No.28

MARCH/APRIL 1995 £2.60

MODEL ENGINEERS' WORKSHOP

THE PRACTICAL HOBBY MAGAZINE

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Turning techniques

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Issue No. 28

Editor: Harold Hall

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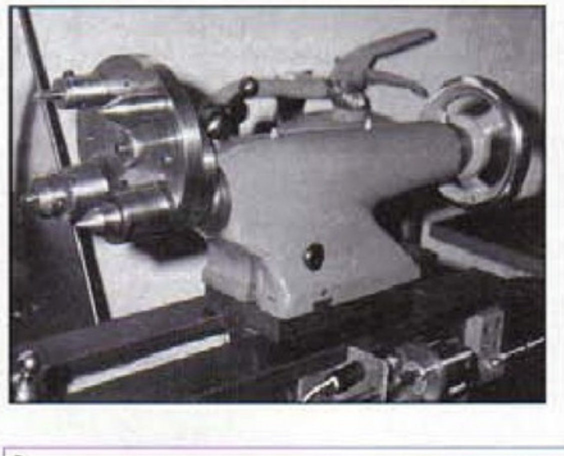
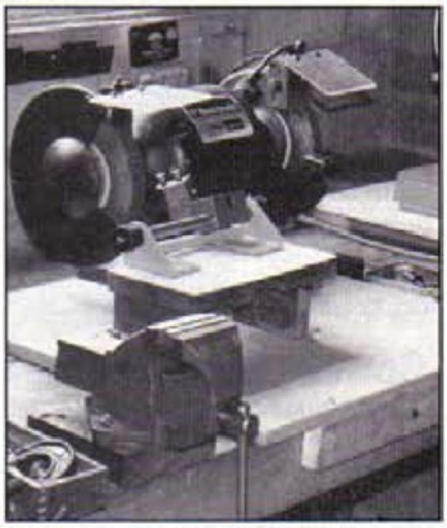


For repetition work involving drilling, centre support, tapping on a number of parts this invaluable tool saves time and temper. See how you can make one for your lathe starting on page 59

MODELLER ON THE COVER

Anthony Porter in his workshop - a more detailed note is on page 33.

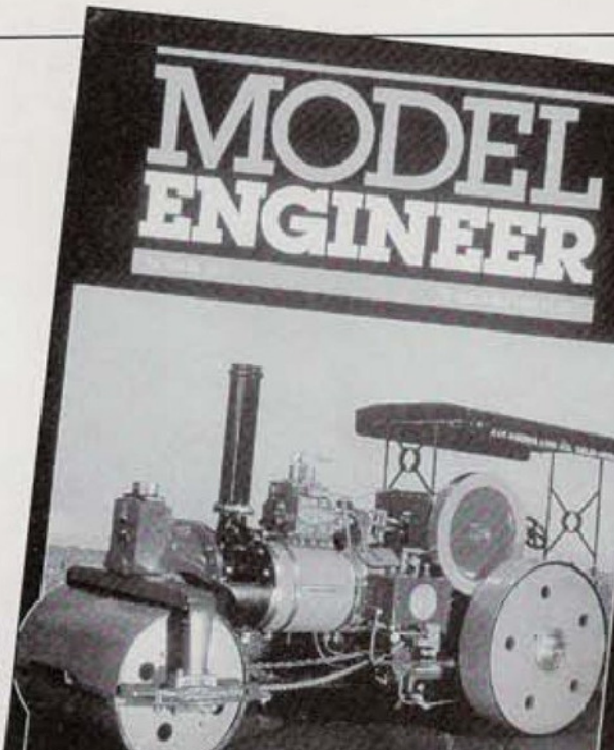


Once you have made this invaluable attachment for your offhand grinder you need never again suffer from blunt or incorrectly ground lathe tools. Description starts on page 12.

ADVERTISERS INDEX

SOMETHING TO LOOK FORWARD TO...

...every fortnight



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

AN ARGUS SPECIALIST PUBLICATION

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Harold Hall

ON THE EDITOR'S BENCH

Did you solve the John Steele give-away I mentioned in my last editorial? If not here is the most obvious one. Look at the pieces of metal in photo 7, page 50 issue 24, you will see some of these in my series on using the bench press. See issue 19, page 49 photo 11 and issue 21, page 63 photo 19.

Some things don't change

Recently a small quantity of *Model Engineer* magazines from the period 1955/56 came through the post and on unpacking these and browsing through them, I soon realised that in many areas there has been so little change. Almost the first front cover I spotted featured the Channel Tunnel, which has now been built. Inside was a suggestion that cars should be made with sliding doors to enable them to be parked closer, helping avoid the problem of insufficient parking spaces. I thought this to be just a problem of the 80s and the 90s.

I was interested to read in the editorial for 29 March 1956 some comments on the subject of making tools, under the heading, *Gadgets Galore*. In this, Vulcan states. " But "Gadgets" - to use the common and not very complementary term for these devices - have a propensity for reproducing their own species and some of their devotees find in the course of time that they do very little else but make gadgets for the purposes of making more gadgets.". I am sure we have read that in *M.E.W.* many times.

To bring this up to date, it is interesting to consider the recent reader survey. This shows that readers are coming from an increasingly wide range of activities, some 45 being listed from a batch of 400 replies. Also, question 5 indicates that 27% consider their main activity to be model engineering, and of the remaining 73%, 49% of these claim workshop equipment as their main activity, that is 36% of the total, 33% more than involved in model engineering. How's your percentages?

Some things do

While some things do not change, *M.E.W.* has been involved in a number of changes recently. These have been organisational with no intention of any major changes to the magazine taking place. However, most changes do have initial teething troubles and these have resulted in situations with which some readers are none too happy.

Much authors text comes typed, rather than on disc, some even hand written, making editorial changes difficult to make. To make editorial changes easier, a character recognition scanner was obtained to transfer text on paper onto disc. Unfortunately these are not foolproof and do make errors which are not always spotted on a computer screen. Typically, figure 1, capital I and lower case L are easily confused. The lessons are being learnt and hopefully errors of this type are mostly a thing of the past.

Next came the change to completing page layouts in house and by computerised methods. This required taking on designers who were new to the magazine; which inevitably resulted in subtle changes of style. I would add here, that as *M.E.W.* is bi-monthly, it is not a full time activity for the designer. At other times, the designer will be working with quite different subject matter, maybe needlework or electronics and so on, and each magazine has its own individual style. This is far more complex to come to terms with than the repetitive nature of a daily paper or a weekly magazine. If you are still unhappy, please be patient for a few more issues before writing to the new editor, who will be deeply involved in more pressing matters in the short term.

You may have noticed in the magazine reference to Nexus Special Interests Ltd. This is as a result of the ASP group being acquired on 1 November 1994 by Nexus. All activity remains at Boundary Way Hemel Hempstead and with largely the same staff. It is unlikely that it will effect the magazine in any major way. Please make use of the change of name in any correspondence, cheques etc.,

More significant is the change in editor, this being my last issue. Starting next issue the editor will be Geoffrey Sheppard.

Geoff comes with much more experience, time and depth, in the subject matter of the magazine than I did, and will be better placed to edit the magazine and help with your queries. He has been involved with other people of similar interests, which I had not and is academically well qualified. Geoff's activities are wide ranging, in modelling, typically steam and I.C., belonging to Bristol Society of Model and Experimental Engineers.

An interest in vintage cars is evident by his owning a pre-war Austin 7 and belonging to the Bristol Austin 7 Club and also its national counterpart.

I wish Geoff well and would request that you give him all the support that you can, as you have done for me. I believe his task will be more difficult than mine, for whilst I took over with no more than 10 articles on file, being a new magazine, any relevant subject was acceptable. For me it was just a case of burning the midnight oil writing articles, until sufficient were forthcoming from other sources. Geoff starts with many more articles on file, but with a diminishing supply, and less subjects on which to write, though my list of possibles was still quite long. Do please help Geoff by providing as many articles as you possibly can.

For my part, I am more than a little surprised, and must confess, rather sad, to be writing my last editorial so quickly. I am not known for making rapid changes. Prior to this job I have only had two, the last for 30 years. My residence has always been in Hemel Hempstead, and surrounding area. As for my personal life, this has involved being a Christian as a member of the Salvation Army all my life. I ran a youth club for 15 years.

Neither have I been one for changing equipment. My first ML7, purchased as a teenager was only disposed of a few years back. My two cameras and two tape recorders are my first serious purchases in these directions. Incidentally my recorders were in service a week or two back and still perform well after some 32 years and much humping about in the back of the car. No doubt some readers have an interest in such items, they are Revox A77 machines made by Studer of Zurich. My microphones are some 20 years old, very good, made by Calrec and, incredibly, British.

You will see from these facts that I am not one to change my direction easily, so my surprise is I think justifiable, but I have found the position too demanding, a sign of age maybe?

I cannot leave without expressing my very sincere thanks, first, to the readers who have supported the magazine, and including a special thanks to those who have written to me. A few have been critical, though only a very small number severely so, whilst by far the majority have been very complimentary. This has been very encouraging and has done much to keep me going.

Next to those authors which have provided the articles which have appeared in the magazine. Without them *M.E.W.* would have folded long ago. Then there are those who have allowed me into their workshop so as to become the subject of readers visits. These have been well received and have generated much interest.

I came with no experience and thanks must go to those at the publishers who have tolerated my ignorance. I must mention Alec Gee who took the full impact of my repeated questioning in those early days, thanks Alec for your help. Also to Ted Jolliffe who has, for the past two years or so, been responsible for giving my efforts the once over and seeing that these went through the in house production processes as smoothly as possible, not an easy task, especially with the changes taking place.

Finally, my wife, who has very willingly tolerated my locking myself away, either in the workshop, or the dining room cum office, for long periods. This especially so for the first two years. She has also answered the telephone, helped with the filing and provided the tea and coffee which was expected at regular intervals during the day, thanks Sheila for all your help and tolerance.

What of the future? Well, I still have some way to go till I draw my pension, so some means of topping up the savings is probably first priority. Also, for those who have been patiently waiting the arrival of an *M.E.W.* index, printed and on disc, I will now be able to devote more time to this project.

I do anticipate having more time for other things. A car accident a few years back gave me 8 months off work. Writing articles intended for *Model Engineer*, though eventually published in *M.E.W.* issue 5, was one way of passing the time and were solely responsible for my becoming editor. During that time, I also took up pencil sketching which was quite successful, had I pursued this, perhaps I would have become an artist rather than an editor.

I do now intend to become involved in this again and for Christmas received some water colours and a book on the subject with a view to trying my hand at painting. While on the subject of painting, perhaps I will at last get round to painting my E. W. Cowell's drill which I made when I was a teenager!

THE SWEEPER

A LATHE TOOL GRINDING FIXTURE

John Scoggins suggests a simple fixture for the sharpening of lathe tools on the off hand grinder

Read most articles on the subject of sharpening lathe tools and it will not be long before the writer mentions that the quality of the work turned out with blunt tools is poor and the only satisfactory solution is to work with sharp and well ground tools. This is where the Sweeper comes into its own.

Let me run through its basic working, starting with the toolpost (9). This is held by an Allen screw, clearly seen in **photo 1**, to the toolpost mount (8). By releasing the fastening the toolpost can pivot about this screw. These are mounted on the pivot block (7), again by an Allen screw, which, if slackened, will allow the assembly to pivot about this screw. This screw can just be seen in **photo 2.** See also fig A. By these adjustments the various angles can be accurately set.

Movement of the pivot block is along, and around, the spindle(5), but the amount of rotation is limited by the baulk (6). With this action the tool can be swept lightly against a rotating grinding wheel until the desired angle is successfully formed. You have probably been instructed never to grind on the sides of the wheels. (*I have my own ideas on this subject, what do you , the readers, think.? Ed.*). I ask you all to stay with me and see if this piece of advice, really applies in this instance. You can then decide for yourselves as to whether, or not, the Sweeper should grace your toolbox.

This fact did deter me when I first considered this device, but, upon careful consideration, my mind turned to the attachment I had bought for the sharpening of drills. This, a professional tool, was made to operate on the side of the wheel. Armed with these thoughts, I went ahead and manufactured the Sweeper, and can report that it has achieved everything, well almost everything, asked of it. As with any such item, it must be treated with respect, confidence, but not over confidence. Caution must be exercised and safety precautions not be flouted. For safety and good working practice:-

1) Always wear suitable eye protection, ordinary spectacles are not to be recommended.

2) Always have the transparent guards in the correct position and clean when the machine is in operation.

3) Store all loose articles, Allen keys and the like, away from the Sweeper, so as not to cause any distraction.

4) Always take time to think before making a move.

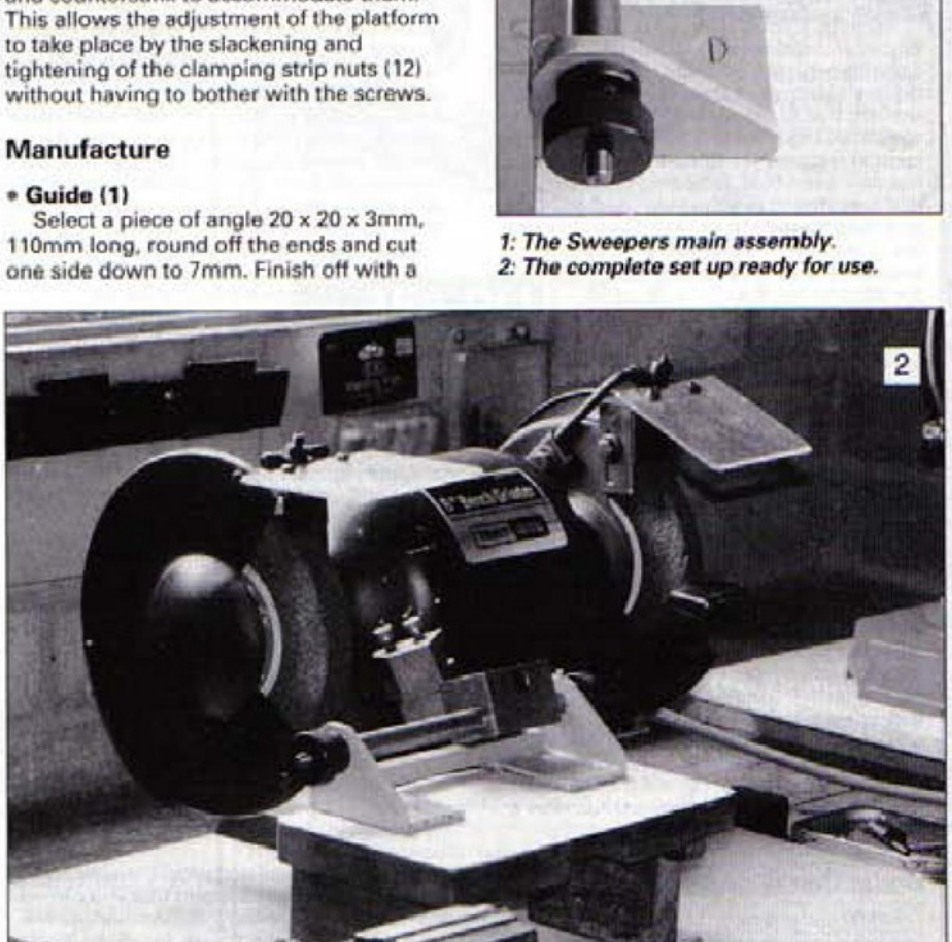
5) Do not use without the baulk. This prevents the operator from sweeping too large an arc.

Workshop reorganisation at the time I built the tool resulted in thought being given to best utilisation of available space. The outcome was to mount the Sweeper, fretsaw, a tapping device and a small pedestal drill, each on their own bases. These had a wooden strip attached to the front through which a screw would pass in order that they could be firmly secured to the bench, see **photo 2**. The base is 460 x 460mm with the securing strip being a piece of wood, 50 x 25 x 300mm. Very little comment is required regarding the base, but I will add that all of these parts are attached to it by M6 countersunk screws. Even though it is wood, the base is tapped and countersunk to accommodate them. This allows the adjustment of the platform to take place by the slackening and tightening of the clamping strip nuts (12) without having to bother with the screws.

