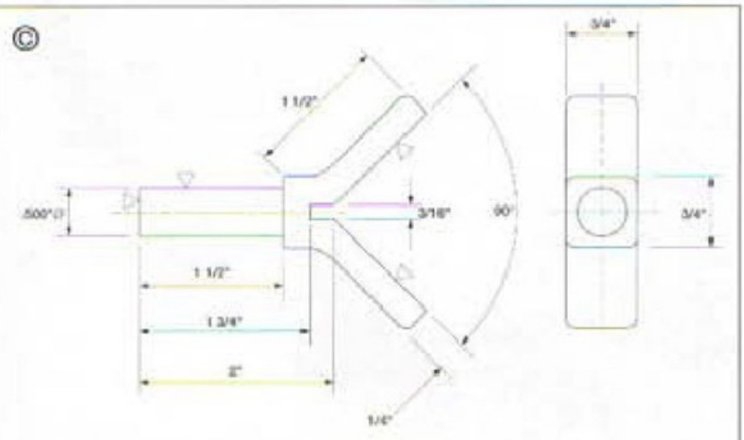


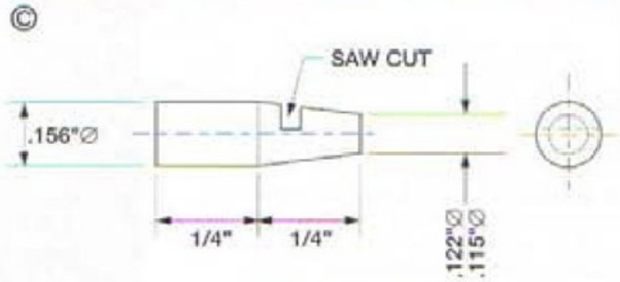
A - 38 SWIVEL BAR
1 OFF B.M.S.



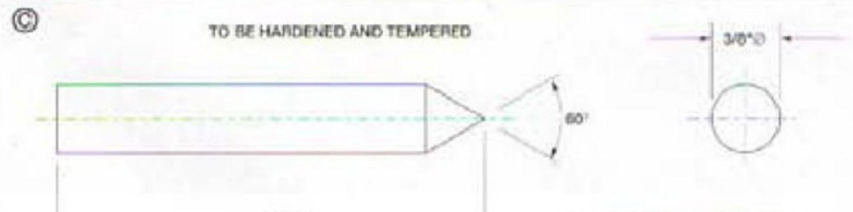
A - 20 MOTOR CRADLE
1 OFF M.S.



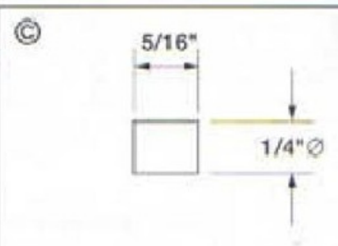
A - 41 CENTRE FINDER
1 OFF STEEL OR CAST IRON



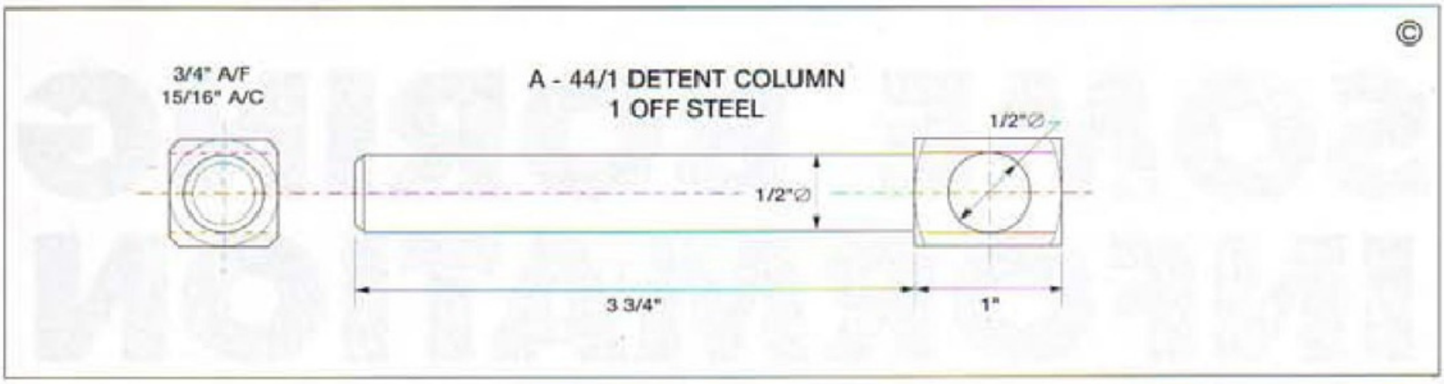
A - 49 PIN - DETENT PLUNGER
1 OFF SILVER STEEL



