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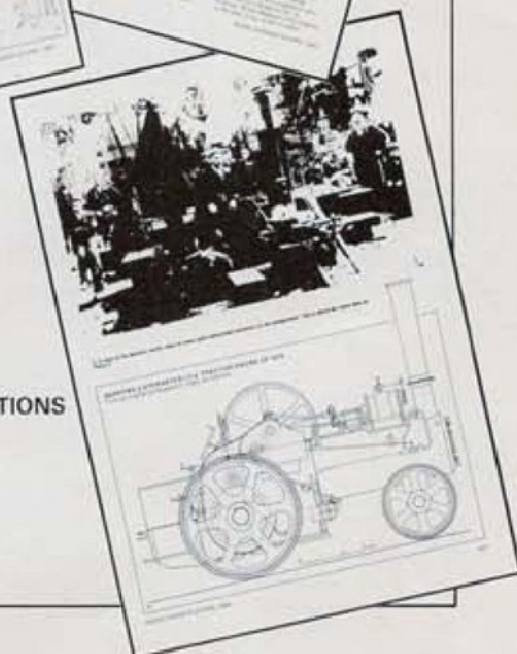
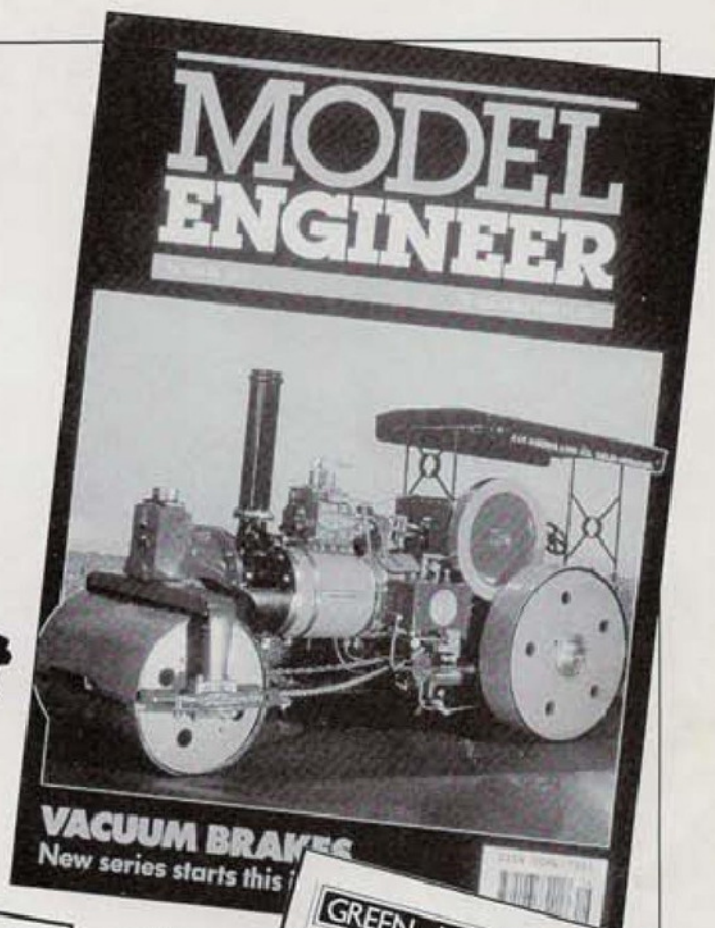
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AN ARGUS SPECIALIST PUBLICATION

ARGUS SPECIALIST PUBLICATIONS
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Boundary Way,
Hemel Hempstead,
Hertfordshire,
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Tel: 0442 66551



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Issue No.

50

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Nexus Subscription Services, Tower House,
Sovereign Park, Lifford Street, Market Harborough,
Leicestershire, LE16 9EF
7 issues UK £18.65, Europe & Eire £26.00,
Sterling Overseas \$27.00 (surface-mail) \$32.50
(air mail), USA overseas \$43.00 (surface-mail)
\$53.00 (air-mail). Cheques payable to Nexus
Special Interests Ltd.
USA Subscription Agent: Wise Owl
Worldwide Publications, 4314 West 238th Street,
Torrance, CA 90505-4509 USA. For
VISA/Mastercard orders in USA telephone (310)
375-6258. Fax (310) 375-0548. Pacific Time:
9am-9pm Weekdays 10am-6pm Weekends.
USPS 010876



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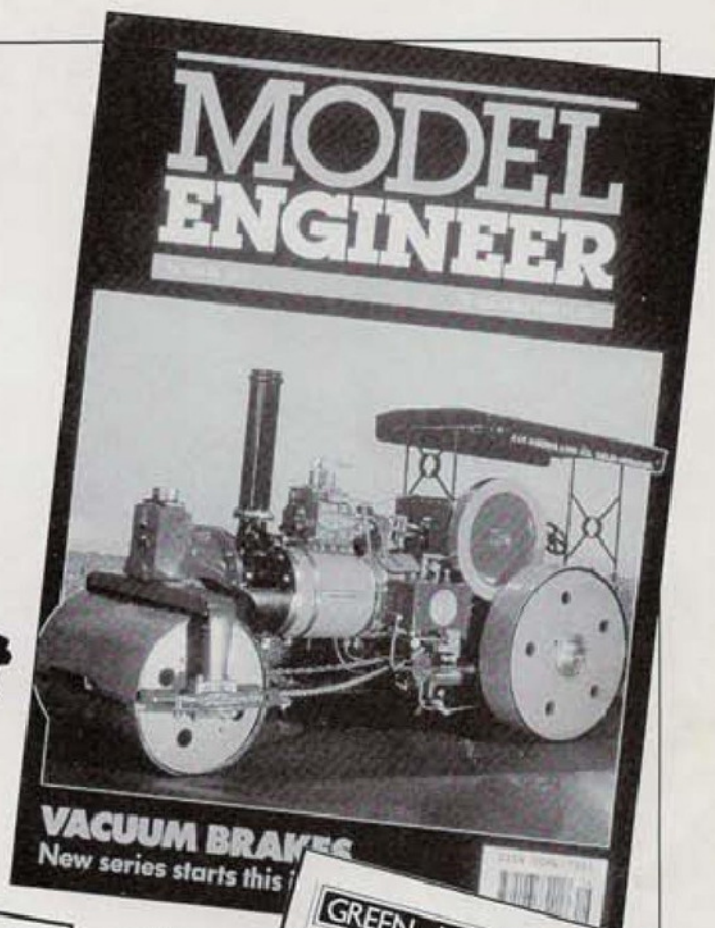
We spotted this home made light milling attachment for the Myford ML10 in the Centennial Village at the recent M.E. Exhibition. It was described a few years back in M.E. under the title of Micro-Mill. Builder is Leonard Walker of Torquay. The tool aroused a lot of attention.
(Photo: John Jolliffe).



Very few commercial chucks will extend this far, however, you can own one, if you make it yourself. Full instructions start on page 28.

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ON THE EDITOR'S BENCH

With this issue, we reach what could perhaps be considered to be one of the first significant milestones in the history of Model Engineer's Workshop, the publication of our 50th edition.

Although overshadowed by the achievement of our companion magazine Model Engineer, which has now been in existence for 100 years, I feel that we can look back with pride and pleasure at the way in which this magazine has developed and become a firm favourite with the owners of home workshops across the world. The words Model Engineer in our own title to some degree disguise the fact that a large proportion, perhaps the majority, of our readers and contributors have established their workshops for reasons other than the pursuit of what we understand to be model engineering. Many of my correspondents refer simply to 'The Workshop Magazine', and seek advice on problems experienced with projects which, in no way, could be classed as models.

The concept arose from an inspired idea from my old and respected collaborator, Stan Bray, who suggested to Argus Specialist Publications that a quarterly journal devoted to the topics of workshop equipment and techniques would find a ready market, and so it proved. Congratulations are due to those advertisers who were prepared to support the launch of this new venture, as none of them could have been certain of its commercial viability. It is interesting to note that the majority of the businesses who took space in the early issues are still supporting us today.

It is a similar story as far as contributors are concerned. Stan's declared intention was to introduce us to new writers on the subject. Looking back, it is pleasing to see that such names as Bob Loader, Pat Twist and Dyson Watkins, among others, are still in contact and producing items of great interest. Unfortunately, a few have passed on and are greatly missed, but their writings serve to remind us of their talents.

The success of the new journal prompted the publishers to increase the frequency to once every two months, so after six issues, Stan decided to hand over to a new editor. As he said, he had already retired more times than he could recall, each time from something different. His successor was Harold Hall, who had a lifetime's experience in the engineering and electronics industry, and who had made many pieces of equipment in his

home workshop. He also lived close to the publisher's offices in Hemel Hempstead, and was ideally placed to take the magazine into the future. Harold was in command from the Autumn of 1991 until the Spring of 1995, and built upon the solid foundations, developing the magazine into the format in which it largely continues today and introducing new authors.

When Harold finally decided that he had done his share as editor, he kindly offered me his support as a regular contributor. I receive a steady stream of messages from readers, saying how helpful his articles are. His recent series A Beginner's Guide to the Lathe has proved to be very popular with newcomers to the hobby, and he has, of course, continued to supply the material for the Data Book, which is gaining in popularity as more topics are included.

Regular readers will also have noticed that Stan still sends us an article from time to time, so the magazine still enjoys the support of the whole editorial team that has guided it since its inception. I feel that there must be a record here of some sort.

We look forward to the future, with the continued support of readers, contributors and advertisers, and of the current publishers, Nexus Media Ltd, who took over the Argus business early in 1995.

Relocation

As it happens, this 50th issue is the last to be produced at the Hemel Hempstead offices. Nexus have decided to concentrate their activities at their headquarters at Swanley in Kent. Modern information technology makes it possible for the various activities involved in the publication of a magazine such as this to be carried out remotely, many of the processes are already carried out at a variety of locations by a number of companies. The main change will be that the majority of the editors of those magazines previously published under the Nexus Special Interests banner will be working from their homes. This will make little difference as far as I am concerned, as I have always operated in this way. It may mean though, that lines of communication will be stretched, and that contact with editors may take a little longer, especially in the near future, until new routines have settled down.

The new address is:-
Nexus Media Ltd., Nexus House, Azalea Drive, Swanley, Kent, BR8 8HU. Tel. 01 322 650070. Fax. 01 322 668776.

This, at present will be the contact point for editorial and advertising matters. Subscriptions will continue to be handled from Tower House, Market Harborough, so to be sure that you are communicating with the service you require, please check the addresses and telephone numbers printed in the panel on the Contents Page.

Change of personnel

A major upheaval of this sort nearly always results in the re-allocation of responsibilities, and so it has proved on

this occasion. A number of new names appear in the 'credits', one of the major changes as far as M.E.W. is concerned being that our designer, Minh Huynh has decided not to re-locate to Swanley, and has moved to pastures new. Minh has looked after our page design for the past couple of years, and it has been a pleasure to work with him. We wish him well in his new venture.

Exhibition news

It has been confirmed that IMS North will again take place at Doncaster Racecourse, this year on 25 & 26 July. The mixture will be much as last year, covering model engineering, aircraft, boats and cars. Entries are invited from clubs and individuals, so that visitors will be able to see that the various branches of our hobby are flourishing in the North of England. If you would like to participate, please contact our Exhibition Co-ordinator, Mike Reynolds during normal office hours.

Planning is now well under way for the next Olympia exhibition, which is scheduled to take place between 29 December and 3 January. The intention is again to concentrate the engineering activities around the area which was set aside for the Model Engineer Centennial Village, with competition and loan sections, demonstration areas and relevant trade stands forming a coherent group. The next exhibition will mark the close of Model Engineer magazine's centenary year, and action has already been taken to re-introduce some of the features that were a traditional part of Model Engineer Exhibitions of the past. I sense a genuine intention to re-invigorate this long established part of the model engineering scene as we head towards the Millennium. Again, if you would like to play a part in this event, please let us know.

The Centennial Celebration Collection

After a somewhat hesitant start, the Centennial Special publications are now beginning to appear more regularly. The Editorial team working on these have apologised for the long delay between Issues 1 and 2, which was brought about by production difficulties entirely beyond their control.

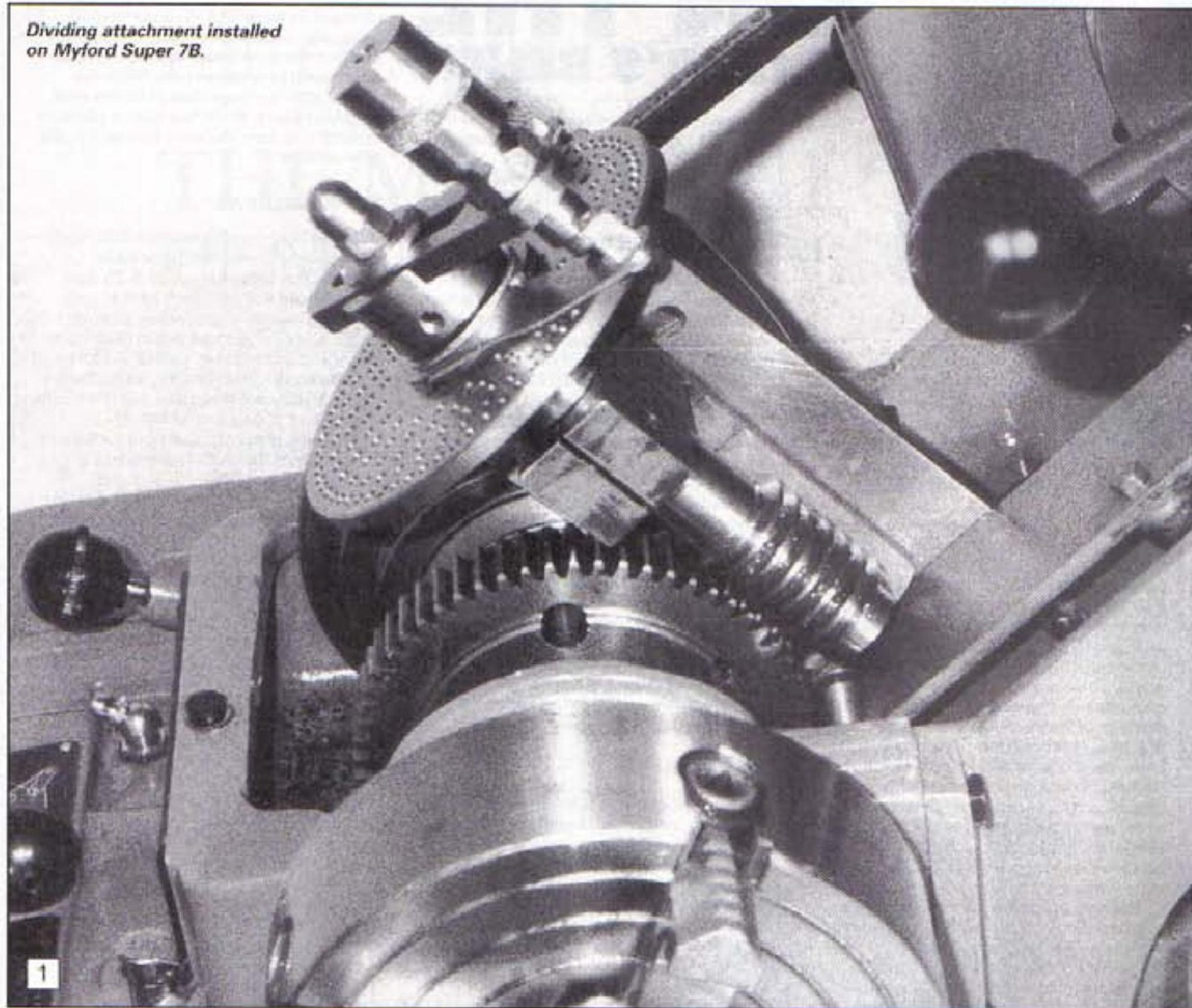
For those who have not previously encountered these interesting journals, they form a collection, each one dealing with the history of one aspect of model engineering, as seen through the pages of one hundred years of Model Engineer magazine. Issue Two is of particular interest to readers of M.E.W. as it reviews Workshop Devices, the selection having been made by contributor Derek Brown.

A price increase

Despite assurances that inflation is being kept to a minimum, production costs still seem to be rising. Accordingly, a decision has been made to apply a small increase to the cover price of M.E.W. This increase has been held to only 5p., the minimum considered possible under the circumstances.



Dividing attachment installed
on Myford Super 7B.



MYFORD SUPER 7B LATHE ENHANCEMENT

Derek Oxley recalls some of the modifications he has made to his example of this popular machine. He also describes a pair of accessories he has made, and suggests a further modification which will facilitate use of the topslide

Modifications

On the recommendation of Myford Ltd., I described and illustrated in earlier editions of *Model Engineer*, seven modifications to a brand new machine and

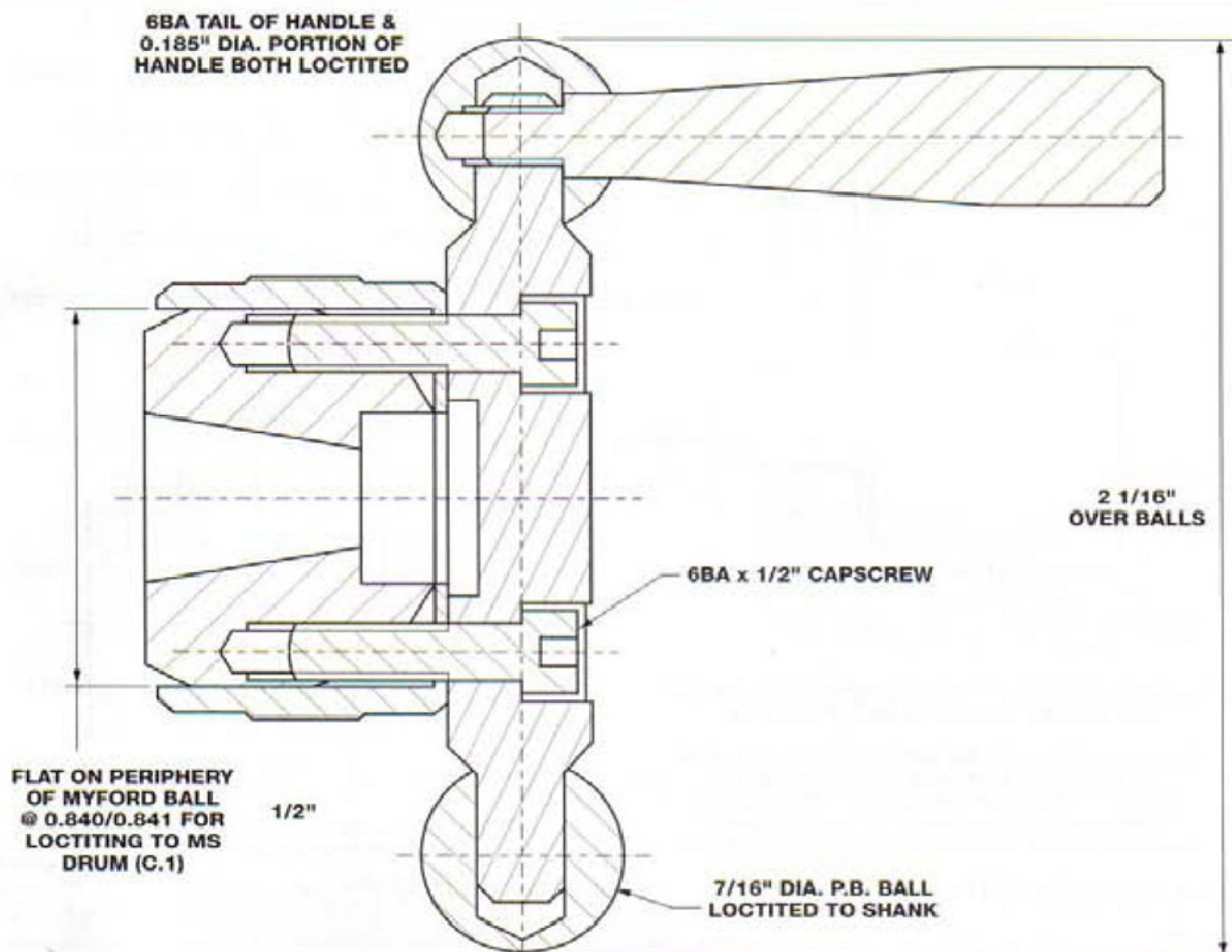
its documentation, for the purpose of enhancing its versatility.

These were:-

1. A folding leadscrew guard, to reduce the risk of the standard A.9196 guard crashing into the gearbox when working

close up to a collet (Ref. 1).

2. Scribing additional fiducial lines on the cross-slide at 30 deg. each side of the maker's original mark, which becomes completely obscured when the topslide is set over for screwcutting and similar



B. MODIFIED HANDLE ASSEMBLY - G.A.

©

operations. I have since scribed further fiducial lines at 90 deg. from the original mark, to combat a problem which arose subsequently (Ref. 1).

3. A revised and corrected lubrication chart for this specific model, replacing the schedule given in the maker's handbook Ref. S723W (Ref. 2).

4. Handled keys, with spanner flats for adjustment of the topslide base locking hex socketed grub screws, and for the cross-slide gib strip adjusting/locking hex socketed grub screws, replacing Allen type hex wrenches (Ref. 2).

5. Replacing the existing dial on the thread dial indicator with a spring loaded resettable one, graduated with 16 divisions, numbered at $\frac{1}{2}$ in. increments 0-4-8-12 (Ref. 3).

6. Fitting an adjustable micrometer scale to the tailstock handwheel, scribed with 150 divisions at 0.002in. increments and numbered in 0.010in. increments, for effecting accurate depth control when drilling from the tailstock. The as-supplied feed rate is rather a fast one at 0.300in. per handwheel revolution from the three start x 10TPI thread (Ref. 4).

7. Fitting an interlock to the leadscrew engagement handle, to prevent simultaneous engagement of the leadscrew and the powered cross-feed (Ref. 5).

I also took up the idea from Don Ainley,

published in *Model Engineer* No.3952 (Sept. 1993) by making and fitting a front shear saddle lock, but I varied the stated or implied dimensions to be compatible with those relevant to my specific machine, and also varied the design so that both halves of the locking pads were free to float in the unlocked mode. At that point I foresaw no need for other modifications to my machine—wrong again!!

Accessories

At the same time as making those modifications, I made two accessories which I deemed to be essential for my purposes, and probably desirable for some other model/experimental engineers, and which are described below:-

1. A headstock mounted, worm geared dividing attachment.

This is illustrated in **Photo 1**, shown in the set-up used for scribing divisions on the aforementioned tailstock micrometer collar. Some details are:-

A worm of 16DP x 20 deg. Pressure Angle, Right Hand, which can be locked into or out of engagement with the 60T bullwheel. The relatively large worm pitch diameter of $\frac{15}{16}$ in. was necessary to get the worm lead angle down to

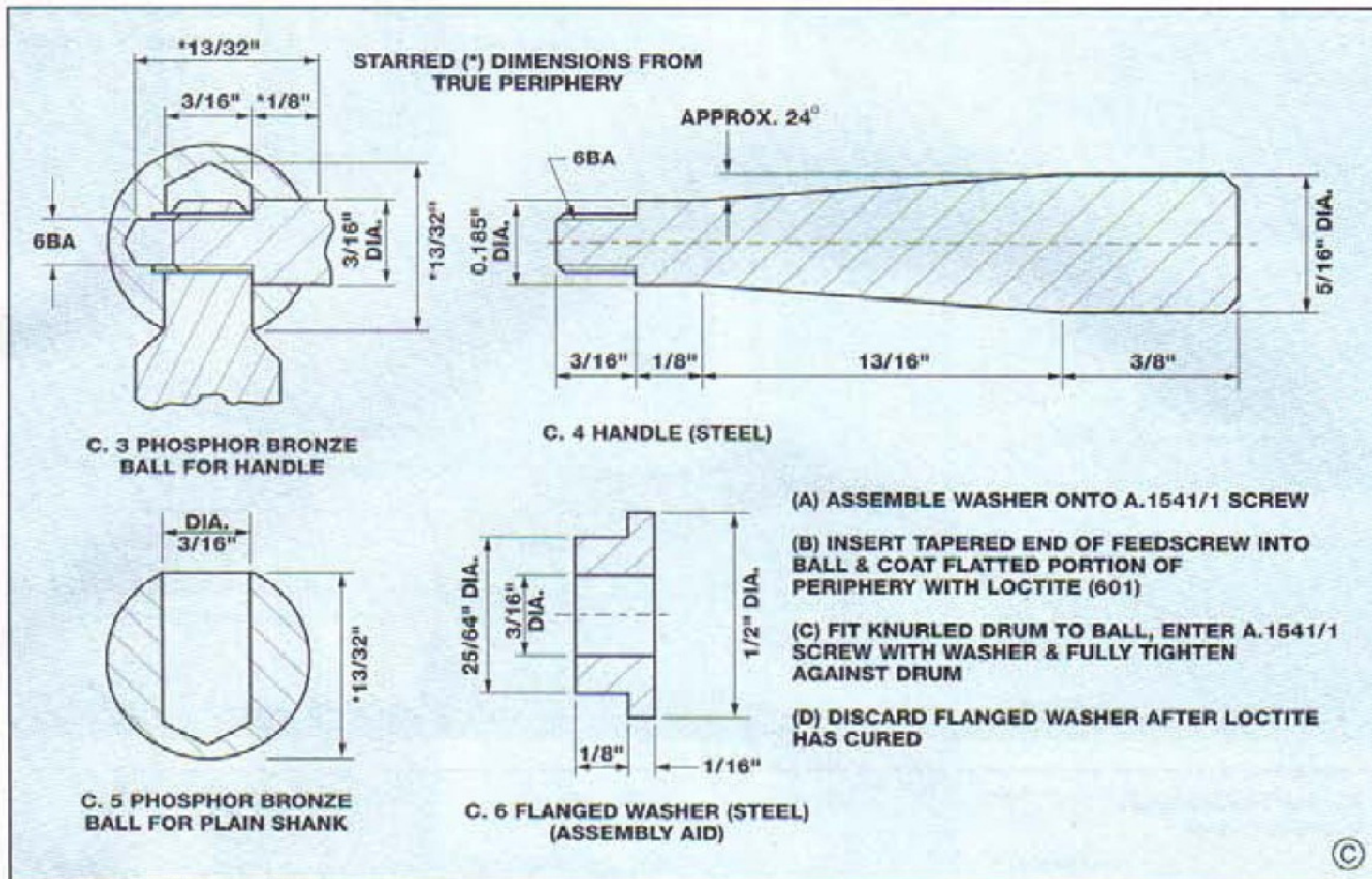
within the preferred range of 3 deg. to 5 deg., and is actually 3 deg. 49 min.

The division plate in use at that time was borrowed from my milling machine's dividing head set, but has now been replaced on a semi-permanent basis with one having just two rows of holes, 60 and 25, giving divisions to any factor of 3600 or 1500.

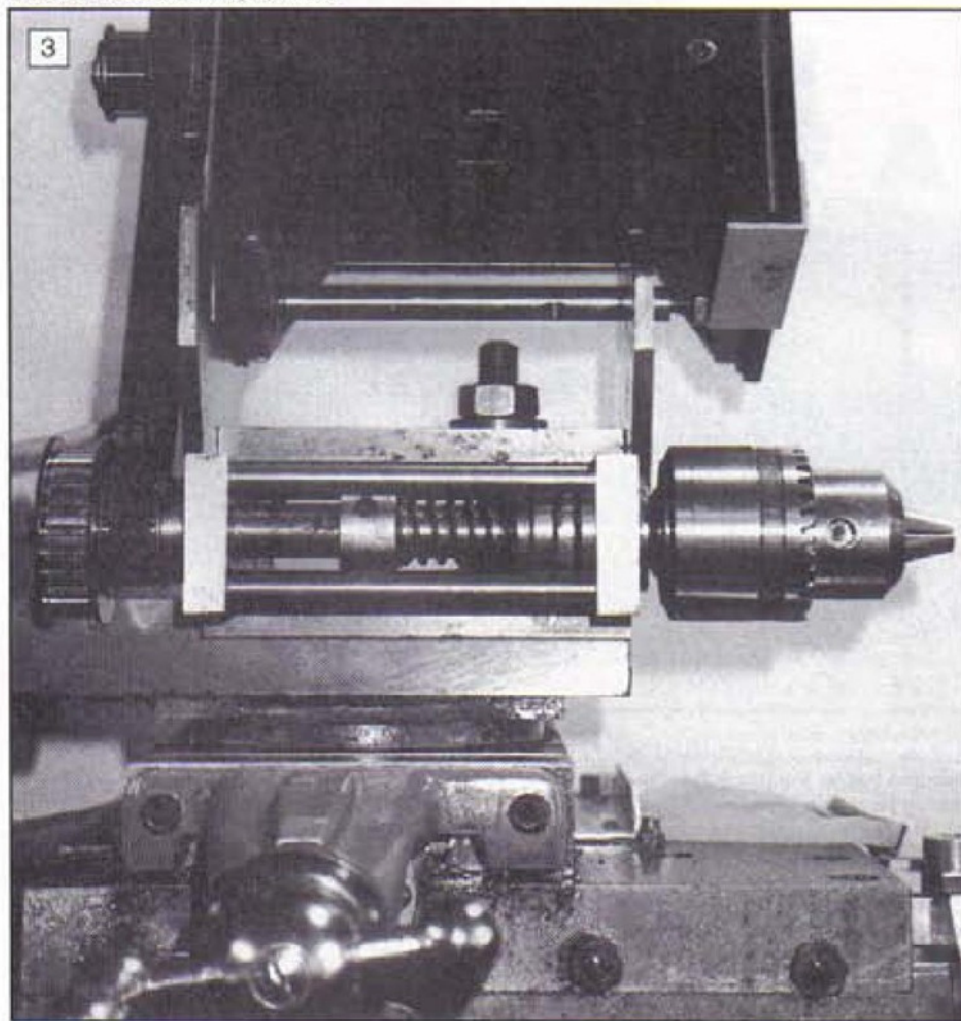
The 40 x 5mm shaped mild steel angle base member is held in a stable position by a three point fixing. This consists of 2 x 2BA hex setscrews into the holes on the countershaft arm casting, originally provided for mounting one of the tension springs locating the belt guard, and one special $\frac{3}{8}$ in. BSF x $\frac{1}{4}$ in. BSF stud entered through the hole for the chuck guard mounting in the headstock casting, and locking against the shaped angle base member.

2. A topslide mounted motorised drilling spindle

Myford Ltd. offer a topslide mounted grinding spindle, but not a drilling spindle, leaving those of us who require such a facility to build our own, based on whatever suitable surplus motor happens to be available at the time. Fortunately, I had two such identical motors to hand (ex-Crew & Co., Cat. Ref. 20/103), and my



Reverse side of drilling spindle.



capacity keyed chuck. The shaft runs in a pair of single row rigid ball bearings, backed up by a spring loaded thrust race to achieve consistency of depthing.

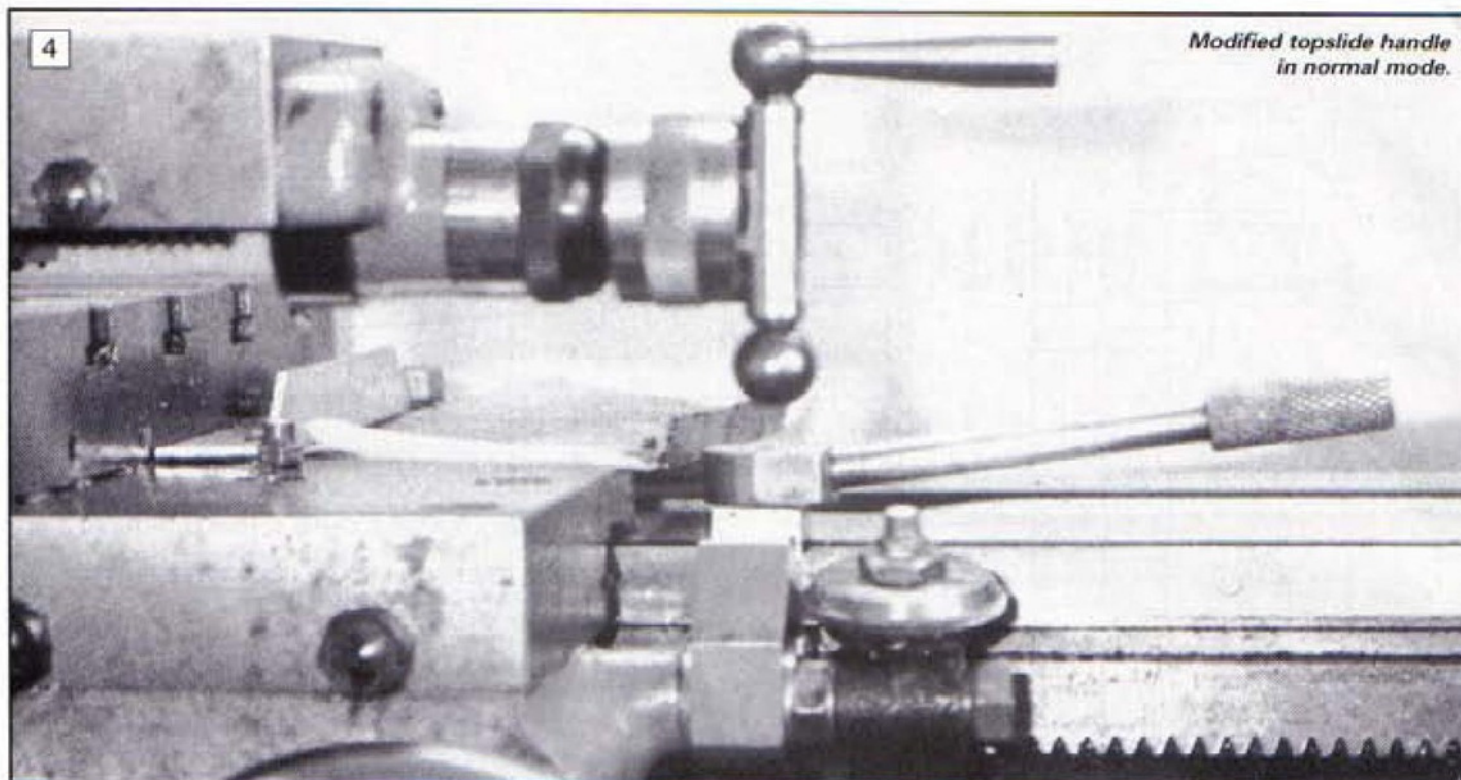
While the majority of jobs only require the spindle to be mounted parallel to the lathe spindle axis, the rotatable base of the topslide enables many other jobs to be tackled. For example, in my manufacture of valved sockets to accept rolled thread necked LPG cartridges to BS.5329:1988 (BS.EN.417) configuration, there is a requirement to drill passage ways at 20 deg. and 35 deg. to datum surfaces. This is achieved more speedily and more accurately than by laboriously setting up in a tilting vice under the vertical mill/drill.

A further lathe modification

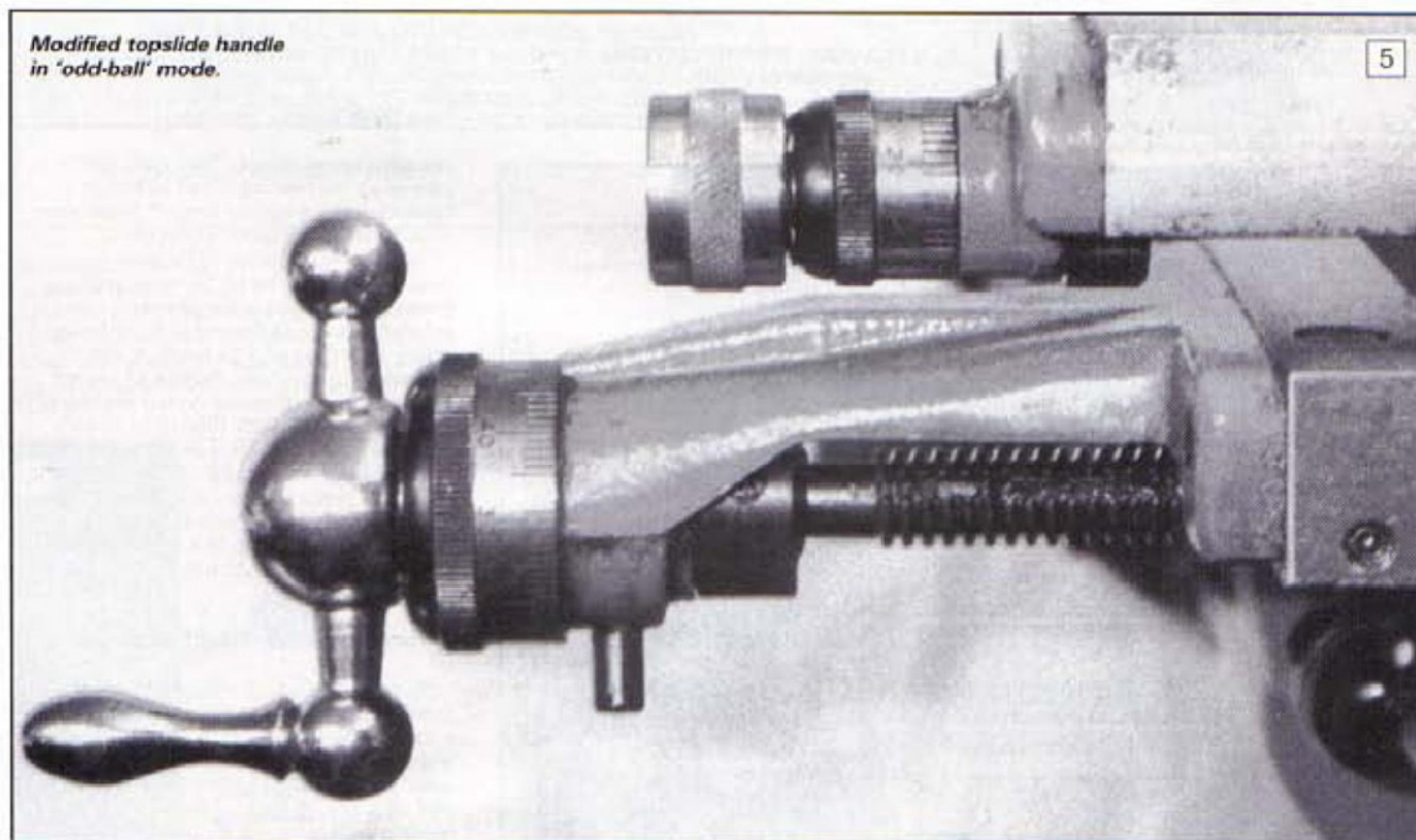
Some time ago, I required to make a small phosphor bronze chamfered disc, conforming to Sketch 'A' - a simple job indeed. However, with the topslide set over from parallel to the lathe axis by 104 deg. (or 76 deg.), I found that its feed screw could not be operated because the A.2093 ball handle fouled the bracket carrying the cross-slide feed screw.

The tapered end of the topslide feed screw was found to be very roughly machined, which may be deliberate, and was, in any case, too short for conventional clocking with an elephant's foot to determine the angle of taper. Modify existing, rather than make new, became the order of the day.

Sketch 'B' shows the general arrangement of the modified handle,



Modified topslide handle
in normal mode.



Modified topslide handle
in 'odd-ball' mode.

and Sketches C.1 to C.6 show the detail of the new parts made. **Photo 4** shows the assembly in normal mode, and **Photo 5** shows it in 'odd-ball' mode, with the bar and handle removed.

After sawing off the two dumpy legs of the original ball, it (with feedscrew attached) was mounted in a $\frac{3}{8}$ in. Myford collet, its periphery cleaned up and a flat formed at 0.840/0.841in. for eventual Loctiting to the steel drum C.I.

In fitting the ball ends to the bar, I found

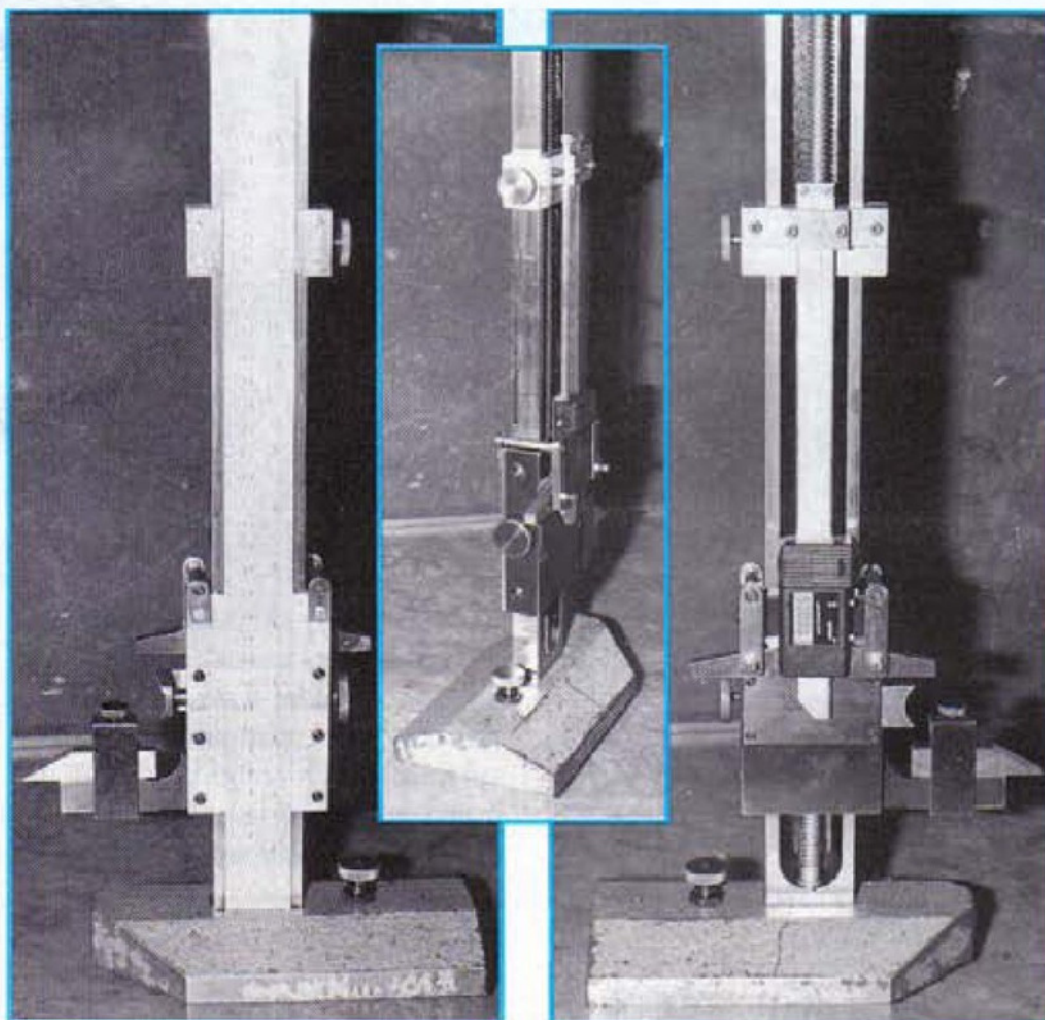
it advantageous to Loctite the intended handled ball to the bar and, after curing, to set the bar up in a dividing head under the vertical mill/drill. The procedure was then to pick up the flat of the bar parallel to table, rotate through 180 deg., pick up the centre line and end of the ball, then set to drill, tap and slot mill, all at one setting. After Loctiting the tapered handle into position, the other ball was Loctited to the plain shank of the bar.

There may be an easier way.



References

1. *M.E.* No. 3956 (Nov. 1993)
2. *M.E.* No. 3958 (Dec. 1993)
3. *M.E.* No. 3960 (Jan. 1994)
4. *M.E.* No. 3962 (Feb. 1994)
5. *M.E.* No. 3964 (Mar. 1994)



A DIGITAL ADAPTATION OF A VERNIER HEIGHT GAUGE

The proliferation of modestly priced digital measuring equipment has encouraged a number of readers to adapt such devices for a variety of purposes. Here, Hubert Peters of Plumstead, South Africa describes the results of one such experiment

In an earlier issue of *M. E. W.*, I read of the use of a digital slide calliper as a height gauge. I tried this adaptation, and although it undoubtedly works, I found the set-up to be somewhat unsteady.

I was recently fortunate enough to purchase a second-hand Vernier height gauge, made by Sanderson Instruments, in the 1960s. This magnificent gauge is very sturdily constructed, and has the advantage of a leadscrew adjustment, actuated by a knob in the base, thus allowing very precise movement. In actual use, however, aged eyes find it difficult to squint at a Vernier, and the creation of a random datum point demands much addition and subtraction.

It struck me that, if the virtues of the splendid height gauge could be combined with the convenience of a digital gauge, I would have the best of both worlds. The digital display would be easy to read, with instant conversion between inches and millimetres. The greatest boon, however, would be the ability to create a zero at any random point, thus avoiding much calculation.

While I was considering this matter, I came upon the advertisement in *M.E.W.*, inserted by G. P. I. Measuring Equipment. Amongst the equipment advertised was an electronic digital depth gauge, at a relatively modest cost. This instrument arrived the day after my phone call.

It was obvious that the bottom end of the shaft of the gauge should be attached to the pillar of the height gauge, and that the cross-bar and measuring head should be attached to the slide. I tried this out with a series of clamps, and found that the idea worked perfectly.

In planning the final method of attachment, I considered the following points:-

1. As both instruments are hardened, and as the electronics of the depth gauge are easily upset, it was not desirable to attempt to drill holes. I therefore designed the clamps as illustrated.

2. I wished to keep the existing Vernier measurements available for use. I therefore decided to attach the digital gauge to the back of the height gauge.

3. As the digital gauge has a 6in. capacity, whereas the height gauge encompasses 21in., it was necessary for the attachment of the shaft of the digital gauge to the pillar to be readily adjustable. I therefore designed a movable slide to hold the tail of the shaft.

The enclosed illustrations clearly show the simple clamps and slide. I have not prepared any drawings (not my forte!) as each application will vary, and I am sure that fellow readers will devise superior methods of attachment.

Application

Using this adapted height gauge is a pleasure! The sturdy construction prevents any shaking, the leadscrew adjustment provides a precise setting, the chisel blade scribes a splendid line, the numbers are easy to read, and zero is instantly available at any point. I checked the Vernier side of the gauge against the digital read-out, and was surprised at the slightly inaccurate result of the Vernier setting, even when using a glass to check the adjustment!

I commend this adaptation to all readers fortunate enough to own similar Vernier height gauges.