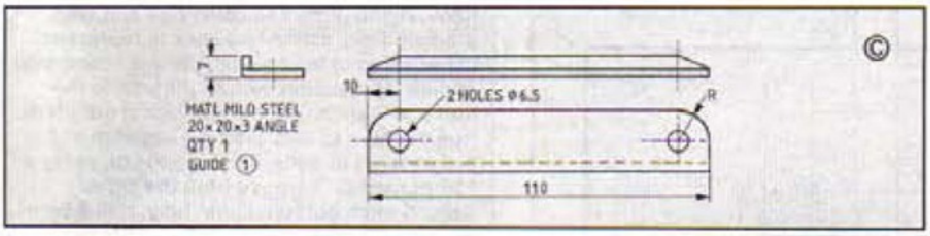
Manufacture

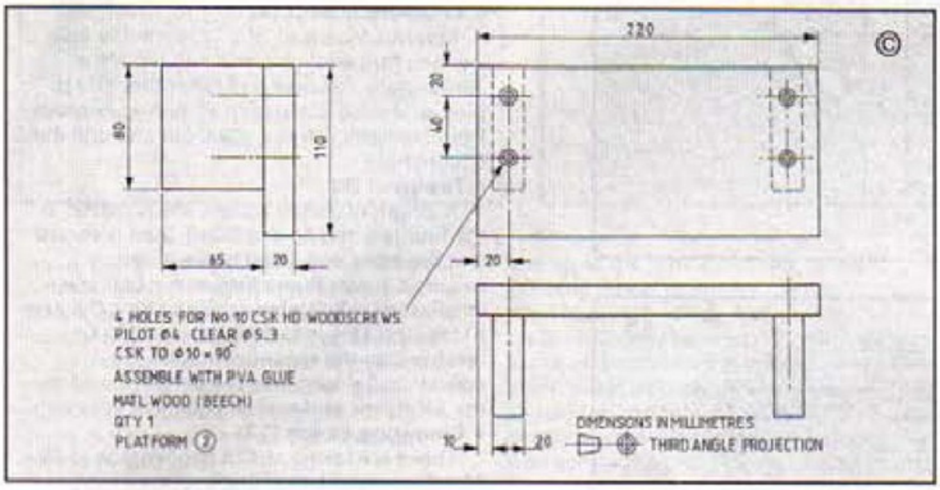
• Guide (1)

Select a piece of angle 20 x 20 x 3mm, 110mm long, round off the ends and cut one side down to 7mm. Finish off with a



1: The Sweepers main assembly.
2: The complete set up ready for use.





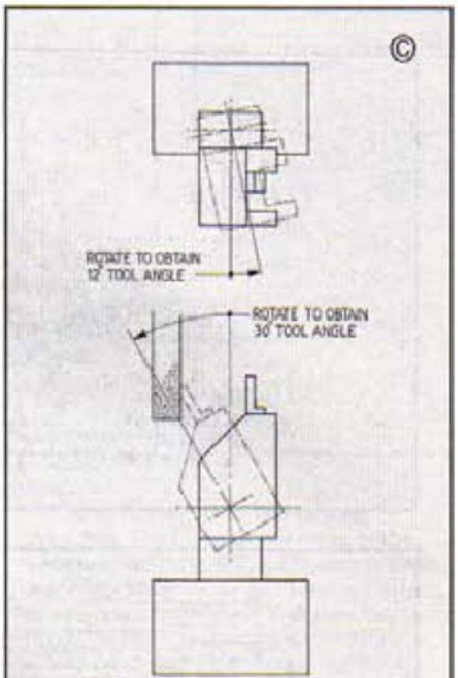


FIG B

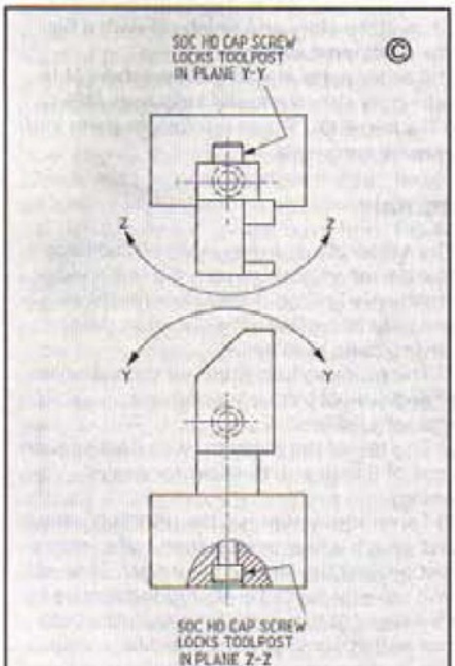
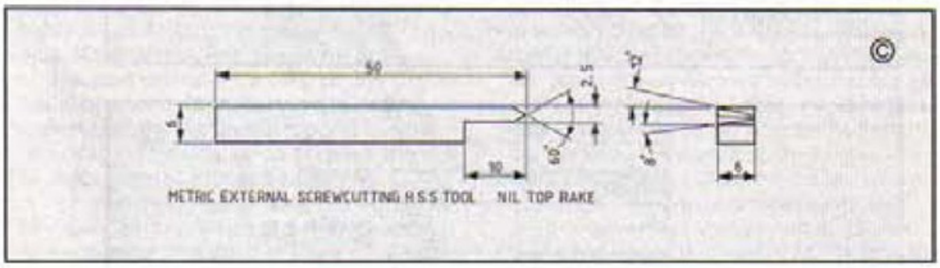


FIG A



file, also not forgetting to put a chamfer at each end and to finally deburr. Drill holes.

• Platform (2)

Beech was chosen, it is strong, and a good finish is easy to achieve. You may wish to use a piece of kitchen worktop, or even make it from mild steel. See the platform for the Hart, issue 23. If wood is utilised, cover the top with Plasticard, this allows for easy cleaning. When fitting the legs to the platform, use wood glue aided by the security of wood screws.

• Support brackets (3 and 4)

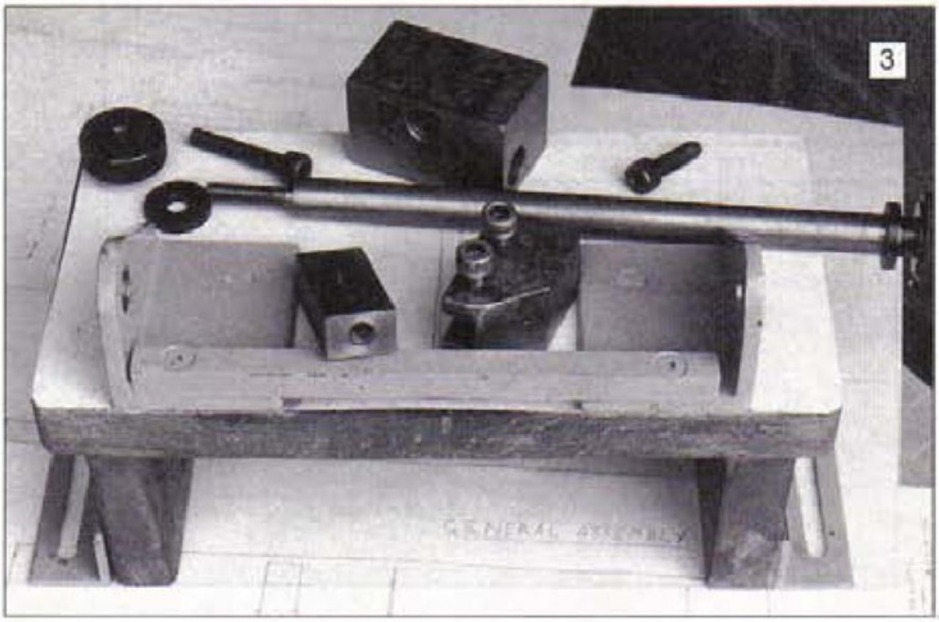
Make these from 50 x 50 x 6mm bright steel angle, but note they are left and right hand. The 12mm hole must be a close fit with the spindle. The bracket is cut away at an angle purely for cosmetic purposes. The M6 hole required for fitting the baulk have been omitted from the drawing as they will be drilled and tapped from the baulk on assembly. See **photo 3**.

• Spindle (5)

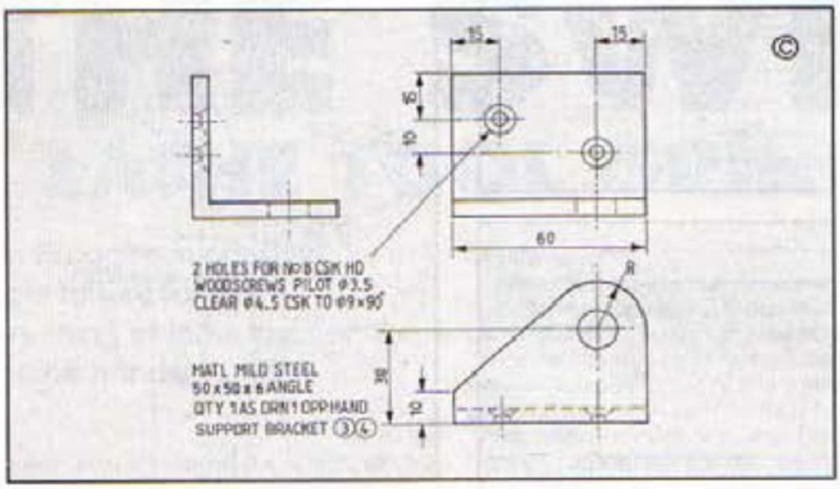
Cut off a portion of 12mm dia. BMS, ensure the material is straight, free from corrosion and bruises. Hold it in the three jaw chuck, checking that it is running reasonably true. Face end and turn down to 6mm dia. over 25mm. Using the tailstock die holder, thread this M6, taking it close up to the shoulder. Repeat these operations on other end.

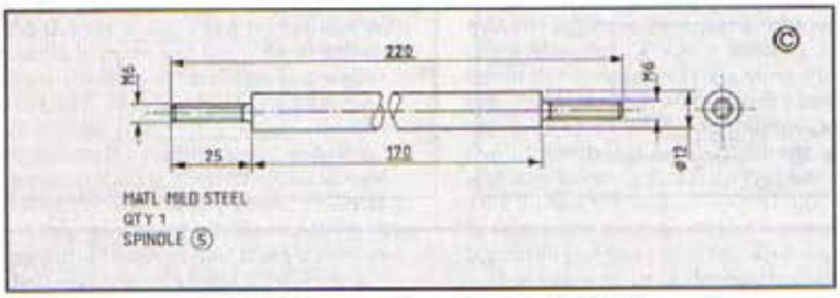
• Pivot block (7)

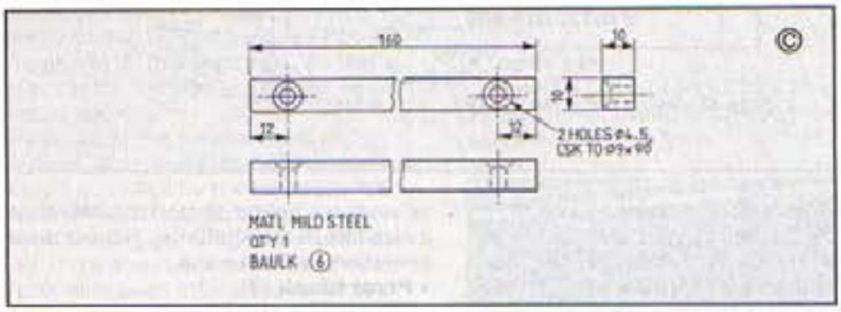
This is one of the more crucial parts because of the fit required between it and the spindle. It should rotate freely and move along the spindle without play. Because of the grit that is produced during grinding, it will be used without lubricant. It is made from 32mm square MS bar. After cutting, the component is held in the four jaw chuck, facing each end in turn, until an overall length of 50mm has been attained.

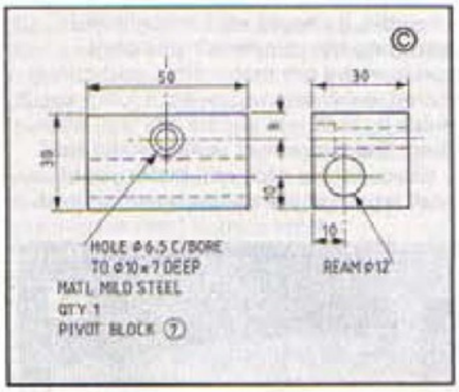


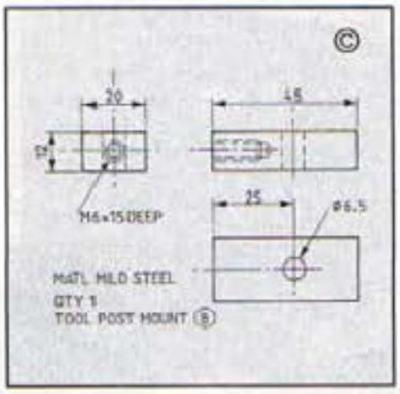
3: The platform together with the other parts ready for assembly. Note the position for the Baulk between the Support brackets, that is flush with brackets front face, as fixings for the Baulk are not given on the drawings.

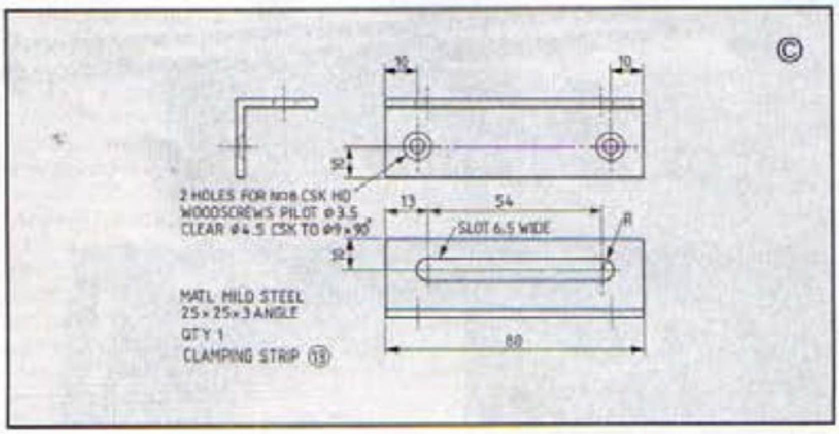












Remove the block and cover one end with marking fluid, scribe two lines to represent the position of the spindle, place a centre-pop at their intersection. Return the part to the four jaw with the centre-pop facing outwards, true the item to this. Start drilling with a progression of drills, finishing to size using a 12mm reamer. Remove from the lathe, deburr, mark out remaining hole, drill 6.5mm dia. and counterbore.

• **Toolpost mount (8)**

Mount a length of 20 x 12mm in the four jaw and face end, also drill and tap M6 x 15mm deep. Reverse and face other end to give an overall dimension of 45mm. Remove from the lathe, deburr, mark out and drill the 6.5mm hole.

• **Toolpost (9)**

A length of 25mm square MS is placed in the four jaw and its end faced, then reversed and the other end faced to the length required. It was then offset in the four jaw chuck and an 8mm hole drilled along the axis of the slot. This is to limit the metal to be removed by the subsequent milling operation. To complete the part, drill and tap the M6 holes, and make the angled cut away.

• **Clamping strips (13)**

These are identical. Cut two lengths of 25 x 25 x 3mm bright steel angle, 80mm long. Mark out and drill as shown in the drawing. Chain drill the slots and finish off with a file.

• **The odds and ends**

The other parts are, spindle washers (11), spindle nuts (10), clamping strip nuts (12), also the baulk (6). These are simple parts and require no comment.

Assembly

The assembly drawing gives an indication as to how the various parts are positioned, but with only limited dimensions as these would only complicate the situation. The following hints may assist;

1) The guide strip is fitted on the extreme left-hand side of the board and is a permanent fixture.

2) The top of the platform was decked with a piece of Plasticard to allow for easier cleaning.

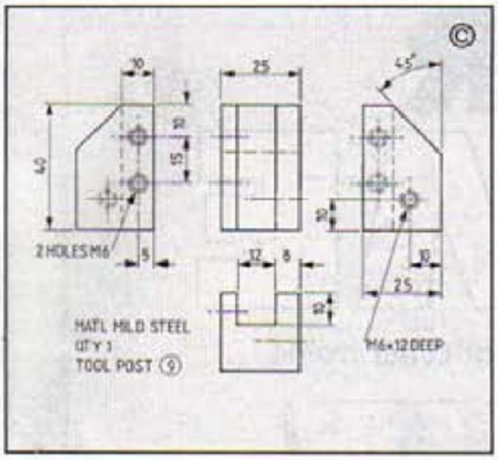
3) Temporarily remove the grinding wheel guard, which will allow the blade of a square to rest against the side of the wheel. This will permit the grinder to be positioned square to the Sweeper at the same time as setting the 10mm and 120mm dimensions. Use a clamp to secure the parts whilst the fixing positions are marked by lightly using a 6mm drill.

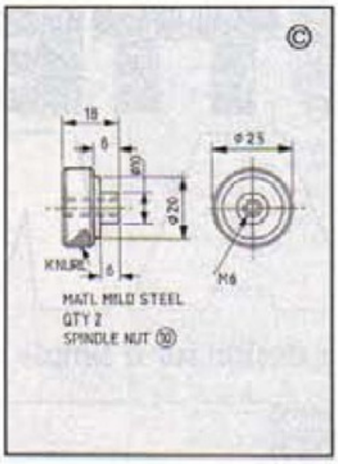
4) Note that the two screws which hold the Sweeper to the base are positioned such that the 10mm dimension is a minimum value.

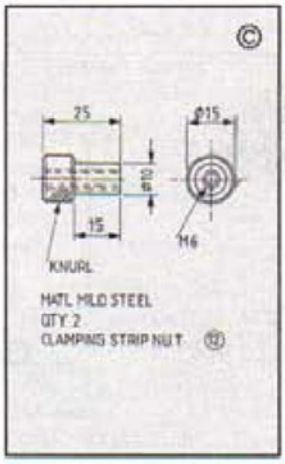
5) On completion of the assembly, refit the grinder wheel guard before being tempted to try your new toy, as the wife may call it.