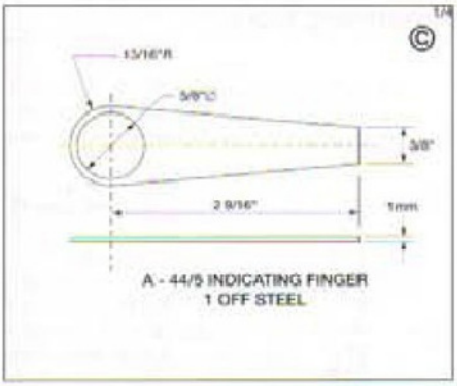
A - 42 SCRIBING CENTRE
1 OFF SILVER STEEL



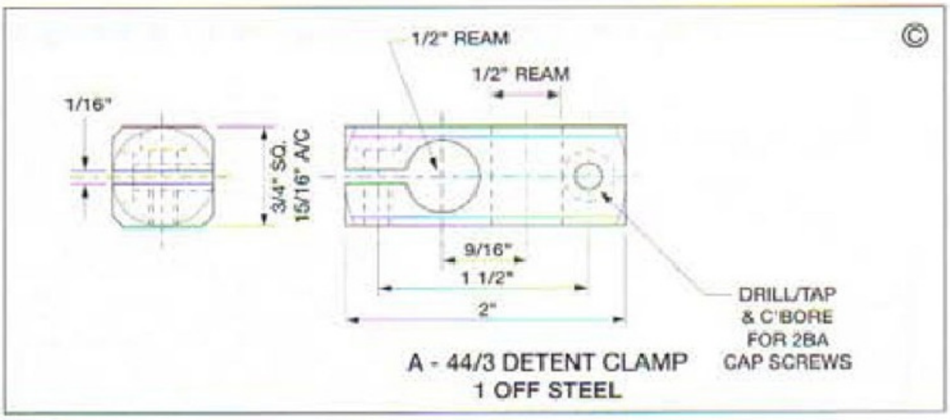
A - 39 DOWEL (SWIVEL BAR)
1 OFF STEEL



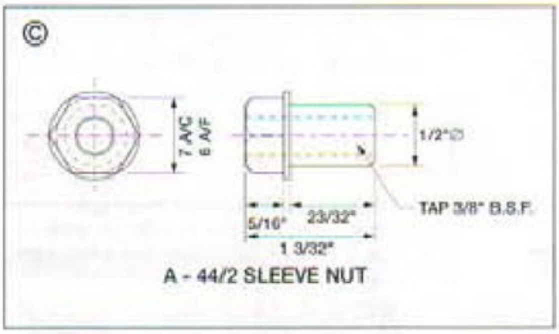
A - 44/1 DETENT COLUMN
1 OFF STEEL



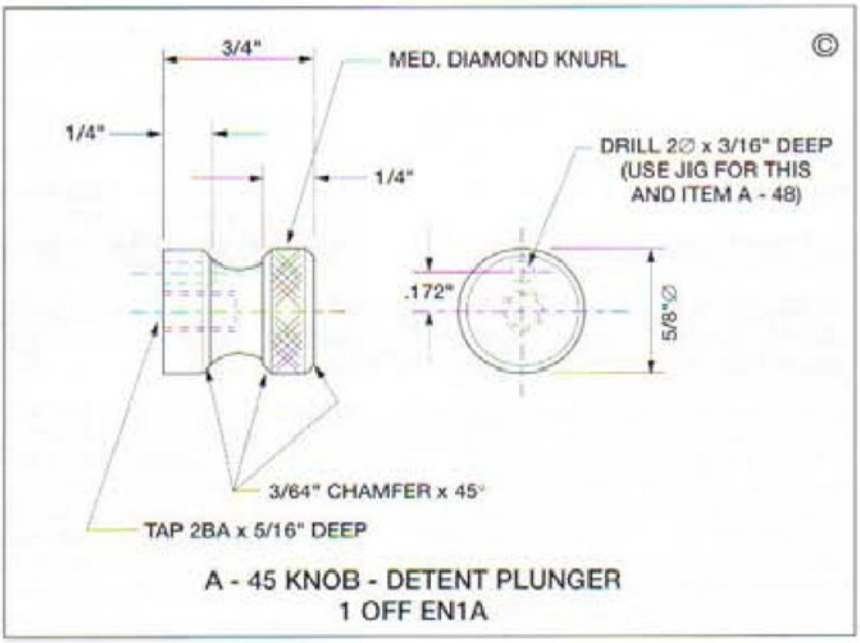
A - 44/5 INDICATING FINGER
1 OFF STEEL



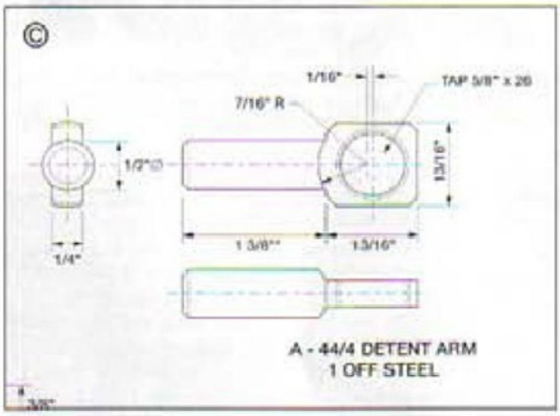
A - 44/3 DETENT CLAMP
1 OFF STEEL



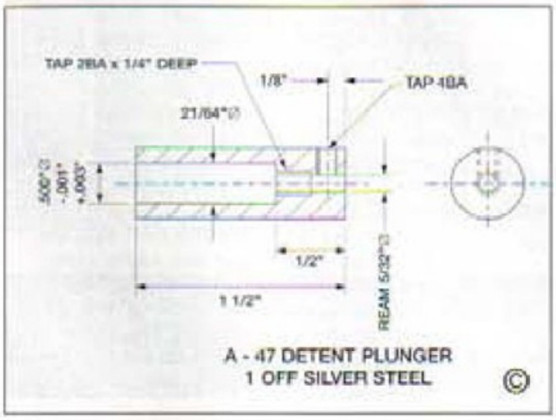
A - 44/2 SLEEVE NUT



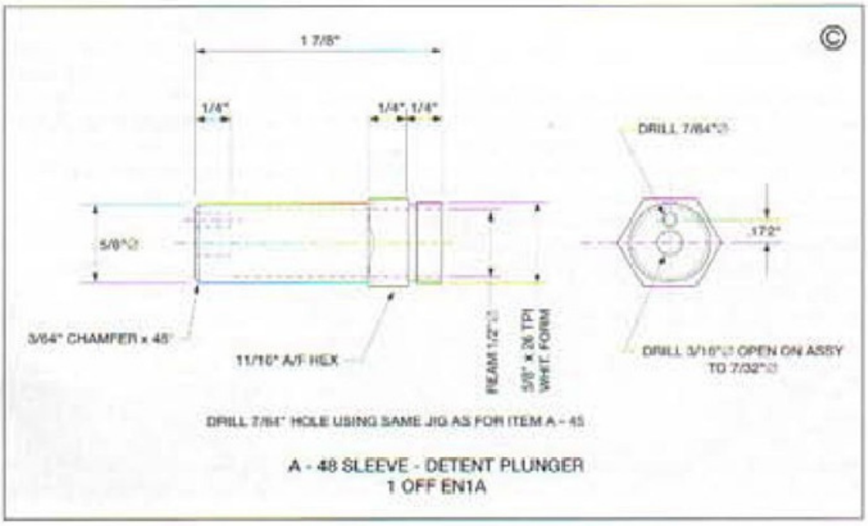