Removal of swarf

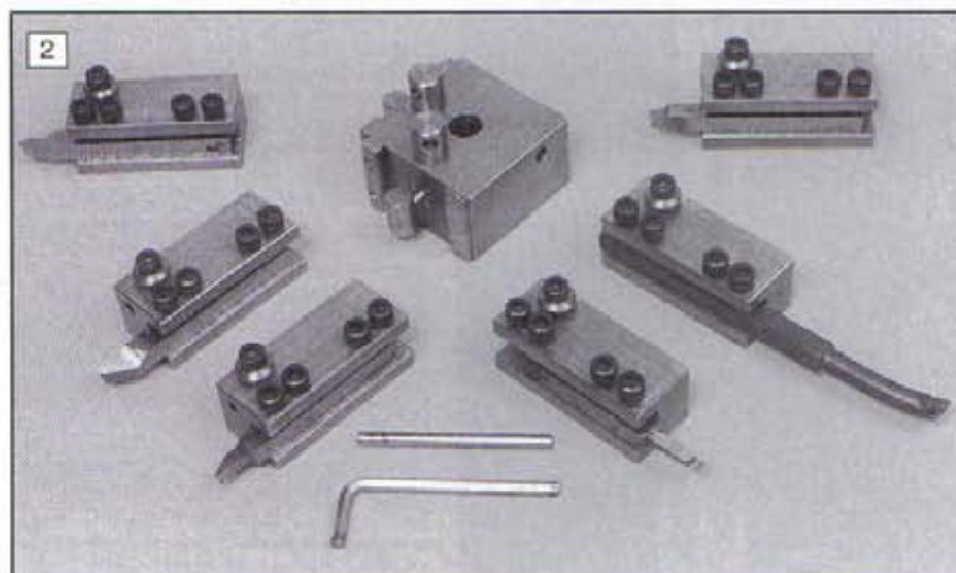
I crave the Editor's indulgence for another brief comment. Of all the most hateful chores which beset our hobby (and there are a few) I rate the removal of swarf from machine tools at the top of my list! A magnet does help with ferrous metals, but the sharp cuttings of brass are really difficult to remove.

The recent purchase of a new household vacuum cleaner, replete with bells and whistles, made our old workhorse, a 'wet-and-dry' tank type machine redundant. This was banished to the workshop, and one day I applied it to the swarf on the milling machine—and hey presto! the swarf vanished—untouched by human hands! The use of the small round brush at the end of the tube is recommended.

This type of vacuum cleaner is ideal, as the swarf never has contact with the working parts. They are readily available for a few pounds at car boot sales. Buy one now and your chore will disappear!



A QUICK CHANGE TOOL HOLDER SYSTEM FOR THE LATHE

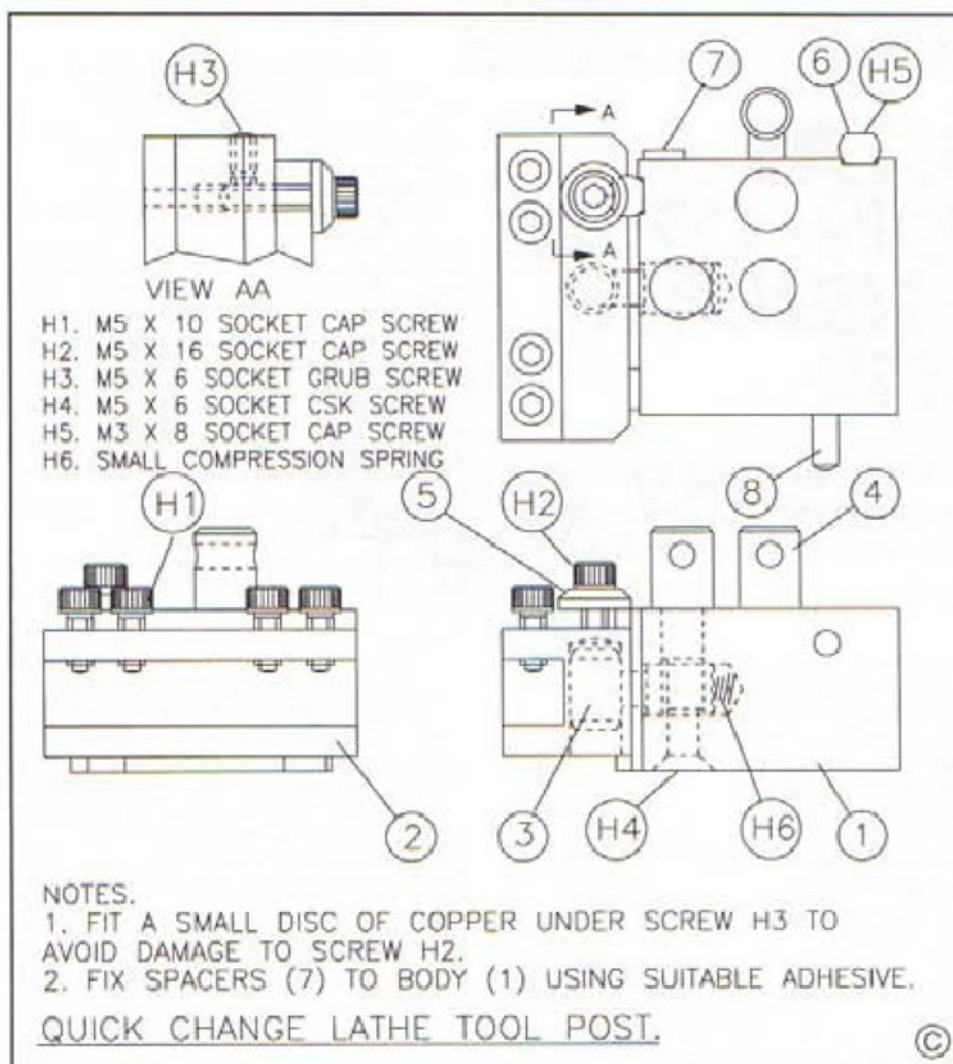


The complete system with six holders. More would be preferable.



The toolholder system in use.

Harold Hall studied the design of commercial quick change lathe tool holder systems and decided that a simplified version, which could be made in the home workshop, would provide a comparable performance

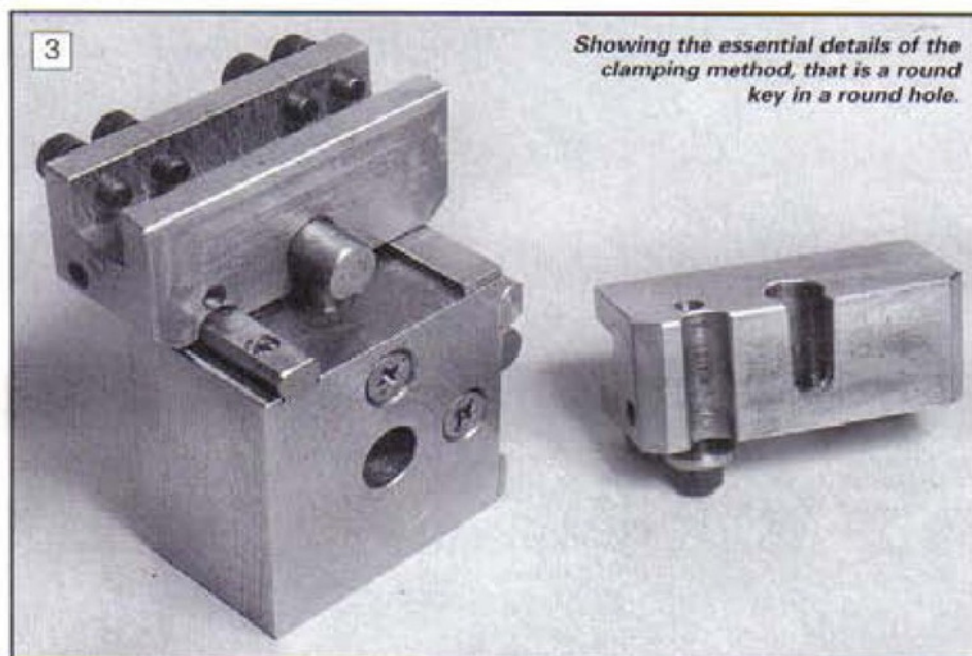


It was decided that a good workshop exercise would be to make a quick change tool post for the lathe which would provide the benefits of those available commercially, but, as is my way, I questioned whether or not the design principles most commonly used were the ones I wanted to employ.

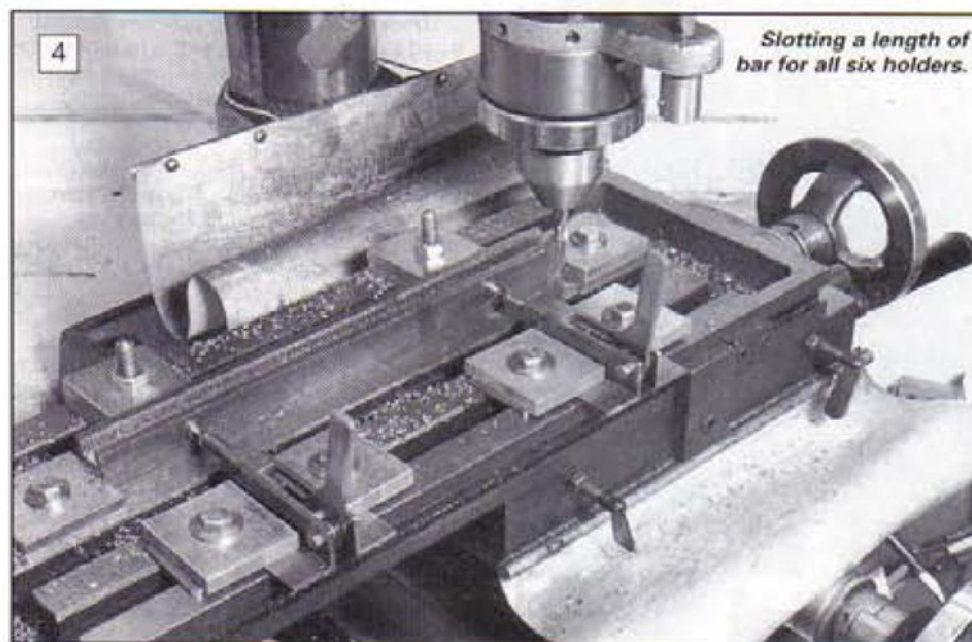
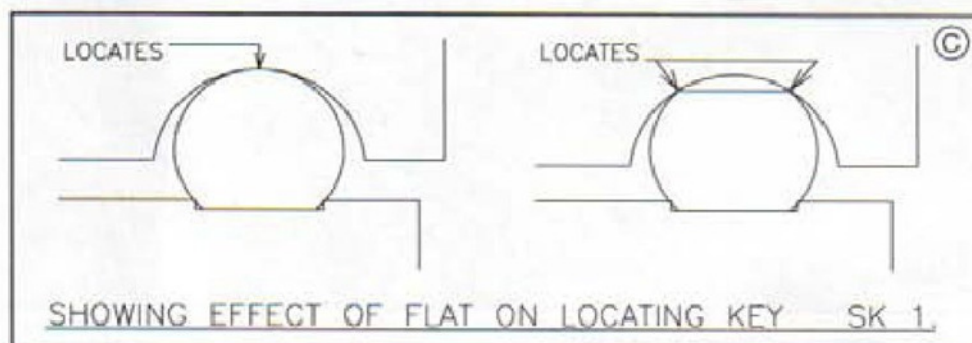
The commercial items are very capable of performing the task required, that is rapid and accurate interchange of lathe tools, because if not, their popularity would not as great as it is, especially considering their high cost. As they perform so well, changing the basic design for reasons of performance was not therefore a consideration. However there was always the possibility of a design to better serve my requirements. They require a considerable amount of machining, especially milling, a time consuming activity in the home workshop. My thoughts were therefore channelled toward a design that was quicker to make, the result is the design published here. It considerably reduces the amount of milling required as, except for the slot in the tool holder (Item 2) and a few very light milling operations elsewhere, the remainder of the machining is drilling and turning. The finished result can be seen in use (Photo 1), and the complete set, Body and Tool holders (Photo 2).

The design

The main feature of the design compared to the commercial items, is the use of a half round key to locate the tool holder, rather than dovetail slides. The key, having a much greater length to width ratio compared with the wider spaced



Showing the essential details of the clamping method, that is a round key in a round hole.



Slotting a length of bar for all six holders.

dovetails, will give a more accurate location, although I suspect this is more a theoretical than practical improvement.

If the key diameter were to be made slightly larger than the slot diameter, the two parts would attempt to lock together, making it more difficult to remove one holder in order to fit another. Ideally therefore, the key and slot must be of the same size, but realising the need for designing in tolerance to manufacturing

errors, a flat is placed on the top of the semi circular key. This ensures that location is exact, even if the diameter of the slot is slightly larger than that of the key. The effect is shown, much exaggerated, in **Sk.1**.

Now, I am sure that some are already questioning my statement on limited milling. How is the half round slot to be produced, if not with a ball ended milling cutter? Well, two tool holders are firmly

clamped back to back and a hole drilled on the join line. Another aspect of other designs which requires some time-consuming milling is the tee slots required for tool holder clamping. These, in my design, are replaced with a round hole and a round key, requiring mainly easier drilling and turning operations. The two features can be seen in **Photo 3**.

Whilst all the machining required falls into the simple category, and precision to a given dimension is not called for, consistency around the areas that make up the tool holder clamping mechanism is essential. Therefore I will cover this in detail, where appropriate.

Because of the need for consistency, the set-ups adopted for machining the parts are of considerable importance, and are largely responsible for achieving this. It is desirable therefore, that all toolholders are made at the first setting. Making further holders at a later date will be more difficult, though by no means impossible.

In making the parts, I aimed for mating items to be a close sliding fit, typically the 10mm dia. Operating piece (Item 31) which fits into a 10mm dia. hole (C) in the Body (Item 1), and this worked well. However, a small amount of additional clearance in a number of places could reduce the need for consistency just a little.

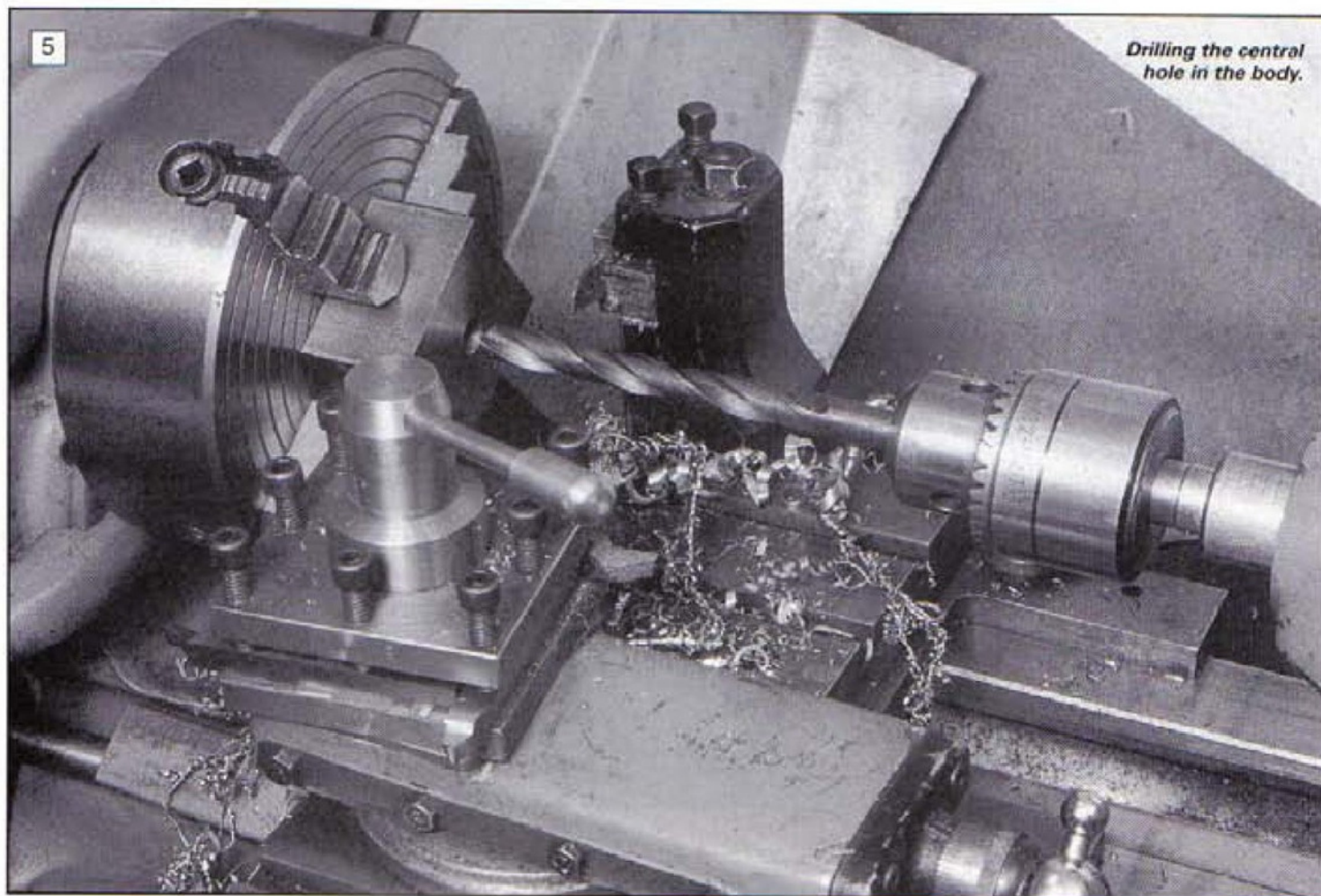
Manufacture

In many cases, manufacture of parts progresses together, rather than one part at a time. Because of this, detailing the manufacture of each part separately is not practical.

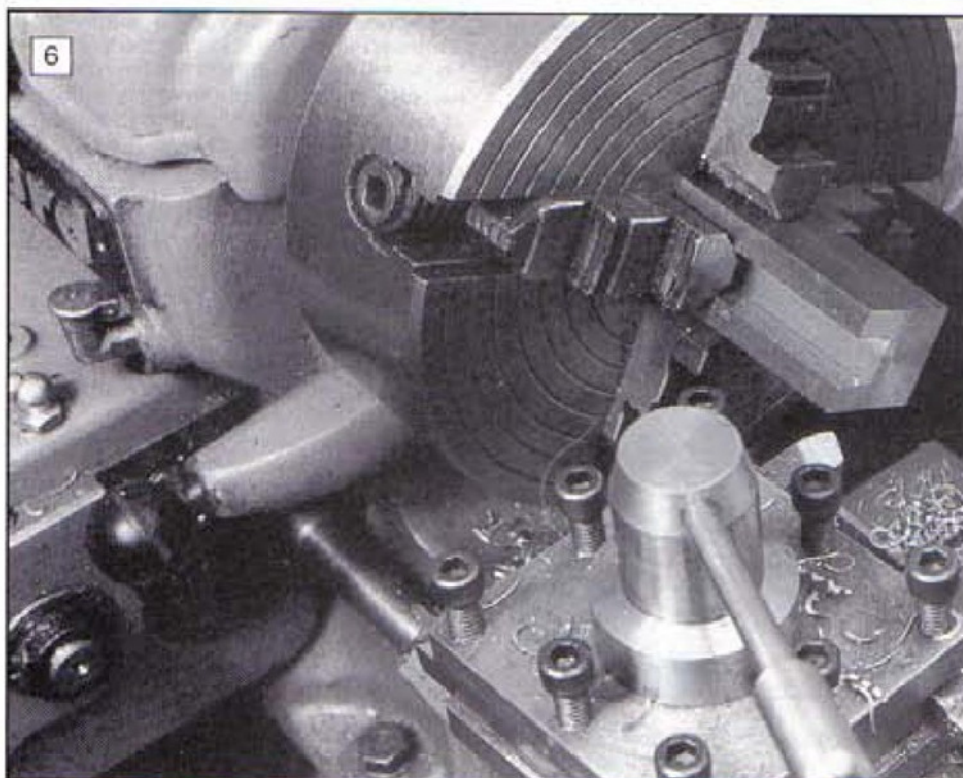
My first task was to slot a length of 25mm square mild steel for the six tool holders (I would already advise making more), completing all the heavy milling at the start. I chose this method rather than slotting individual pieces, as I considered it would be quicker. **Photo 4** shows the set-up, using toggle clamps.

While having used the toggle clamps on numerous occasions, it was now that the extent of their clamping force became apparent. Initially I clamped a second length of 25mm square to the milling table, using two overhead clamps with packing pieces on their outer ends, to be used as a fixed jaw. With a DTI, the bar was set to run parallel to the machine table travel. I soon found that the toggle clamps created sufficient force to move this fixed jaw and, due to the toggle action, the clamping force reduced as the fixed jaw moved away. The set-up was therefore quite impracticable. The 25 mm square fixed jaw was replaced by two separate fixed jaws which were clamped directly to the table with a through-hole fixing. These were able to withstand the clamping force and machining went ahead without further problem.

While I was slotting the bar for the tool holders, a piece of 50mm square mild steel from which I would make the body was being cut off on the universal band saw. How did we manage without these workhorses? Nowadays we probably, now suffer as a result of the loss of physical effort. The body was placed in the four jaw and faced and drilled for the central fixing stud, as seen



Drilling the central hole in the body.



Facing the ends of the toolholders.

in **Photo 5**. During this time, the saw was making short work of cutting off the tool holders from the already slotted bar.

The six tool holders were now ready to be finished to length on the lathe, as shown in **Photo 6**. With the holders

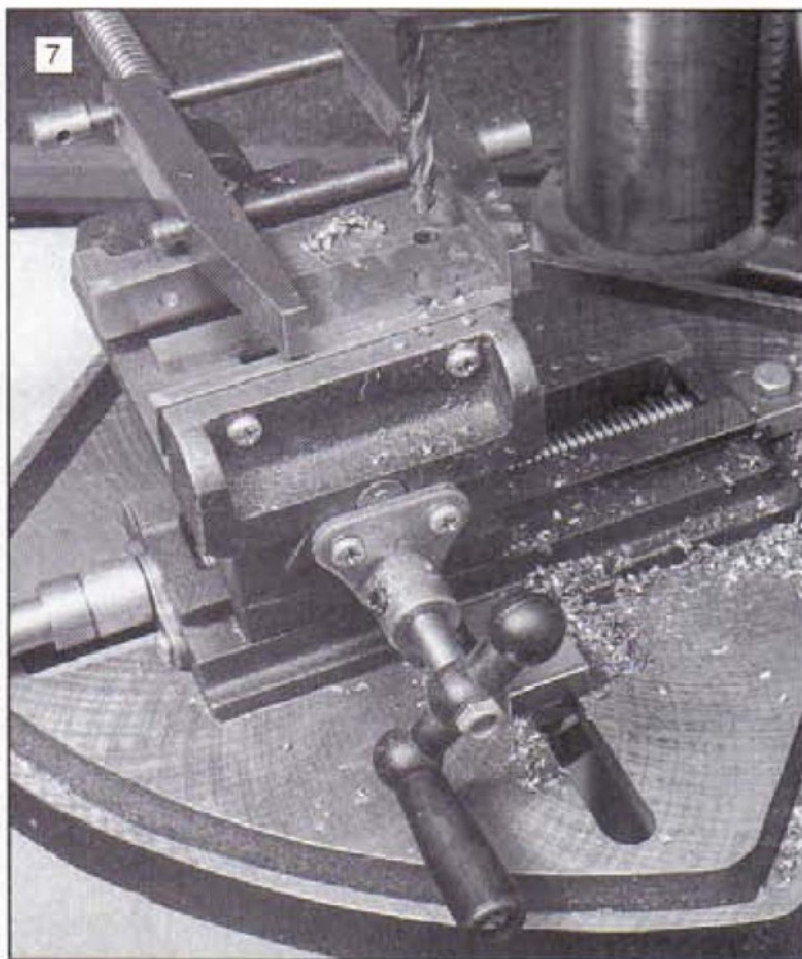
placed against the chuck face, a final facing cut on all six holders was made, using the cross slide, but without moving the saddle or the top slide, thus ensuring that all six parts were of the same length,

Machining the half round slots

The next stage was to produce the half round slots on the back of the tool holders by drilling them in pairs. As can be seen in **Photo 7**, this was done on the drilling machine. In retrospect, using the milling machine with its accurately calibrated leadscrew and more accurate construction, would have been marginally preferable. This would have avoided the need to centre punch on the joint line, in order to position the hole. The hole was started, after centre punching, with a centre drill and finished with an 8mm diameter drill. It was essential to have sufficient height between chuck and workpiece for the 8mm drill when using the centre drill, as moving the head after centre drilling would lose register. It was preferable that the hole was reasonably central to the join. As will be realised later any error, within reasonable limits, would be compensated for by the machining method.

The distance of the hole from the end of the holder is not critical, neither is the diameter, provided that a flat is made on the locating key, as mentioned previously. A drilled hole can though, turn out to be slightly larger at the start end, for a number of reasons, which may cause the holder to rock a little rather than to locate precisely. Typically, this will happen if a drill is not running true, when it may remove a little more from the side of the hole as it is retracted and returned when clearing the swarf in the flutes. Provided that care is taken, this should not be a problem, but do check the first pair drilled.

If an 8mm reamer is available, it would



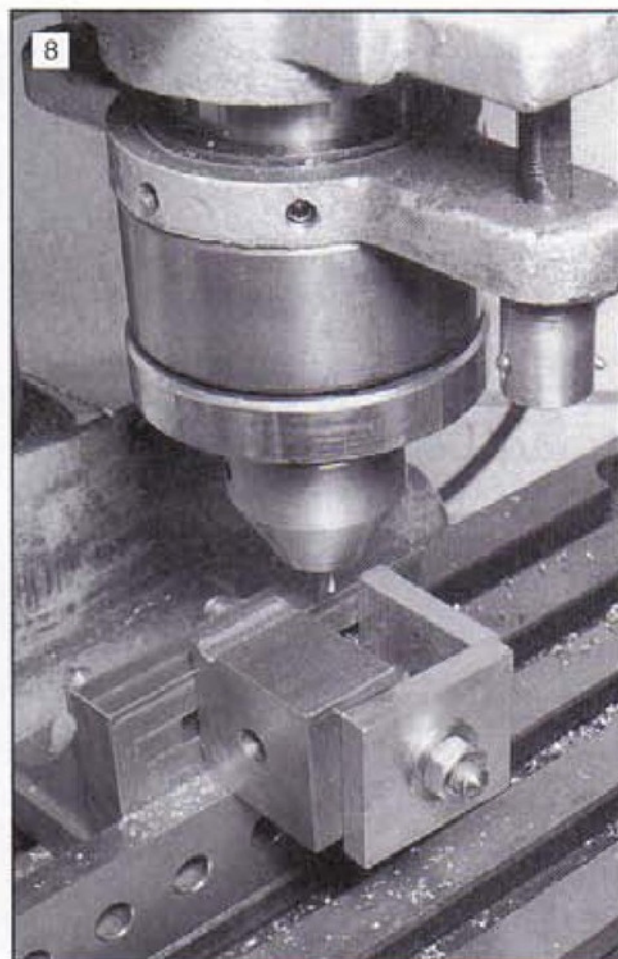
Drilling two holders at the same time to produce the half round slots/

be worth using, though it is by no means essential. Some workers may even prefer to mount the holders in pairs in the four jaw chuck and to drill and bore the hole to size, accepting that this will take a little longer.

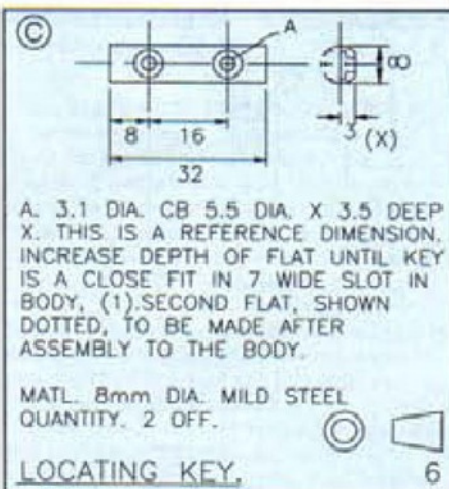
The effect of the rotating drill is to attempt to move one holder in one direction and the second holder in the other. This was prevented by using the toolmaker's clamp as shown in the photo, though if the vice is well tightened, this need not be a problem.

The more critical dimensions

Now we come to the more complex procedures. An angle plate was fixed to the milling machine table and accurately aligned with the table travel. The two 7mm wide slots were then machined as can be seen in **Photo 8**. Using the same index numbers ensured that width and position relative to the edge were the same for both slots, and that depth of slots were also the same. I would advise that the slot be made adjacent to the clamp, rather than adjacent to the angle plate as shown in the photograph. This would ensure that all machining is done whilst registering on the same faces of the body, though if, as in the case of the prototype, the material is accurately square, there is no problem. Had the body not been truly square, then a problem would have resulted, as will become obvious as the process is explained.



Milling the slot for the locating key.



The Locating keys (Item 6) were now made and the flat on the under side milled. Having a second milling machine made it possible to leave the angle plate on one machine table for later operations, using a vice on the second machine. With only one machine available, it will be necessary to clamp the key to the face of the angle plate so as to complete the machining. The amount removed was increased little by little, until the key just fitted in to the slot in the body without sideways movement, ensuring that the key would not move while locating the tool holders.

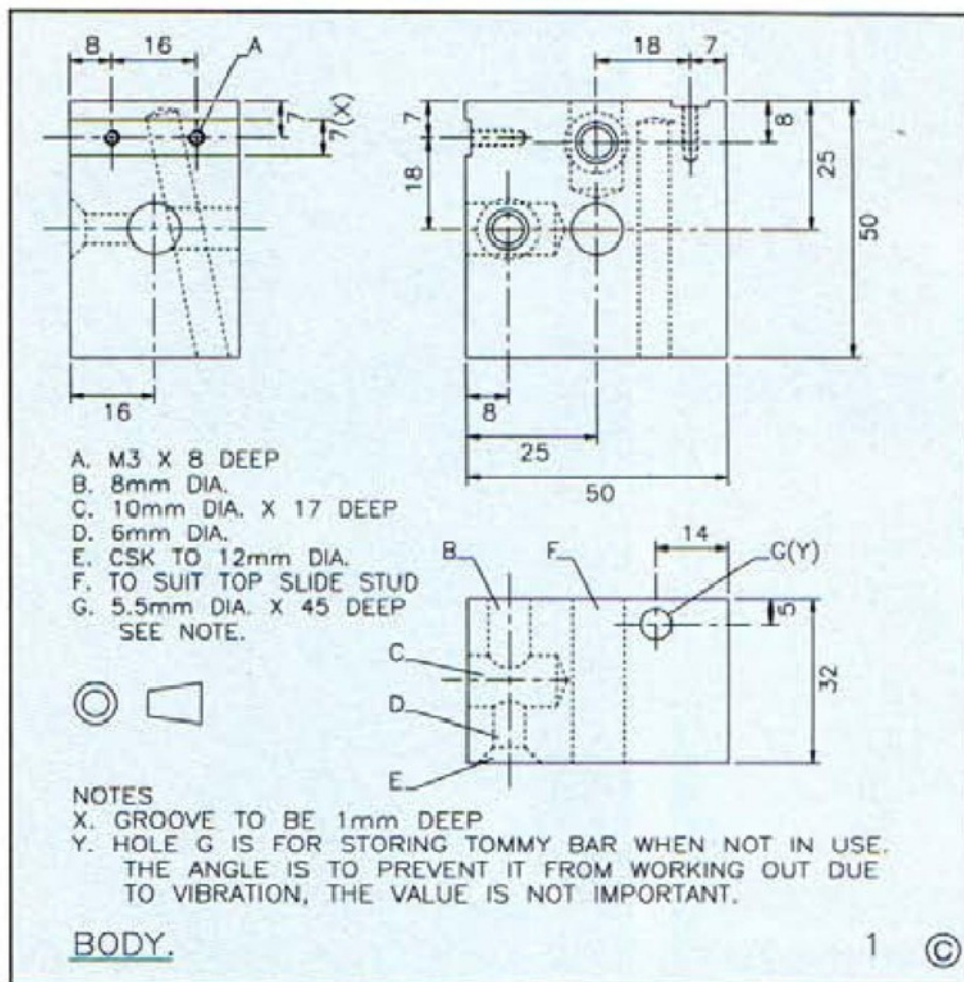
The keys were then drilled and counterbored for the fixing screws and used as a template for marking out the position of the fixing holes in the body. The keys were made a little on the long

side and fitted to project very slightly above the top face of the body, being finished flush after fitting. The reason for this will be explained later.

With the keys fitted, the body was returned to the milling machine, exactly as shown in **Photo 8** and the flat on the top side of each key milled.

The next stages are all crucial in ensuring that important parts on the body and tool holder align and that the clamping mechanism adequately clamps all the toolholders, without any being either loose or tight. For the first requirement, the 18mm dimensions on the body and tool holder must be held, and for the clamping mechanism, typically, the 7mm dimension for hole C must be consistent on all holders.

The face of the angle plate was located using an edge finder (wiggler) and from this, the table wound back to give the 18mm dimension between key and hole, consistency between parts being more important than the precise dimension. The table back-to-front movement was locked in position and maintained for the remainder of these operations. Prior to doing this it was essential to ensure that sufficient room between chuck and workpiece was available for the longest drill to be used in the sequence. If not, and the head had to be raised, the consistency required would have been lost. The angle plate must not be moved either during the following operations. However, if you observe closely, you will see that the angle plate slots run left



was then removed and rotated to bring the base into the face position and, while held against the bar, re-clamped to the table, thus returning it precisely to the same plane, maintaining the 18mm dimension.

Body (1) hole C

Now to return to the operation shown in **Photo 9**, that is the drilling of the two holes C in the body. With two holes to be drilled, it was essential that, when rotated for the second hole, the body took up the same position in all three axes. The angle plate looked after one, the parallels the second, but for the third, some form of stop was required to position the body along the length of the table. Just visible, for this purpose, is a thick washer placed onto the clamp stud and secured with a nut. Therefore, the body registered on the angle plate, the parallels and the washer. After drilling the first hole, the body was positioned exactly for drilling the second, using the same locations.

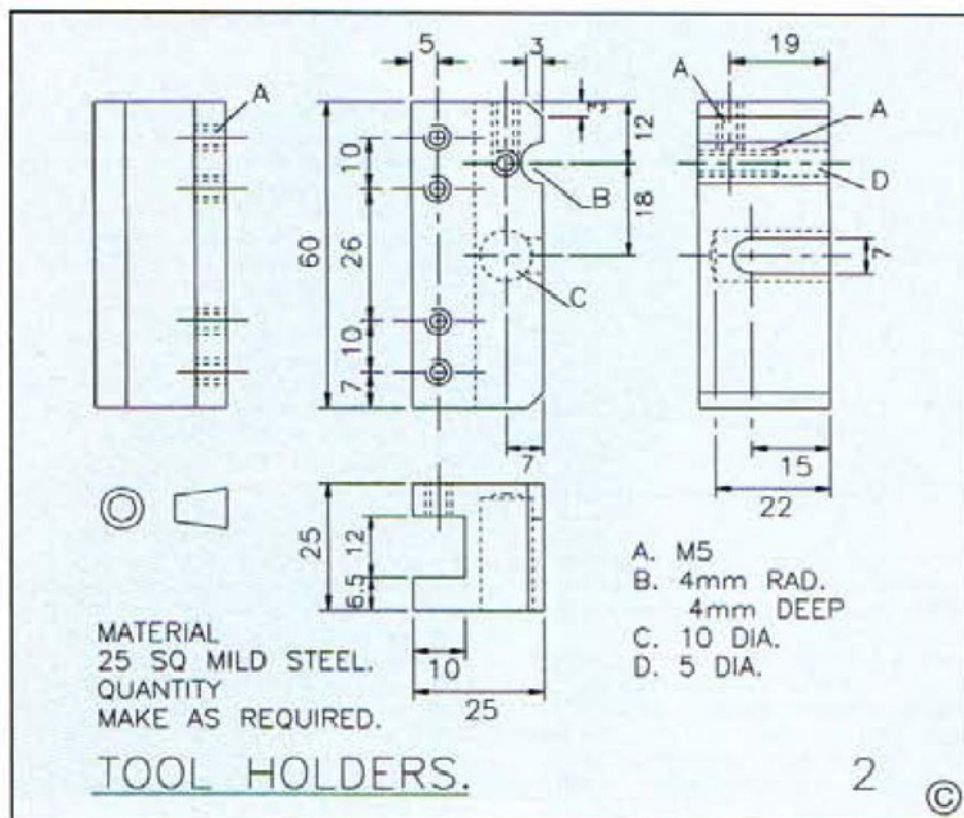
The edge finder was used to locate the bottom face of the body and the table traverse used to establish the 16mm dimension. A centre drill was used first, followed by a 10mm drill. The process of using a centre drill was employed to position all holes in the sequence described below.

Body (1) holes B and D

The body was next rotated in order to drill holes B and D, again using the angle plate, parallels and washer to position it. Not having moved either the table or the angle plate, the hole was exactly in line with hole C. The edge finder was again used to locate the side of the body and the traverse used to arrive at the 8mm dimension. After centre drilling (**Photo 10**), it was drilled 8mm dia, through into the 10mm hole, and further to produce a dimple in the base of the hole. This was used to locate the 6mm drill for hole D. The body was then rotated and the second set of holes drilled at the same settings. The countersink (E) was produced on the drilling machine, as was the storage hole (G) for the tommy bar.

Spacer (Item 7)

The spacer was made from 2mm thick material and fixed to the body on a temporary basis, using thin film double sided adhesive. It provides a parallel gap between toolholder and body when the toolholder is located on the key. The thickness of the key may be reduced or increased to achieve this. It is not essential but it looks better if the parts are parallel. My intention is eventually to fix the key using a two part resin adhesive, but the double sided adhesive tape worked so well that I must admit to not having done so yet. Those who are unhappy with the use of adhesives could fix the spacer using countersunk screws.

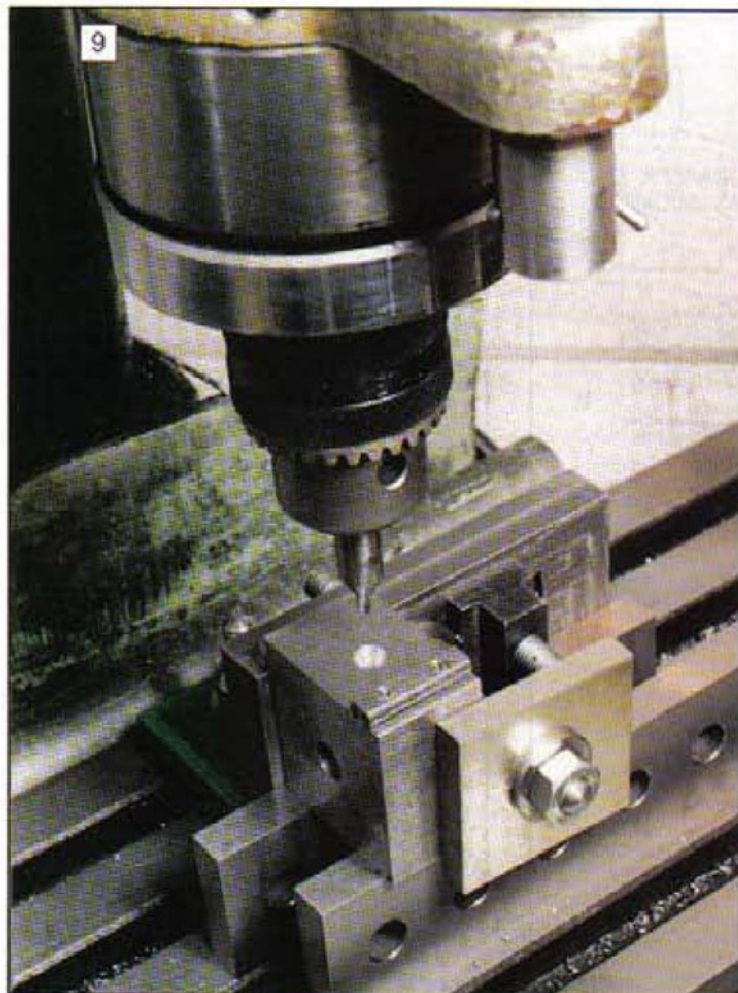


to right in **Photos 8, 9 & 10**, and top to bottom in **Photo 11**, showing that, in fact, the angle plate had been removed and refitted. This was done to make the clamping set up in **Photo 11** possible, a clear case of not planning sufficiently ahead.

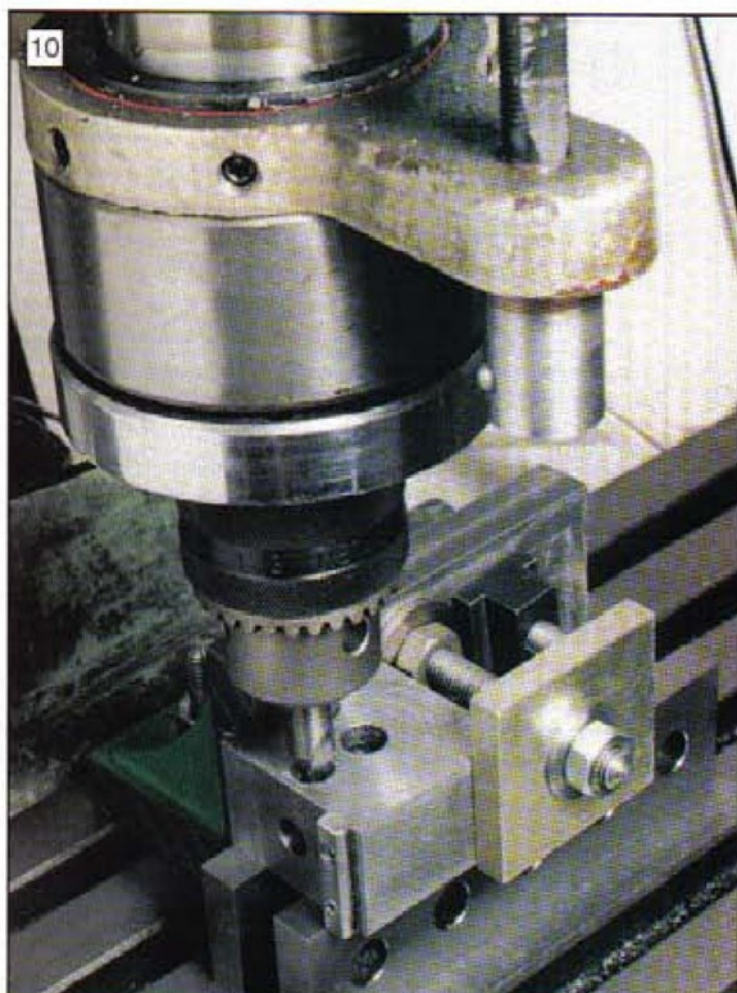
The following approach was adopted to return the angle plate precisely. With the parallels removed and the table and angle plate thoroughly cleaned, a bar was positioned against the face of the angle plate and clamped to the table. The angle plate

Toolholders (Item 2) hole C

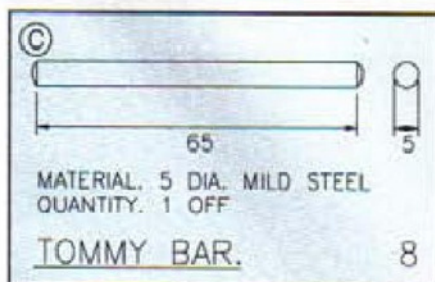
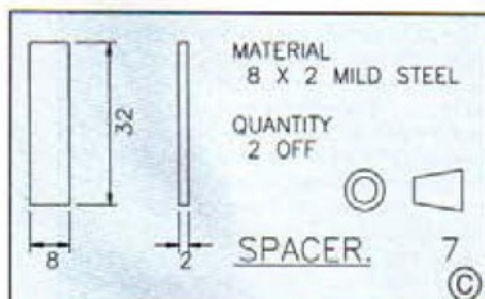
The body was next clamped to the angle plate, as shown in **Photo 11**, not to be machined, but to act as a carrier for the toolholders whilst drilling hole C. I had



Drilling the body (i)



Drilling the body (ii)



intended to use my largest toolmaker's clamp to fix the holder to the body, but it turned out to be too small, hence the last minute requirement to change the angle plate to allow the clamp bar to pass through one of the slots.

The method worked well, though a third hand would have been useful. To make the process easier, double sided adhesive tape was used between the body and the packing piece and between the packing piece and the rear clamp bar. This held

them in place, leaving two hands free to position and clamp the toolholder itself. With the toolholder locating off the key and not having moved the table or the angle plate, alignment of the holes in the body and in the toolholder was assured. Drilling was again achieved, first using a centre drill and then a 10mm diameter drill. By this method, the distance between hole C in the holder and hole B in the body will be maintained, even if the depth of the half round slots varies from one holder to another.

Very little comment is needed regarding the remainder of the work on the toolholder, other than to say that, having marked out and drilled the four holes for the tool bit clamping screws in one holder, it was then used as a drilling jig for the remainder. This avoided the need to mark out the holes on all six holders.

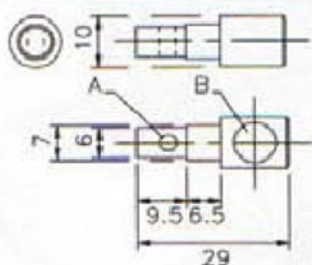
Clamp assembly (Item 3)

This assembly was mainly a simple turning and drilling exercise. Operating piece (Item 31) was turned, but the holes not drilled at this stage. Clamp piece (Item 32) was turned, complete with chamfers and through hole, followed by adding the flat and drilling hole A. It was necessary to ensure that the hole was central across the diameter for, if offset, it would not align with the hole C in the toolholder when assembled to the operating piece. It was then assembled on to the operating piece and the two lightly riveted together. This



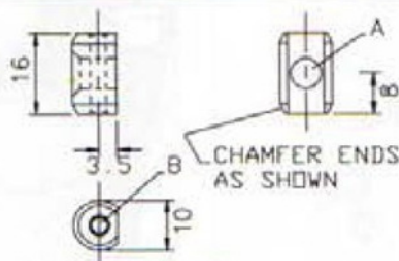
Using the body to carry the toolholder for drilling the clamping hole. Note that the operations in Photos 8 to 11 have been carried out without moving the table in the back to front direction. This ensures that the 18mm dimension is maintained for all parts.

was not to provide long term strength, but to hold the parts together whilst drilling through for fitting the Rivet (Item 33). The two sides (Y) were then filed flat to provide clearance in the slots in the toolholders.



A. 3mm DIA.
B. 8mm DIA.
POSITION HOLES A AND B
FROM MATING PARTS.
MATL. 10mm DIA. MILD STEEL
QUANTITY 2 OFF.

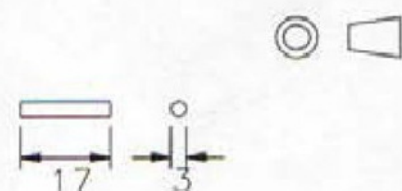
OPERATING PIECE. 31



A. 6mm DIAMETER
SLIGHTLY CSK OUTER END.
B. 3mm DIAMETER
SLIGHTLY CSK BOTH ENDS.

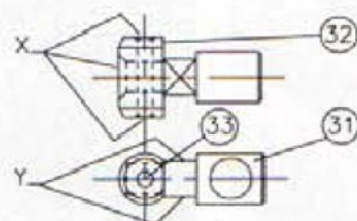
MATL. 10mm DIA MILD STEEL
QUANTITY 2 OFF.

CLAMP PIECE. 32



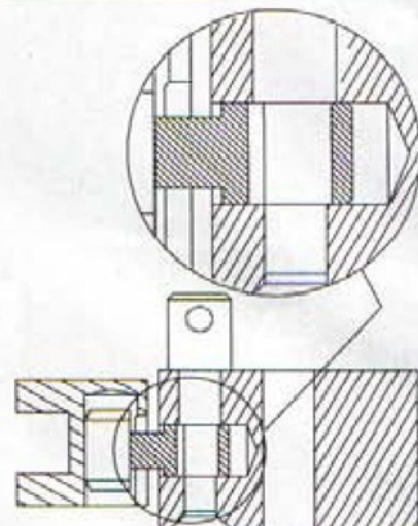
MATL. 3mm DIA. MILD STEEL
QUANTITY 2 OFF.