The Sweeper at work

One final check, that the grinding wheel guard is firmly attached in its correct position, the eye shields are sparkling and your safety goggles are at the ready, before starting. They can easily get forgotten in the excitement. The idea behind the sweeper is to gently rock or sweep the tool to and fro on the side of the wheel. (This device became affectionately known as the Sweeper because of this action.) Keep the tool in contact with the wheel at all times otherwise, as I have







found, due to a small amount of end float in the wheel bearings, it is possible to get a double edge, which of course was one of the reasons for creating the Sweeper. Let us assume an external metric screw thread tool is required. I would recommend producing a drawing for any tool being made, but to save time on this occasion, I have provided one.

These could be made on filing cards, and kept for reference in the workshop when subsequently re-sharpening tools. Most of my lathe tools are made from ground HSS, 6mm square x 50mm long, therefore we will use that. Fit the piece of HSS in the toolholder, hard against the side, and so that it protrudes by approx. 12mm, then securely tighten the cap head screws, making sure that the tool blank has not moved. As can be deduced from **fig.A**, the toolholder has to be accurately adjusted around the axis of each of the two cap heads. We start by reducing the width to 2.5mm for a length of 10mm. A square is used for the setting the tool square in both the YY and ZZ axis, and the l0mm dimension being achieved by movement of the platform. With the wheel at rest, bring the tool up to and nearly touching it, and as we see many a time on TV, a golfer making practice swings without hitting the ball, so we will have a trial run.

With a bit of practice under our belts we now have the "feel" of the sweeper. Enough practice, safety specs on, the transparent spark guards swung into position, the machine is started. Taking a firm grip of the sweeper, guide it carefully towards the rotating wheel until the sparks begin to fly. All that is required is a very light contact with the wheel and you will be pleasantly surprised at the rate the material is removed. Remember to keep it on the move. As you are not holding the toolbit you will not get an early warning that the tool is becoming over heated. If it does start to discolour, switch off the machine and allow the tool to cool, it will lose its heat very quickly. When it is considered that the width of the tool is reduced to 2.5mm, stop the grinder and check using a steel rule.

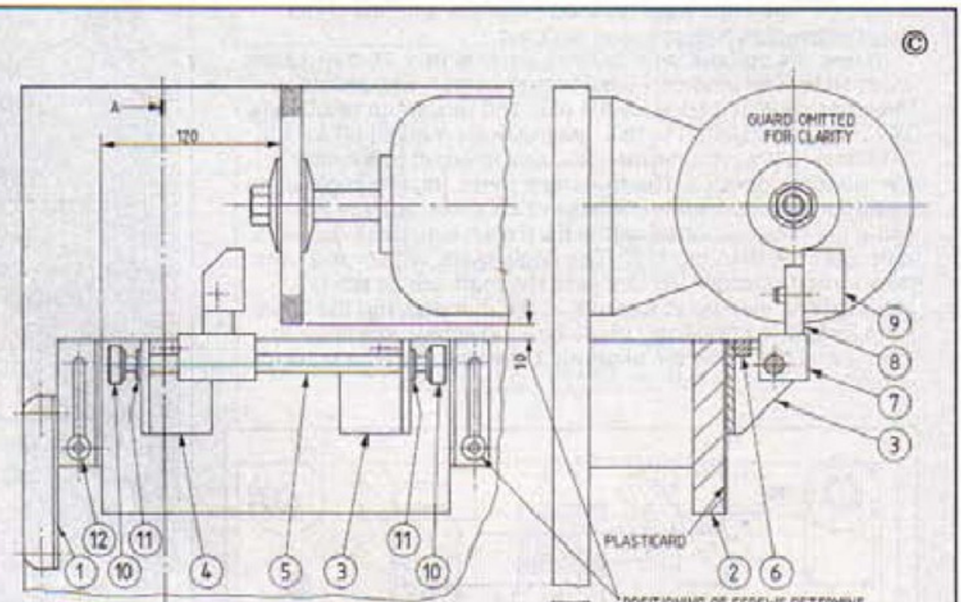
I insist that the machine is brought to rest on every occasion that adjustments are made, or measurements taken. Start along the safety trail and it will become second nature. With the width correct, attention is turned to **fig.B**. Set a protractor to read 30 deg. and set the YY axis as in that figure. Reset the protractor to l2 deg. and set the ZZ axis. Offer the tool up to the right hand side of the grinding wheel to ensure the angles have been correctly interpreted. Just a preliminary few sweeps with the machine in the off mode, switch on and sweep the blank along its path, nice and slowly. This should take no time at all. When sufficient land has been ground, that is just over half way across the end of the tool, switch off. The set up is now reversed to that we have been following in fig B, but this time with a side rake of 8 deg., and using the left hand side of the wheel. Proceed as before.

The next operation is very similar to the initial operation for reducing the width, except that the tool being ground is now mounted on its side, so as to grind, the top face, just lightly. Proceed as before.

We now have nearly achieved our goal, being the proud owner of a metric external screw cutting tool. All that remains, when the tool has been removed from the fixture, is to check with a screw cutting gauge, and to produce a small radii in place of the sharp point, followed by a dressing of the top and side surfaces. This being done with a hand held stone. That completes a typical lathe tool, other tools being produced in much the same way.

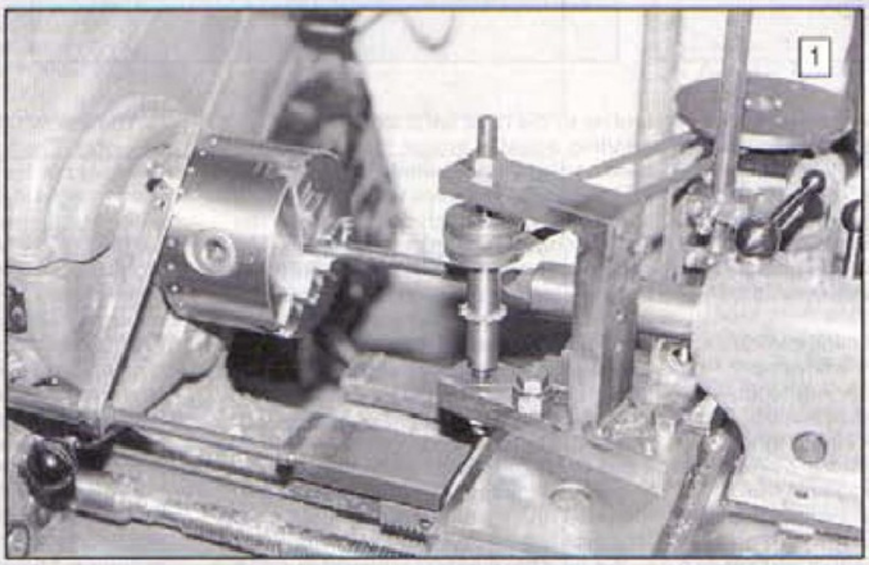
The following are a few closing thoughts. The finish of the parts of the sweeper can be to leave all parts in their raw material state, or paint those parts where it is permissible. This was the choice for the prototype. Another possibility would be to gun blue all of the steel components. If my memory serves me correctly "G96 gun blue creme" is what it is called and is obtainable at the local gunsmiths. It is easy to apply, no distortion to worry about as it is applied cold, and it leaves the component being treated a deep rich black. It was decided not to harden any parts, my thinking was that any wear that took place could be simply rectified when the occasion presented itself. Dust covers were considered but seemed a bit elaborate. I have tried scribed lines and gauges of various shapes and sizes, but found the use of the square and protractor just as convenient.

So I wish you the very best of luck with the construction and that, as a result, your toolbox will be graced by the presence of a Sweeper. It makes tool grinding so easy. Finally, remember that you do not have to be a football manager to own a sweeper!



CUTTER FRAME

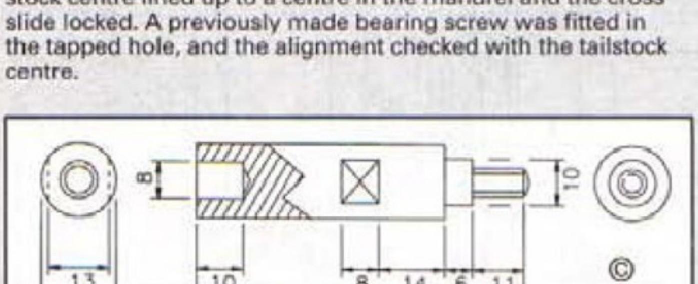
Geoff Gray provides a design for a simple gear cutter frame.

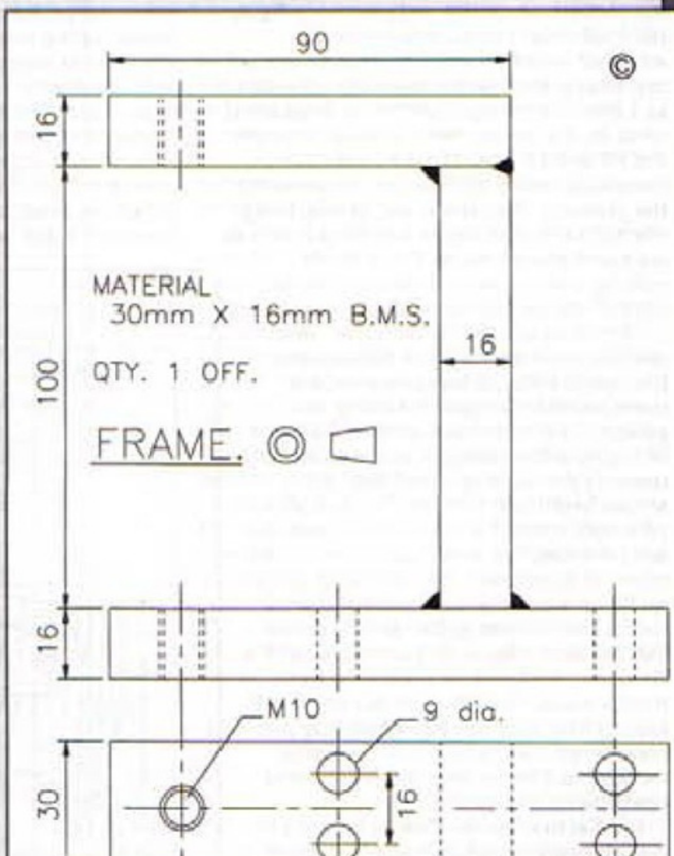


Now that clock making is my main hobby, I decided it was time I found a better way of cutting wheel and pinion teeth. I wanted something quicker to set up and much more rigid. I considered a wheel cutting engine but, because of the time needed to make it, and the storage space required, soon disposed of that idea. Eventually, I came up with the cutter frame in photo 1.

I did not have enough 30 x 16mm BMS for the frame so used thinner material for the top member. This is apparent on the photographs, but I have quoted 16mm throughout on the drawings. The ends were cleaned up in the four jaw chuck before clamping together and welding.

In use, the spindle must be truly vertical or at 90 deg. to the cross slide. The method I used was to bolt an angle plate to the cross slide at 90 deg. to the axis and facing the headstock. The frame was bolted to this, having been marked off for the M10 hole in the top member, and this lined up to a centre in the mandrel, photo 2. The foot must overhang the angle plate by about 25mm. After locking the cross slide, drill the hole using the tailstock, fitted with a hard centre, to push the work onto the drill, then tap M10. The angle plate, with frame, was now turned through 180 deg. and the mark left by the tail stock centre lined up to a centre in the mandrel and the cross slide locked. A previously made bearing screw was fitted in the tapped hole, and the alignment checked with the tailstock centre.





The frame is drilled with four holding down holes. This enables it to be fixed at an angle to clear the tailstock barrel, see photo 1. This shows a length of pinion being cut while supported by the tailstock, using a half centre.

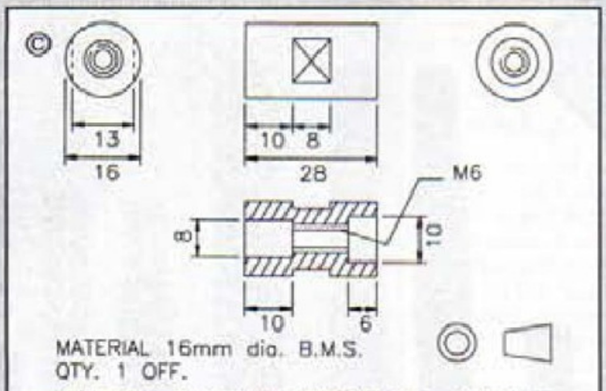
Before making the bearing screws I made an M10 gauge nut. The screws were threaded with a tailstock die holder, set to cut large, and then reduced until the nut was a perfect fit. The screws are left dead hard at the point. The cone bearings are also left dead hard and are fixed into the spindles with Loctite.

I made two spindles, one in two parts for multi tooth cutters, each half having spanner flats. It must be accurately made if the cutter is to run true. The other is a one piece spindle for fly cutters, photo 3 shows this cutting a dead beat escapement wheel with a flycutter in one pass. There is a large diameter washer on the exit side to prevent deflection of the blank. Because of the direction of rotation of the motor, the cut is from left to right. The driving belt is an oil filter sealing ring and is doing a first class job.

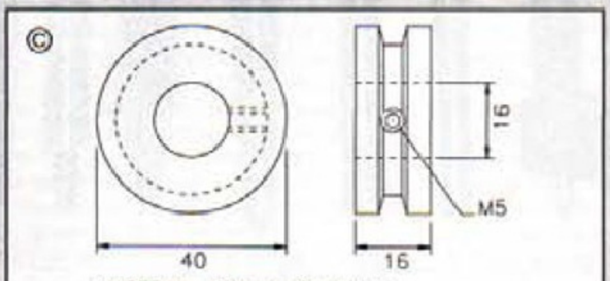
It is essential that the cutter, be it a wheel or single point, is at lathe centre height. The bearing screws, in addition to eliminating play, also give limited adjustment with regard to height. Before drilling the one piece spindle for the cutter, and making the split spindle, ensure the dimensions are acceptable to your machine. If not, amend to suit.

When cutting silver steel the speed should be about 200RPM. As the motor in photo3 is very high revving, a slower motor is mounted on the cross slide, as in photo 1. The drive in this case is by 1/4in. vee belt.

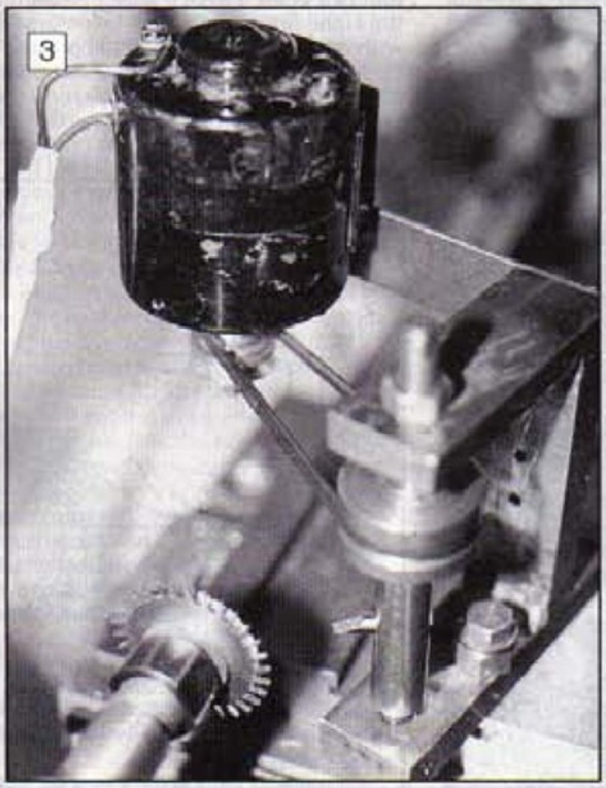
The frame could be used to hold cutters up to about 14DP, if the bearings were made 1/2in. dia, and a spindle made to hold 1in. bore cutters. I think that just about covers it. It has proved to be much better and quicker than my original approach.

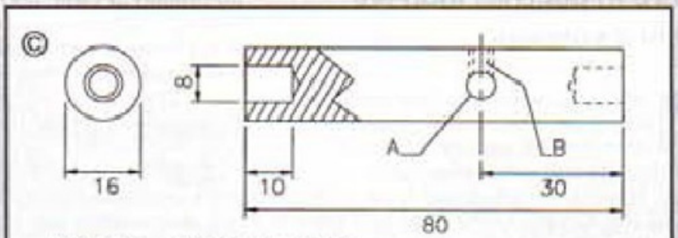


MATERIAL 16mm dia. B.M.S.
QTY. 1 OFF.
WHEEL CUTTER SPINDLE, LOWER.