A - 45 KNOB - DETENT PLUNGER
1 OFF EN1A



A - 44/4 DETENT ARM
1 OFF STEEL



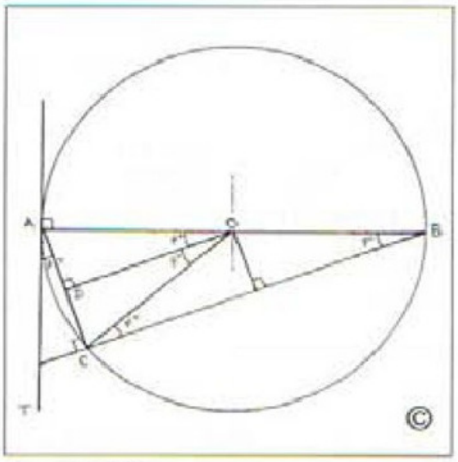
A - 47 DETENT PLUNGER
1 OFF SILVER STEEL

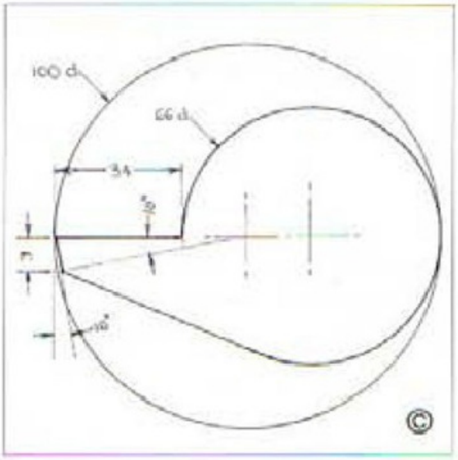


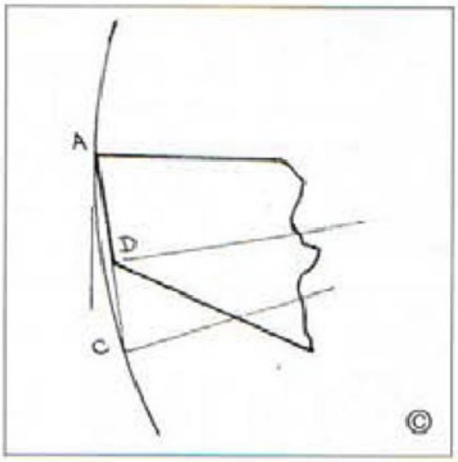
A - 48 SLEEVE - DETENT PLUNGER
1 OFF EN1A

SOME BORING INFORMATION

Philip Amos investigates the geometry of boring and trepanning tools







Introduction

In this information age there is much information which is boring, but this article is about the workshop technique of boring.