RIVET. 33



X. RIVET AND FINISH FLUSH
WITH A FINE FILE.
Y. FILE FLAT ON EITHER SIDE TO
INCREASE CLEARANCE IN SLOT

CLAMP ASSEMBLY. 3



NOTE HOW, IN THE CLAMPED POSITION,
THE HOLE IN THE OPERATING PIECE
(31) DOES NOT ALIGN WITH THAT IN
THE BODY (1). THIS MUST BE TAKEN
ACCOUNT OF WHEN USING THE BODY
AS A DRILLING JIG FOR DRILLING
THE OPERATING PIECE. SEE TEXT.

CLAMP ASSEMBLY SK2.

(C)

Despite the efforts aimed at achieving consistency, it was considered best practice to keep each clamp assembly for use in the same position in the body. To facilitate this, body and clamps were lightly centre punched with one mark for one and two marks for the other position. It will also be best if the clamp assembly is used the same way up, so the marking should be located in a position which will assist in achieving this.

Operating piece (Item 31) hole B

Hole B was drilled using the body as a drilling jig. However, the operation is not quite as straightforward as may first be considered, as due to the dimensions of the clamping cam on the locking spindle (Item 4), hole B in Item 31 and hole B in Item 1 do not align when in their clamped position. This is illustrated in **Sk.2**. The following procedure was therefore necessary.

The clamp assembly (Item 3) was assembled with the body (Item 1) and a toolholder (Item 2) and, while held together, the dimension between the flat on the clamp piece (Item 32) and the body (Item 1) measured. Due to limited access, this was done using the shanks of drills as gauges. Packing of a thickness 0.5mm less than the dimension arrived at above was then placed between both flats on the clamp piece and the body. The parts were next clamped together, Item 32 was checked to ensure that it was upright, using a square on the surface plate, as can be seen in **Photo 12**. When correct, the assembly was transferred to

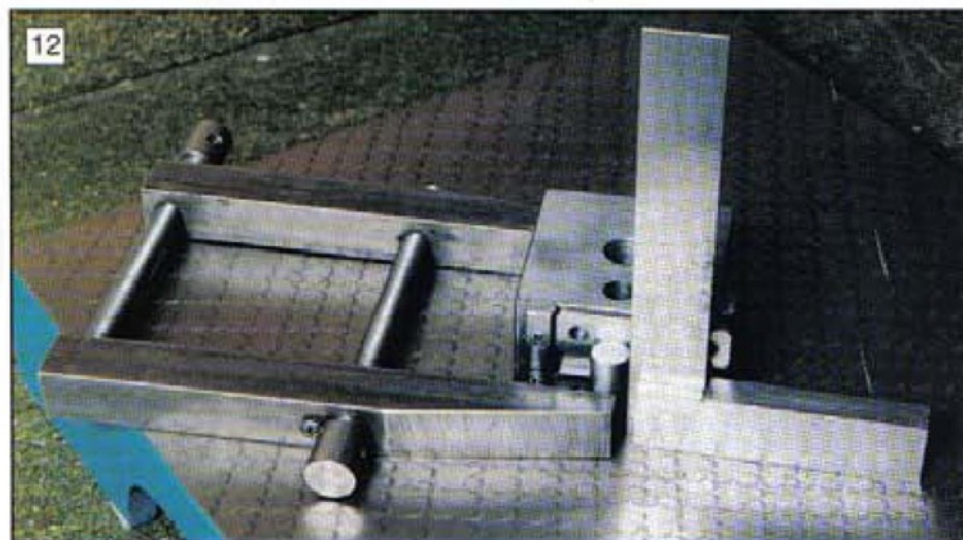
the drilling machine and the hole drilled (**Photo 13**). The second clamp assembly was then drilled while assembled in the second position.

Locking Spindle (Item 4)

Next came the part that would prove whether all my attempts at consistent manufacture were going to pay off, this being the locking spindle. It was a fairly straightforward turning operation, first producing the 8mm dia and then the 6mm dia, the 8mm dia being turned 21mm long. Again it was considered worthwhile to

allocate each spindle to its own position, so these were also marked with one and two centre punch marks. Before turning the offset diameter, the hole for the tommy bar was drilled.

The spindle was returned to the four jaw chuck and set to run off centre, so as to produce the offset cam. It was adjusted to produce a total indicator reading of 0.5mm (0.25mm offset) and the 10mm long portion turned to 7.5mm diameter. It was then assembled with a clamping piece and toolholder to check the clamping action. If the quoted dimensions have been achieved, it should not yet have been adequate. The spindle was returned to the lathe for the 7.5mm diameter to be reduced a little, then the parts re-assembled and the clamping action re-tested. This process was repeated until a satisfactory action resulted.



Ensuring that the key is upright prior to drilling the hole B in Item 31.

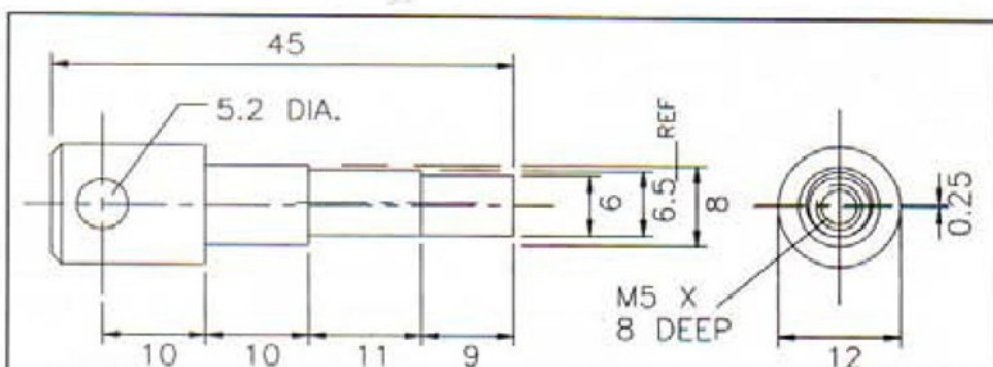
Note that, when returning the spindle for further machining of the cam, the latter had to be set to run true, so as to maintain the offset dimension.

Some further comments

A short compression spring (Item H6) is fitted behind the operating piece, so that the clamp assembly automatically moves out when the clamping pressure is released. This makes fitting another holder much easier.

When turning the offset cam on the locking spindle, check its operation with all toolholders made, making it initially correct for that holder which permits the cam the greatest rotation. I would advise that, even having found the holder which allows the clamping spindle the most travel, you initially err on the side of caution. You can always take a little more off later, if in the light of experience it is considered worthwhile. For very small adjustments, the operating face of the cam can be lowered a little by the use of a fine file, as there is no need for it to be truly circular.

Having arranged things so that the locking spindle will correctly lock the loosest holder, if any of the other holders do not allow the locking spindle to rotate sufficiently, a very small amount can be taken off that face which contacts the spacer (Item 7). This will allow the holder to rest a little closer to the body, and will permit the locking



NOTES.

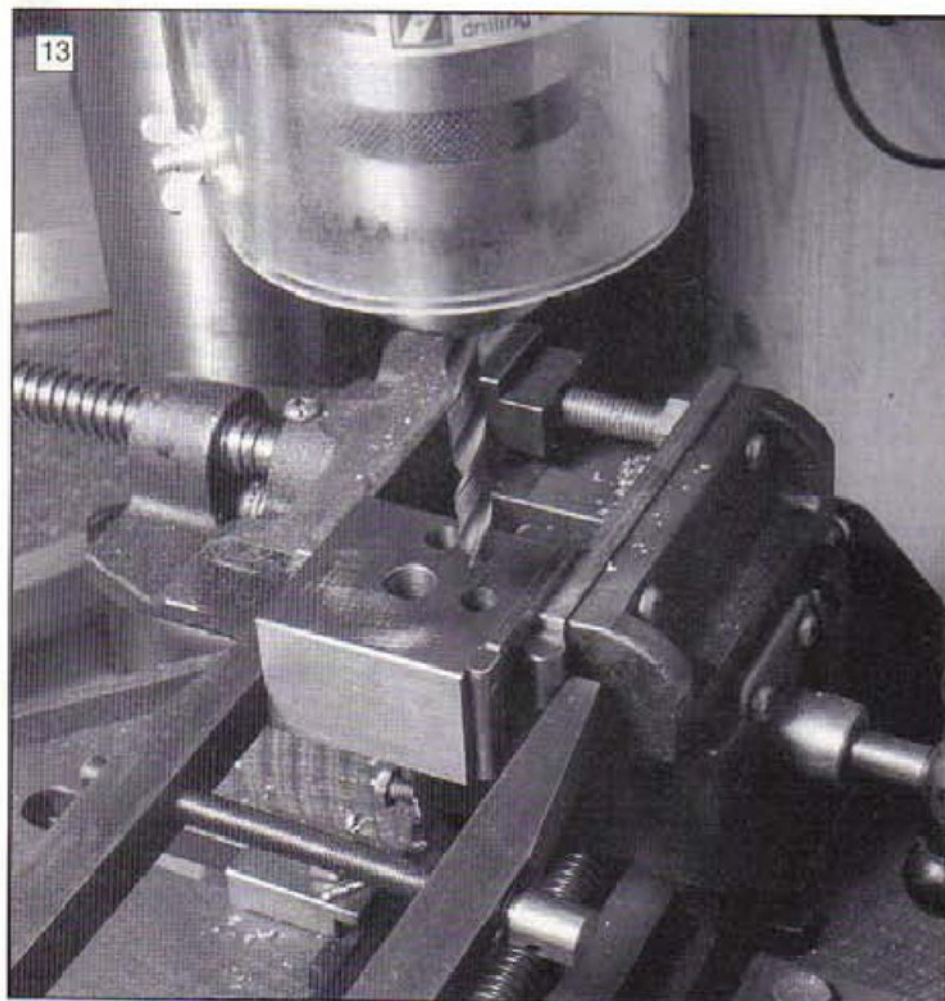
1. FIRST TURN 6mm DIAMETER x 9mm LONG AND 8mm DIAMETER 21mm LONG. OFFSET IN FOUR JAW CHUCK BY 0.25mm (0.5mm TOTAL INDICATOR READING) AND TURN THE OFFSET DIAMETER. THE 6.5mm DIAMETER QUOTED IS FOR REFERENCE PURPOSES ONLY. INITIALLY TURN TO 7.5 mm DIAMETER, REDUCING IT IN STAGES UNTIL A SATISFACTORY CLAMPING ACTION IS ACHIEVED.
2. ON FINAL ASSEMBLY, REDUCE THE 9mm LENGTH UNTIL THE M5 CSK SCREW, WHEN TIGHT, PERMITS THE SPINDLE TO ROTATE WITHOUT EXCESSIVE END PLAY.

MATERIAL. 12 DIA MILD STEEL
QUANTITY. 2 OFF.



LOCKING SPINDLE.

4



Drilling hole B in Item 31.

spindle to rotate a little further. If, on the other hand, you remove too much from the cam, thus allowing the spindle to rotate a little to far, the spacer can be made a little thicker to compensate.

It would be less than honest of me to give the impression that the six that I made all worked perfectly. Five did, but the sixth allowed the cam to rotate what I considered to be just too far, although clamping was still adequate. I chose to make this one operate in the same manner as the other five. This could have been achieved by adding a shim to the holder, using adhesive, in the area of the spacer, but I chose to mill away the half round slot and to replace it with a smaller piece of metal incorporating another half round slot. The thickness of this piece was gradually reduced until the clamping action was identical to that of the other five. The additional piece was then fixed in place using adhesive, and machining it flush with the faces of the toolholder made the addition virtually undetectable. In retrospect, I realise that I was unduly fussy, and it would have worked adequately as originally made. It serves to indicate that there are ways of avoiding the scrapping of a rogue tool holder.

The clamping action with the 0.25mm offset has proved to be very easy, requiring little torque to lock the toolholder. Making the offset greater, say 0.3mm or maybe even 0.35mm, would require greater operating torque, but the system would be more tolerant of manufacturing variations. The locking spindle is a quick and easy part to make and uses very little material. Readers making the toolholder system may like to experiment to find the best degree of cam offset.

When fitting the locking spindle, the length of the 6mm dia. end was gradually reduced until the spindle rotated freely, but without end play when the countersunk screw was fully tight.

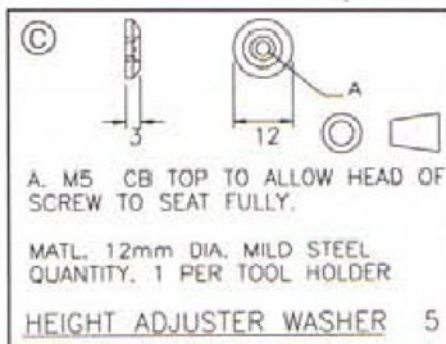
I did not attempt to case harden the operating piece and locking spindle, as the amount of use the system will get in my workshop is not likely to be that great. Readers who do a lot of turning, with frequent tool changes, could case harden the two parts if so desired.

A small plug of copper was placed under the grub screw H3 to prevent it damaging screw H2. It is necessary only to make the screw H2 stiff to turn and does not need to be fully locked. For this reason it is only necessary to adjust screw H3 infrequently.

For any reader not familiar with this type of tool holder, it is easy to assume that the position on the body that is at right angles to the lathe axis is for the more usual tools, and that the parallel position is for boring tools. However, it can be used rather like a four way tool post, but with only two tools fitted. Because of this, any tool holder, complete with tool, can be used in either position, and for this reason, as mentioned earlier, both keys (Item 6) have to be the same height, because the height adjuster washer (Item 5) rests on the keys and not on the body itself.

Making further toolholders

I mentioned at the beginning of the article, it is preferable to make as many toolholders as will be required in one go. After experiencing the major benefits of this type of holder, some builders may decide that



further holders are desirable. The following procedure should make this possible.

The only crucial aspect is the precise positioning of the hole C relative to the half round slot and the face that sits on the spacer (Item 7). All other operations can proceed as previously described.

Mount the body, upside down, on the milling machine table using a single fixing through the central hole. Surprisingly, there is no need to accurately align it in any way. It will be necessary to remove the two clamping mechanisms. Now turn a plug of mild steel to be a close shake-free fit in hole C of an existing holder. Make it long enough to project from the holder by say 20mm. Using a toolmaker's or other clamp, clamp this existing holder to the body with the key engaged in the half round slot. Using a dial test indicator, align the milling machine spindle with the projecting portion of the plug by adjusting the table using both leadscrews, until the indicator reads the same all the way round the plug. The machine spindle is now perfectly in line with hole C in the existing holder. New holders can now be

clamped to the body and hole C drilled as before. This will replicate the dimensions of the initial holders and should therefore fit correctly.

Final comment

The finished result was beyond my expectations and very gratifying. I wish that I had made a record of the time taken to make the system, but did not. Even so, I worked on the project for five, maybe six days, spending just a few hours each day, and am sure that this was much less than if I had attempted to use dovetails and tee slots as the locating and clamping method. Readers with the benefit of this article should do even better.

Postscript

Having made the holders and written the article, I read with interest in *Model Engineer*, No. 4039, reference to a design for a quick change toolholder published in that magazine during December 1970. This also employed half round keys as the method of locating the holder, albeit two per holder. Not possessing *Model Engineer* for that period, but having in the past had access to earlier issues, I wondered if just possibly, I had been influenced by the article.

Now, having looked up the article, I am confident that I had not seen it before, and that we have both come up with the same idea, not that uncommon a situation. The design did still require tee slots for clamping the holders, so that proposed in this article is still the quicker to produce.



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Tel. Derek on 01243 863082 (Bognor Regis) Daytime, Monday to Saturday.

● Maintenance/instruction manual for Tom Senior milling machine. Can copy or will reimburse cost of copying. Any information would be much appreciated.

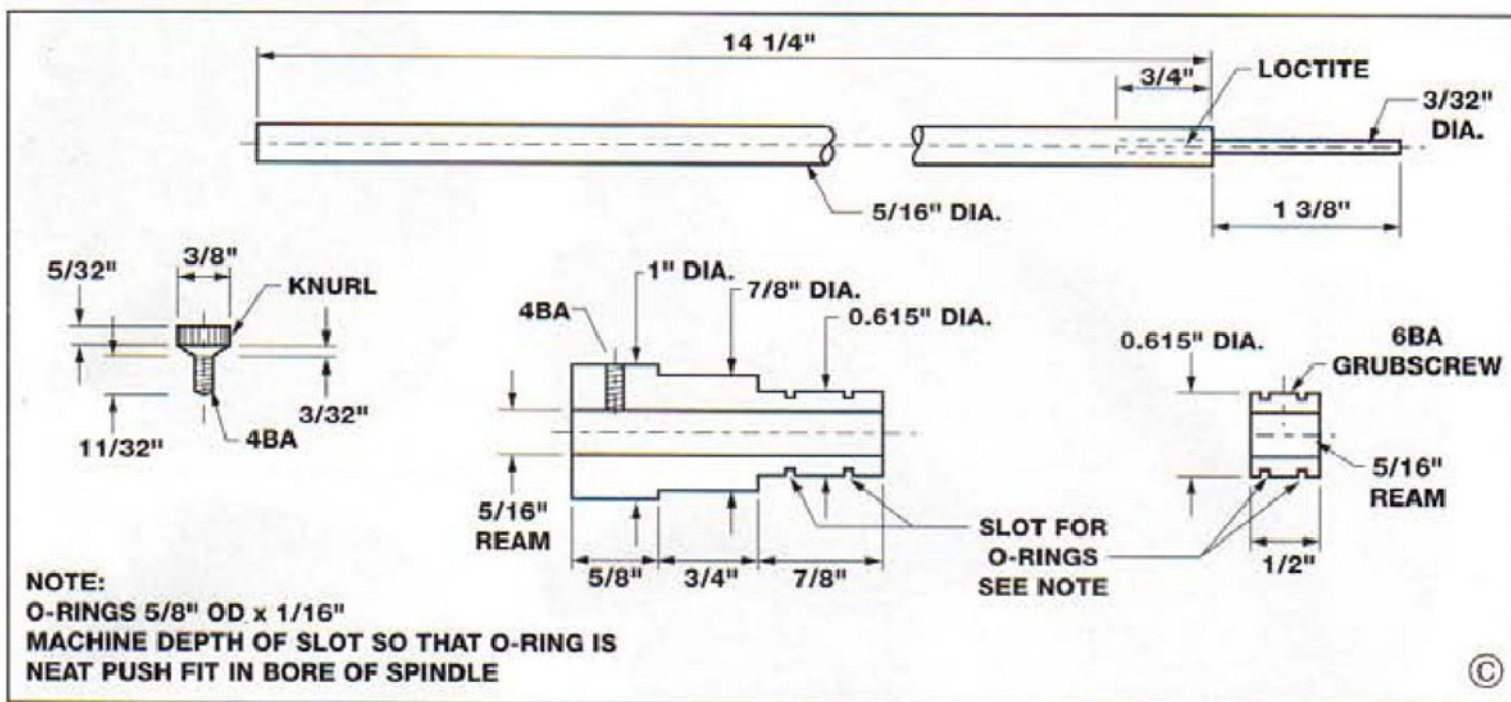
Tel. Peter Stallard on 01708 341216 (Essex)

● Building instructions for 3 5/16in. screw cutting centre lathe designed by J. A. Murrell, Nexus Plans Service reference MM203.

D. Lambert, 33 Holme Lacy Road, Hereford HR2 6DD Tel. 01432 354960

● I am trying to find a source of half round mild steel, approximately 3/4in. across the flat. I can find no supplier in the London area, and would be quite prepared to venture further afield.

Mike Lambert, 2 Ashfield Road, London W3 7JJ Tel. 0181 743 7243



The completed depth stop, this one was made for a Myford Super 7 but there is no reason why the design should not be made applicable to any other lathe with a hollow mandrel.

A Lathe Spindle Depth Stop

Some time ago, I was working on a project which required a large quantity of small diameter silver steel rods, which all had to be machined to a specific length. The rods were to be used for a catwalk round an engine, hence the large quantity involved. It was necessary to fit both ends of the rods into retaining bars suitably drilled with blind holes in order to hold them in place, so there was a need for accuracy of length. This called for some form of a device that could be used on the lathe as a depth stop.

I gave the matter some thought and came up with a simple solution—an adjustable depth stop that could be fitted down the inside of the lathe spindle. My only requirement was that it had to be simple—easy to fit and to adjust. The device as it turned out worked extremely well, so much so that I have subsequently used it on several occasions for other jobs.

I use a Myford Super 7 lathe, so I have dimensioned the parts accordingly, but there is no reason why the principle of the

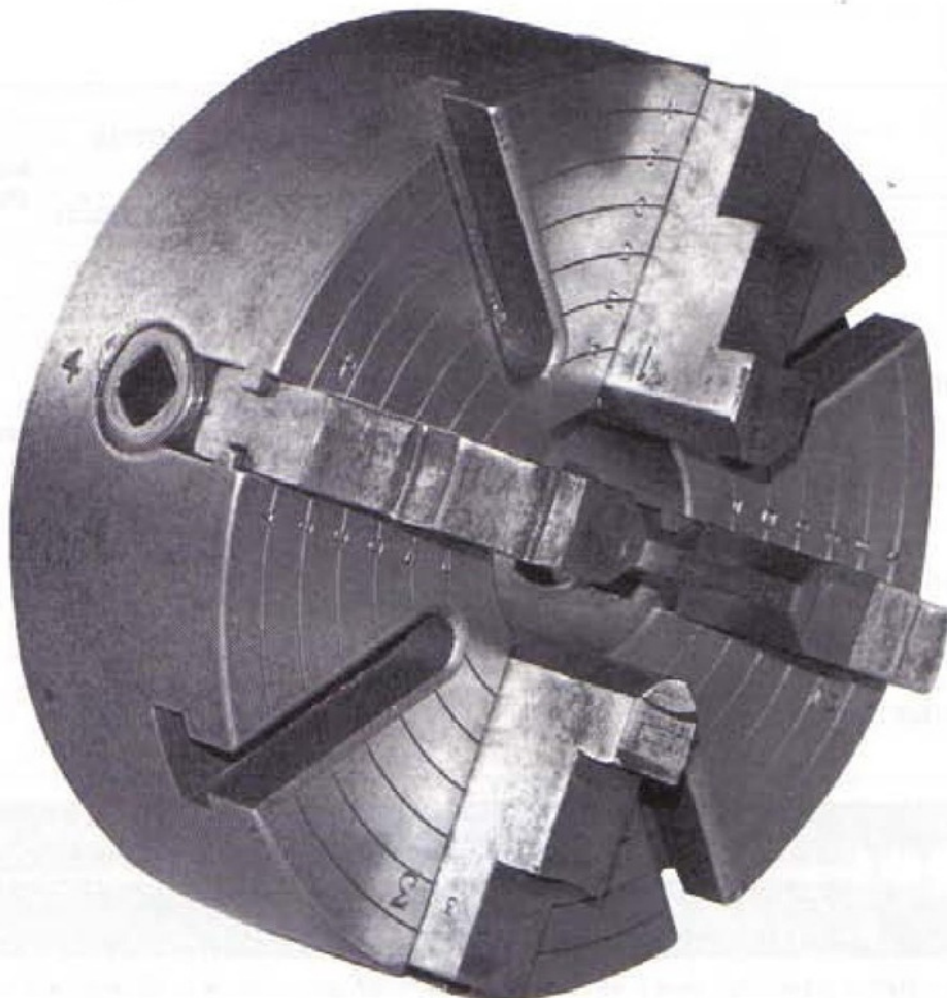
Simple accessories are often the most useful. Raymond McMahon of Co. Antrim, Northern Ireland used 'O' rings to help retain this lathe depth stop in position

design could not be used to suit other machines, with suitably altered dimensions. The design relies on the 'O' rings to hold it in place. Needless to say, the grooves in the support collar and the end piece have to be carefully machined; too slack and the device will not stay put, too tight and it will not go into position without forcing it. I would recommend that you groove a piece of scrap material and fit an 'O' ring in order to check it against your spindle, just in case there is a slight difference in the diameter of the spindle

bore. It goes without saying (even though I have just said it) that you must clean out any loose cuttings or swarf that may have found their way down the spindle of the lathe before fitting the test piece in place. Remember to do this always when using the device; we don't want it to get stuck down the inside of the spindle!

The support collar is positioned so that, when it is in place, it is behind the Morse taper. This gives support to the rod and stops it whipping around the inside of the spindle. It also keeps it central. The reason for the reduced end diameter is so that the rod can go part way up the inside of the chuck jaws, so facilitating the machining of small diameters and short lengths should it be necessary to do so.

The material used for construction of the depth stop was just whatever came to hand. For my example, I used a length of silver steel for the rod and light alloy for the end piece and support collar.



A HOME MADE 4-JAW CHUCK FOR THE LATHE

Alan Jeeves happened to become the proud owner of a large steel blank, so he decided to turn it into a useful 4-jaw chuck

I don't really work that much with a 4-jaw chuck. Until this project was undertaken, the largest one I had owned for years was a 110mm diameter example, which came in useful for the odd square or rectangular piece requiring turning or boring in the lathe. Large and awkwardly shaped work could always be mounted on to a face plate, and such occasional jobs as model traction engine crankshafts or front axles could be dealt with between centres. This 110mm chuck was initially for use on a 3 1/2in. lathe, but

it can also be attached to the spindle nose of my larger 5in. lathe, upon which machine it looks completely lost.

I have often considered the possibility of obtaining a larger diameter 4-jaw chuck. I could see the advantage of mounting my 100mm 3-jaw chuck exactly true within a 4-jaw, for turning extremely accurate small work, but a new one would really be too expensive for the extent of use to which it would be put. The preferable option would be a second hand chuck, but such a chuck never seemed to turn up.



The chuck body, fully machined.



The chuck body seen from behind, showing backplate recess.

Some time ago, a fabricator friend brought me a large piece of steel in connection with a job which he was doing at his work. This 200mm diameter x 65mm long blank was to be accurately bored and keywayed in my workshop, and was also to have a concave radius machined into the outside diameter, which was to be concentric with the bore. The aim was to make a female die for use on a hydraulic swaging machine. This powerful machine could already produce long straight lengths of half round hollow section and a second female die (or roller) would permit the section to be made into rings or segments of rings, there then being three forming rollers instead of the original two.

Time passed by, but the details of the die did not arrive, and eventually my fabricator friend left the company which, in turn, left me holding the 200mm x 65mm blank of steel. As he had no further use for the material himself and the swaging die project had been completely abandoned. I was allowed to keep the steel billet.

First thoughts

It was now becoming feasible for me to consider manufacturing a 4-jaw chuck for myself, one which I could readily adapt to hold much larger work than the actual diameter of the new chuck body. As this was to be a turning/milling project both a lathe and a milling machine would be required, and after careful deliberation, I concluded

that my mill/drill would be able to tackle the job. It would involve removing material to create the four slots in the body and making the jaws to fit. In addition, some large diameter hole drilling would be called for, and I consider that the mill/drill is just the machine for drilling large holes when required to do so in the home workshop.

The design

I would make my new chuck as large as possible by barely cleaning up the (black) bar stock which was to form the body, resulting in a finished diameter of 198mm or so. One advantage of making the conventional pattern of 4-jaw chuck is that the jaws move independently of each other, thus eliminating the need for the spiral scroll which would be required for a self centring chuck. This makes life a little easier.

On most larger sizes (over about 80mm) of 4-jaw chuck, the jaws are furnished with a half nut type of thread which engages with a captive screw, which thus provides the drive. This screw cannot move relative to the body, so as it is rotated by the chuck key, only the jaw is propelled inwards or outwards. However, on smaller chucks a different arrangement is usual. There are no threads cut into the jaw, but instead there is a fork which locates in a groove machined into the driving screw. Consequently, in order for the jaw to move, it is necessary for the screw to move with it. It is a simple idea, perhaps not quite as efficient as the captive screw principle, but it will never the less serve the amateur engineer well enough.

Turning the body

This very large piece of metal has to be machined to form the chuck body (Item 1), this being the main component. My 5in. lathe is equipped with a screwed spindle nose which is threaded 1in. dia. x 8 TPI (1in. BSF). I had considered screwing the body directly with this nose thread, as is done on some chucks for popular lathes such as the Myford 7 Series. However, second thoughts turned me against this idea, for if, in the future, this lathe is replaced by another model, the spindle nose attachment thread may be different, making the chuck no longer usable. The backplate method of mounting was therefore the preferred method.

In order to get the job under way, the body material had to be 'chucked' in the lathe and, as I did not have a chuck which was large enough to get hold of the blank on the outside, the centre was marked accurately and a 30mm diameter hole drilled through it, using the mill/drill. This now allowed the component piece to be put up in the 3-jaw chuck, taking a bore grip. It was not the best of holds on such a large piece of material, so extreme care was taken whilst it was held in this way. Even so, one face could be machined true and a suitable recess provided for the backplate. A matching backplate already existed, as I have one or two spares put by for just such a situation, and the chuck body was made to be a good fit on one of them.

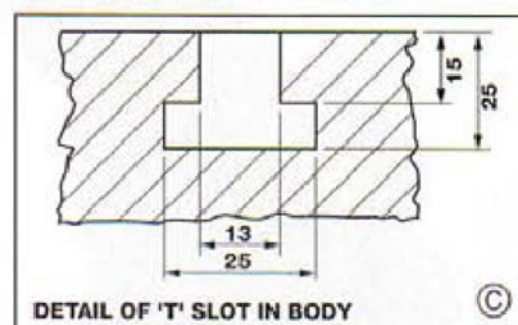
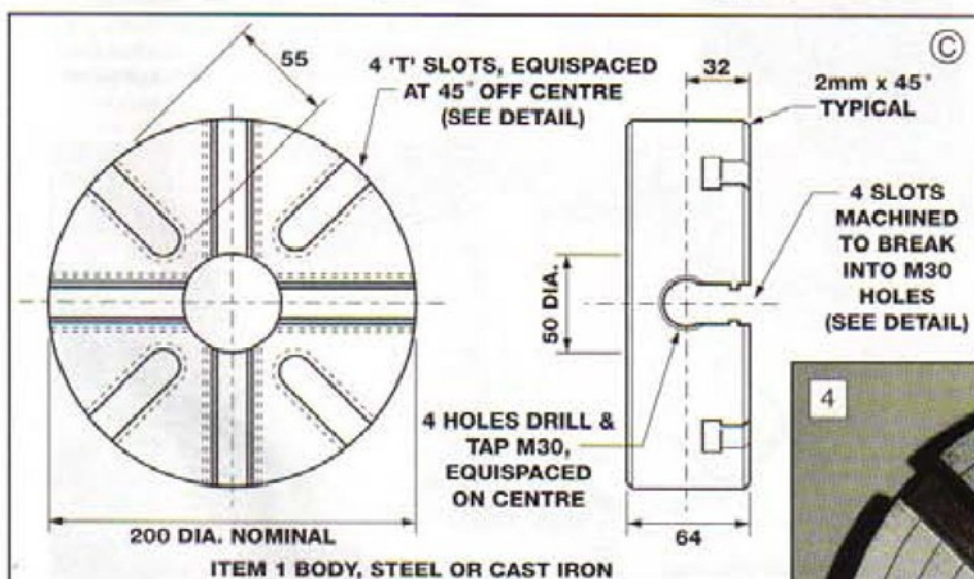
The body was next removed from the lathe to have the backplate mounting screw holes drilled and tapped on the mill/drill.

When the backplate was actually screwed securely to the part machined body, the whole thing could be mounted directly on to the spindle nose of the lathe on which it was to be used and the remainder of the turning work carried out with this set-up. The outside diameter was cleaned up, removing the minimum amount of metal possible, and the opposite (front) surface faced true. The body was also finish bored to produce the required diameter of the centre hole.

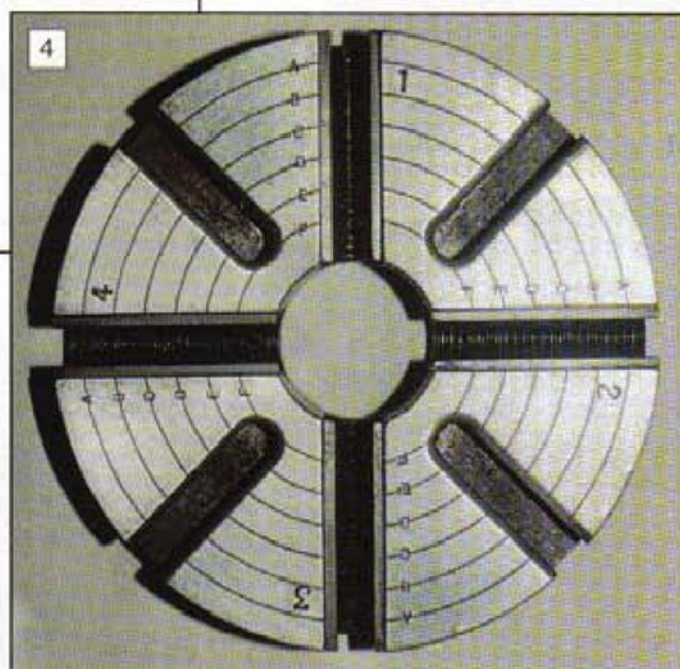
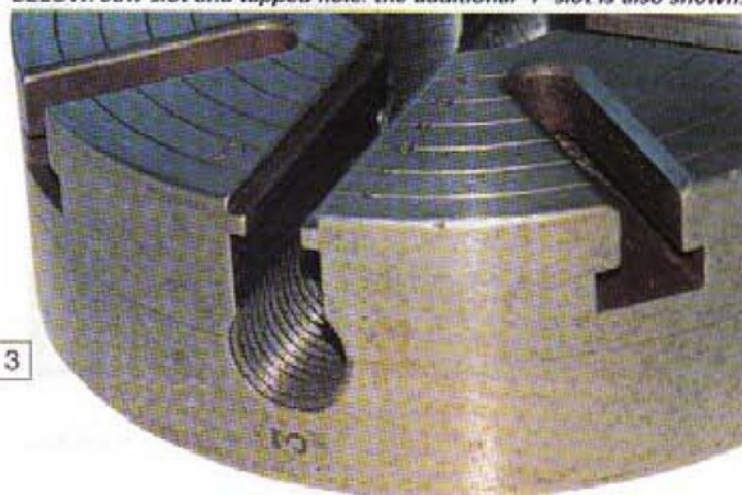
At this stage, anyone making such a chuck may consider that it is worth putting a few light radial grooves into the front face, an enhancement which later assists greatly in the setting up of work, by allowing one 'sight' the job true to one of these simple visual aids, leaving only a minimal amount of truing to do with the DTI. I machined in six circles at 10mm intervals and stamped them 'A' to 'F' (starting from the outside) as an additional feature (see **Photo 4**). A small chamfer was machined on to the outer corners and the front of the bore to complete the turning of the chuck body.

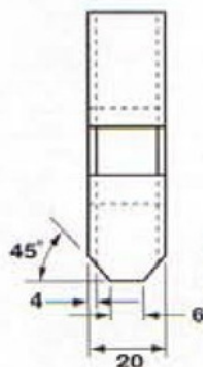
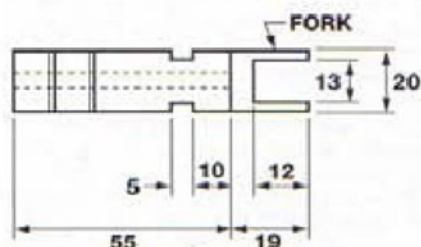
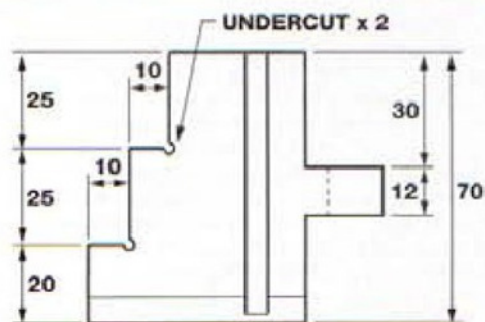
Heavy drilling & tapping

The four holes which had to be drilled and tapped to accommodate the jaw adjustment screws are quite large. I have used M30 for this thread, which meant drilling a tapping hole of 26.5 mm diameter. I chose M30 because I had a tap of that size to hand, although any similar thread such as 1 1/8in. BSW would have done just as well. Whatever thread is chosen, it will be obvious that one full turn of the chuck key will move the chuck jaw



RIGHT: Chuck face showing radial setting rings. BELOW: Jaw slot and tapped hole. the additional 'T' slot is also shown.





ITEM 2
STANDARD JAWS, 4 OFF, STEEL



Standard and extended jaws.

by a distance equal to that of the thread pitch. In my case, this is 3.5mm. Adjustment screws featuring a 1 1/8in. BSW thread (7 TPI) would move the jaw by 3.63mm per turn.

It is simple enough to mark out four equi-spaced holes on the outside diameter of the chuck body and to set it up on the mill/drill table, ready for drilling. In any event, these four holes do not need to be exactly equi-spaced. Half a millimetre either way will not matter a great deal. I found it to be a good idea, to tap the holes while the job was still in the milling machine, using a lathe centre to guide the tap, thus keeping the thread square with the hole.

When the holes had been tapped, a good sized chamfer had to be formed, in order to remove the first thread or so. This makes a nice smooth start to the threaded area, leaving no sharp edges which could cut the hand, should one get too close.

Milling the jaw slots

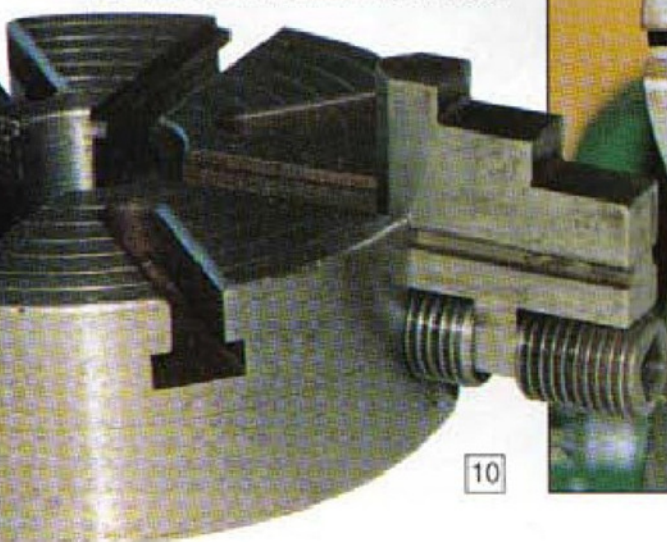
These jaw slots have to be machined from the front of the body and they do actually break into the tapped holes, interrupting the continuity of the thread spiral. They are not merely plain slots, but are provided with tenons which retain the jaws and effectively guide them in and out of the body.



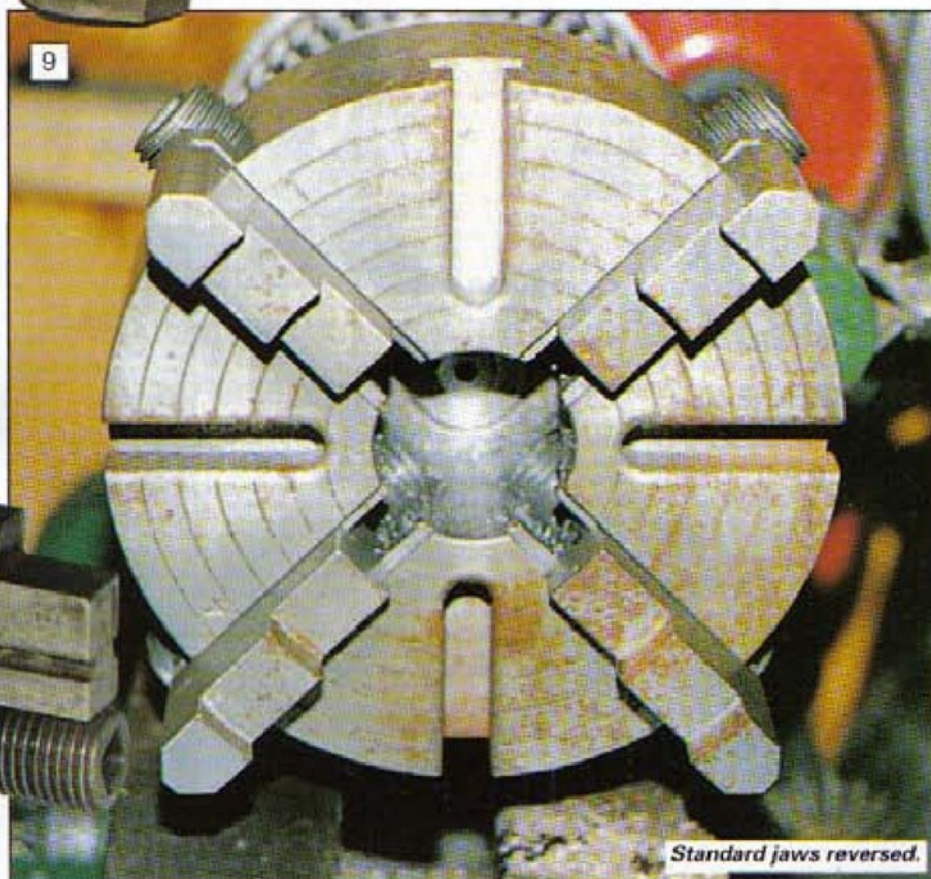
Jaw adjusting screw.



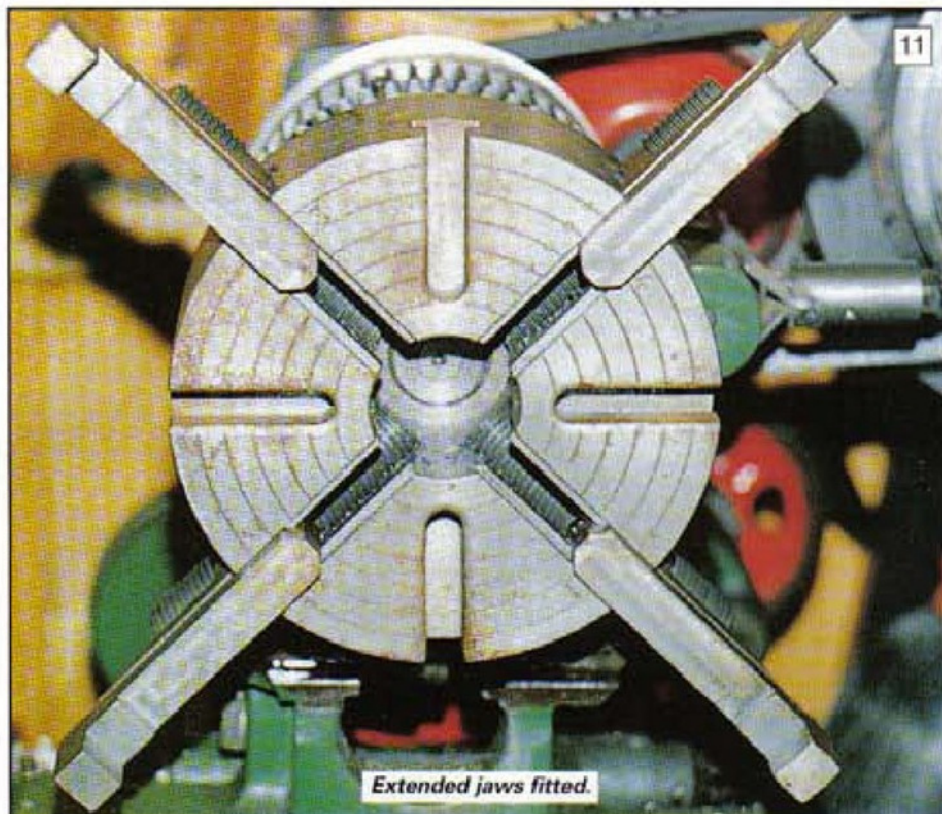
ABOVE Adjusting screw fitted to a jaw.
BELOW: Jaw and screw started in body.



The fork on the jaw.



Standard jaws reversed.



Extended jaws fitted.

Each slot was cut in three separate stages (Fig. 1). The first stage was to mill a pilot slot with an end mill of a diameter equal to the distance between the tenons. The second stage was to remove the metal between the thread and the tenon using a 'T'-slot cutter, and the third and final stage was to remove the metal between the chuck face and the tenon, again using an end mill. Great care must be taken to ensure that this jaw slot is exactly in the centre of the tapped hole for the adjusting screw.

The chuck body was simply clamped flat to the table of the mill/drill and the work carried out by conventional vertical milling. All the sharp edges must be removed after milling, an operation which completes the chuck body unless the slots are to be numbered. The advantage of numbering each jaw slot is that setting the work correctly is made so much easier if it is possible to identify an individual jaw. For example, if several pieces of the same size of square bar have to be set up in sequence, once the first has been set accurately, then the remainder should be able to be chucked by releasing and re-tightening two adjacent jaws only, the same two being used each time. This can save a considerable amount of time.

The standard jaws

The four jaws (Item 2) were quite simply made from stock bright bar, and were a nice sliding fit in the previously machined slots. The tenons prevent the jaws from moving outwards from the body when

they start to grip the work. On a factory made 4-jaw chuck, the jaws would be case hardened, but for amateur workshop use, they should give good service even if left soft. After all, soft jaws for the 3-jaw chuck are usually found to be very serviceable.

The jaws are made in 'step' form and are reversible in their slots, thus enabling them to be used to take an outside grip. The drive from the adjusting screw is transmitted by a fork which is carefully positioned on the back of the jaw in order to allow the jaw to be reversed. To achieve this, the adjusting screw must be completely removed from its tapped hole. Although all of the machining required to make the jaws is milling, when they are completed and can be set up in the chuck in the reversed position, they can be lightly skimmed with a boring tool to give a slightly radiused gripping area, which helps when taking an outside grip.