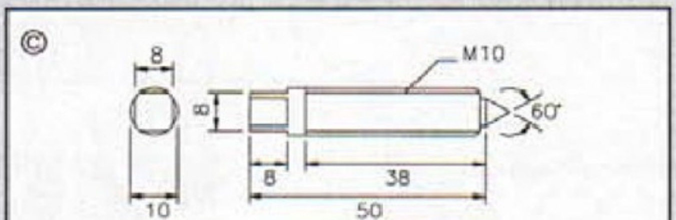


MATERIAL 40mm dia B.M.S.
QTY. 1 OFF.
MAKE GROOVE TO SUIT CHOSEN BELT
PULLEY.

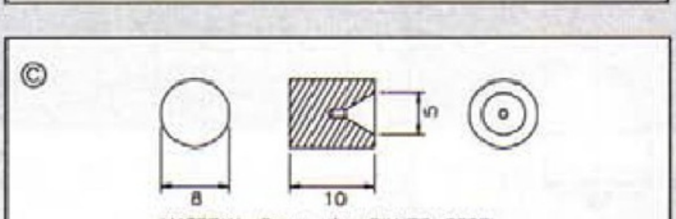




MATERIAL 16mm dia. B.M.S.
QTY. 1 OFF. HOLE SIZES A. 6 dia. B. M5
FLY CUTTER SPINDLE.



MATERIAL 10mm dia SILVER STEEL
QTY. 2 OFF.
BEARING SCREW.



MATERIAL 8mm dia. SILVER STEEL
QTY. 4 OFF.
BEARING.

HAND PUNCHES EXPLAINED

1: Selection of the author's punches, from left to right, spotting or transfer, riveting, special transfer(long reach), case-hardened for seed box holes, 2 pin, 2 centre, 2 hand bag.

Bob Loader explains that there is more to punches than we may first envisage

Model engineers use punches a lot. Other things are sometimes pressed into service, like nails, round toolbits and other unsuitable objects. There is no substitute for a reasonable selection of the right tool for the job. **Photo 1** shows a few of my own, most of them home-made. I include the one, 3rd from right, which looks as if it had no business to be there, for sentimental reasons: I made it when I was in the training workshop, some 40 odd years ago, it started off almost as long as the one on it's left.

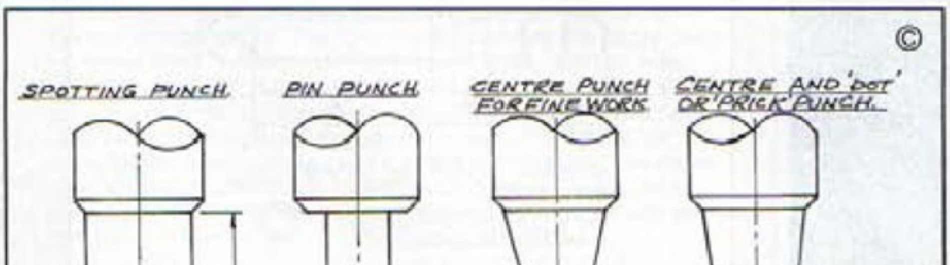
Without a good selection of punches we would have nothing to mark centres for drilling or radii; nothing to knock out pins, or mark numbers and letters; nothing to cut holes in soft materials, spread hollow rivets and many other vital tasks.

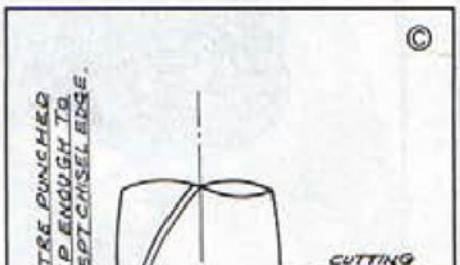
Centre punches

These are the ones we use most and there are one or two variations. The main use is to make a dent in metal to start a drill cutting. The reason for using it is shown in **Fig.2.** I know that smaller drills will start without it, but try starting a drill of 12mm or over without a punch mark and judge for yourself.

Centre punches also make small dot marks to accept divider or trammel points for marking radii. Made with a finer point, like the prick punch **fig. 1**, it will make a smaller and finer location which will be more accurate and take less filing out afterwards. The angle can be finer than the 45 deg. shown, but beware of the time when it could be taken for a normal centre punch, it could be damaged if it is clouted too hard.

Another useful centre punch is the one in fig.1. with the reduced diameter, I use this one when it is vital to be accurate. An ordinary one, especially one with a big point, has to be tilted quite a bit to see the place to be marked. The one with the reduced point makes it easier to sight and the small dot it makes can be enlarged with another more substantial punch. Both this one and the prick or dot punch should not be used for heavy work, they are not strong enough.





Quick tip

Holding small drills

If your chuck will not hold small drills, take the drill and wind a soft wire coil tightly around the shank so as to effectively enlarge the shank diameter to a size that the chuck will accept. Copper wire seems best for this as it does not spring open. The drills holds well and runs true.

R. Harries

Other variations

Two more shapes which are very useful are the spotting punch in fig.1. and a riveting punch, 2nd from left in photo 1. The spotting, or transfer punch, is for transferring a hole position from a cover plate, or other application where holes have to line up. The diameter and 60 degree point have to be machined true and it can have a set of bushes to extend the range upwards. They are used in production workshops and can be bought in standard sizes, plain or threaded. Expanding ones are also available. The riveting punch is for spreading hollow rivets and the included angle is 90 deg. or larger if needed.

Pin punches

A set of pin punches is almost as important as centre punches. They are available in standard sizes and also as a body with interchangeable inserts. The feature which needs watching is the diameter of the part which does the job. It must be smaller than the size of pin it is used for. This makes sure that it will clear the hole, essential when it has been used a bit, because it will tend to spread a little under the pressure of hammering. I learned this when I was an apprentice and got one I had made, and was very proud of, badly stuck; I had to ruin the punch to get it out. There are two in the middle of photo 1. For small diameters they will need making carefully so that the diameter isn't too long and blends into a larger one. Make your own. Commercially made punches are knurled, sometimes have square heads and are nicely tapered and finished, Very nice too, but it is easy to make one from a length of silver steel 10mm. or so diameter and 100mm. long. The simplest one needs a reduction at the head and a taper to the point. It does not have to be knurled, just as well for those of us who have not got a knurling tool or a lathe which will take the pressure. One or two grooves with a 90 degree vee tool will make an acceptable grip, although it could be made smooth; my favourite fountain pen is smooth and polished and I don't have any trouble holding that.

Photo 2. shows the grooves being machined in the body of a punch. Notice that the vee tool has been used for turning the head, and chamfering as it turns. Slow the speed down for the grooving, if you use this method.

Recycling

One of the sources of material I use a lot is old files, I was lucky to be on the right spot once when a lot of files were to be disposed of, so I took four or five and softened them. Since then I have not wanted for carbon tool steel in several shapes. I recently made a centre punch from the tang end of an old square file from my stock. **Photo 3** shows what I started with: it is not a difficult job to make, and superb to hold and use. Round or three square files would be just as good and easier to hold in a three jaw chuck, not that holding the square one was any problem, and I would like to dispel the myth that you always need a four jaw chuck to hold square material.

Photo 4 shows the method. A bush is made with the bore equal to, or slightly smaller than the diagonal of the square to be held. The bush is split and the job gently tapped in. It will hold and centre in a three jaw chuck, It is not important what the bush is made from, as long as it is tough enough to hold the work.

There are problems when doing this type of job on a small lathe like a Unimat, namely the impossibility of threading the job up the lathe spindle. To give some rigidity, it is as well to support the head end with a centre, as I have in the photo. The centre hole will be no trouble when using the finished punch. For those with larger lathes the job can be held further in the chuck. Turning the long taper needs support too. As a matter of course, when making punches, I always turn the point first because the bulk of the material gives plenty of support and I don't want the point waving about while I am turning the last little bit. With this one, it was not so easy, as can be seen in **photo 5**.

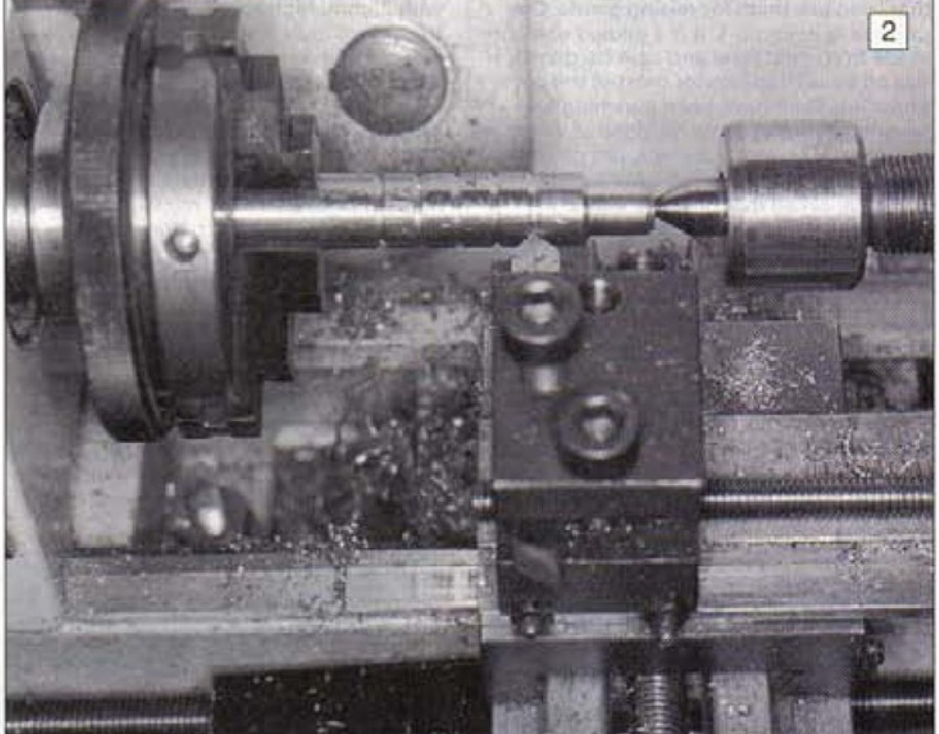
What I had to do was shape the point by filing and then use an improvised double centre. In the photo the long taper is being machined, very carefully and with light cuts, because of the long overhang.

Chisel steel

Another excellent material for all sorts of punches is chisel steel. The octagonal section can be held in a three jaw chuck just the same as for the square. Because of the shape of the steel, it needs no knurling or other decoration, merely shaping at head and point ends. Chisel steel has exactly the right composition for the job.

Special punches

Among the odds and ends I have made or accumulated over the years, are several specials. The two on the right of photo 1, I call 'handbag' punches because they are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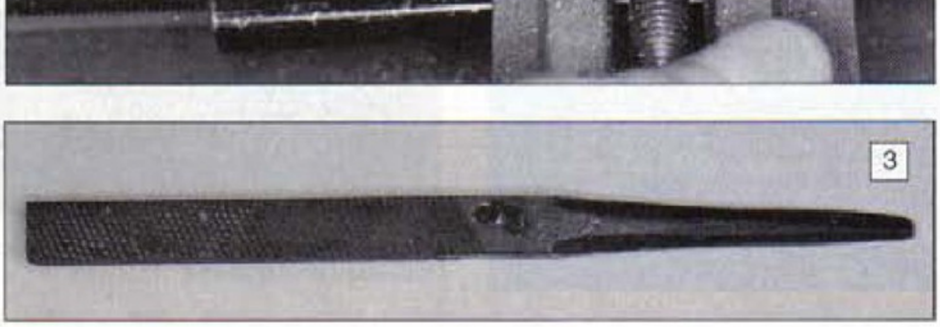
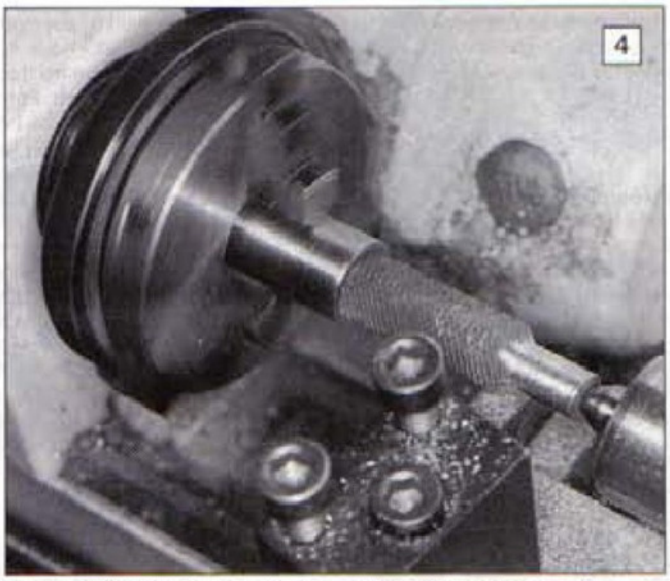

3

2: Machining grooves in a punch body instead of knurling.

3: The tang of a square file which converted into a very good centre punch.



4: Machining the head end of the square file, using a 45 deg. form tool.

used for cutting holes in handbag straps and other leather work. My wife has trouble with straps being too long, or holes in the wrong place, so I have several sizes of hollow punches. They are quick to make, a short length of steel with a hole drilled in the end, tapered off to a cutting edge. There is a slot filed a little way back from the edge so that the slug of material removed can be poked out. If this isn't done the punch soon gets blocked.

I use a similar but larger punch for putting a drainage hole in yoghurt pots, so that I can use them for raising plants. One of these is in photo 1. It is a piloted one and made from mild steel and case hardened. I use an un-piloted one for most of the pot punching. Both have been punching for several years and show no signs of wear. Commercially, soft materials, like gaskets and similar, are punched with 'bucket' punches, called that because they are shaped like a bucket, the bottom of the bucket is the cutting edge and the handle is where the hammer strikes. Of the other specials, a set of number punches is essential for marking the jaws of a chuck or numbering an indexing dial. They need a simple jig for holding in position when they are used. Do not use them free-hand, it doesn't work and the result can make a good job look unsightly. To make sure that there is a clean profile it is as well to strike the punch several times, moving it slightly to make the punch mark all over the profile. A dummy run on a piece of scrap works wonders.

An ambitious project

The most difficult punch I have ever made was one for hall-marking; a friend's wife does silver work and she needed a punch to identify her work. It was not elaborate, merely 3 initials enclosed in a cartouche. The cartouche; a flattened oval shape, measured 7mm. long and just over 2mm. high. I made a pattern from wood with 25mm, high letters and used the maximum reduction. The machine was a Taylor Hobson engraver and the job was a question of cutting away the waste from round the letters, the reverse of the normal process. I had a lot of luck and the third or fourth try come out good enough. I lost count of the cutter regrinds and the number of times I said, my word, how unfortunate, or words to that effect.

Accuracy when punching

Making punches is one thing, using them another, especially getting a centre punch dot in the right place. It isn't easy to pick up the intersection of two scribed lines. In theory the punch should drop into the right place, if it is drawn along the one line to meet the other. It never works for me, so I dot lightly for starters and correct by drawing the dot over till I have it right, If the job has to be very accurate, I use an eye glass or a scale reader to check. I also rotate the punch while tapping it, in case there are any irregularities in, the point from re-grinding.

There are gadgets to make accurate punching easier. Several have magnifying lenses which can be replaced by a punch when lined up. These are excellent and do the job beautifully, but they are expensive. There are other ways of putting holes in precisely the right place, but they are another story.

Like any cutting or marking tool, punches must be correctly heat treated. The only exceptions I make are the hand bag ones which I often leave un-hardened and sometimes make from mild steel, hard enough to do what I want them to do with a bit of a sharpen if needed, by filing the cutting edge. I have written enough over several recent issues about the hardening and tempering process, so the only advice I'll repeat is that of my friend 'Steamboat', the blacksmith, long dead now, but in his time a fount of wisdom 'You only 'ots the bit you wants to work on', was one of his favourite sayings, Translate it as 'only hardening the bit which has to be hard'. Also, do the tempering so that the business end is as hard as you want it to be, and the hardness gradually decreases up the shank. Do not harden the head end of a punch, it damages the striking face of the hammer Finally, even if it is tempting to use the first punch which is handy, resist it and have a selection, so that there is one for each job.

Quick tip

Circle to internal square ratio

Want to know the depth of cut to machine a square on a round shaft where the diagonal of the square is the diameter of the circle? Multiply the radius by 0.707, subtract the result from the radius, and that is the depth of cut.