There is an excellent description of the process by George Thomas - how it is done and the tools to use - in **Reference 1**. However, it may be useful to consider some of the basic facts to allow rapid achievement of best results.

There are essentially two types of operations involved. In one case the aim is to make a hole either parallel or tapered i.e. an axial process. The other is to make a recess by a radial process. In either case, the starting point must be a hole of some sort, so that the boring tool can be put into position to start its cutting work.

Axial

In the axial case, a drilled hole will be used, of sufficient diameter to accommodate the end of the boring tool. The bigger the hole, the larger and stiffer can be the tool, which will lead to less tool deflection, chatter, clogging with chips etc. **Reference 1** suggests that the tool bar be no bigger than $^{2}/_{3}$ the hole diameter, to allow free exit of swarf. So rule 1 is - "Go for the biggest allowable hole"

Radial

In the radial case a drilled hole may be suitable as a starting point, but if a flat bottomed recess is desired then the hole may have to be made with a slot drill to get a flat bottomed starting hole. In another case the required recess may be annular, and here we must start by using a trepanning tool. In some cases this tool may be used to complete the job - but see later.

Accuracy

A boring operation with a single point tool can improve accuracy by centralising a hole, and also bringing it to a precise size. It may therefore often be a preferable process to reaming.

Clearances

Most references make mention of the need to cut away the bottom corner of the tool to avoid interference with the bore; none seems to quantify this matter except **Reference 1**, which makes an indirect comment.

If the cutting edge of the tool is set at centre height, then it is a matter of simple geometry to determine where its front face will interfere with the hole for various clearance angles.

Proofs of the geometrical properties which are stated below can be found in any geometry text.

Drawing 1 shows the situation where a tool with zero rake is presented at centre height to the wall of the hole at A. The front clearance of the tool to the tangent AT is angle F deg. This face of the tool will interfere with the bore at C. Diameter AB subtends a right angle ACB and the angle ABC is also F deg., as is the angle OCB. The bisector OD of angle AOC is parallel to BC and so angles AOD and DOC are also F deg.

Thus AC subtends an angle 2F deg. at the centre, so the arc AC represents 2F/360 of the circumference or x 2F/360 of the hole diameter.

For example if F is 10 deg. then interference will occur at 2 x 10/360 or $^{1}/_{18}$ of the circumference, or roughly $^{1}/_{6}$ of the diameter.

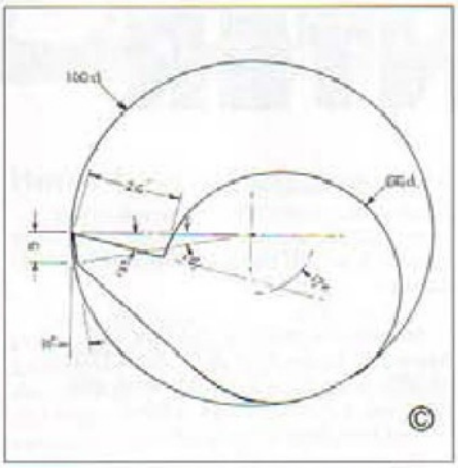
Drawing 2A shows the tool section, complete with the recommended bar dimension $^{2}/_{3}$ the hole diameter.

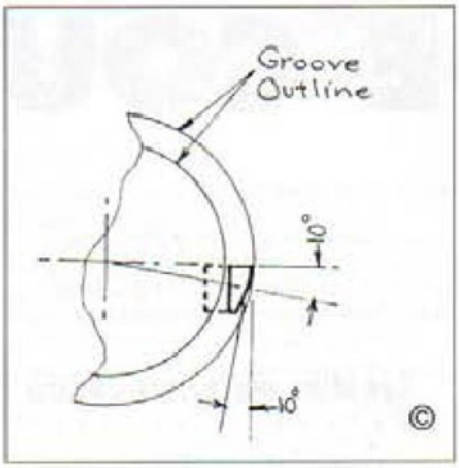
Reference 1 suggests the front face be limited to $^{1}/_{12}$ of the hole diameter, which is conservative, but certainly allows more room for chip egress. Note in **Drawing 2B** the clearance to the bore increases progressively from A to D and then decreases again to the interference point C, so that there is more chance of chips jamming in this second section. Therefore adopt $^{1}/_{12}$ of the hole diameter for the maximum length of the front clearance face.

Of course clearance angles of less than 10 deg. will result in smaller proportions of diameter to the interference point, but the principles remain the same.

Drawing 3 shows the tool section with 15 deg. rake and the same size bar. Note that the projection of the 'tooth' is reduced by about 20%.

Although the drawings are large scale to show the principles, the shapes remain the same if they are scaled up





or down, so the proportions can be used to define boring tools in any particular case.

Trepanning

The action required here is rather like that used in a carpentry hole saw. In fact, in **Reference 2** Professor Chaddock uses such tools made for the purpose in the manufacture of the Quorn spindle.