Extended Jaws

Extended jaws (Item 3) may be made as required, these being able to hold a much larger workpiece than do the standard jaws. I made a set for my chuck, for the

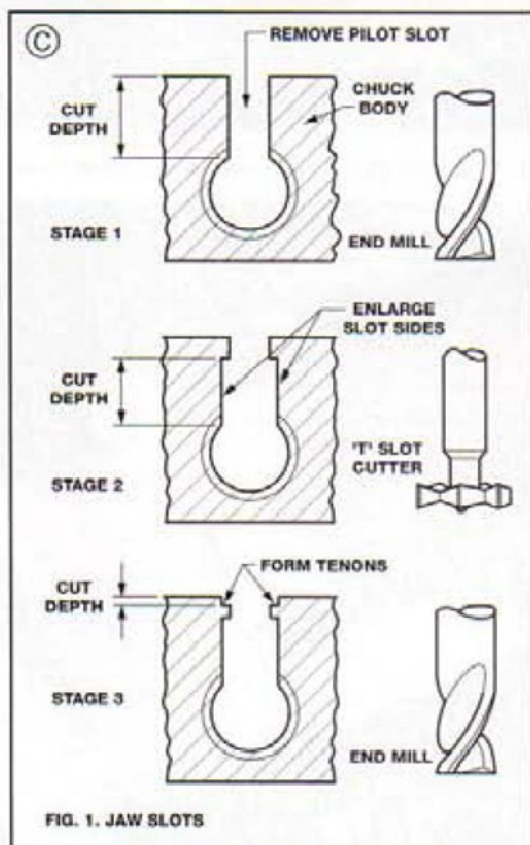
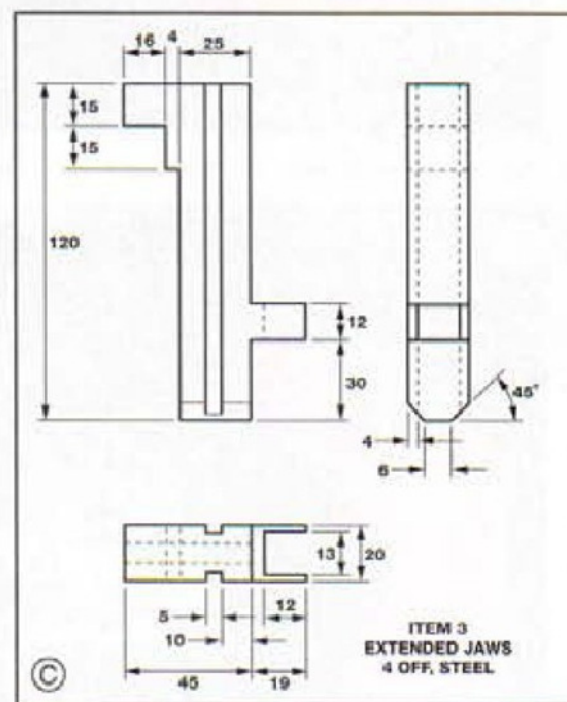
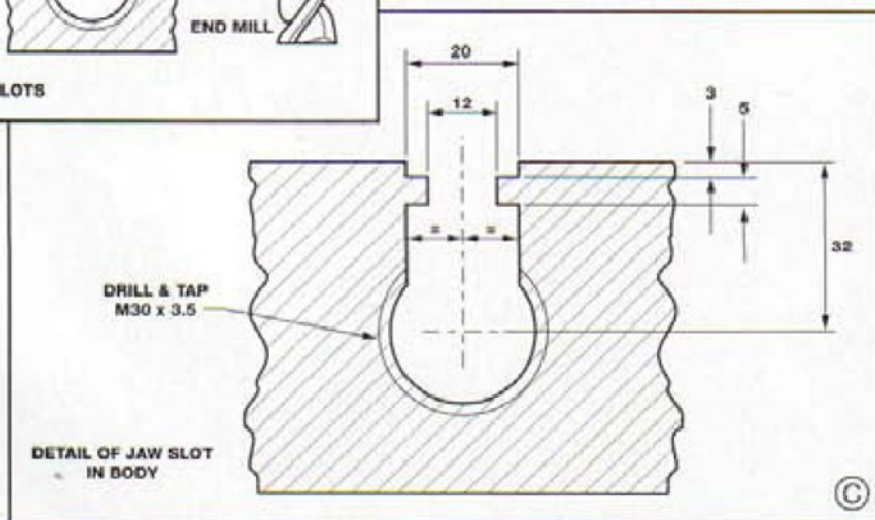


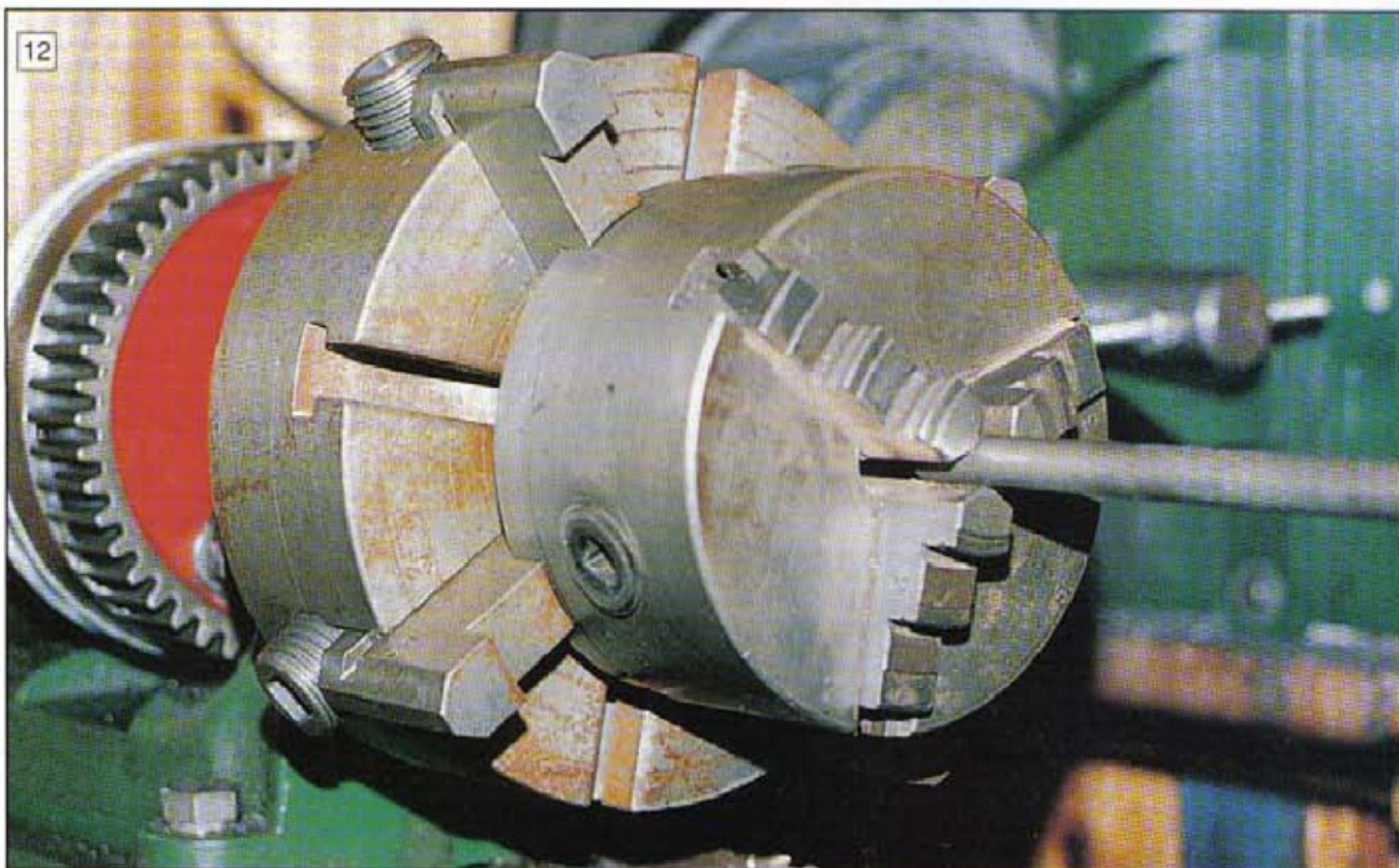
FIG. 1. JAW SLOTS



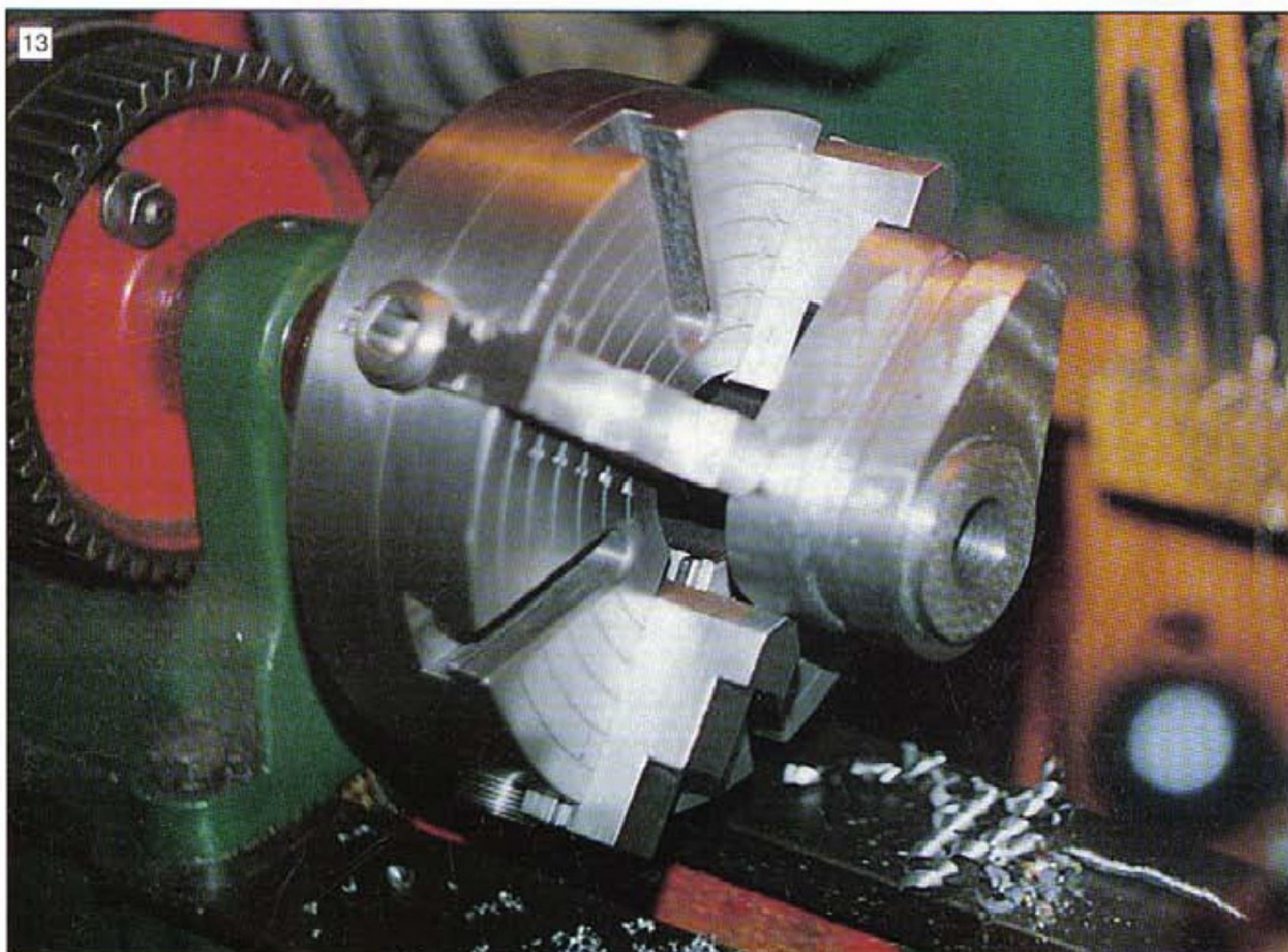
ITEM 3
EXTENDED JAWS
4 OFF, STEEL

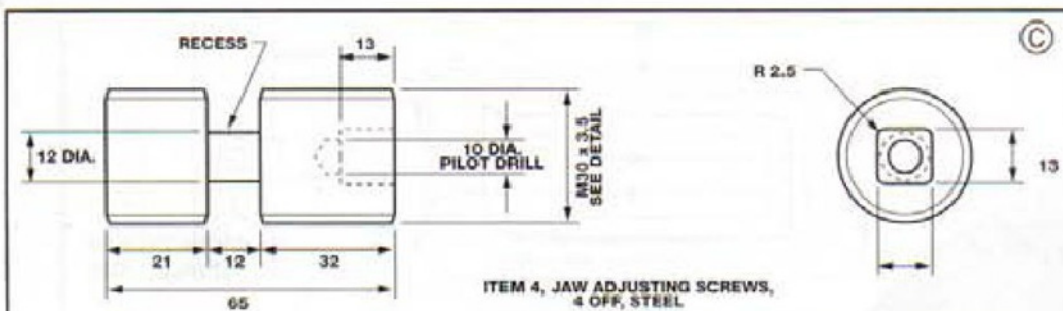


DETAIL OF JAW SLOT
IN BODY

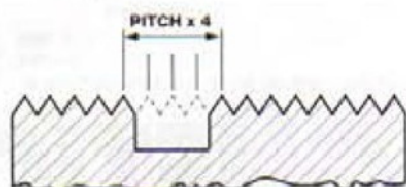


12 ABOVE: Double chucking. BELOW: Typical use - a hub for a traction engine hind wheel (one jaw reversed).





It will be seen in the various illustrations of this chuck, that four additional slots have been machined into the front face of the body. These are 'T'-slots which are compatible with the 'T'-nuts supplied with my milling clamp set. Their purpose is to provide additional means of securing large jobs should this become necessary. They also serve to lighten the chuck slightly.



express purpose of swinging a 480mm dia. model traction engine hind wheel, in order to be able to bore the hub accurately. A 480mm wheel in a 200mm chuck! Again, these jaws are machined from stock bright bar, but cannot be reversed as can the standard jaws. They can, however, be radiused in the same way as were the shorter jaws.

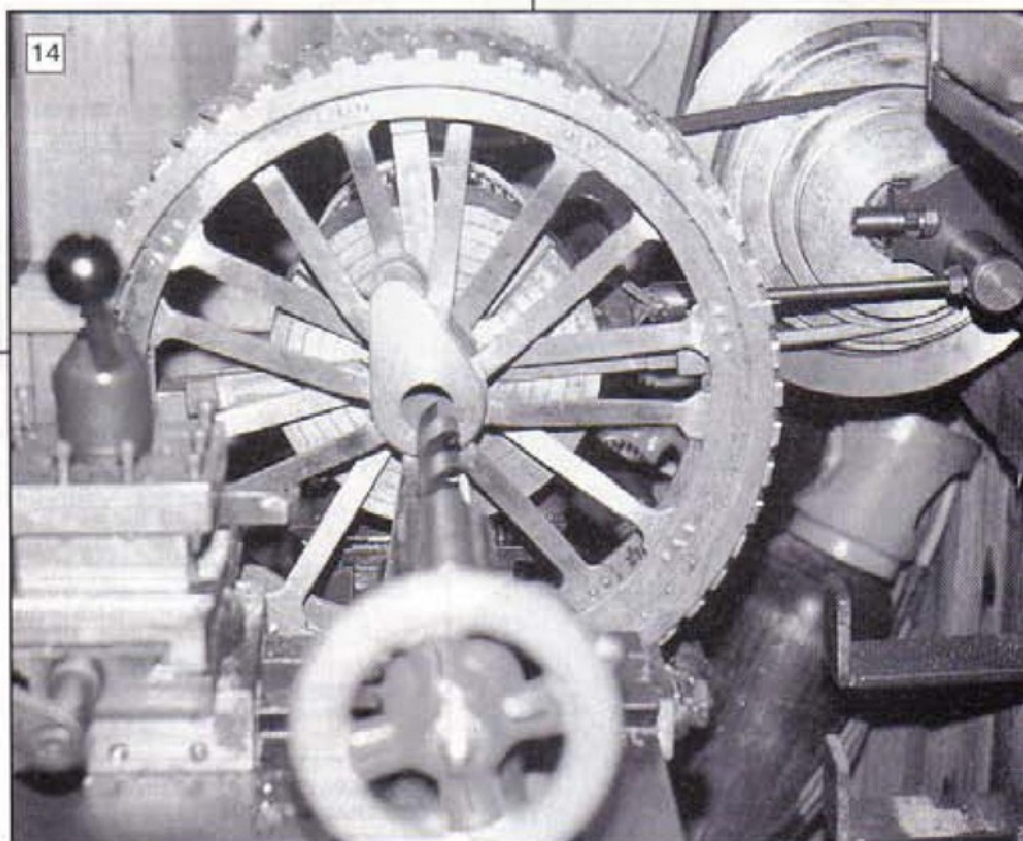
Adjusting screws

Four jaw-adjusting screws (Item 4) were made from mild steel, screw cut on the lathe to fit the tapped holes in the chuck body. They should not be a slack fit, but on the other hand, they must not be too tight, otherwise the jaws will be difficult to adjust. Sensitivity will also be lost when truing work if the screws are not easy to turn. A groove machined into the screw, positioned asymmetrically along the length, accommodates the fork on the jaw, thus causing the jaw to move as the screw is turned.

The adjusting screw is turned in the conventional manner, by means of a square drive chuck key. The socket required to receive the square had to be cut by extending a pilot hole drilled into the head of the screw. This was done using an end mill of such a diameter which would create an acceptable radius in each of the four corners of the socket, the square end of the chuck key being radiused (by filing) to suit. Consideration should be given to the length of chuck key required if extended chuck jaws are to be used (Fig. 2).

Using the chuck

When completed this chuck is used in the same way as is a conventional 4-jaw chuck, the only possible difference being the use of the extended jaws. They will be found to be very useful for jobs such as boring centre holes in large plates or flanges, especially so when the lathe is equipped with a gap in the bed, as is my machine.



380mm dia. wheel being bored true. An extended jaw is visible between the two uppermost spokes.

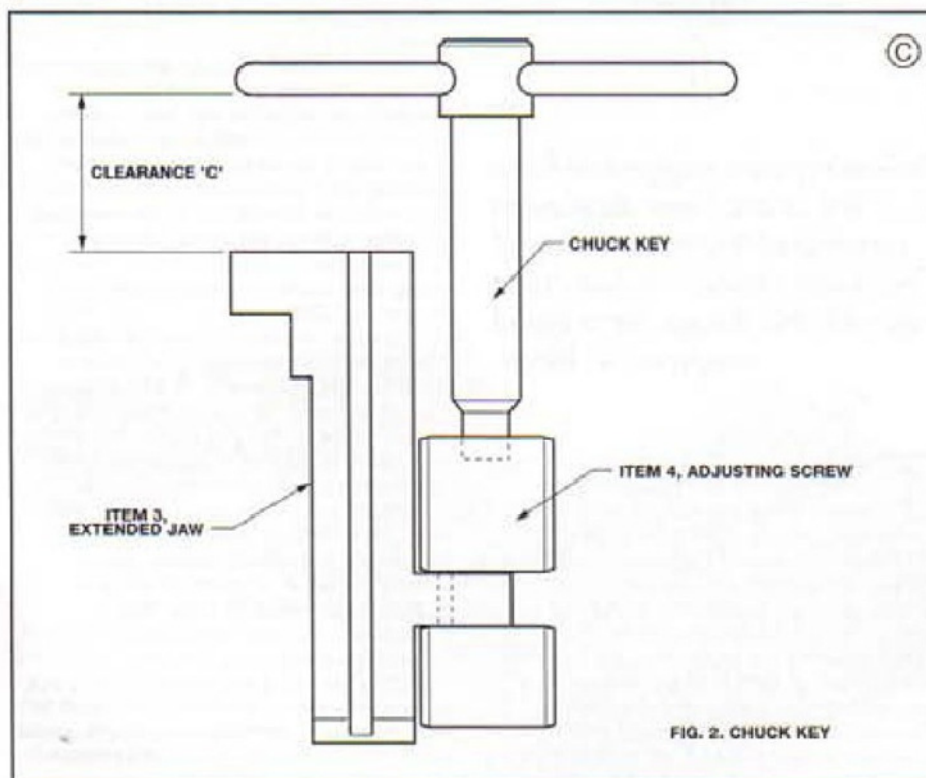
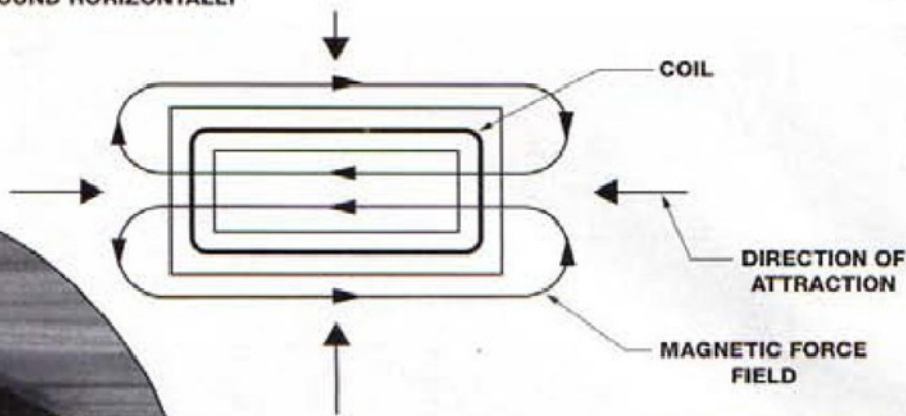


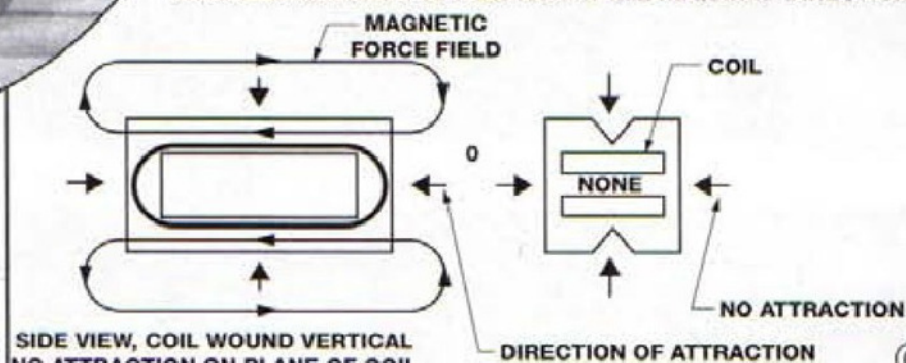
FIG. 2. CHUCK KEY



PLAN VIEW, HORIZONTAL COIL, NO VERTICAL ATTRACTION

A MAGNETIC 'V' BLOCK

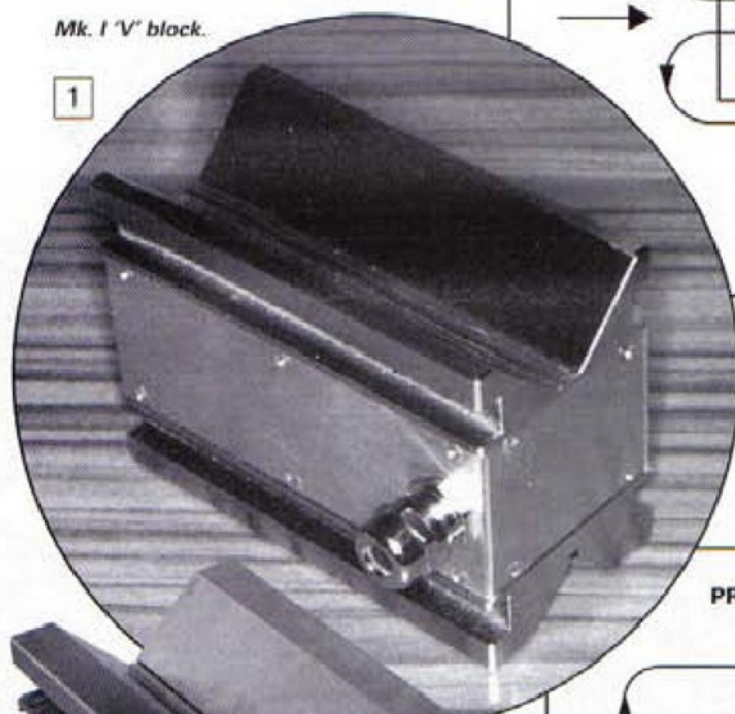
DRG. 2. REVISED LAYOUT, COIL WOUND VERTICALLY, PROVIDES MAGNETIC ATTRACTION IN THE REQUIRED DIRECTIONS



SIDE VIEW, COIL WOUND VERTICAL NO ATTRACTION ON PLANE OF COIL

Mk. I 'V' block.

1



The Mk. II: block.

2



Following up a suggestion from the Editor, Peter Rawlinson researched the construction of magnetic chucks. He has come up with this design for a useful magnetic 'V' block.

This project was first proposed by the Editor, but in a somewhat different format. His suggestion was for a permanent magnet chuck of some type, and towards this end I started to acquire a certain amount of information.

I have in my workshop a surface grinder and an 'Eclipse' magnetic chuck, but I was reluctant to strip this down. I also have a smaller chuck, so this was partially stripped, that is the base was removed from the top, leaving the magnet still attached to the underside of the top

surface. My later findings would suggest that I did the right thing, as the magnetic strength can be lost if a magnet is removed from its 'keeper'.

I then contacted Eclipse who were most helpful, although the information that I gained from them did not help with the project. Indeed, it virtually cancelled it, the main reason being that the method of building up a permanent magnet of this type requires the magnet to be energised on completion of the build, using a Capacitor Discharge Magnetiser. This equipment is very expensive, costing in excess of £2000.

The other problem is that the cost of pieces of magnetic material of the size required (approximately 15 x 10 x 75mm), was of the order of £3.25p. each, based on the purchase of 100 pieces.

I was still thinking it over some time later, when a colleague lent me some bound volumes of *Model Engineer*, dating from June 1942 to December 1946. While looking through these, I came across an article entitled *A Magnetic V Block* by a Mr. K. Armytage, dated 31 May 1945. Incidentally, it is interesting to read articles and the accompanying advertisements from this period. It would seem that there is very little new in the world, unless it is very high tech. As for the adverts, it would seem that our modern ones still follow

basically the same pattern, with one exception, which I must reproduce here:-

"Buck & Ryan's Lathes & Light Machinery Dept."

"Lathes can only be supplied for war work."

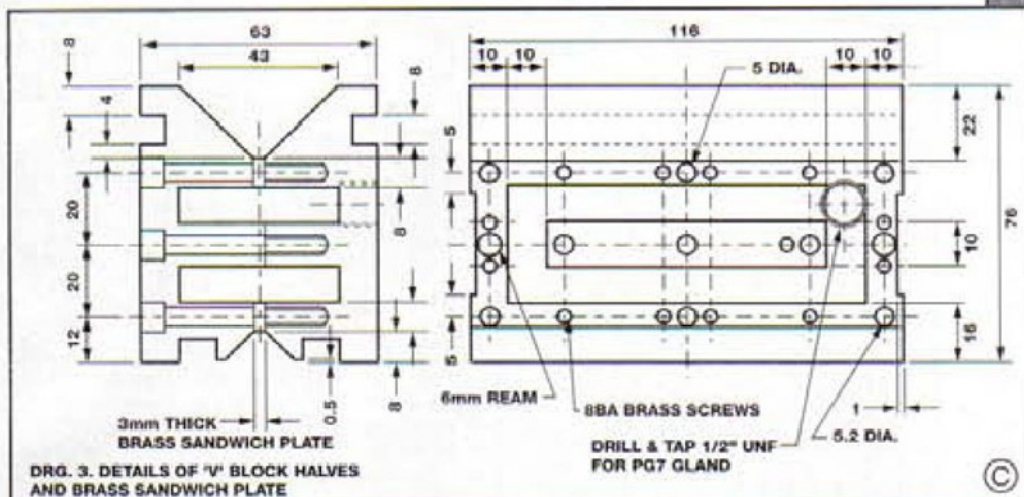
"Buck & Ryan Ltd. 310 Euston Road. London. N.W.1."

Short and to the point!

Difficult times

However, taking those times into account, it must have been extremely difficult to carry out any modelling work. Indeed, I can remember (just) my father building a model of a *Spitfire* and covering it with silk from an old petticoat of my mother's. Needless to say, balsa was not obtainable, the model was too heavy and it crashed on its first flight. The model engineers of those days are certainly to be congratulated on their tenacity and also on their 'make do and mend' philosophy.

Mr. Armytage's article describes the winding of a coil (using second-hand wire from a door bell) which is sized to drop over a standard Moore & Wright 'V' Block.



It is then tested on AC and fails, and is then connected to 8 volts DC, which is found to give a good strength of attraction. The Moore & Wright 'V' block used was approximately $1\frac{1}{2} \times 1\frac{1}{2} \times 2$ in. in size.

My first attempt

I decided to revamp the 'V' block and to make it a self-contained unit which would work off a 12v DC supply, either from a car battery or a battery charger. These are the power sources most modellers are likely to have on hand. The very low voltage would be safe, even with the coolant splashing around unsealed coils.

Photo 1 shows my first attempt at making this 'V' block, which I am sorry to say was a resounding failure. I still do not know why, as the only difference between Mr. Armytage's and my own was that my coil was enclosed, while his was open. Both coils were wound horizontally, and I would guess, use a similar amount of wire. Mine was powered at 12v DC, and uses approximately 0.5 amperes, but there is no grip to the table and none to a round bar in the 'V'. There is, however, excellent attraction on the ends and the sides. Can anyone tell us why my 1997 version will not work while the 1945 version did?

Not all my time was wasted as, during machining, I cut grooves around the top and bottom to accommodate clamps, so I can still use the 'V' block in a standard manner. As I did not anticipate failure, I photographed all the stages of manufacture as they were carried out. As the principles of the basic machining are similar for both types, I have used these photos where appropriate.

After this failure I did not want another, so went to the local Library to seek more information. It would seem that what I was trying to do was to build a 'Horseshoe Electro Magnet' or a horse shoe shape, with a coil wound round the centre. This meant that the coil had to be wound, not horizontally, but in a vertical plane (see **Drawings 1 & 2**).

If a letter 'H' were to be cut from steel or iron, and the coil wound around the 'cross bar', then a pair of back to back magnets would be made. If it is then looked at from a plan view, then the ends, if extended past the coil would also become the poles of the horse shoe magnets, and create an attraction on the ends as well as the top and bottom.

I have a permanent magnet 'V' block, which I find most useful, not only on the surface grinder, but also on the drill, and for 'small' milling jobs. It not only holds on the

top and bottom 'V's, but also on the ends, and can therefore be mounted on end, with the 'V's vertical. Material can then be held for work to be carried out on the ends.

The Mk. II version

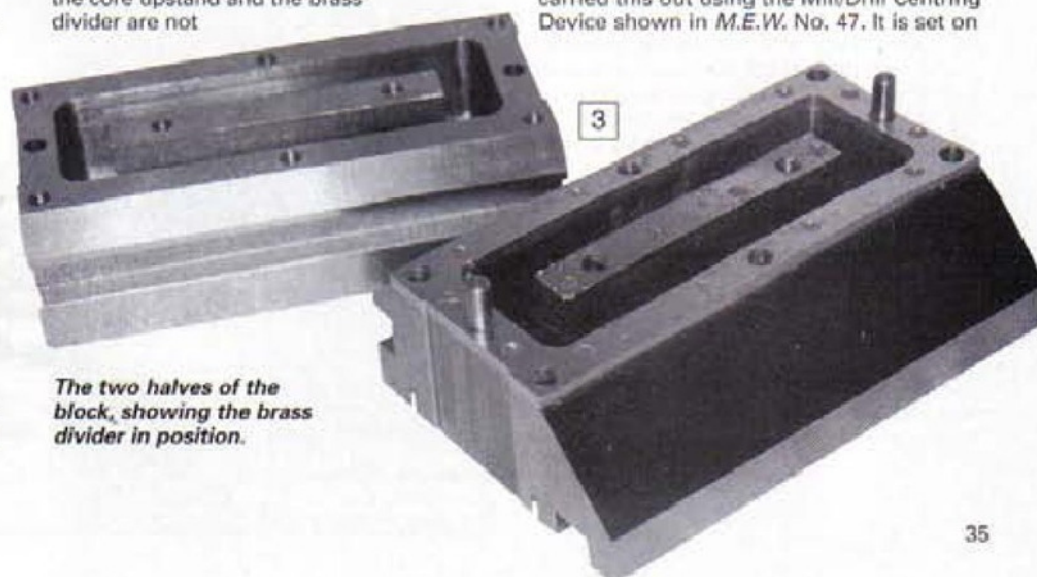
Armed with the new information, I produced a new design (**Drawing 3** and **Photo 2**). My original unit was made from mild steel. This is acceptable, but does retain magnetism, which builds up progressively as it is used. It can, however, be demagnetised. The best solution is to make the unit from a soft cast iron, which will not retain the force.

The block is made from two parts, split on the centre line vertically, and uses a brass sandwich plate to isolate the two halves on all the faces with the exception of the centre core, which has steel to steel (or cast iron to cast iron) contact. In this way the 'horseshoe' configuration is maintained (**Photo 3**).

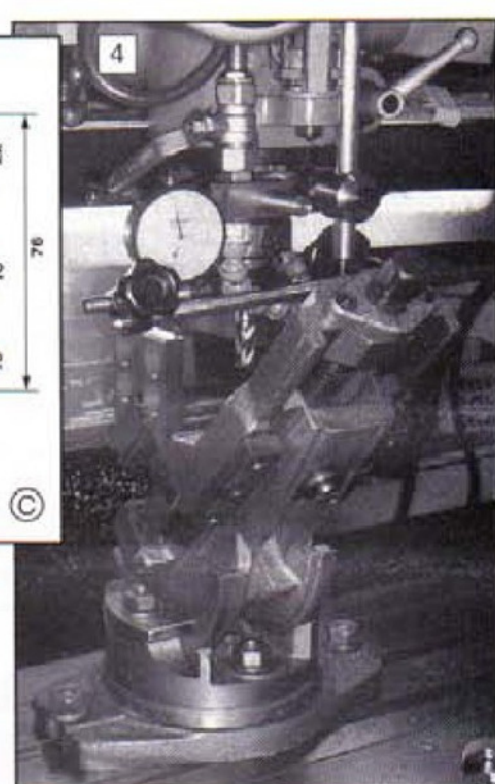
Whether using steel or cast iron, I would recommend that the blocks are first cleaned up, leaving sufficient to finish off later. The inner face of the first block is then machined, leaving the central core protruding by 3.3mm (or the thickness of the brass to be used). The sandwich plate is now screwed into place using 8 BA brass countersunk screws. The inner should be small and the outer large. The top and bottom, however, should be to size. It is then finished to size during the machining of the coil recess and the outside of the block.

Lastly, a fine cut is then taken over the whole surface, so that the outer rim and the inner core are in the same plane and, when bolted up tight to its mate, nothing will distort.

The second half is now machined, but the core upstand and the brass divider are not



The two halves of the block, showing the brass divider in position.



Setting up the angle vice.

required. The mating surface should, however, be given a fine machined finish.

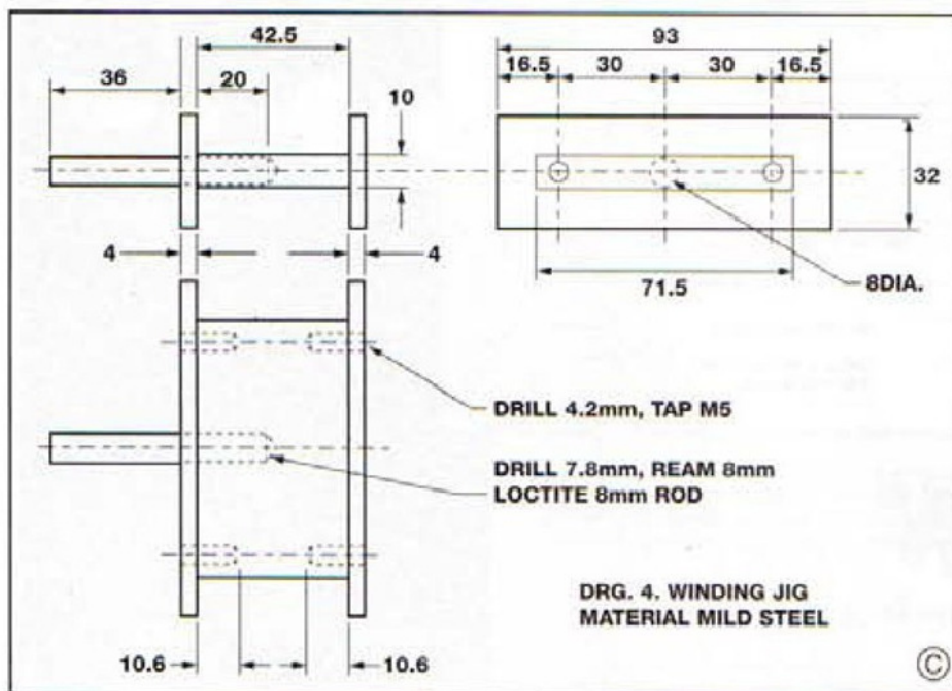
All this machining work must be carried out very accurately, as the two halves, when put together, must line up and fit to allow the coil bobbin to enter. To this end, line up on one face and one end, but do remember to work from the 'right' end of one half and the 'left' end of the other.

I would recommend that the holes for the bolts (4.2mm tapping size) and dowels (4.8mm) be marked out and drilled through the brass, into the steel and right through, reaming the dowel holes 10mm deep. The two halves are then put together, using the original setting-out faces for alignment, and the holes drilled through, using the first half as a jig. The halves are then split, the appropriate holes tapped M5, the counterbores machined and the reaming completed on the second half. The dowel holes need not be drilled through on this half.

Make two dowels from silver steel, 5mm dia. x 20mm long. These may be hardened if preferred.

Assemble the two halves on the dowels, and if the fit is good, then no movement will be apparent. The parts can then be bolted together using stainless steel or brass bolts, which will prevent magnetic transfer.

The milling machine vice now requires to be set up at 45 deg. (**Photo 4**), and I carried this out using the Mill/Drill Centring Device shown in *M.E.W.* No. 47. It is set on



Drill and tap the hole for the cable gland. The only gland I had available was equipped with a P.G.7 thread, for which I did not have the correct tap, but I found that a 1/2in. UNF proved satisfactory, using a 11.5mm drill.

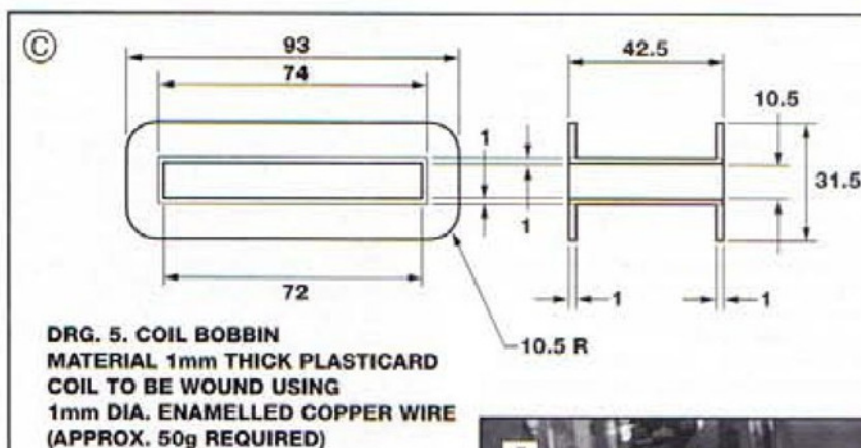
The coil assembly

We now come to the 'electrical' part. My first thoughts were to machine the bobbin on which the coil is to be wound out of a solid piece of plastic, but this seemed to be a waste of expensive material and time. I therefore decided to build the bobbin from 'Plasti-Card', which is available from model shops and can be obtained in various thicknesses in A4 size sheets, together with a solvent to aid fabrication. I chose 0.040in. or 1mm thick sheet.

The problem now arose of how to build it and how to hold it during the winding of the coil.

It became obvious that a jig of some type was required, and as it would only be used once, a wooden one seemed appropriate. However, it had to be accurate, strong and smooth, as the bobbin had to be removed after the coil was wound. During the winding, the wire would exert a pressure on to the bobbin and would tighten the bobbin on to the jig. I therefore decided to make the jig out of steel, and as I eventually had to make two bobbins, it turned out to be the correct decision.

Drawing 4 & Photo 7 show the jig. It might appear to be a little complicated, but was in fact quick to make and works well. After making the three components, they were covered with brown plastic parcel tape to give a smooth, slippery finish, and finally after a trial assembly of the loose



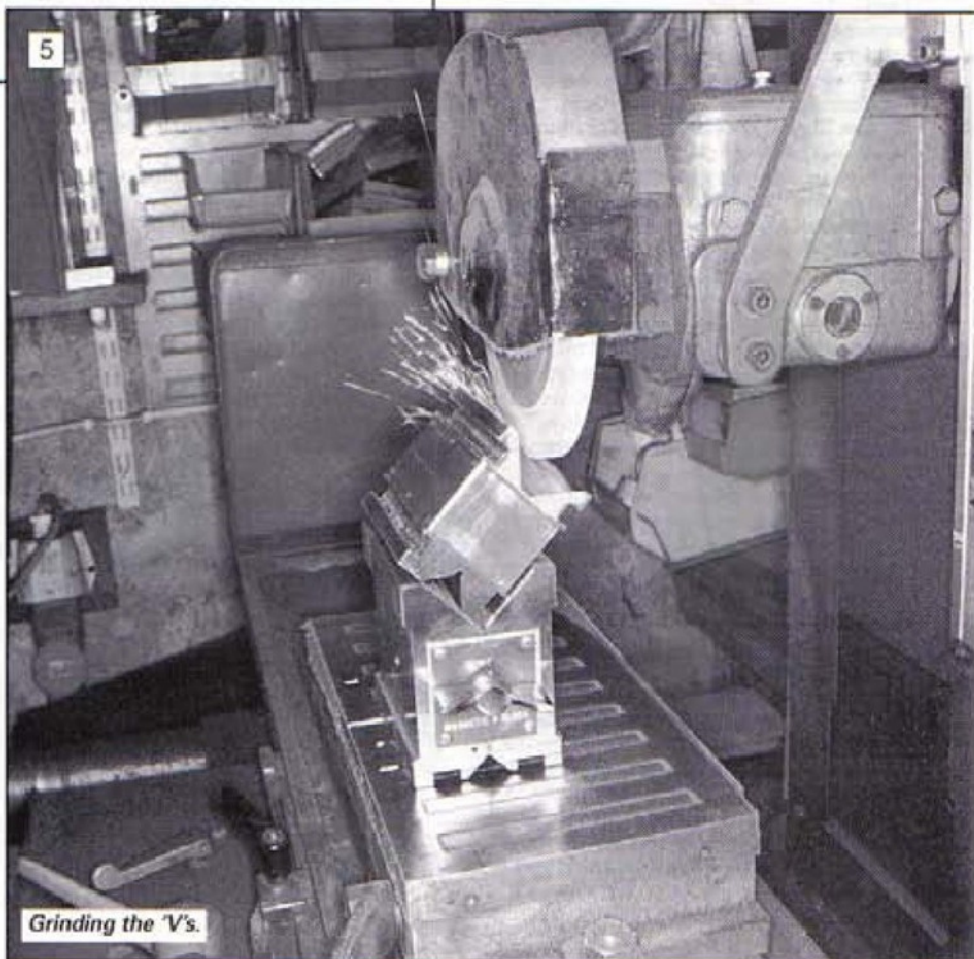
the workpiece and aligned using a dial gauge. This can also be accomplished using a sine bar or a standard angle block.

Machining of the outside surfaces can now be completed, using the same two faces as datum surfaces. Spend some time on getting this set-up spot on, as this is a piece of tooling and is used for machining other components. Any errors will be carried through.

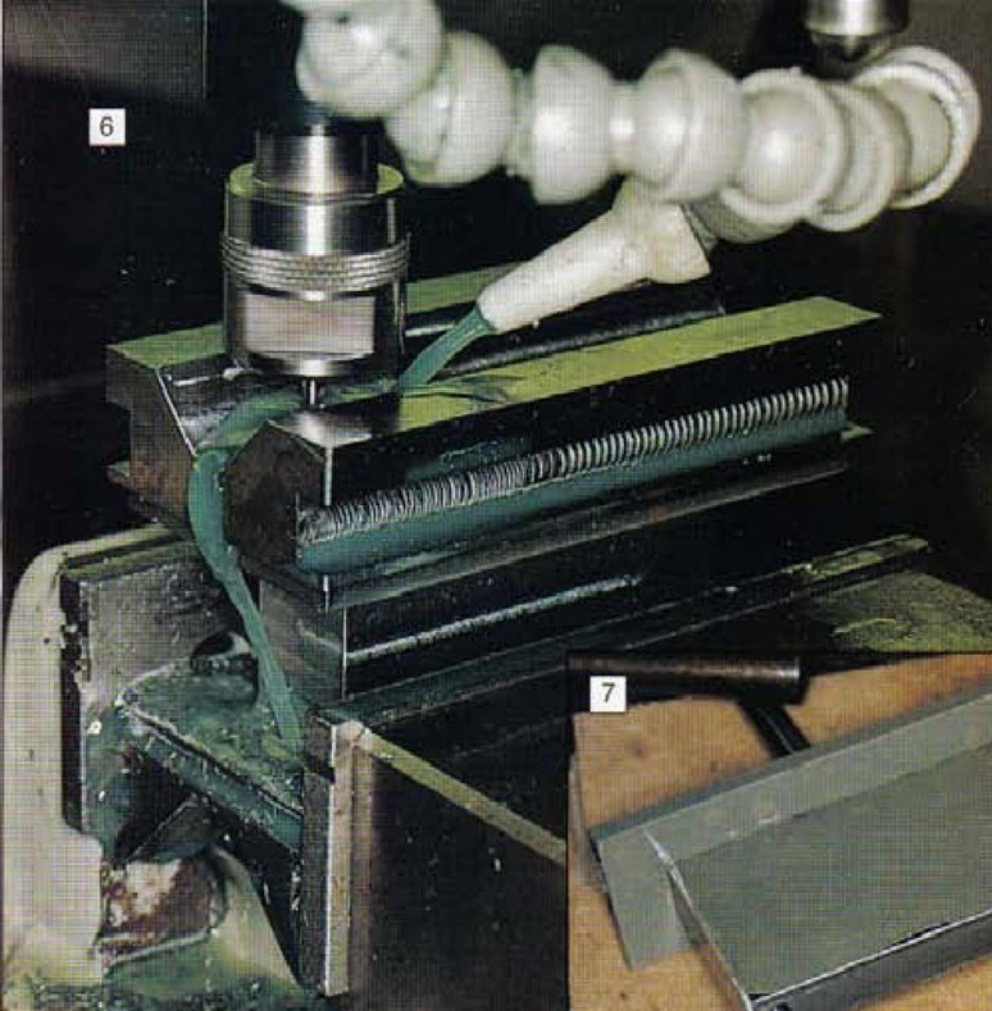
A fine finish can be transformed using Wet & Dry to give a smooth matt finish, which will not show up the scratches and rub marks which will inevitably appear if the block is used in the workshop, and not just kept for exhibition purposes. Of course if a surface grinder is available, then this should be used, as this will certainly give a more accurate finish (**Photo 5**).

Grooves can be machined in the sides of the block if it is thought that it may be required to use it with clamping devices on some occasions (see **Photo 6**).

The two halves could be hardened, as long as a surface grinder is available for final finishing, but this is not really necessary for our type of use, or possible if using cast iron. I would not recommend it as may only introduce other complications.

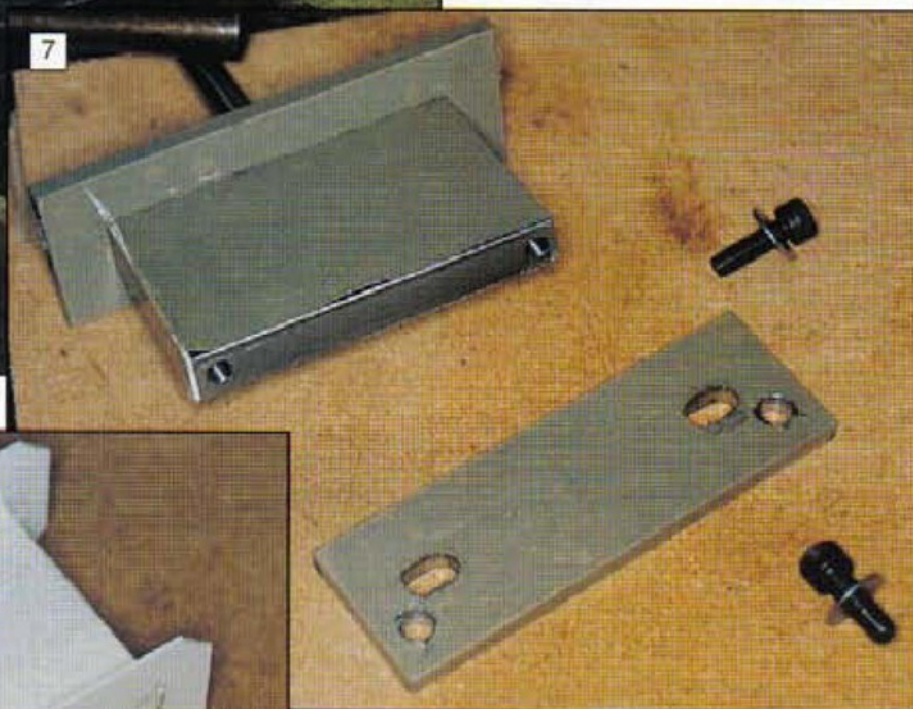


6



Grooves can be machined if thought necessary.