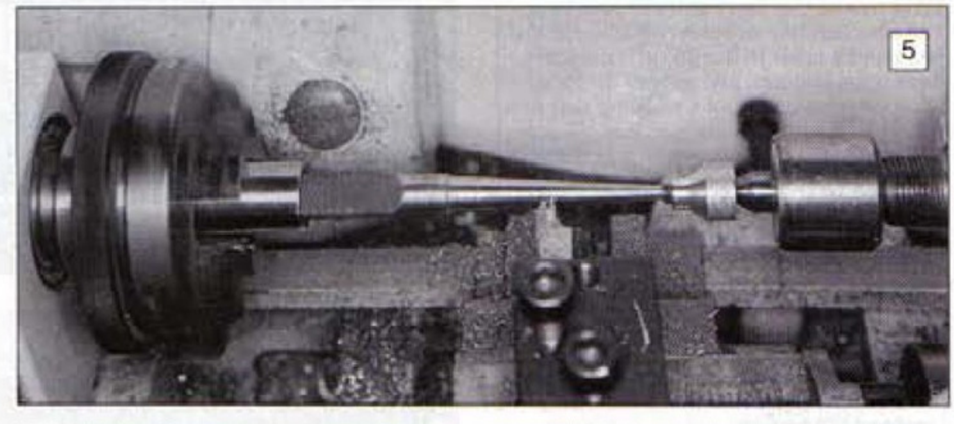
W. J. Vaughans

Quick tip

Grinding precaution

If you have an angle grinder make sure all other materials in the vicinity are covered over when you are using it. Each spark is a tiny particle of the material you are grinding. It will infuse itself onto nearby brass, aluminium, stainless steel, glass etc., causing the affect of 'rusty brass' or whatever.

Alan Jeeves



5: Machining the taper on the square file, note the holding method with a bush and the improvised double centre.

ACCURATE DIVISION WITH SIMPLE TOOLS

H .S. Harvey suggests a method for making division plates, not the simplest, but, with only a little care, probably amongst the most accurate. It is worth reading, if only as food for thought.

There are occasions when an accurate method of division is needed, at which time the following scheme will produce accuracy of a few seconds of arc, using no more complicated measuring gear than a steel rule and feeler gauges. It uses standard ball bearings confined in a circular recess.

Referring to the diagram, showing a small number of large diameter balls, the trigonometry is simple. Assume 113 divisions are required and 1/8in. balls are available.

r = 0.125÷2 = 0.0625
A = 360÷(2 x 113) = 1.5929 etc.
H = 0.0625÷Sin A = 2.2483 etc.
R = 2.2483 + 0.0625 = 2.3108 etc.
Dia. = 4.6217 etc.

From this, a recess having an outer diameter of 4.6217in. should contain 113 balls 0.125in. diameter.

Mount on the faceplate a piece of plate (note two pieces needed), turn a recess, between ⅞ and ⅝ of the ball diameter, deep, in this case, between 7/64in. and 5/64in. Open out the recess until it is slightly smaller than 4.6217in. to the nearest 1/64in. (i.e. 4 39/64in.), using the rule.

Now the messy bit, clean away all swarf, apply a good smear of stiff grease and stick the balls into the recess, you should get 112 in position. Measure the gap between the last two balls, with feeler gauges. Whatever the distance, take it away from the ball diameter and, using the cross slide graduations, open out the diameter of the recess by ¼ of the result. Try the grease trick again. In theory the recess should be opened out by nearly ⅓ of the ball minus gap dimension, but it is better to be on the safe side. The aim is to get the balls a snug fit around the recess. If accurate measuring tools are available, aim for a diameter about 0.0005in. smaller than theoretical. While the plate is in position, bore out the central datum hole, to the size of your choice. Repeat with the other plate. When the recess is correct the last ball should just click in with very light pressure.

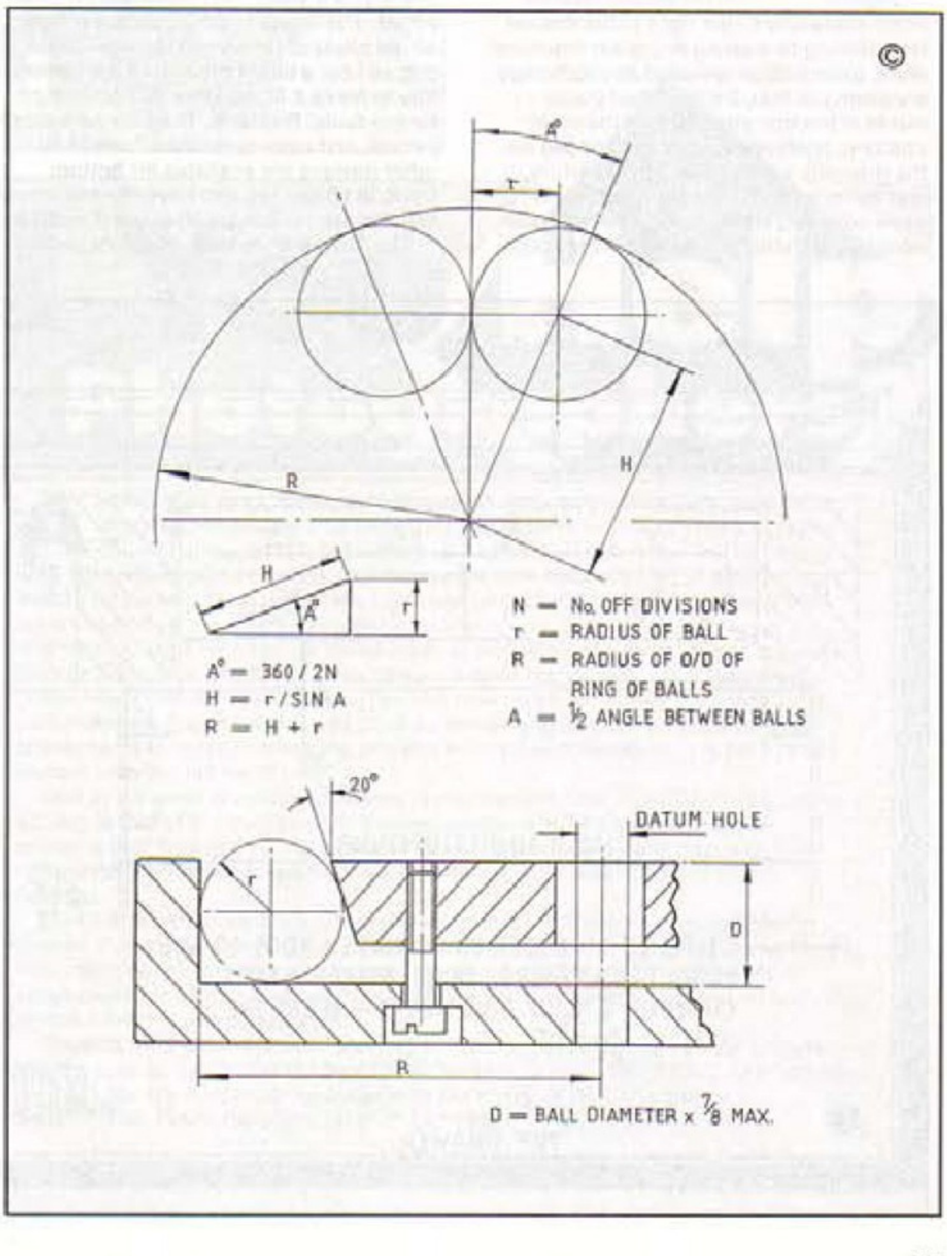
Next turn two discs with bevelled edges as shown, turn the bevelled edge so that the top face is level with the top of the main disc. Bore a central hole slightly bigger than the datum hole. Drill and tap for four or six equally spaced securing screws.

Now clean up and fit the balls in place, and lightly clamp with the bevelled disc. If the two rings of balls are brought together it will be found that they index and remain concentric in a very positive fashion. It is possible to turn a circular groove for the balls, but it would need accurate means of measurement.

With very little pressure from the bevelled disc the balls will stand a fair amount of torque. However, to secure them in a more positive fashion, one could try application of one of the penetration adhesives, such as Loctite 601 or equivalent, or even a small amount of soft solder, provided it is kept clear contact faces of the balls .

The plates can be used direct, or to produce more conventional plates. When requiring a small number of divisions, the diameters may be too small for convenience. In these cases, just multiply the number of divisions by two or three or more, to get a more reasonable size of ring.

I once made a pair of these plates using a dense plywood, about 10in. dia. with ½in. dia. balls. When checked, the angular error was less than 10 seconds. The idea came to me after looking at a Newall Jig borer, which used a series of rollers as the linear reference. (It is worth considering that with a suitable detent, perhaps a fork to go between adjacent balls, a single plate may prove satisfactory for some applications. - Ed.)



A DRAWER FOR A LATHE CABINET

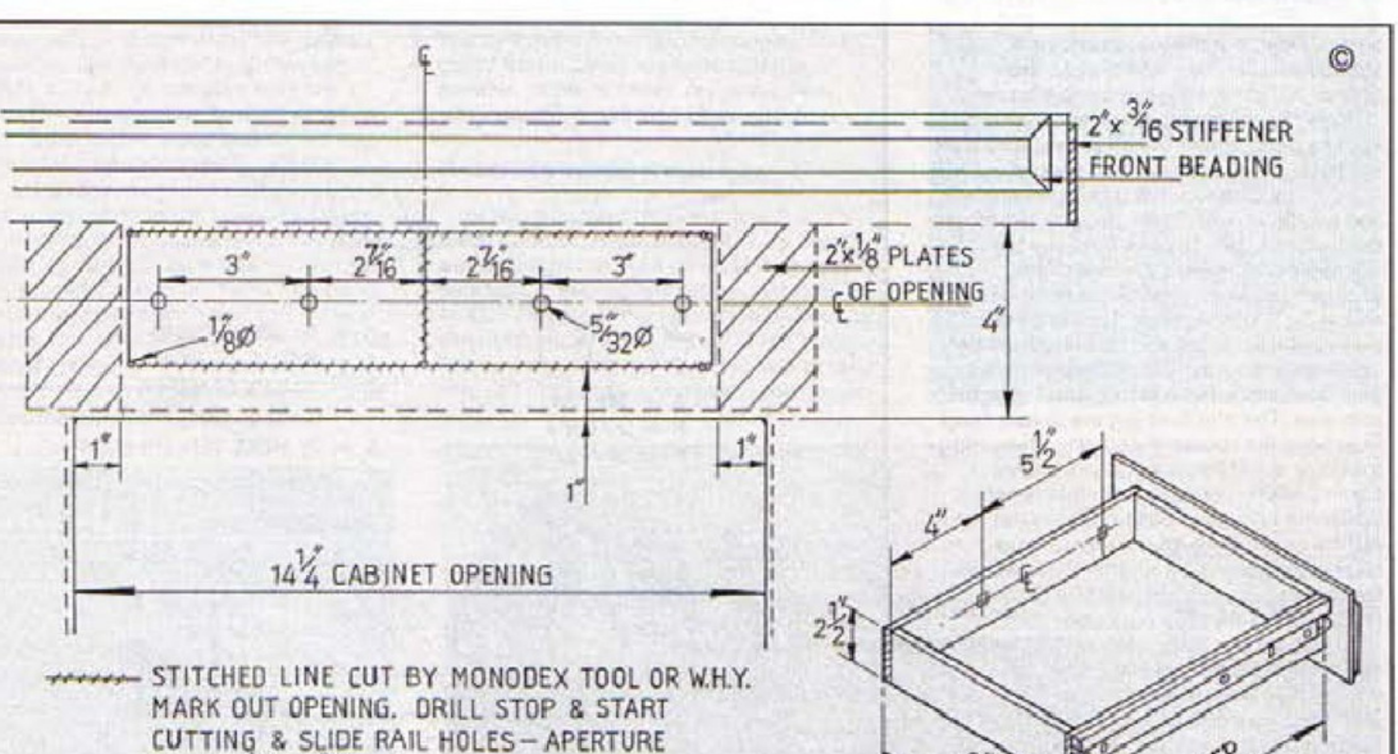
Lack of space in the workshop, and making best use of what is available, is a problem for many. Sid Reid suggests adding a drawer to the Myford lathe cabinet in a position which is otherwise wasted space.

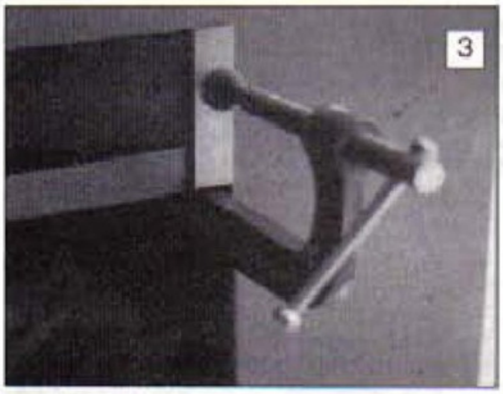
Having purchased a good quality Myford 7B Lathe, I decided a modification to the cabinet was necessary to enable me to fit a drawer, for cutters, dead centres, etc. Checking that what I had in mind was possible, I then removed the Myford Label, and later re-sited it centrally to the right of the drawer. Not wishing to weaken any main structural work, examination revealed strengtheners consisting of two, 2 x 1/8in. steel plates inside at the top either side of the main opening, positioned as shown shaded on the drawing. I marked out the aperture, and fixing holes for the runners, which were drilled 5/32in. Next, the 1/8in. stop, and double start holes for the Monodex metal removing tool were drilled. Although the cabinet is quite robust, the Monodex soon cut through the 16swg metal. Only the stitched lines, two horizontal, and centre vertical, are cut. The idea being to bend the tongues, so formed, inwards, to support the drawer runners. **Photo's 1 & 2.**

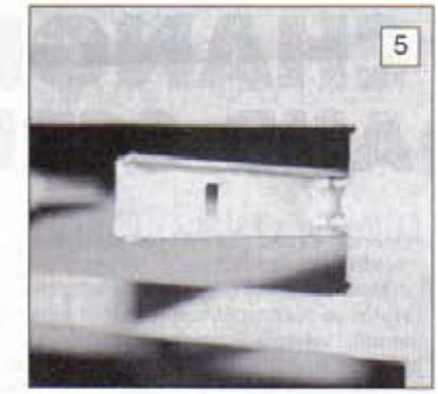
I thought it prudent to G clamp mild steel flats each side, prior to bending. **Photo 3.** The bending is easy, and can be started with firm hand pressure, *watch the sharp edges*, use a rag. Finally the use of a block of hardwood and a reasonable hammer, make a neat job. Clean up the rough edges with a file.

The drawer is simplicity itself, constructed as shown, in the drawing, glued and pinned, with a 1/8in. x 3 ply base, and a 13 x 3 1/2in. front panel with mitred edges. The wood was 3/8in. thick oak from an old chest of drawers. The missus was out, so I cut a bit off the end of her cutlery tray to make it fit, and this sectioned it off for my tools. **Photo 4.** The runners cost £2 per set, and were purchased from M.F.I, other runners are available for bottom fixing at £3 per set, and have the advantage that the drawer can be lifted out if required.

The drawer does tend to collect swarf if,







like me, you forget to close it, an old vacuum cleaner soon clears it out, so its no trouble. The inner runner is bolted to the metal tongue with 4BA screws and nuts, countersunk, or flat head, to clear the plastic ball bearing spacers. The outer runner needs an additional fixing drilled 4in. from the backstop, which with the existing M4 tapped hole at 9 $\frac{1}{2}$in. gives adequate support. These holes can be drilled $\frac{5}{32}$in., watch the head room in the runners, i.e. countersunk, or flat head through the outer runner, and square nutted inside the drawer. I topped my channels with timber strips glued and pinned to the sides, they support the drawer whilst fixing, and improve the looks. **Photo 5.** The handle is a leftover over from a bedroom suite.

The Myford label is replaced, give the tapping screw almost clearance holes, or with 16G metal they will twist in half.

Finally, may I say its use, has more than repaid the effort (about 4hrs) to complete, and I was kidding about the tray, it probably came from the local Grot shop. I hope you find this quickie, as easy, and rewarding, as I did.

Could You Help Disabled Photographers?

The Disabled Photographers' Society, a registered charity (262866) sponsored by film and camera manufactures, Konica, needs your help.

As part of its work, the society adapts, designs and makes devices to help disabled people use a camera. This can involve anything from a special wheelchair support for a camera to a soft touch switch for use by people with little power to their hands. Volunteers are now being sought to help produce individual parts or even undertake complete projects from plans supplied. "We want to build up a network of volunteers throughout the country with basic engineering skills who can be called upon as and when the need arises" explains George Saunders, The D.P.S. committee member responsible for adaptations. "Depending on their level of expertise and how much work they are prepared to undertake, we might ask them to produce something as basic as cable release attachments to more challenging projects such as an adaptation to allow use of a camera with the left hand only"

One of the most common problems encountered by the Disabled Photographers' Society is that of a normally right-handed person who has an illness which prevents them using their right hand. The best type of camera in this case is a lightweight compact camera with full auto-focus, auto-exposure and auto-wind facilities.

Creative possibilities are increased if the camera is fitted with a power zoom control. Konica, sponsors of the DPS, produce a range of cameras including the Big Mini zoom which answers all of these requirements. Some of the commercial adaptations for left handed use, however, are not very satisfactory and, in any case, do not allow for zoom operation.

Anyone willing to offer their services to the Disabled Photographers' Society should write to the DPS at PO Box 130 Richmond, Surrey, TW10 6XQ. Alternatively, they can leave a telephone message with the charity's PR Consultancy, Judith Patten Public Relations on 0181-547-1566.

This article seeks to explain to the uninitiated the principle of using change wheels, and suggests methods for overcoming the problem of missing wheels, especially a problem when purchasing older machines. It also includes a change wheel chart which has been established with the aim of making setting up the gear train as easy as is possible. This chart is worthy of consideration by anyone who does not have a screw cutting gearbox.