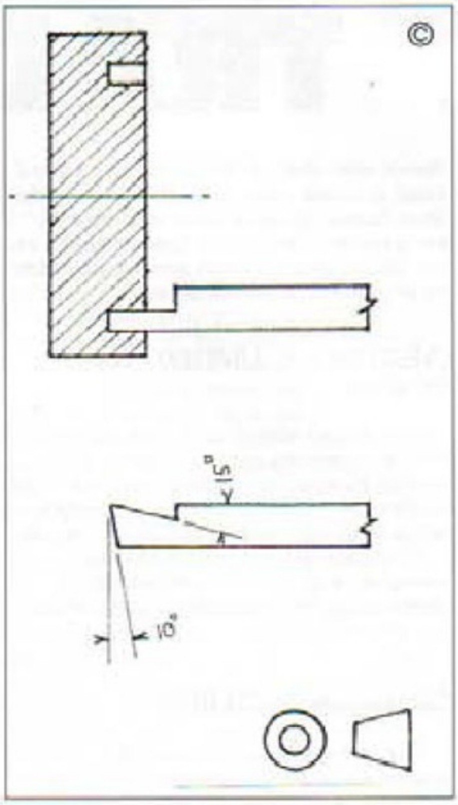
However for more normal cases, a single point tool is probably easier to make.

As shown in **Drawing 4**, it enters the work axially and must have appropriate clearances on the front face which does the cutting, and on the sides to allow it to follow the cutting edge into the work. The tool must necessarily be narrow to avoid chatter; it should have appropriate rake back from the cutting face towards the shank - so it may look rather like a parting off tool.

If it is desired to widen the groove from that initially trepanned, it is better to use a boring tool for this purpose, as the trepanning tool does not usually have side rake which would tend to weaken an already delicate tool.

Conclusion

Euclid's teachings can often assist in the home workshop, allowing clarity in the analysis of problems and facilitating the arrival at correct tool shapes to achieve best results.

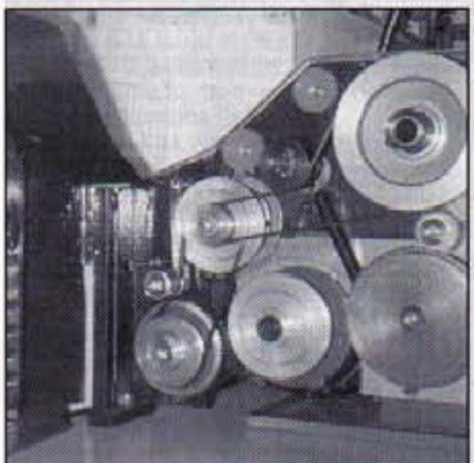


References

1. Model Engineers Workshop Manual - G.H.Thomas.
2. The Quorn Universal Tool & Cutter Grinder - Professor D.H.Chaddock.

IN OUR NEXT ISSUE

Coming up in Issue No. 54 will be



A TALE OF TWO CHUCKS

Ted Wale relates how he provided a newly acquired Southbend lathe with a pair of serviceable chucks

A SLOW SPEED DRIVE FOR A WARCO 918 LATHE

A system which will give nine mandrel speeds instead of the original six is described by David Berrecloth

THE HOLBROOK LATHE

A further look at the miniature Holbrook lathe being built by Bob Mellows

Issue on sale 27th November 1998

(Contents may be changed)

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

CHESTER U.K. LIMITED - New location

Well-known suppliers of machine tools and associated equipment Chester U.K. Limited have re-located their operation from the Waverton Business Park to Hawarden, which lies to the west of the city of Chester.

Their new address is Clwyd Close, Hawarden Industrial Park, Hawarden, Chester CH5 3PI. Telephone 01244 531631 Fax. 01244 531331.

Catalogues on CD ROM

Increasingly, we are receiving catalogues from our suppliers in the form of CD ROM. These make a handy form of transmitting and storing information, taking up much less shelf space than the hard copy equivalent. A number of these are accompanied by free software which enable the user to carry out a variety of other tasks. For instance, one contains a general-purpose 'search engine' which can be used with other files, while another includes some free anti-virus software and a 30 day Internet trial. A point to watch when acquiring catalogues in this form is that the equipment on which they are to be run is compatible with the format. Most seem to be suitable for both IBM AT compatible PCs and Apple Mackintosh machines, but a number require at least Windows 95, while others will operate on Windows 3.1 as well.

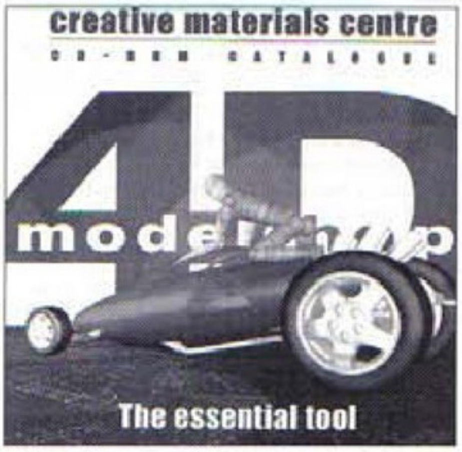
A further advantage of this type of catalogue is that customers with Internet connections can place orders electronically by using a 'shopping basket' facility included with the system. The majority of these CDs are now being supplied free, but some companies do make a small charge, so you are advised to check the current position when requesting a catalogue.