7



LEFT: The completed bobbin. ABOVE: The jig for the bobbin.

BELOW: Winding the coil. The bobbin is mounted on the jig and the lathe is being run slowly in reverse.

8



parts, a thin coat of grease was applied.

If builders wish to make this as it might perhaps be done in industry, then the centre should be a truncated cone, with loose outer parts to form the parallel sides.

The bobbin is shown in **Drawing 5 & Photo 8**. To make this, cut the centre from one long piece of card, score for the four corners and then cut to length. Bend carefully and fit over the jig. Cut the two end parts and chamfer the corners 6 x 6mm or radius as drawing. Try over the centre part and adjust if required, cutting an exit hole for the wire. Fit all together on the jig and apply the solvent along the folded joints, at the junction of the centre section

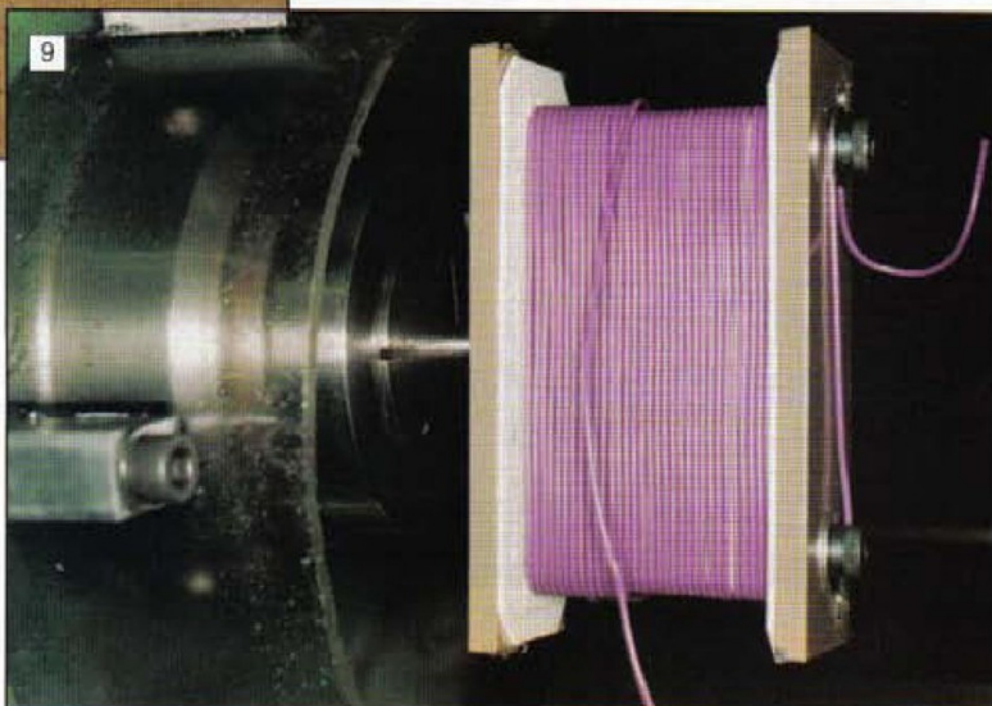
and where the ends attach. I wrapped a single layer of electrical tape at each end, so that it lapped the end piece and the centre, thus reinforcing the joint. The bobbin should be left on the jig for about two hours for the solvent to do its job.

One word of warning! Don't over-bend at the folds, as the material is very likely to break.

Winding the coil

My lathe has a variable speed motor drive and I can therefore run it very slowly and in reverse. This is an advantage, as with reversed rotation, the wire can be seen more easily as it runs on to the bobbin (**Photo 9**). This makes it far easier to control the winding because, as this bobbin is rectangular, it will be found

9



much harder to wind in layers than a circular coil. There is nothing to help guide the wire for a large percentage of the revolution. Winding was slow. I found that there was just room for six layers, but this made for some difficulty in fitting the bobbin.

After winding the coil, some protection is required to prevent damage during subsequent handling and when inserting the bobbin into the block halves (**Photo 10**). For this I used standard electrical tape. Apply two layers after making-off the ends of the coil to the input cable.

To complete the assembly, the gland and the bobbin are now fitted in to place, the input cable fed through the gland, then the two halves bolted together. After tightening the gland, all is ready for testing.

Testing

If you have a battery charger equipped with an ammeter, this will give an indication of current requirements, and therefore power consumption, but first it would be best to check that there is no earth short and that the coil is not broken or disconnected from the input cable.

Place the 'V' block on a flat steel surface, connect to the battery charger and turn on. If all is correct, the battery charger should hum and show a current reading. It should not be possible to pull the block off of the steel surface.

Photo 11 shows the set-up I used to finally check the grip exerted by the 'V' block. It consists of a 20mm bright steel round bar, with a spring balance positioned approximately 65mm from the end of the block. This gives a tearing action, as a direct pull would be considerably higher and perhaps not easily measured. The force required for separation was 16 Kg., but this value does seem to depend on the type of base to which the block is anchored.

The current measured at the time was



The test set-up.



The coil, wrapped with protective tape, is fitted into the recess.

4.5 A, which most modern battery chargers will handle.

By using the set-up shown on the bench drill, more control is available due to the mechanical advantage, and as there is a good base to which the magnet can adhere, there is less likelihood of an accident.

I hope that this tool will be of help in the shop. It has been another interesting project, and I think that you may also find it so.

Suppliers

Since the original was constructed, arrangements have been made to have cast iron bar of an appropriate section made available by College Engineering Supply.

College Engineering Supply, 2 Sandy Lane, Codsall, Wolverhampton, WV8 1EJ
Tel/Fax. 01902 842284

Suitable wire is available from Magtor Limited, West End, Westinghouse Road, Trafford Park, Manchester, M17 1QU.
Tel: 0161 872 4657. Fax: 0161 872 4659



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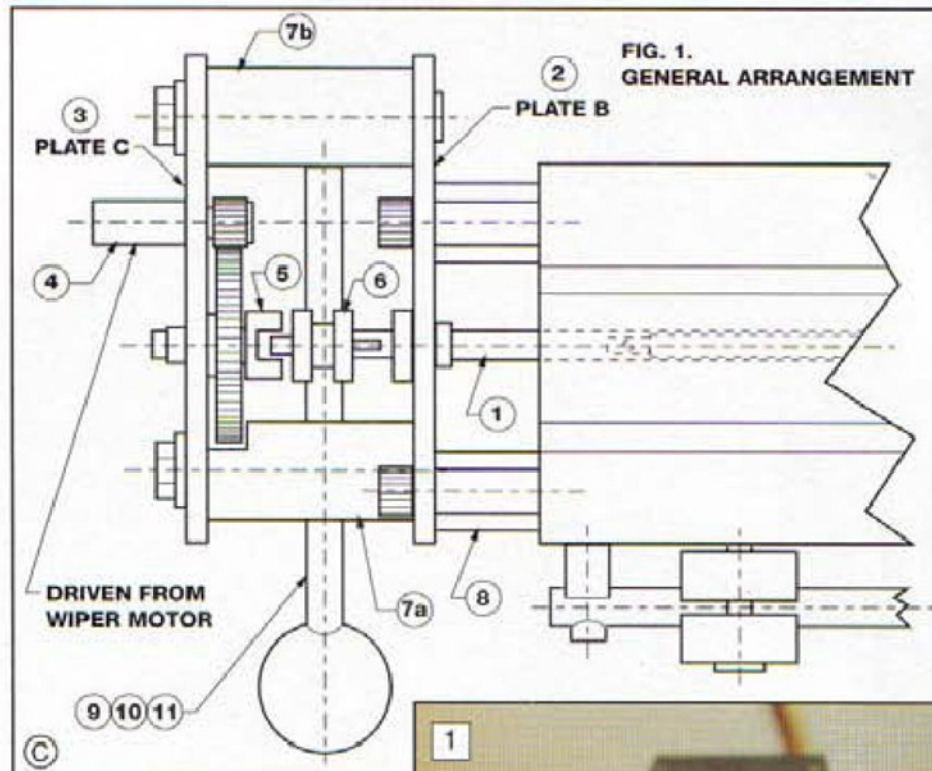
Address: _____

Postcode: _____

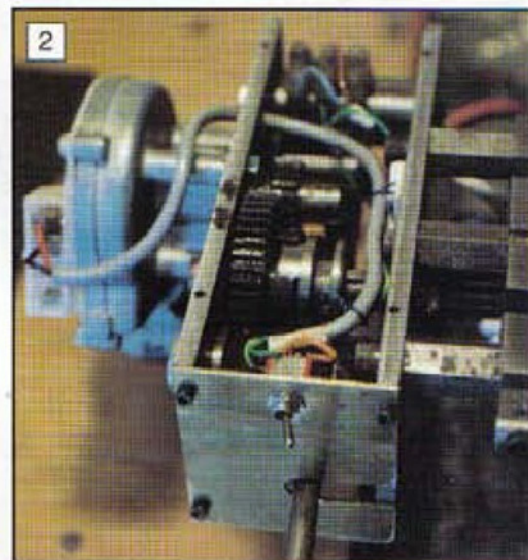
Tel No: _____

Rexon UK Ltd
1 The Summit, Barbot Hall Industrial Estate
Mangham Road, Rotherham, S61 4RJ
Tel: 01709 361158 Fax: 01709 821966

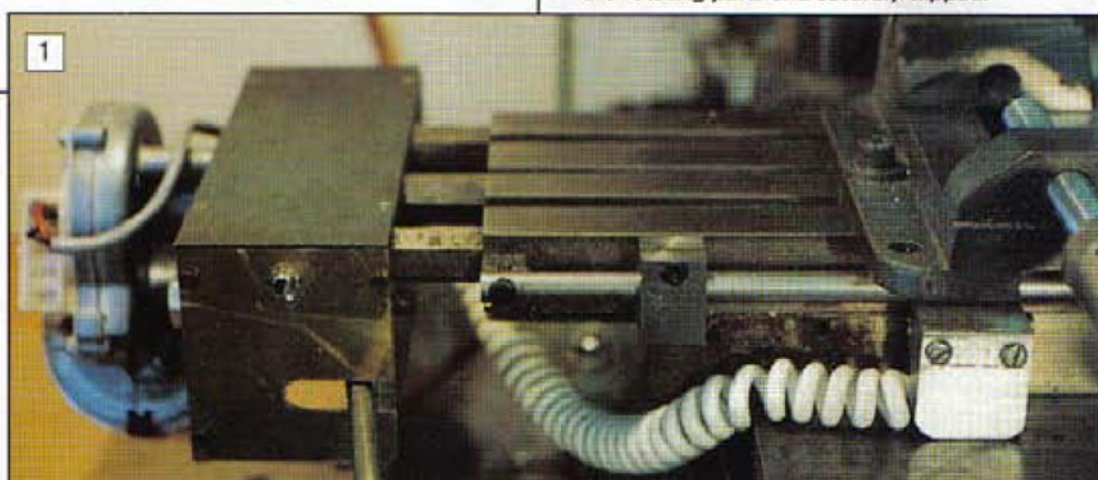
FIG. 1.
GENERAL ARRANGEMENT



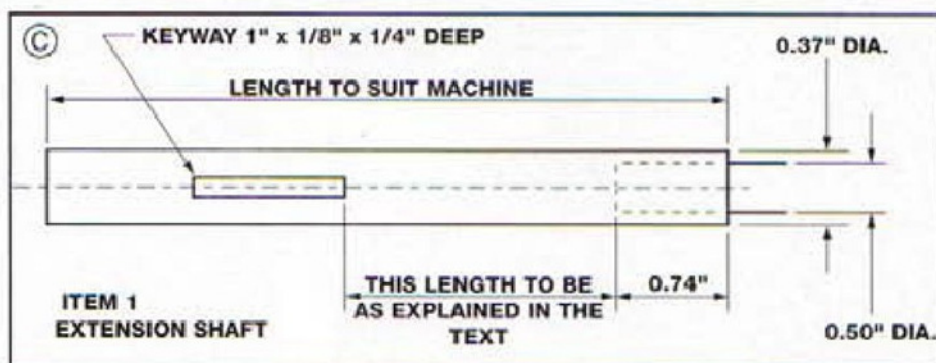
In common with many milling machine owners, Stan Wade of Guiseley found hand feeding the table a bit of a chore, so devised a drive employing a surplus car windscreen wiper motor. In our next issue, he will describe an auto stop system.



1: A general view of the self-act attachment. 2: The dog clutch can be seen clearly in this view. The wire to the forward/reverse switch must be clear of the rotating parts and securely clipped.



A SELF ACT FOR THE MILLING MACHINE



I have been using a Sharp vertical miller for a number of years, and it has given every satisfaction, but I have always put up with the hand feed rather than enjoyed it. Another of my interests is attending steam rallies and, browsing round the stalls, I saw a brand new Delco windscreen wiper motor, just the thing for a self act. The price was very reasonable, so it was promptly purchased, then put in the 'jobs to do' box and forgotten about.

A visit about a year later to a fellow club member's workshop revived memories, as he had a similar set-up to the one I had envisaged for my machine. Back home, a visit to my chief supplier (the scrap box) revealed most of the necessary materials, so on with the job. (Editors' note: *If contemplating undertaking this work and using a windscreen wiper motor, remember that you will need one where the output is rotary, not part of an arc, as*

was the case with some of the older motors which may still be found).

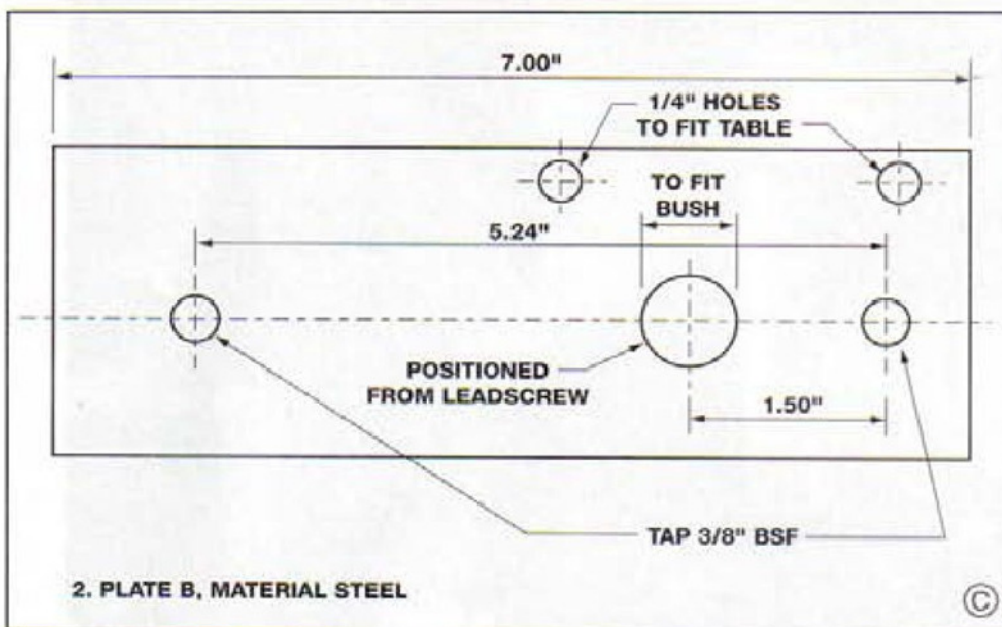
No drawings were made, as I wanted to use available metal and parts as found as much as possible, but a sketch was made to obtain some vital measurements, the main one being for the lead screw extension (See Fig. 1, the General Arrangement Drawing).

Drawings have been made since the modification was made, but sizes are for the Sharp machine, so would have to be adjusted for other makes, and imported machine tools.

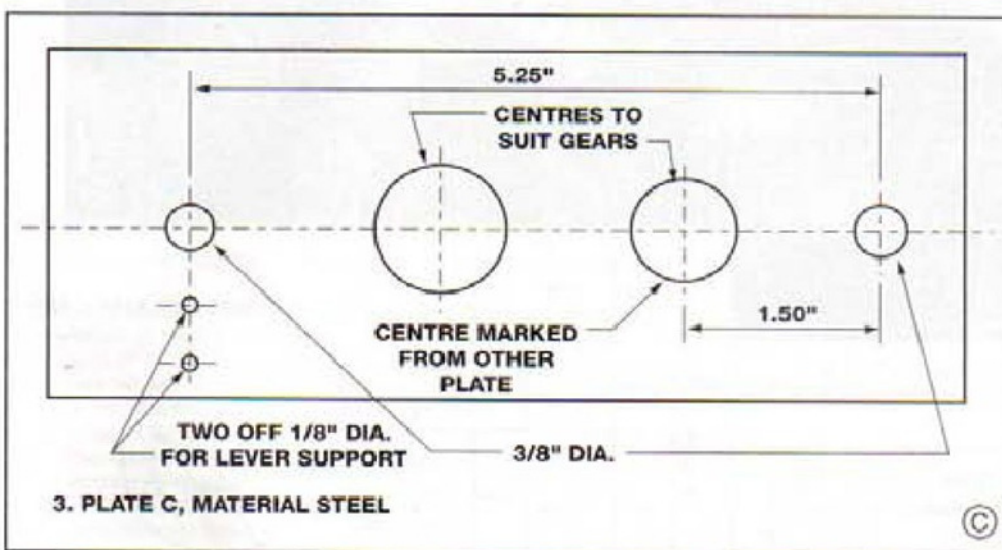
Lead screw extension (Item 1)

As I did not want to dismantle the table more than necessary, the first part to make was the lead screw extension, as once this was fitted, all could be reassembled and the machine used to make other parts. This extension would have to have a keyway milled in it to accommodate the sliding dog clutch, and this had to be done before any dismantling could take place.

I measured the distance from the free end of the lead screw to the end of the table; to this was added $1\frac{1}{16}$ in. (the length of the spacers, Item 7) plus $\frac{3}{8}$ in. (the plate thickness plus the bearing flange and $\frac{1}{16}$ in. clearance) plus $\frac{3}{4}$ in. to allow fitting to the lead screw. The result of this fixed the start of the keyway, which was



2. PLATE B, MATERIAL STEEL



3. PLATE C, MATERIAL STEEL

cut 1in. long by $\frac{1}{8}$ in. wide by $\frac{1}{4}$ in. deep.

This part was made over-length, as the finished length could be found later, on final assembly.

The table was then dismantled and the leadscrew turned down at the end, to fit the extension. Both were then drilled for a roll pin.

I was now able to screw the leadscrew into the nut and then to fit the extension, with the roll pin.

The plates (Items 2 and 3)

These were made from two pieces of salvaged steel plate. These already incorporated a number of holes, and I managed to make use of some of these, so this fixed some of the measurements. Although I used steel, any other plate of a similar size would be acceptable. It is not even necessary for it to be of the same thickness. Whatever is available could be adapted.

My plates are not the same size and shape, one being $2\frac{1}{2}$ in. wide and the other $2\frac{3}{4}$ in. Both are $\frac{1}{4}$ in. thick, the narrow one (Plate B) being Item 2.

The fixing hole centres in Item 2 were made the same as those in the leadscrew support and, as I wanted the top surface to finish flat, the holes were raised $\frac{1}{16}$ in. to

allow for a cover plate to be fitted. They were set back about an inch from the end of the plate, as this was to be cut off later. The hole positions were then transferred to the end of the table (not forgetting to allow for the $\frac{1}{16}$ in.) and drilled and tapped $\frac{1}{4}$ in. BSF. A point to watch when carrying out this operation is to make sure that the holes in the table do not run into the tee slots. In my case there was not a lot of room.

The plate was now screwed to the table, ready for marking the position of the leadscrew extension. This position is the most critical in the whole set-up, and was done as follows:-

The leadscrew support was fastened in place and the table laid on its back on the surface plate. This, in my case, is the top of the bench, which is a kitchen worktop. Being Formica covered, it is flatter than anything else available to me.

The hole position in the leadscrew support was carefully measured and transferred to the plate, and the centre marked. The best way to do this, I found, was by using a scribing block, setting the pointer first to the top of the hole then marking the plate, and then doing the same with the bottom. By turning the table a quarter of a turn, on to a pair of parallels under the table front, I was able to do the same again, and thus finished up with a

square marked on the plate from which it was easy to find the centre and make a centre punch mark.

On removing the plate, I was able to reassemble the table, so enabling me to use the machine by hand again, as there was more milling to do before I could enjoy the benefits of power feed.

I next clamped both plates together and drilled a pilot hole through them. The holes for the leadscrew bushes were bored using the lathe, and all other measurements were taken from these. The bushes were a pair I have had for a long time, just waiting for such an opportunity. They were bronze, $\frac{3}{4}$ in. dia. x $\frac{1}{2}$ in. bore x $\frac{1}{2}$ in. long, with a flange at one end.

The other plate (Plate C), Item 3, was now marked with a centre line running through the bearing hole, parallel to the top edge.

The next requirement was a pair of gearwheels. I used Myford change wheels, a 20 tooth driving a 45 tooth, as I had these spare. The 45 tooth was the largest that would go in the room available. The centres were measured and the distance marked from the bush centre towards the rear, on the line on Item 3, then centre punched. This mark was used to mark out the holes for fixing the windscreen wiper motor and was also the centre for the motor shaft. These holes are, of course, dependent upon the type of motor to be used.

The Delco motor has three screws, located in a circle round the output shaft, so the holes for these were marked on the plate and drilled to fit the bolts. The shaft hole was bored out large enough to enable the 20 tooth gear to pass through, thus enabling the motor to be removed if ever it becomes necessary.

The $\frac{3}{8}$ in. holes are for holding both plates together, but with the 2in. x 1in. dia. spacers (Item 7) in between, so the next job was to transfer the position of these to Item 2 and to drill and tap them to take the bolts. I used some which were $\frac{3}{8}$ in. BSF x 3in. long.

Two $\frac{1}{8}$ in. holes were drilled for the actuating lever pivot support (Item 11). These can be opened out later to suit the screws used to fasten the support.

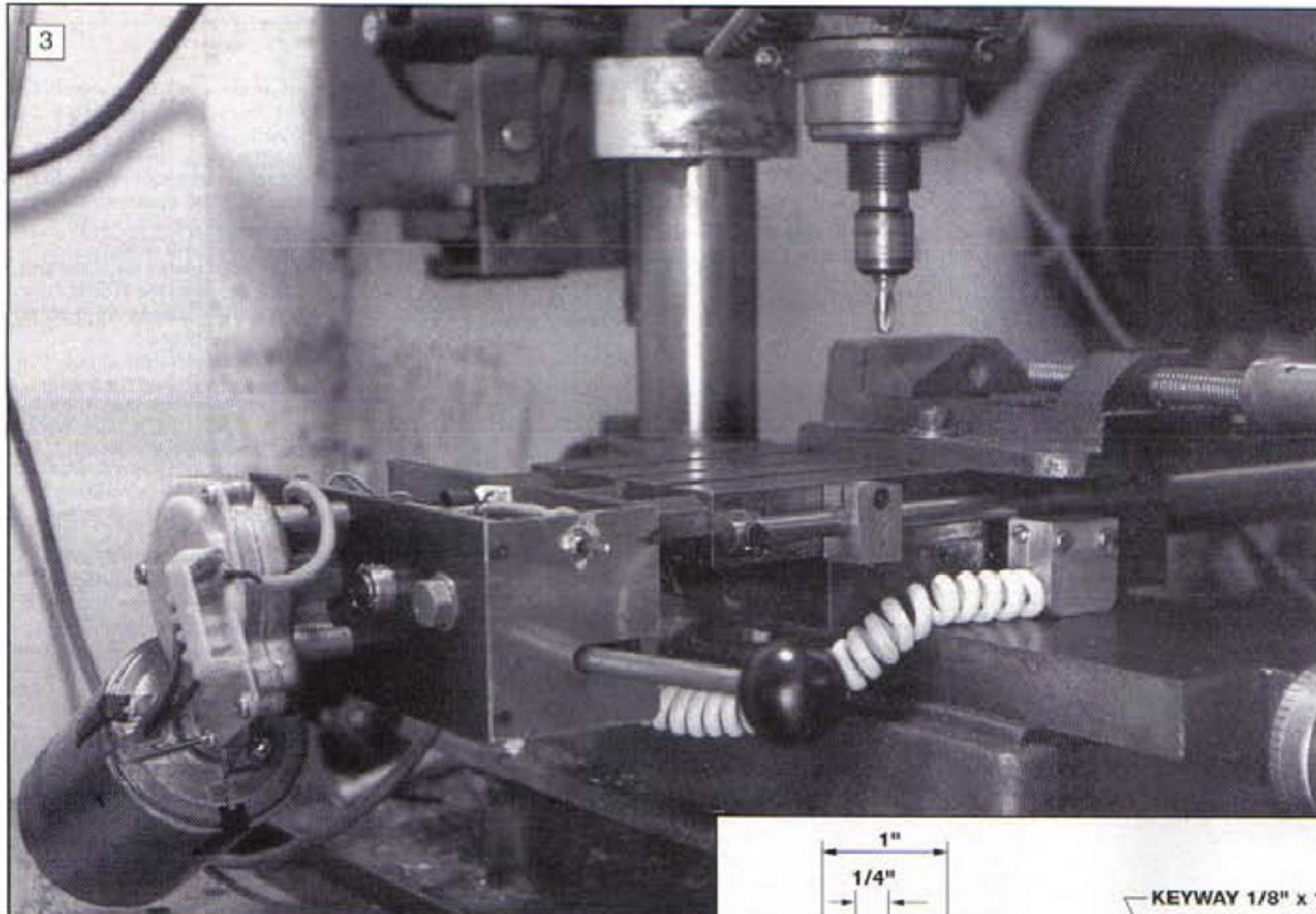
As the plates needed to be of no particular length, they were marked out long enough to allow for the spacers and then cut with a slitting saw in the milling machine.

Motor shaft extension (Item 4)

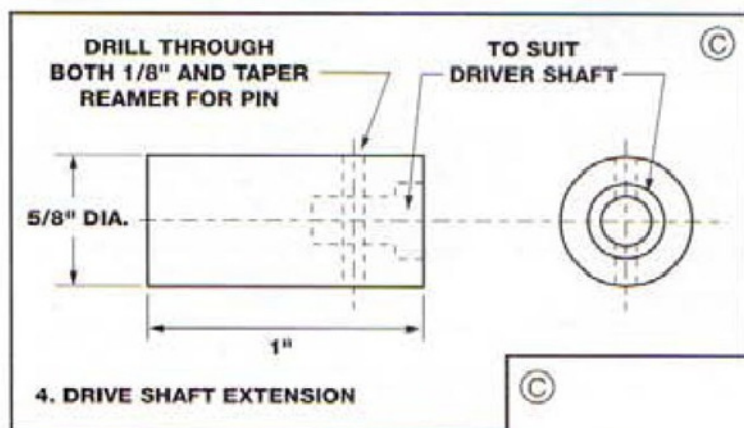
As the motor shaft was short and had a $\frac{5}{16}$ UNF thread, an extension had to be made to fit the $\frac{5}{8}$ in. bore of the gear wheel. This was made as per drawing, screwed on as tightly as possible, then both were drilled and reamed to accept a $\frac{1}{8}$ in. taper pin. This was cut off flush at the small end and $\frac{1}{8}$ in. left protruding at the other, so that it would fit the keyway in the gear wheel. I tried to get as tight a fit as I could, so that the gear had to be pressed on (I also put Loctite on the shaft for luck!).

45 Tooth wheel and driving dog assembly (Item 5)

The dog was made from a piece of $1\frac{1}{2}$ in. dia. steel, $\frac{5}{8}$ in. thick. The first



3: The Delco windscreen wiper motor fits neatly on the end of the unit. The white coiled cable is part of the auto stop system, which will be described in our next issue.

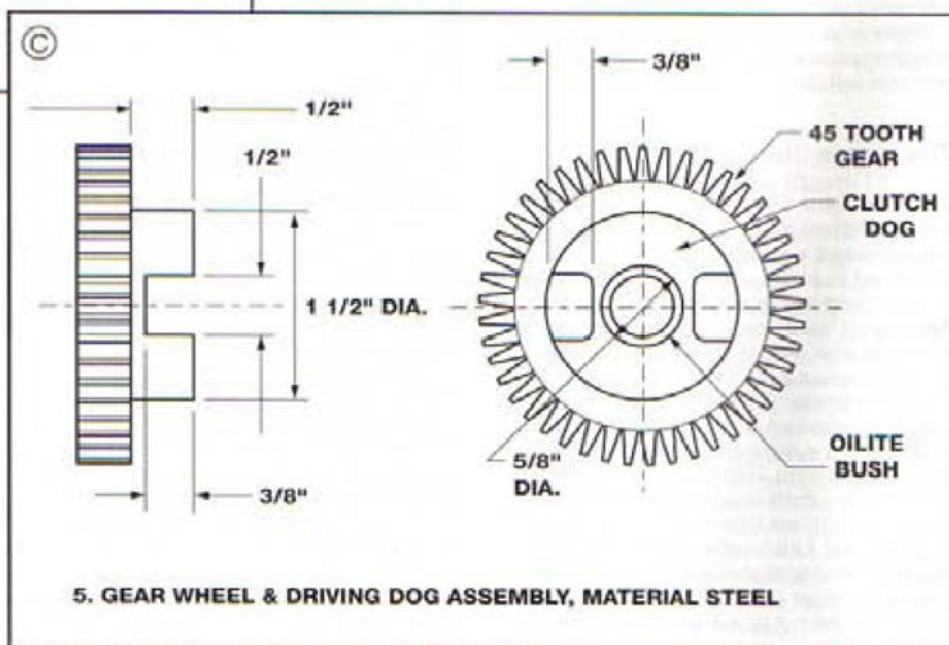
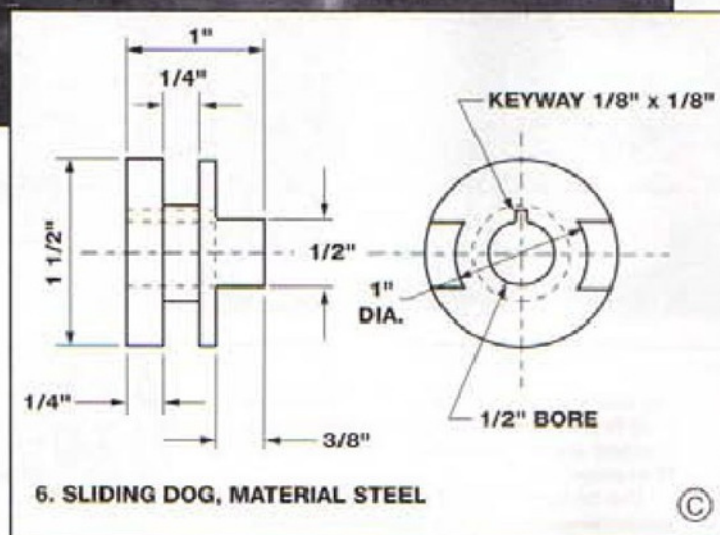


operation was to face off one side and bore out $\frac{5}{8}$ in. to match the Myford wheel. These items would be fastened together later, with an Oilite bush fitted to both. The other side was faced off to give a thickness of $\frac{1}{2}$ in.

The next operation was to mill out the slots for the dog, these being $\frac{1}{2}$ in. wide x $\frac{3}{8}$ in. long and $\frac{3}{8}$ in. deep. I found it best to clamp the disk down on the milling table and to take all measurements from the centre hole, using a $\frac{1}{4}$ in. slot drill for the machining.

The gear wheel as supplied has only a small face machined in the centre, the rest being as cast, so I found it best to mount it in the three jaw and to relieve the centre until it faced up to $1\frac{1}{2}$ in. dia. to take the dog.

The next operation was to mount both on a Oilite bush and then drill and tap for screws to fasten them together. I used 4 x 4BA countersunk.



Sliding dog (Item 6)

Another piece of $1\frac{1}{2}$ in. dia. steel was chucked in the three jaw, faced off and bored $\frac{1}{2}$ in. diameter. The groove was then cut with a parting tool, $\frac{1}{4}$ in. wide x $\frac{5}{16}$ in. deep, before the piece was parted off $1\frac{1}{16}$ in. long.

The next job was to re-chuck and face the other end, to finish 1in. overall, then to cut a recess in the centre 1in. dia x $\frac{3}{8}$ in. deep. The dog teeth now needed milling, and I did it as follows:-

A short length of $\frac{1}{2}$ in. dia. bar was put through the hole, then the piece clamped vertically in the milling vice with the bar resting on the top of the vice jaws. A $\frac{3}{8}$ in. end mill was lowered until it just touched the top of the bar, and a cut taken right across the end of the metal to the full diameter of the cutter. On turning the blank over and resting it on the jaws as before, it will be seen that the cut portion holds the piece in a position ready to be cut in a similar manner, thus completing the dogs.

All that is left to do is to cut the keyway. I marked the position and then drilled a $\frac{1}{8}$ in. hole before filing the slot $\frac{1}{8}$ in. wide x $\frac{1}{8}$ in. deep, with square corners, to take the key in the leadscrew extension.

Spacers (Items 7 and 8)

Spacers are basically of two types, the larger of which fit between the two plates. One of these has a cut-out for the large gearwheel, which also maintains the gear in its position on the shaft. The smaller ones fit on the end of the table and hold the assembly in the correct position. Because the table tee slots come right to the end of the table, a gap has to be left between the table end and the unit to allow tee nuts to be inserted in the slots.

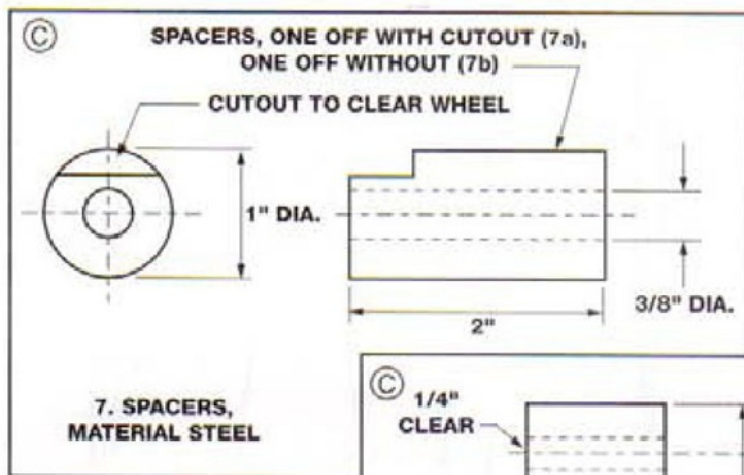
Assembly

Assembly is fairly straightforward, but I found that there were one or two points to watch. As mentioned above, it was necessary to ensure that the spacers did not block the tee slots and that the clutch dogs went home in both rotational positions. If they do not, then a bit of careful fitting will be required.

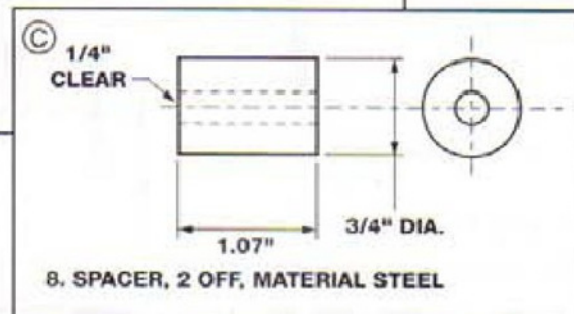
Actuating lever assembly

When I was sure that all was operating satisfactorily, I started on the actuating lever (Item 9) and its support. The latter (Item 11) was made from a length of 1in. bar, a slot being milled in it for the lever and a cross hole drilled for the pin. The top fixing hole was drilled and tapped with a suitable thread, leaving the lower hole to be marked on assembly.

The lever that I used was one that I had in stock, and which only needed drilling for the bronze peg (Item 10). The position for this was measured from the job, its distance from the pivot hole being the same as that between the centre of the support and the centre of the leadscrew extension.



On assembly, the position of the lower support hole can be ascertained, then marked, drilled and tapped to suit.



Power supply

For a power supply, I have used a 10 amp battery charger, which also provides 12 volt power to the rest of the workshop for extension lights, small drills etc.

For power outlets/pick-up, I use 5 amp three pin plugs and sockets—the old fashioned type with round pins. With this method, there is no chance of making a mistake and plugging low voltage equipment into the mains.

mounted in a box, on the wall, out of the way of stray cuttings. The speed can be controlled with ease. I mounted the forward/reverse switch on the front panel of the drive unit, above the actuating lever. This switch is a two pole, double throw, centre off type, as this makes sure that the drive cannot be reversed without first being stopped; doing so is not good for the electronics.

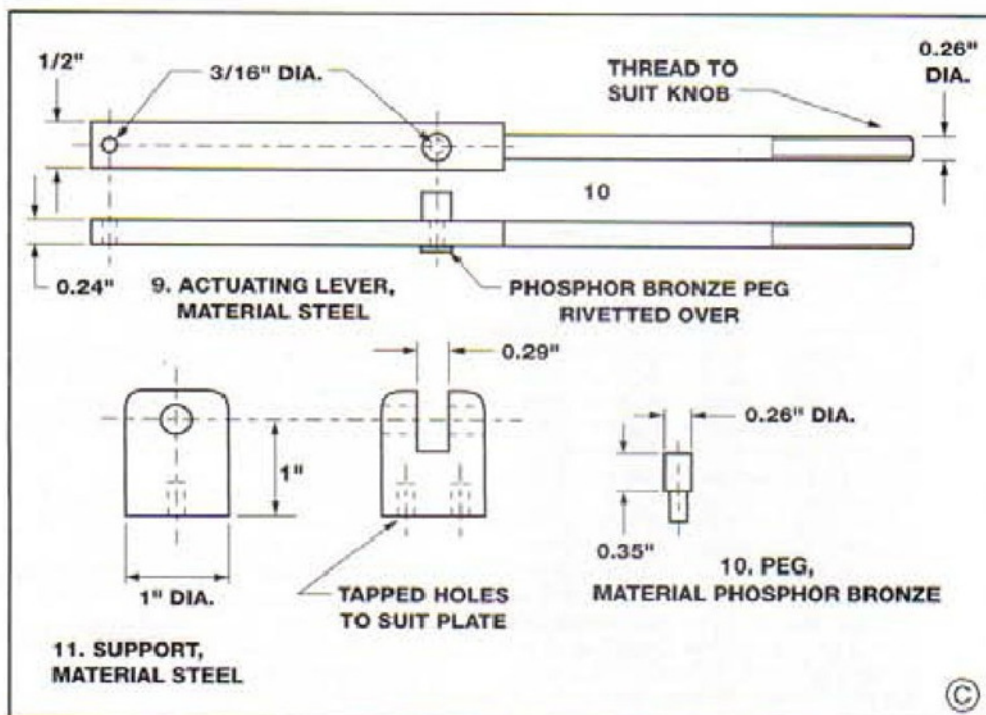
Speed control

The speed control that I have used is one that is described in page 69 of *Electric motors in the home workshop*, by Jim Cox. (Published by Nexus Special Interests, ISBN 1-85486-133-6, Workshop Practice Series book No 24) which gives very satisfactory results. The unit is

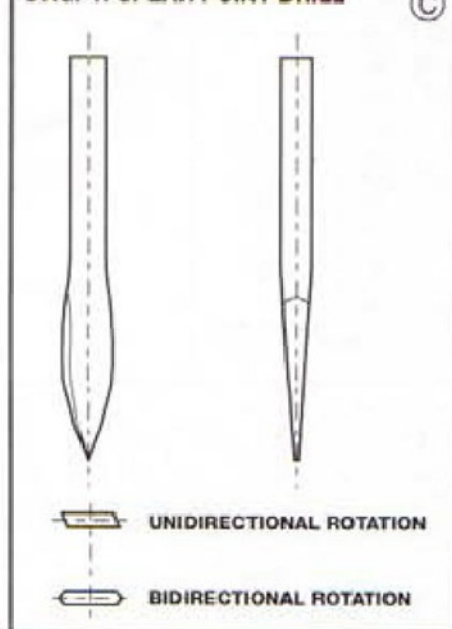
Top panel

This is just a cover over the top of the unit, and can be made of whatever is available. It may be fastened on with screws or spring clips.

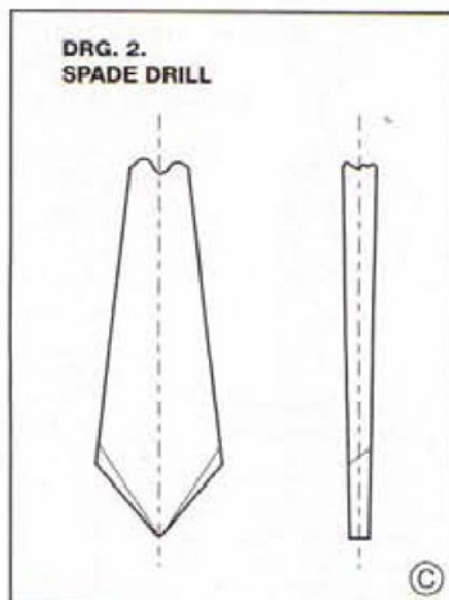
The whole job was worthwhile and did not take long to do, once I got down to it. Milling is now more of a pleasure, and a much better finish is obtainable.



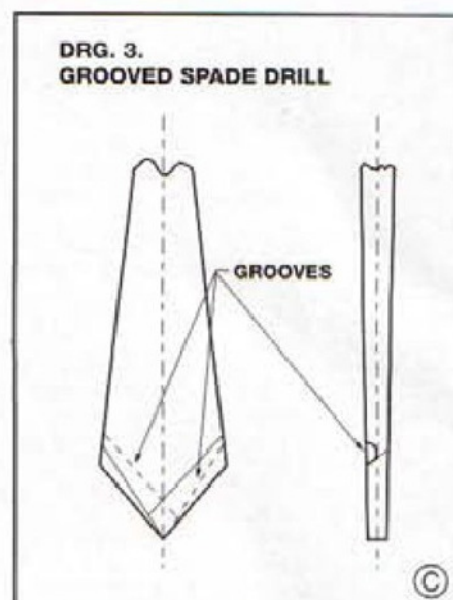
DRG. 1. SPEAR POINT DRILL



DRG. 2. SPADE DRILL



DRG. 3. GROOVED SPADE DRILL



DRILLS AND DRILL SHARPENING

Much has been written about the various methods of sharpening drills. Philip Amos reviews the types of drill available and some of the possible methods of sharpening. Instead of attempting to describe these in detail, he gives us an extensive bibliography for further reference.

Background

This article relates only to metal cutting drills, and excludes those intended for masonry or glass and the wide variety intended only for woodwork.

Historical

Almost since time immemorial, drills of the spearpoint type shown in **Drawing 1** have been used to make holes in metals. Their action was rubbing, and it was not an efficient mechanism to achieve the result required. With the industrial revolution, spade point drills (**Drawing 2**) evolved, and although these still had a rubbing action, the holes produced by each drill were more uniform in size. By grooving the edges as shown in **Drawing 3**, the action changed from rubbing to cutting, with greatly improved efficiency. However, these drills tended to wander in deep holes. **Drawing 4** shows the next development, which was designed to offset this problem by having a cylindrical edge section for guidance.

Then, in the mid 19th century came the straight flute cylindrical type to improve this aspect. Its end was shaped with two backed off conical surfaces, but it still had mainly a rubbing action (see **Drawing 5**).

Finally, the twist drill (**Drawing 6**) was developed from the straight flute type. This had two advantages—firstly the helical grooves produced positive rake on

“To Quorn or not to Quorn, that is the question.”

the cutting edges and secondly, the helical grooves fed the chips back up the hole out of the way.

Straight flute drills are not shown in Holtzappel's book of 1846 (Reference 1), but the 'Morse twist drill' is illustrated in Spon's book of 1885 (Reference 2).

The geometry of the shaping and sharpening of twist drills was addressed in the seminal paper by L. A. Van Royen in *Model Engineer* in 1913 (Reference 15). In his paper he illustrates a grinding attachment made by the Washburn shops of Worcester Polytechnic in Worcester, Mass. USA. (See **Drawing 7**).

Based on this approach, drill sharpening attachments (reported in M.E.) were designed by Potts in the late 1930s and Duplex (Ian Bradley & Dr. Norman Hallows), first in 1951 and then in 1963/4. The latter design is still available (Reference 13).

In more recent times, the Van Royen approach has been reworked with some amendment by Frank Fallows, and a redesign produced in 1991 (Reference 14).

Four facet grinding, although known since about 1905, has only become popular since World War II. Both it and six facet grinding are commonly used for drills employed in the manufacture of electronic printed circuit boards.

Tool and cutter grinders such as the Quorn, the Kennet and the Stent lend themselves to sharpening drills by this method.

Present day drill types (some of these are shown in Photo 1)

(i) Spade Drills

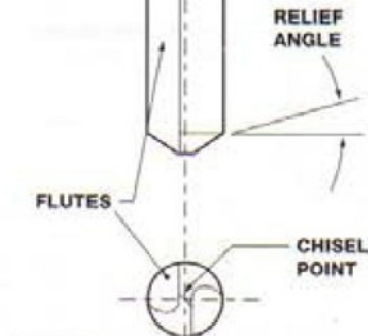
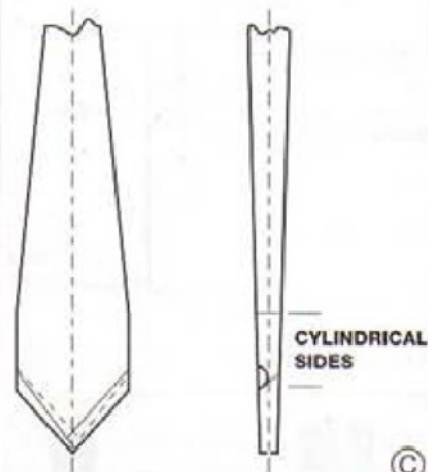
These may be forged from a single piece of steel, but more usually comprise a blade of tool steel attached to a mild steel shank, as shown in **Drawing 8**. These drills are used for 1 - 6in. plus diameter holes.

The grooves along the cutting edges can be readily effected by the use of an end milling cutter, with the work held at an appropriate angle. The stiffer the shank the better, but its diameter must still allow chips to pass by. About $\frac{2}{3}$ of the drill blade diameter might be appropriate.

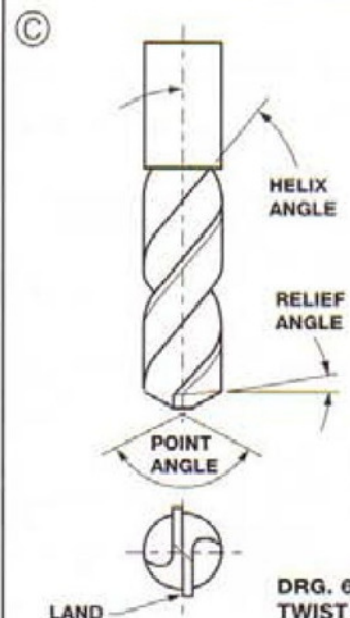
Commercial shapes available (e.g. Waukesha) are shown in **Drawing 9**. They are frequently used in turret/capstan lathe operations to produce holes larger than 28 mm. Usually they do not revolve, and operate horizontally. In special purpose machines, they are often in inverted positions, so that the chips drop out under gravity.