CHANGE WHEELS AND SCREWCUTTING

The most frequent request to M.E.W. is for help relating to second hand machines which are no longer in production, and are for manuals, sources of spares, frequently change wheels. However, the letters frequently lead one to believe that the principles of the gear train are not fully understood.

Most gear chains for screw cutting will commence at the lathe mandrel, albeit via the tumbler reverse in many cases, and finish at the leadscrew. It should be obvious therefore, that, for a given TPI (threads per inch) being cut, the gear ratio will depend only on the pitch of the leadscrew, the make of lathe being irrelevant. Having a change wheel chart for the specific lathe is therefore far from essential.

Most lathes are supplied with change wheels in increments of 5 teeth. While others may use increments of 4 teeth, these are very much in the minority. They may have two gears of one or more sizes, also one or two odd men out, typically gears with 21 and 38 teeth.

To achieve a precise metric thread on an Imperial lathe a gear with 127 teeth is required. This would normally be too large, but the admirable suggestion by Tony Skinner in issue 24, Scribe a Line page 67, is well worth considering. Lathe suppliers will list, and maybe supply as standard, a smaller gear, typically 21 teeth, which will permit metric threads to be cut sufficiently accurate for most purposes, though not precise. This article refers to Imperial threads, but the principles will equally apply to a lathe with a metric leadscrew.

We must first endeavour to understand what is being achieved by the gear train. If we consider a lathe with an 8TPI leadscrew, then for 8 turns of the leadscrew (one inch travel of the saddle) the lathe mandrel must rotate a number of times equal to the TPI of the thread being cut. Therefore, when cutting say an 18TPI thread, 8 : 18 is the ratio of the gear train required.

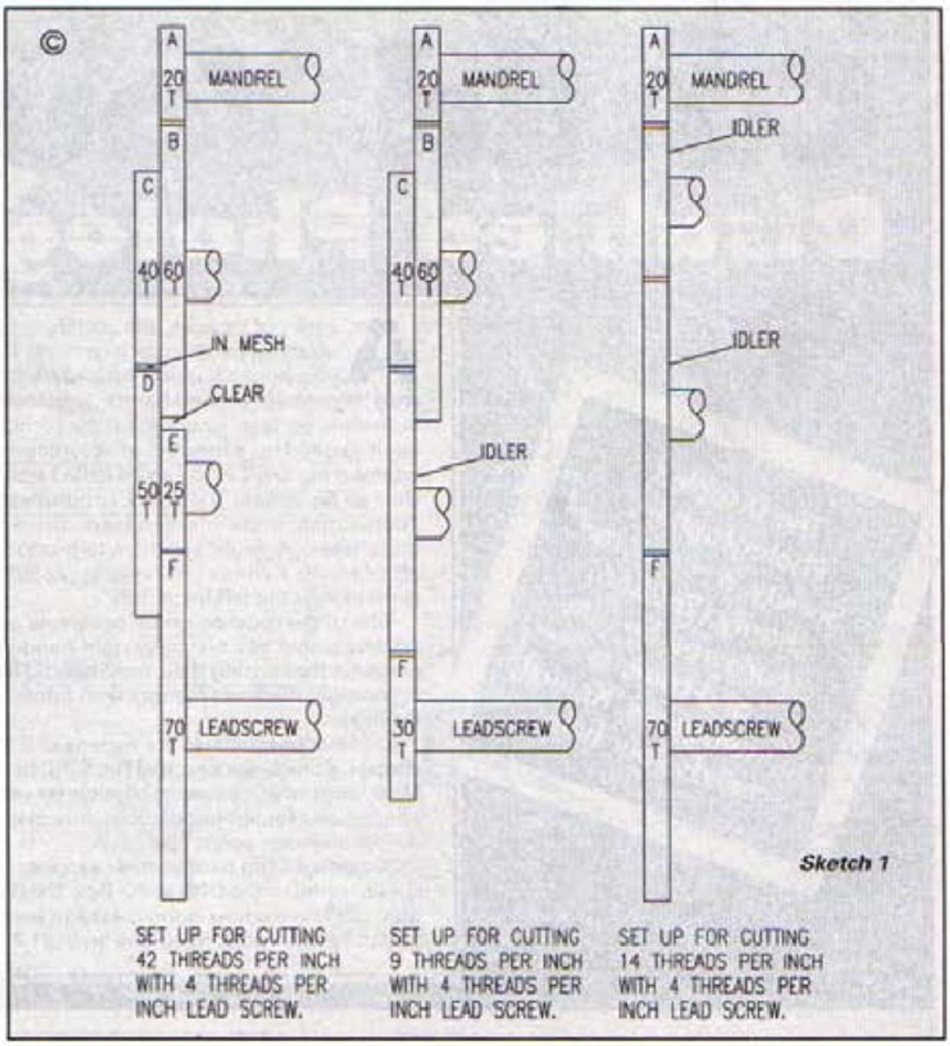
What are the requirements for a suitable gear chain? First and foremost, it must mathematically give the required result. Let us consider the most simple example, that is cutting a thread equal in pitch to that of the leadscrew, obviously requiring a ratio of 1 : 1 between lathe mandrel and leadscrew.

Now there are two reasons why this cannot be accomplished with just a pair of identical wheels. First, the distance between mandrel and leadscrew is fixed, and will likely create a situation where the distance can only be spanned using gears cut with a non standard DP. Secondly, the gears would be large and, as a result, economically out of the question. The answer is to use an idler, or idlers. The principle of an idler is that they are placed between two gears in a train and in no way effect the overall ratio. It can therefore have any number of teeth that the space available dictates. Also the three spindles (mandrel, idler, leadscrew) do not have to be in line, so the system can easily accommodate standard diameters.

A typical example would be to fit a 20 tooth gear on both the lathe mandrel and leadscrew, or any other pair of identical gears, with a suitable idler, or idlers. This requires two wheels of the same size being available, not always the case. One list suggests a gear train for this condition of 60 on the mandrel driving a 40 tooth gear. The 40 tooth gear is coupled on the same spindle to a 50 tooth gear which drives a 75 tooth gear on the lead screw. This gives a **1.5 : 1** ratio on one pair, and a **1 : 1.5** on the other, combining to give the required ratio of 1 : 1. At this point the first important point has been simply illustrated, that is, there is frequently more than one arrangement which will give the required result, in fact on the simpler TPI numbers, many.

While a gear train is mathematically correct it will be dependent on gears being available and, equally important in some cases, a mechanical restriction which will be covered latter. If therefore you are missing a gear, or gears, this may not prevent a given TPI being cut. If you want to be prepared in advance, go through your change wheel chart and see what cannot be accomplished and consider alternatives. If you do not have the chart for your lathe then look at the chart in the *M.E.W. Data Book* for the pitch of your leadscrew.

As mentioned, there are mechanical considerations which must be met, even if the chosen gear sequence is mathematically correct. The main consideration is probably not immediately obvious but is none the less absolutely vital. Considering **sketch 1A** it will be



Sketch 1

obvious that for the required clearance between B and E to be present, the sum of the radii of gears C and D must be greater than that of B and E. This more easily considered in terms of number of teeth rather than gear dimensions, that is, C + D must be greater than B + E.

The other mechanical consideration will only apply if a new set of gears are being made or purchased, and should be much more obvious. Some readers may overlook the fact that if a complete set of gears is being obtained, matching these, DP, bore, width etc., to those originally supplied with the machine is far from essential. In any case DP, bore, width etc., may not be known. The gears must of course be of a suitable size within limits. Too small is not such a serious problem as additional idlers can be included. A little large may be acceptable if you are prepared to run without the safety guard fitted, but any larger and there will not be sufficient room between mandrel and leadscrew. Just one factor may add a slight complication to this statement, and this is the tumbler reverse. If such a device was part of the original machine then, as it is a fixture, it is probable that it is still in place, even if the remaining gears have been lost along the way. If gears of a differing DP are being fitted, those on the tumbler will also need changing . This will probably require the gear centres to be changed and it may be easier to make the whole assembly from scratch.

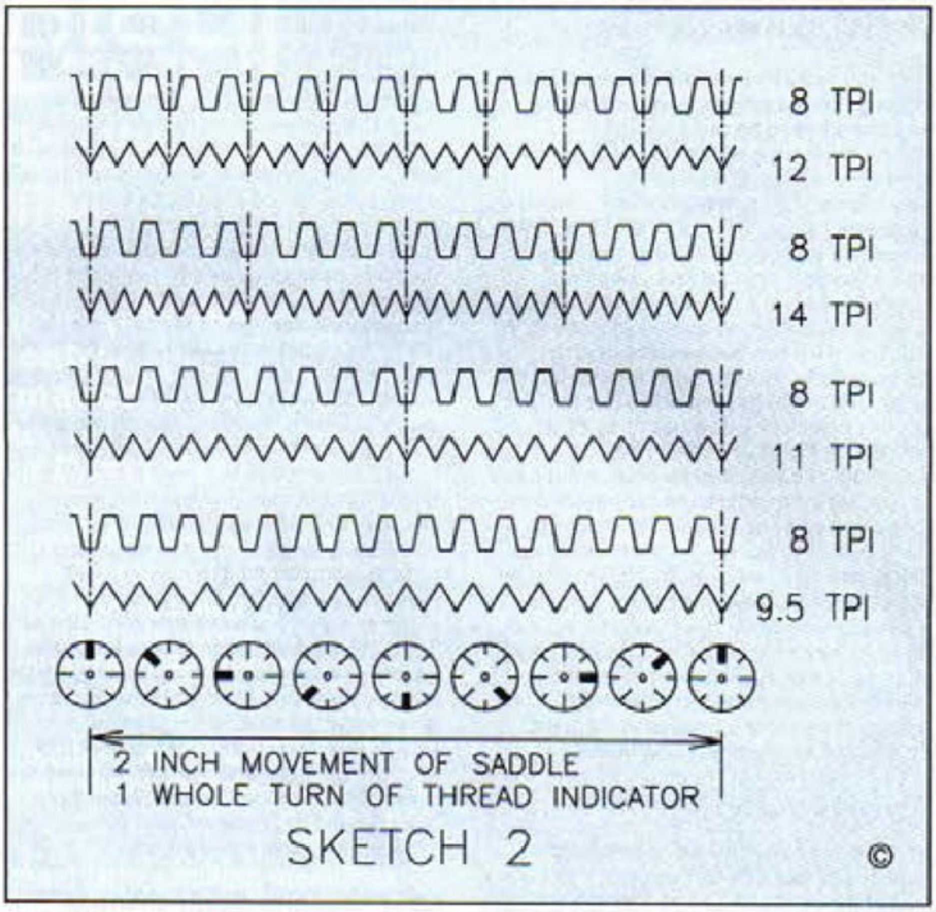
It is a fact that the load placed on the gears is relatively low and, a smaller, rather than larger gear will certainly suffice for the degree of use likely in the home workshop. If therefore you have a lathe with none, or only a few change wheels, investigate the possibility of purchasing a set available for a modern lathe of similar, or smaller, size. Some adaptation may be necessary such as opening up the bores, reducing the width, or even fitting bushes to reduce their bores. When considering the complications of thread cutting, anyone intending to carry out this task should have no problem with such simple modifications.

For the lathe owner who has most gears, but still finds that a thread to be cut cannot be achieved, either by the listed gear train or any other alternative, all is not lost. The first action will be to determine the DP of the gears available. This can be calculated by measuring the outside diameter of a gear and calculating this from the formula;

DP = (number of teeth + 2)÷outside diameter.

Armed with this value one can enquire regarding those available for modern lathes, or contact any of the well known gear makers. There is also the question of pressure angle which ideally should be considered. This is beyond the scope of this article, but the article in this issue by Don Unwin should help. It is probable that with the limited duty and a generous clearance the matter could be ignored. I would purchase a single gear for a trial, before buying a number to make up a set. An alternative would be to make one's own.

A point to take note of when considering making one's own change wheel is the relatively light duty imposed on the gear. Considering this in more detail, there are three main aspects:-



SKETCH 2

1) Very limited use likely in the average home workshop.

2) Only slow speeds will be used when screwcutting. However, if the gear train is set up to give fine feeds this may not be the case.

3) Can tolerate a generous clearance between gears.

All these points to being able to get by with a gear that would not be acceptable in more arduous conditions.

The most likely deterrent will be the expense of a gear cutter or the complications of making a cutter to the methods detailed by Don Unwin in the Aug/Sept 91 and Oct/Nov 91 issues of *M.E.W.* This is understandable. However, with a little care, and an existing gear having a similar number of teeth to use as a template, it should be possible to make a single tooth cutter adequate for the task. I had intended to go into the process, but an article has been received detailing this approach and is published elsewhere in this issue.

Idlers and left hand threads

It was mentioned earlier that the size of an idler chosen was not that important, provided it could be fitted in the space available. Idlers cause a reversal of rotation when compared to a similar gear train without idler. This reversal will be of no consequence if the lathe is fitted with a tumbler reverse as this can be set to achieve the left/right hand thread as required. If, on the other hand, no tumbler reverse is present, thought must be given as to whether the correct hand of thread will be achieved. If not, then either an attempt to leave out the idler being considered must be made, alternatively, a second idler fitted to cause an additional reversal. If space for additional idlers is likely to be a problem then the suggestion made by Joe Briffa in issue 20 page 54 is worth considering.

Formula

The simpler values, say 16 TPI on a lathe with an 8 TPI leadscrew, are unlikely to have one reaching for the calculator. However, for more complex numbers, the following formula will enable a conclusion to be reached with certainty. The formula for calculating the arrived at thread pitch with the arrangement in **sketch 1A** is;

Leadscrew TPI x B/A x D/C x F/E = TPI being cut

In the example
4 x 60/20 x 50/40 x 70/25 = 42

This becomes, for **sketch 1B**,

Leadscrew TPI x B/A x F/C = TPI being cut

And for **sketch 1C**,

Leadscrew TPI x F/A = TPI being cut

Any idlers fitted to make the set-up mechanically possible do not affect the result, and do not therefore appear in the calculations.

If you have change wheels in increments of 4 teeth and a chart for increments of 5 teeth, make the following mathematical adjustment. Reduce each quoted gearwheel in the chart by a factor of 4/5. Typically, that is, 35 teeth becomes 35 x 4/5 = 28, similarly 55 becomes 44, 75 becomes 60, and so on.

Setting up change wheels

I anticipate that the work involved in setting up a gear train is considered by most readers to be rather a chore. Positioned as it is at the side of the lathe and with limited access in many workshops due to their small size, this is understandable. The major problem is that of setting up the gear centres by means of the adjustable spindles and quadrant.

Published as a postscript to this article is an excellent screw cutting chart by R. W. Gillings. This has been established to considerably limit the need for altering the positions of the gear spindles (1st and 2nd studs). In fact 14 TPI values (8, 9, 10, 11, 12, 14, 16, 18, 19, 20, 24, 26, 28, 30) can amazingly be achieved by only swinging the quadrant to adjust the centre distance between lathe mandrel and first spindle. This though is not the full story as seven additional fine feeds, up to 455 TPI, can be achieved, again using the same spindle centres as those for the screw cutting pitches. Not only is this an excellent idea, it also serves to indicate the potential for alternative combinations over those frequently published, either in the lathe manual or elsewhere in text books.

Thread indicator

Another mathematical consideration which often causes confusion is in the use of the thread dial indicator, again it will help to understand the principles involved.

If you have one of the smaller lathes with a solid nut mating onto the leadscrew a thread dial indicator will not be fitted and the following will not be a consideration. The lathe will be less convenient to use when screw cutting. The problem stems from the split nut which, when open, permits the saddle to be moved rapidly along the length of the lathe bed. In the case of cutting threads, this permits the cutting tool to be easily returned to the start after making a pass along the length of the thread. However, if the nut is not closed onto the leadscrew in the correct position the cutting tool will not align with the part cut thread when the next cut is attempted. Two simple examples best illustrate this.

First consider a thread being cut having a TPI of 8 and on a lathe with an 8 TPI leadscrew. With the lathe mandrel and leadscrew running at identical speeds it will be obvious that the half nut can be closed at any point while still ensuring that the tool aligns with the already part cut thread. If we now consider a 12 TPI thread being cut, then the mandrel will be making 12 turns while the leadscrew makes 8. In this case only every other position on the leadscrew will produce a satisfactory result. That is to say that the second position on the leadscrew will line up with the third turn on the thread being cut, and so on. This can probably best be understood by looking at **sketch 2**.

From this, it can be seen that, depending on the number of threads being cut, only at specific places along the leadscrew will the tool line up with the part complete thread. It is for this reason that the thread indicator is required. Typically, for an 8TPI leadscrew, the indicator will have a 16 tooth gear in mesh with the leadscrew and will make one full turn for 16 revs of the leadscrew. This corresponds with a 2in. length of thread, and as the indicator is likely to be calibrated with four main divisions each division relates to 4 turns of the leadscrew or ½in. length of thread. Half divisions may also be present.