4D Model Shop Creative Materials Centre

The first of the CDs came from the London based 4D Model Shop. They stock a wide range of modelling items, materials and tools which could be termed to be at the 'lighter' end of the market. Of particular interest are likely to be a variety of modern adhesives, small electrical/mechanical items and various types of finishing materials, including acrylic, cellulose and enamel paints. In their 'Strip and Shape' category come a number of sections in non-ferrous metals and plastics.

4D also offer services such as custom acid etching, the manufacture of dry transfers and waterslides and custom white metal casting.

4D Model Shop Creative Materials Centre, 151 City Road, London EC1V 1JH. Tel. 0171 253 1996 Fax. 0171 253 1998. email info@modelshop.demon.co.uk



S. H. Muffett Ltd

Well known for their standard gear and transmission products, S. H. Muffett Ltd have now issued their catalogue in CD form. This one includes Acrobat Reader software from Adobe, which can be installed without infringing copyright.

S. H. Muffett Ltd., Woodbury Park Road, Tunbridge Wells, Kent TN4 9NH Tel. 01892 542111 Fax. 01892 542117 web site: http://www.muffett.co.uk email: sales@muffett.co.uk

Maplin Electronics

Perhaps the biggest saving of shelf space is achieved by this CD version of the Maplin Electronics catalogue. Entitled 'Electronics & beyond', the catalogue is valid for the period September 1998 to February 1999 and includes a semiconductor supplement, with 17000 new products. In addition to a free datasheet CD, this is the one which includes the McAfee virus scan and the 30 day Demon Internet trial.

The electronic version of the catalogue is obtainable against order code CQ02C, while the traditional printed version can still be obtained (order code CA18U).

Maplin Electronics, PO Box 777, Rayleigh, Essex SS6 8LU Tel. 01702 554000 Fax. 01702 554001 web site: http:/www.maplin.co.uk email: <recipient>@maplin.co.uk

Return of the Hobbymat

Many people were dismayed when the Hobbymat range of machines disappeared from the market. It is therefore with pleasure that we report that the title, manufacturing drawings and selling rights have been acquired by Precision Spezialmaschinen GmbH of Chemnitz.

At present, the range consists of the SD300 model-makers lathe and the larger capacity SD400 small engineering lathe, both of which can be combined with the BF400 mill/drill, the KT450 co-ordinate table and an extensive range of accessories.

No firm arrangements have yet been made to import the machines into the United Kingdom, so anyone interested in doing so should contact Manfred Friedrich, the Managing Director, at the address noted below. In the meantime, advice, service, spares and accessories continue to be available from Stephen Lacey of Essel Engineering.

Precision Spezialmaschinen GmbH, Otto-Schmerbach-Strasse 19, D-09117 Chemnitz, Germany Tel. 0049 371 8 66 32 08 Fax. 0049 371 85 09 16

Essel Engineering, 23 Cavell Road, Billericay, Essex CM11 2HR Tel./Fax. 01277 659774

SCRIBE A LINE

Home built air compressors

From John Noakes, Aldershot, Hants.

I am indebted to Ray Harding for providing the test and working pressures of air reservoirs as used on vehicles and for the information about the threads used in vehicle pneumatic systems. (Scribe a Line Issue 52).

From his figures of test to 17 bar and working in the region of 7 bar, my reservoir is being used within its design limits. I realise that a used reservoir may have defects which could compromise its safety and this was made clear in my article. Any pressure vessel, be it an air reservoir or a boiler, should be used with caution and in accordance with accepted practice. When used in a public place, it must be covered by insurance.

I have, without success, tried to find data on the National Pipe Taper threads. However by meshing a 1/2in. NTP with a 1/2in. BSP taper, the fit of the threads as seen when held against a light is close and regular. The BSP thread may have more rounding of the crest and trough than the NTP, but the difference would appear to be minimal.

The possibility of corrosion within the reservoir due to condensation causing a thinning of the reservoir wall must be taken into account, as must be the condition of the pipework and fittings. My air system is regularly tested to 10 bar to guard against such an eventuality. Again, this is just like testing a boiler.

Perhaps information on various pipe threads could be made available for inclusion in the MEW Data Book.

Looking for the 'Levitron'

From Sandy Sadler, Waterlooville, Hants

Re. the letter from Dennis Fielder in Issue 51, when faded many times in the past with the situation of locating companies and organisations all over the world, I have resorted to contacting the commercial Departments of that country's embassy, with a great deal of success. This may be useful to other readers in the future.

A cautionary tale!

From Peter J. King, Christchurch, New Zealand

I scribe a line in a state of sorrow and mortification; in a moment of mental aberration and desperation I used my (once) lovely large 'V' blocks to secure a heavy shaft (a skeith mounting column from a plough) from rotation under my hydraulic press, whilst straightening the shaft. It became necessary to tap a small 'rol-pin' in one end ever so slightly one way. I used a really small tack hammer - honest!. Both 'V' blocks split in two instantly. No amount of engineering Esperanto would put them back together again either! Alas they were cast iron, not steel as thought. Others take note!