If chip breaking grooves are made in the cutting faces, they must be at different radii from the drill axis on opposite faces, otherwise there would be no cutting action at a particular radius if both grooves were at that radius.

**DRG. 4.
IMPROVED SPADE DRILL**



**DRG. 5.
STRAIGHT FLUTE DRILL**



**DRG. 6.
TWIST DRILL**

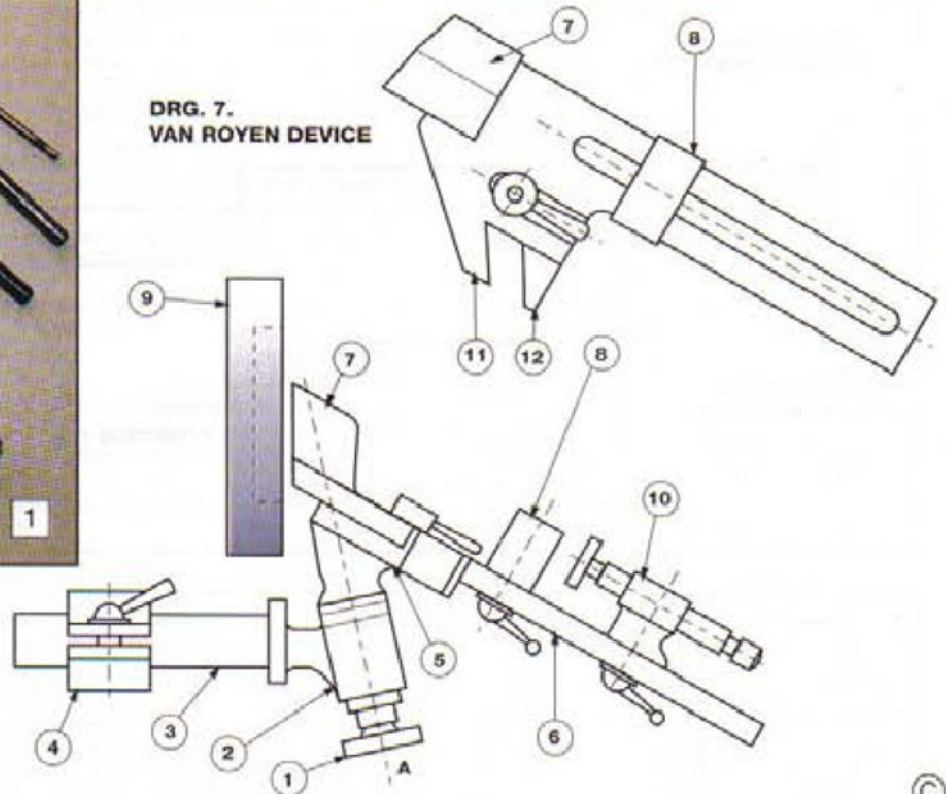


From bottom to top - Sloccombe centre drill; reduced shank drill; Morse shank drill; pilot point drill; long series drill; jobber's drill; panel drill.

The power required to drive spade drills into steel is considerable. Worked examples in Reference 9 show that a 2in. dia. drill requires about 4 kW. As the power varies with the square of the drill diameter, a 1in. diameter drill would need about 1 kW. These power consumption figures are for making the full diameter hole in one pass; lower power requirements would apply for progressively opening out holes.

In 1953, at the Westinghouse Manufacturing Laboratory in Pittsburgh USA, I witnessed a demonstration of an experimental procedure in which a 1/2in. dia. spade bit of conventional shape, with grooved edges and chip breaking grooves across the faces, was rotated at 20000 rpm by a router, and driven by an air cylinder through a bar of 1/2in. thick copper. This action was virtually instantaneous and rather like a punching operation. It left a clean hole and the bit remained quite cold after the action.

**DRG. 7.
VAN ROYEN DEVICE**

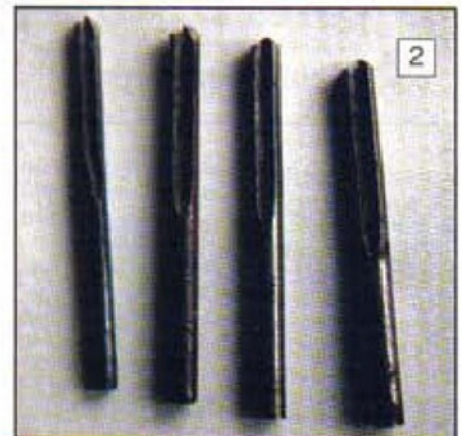


(ii) Straight Flute Drills

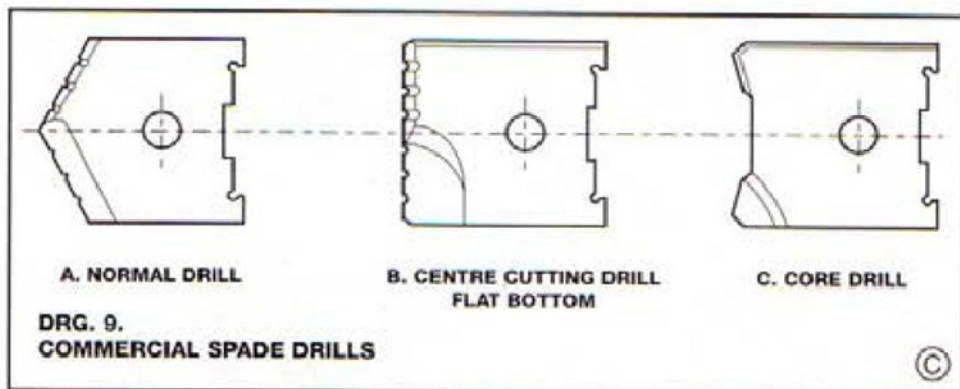
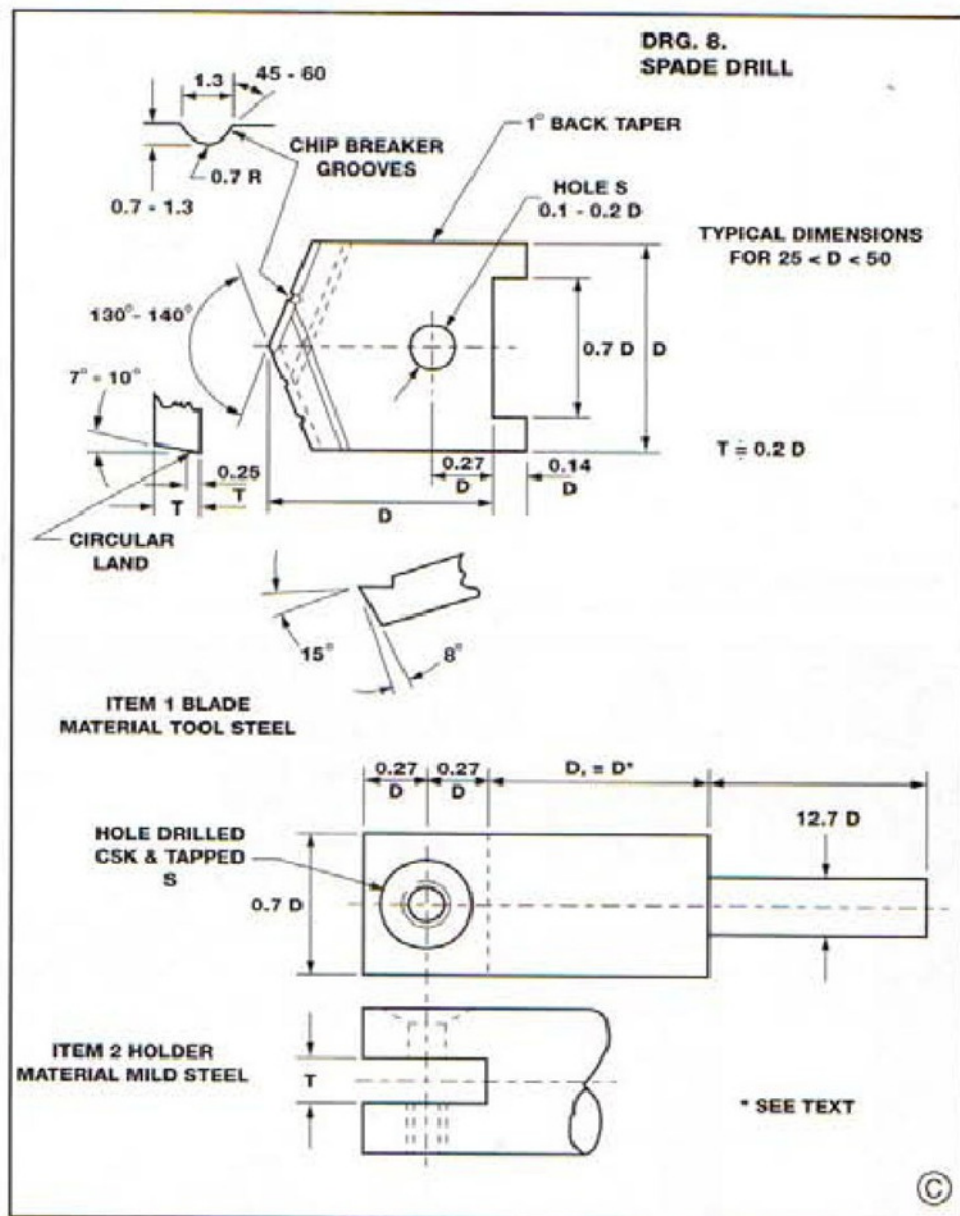
These continued in use until about World War I, particularly for drilling brass and soft metals. In effect, these drills have zero rake on the cutting edges, but have relief clearance ground on the end. In soft materials such as brass, tools with positive rake tend to dig in, so straight flute drills have some advantage for use with these materials. I have a (very) few left over from my father's tool kit. They do not seem to appear in any catalogues nowadays (See **Photo 2**).

(iii) Twist Drills

Originally known as Morse Twist Drills, as Morse played a large part in their development, they now represent the bulk of drills used in engineering



Straight flute drills.



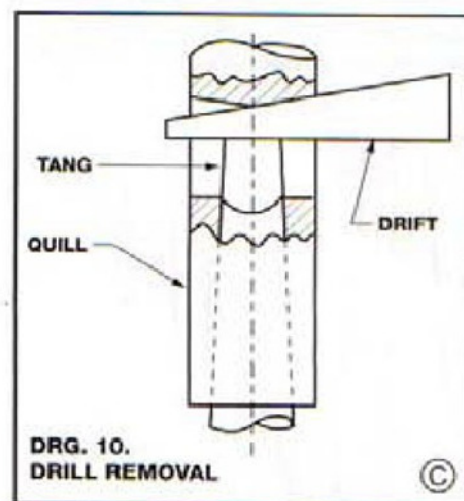
workshops world-wide. When first introduced, they were made of high carbon steel, but are now almost universally made of high speed steel. They are catalogued in a wide range of diameters, both metric (from about 0.2 - 20mm) and Imperial (from No.80 - 0.0135 - 0.75in.) with parallel shanks; and metric (from 2 - 52mm) and Imperial (from 1/16 - 3in.) with Morse taper shanks.

Parallel shank drills are available in four lengths - stub, jobbers, long series

and extra long series, with jobbers being the most common; the other types have a restricted range. Stub drills are intended for holes 2 to 4 diameters deep; jobbers 4 to 10; long 5 to 12 and extra long up to 30 diameters deep. Panel drills are double ended stub drills.

Taper shank drills are available in standard or a more restricted range of extra length types.

Twist drills are manufactured with slow (22.5 deg.), normal (35 deg. to 40 deg.) and fast (45 deg. to 50 deg.) helix angles, but



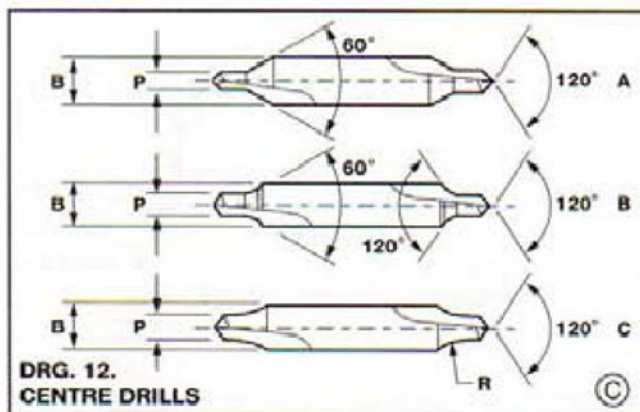
supplies of drills other than normal helix are difficult to find.

(iv) Reduced Shank Drills

These are similar to parallel shank twist drills, but have the shank reduced in diameter below the drill diameter. They are sometimes referred to as Blacksmith's Drills. In general, they are made in three series, having 1/4in., 3/8in. and 1/2in. dia. shanks respectively. The two former series seem to have little utility in a home workshop, but the 1/2in. series is most useful. The normal listed range of diameters is from 17/32 - 1in. by 1/32in. steps, and then to 1 1/4in. by 1/16in. steps.

I have, however, been able to obtain the intermediate 1/64in. steps from 33/64 - 39/64in., which have proved very handy.

Most pedestal and bench drilling machines with Morse taper sockets in the quills are equipped with transverse slots to take the drill tangs and to allow drill removal by means of a tapered drift (see **Drawing 10**). Alternatively, or sometimes as well as, provision is made for a drawbar, to ensure retention of Morse taper chuck shanks and the like. Usually the tailstocks of modern lathes are not so equipped, and taper shank



drills or chucks must rely on friction in the taper to resist turning under cutting load. For drills small in diameter relative to the Morse taper size, problems seldom arise, but for larger drills it is a different story. If the drill feeds itself into the work at a faster rate than the tailstock/chuck is fed forward, then there is a net force tending to pull the shank out of the socket, and as soon as it is loosened, the cutting load torque spins the shank in the socket. This can produce damage to both the shank and the socket; the latter is of the greater concern and should be corrected immediately with a taper reamer, to prevent increasing cumulative damage.

So, while reduced diameter parallel shank drills can be accommodated in the tailstock drill chuck, it may be better to make other arrangements. For example, they may be held in the headstock 3 or 4 jaw chucks in some cases. Another solution is to make a split sleeve holder to fit the tool post on the top slide, as shown in **Drawing 11**. If this is made to accommodate $1/2$ in. diameter, then it can be used for reduced shank drills from $1/2$ - 1 in. or more diameter. Furthermore, it is then possible to operate with power feed, which produces more uniform holes.

(v) Slocombe Centre Drills

Such drills come in three distinct types, as shown in **Drawing 12**; the normal type a) That which produces a recess to guard the centre hole against damage.

b) That which yields a curved profile centre hole.

c) The latter aids precision in light work, but is not often used.

The normal type comes in eight standard

sizes, with body diameters 'B' ranging from $1/8$ - $3/4$ in., and pilot drill diameters 'P' from $3/64$ - $5/16$ in. The protected type body diameters range from 5 - 19mm, with pilot drill diameters 2 - 6.35mm.

(vi) Core Drills

With either three or four flutes, these are used to enlarge existing holes, be they previously drilled, flame cut or just cored holes in a casting. The existing hole diameter must exceed the web diameter of the core drill, as it has no chisel point and cannot cut its way into a solid workpiece. These drills have Morse taper shanks and range in size from $1/4$ - $1 1/2$ in. in $1/32$ in. steps (see **Drawing 13a**).

(vii) Pilot Point Drills

These are a relatively recent introduction and are probably intended more for DIY applications. The end has a short reduced diameter pilot, sharpened four facet, and the main drill is sharpened 'sort of four facet' (see **Drawing 13b**).

(viii) Concut Drills

As shown in **Drawing 14**, these are of two flute design (see also **Photo 3**). They are used to open out or elongate holes in thin materials - steel up to 2.5mm and softer materials up to 5mm thick. They have their end formed like a normal drill, so they are able to drill directly into solid material if required. There are various sizes to cover a range from 3 - 52mm diameter. I have two which cover 3 - 14mm and 8 - 30mm respectively. They are of moderate cost.

The hole sides are slightly tapered. The use of a steel washer with desired hole diameter placed over the drill gives a quick indication of when the drill has reached the desired size in the work.

(ix) Step Drills

These are made with two, three or four flutes, and are as shown in **Drawing 15**. They are intended to open out holes in fixed diameter steps (typically 4 to 11mm). They are suitable for

material up to about 3mm thickness (but some go to 5mm, and others to 10mm) and they are available variously with parallel or Morse taper shanks. They come in metric or Imperial forms - e.g. 5.5 - 35.5mm, $1/4$ - $1 1/2$ in.; 35.5 - 59.5mm, $1 1/2$ - $2 1/2$ in.; 60 - 100mm, $2 1/4$ - 4 in. They are expensive.

Geometry

(i) Spade Drills

This information has been mainly gleaned from References 5, 6, 8, 9 and 24. Referring back to **Drawing 8**, it will be seen that the blade is essentially a flat piece of plate, with its point angle 120 deg. to 140 deg. The lips are flat at a clearance angle of 8 deg. The blade thickness 'T' is about 0.2 times the drill diameter 'D'. For home workshop use, the maximum probable D would be 50mm and the minimum 25mm, so the blade thickness would range from 5 - 10mm. The outer diameter D is circular with a land of about 0.25T in width and a following clearance of 7 deg. to 10 deg. The chip breaking grooves are detailed. The lip grooves could be filed, but are better made by end milling.

The holder is probably suitable for general use, but dimension 'D1' could be increased if deeper holes were envisaged.

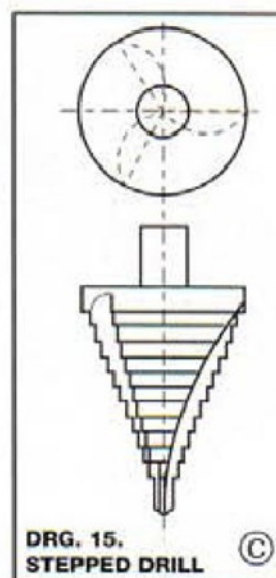
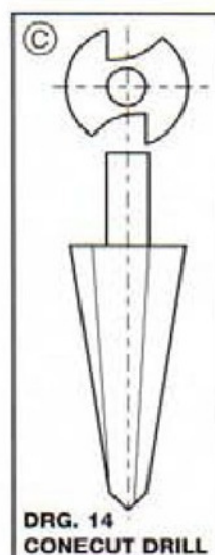
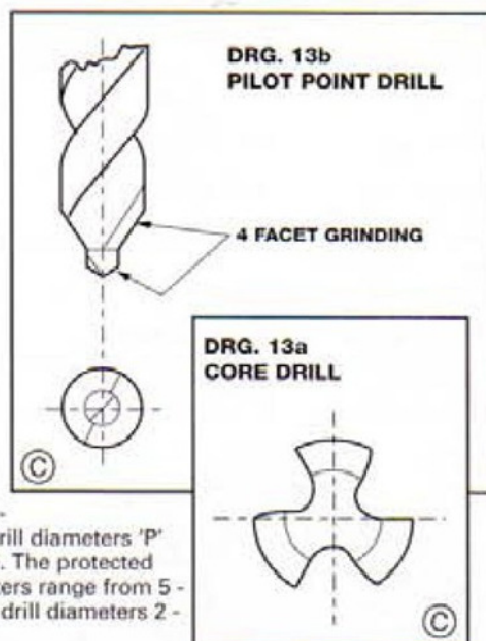
(ii) Straight Flute Drills,

(iii) Twist Drills and

(iv) Reduced Shank Drills

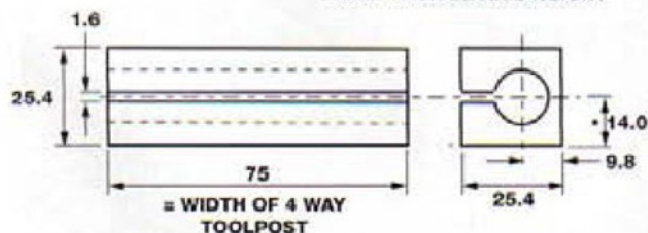
The cutting ends of these types can be shaped (sharpened) in a number of ways as shown in **Drawing 16** (see also **Reference 27**):

- a) Conventional point - relieved conical shape.
- b) Spiral (Helical?) point.
- c) Four facet point. (Six facet point similar).
- d) Split (Crankshaft) point.
- e) S-form chisel point.



DRG. 11. DRILL HOLDER

* DIMENSIONS SELECTED SO THAT DRILL AXIS HEIGHT EQUALS LATHE SPINDLE AXIS HEIGHT



MATERIAL MILD STEEL
SCALE FULL SIZE

f) Modified conventional point (Bradley); may also be considered as a form of web thinning (this will be dealt with later in the article). Its production and action are described in detail in Reference 4.

Types (b) and (e) require special machinery to produce.

The nominal diameter of a twist drill is the diameter of the lands; there is a small clearance to the actual drill body; Also, there is ground a slight taper from point to shank, to prevent a worn drill binding in holes.

It is important that the lengths of the two cutting edges of the drill are identical, and likewise the edges must be at the same angle to the drill axis (see **Drawing 17**)—otherwise the drill will cut oversize.

The web of a normal twist drill increases in thickness from point to shank. Thus, as the point is progressively sharpened, the web width at the point becomes greater, leading to problems of wandering at the start and greater power requirements during drilling. To overcome these problems, the web can be thinned by grinding, as shown in **Drawing 18**, which displays various methods. The adverse effects are not very noticeable for drills below about 10mm diameter, so this web thinning is not usually

applied to sizes smaller than this (see References 4, 5 and 7).

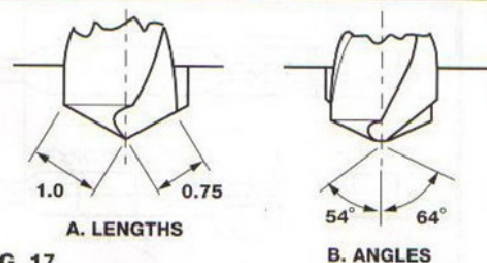
To address the tendency of twist drills to dig in when used on soft materials such as brass, narrow flats can be stoned on the cutting edges, thus yielding zero rake (see **Drawing 19**).

(v) Slocombe Centre Drills

The geometry of the Slocombe drill is shown in Drawing 12.

(vi) Core Drills

The end view of a core drill shown in Drawing 13a shows the differences between this type and a twist drill.



DRG. 17.
UNEQUAL CUTTING ANGLES

©

(vii) Pilot Point Drills

Refer again to Drawing 13b.

(viii) Concut Drills

Refer again to Drawing 14.

(ix) Step Drills

Refer again to Drawing 15.

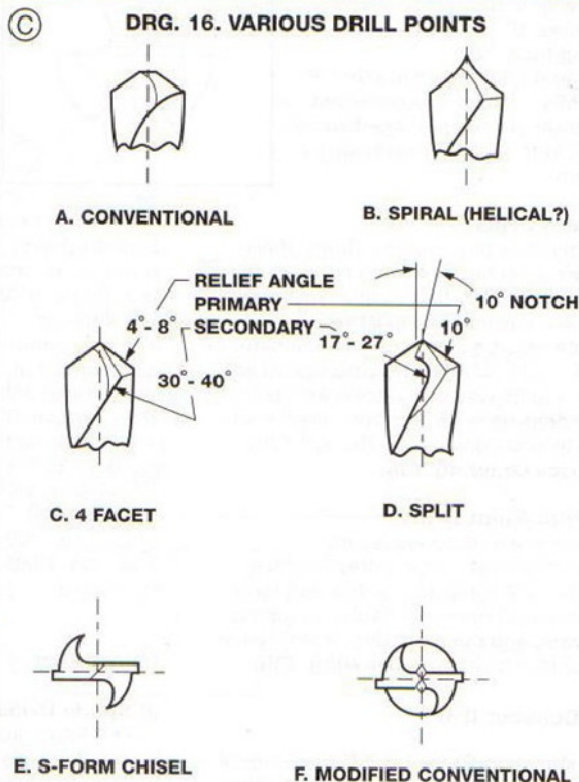
Commercial Drill Grinding Attachments

The style of drill sharpening attachment for use with bench grinding wheels of 150 to 200mm diameter, shown in **Photo 4** was popularised by General Hardware Manufacturing Co. of New York. It has been widely copied by Far Eastern manufacturers; mine comes from Japan and currently is priced at \$A 23.

Its advertised attributes are to sharpen drills from 3 - 19mm diameter. It has three adjustments. Drill point included angle can be set for 82 deg., 98 deg., 118 deg., 136 deg. and 176 deg. It has a lip stop which can be moved vertically to best suit different drill diameters, and it has a feed screw and locking nut to advance the drill for grinding. It is claimed to produce a clearance angle of 8 - 14 deg. depending on drill diameter.

In contra-distinction to the Van Royen / Potts / Duplex / Fallows approach, the attachment swinging axis is vertical to the mounting base, rather than inclined at 13 deg. towards the grinding wheel. The drill axis is a fixed distance of 3mm behind the rotation axis.

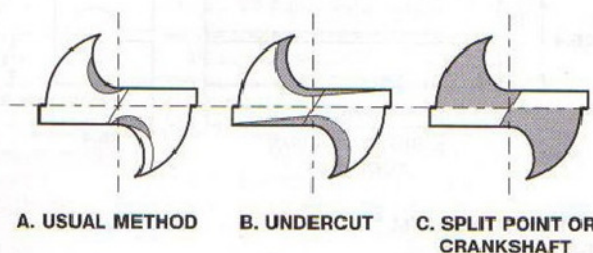
If one follows the operating



E. S-FORM CHISEL

F. MODIFIED CONVENTIONAL

DRG. 18.
WEB THINNING



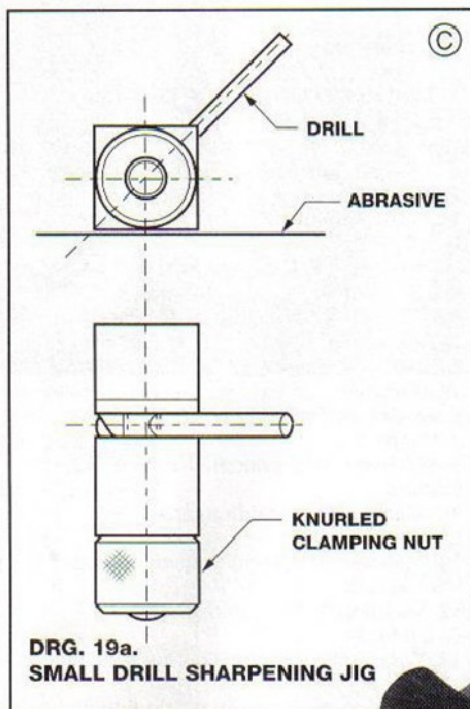
A. USUAL METHOD

B. UNDERCUT

C. SPLIT POINT OR
CRANKSHAFT

©

Commercial drill grinding attachment.



**DRG. 19.
POINT GEOMETRY FOR
SOFT METALS**

FLAT STONED AXIALLY TO
PRODUCE ZERO RAKE ANGLE



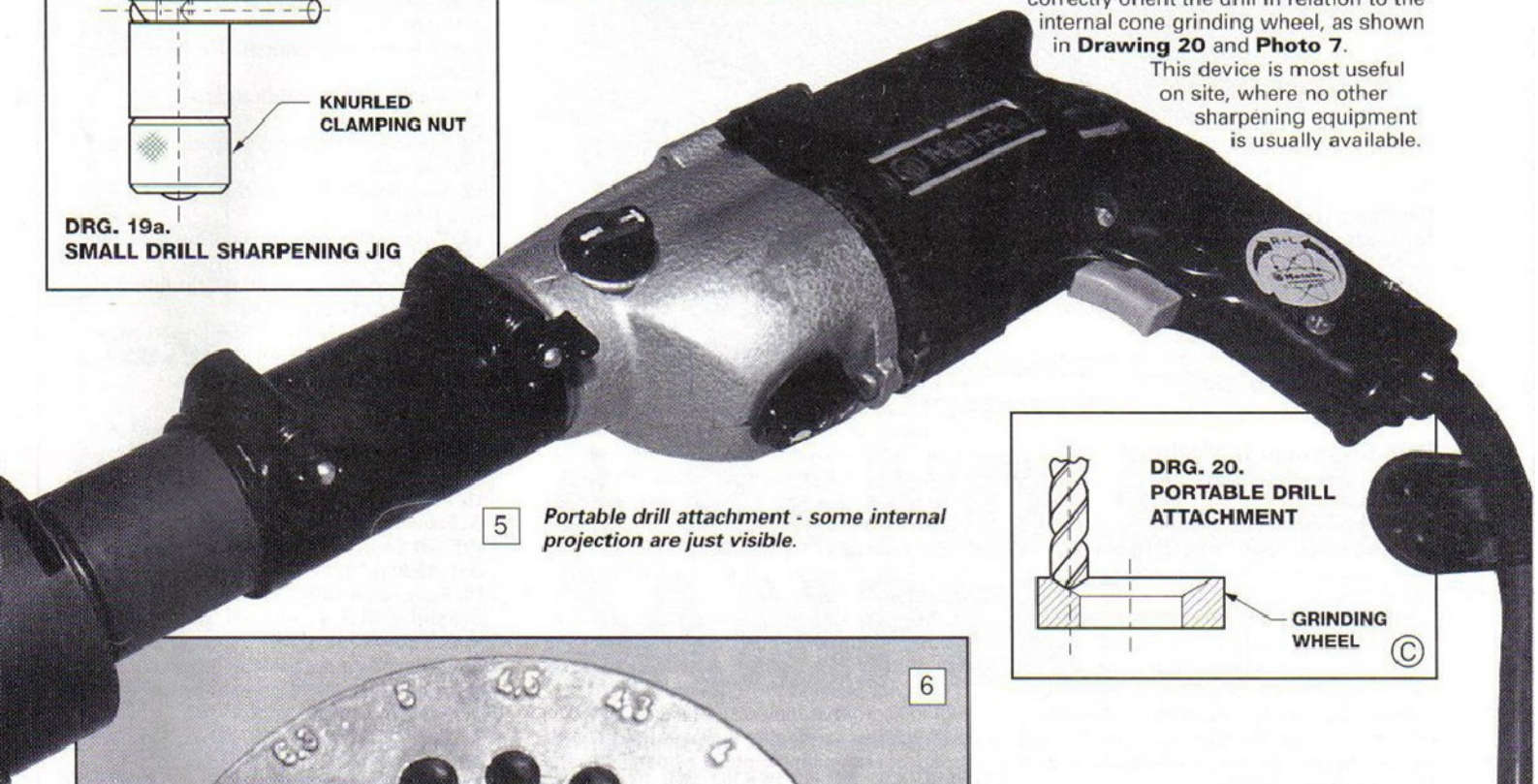
instructions, this attachment will allow satisfactory sharpening of drills within its diameter range.

Portable drill attachment

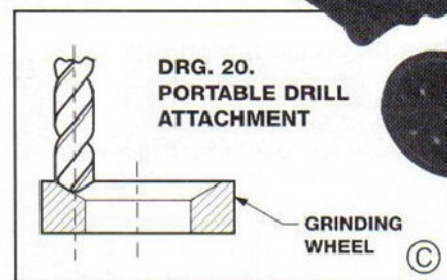
A number of firms market a device which fits on to the end of a portable drill, and which allows sharpening of a range of smaller twist drills. Mine is of Bosch manufacture, and is shown in **Photos 5 & 6**. The current price is about \$A 70. It covers a range from 3.6 - 10mm in 16 steps.

Projections inside the guide holes correctly orient the drill in relation to the internal cone grinding wheel, as shown in **Drawing 20** and **Photo 7**.

This device is most useful on site, where no other sharpening equipment is usually available.



5 Portable drill attachment - some internal projection are just visible.



With practice and care, acceptable results can be obtained, but the device should not be expected to produce precision results. Similar devices are marketed with self-contained motors.

Specialised toolroom drill sharpening machines

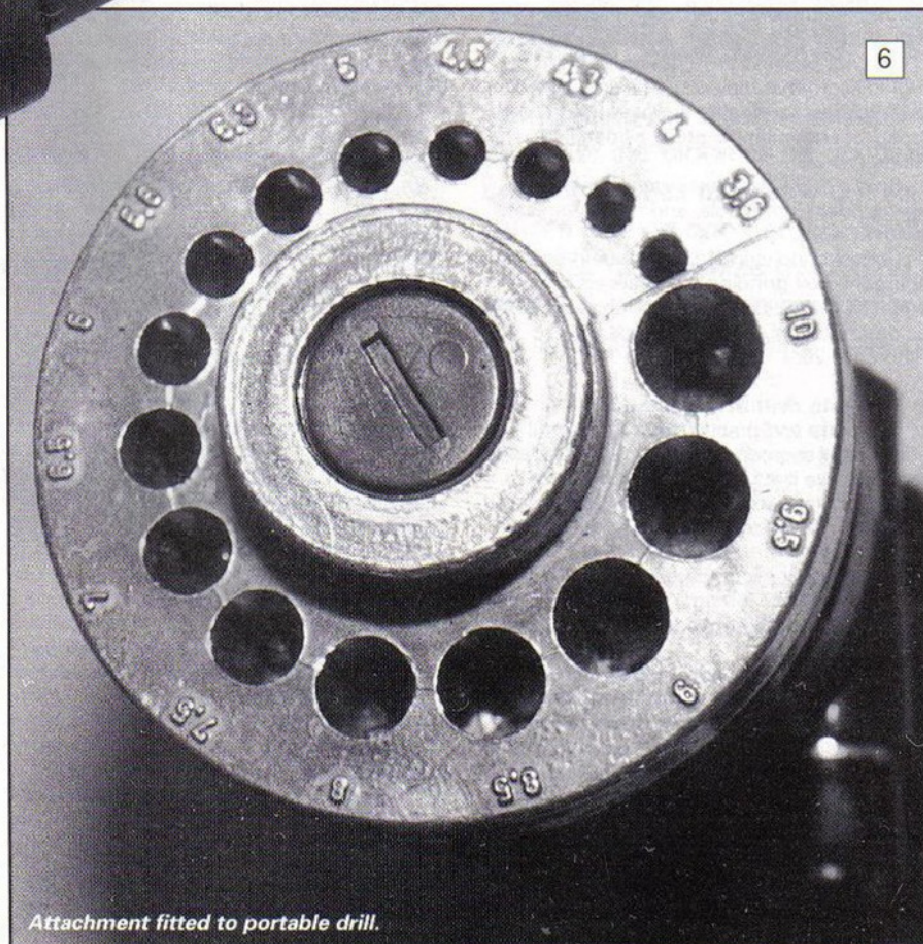
Although a variety of these are on offer, their pricing —\$A 300 and upwards— means that it is difficult to justify their acquisition for a home workshop. Three examples are:-

a) Davex Drill Doctor

3/32 - 3/4in., 1 HP motor, with Alox, Green Carbide and Diamond wheels. For use with carbide, HSS, standard, masonry, split point, cobalt and parabolic (?) twist drills. \$A 282 (1997)

b) Brierley ZB 50 Twist Drill Grinder
3 - 51mm, any drill geometry —Spiral point, Four facet, S-point, Split point. \$A 3000+ (1983).

c) Mello Spiramex ABH - 85 Drill Grinder
2.5 - 32mm. \$A 4800 (1983).





Grinding wheel for portable attachment.

Devices for sharpening small drills (say less than 2mm)

These usually comprise methods of holding the drills in correct orientation while they are moved past oilstone/abrasive paper or cloth/diamond laps (see **Drawing 19a**).

Drill Sharpening Methods

a) Offhand

This means the conical backing off on a grinding wheel by free hand operation. This requires the development of considerable skill if accurate work is to be achieved. It was a fairly common trade skill up until about World War II, but for most of this century, home workshop people have tended to use mechanical aids to get satisfactory results, rather than using the offhand method. References 7 and 23 contain helpful advice on offhand grinding to sharpen twist drills.

b) Van Royen/Potts/Duplex/Fallows type attachments

These devices produce excellent, repeatable results and are well worth the effort needed for their manufacture. Possibly, the Fallows design would be the best choice nowadays.

Reference 16 relates how such an attachment can be mounted on the Quorn.

c) General Hardware Type attachment (and clones)

The results from these are quite adequate and their low cost makes them an attractive approach to the drill sharpening problem. Reference 21 describes home made attachments, having a capacity range from 0.3 - 10mm dia. drills, and which may be extended to larger diameters.

d) Small drill sharpening

Over the years, a number of simple devices have been described, mostly allowing the drill to be held in correct orientation to permit it to be sharpened by moving it over a sheet of abrasive paper or cloth. Some use oilstones or diamond pads instead. Those described by Lautard

(References 10, 11 and 12), Brown (References 17 and 18) and Unwin (Reference 22) all seem suitable, with varying degrees of cost and difficulty to manufacture. It will be an individual's decision which type to select.

e) Quorn

This very useful machine can readily produce four facet (or six facet) points on drills. Professor Chaddock gives instructions on pages 110 - 115 of Reference 3. Peter Foyle comes up with a shorter procedure on page 282 of Reference 20. Pilot point types could probably be dealt with similarly in this way. A stand-alone four facet grinding jig is described in Reference 19.

Professor Chaddock also describes the reconditioning of centre drills on pages 116 - 118 of Reference 3.

I do not possess any core drills, but it would seem that they could be sharpened in a similar fashion to that adopted for the end facets of end milling cutters, as detailed in Reference 25.

Spade drill sharpening would be rather like grinding lathe tools, and readily effected on the Quorn.

Concave and stepped drills would be sharpened by grinding the near-radial surfaces in the flutes in much the same way as described for sharpening taps in Reference 26.

f) Portable drill attachment

With care and practice, this device will adequately sharpen twist drills within its size range. While it is useful on site, it cannot be considered as satisfactory as (c) above.

Conclusion

From all of the above, some conclusions can be drawn:-

i) Almost all commercially available drills are sharpened to a conventional point. To reshape one's collection to four facet would be an immense task, and the results may not be worth the effort. Hence, reshaping using a conventional grinding attachment of the Van Royen/Potts/Duplex/Fallows pattern or the readily available commercial General Hardware pattern seems to be the sensible way to go for straight flute, twist and

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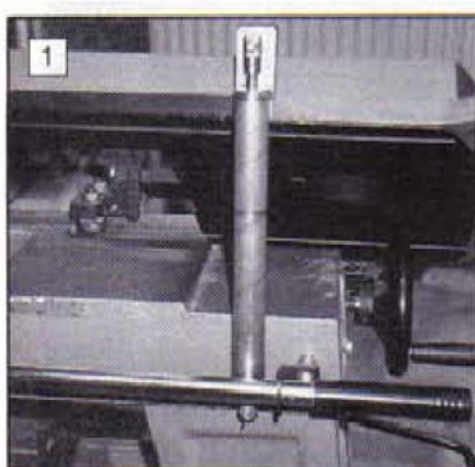
reduced shank drills from about 1/8in. or 3mm upwards.

ii) Drills smaller than this would seem to be best dealt with by using one of the home-made devices such as described by Lautard/Brown/Unwin.

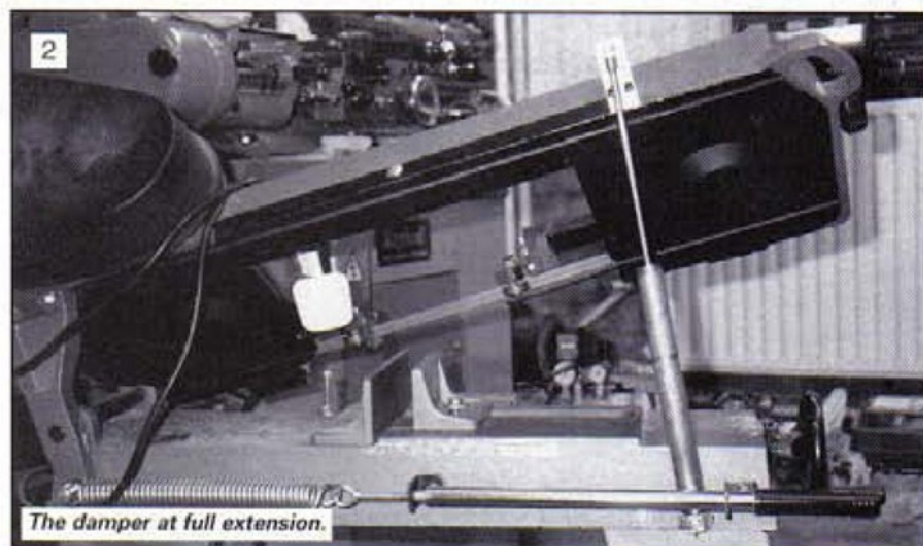
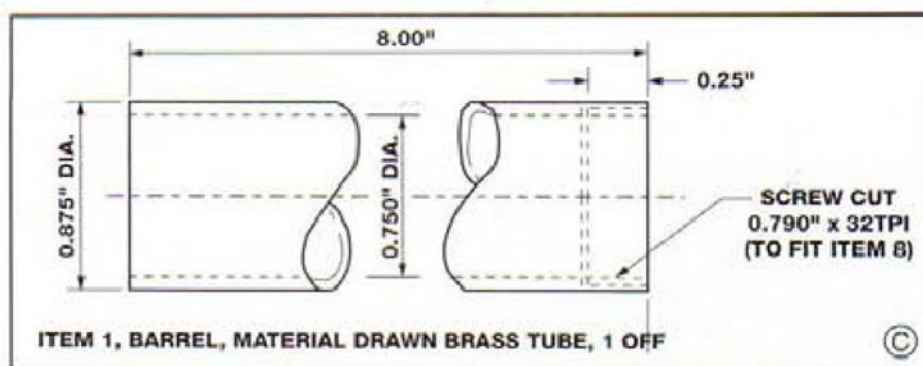
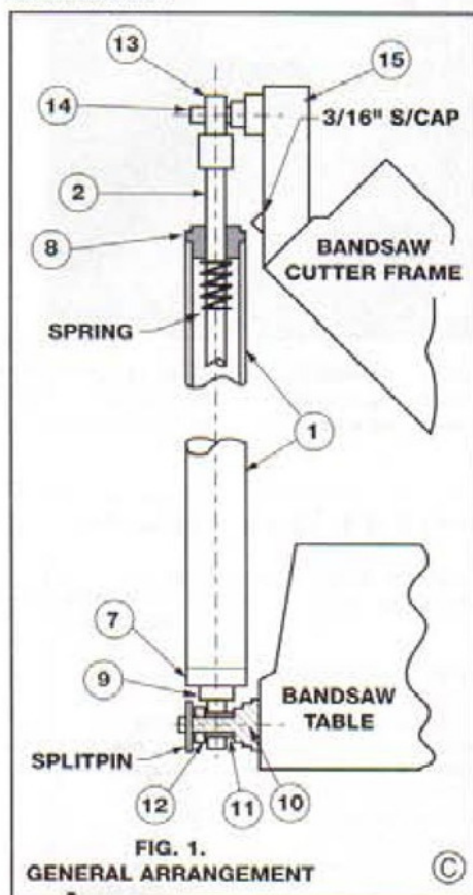
iii) The Quorn can be used effectively to grind four facet or six facet points, to deal with Slocombe centre drills, to sharpen core drills, spade drills, Concut drills, stepped drills and pilot point types.

iv) Specialised drill sharpening machines are probably too expensive and bulky to justify for home workshops.



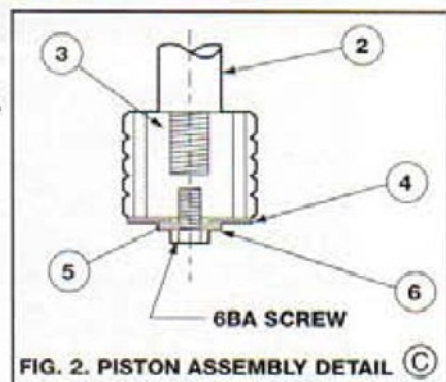


The blade is resting on the stop, the damper is fully retracted. Note the repositioned spring handle bracket.



A BAND SAW DAMPER

Anticipating the crash resulting from the failure of the blade of an unattended band saw does not allow one to concentrate on another job. Shelley Curtis modified his machine by adding a damper strut and can recommend it for the added peace of mind it brings.



You have put a 3in. dia. bar in your Taiwanese Universal Band Saw, started it running—and walked away to carry out some more interesting task. What happens if the blade breaks with the heavy cutting at this height? Whatever the damage to the machine you can be sure you'd hear the crash!

These 1/2in. blades can break, so I stand by with a hand ready to catch the frame until the cut is almost complete. Ergo, potential disaster averted—and much time spent, less than productively.

All industrial hacksaws and bandsaws have a damper to control the fall of the cutting frame. Thus, if the blade breaks, the assembly is lowered—at a controlled rate—on to the stop.

My first thought was to fit a gas strut (as used on hatchback rear doors), but I could not find one short enough—and, in any case, the price was ridiculous.

Answer—brew your own.

Figure 1 shows the layout of the simple unit which is permanently

attached to the band saw table, but can be slipped off its top pivot (the one attached to a bracket on the cutting frame), so that the saw can be operated in the vertical position. Figure 2 provides details of the piston assembly, so arranged to allow the cutter frame to be lifted without difficulty, but to provide a damping action on the descent.

reverse it in the bush, face off and screw cut internally 32 TPI, as per drawing. (You may prefer to make Item 8 first and use it as a thread gauge). Unless you have a large lathe, you will need to use a fixed steady for these operations.

Item 1 - Barrel

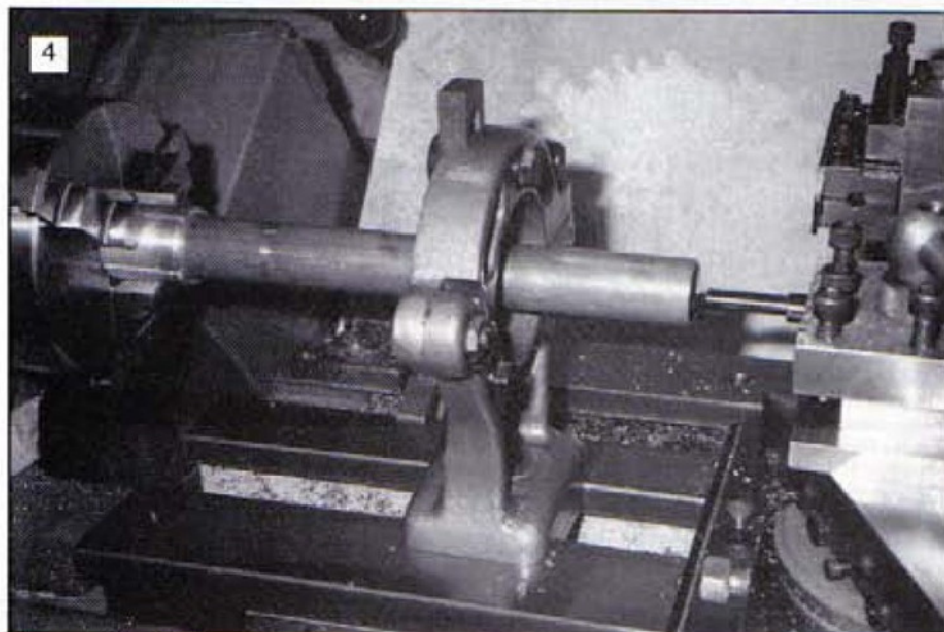
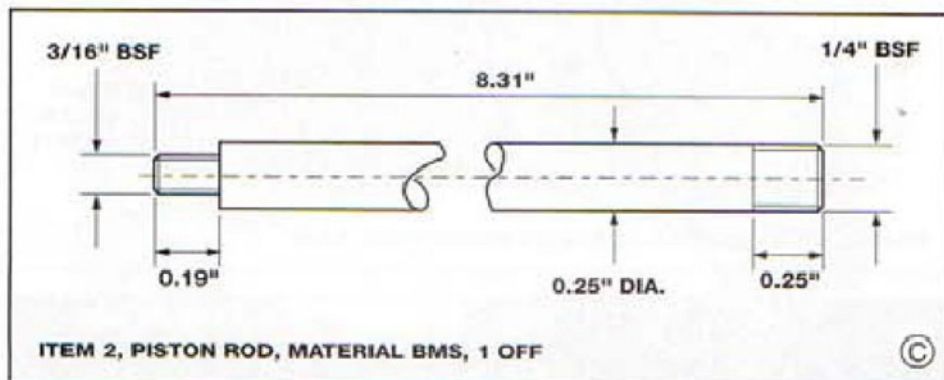
This is drawn brass tube, 7/8in. OD, 3/4in. ID, 8in. long. To hold this in the chuck accurately, make a bush from any bar end of about 1.125in. diameter. Drill and bore out using the brass tube as a gauge. Mark so that it can be replaced in the chuck in the same position, remove and slit lengthways. Slip it over the tube and replace in the chuck. Face off the end,

Item 2 - Piston rod

A straightforward job, but ensure that you have an accurate shoulder on the 3/16in. BSF end.