The limiting factor for use of the thread indicator is whether or not at any point along a 2in. length of thread a whole number of turns of the thread being cut corresponds to a whole number of turns of the leadscrew and that this sequence is repeated for each 2in. length of the leadscrew. Reference to sketch 2 should make the situation relatively easy to understand.

The following is however a simplification of the situation on the basis of being easier to remember, why not make a note of this and keep it handy in the workshop. For even numbers engage at any of the numbered divisions. For odd numbers engage at any two opposing numbers and for a pitch having a half number, say 9 ½ TPI, engage only at the same position. For more complex pitches, say cutting metric threads on a lathe with an Imperial leadscrew, it is generally stated that the half nut cannot be disengaged and is probably the best policy to adopt. However, with careful organisation, it is possible to disengage the half nut even in these circumstances. See the letter from Arch Gibson in *Scribe a Line*, of this issue, for explanation of the method.

Easy to achieve gear changes

This excellent screw cutting chart has been provided by R. W. Gillings and is for use with an 8 TPI leadscrew. The following change wheels are required. 20, 20, 30, 38, 40, 40, 45, 50, 55, 60, 65, 70, 75. For the fine feeds a 25 tooth gear is also required, as is a 25/12 cluster for the finest feed. Two 21 teeth gears can be used which will further simplify setting up 22TPI.

The only adjustment required for 21 of the gear trains listed is that between the mandrel driver and the driven gear on the first stud. This is effected by swinging the quadrant. The exceptions are. The 32 and 40 TPI which require the first stud to be moved and the quadrant swung, but see note 3. The 22, 48 and 60 TPI trains require both studs to be moved and the quadrant swung, but see note 2.

All the slow feed set-ups are double compound trains but fit on the studs as positioned for the 21 gear trains above.

To change from any one of the 21 trains to a slow feed requires only the replacement of the wheels and the quadrant swung to suit.

Note 1. 19TPI

The 38 tooth gear meshes rather loosely with the 55 tooth wheel at the standard stud spacing but is satisfactory in practice.

Note 2. 22TPI alternative train.

If two 21 tooth gears are available, normally used for metric screwcutting, these can be meshed with the 75 tooth wheel at the standard spacing providing the original 20 - 75 - 20 train was fairly slack. Full train becomes 20 - 55:21 - 75 - 21. If a third 20 tooth wheel was obtained it could be the mechanically more correct train of 20 - 55:20 - 75 - 20.

Note 3. 40TPI alternative train.

Using the 12 tooth gear of a 25/12 slow feed cluster, and meshing this with a 60 tooth gear on the first stud produces the full 5:1 ratio, thus eliminating the need for the second reduction stage. The full train becomes 12 - 60:40 - 55 - 40 and fits the standard stud spacing.

TPI screw	Mandrel	1stStud	2ndStud	Lead	Comments
8	40	40:20	75	20	
9	40	45:20	75	20	
10	40	50:20	75	20	
11	40	55:20	75	20	
12	40	60:20	75	20	
14	40	70:20	75	20	
16	30	60:40	55	40	
18	20	45:40	55	40	
19	20	50:40	55	38	Note 1
20	20	50:40	55	40	
22	20	55:40	60	40	Both studs moved. Note 2
24	20	60:40	55	40	
26	20	65:40	55	40	
28	20	70:40	55	40	
30	20	75:40	55	40	
32	20	40:20	55	40	1st stud only moved.
40	20	50:20	55	40	1st stud only moved. Note 3
48	20	60:20	70	40	Both studs moved.
60	20	75:20	70	40	Both studs moved.
Slow Feeds					
168	20	40:25	70:20	75	
189	20	45:25	70:20	75	
210	20	50:25	70:20	75	
231	20	55:25	70:20	75	
252	20	60:25	70:20	75	
273	20	65:25	70:20	75	
455	12	65:25	70:20	75	

: indicates wheels keyed together.

DATA FILING

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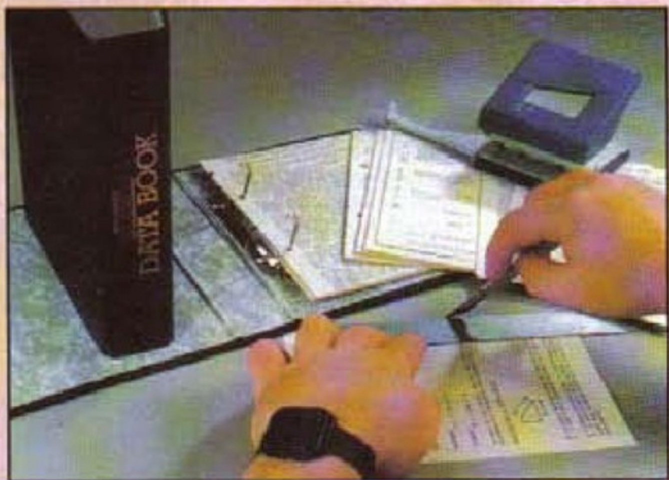

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GEARING AND GEARWHEELS

Don Unwin describes the development of gearing, and whilst mainly historical, there is much technical data which is equally relevant to today's methods

When you have been cutting that gearwheel with umpteen teeth have you ever wondered where the bright idea originated?

The first reference to gear wheels occurs in the oldest known engineering textbook *Mechanika* written by Aristotle or his pupil Straton, or both, about 350BC; here there is mention of a train of three gearwheels and that each wheel turns in the opposite direction to the adjacent wheel. We do not know if these were cogwheels or only friction drive.

Two later mechanicians, Hero of Alexandria (Heron in Greek) and the Roman engineer Pollio Vitruvius write of an early Greek mechanician Ctesibius of Alexandria 300-250BC who is reputed to have made a water clock in which there was a pair of contrate gears, almost certainly with peg teeth. Hero, who flourished around the 1st century AD was a mechanician responsible for many clever inventions and whose writings included *Mechanica* which includes references to the screw into which a cogwheel engaged our worm and wheel. He deals with the mathematics of these, the pitch of the thread, the profile of the groove and the mechanical advantage that can be obtained.

In another manuscript entitled *Dioptra* which discusses surveying he describes a theodolite which has two worms and wheels, **Fig. 1**; also a distance measurer which had rotating pointers driven by worms and wheels from a chariot wheel, a very early version of our present day 'Waywiser'.

Hero cut his threads and worms by wrapping a wedge shaped piece of paper (or was it papyrus?) round the rod, marking the helix and cutting the groove by hand tools.

Vitruvius the Roman engineer/surveyor wrote his treatise *De Architectura* sometime around 30BC, covering architecture, building and water engineering in the broadest terms. One subject being the water driven corn mill. The primitive inefficient Greek or Norse mills of the time had a vertical shaft with the wheel at the bottom and the stone at the top. Vetruvius improved the efficiency by putting his shaft horizontal with the

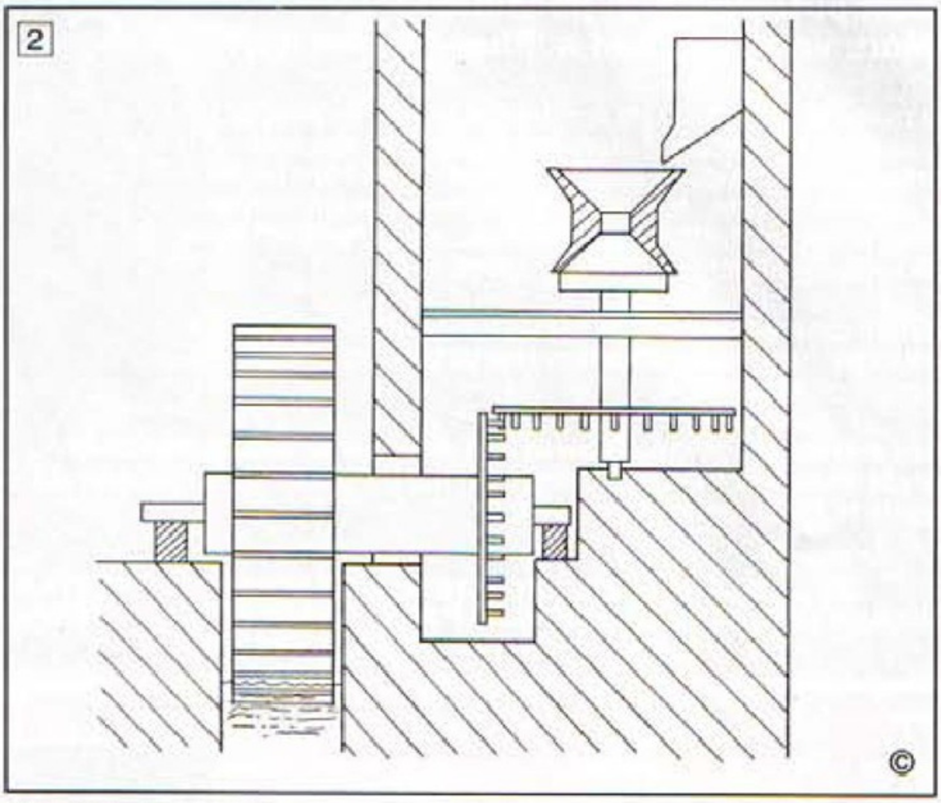


Fig. 2. Vitruvian Corn Mill. 30BC.

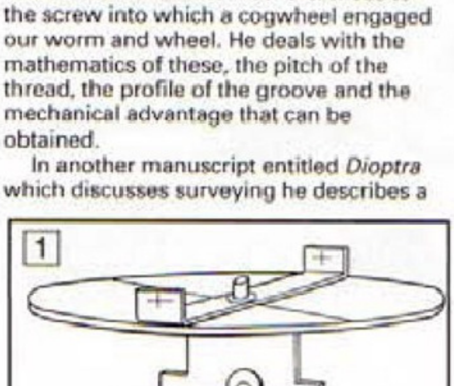


Fig. 1. Hero's Dioptra. 1st century AD.

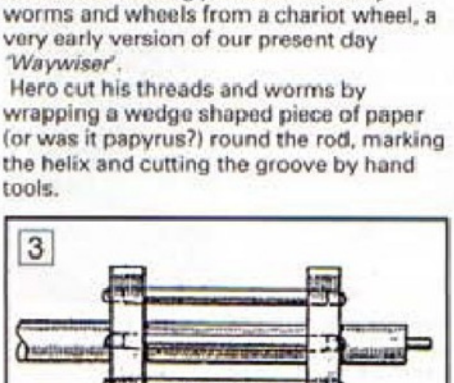


Fig. 3. Diagram of Lantern Pinion.

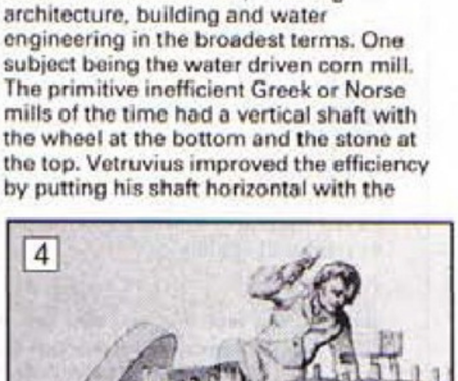


Fig. 4. Millwrights. Pynes "Microcosm" 1803.

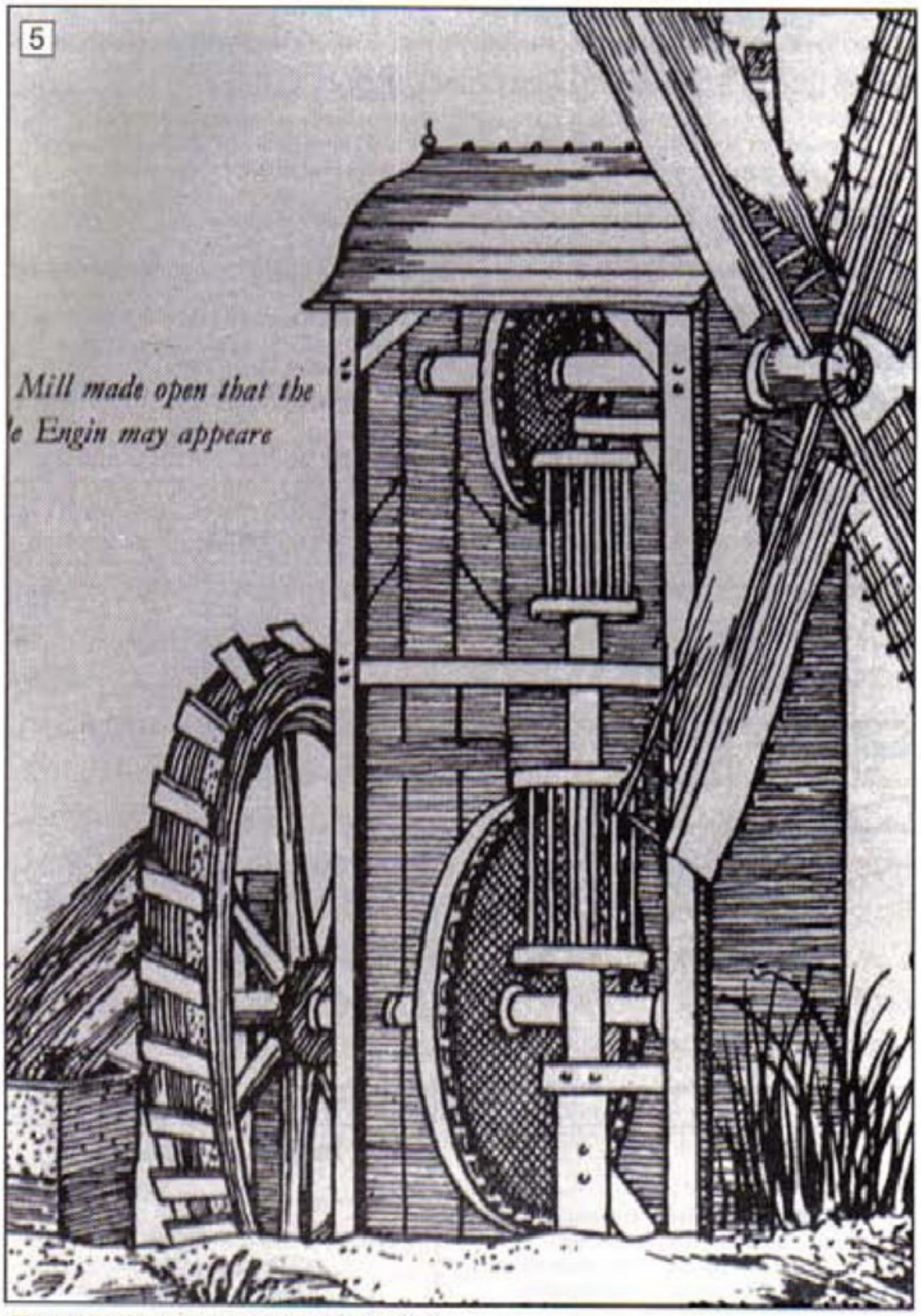


Fig. 5. Drawing of English Windpump 1652.

Fig. 6. Gear with inserted teeth, showing a cast socket.

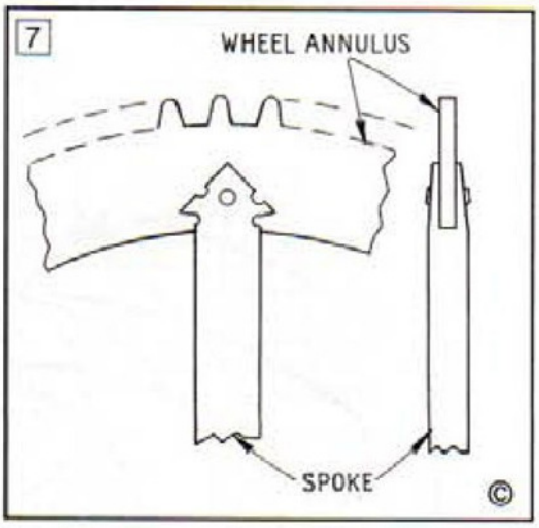


Fig. 7. Diagram of Medieval Gear Tooth.

wheel paddles dipping into the water; i.e. an undershot water wheel. To convert the motion of this to the vertical shaft with the grinding stones at the top he describes a right angle gear drive. As he says that the horizontal shaft has a 'toothed disk which engages with a larger one, toothed in a similar way', **Fig. 2**. It can be implied that he had not envisaged the lantern gear at that time, although a discovery of a Roman wood and iron lantern pinion in a mill in Germany suggests that he did so later. A lantern gear or pinion consists of two disks on the shaft with a ring of rods or 'trundles' between them, **Fig. 3.** The Vitruvian mill became almost universal, but it is odd that he talks of a reduction whereas most mills used a step up ratio of 2:1 and 5:1. The wood peg and lantern pinion gearing was used almost without change for power transmission until the 19th century as we can see from W.H.Pynes little sketch drawn in 1803 showing a millwright at work, **Fig. 4**, although wooden wheels with mortised in shaped wood teeth were being adopted from the 1600s, **Fig. 5.**

First cast iron gearwheel

In 1709 Abraham Darby produced coke smelted iron which produced castings of much better quality than the charcoal smelted iron. But the process was not adopted by others until the 1750s when John Smeaton at the Carron Ironworks, one of the first users, began the change in power transmission by making the first cast iron gearwheel in 1754.