Yours dolefully

The 'Spenborough' gear hobbing machine

From P.Redhead, Burscough, Lancs.

I was interested in the gear hobbing machine shown in your report of the Harrogate Exhibition (Issue 51, page 55). No doubt that by now you will have had several letters with reference to the information that members of the Spenborough Model Engineers are seeking about the machine. It would appear to be similar, if not actually made from a set of plans and castings which I purchased some years back from a Mr. J. Buckley of a company called Preserved Technology Limited of Oldham, Lancs., and referred to as a 'Jacobs Type'.

A table for gear trains required to cut numbers of teeth is provided on the plan sheet. All gears used in the gear trains were from a standard set of Myford change wheels of 20 DP gears i.e. :20 - 20 - 25 - 30 - 35 - 38 - 40 - 45 - 50 - 55 - 60 - 65 - 70 - 75 teeth, plus extra gears of 72 - 80 - 90 and 100 teeth (all 20 DP).

In the photograph, this 100 tooth gear would appear to have been enclosed in a casing seen between the motor pulley drive and the gear train on the left of the photograph. This casing is not shown on my plans, so must have been a later modification, either by Mr. Buckley or by the builder.

Basically, the motor drove through a belt and smaller gear on to the 100 tooth gear which was on the same shaft as, and drove the hob. At the same time, a smaller gear on the same hob shaft drove, through the gear train on the left end and a shaft with two universal joints (to take care of the vertical and horizontal movement of the workshaft), the workshaft and its feed on to the hob.

Please excuse the non-technical description, which I hope can be interpreted by any engineer. (I am not yet proficient in dohickies and whatsits language).

It is some years since I collected my castings and plans and have no knowledge if Preserved Technology Ltd are still in business. I think that it was Mr Buckley from whom I received the plans and parts. Was it only a fable that the machine could cut its own gears, using a hob cutting on the correct sizes of freewheeling blanks?.

At the time I had access to a commercial gear hobbing machine at the evening classes, sadly discontinued some years back, so was able to cut a complete set of gears including the 100 tooth, saving using my lathe change wheels.
Unfortunately the instructor who was the expert with this machine had retired soon after I had joined the class and so I only learned basic gear hobbing and non of the more advanced techniques, but we passed some pleasant evenings. A fellow club member also bought the castings at about the same time and cut gears with the completed machine.

I do hope that this may be of help.

Editor's note:- Thanks to Mr. Redhead for the above information. We studied the machine very closely while it was at Harrogate and came to the conclusion that, while it seemed to be based on the Jacobs machine, it did not seem to be made from the Preserved Technologies castings, which were marketed under the 'Helix' name. Tom Jacobs built the original version as a fabricated unit, and legend has it that he picked up the piece of channel section used as the bed from the side of the road. This prototype device is now in the care of The Society of Model and Experimental Engineers.
John Buckley adapted the design to produce the cast version.
I am pleased to report that the castings and drawings are still available, now from College Engineering Supply, and that Harold Hall has just started to build one, and will describe the process in these pages in due course.

Making taper reamers

From Henry J. Kratt, Meridian, Mississippi USA

I have made a number of reamers for a professional instrument maker who's customers willingly pay £2.000+ for his instruments and wait two years for delivery. These reamers were made to reproduce exactly the bore characteristics of specific instruments made from about 1650 to 1800 by various renowned European woodwind makers of that period.

Old instruments are borrowed from

collectors or museums and the bore diameter measured to a tenth of a millimeter at specific intervals throughout the length of each section or joint. I always thought this to be a bit extreme, since the material of which the instrument was made was most often wood and maybe three-hundred years old, to say nothing of the fact that, most likely, the bore was not a perfect diameter because of the swelling and contraction occasioned by constant wetting by warm moist breath and drying out, often every day. I was not solicited for an opinion on the propriety of the measurement, "Just make the reamer to specifications. Yes, Sir."

Of course the reamer must taper else it couldn't be got in or out, but the taper in these old instruments is quite complicated and varied to coincide with the placing of the holes, different lengths, and to improve intonation. These subtle and small variations are what made the instrument of one 'Old Master' play differently from another. Professionals today playing music from this Baroque period frequently want instruments that reproduce, as closely as possible, the pitch and sound of that period. Since all instruments are a bundle of compromises, the bore is too. Simplicity gives way to tone, pitch, and art.