Item 3 - Piston

Face off and rough turn to about 0.1in. over size. Drill and tap 3/16in. BSF x 3/8in. deep. Part off to dimension plus allowance for facing off. Reverse in chuck, face off, mark the positions of the



Screwcutting the barrel for the piston rod guide. Note the split bush in the chuck.



four 2.00mm holes at 0.550in. PCD, then drill them, using your preferred method.

Next—as in Item 1 (unless your 3-jaw is really accurate) make a bush drilled and reamed $\frac{1}{4}$ in. Incidentally, if you find that internal stresses of drawn bar cause these bushes to close after slitting, just heat to cherry red and allow to cool.

Screw the piston blank firmly on to the piston rod, slip on the bush and place in the chuck. Centre drill, using a BS1.

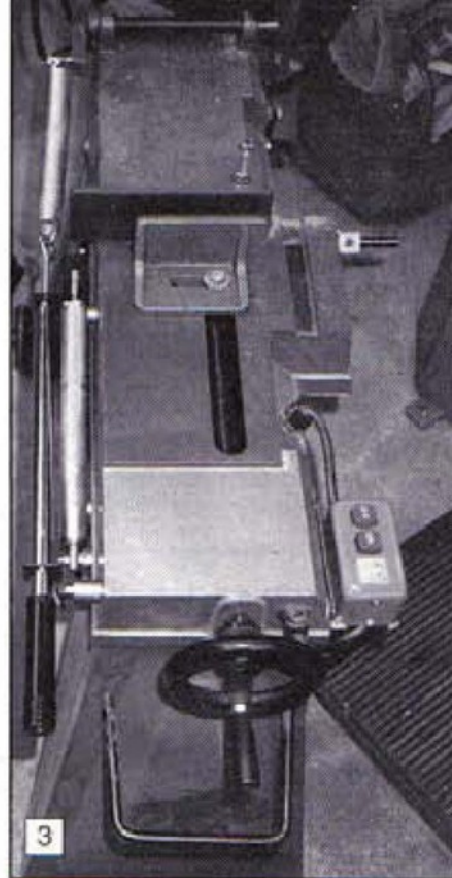
Support with a revolving centre and finish turn to 0.748in. Using a screw cutting tool—angle not critical—cut the

oil retaining grooves to a depth of 0.020in. Finally, drill and tap the piston end 6BA.

Item 4 - Non-return valve

The material for this must be oil resistant—use nitrile rubber.

The most efficient way of making this is to use the Washer & Gasket Cutter, described in our sister magazine, *Model Engineer* in August 1995. (You haven't made one? Then you'll have to use scissors!)



Damper disconnected, with cutter frame vertical. The repositioned spring handle bracket and spacers can be seen in this view.

Items 5 & 6 - Spacer and washer

Simple turning jobs, so no special instructions required.

Item 7 - End stop

Again, a straightforward turning exercise. Start by facing off $\frac{7}{8}$ in. dia. brass bar and drilling and tapping the $\frac{5}{16}$ in. BSF hole—while there's plenty to hold in the chuck. Cut off to length—plus a few thou. Chuck carefully, face off, turn down to 0.748in. for $\frac{1}{4}$ in., ensuring an accurate shoulder, and bore out the recess.

Item 8 - Piston rod guide

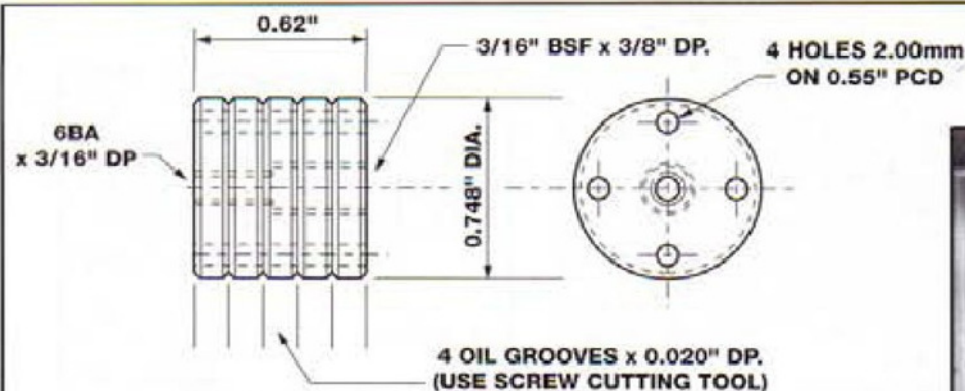
Chuck a piece of $\frac{7}{8}$ in. brass bar. Turn down to 0.790in. for $\frac{1}{4}$ in. Drill and ream $\frac{1}{4}$ in. to a depth of about $\frac{3}{4}$ in. Cut a run-out groove $\frac{1}{16}$ in. wide x 0.020in. deep and screw cut 32 TPI.

Part off to dimension and mill spanner flats as per drawing.

Item 9 - Lower pivot pin lug

Turn down $\frac{1}{2}$ in. BMS to $\frac{5}{16}$ in. dia. for $\frac{1}{4}$ in. Thread $\frac{5}{16}$ in. BSF and part off at 1in. Make a fixture from $1\frac{1}{2}$ in. of $\frac{3}{4}$ in. square BDMS (or similar from the scrap box). Square up one end and drill and tap $\frac{5}{16}$ in. BSF.

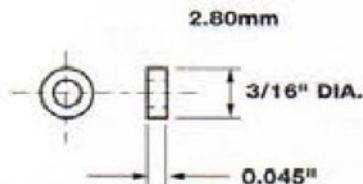
Screw the part-finished component in firmly and mount vertically in the milling vice. Mill away the surplus to provide lug. Next, place horizontally in the vice and drill the 9.00mm hole.



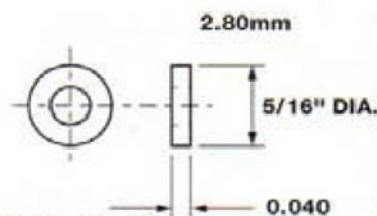
ITEM 3, PISTON, MATERIAL BMS, 1 OFF



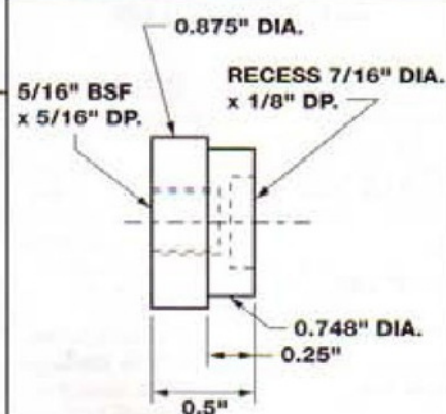
ITEM 4, NON RETURN VALVE, MATERIAL OIL RESISTANT RUBBER (NITRILE), 1 OFF



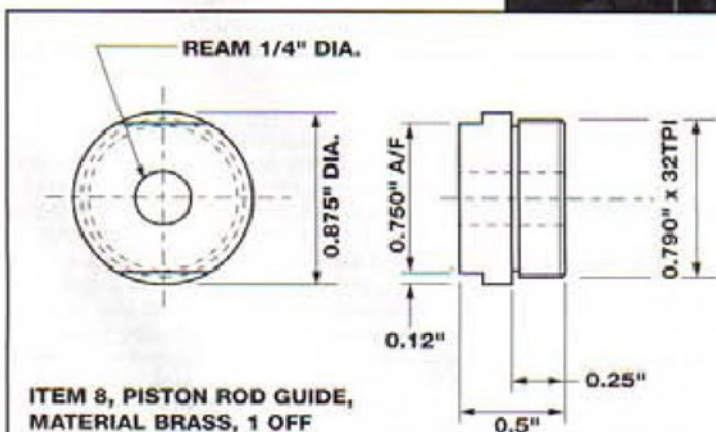
ITEM 5, SPACER, MATERIAL BMS, 1 OFF



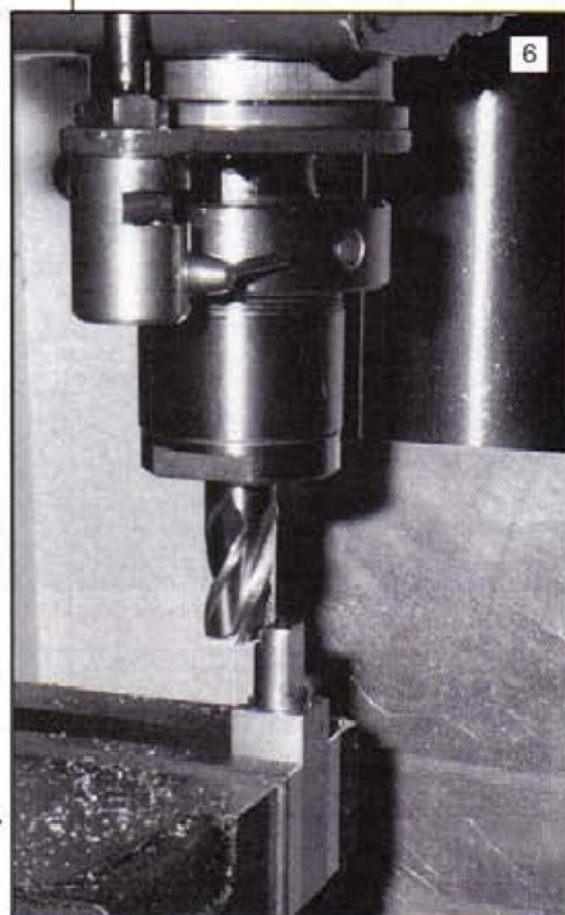
ITEM 6, WASHER, MATERIAL BMS, 1 OFF



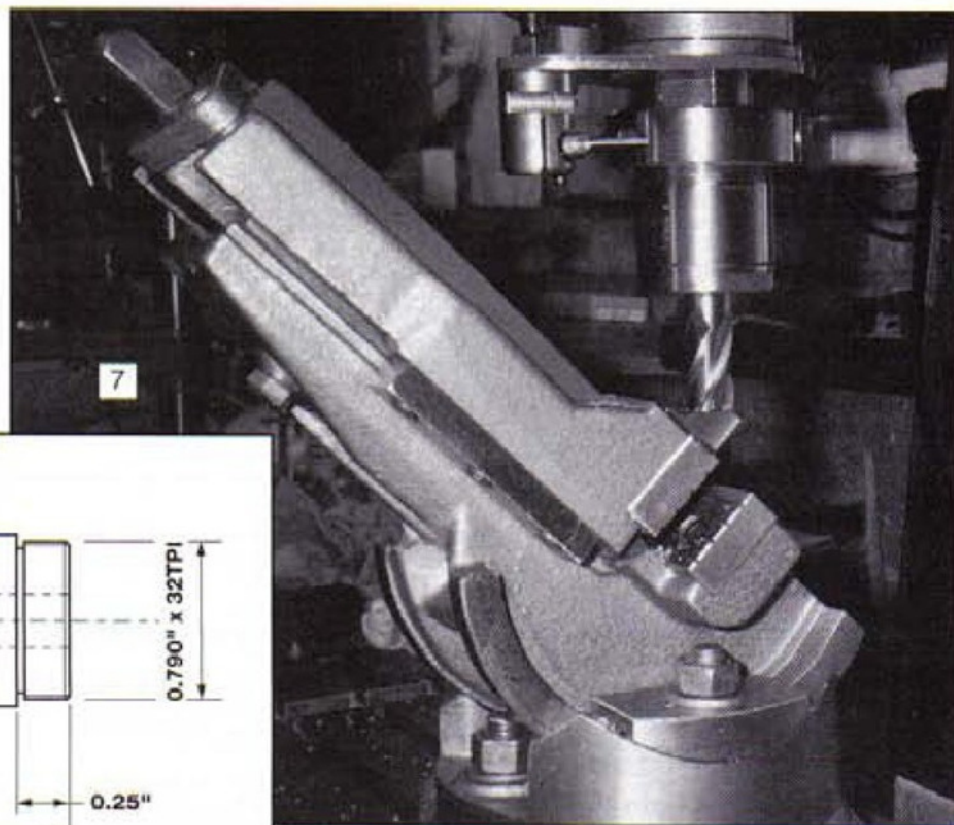
ITEM 7, END STOP, MATERIAL BRASS, 1 OFF



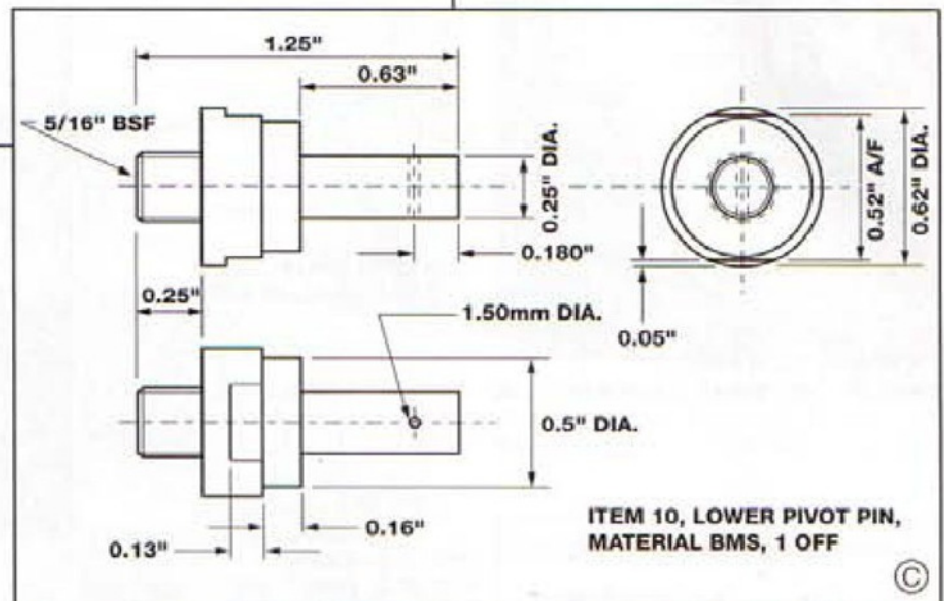
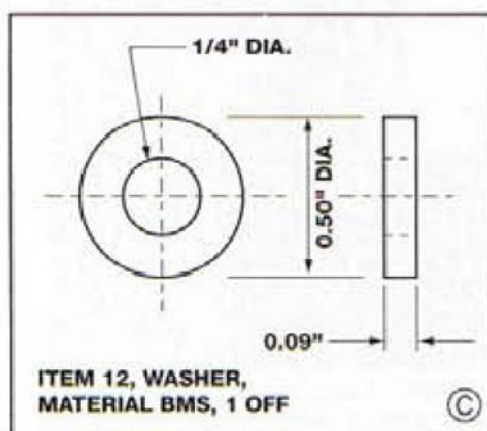
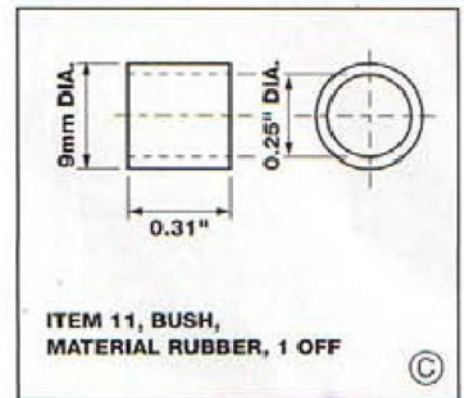
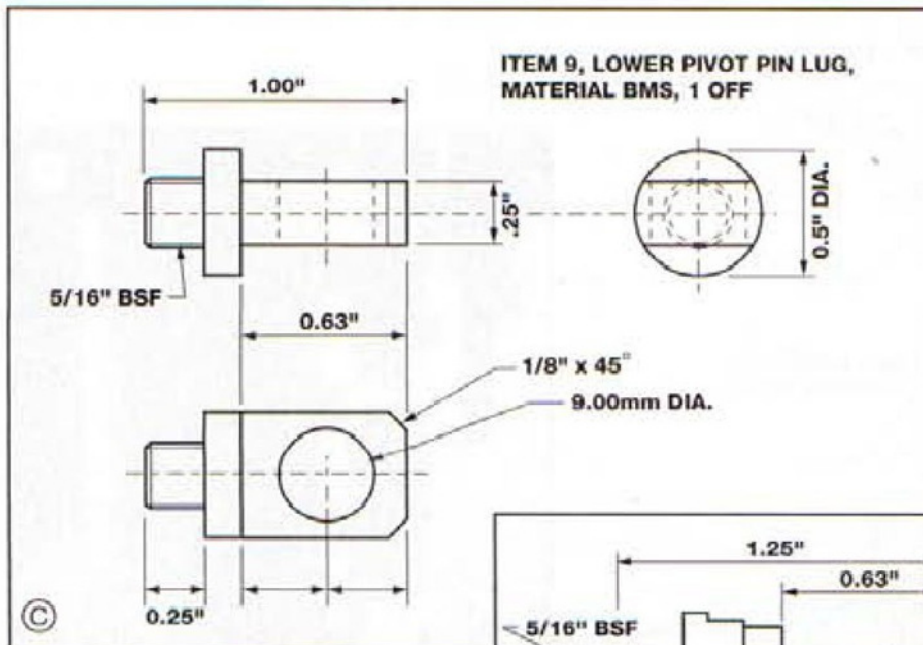
ITEM 8, PISTON ROD GUIDE, MATERIAL BRASS, 1 OFF



Milling the lower pivot pin lug. The holding fixture makes it possible to grip the component in the vice.



Milling the 45 deg. angle on the upper bracket.



Item 10 - Lower pivot pin

Turn down 5/8in. BMS and thread 5/16in. BSF for 1/4in. Part off to length. Face off a short piece of 5/8in. BMS and drill and tap 5/16in. BSF x 1/2in. deep. Screw the component into this fixture and turn the remaining diameters. Use the fixture you made for Item 9 to hold this component for drilling the 1.50mm hole and milling the spanner flats.

Item 11 - Bush

Rubber tube to dimension shown.

Item 12 - Washer

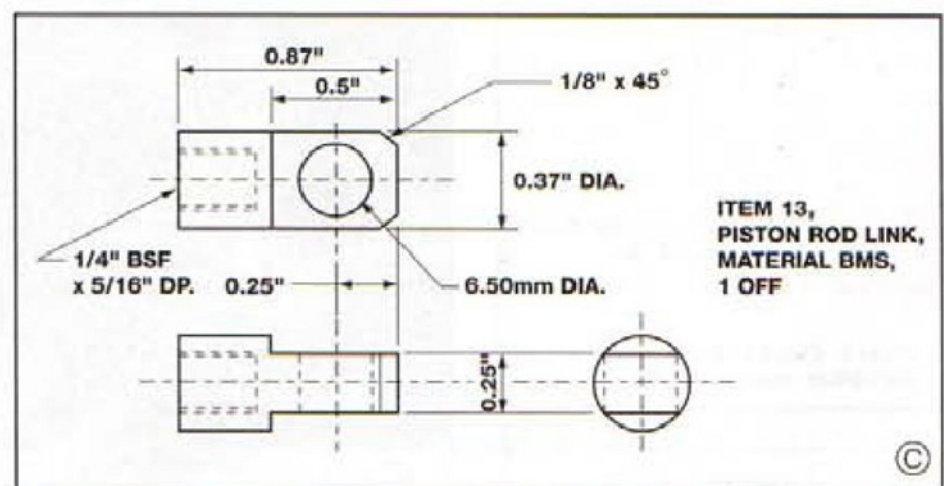
Make as per drawing.

Item 13 - Piston rod link

Made from 3/8in. BMS. Start with the 1/4in. BSF hole. Part off to length, reverse in chuck and machine the 45deg. bevel. Mill to the form shown and drill the 6.50mm hole.

Item 14 - Upper pivot pin

Start with the 5/16in. BSF thread. Part off to length and, using the fixture you have made for Item 9, turn the remaining



diameter. Place component in the milling fixture and produce the spanner flats.

Item 14 - Upper pivot pin bracket

Take a piece of 1in. x 5/8in. BDMS and mill all surfaces to produce a decent finish and the dimensions shown.

Start by milling the 45deg. angle. To mark the 3/16in. hole positions, bisect this diagonal and at 90 deg., scribe a line to front edge. Extend that dimension across the front face to provide the centre line for the holes.

Mount the workpiece in the vice at 45 deg. with the diagonal face set on parallels. Using an edge finder, position the spindle 0.196in. from the edge and zero the cross slide dial. Move the table to centre the spindle over the scribed line and set the table stop. Using a 5/16in. slot drill, mill out until a flat seating appears, suitable for the 3/16in. cap screws. Note the quill downfeed dial reading, then raise spindle, move the cross-slide 0.583in. and repeat the operation. Replace slot drill with a 3/16in. drill and drill through. Reposition the spindle over the first hole and drill through. (For a quick

change from milling to drilling—which occurs very frequently in our hobby—I have a Jacobs chuck mounted on a $\frac{5}{8}$ in. diameter shank, screwed 20 TPI. It's less hassle than changing chucks. Drill and tap the $\frac{5}{16}$ in. BSF hole.

Preparing the band saw

These machines may vary in some details, but reference to the photographs will show what is required.

1. Make two 1in. spacers, drilled $\frac{5}{16}$ in. to reposition the spring tensioning handle brackets, and re-site the one at the handle end to 1in. from the edge of the main casting.

2. Drill and tap $\frac{5}{16}$ in. BSF $2\frac{3}{4}$ in. from the end of the main casting and $\frac{3}{8}$ in. above the lower edge. File to produce a vertical seating for Item 10.

3. Drill and tap two $\frac{3}{16}$ in. BSF holes on the top edge of the cutting frame so that the damper, when fitted, will be vertical when the blade is on its stop.

Assembly and fitting (See Figures 1 and 2)

Solder Item 7 (End Stop) into Item 1 (Barrel). Soft solder is all that is required. Screw in Item 9 firmly - with some PTFE tape to ensure an airtight joint.

Assemble the non-return valve on the piston (see Piston assembly detail drawing, Fig. 2). Tighten the 6BA screw and check that the rubber non-return valve is free to revolve, i.e. not clamped or distorted.

Slide a short spring onto the piston rod (This acts as a shock absorber when raising the blade to the full extension of the damper unit). Slide on the piston rod guide (Item 8). Screw on Item 13 (Piston rod link). Smear the piston with light oil and insert into the barrel. Squirt in a few drops of oil and screw in the guide (Item 8).

Fit Item 15 (Upper Bracket) with two $\frac{3}{16}$ in. BSF socket cap screws and fit the Upper Pivot Pin (Item 14).

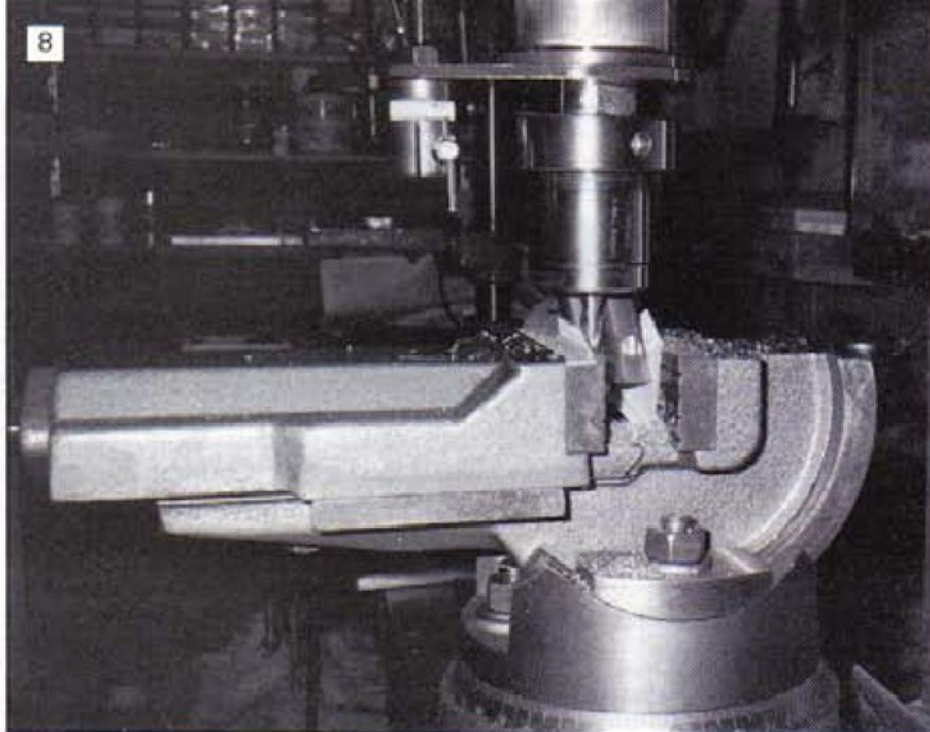
Fit the Lower Pivot Pin (Item 10). Insert the rubber bush (Item 11) into Item 9 and push on to Item 10. This needs to be a firm fit, as it holds the unit vertically, but must be flexible enough to allow the unit to be slid off the upper pivot, thus enabling the cutting frame to be raised to the upright position if required. Fit washer (Item 12) and secure with a $\frac{1}{16}$ in. split pin.

Reassemble the spring tensioning handle brackets with the 1in. spacers and longer bolts.

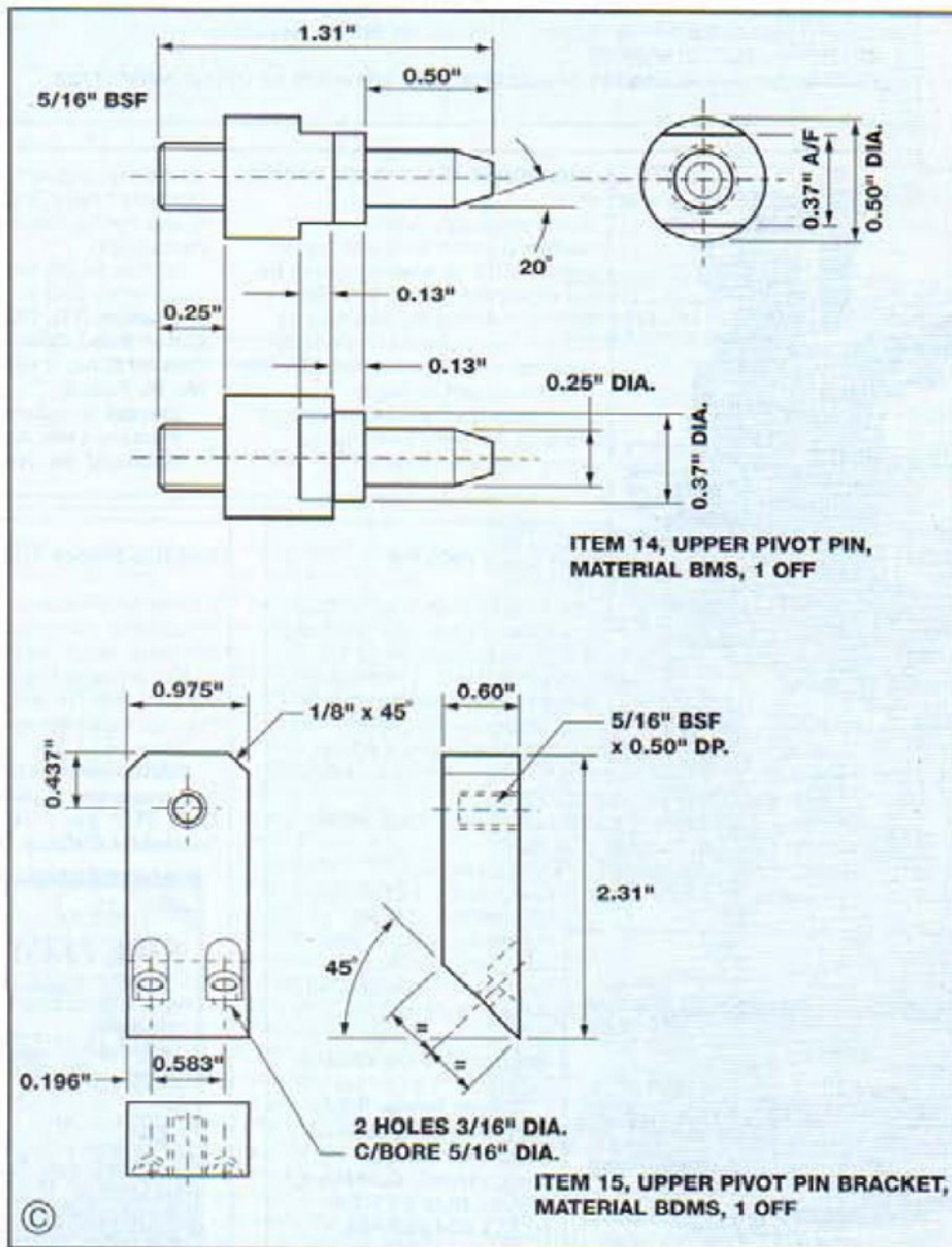
I have kept this simple, by relying on the bleed of air past the piston to regulate the cutting frame's rate of descent in the event of blade breakage. The non-return valve allows for unimpeded movement when raising the blade.

Use thin oil - ISO 32 or 38 hydraulic oil. Too thick an oil will prevent air bleeding past the piston. On the other hand, if you have made the piston with too much clearance, a heavier grade of oil may cure the problem.

All that remains is to put in that 3in. bar, start the saw—and go and make yourself a nice cup of tea!



Milling out the cap screw seatings on the upper bracket.



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

New Multi Vice from Minicraft

This small swivelling vice features a ball joint design which allows the jaw section to be rotated through 360 deg. and locked at any angle.

Of aluminium die cast construction, the MB716 vice has 74mm jaws, which will open to allow a workpiece of 60mm to be held. These jaws are grooved to assist in the holding of pipe and dowelling, either vertically or horizontally. With the detachable soft jaws fitted, the capacity is reduced to 54mm.

The vice is fixed to the work bench with a screwed base clamp, and may be used as a holder for Minicraft drills when grinding, sanding or driving the MB720 Flexi Drive.

The RRP for this unit is £24.99

For free catalogue and list of stockists, call Minicraft on 07000 646427238



Alexander Machinery spares

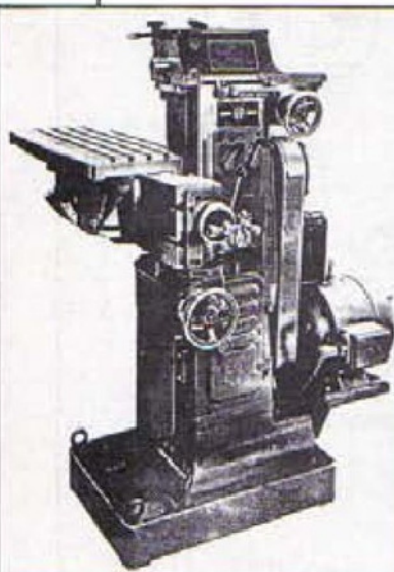
Some while ago, one of our readers based in Cornwall put an entry in *Link Up* seeking spares for his Alexander Master Toolmaker milling machine. He now tells us that his search has been partially successful and that Comsat RSI, PG Technology are willing to manufacture small batches of such items as the table feed change gears if sufficient interest is

expressed. Comsat RSI also tell us that they have a limited range of spares for the Alexander Pantograph.

Collets for the Master Toolmaker can be supplied by Deckel Grinders Ltd of St. Helens.

Comsat RSI, PG Technology, Mill Green Road, Mitcham Junction, Surrey CR4 4TX Tel. 0181 648 9461 (Contact Mr. M. Parodi)

Deckel Grinders Ltd., The Barn, Pasture Lane Business Centre, Rainford, St. Helens WA11 8PU



Kity 417 Fretsaw

The Stayer Power Tools Group has added to its range of smaller machines by introducing the Kity 417 Fretsaw. A two-speed unit featuring a 100W motor, the saw is suitable for use on

metals, wood and plastics. Maximum cutting height is 50mm and capacities are: ferrous metals 4 to 6mm, aluminium alloys 10mm, softwood 50mm and plastics 20mm.

Throat size is 375mm and the table dimensions are 355mm x 180mm. The table can be tilted to 45 deg.

Blades of a maximum length of 130mm can be accommodated, and the machine incorporates a unique non-slip method of blade

tightening using a 'clock screw' system. A dust extraction facility is fitted.

The new Kity 417 Fretsaw is available from all appointed Kity stockists at £256 RRP, including VAT.

Stayer Power Tools Ltd., Unit 9, Guildford Industrial Estate, Deaconfield, Guildford, Surrey GU2 5YT Tel. 01483 454502 Fax. 01483 454415



Loctite Super Glue Brushable

Loctite have recently introduced a much more convenient means of applying their cyanoacrylate Super Glue by packing it in a container which incorporates a brush applicator.

The anti-spill bottle contains 5g of the glue, but is filled only to the 50% mark to enhance safety in use. A brush is attached inside the cap, making application a much more certain process.

The new pack is available from all major retailers at £3.19.

Loctite products are distributed by Henkel Home Improvement & Adhesive Products, Winsford, Cheshire CW7 3QY. For technical and practical advice, contact the Technical Service Department Tel. 01606 593933



IMPROVING THE PRECISION OF A MILL/DRILL

FIG. 1.
RACK DETAILS

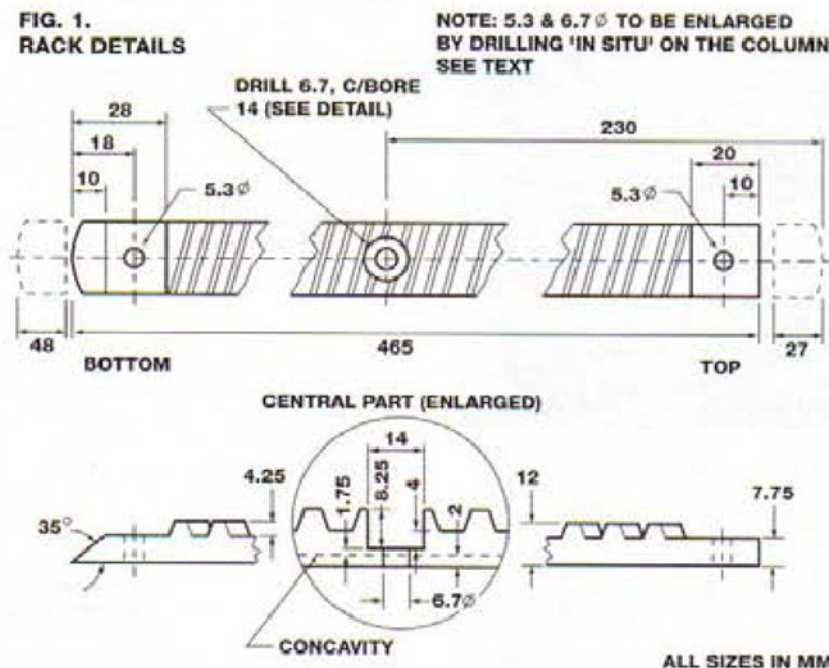
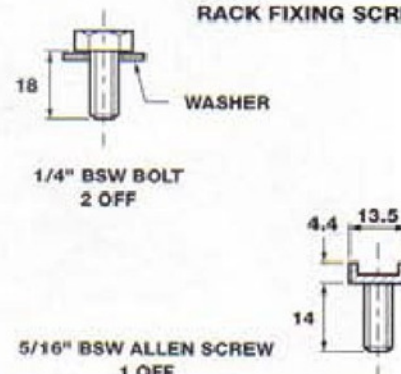


FIG. 2.
RACK FIXING SCREWS



NOTE: THE 4.4mm HEAD HEIGHT GIVEN PERMITS AN ACCEPTABLE DEPTH FOR THE ALLEN KEY. THE CORRESPONDING C/BORE IN THE RACK IS ONLY 4mm.

For many years, we have been using a Taiwanese mill/drill, the type of unit which is very popular among model engineers—not too bad on the whole, but yet subject to the saying "You get what you pay for".

One of the biggest drawbacks, and not only for us if we are to believe what we read, is the impossibility of maintaining the setting when moving the head up and down. We have managed, more or less up until now, but a little while ago, crisis point was reached.

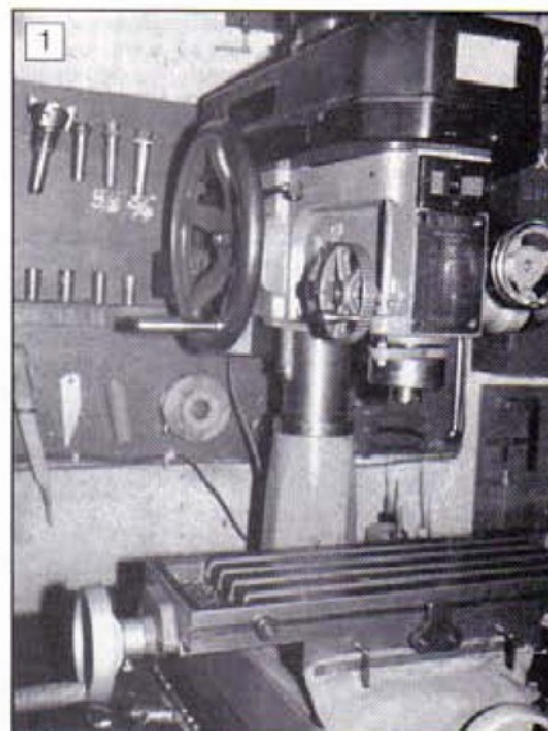
We needed to enlarge the bore of a large handwheel and it couldn't be handled in the lathe. The bottom of the hole was blind, and we needed to drill it out with drills of various diameters and lengths and then use the boring head. These and the centring tool all seemed to need quite different chucking systems and, of course, continuous re-setting of the head positions.

Many users of mill/drills complain that the setting of the head location is lost if it has to be raised or lowered in the middle of a job. Yves Rayssiguier of Brest, France, decided that the problem had to be fixed.

To crown it all, we discovered that the specially long draw bar needed for the boring head would not clear the ceiling of the workshop when the head of the machine was set at the position required for the final boring operation—back to square one!

Adding all this re-setting time to the time needed to correct the inevitable errors, plus "patati and patata" (this and that), you will understand that many hours were lost before we actually got round to the main job of opening out the bore, which was actually completed in ten minutes.

ENOUGH! A decision was made. If it should not be possible to modify the machine to incorporate a means of precisely maintaining the centre setting, then it would be discarded and we would have to acquire one equipped with an accurate elevating knee or head.



This popular mill drill was modified to incorporate a means of precisely locating the head. It is shown here in the modified condition. Note, on the left, the large hand wheel which starts things.



ABOVE: The rack, modified as shown in Figure 1.

BELOW: The rack is now set up for machining the front face. Note the feeler gauge used to determine the distortion existing.



To begin with, the challenge looked immense, underlined by the fact that, despite many complaints about this problem in the past, to our knowledge, no-one had set about producing a remedy. However, wasn't it a famous Prime Minister who said "Difficulties always appear smaller when studied more closely"?

One of the things which makes a machine with accurate elevating knees or heads so expensive to buy or difficult to make is that they have two functions to deal with - lifting a heavy component and simultaneously achieving a precise vertical micro-feed. With our machine, these functions would be separated. The precise vertical adjustment would be provided by the set of the quill and the worm micro-feed, while the bulk of the elevating movement would be by the head rack and pinion gear. Never mind the head wobble while it is being lifted as long as, at the end, when it is tightened up, it comes back to the same vertical plane as it was in at the start. It is sufficient to have a true vertical surface near the front side of the rack, on which the corresponding front face of the head keyway will bear. As it happens, the surface finish of the latter item is not terribly important because it will always bear along its entire length.

A couple of days of deep thinking on the theoretical approach persuaded us that this solution was quite feasible, so much so that we could define the conditions to be observed right at the start:-

It would be possible to return the machine to the original condition at any time.

The machine head would not need to

be removed (interesting, no?).

The machine would remain in a usable condition at all times, essential in order to be able to modify the rack to the new configuration.

Now, it was time to have a go.

Figure 1 shows the new state of the rack after machining. Dimensions (in mm) should be read in relationship with a head height of 215 and a column length of 565. This will allow a comparison with the different dimensions which may be encountered on other machines.

The use of three Whitworth bolts is due

to the fact that this form of thread remains unsurpassed for screwing safely into cast iron, the material from which our column is made (See Fig. 2).

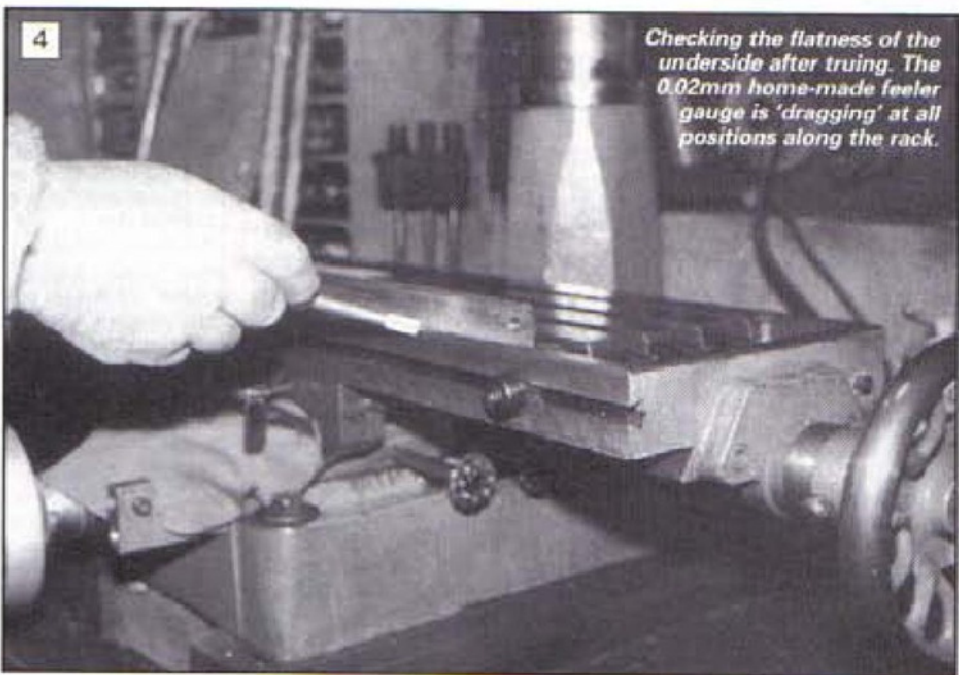
Now, the first act of faith. This was to saw through the rack, just at the beginning of the first tooth down. A wise precaution was to put a 1mm shim underneath the rack, so as not to damage the column, and the end was firmly secured with a G-clamp while the operation was being carried out. After tightening the securing bolt on the head, it was possible to easily remove the rack by cranking in an anti-clockwise direction. Incidentally, if this modification had been incorporated by the machine manufacturer, dismantling the machine would have been made a lot easier.

The lower end of the rack was re-worked to restore the angled shape (rounding with a hand file) and to produce the flat for the lower screw head to bear upon (see Fig. 1). A small section of the other end was also discarded, in order to allow the head to be raised a little more and consequently to prevent the rack from fouling the column cap, as perhaps will become plain a later.

As it happens, if absolutely necessary, it would now be feasible to re-fit the rack and use it to raise or lower the head for other milling operations.

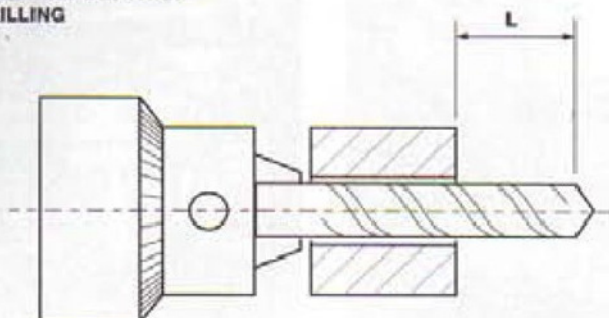
It was now possible to complete the machining and drilling of the rack, to the dimensions shown in Fig. 1 (see also Photo 2), including machining of the front face. If you decide to carry out this modification, a word of warning is appropriate here. You can almost be certain that your rack will be bent, due to the stresses to which it is subjected when installed on the machine. Using the milling machine table as a surface plate, put the rack on its side and you will notice immediately that it will rock. Pass a feeler gauge beneath it and you will be able to measure the concavity. Ours was 0.15mm out, the concavity being on the rear face, so we had to proceed as follows:-

We had to avoid clamping from the top, as all we would have done would be to temporarily remove the distortion, which



Checking the flatness of the underside after truing. The 0.02mm home-made feeler gauge is 'dragging' at all positions along the rack.

**L = USEFUL LENGTH FOR
REQUIRED DEPTH OF
DRILLING**



**FIG. 3.
SAFE DRILLING DEVICE**

would have been restored as soon as the rack was unclamped. After setting the rear face on the machine table, a check was made with the feeler gauge to ensure that the upper (front) face remained convex, then the rack was secured by side clamping, taking care to see that it remained upright (**Photo 3**). The depth of cut was set equal to the amount of concavity plus 0.05mm and a surfacing cut taken. Unfortunately, the table travel was not adequate to be able to machine the length of the rack in one pass, about 60 to 70mm remaining unmachined. The rack was unclamped, shifted by the required amount, re-clamped and milling completed. Ideally, the two machined surfaces would be in the same plane, but it proved impossible to reset the work exactly vertical, so there was a very slight difference between them. However, a few strokes with a fine file soon improved matters and moreover, this is an area which is rarely, if ever, reached by the machine head.

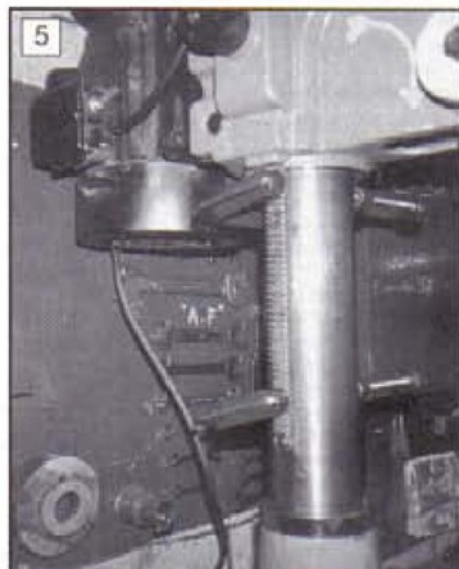
What about if the front face of the rack had been concave? It would have been necessary to true up the back face first, and then machine the front.