Like you, I turn my reamers from tool steel. The steel must be relieved of any stresses (one reamer I made with steel given me by the instrument maker curled like a pretzel after the side was cut away). I begin with the large diameter end at the head stock. Allow 50mm before the start of the taper to hold in the chuck. Flats may be cut on this later to assist in holding. I turn a small but distinct groove at the start of the taper to show the depth to which the reamer must go - and no farther. Face the tail stock end to be over-all 100mm plus the length of the taper; this face is the datum. From here on it is a case of measuring from the right end and setting the left face of the tool to this distance and calculating the depth of cut to increase from the last cut. Then I turn on the lathe and feed in to depth and turn on the self-act and cut to the right and off the end. This forms a series of steps where the left corner is at exactly the right diameter and distance from the end. It is a series of offsets actually. When I have finished the steps, I put layout blue on the work and file off all but the trace of blue left in the left-hand corner of the step. I continue smoothing the work with a fine file. With a small 'V' tool, I mark the end of the taper. Turning against the tailstock is unusual but convenient in this instance. I also use a ball-bearing live center. I have one of those big cheap Chinese calipers (33cm) I use for measuring the distance from the right end.

Some reamer makers then cut the reamer down the middle, making a 'D' section and grind to centerline. With the larger diameter reamers, I put them in a dividing head with tail stock and mill a cross section that resembles a "W" with the first and last legs flattened down to a seven degree angle with the horizontal. This gives a little more cross section to the reamer and provides control of a cutting edge angle. It also retains the center.

I have successfully made reamers in this way with diameters from over two inches, in the case of the foot joint and 'bell' to three-sixteenth inch for the joint mounting the reed. This whole technique is really low-tech. No sophistication, but it works! All the measurements are made on the work piece with no taper attachment required. I have used my taper attachment to remove lots of the unwanted metal, but in the end it was measure-and-cut.

From John Keane, Reading Berks

I read with interest John Summers' letter describing his difficulty in turning a thin, tapered reamer for a musical instrument bore. I encountered the same problem when making a reamer for a baroque oboe. The silver steel reamer took on a wobble as turning progressed and, initially, I could find no turning or cooling technique that prevented it.

However, I came to the tentative conclusion that even a moderate increase in temperature of the steel might be causing the reamer to increase its length. Being securely held between centres, it would be bound to bend. I thought a possible contributory cause might have been that the work piece was precompressed, between the centres, in my anxiety to hold it securely; again the only place for the stress to be relieved would be to bend when the tool pressure was applied near the thin end. I had little confidence in any of this as I calculated that the increase in length due to temperature should be very small, but being desperate, I decided to eliminate this possible cause anyway.

My solution was to make a simple, spring loaded centre for the offset tail stock (of a Myford ML10) which would allow the work piece to expand and contract slightly without loss of centring. This was made by drilling and reaming a blind hole in a 2MT blank and dropping in a stiff compression spring followed by a piece of ground silver steel with a tapered nose to act as centre.

Whether my theory was correct or not, I found that this completely cured the problem. I wish I had thought to measure the work piece temperature, but I was glad enough just to have muddled through.

Until now, I had not heard of anyone else having this difficulty. I suspect that amateur reamers for this purpose are often not turned at all, but are ground from, say, tapered files of triangular or square section. Anyone using a wood turning lathe would have to take some such approach anyway.

I would be very interested to hear whether my cure is any help to Mr Summers and also whether anyone has a different explanation and solution - or can tell us both what we were doing wrong in the first place!.

From Gordon Read, Waltham Chase, Southampton

The method I have used in the past to turn S.U. carburettor needles from 1/8in. diameter brass wire should make Mr. Summers' reamer. I know it worked for brass, and can't see any reason why steel should present problems.

Three pre-requisites need mentioning. First, a collet of some kind to hold the stock in the chuck; a split brass bush will do, provided it can't rotate in the chuck jaws when they are slackened. Second, a really accurate centre-drilling for back centre support of the workpiece. Third, a really sharp left-hand knife tool, with the cutting edge dead on lathe centre height.

Start with a pad and pencil, plus a calculator. Work out a stepped surface which will just contain the final taper shape required. That gives a series of lengths and diameters, the diameters starting from just over 3/16in. in your case. Note that lot down for reference while doing the job on the lathe.

Next, make a split-bush collet for the chuck. Put the workpiece in it with only a fraction of an inch protruding, and centre the exposed end. Pull the workpiece out for a little more than the length of the first step to be turned, and turn down to diameter. Follow that by successive similar operations until all steps have been turned; it is apparent that all turning is done with the tool cutting very near the support of the workpiece in the collet, so bending is not a problem.

With all steps turned, and the tailstock supporting the outer end of the workpiece, use a fine file to remove the steps until a smooth taper has been produced. That done, finish off with 'wet and dry' abrasive paper, well oiled, until a suitable smooth surface has been produced.

The above will generate the tapered object you require, but does not encompass the making of a cutting edge or edges. Just what shape of cutting edge you need I don't know, but I suspect that it will be based on an axial groove. That, I imagine, would best be produced by grinding. The little 12V miniature drills and their tiny abrasive wheels can be used very well as toolpost grinders, so there may be a method in that.

Another method might be to make a tapered object from a piece of flat stock such as gauge-plate, harden and temper, and then coat both sides with something like 'Plastic Padding' filled epoxy. When cured hard, that material could be sanded down to produce a circular cross-section taper near enough accurate to form a guide for the tool in wood.

I hope this lot is of use. As I said at the beginning, it worked to make S.U. carburettor needles from 1/8in. diameter brass stock.