The final operation on this part was to check that the newly machined face was true, and this was carried out using a home-made feeler gauge consisting of a piece of 0.02mm metal foil held in an XActo craft knife shank. The foil was progressively inserted between the skimmed face and the machine table at 2cm intervals, ensuring each time that, as it was removed, it was dragging between the two (**Photo 4**).

Fixing the rack

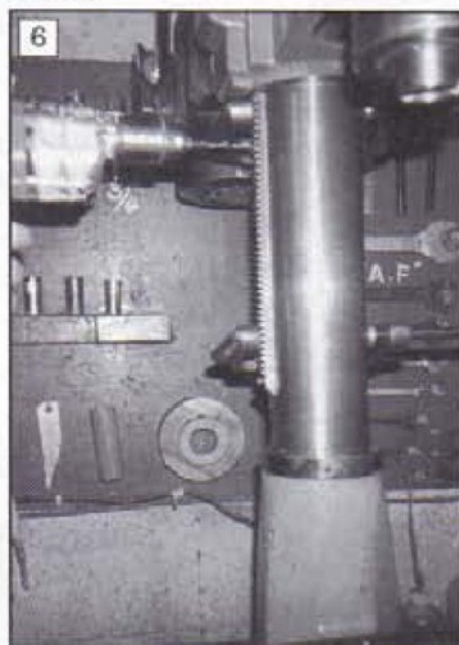
The first job was to thoroughly clean the head. A round brush, moistened with petrol did the trick, working halfway down from the top and the other half up from the bottom, as the pinion located in the middle would not permit a clear passage right through. The head was then tightened.

The rack was positioned on the left hand side, using two "C" clamps, with the head square to the table. The lower end of the rack was set 5cm above the column



ABOVE: The rack clamped to the column so that the screw holes can be drilled and tapped.

BELOW: Drilling in situ. Easy and precise work if the method described in the text is followed.



collar, and the profile of the face of the rack and the shape of the column automatically aligned the rack vertically, accurately enough for hole drilling purposes (**Photo 5**).

Using the holes in the rack as guides, the column was drilled tapping size, 5.3mm for the lower hole and 6.7mm for the central one (**Photo 6**). The holes in the rack were then opened out to clear, 1/8in. and 1/4in. respectively, this work being carried out in situ, but being careful not to drill deeper than the thickness of the rack, as indicated in **Fig. 1** (i. e. about 8mm at the bottom and 4mm in the middle). If you try this, don't rely on any stop system fitted to the drill, rather use a stub drill packed up with a spacer, thus leaving only the required length protruding (**Fig. 3**).

The holes were tapped 1/8 and 1/4in. BSW, then the lower hole in the rack further enlarged to 8mm to permit final adjustment. There was no need to touch the central hole as the rack is required to pivot on the central screw during the adjustment, so no clearance is needed here. After tightening the two screws, the head was released then gently wound down far enough to expose the upper hole, then re-clamped. The upper hole was treated in the same way as the lower one, securing the rack with a "C" clamp (**Photo 7**), and a screw inserted.

Fine adjustment of the rack

After moving the head up sufficiently to expose the centre bolt, the latter was released slightly to permit the rack to pivot, then the head was re-located in the middle of the column. A true vertical slide was fixed to the mill table and a lever dial indicator (DTI) gripped in the drill chuck, with the spindle locked (**Photo 8**).

During all the following operations, the head was released and abutted against the front face of the rack using gentle hand pressure. The mill table was traversed by means of the leadscrew until the pointer of the DTI touched the upper area of the vertical slide, and the dial reading noted (**Photo 9**). While in this position, the



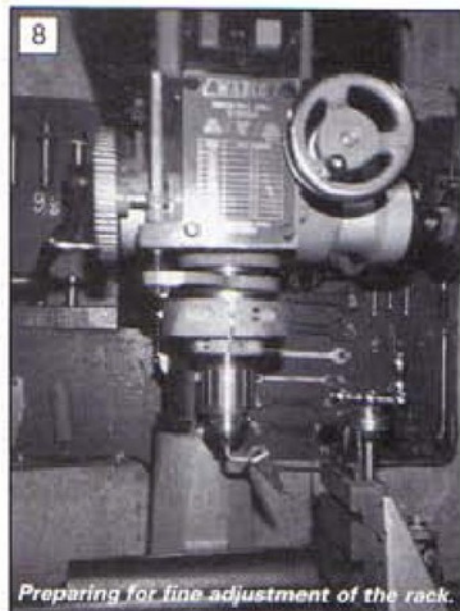
The upper end of the rack secured for drilling.

lead screw handwheel ring was zeroed. The table was then withdrawn to the right to move the vertical slide out of the way while the head was lowered to bring the pointer of the DTI to the bottom. Returning the table to its former position, as noted on the handwheel, the pointer once more made contact with the vertical slide, but of course, this time the reading was different. Slackening the upper rack retaining screw so that it no longer constrained the rack and slightly releasing the lower one now allowed the rack position to be finally adjusted.

In passing, it will now be realised that all the weight of the head is being taken by the central screw, which is one reason for its larger size.

By gently tapping the lower end of the rack in the right direction, it was possible to make the DTI reading reduce by half the error, then the upper and lower screws were re-tightened. The vertical slide was withdrawn, the head raised to the upper position, then the table returned to the original lead screw dial position. The two DTI readings were now virtually identical. If this had not been the case, the process would have been repeated until they were.

When we tightened the head and made a last test, we found an error of 0.05mm, which we chose to accept. It must be appreciated that any error resulting from movement in the rack abutment area as the head is tightened is multiplied by five due to the distance between column axis and quill. Consequently, this 0.05mm error on the quill corresponds to a movement of only 0.01mm at the rack, which we considered to be impossible to eliminate,



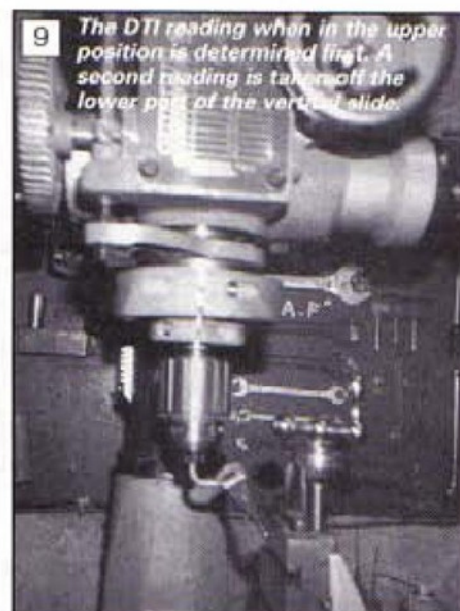
as it is essential that there is some clearance in the keyway.

To conclude

The ability to return to the original configuration has been maintained. All that is necessary is to remove the three screws which retain the rack.

The loss of the ability to swing the head is not important. There is always enough clearance for setting when the head has been raised to the highest position.

Regarding the removal of the quill for removal or adjustment of the cone

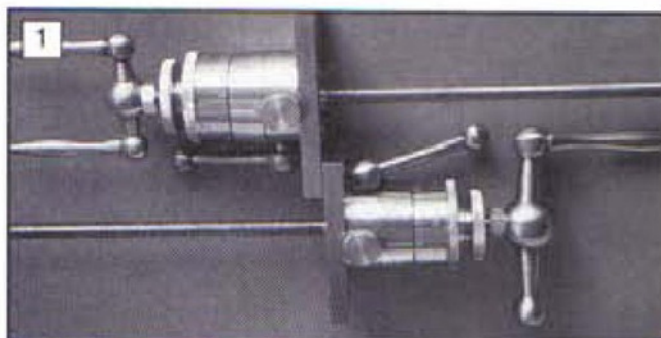


bearing, this is still possible with the head in this location by moving the cross-slide well forward, then pulling the quill downward and tilting it rearward. This was the main reason for elevating the position of the rack, and consequently the head, compared to the original position.

In all, we spent about a week on this modification. This was somewhat longer than was really necessary because we came up against the problem of aligning the rack, and didn't find the solution immediately. Having sorted this out, we think that the job could be completed in two or three days. Why not have a go, and get rid of "patati and patata"? 

IN OUR NEXT ISSUE

Coming up in Issue No. 51 will be



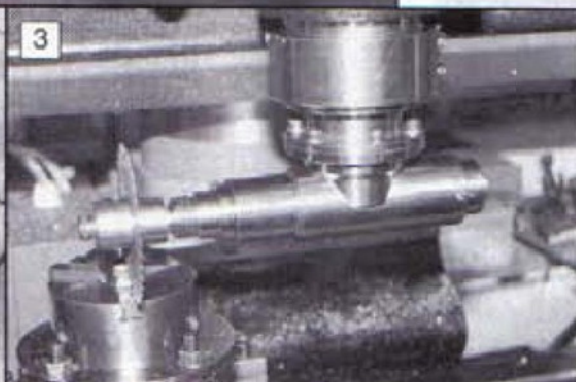
1. HOBBYMAT MODIFICATIONS

E.J. (Mac) Mackenzie describes more ways in which to enhance this popular lathe, including the addition of revised cross-slide feed arrangements



2. AN AIR COMPRESSOR FOR THE WORKSHOP

Compressed air can be used in a number of ways in garage and workshop. John Noakes suggests how this facility may be provided



3. RIGHT ANGLE DRIVE UNIT FOR A VERTICAL MILL

Peter Rawlinson gives his vertical mill a horizontal milling capability

Issue on sale 10 July 1998

(Contents may be changed)

An Introduction to Robotics by Harprit Sandhu

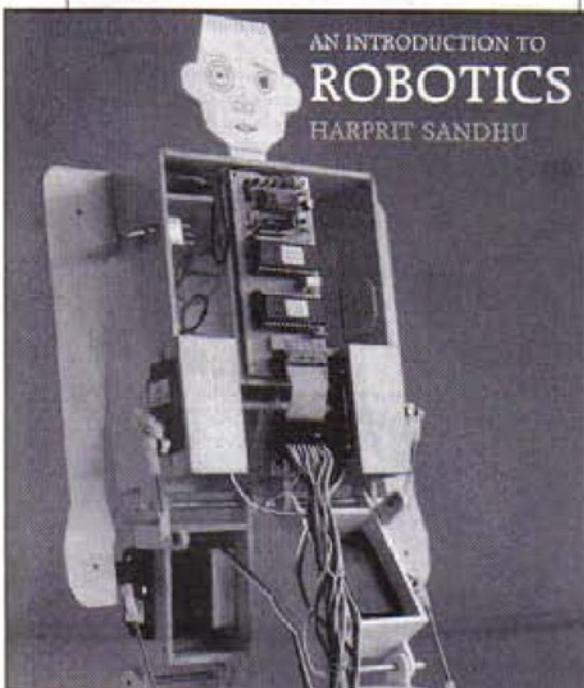
Contrary to the thoughts on the nature of model engineering discussed in the book reviewed opposite, the hobby has always encompassed a substantial amount of electrical engineering. Indeed, when Model Engineer magazine was first published, its full title was The Model Engineer and Amateur Electrician, so the mechanical and electrical disciplines have always been closely allied. It is now becoming evident that the experimental side of model engineering is following the industrial lead and applying 'mechatronics', that is seeking design solutions which integrate the use of both mechanical and electronic techniques.

Harprit Sandhu's book introduces one of the branches of this science, describing the different families of robot and the uses to which they are put. The terminology and operating principles are introduced, as are the readily available items of equipment which may be used by those wishing to experiment in this fascinating branch of the hobby.

As a practical exercise, instructions are given for the manufacture of a simple walking robot, based on the use of servo motors normally found in model radio control systems.

The well indexed and clearly presented 198 page soft covered book contains a wealth of information for those who would like to understand some of the basics of what is likely to become an expanding aspect of model engineering.

An Introduction to Robotics by Harprit Sandhu. ISBN 1-85486-153-0. Published by Nexus Special Interests Ltd.



covers with a clear typeface and good line drawings and photographs, it will provide sound basic advice to anyone just taking up the hobby and will be a useful reference work to the more experienced when they come up against that infrequently encountered problem.

Model Engineering, a Foundation Course by Peter Wright. ISBN 1-85486-152-2. Published by Nexus Special Interests Ltd.

A selection of recently published books which may prove of interest to readers

FIRESIDE READING

Model Engineering, A Foundation Course by Peter Wright

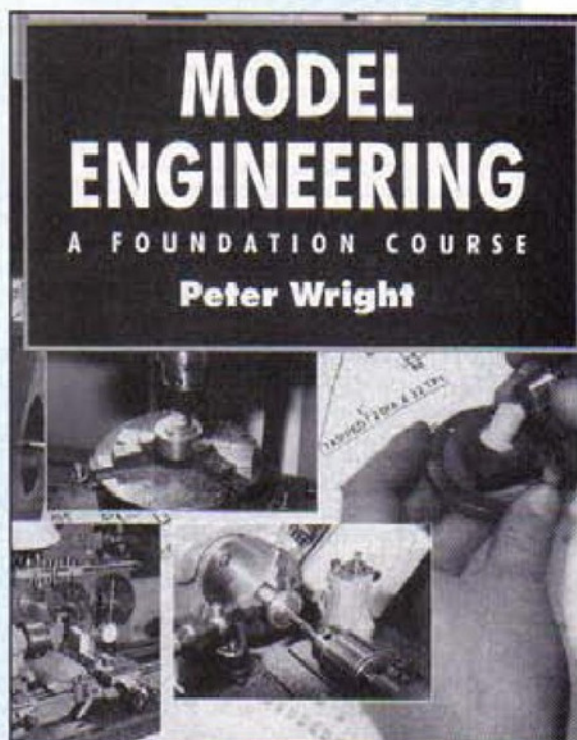
As soon as I opened this substantial book, I experienced a feeling of familiarity which had me delving into the more remote corners of my bookshelves. I was not mistaken, for Peter Wright has produced the model engineer's version of those excellent publications which were in circulation when formal craft engineering training was probably at its most organised. Logically sequenced, well illustrated and containing a wealth of good common sense, it is "a comprehensive guide aimed at practical people with little experience of working in metal wishing to embark on this fascinating hobby". That said, there is still much to interest the more experienced worker and perhaps even the professional whose experience has been confined to one branch of the craft.

The book opens with a review of the hobby, and poses the question "What is model engineering?", going on to give a brief survey of each subject area, ranging from those which involve the manufacture of most, if not all, of the component parts of the finished article through to those which rely on commercially produced kits, where the emphasis is on the use rather than the construction. It is suggested that 'mechanical engineering in the home workshop' would be a better description of the activity, but it is concluded that the term 'model engineering' is so ingrained into the language that no-one would prefer to use it. Validly though, it is pointed out that the hobby encompasses subjects such as clock making which do not sit comfortably within the current terminology.

In-depth coverage is given to the equipment, materials and processes involved, with advice on the setting up of a home workshop and the tools and machinery with which it may be equipped. Sound advice is given on safety, not only during the machining and fabrication phases, but also when painting the finished model, when the use of solvents may present hazards which are not generally appreciated.

Choice of project, the availability of required materials and the interpretation of drawings are covered, with a brief mention of the metric v. Imperial dichotomy. A substantial chapter is dedicated to measuring and marking-out, then virtually all the engineering techniques likely to be able to be undertaken are described from the viewpoint of the user of a home workshop, rather than from the industrial standpoint.

A 408 page book in soft



Building Simple Model Steam Engines - Book 2 by Tubal Cain

This little book is a follow-on to one published in 1980 and similarly, contained designs for four small self-contained steam plants.

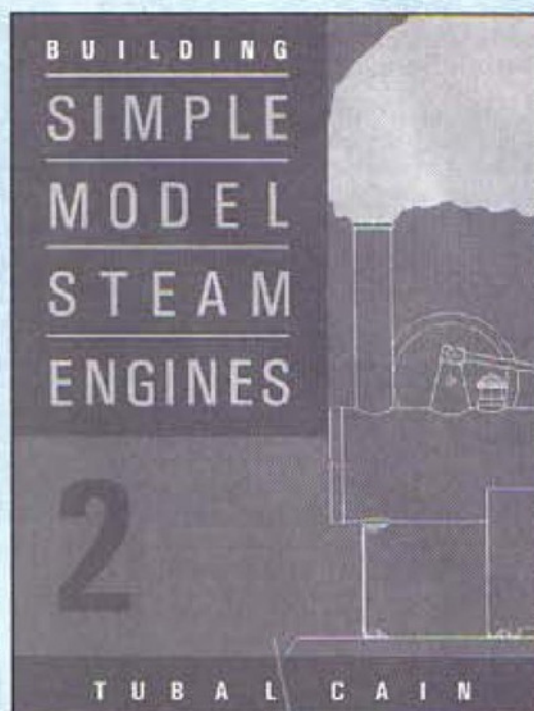
The first of the four designs included in this new book is Kitten, a small overtype engine, the drawings for which were first published in *Engineering in Miniature* in 1982. No castings are required for this simple unit, which the author has based upon one of the cheaper examples produced many years ago by the Carrette Company, and which he believes can be made in two or three evenings work.

Another Carrette design was the inspiration for Otto, which is a simple steam turbine which has a 1 3/4 in. dia. rotor running in simple bearings fixed to the top of the boiler. Although the engine is not capable of doing useful work by driving anything, it clearly demonstrates the principles by which such turbines work and, as the author states, makes quite a musical note when running. Again, the unit may be made from stock materials, no castings being involved.

Henry is described as 'A Powerful Oscillating Steam Plant', being based on a design of Henry Muncaster, an engineer of some note who contributed many articles to *Model Engineer* in the early years. Some castings are required for this unit, the source being quoted in the book. A vertical boiler sits on a base plate which also provides the foundation for the engine, which has the crankshaft located above the cylinder. Whereas the two previously described units are spirit fired, this one is arranged for heating by a commercially available gas burner.

To complete the quartet is Wenceslas, 'A Steam Engine of the Most Superior Design', prompted by an illustration in a 1911 catalogue. A twin cylinder oscillating engine, constructed from readily available commercial castings is mounted on top of the casing of the horizontal water tube boiler, which is heated by Meta tablets. A belt driven countershaft mounted in standards located on the boiler casing alongside the engine gives the whole unit a delightful period air.

As in the first book, an introductory chapter deals with construction methods under the title Ways and Means, but whereas the former shows a photograph of the author with his first steam engine in about 1920, this new book includes a contemporary photo of him at work. A life long interest in model engineering, during which this highly regarded writer has accumulated a wealth of experience, could not be better illustrated.



Building Simple Model Steam Engines - Book 2 by Tubal Cain. ISBN 1-85486-147-6. Published by Nexus Special Interests.

The Model Locomotive From Scratch by B. Terry Aspin (Chuck)

Coincidentally, just before receiving this book, I had come across an earlier contribution from the same author, a series in *Model Engineer* entitled *From Scratch - A Sensitive Drill*. This appeared like *Petrol Engines From Scratch* in 1955, illustrating as with Tubal Cain, that we are fortunate in having writers who have gained practical experience over a long period.

The delight of any book or article from B. Terry Aspin is that it is always prolifically illustrated, with both superb technical drawings and with cartoons depicting the escapades of the authors other self, Chuck. The cartoon strip which appeared years ago in *M.E.* can still raise a smile when I come across an example, particularly the one where Chuck machined a locomotive boiler from solid copper!

This new book expounds Chuck's theory that it is possible for the model engineer to carry out most of the processes of designing and constructing a model locomotive himself, limiting purchases to raw materials such as sheet metal, rod and bar, and to a limited extent, commercially made nuts, bolts and rivets.

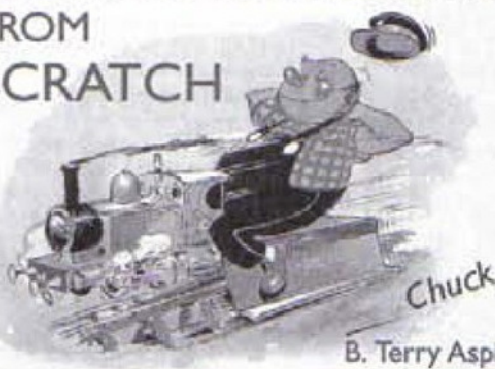
Although describing the construction of a model of a Kerr-Stewart 'Wren' locomotive at a scale of 72mm to the foot (almost a quarter full size), the book is intended to be regarded as an indication of what can be accomplished, rather than an instruction for building a particular model.

Chapters are devoted to the design process and to the manufacture of the major groups of components, with reference to the processes used, giving hints and tips applicable to locomotive building in general, along the way. As may be expected from the author of such successful books as *Foundrywork for the Amateur* and *The Backyard Foundry* there is a heavy emphasis on the home production of patterns and castings, with helpful illustrations on the construction of core boxes to facilitate the inclusion of cast-in steam and exhaust passages within the cylinders.

The book contains 92 pages of very readable advice, many good drawings and photographs and, of course, a liberal sprinkling of sketches of Chuck in action.

The Model Locomotive From Scratch by B. Terry Aspin. ISBN 1-85486-165-4. Published by Nexus Special Interests Ltd.

THE MODEL LOCOMOTIVE FROM SCRATCH



Steam Heritage Museums and Rally Guide 1998/99 from TEE Publishing.

This isn't so much a book for fireside reading, as one for keeping in the glove compartment of the car. It should, though, be perused thoroughly as soon as received, so that at least a few expeditions can be planned in advance and dates of significant events noted in the diary.

The scope of this useful publication is 'Preserved Railways, Industrial, Transport, Ship, Aircraft and Military Museums' as well as rallies and events associated with these topics.

In the region of 850 museums and similar establishments are listed, cross-referenced by subject and geographical location, and the diary section contains 1100 special events. If you get out and about and your interest is our industrial heritage, this Guide is an essential reference work.

Steam Heritage Museums & Rally Guide, TEE Publishing, The Fosse, Fosse Way, Radford Semele, Leamington Spa, Warwickshire CV31 1XN Tel. (24hrs. Credit Card Hotline) 01926 614101 Fax. 01926 614293 email 100544.1675@compuserve.com Price, including postage is £3.50.

FROM THE PLANS SERVICE

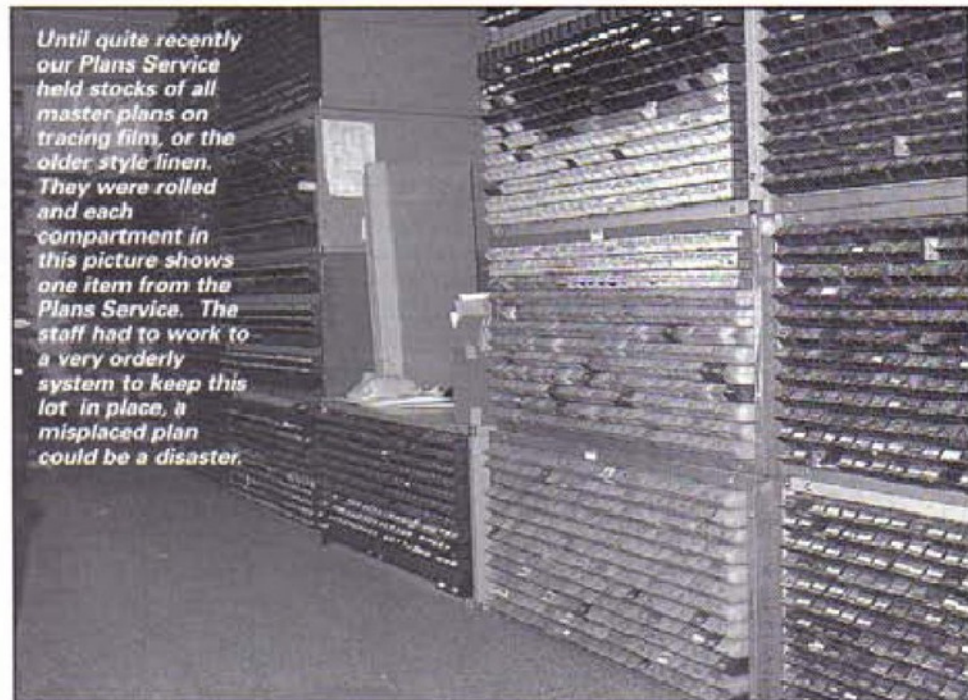
Digital Plan Printing

Over recent months, fundamental changes have been taking place in the methods used to store and print the drawings offered by the Plans Service. We thought that this would be a good opportunity to ask Bill Burkinshaw, Manager of this part of the Nexus operation to describe the changes.

There can be very few areas of modelling that the digital revolution has passed by. One would think that the plans that we have used for so many years would be immune to change, simple lines on plain paper, printed by processes that our grandparents would readily recognise but it is not so. Machines wear out and have to be replaced, technologies develop and in rapid succession our Plans Service has changed from ammonia dieline printing to a semi-dry process and now to laser plotting.

The semi-dry dieline machines were heavy consumers of 3 phase electricity, needed powerful ventilation systems and were unpleasantly hot to work on in the summer months and by current reprographic standards, slow and short on versatility. The digital plotters that have replaced them are virtually silent, will run from a single 13 Amp socket and, being driven by powerful computers, can

Until quite recently our Plans Service held stocks of all master plans on tracing film, or the older style linen. They were rolled and each compartment in this picture shows one item from the Plans Service. The staff had to work to a very orderly system to keep this lot in place, a misplaced plan could be a disaster.



perform unattended and output in any size or format that can be accommodated on the 1 metre wide paper roll.

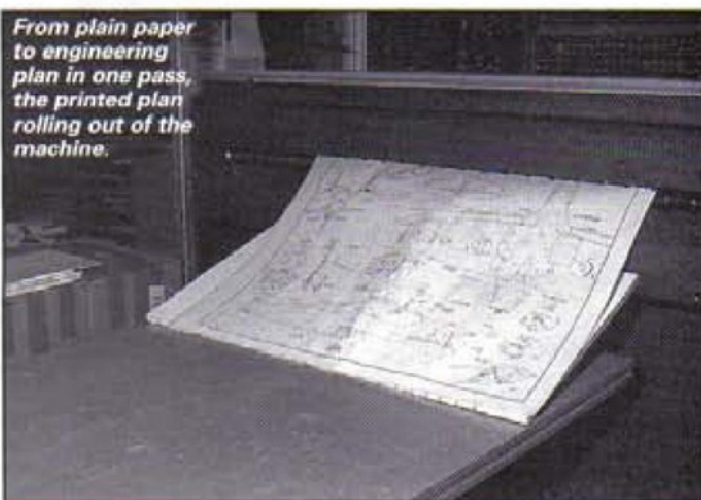
Some two years ago it was apparent that our dieline machinery was approaching the end of its useful life and the decision to convert to digital plotting was made. At first glance the transition appears to be very simple. Take our original drawings, scan them using a large format scanner, store the scanned images on a computer and digitally plot them as required. It never is as simple as one would hope. The first of many problems was the quality of the original material that

we had to work with. The Plans Service has grown over many years from very small beginnings when it was run as a genuine service without any real concern for profit. The plans were printed from the actual ink-on-linen originals as it did not seem at the time that there would be a demand for prints in 50 years time. Consequently, by the time it was apparent that these drawings were going to be in demand for a long time, many of the originals were in a fairly sorry state. Copies were made but from originals that were by no means pristine.

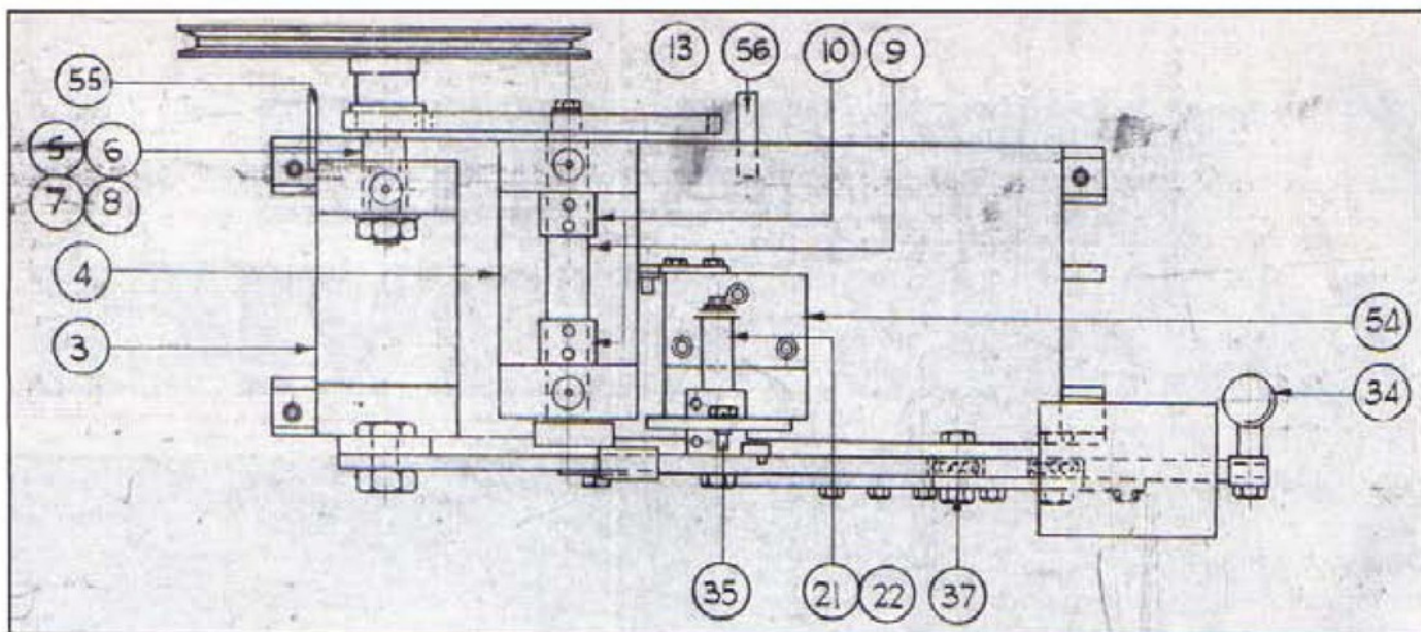
We therefore started to scan from poor



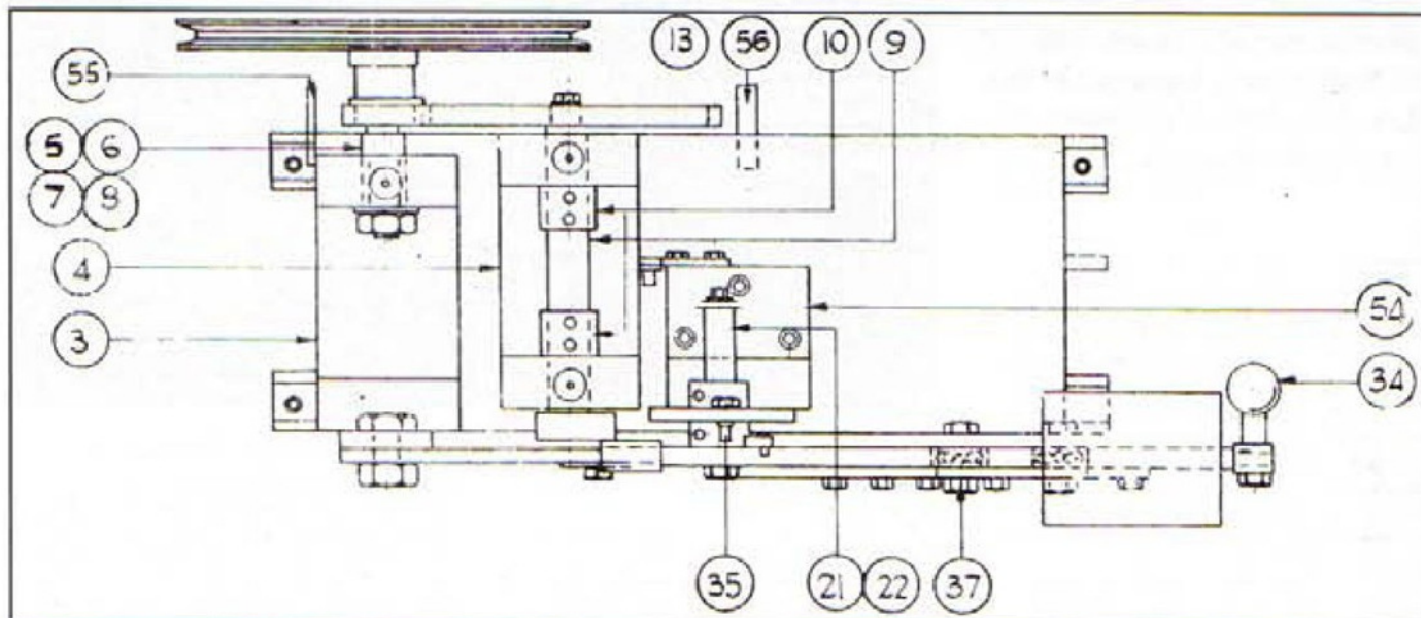
These were the semi-dry dieline printers which did yeoman service for several years. Peter Dunnet is seen here fulfilling another order.



From plain paper to engineering plan in one pass, the printed plan rolling out of the machine.



ABOVE AND BELOW: Compare these two prints, the stained one is from a very ancient linan master, through the dieline machine, the ravages of many passes through the machine and years of rolled up storage show through on the drawing. When it was digitally scanned much of the background clutter disappeared, although the finished result was originated from the same hand drawn tracing. Incidentally the drawing is a view of a Power Hacksaw designed by the late Ian Bradley, available as WE5.



quality material and, to make matters worse, a lot of the originals were on 40 inch width material, too wide for modern scanners and too wide for the digital

plotter. Each drawing had therefore to be scanned in strips and edited digitally onto additional sheets. Whilst the scanning was carried out, some cleaning up of the

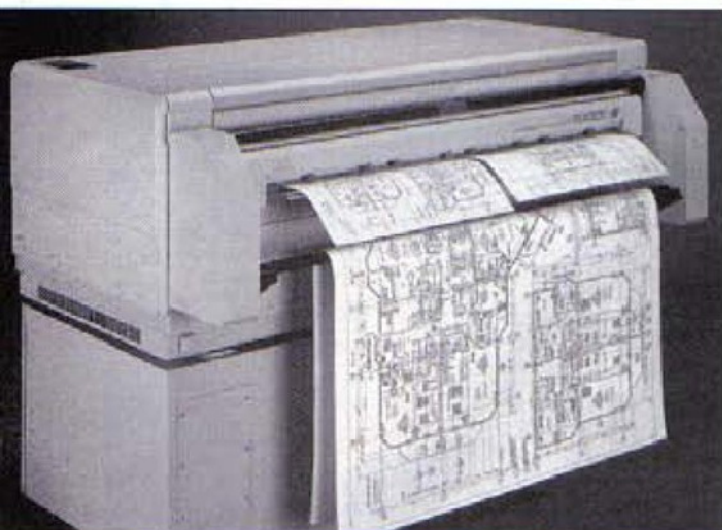
images was undertaken and in many cases, the resulting digitally plotted drawing is clearer and cleaner than the dieline print of a year ago.

Our original target was completion of the digitising in 12 months but the editing took longer than our estimates and it has taken almost 15 months to complete the task.

LEFT: The latest technology, the original plans have been digitally scanned, and recorded on floppy disc. When a paper print is required the information is fed into this machine and an excellent print is produced. Instead of a room filled with masters they can now all be stored in a small cabinet.

Although the print is now generated from digital information, if the original was in poor condition, the new prints will also be less than perfect. They are usually better than the dieline prints would have been and we can at least take comfort from the fact that they will not deteriorate from now on. It would be great to think that we could re-draw some of the older plans but alas, even the best selling plans rarely sell more than a couple of dozen copies a year and, do not commercially justify the draughting costs.

The most dramatic illustration of the changes resulting from the new technology is in the physical size of the operation. The printing is carried out on a machine about half the size of an office desk connected to an ordinary PC, all of the "originals" are now stored on the disk drive of the PC and can be copied onto 20 Compact Disks. The print room that this equipment replaced needed a space 14 metres square. Our stock of envelopes and catalogues now takes up more space than the printing system.



SCRIBE A LINE

Metric pitches with a gearbox

From John Peters, Harrogate, North Yorkshire

In *Scribe a Line*, MEW 42, John Walford reminded us of a table of settings for cutting simplified metric and BA threads on a Myford Super 7B. These left the ordinary quadrant in place, but used various driver gears, not just the standard 24 tooth gear. The approximations obtainable when a 34 tooth gear is used were not given in the original table. It is a curious fact that with a 34 tooth gear, several useful pitches can be cut to an accuracy of 0.05% (1 in 2160); namely 4.00mm, 3.00mm, 2.00mm, 2.25mm, 1.50mm, 1.00mm (08A), 0.90mm (1BA), 0.75mm, 0.50mm, as well as 0.40mm, 0.25mm (13BA), 0.20mm and some others that are less useful. Myford Ltd. sell a 34 tooth gear at modest cost (£7.28 in March 1998), so this may be of practical interest. The settings required are given in the table below.

Pitch in mm.	Gearbox Setting
4.00	9 t.p.i.
3.00	12 t.p.i.
2.25	16 t.p.i.
2.00	18 t.p.i.
1.50	24 t.p.i.
1.00	36 t.p.i.
0.90	40 t.p.i.
0.75	48 t.p.i.
0.50	0.0139 in./rev.
0.40	0.0111 in./rev.
0.25	0.0069 in./rev.
0.20	0.0055 in./rev.

Tungsten Carbide Tooling

From Bob Loader, Harlow, Essex

My article about tipped tools in issue No. 43 has caused some discussion about the smallest size which can be bored using the boring bar I described. The latest opinion, in Issue No. 48 is a little over 17.5mm.

As the original culprit, I claim the right to the last word, or words, which are, 'a touch over 11.3mm'. It proves that the theoretical answer isn't always the whole story. I did state in the article that the minimum diameter would be about 12mm using the boring bar made to the dimensions shown. I also mentioned that the 12mm could be bored by setting a slightly larger clearance, which would change the rake angle to a small negative value.

I haven't done the sums, but I recently needed to tap an M14 x 1 thread in a disc of a size perfect for boring out and checking as I went. The tapping size is a little over 13mm, so I checked while I bored. Before I started I rotated the bar in the holder to increase the clearance to what I thought would be enough. It did make the rake slightly negative, but when using tipped tools I've not found it to be that important, within reasonable limits, especially with boring tools - and that's how I determined my minimum size. It depends on the tool holder being made accurately to the dimensions shown in issue No. 43, with the tip securing screw filed off flush with the bottom of the bar.

I hope that this clarifies the matter. It shows that a little adjustment can often solve a theoretical problem.

A cautionary tale

From Vic Smith, Tilbury, Essex

In order to face off some 3in. diameter by 3in. length hardwood blanks, I foolishly held each in the three jaw chuck, with some 2 1/2in. protruding. The lathe is a Myford Super Seven, a spindle speed of 1020 was selected and the top slide was unfortunately left at a 30 degree angle from a previous operation. The first two blanks were faced without problem, but the third jammed with frightening results!

The blank flew past my left ear and crashed against the far wall. Having switched off and recovered from the shock, I was amazed to discover that the top slide had disappeared. It was found in the scrap box on the floor, behind and to the right of me. The retaining screws of the topslide feedscrew nut were still secured to the topslide base, together with broken pieces of the nut. The remainder of the nut was still attached to the leadscrew, which had been dragged out as the slide was forced away by the wedging action of the jam. This must have narrowly missed my right elbow. The screws had broken through from the counterbores of the nut casting which, although slightly distorted, I was able to refit with washers spanning the counterbore. Needless to say, the chuck was replaced by a four jaw, the topslide set parallel to the bed and the remaining blanks faced without further trouble.

All this happened on a Thursday morning. When the job was finished I phoned Myford's and, having confirmed availability and cost of a new nut, a cheque was sent off that afternoon. To my surprise and delight the new piece was received first post Saturday. Ten out of ten to Myford.

Me? 500 lines 'Do not be so damned stupid in future!'

Water based coolants

From A.E.Hewitt, Chippenham, Wilts.

The letter from Andy Nichols of Chelmsford, Essex describes an all too familiar problem of rusting with water based coolants. This problem is most likely to be self generated due largely to a misunderstanding of how a water and oil emulsion is created and maintained. Most people are aware that oil and water do not normally mix and, on leaving to stand, will separate again. It is necessary to use polarised emulsifiers to make the oil droplets disperse in the water phase and remain dispersed whilst in use. The polarised droplets are negatively charged (Anionic) and repel one another just like magnets. (Like poles repel, unlike poles attract).

When rusting appears, some of the oil droplets have lost their polarity and recombine to be seen as oil floating on top of the emulsion. This means that some free water is now in the bottom of the storage vessel, from where it will be pumped round the machine to lay on unprotected surfaces. Result rust.

This is never apparent until it has happened because the appearance of the coolant remains just as normal.

To prepare a sound emulsion that will last, always pour the concentrate into the water, not the other way round, as this will form an invert emulsion which will separate on standing. Mix the emulsion in a separate clean vessel with a stirring action, then fill or top up the machine tank. The water requires no special treatment but in hard water areas it may be softened by the addition of a proprietary softening agent.

If subscribers have any questions on this or related topics I will be happy to try and answer them through *Scribe a Line*, having spent the last 25 years advising industry on the do's and don'ts of this complex subject.

Is it all done by magnets, or was it too much of the hard stuff?

From Geoff Pace, Harlow, Essex

I was amazed to see, on television, a couple of weeks ago, on a programme called 'Collectors Lot', a gentleman demonstrate what I can only describe as a levitating top.

The top was spun by hand on top of a square block, on top of which was placed a sheet of glass. Whilst still in motion, the glass was lifted gently with the top still spinning, about 4 - 5in. above the square block, then the glass plate was deftly slid from under the top. The top remained spinning freely, at that height, without visible support!

Apparently, it was a toy that was once produced commercially, but unfortunately

Repairs to cracked cast iron components - An alternative method

From Arthur Miller, Doncaster, South Yorkshire

The recent correspondence in Issues 48 and 49 initiated by David Pettengell's call for help in the repair of a vintage Allis - Chalmers tractor exhaust manifold was, together with the informative replies, very interesting. There is however an alternative repair method that may be applicable to this repair which does not involve the use of heat, Sif Bronze, or any of the very skilled welding techniques described in detail by T. D. Walshaw, F. J. Arnold and D. T. Bartram.

The cold method of repair, which has the registered title of METALOCK has been in extensive use for the repair of cracked cast iron components in both marine and industrial environments for over 50 years.

This method employs nickel alloy keys (Invar) which are inserted and peened in place across the line of fracture, through jig drilled and slotted holes placed at regular intervals. The size of key and spacing are determined by the nature of the fracture and the metal thickness. These keys, together with interlocking over-lapping studs inserted into blind tapped holes spaced along the line of fracture and which load or stress the keys ensure a rigid permanent repair.

Although this is a commercial activity employing specially manufactured key material, the purchase of which is restricted to registered METALOCK companies, and which also requires the use of hardened drilling jigs, I thought that the method may be of interest to the readers of MEW.

I have no current connection with Metalock, although I managed Metalock (Yorkshire) for two years, 28 years ago (between 1969 and 1971) but have had no connection since that date. During my time at Metalock, a number of repairs were carried out on vintage vehicles as well as some spectacular repairs for industry. These included repairing the machined bed ways of an enormous Craven double headed lathe, which was over 60 feet long, with four ways in the bed spanning over 12 feet. It was located at the gun shop at English Steel in Sheffield (no longer existing alas), the sort of lathe where the operator sits on a chair placed on the saddle and reads a novel whilst waiting for a cut to progress along the work piece! The lathe was also fitted with a conveyor belt system, in a cellar under the lathe, to remove the swarf. An unfortunate accident involved a 90 ton billet slipping, smashing the cross-slide double roller steady and finally coming to rest after also smashing 14 feet of one of the middle bed ways. The break was cleaned up, a new section of bed was cast then pre machined and Metalocked in place, with the top bed surface a thou or so proud, allowing final hand scraping to take place after the repair.

no more. What a pity. I would have thought that if it were disguised as perhaps a 'UFO', children (like me at 66) would go mad for it.

How I would love to be able to make one for my grandchildren. Oh!, what magic - truly, Grandpa's a genius!!

Did any other reader see this programme, or know of someone who did? More to the point, can anyone offer an explanation of how it works? I'm not completely mad, and I wasn't drinking at that time!

So you want some little nuts?

From Eric Ball, Croydon, Surrey

Nothing new in that, just buy a packet of 14BA full nuts - or make them! I needed 40.

For 14BA steel nuts first get some 14BA hexagon - 0.069 in A/F. A lot has been written about the correct sizes in this post-Whiston era. Next, look at the tables. It is all very well for the expert to say if it looks right it is right, but they probably have years of experience. For 14BA, tapping drill size is given as 0.82mm or No. 66 (0.0330in). A Super Seven will do the job, and I used it at maximum speed, 2105 rpm, including for parting off, taking great care. Time was of no great importance. Ensure the hexagon is held centrally, using a DTI and square off the end. Check that the tailstock is also central. I used three tailstock drills, two in No. 2MT holders, the third was a No.1MT in a 1-2 sleeve. (A fourth would have been convenient). First centre pop lightly, then drill down about 0.200in. Use a sharp drill, the swarf should come off in two equal

More lathe information sought

From G. R. Niell, Fareham, Hants

I have been fascinated by the articles submitted by John Shrubsole on the restoration of the early Myford, and they have prompted me to write.

I need some information on a lathe which I have recently purchased. Although working perfectly, there are some bits missing and I have tried to find details from the local experts, but to no avail. The lathe in question is very similar to John's, having a twin flat bed, 5in. inch swing and about 24in. between centres. It has a motor on an adjustable plate at the rear, an intermediate shaft and pulley cluster which in turn drive the mandrel. This arrangement appears to be identical to John's modification, but mine was built in from new. It is equipped with back gear and screw cutting change gears, all of which are present. Inside the change gear cover side plate is a brass table plate which shows all the gear configurations for screw cutting.

An interesting feature is that the pulleys appear to be a form of hard black plastic, but the only identification I can find is a brass plate which states, HALIFAX 524. I suspect, but this is only a guess, that it is about 1950 vintage.

The parts that are missing are the components which go in the small box which is located next to the gear change box and which straddles the screw cutting drive shaft. I suspect that it is for engaging or disengaging the screw cutting gears. The box is in position, but it has no levers or 'innards'.

Any information which can be supplied, or perhaps even a photo copy of a user hand book would be very gratefully received.

spirals. Clear the tiny chips frequently. Next tap, not under power, using a taper tap and your favourite compound, to about 0.150in., then repeat with a plug tap. Finally part off, in my case 0.040in. Once again take it slowly - very slowly at 2105 rpm. (If I had a 254 I would have changed the speed). I made 40 nuts this way, and at the start broke the end off a No. 66 drill, but was able to sharpen it and use it for the rest of the task. After making half a dozen nuts, the drill may

have wandered in the hexagon, so watch very closely when drilling, and if the drill appears to move eccentrically, cut off and make a new start with a squared up hexagon and a new centre pop. I ground the Eclipse HSS cutting off blade to have a square end about 0.010in., and the left hand side ground back about 15deg., total width 0.045in. I didn't time myself; model engineering, to me, is a relaxing pastime in the workshop.