When John Rennie designed and built the renowned Albert Mill in 1754 he used cast iron for transmitting the power from the two Boulton and Watt steam engines. These were not completely successful as the imperfectly pitched and profiled gears made a dreadful noise and rapidly wore themselves out. The result was a successful compromise, one wheel having cast teeth and the mating wheel cast with sockets into which were wedged teeth made of a hard wood, **Fig. 6.** The teeth were profiled according to the ideas of the foundry or millwright, but as we shall see later the mathematician was coming to the assistance of the engineer.

Arabic instrument makers were making geared astrolabes by the 11th century, all surviving examples having triangular teeth with an angle of about 60 degrees. The

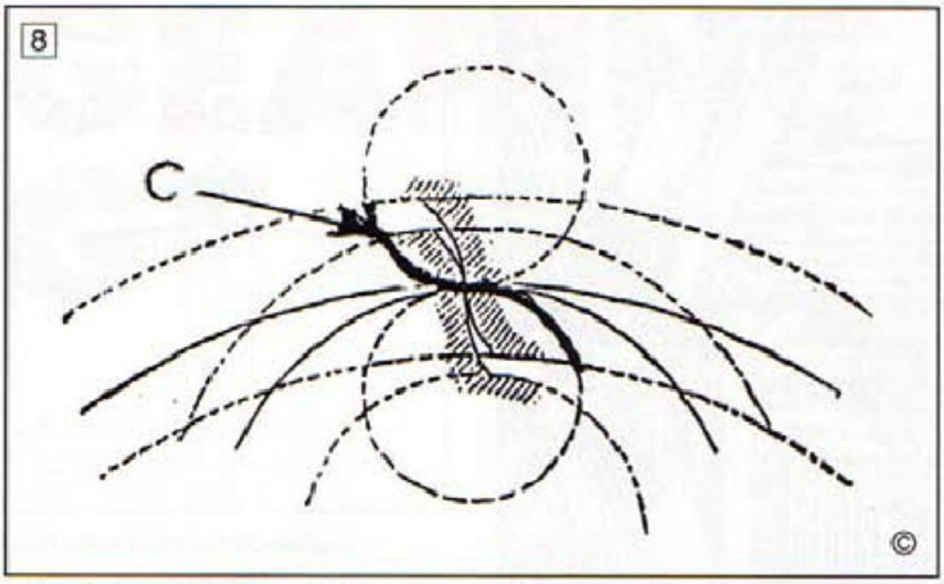


Fig. 8. Cycloidal Tooth showing contact line.

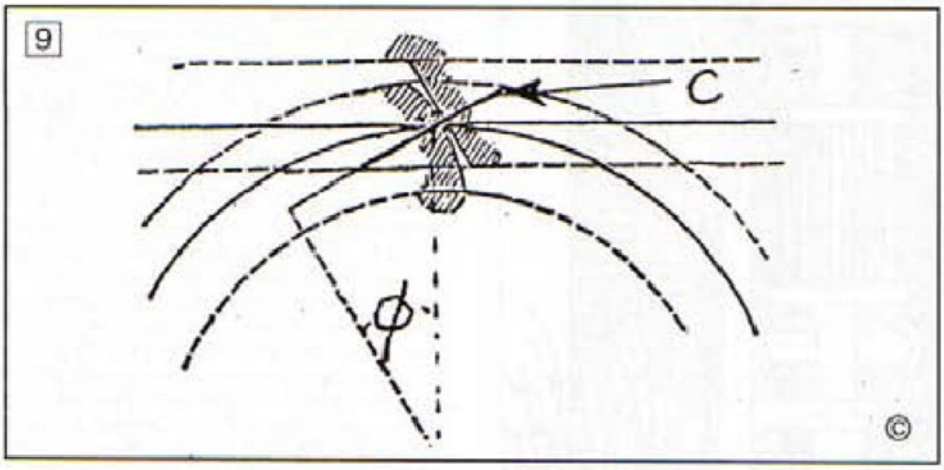


Fig. 9. Involute Tooth showing contact line.

remarkable planetarium constructed by Giovanni de Dondi in 1342 (my replica described in *Model Engineer* 6 Feb 1987) had teeth of this form. The mechanical clock had appeared only about 60 years before and, unlike the Dondi planetarium, were crude mechanisms made of iron by skilled blacksmiths. Lantern pinions were driven by iron gearwheels with short rather narrow slightly tapered teeth and slightly rounded tops, **Fig.7**. These were stepped out with dividers, marked with a centre punch, cut with a hacksaw or chisel and filed to shape.

The earliest examples surviving are at Salisbury Cathedral, 1385, the Wells Cathedral clock now in the Science Museum, 1395 and the Rye church clock. All were made by the same craftsman as the tooth marking centre punch marks were all made with the same punch.

Domestic clocks

By the 15th century smaller clocks were appearing, first of iron then with some brass. As in large clocks the gear teeth were stepped out and filed and meshed with lantern pinions. Many different tooth shapes were used depending on the clockmakers ideas, often parallel slots with rounded tops. Eventually dividing engines and filing guides were devised to assist with gear cutting. The lantern pinion continued to be used but was being gradually replaced by the solid cut tooth pinion from 1500. Clocks were very poor time keepers so the need to reduce friction did not concern the clockmaker until 1657 when Christiaan Huygens invented the pendulum which enabled clock time keeping to be improved ten fold. This encouraged more precise gears. Dr. Robert Hooke probably replaced the scriber and file of the gear dividing engine by a rotating cutter although it was slow to be adopted. Nicholas of Cusa had studied the cycloidal curve as long ago as 1451 and the epicycloid was discovered in 1525 by Albrecht Durer. De la Hire in France wrote the first mathematical treatise on gear design in 1694, in it he concluded that the involute was the most satisfactory profile but it was not until the end of the 19th century that it came into general use.

Very briefly the epicycloidal curve is a cycloidal curve traced out by a point on a circle when that circle rolls without slipping on the circumference of a second circle. If the circle rolls inside the second circle the curve is a hypocycloid. The involute is the curve traced out by the end of an imaginary piece of string as it unwinds from a circle. Roemer and Huygens in 1674 and 1675 first showed the advantages of the epicycloid tooth form for clock teeth and Huygens investigated crown wheel teeth in 1680. Camus in 1735 and Thiout in 1741, both of France, investigated further. Although instrument making and clockmaking advanced in accuracy, the clockmakers concentrated more on pitching than on tooth profiles. However this work had practically no effect on millwrighting and engineering until the 19th century.

Help for engineers began with a translation in 1806 by John Hawkins of the 1766 work of the French mathematician Charles Camus, then a description of his mill gearing by Robert Buchanan in 1808 and some work by a Cambridge mathematician Robert Willis in 1837 and 1841.

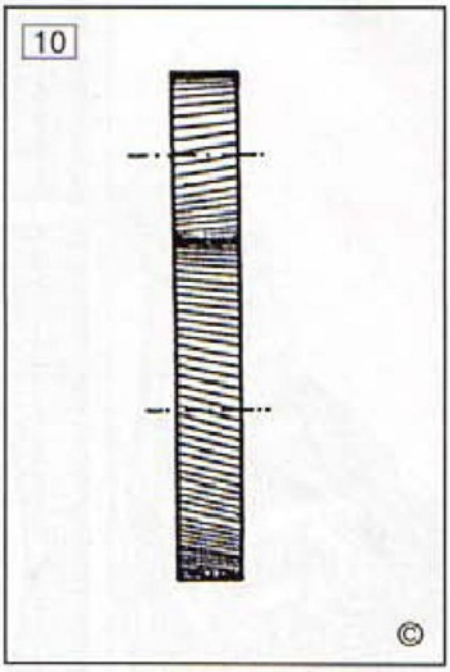


Fig. 10. Diagram of Helical Gearing.

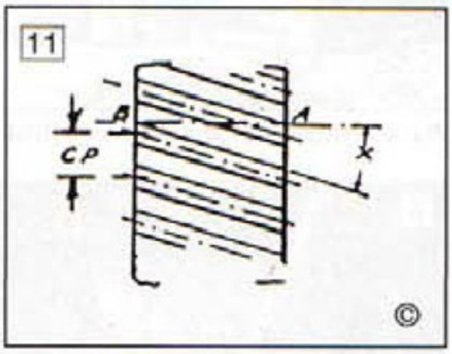


Fig. 11. Diagram of Helical Gear Tooth Angle.

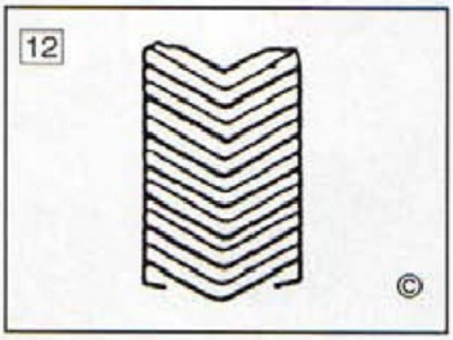


Fig. 12. Diagram of Herring-bone Gear.

Fig. 13. Diagram of spiral gears

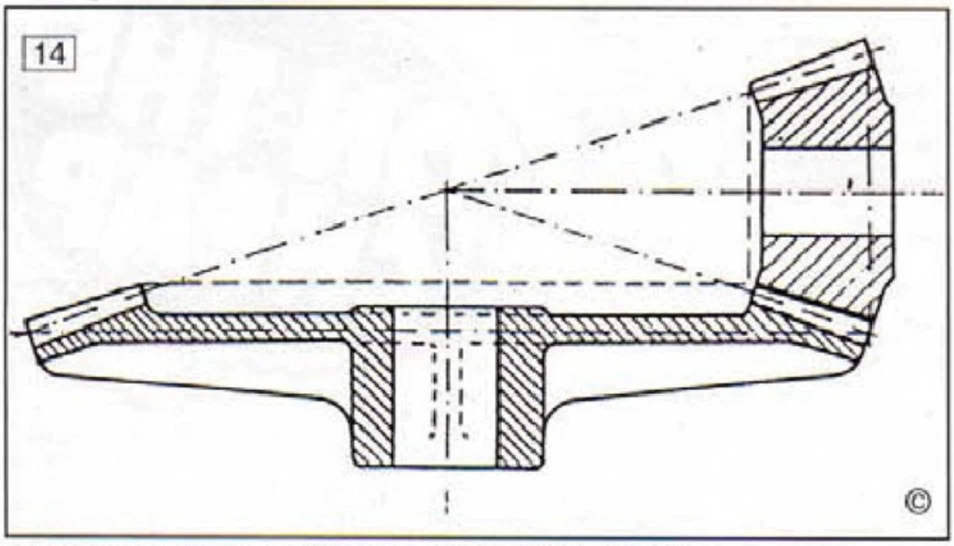


Fig. 14. Diagram of Bevel Gears showing conical tooth form.

Rule of thumb

Hawkins in the 1830s had enquired into the current workshop methods of producing gears. The results were interesting: several used 'rule of thumb' or left it to the workman, others used various methods of setting out with dividers, mostly wrongly interpreting the requirements. Some instrument or clockmakers used their 'eye', others drew it out correctly to a large scale to 'guide the shaping' whilst for pinions the 'bay leaf' shape was used by many. Willis had laid down that the 'describing circle' for a set of cycloidal gears should be equal to the radius of the smallest wheel, the standard still used today whilst in the 1840s J.G.Bodmer, a Swiss engineer who had a works in Manchester which made machine tools including a gear cutting machine, pioneered the use of the 'diametral' system of gear pitch measurement. As most prime movers rotated slowly and the drives from them involved a step-up, the cycloidal profile was adequate, but due to resistance to the involute profile the epicycloidal tooth also persisted in the early 19th century in step-down ratios where it was less satisfactory.

If the teeth of a pair of gears are perfectly formed the motion of the wheels should be constant, any variation in the angular velocity introducing variable forces and hence vibration and wear. The objective of the tooth profile is to achieve uniform angular velocity, or minimum turning error as closely as possible. This has to be consistent with minimum friction, hence wear, tooth strength, the forces tending to separate the wheels, the avoidance of tip interference and minimising the effects of manufacturing imperfections. For more information on gear theory, the excellent book by W.O.Davis *Gears for Small Mechanisms* cannot be bettered. Provided a pair of cycloidal gears are at the correct centre distance there is no force tending to separate them, **Fig. 8.**

In the involute case the accuracy of the centre distance has less effect on the turning error but there is a separating force equal to the transmitted force multiplied by the tangent of the pressure angle, **Fig.9.** It was objection to this factor which delayed the introduction of this tooth form by British engineers until late in the 19th century.

In clock and watch gear trains the prime mover, as in the earlier power sources, is the slow moving spring or weight barrel having step-up ratios involving large gears meshing with small pinions with few teeth. The involute is unsuitable for these and cycloids or, more often, the ogival approximation is used.

However, for power transmission the involute is now universal with its stronger tooth, interchangeability of gears of different sizes and smaller effect on turning error by centre distance variations. Both cycloids and involutes can be set out approximately by circular arcs odontographically by a method devised by George B. Grant a 19th century American engineer. This being used for laying out gear teeth from the 1850s onwards. It is described in *Machinery's Handbook*. .

In 1864 the Brown and Sharpe Company of America introduced their range of form relieved gear cutters for 12 teeth to rack with involute profile using 8 cutters, each covering a limited range. See my articles in *M.E.W.*, October and December 1991. For pinions of less than 12 teeth the profiles are modified to avoid undercutting by generating the curve from a different base circle. This has the effect of increasing the pressure angle and hence the force tending to force the wheels apart. They also made a set of cycloidal cutters needing 24 cutters to cover the same range.

Helical gears, **Fig.10**, in which the teeth form part of a helix are often used for power transmission where quiet running with minimum vibration is required. The main advantage is that the action is progressive from one tooth to the next. To ensure this the helix angle should be such that the end of one tooth is at least level with the start of the next, **Fig.11** (Line BA). One disadvantage is that there is an axial thrust along the gear axis, to overcome this the herring-bone tooth can be adopted, **Fig.12.**

Spiral gears are another type of helical gear and used where the two shafts are not parallel and the axes do not intersect, **Fig.13**. The profiles of bevel gears is exactly as for spur wheels except that the pitch circles are cones with each apex at the intersection of the two shaft axes and the dimensions of the profile are proportional to the distance from that intersection, **Fig. 14.**

Hypoid bevels are of course a special case in which the shaft axes do not intersect. The meshing of crown wheels can only be imperfect as the tooth of the gear has flanks tapered in from the circumference whilst those of the pinion are parallel.

Enlarging on the past

It may be appropriate here to discuss points about my articles which have arisen. The radius of the curved flank of the involute tooth approximation is given by the sine of the pressure angle multiplied by the pitch circle radius, so the smaller the pitch circle the more curved is the flank giving maximum tip clearance. Therefore to ensure adequate tip clearance each flank radius must be calculated on the lowest number of teeth in each cutter range. This is illustrated in the case of cutter No. 1, 135 to rack. The basic rack has straight flanks which if meshed with a 135 tooth gear cut with a cutter of basic rack form, the upper limit of the cutter range would clearly give tip interference but by using a radius calculated by the lower number of teeth in the range, 135, tip clearance is ensured.

Clock and watch makers often use the ogival approximation of the epicycloid tooth for the going or step-up trains, full ogival is recommended for 6 or 7 teeth and ½ ogival for 8 or more. BS 978 is another epicycloidal approximation, designed primarily for large production users.

The values given in Table 2 of the *M.E.W. (Aug/Sept 91)* article were worked out from the W.O.Davis book in which he suggests that the ½ ogival is the best compromise. However it has been pointed out to me by a Mr. Clarke that an error occurred in working out the angles given which results in thin teeth. The angle which I have given as 180deg./N should be $360/\pi \times S/N$, which is $1.99 \times 114.6/N$.

Therefore the bottom two lines of Table 2 page 15 should read:-

N 6 7 8 9 10 11 12 13

Ø 38.0 32.6 28.5 25.3 22.8 20.7 19.0 17.5

By now you will have finished cutting your gear wheel so we will bring this survey of the evolution of gearing to an end.

INTERNAL CHASERS

Alan Jeeves recycles old taps to make internal chasers

How handy screw thread chasers are, for finishing off threads which have been cut using a single point tool in the lathe. Similarly, for slightly enlarging a threaded hole, where a little extra clearance is required, say for a stainless steel screw and nut which are notorious for 'picking up' and seizing together. Thread chasers do tend to be expensive and, as several different pitches will be required in order to make a decent set, a fair amount of money can be involved.

Fortunately internal chasers can be made by reworking damaged taps, preferably HSS ones. Damaged taps are one commodity the world is not short of. If a chaser is to be made having a pitch of 1.75 mm, an M12 tap is found having either 3 or 4 flutes which, of course, form the cutting edges. Only one edge is required, so it is of no consequence if all but one are damaged, no matter how badly. What is proposed, is to remove (by offhand grinding) the unwanted portion leaving only one cutting edge, selected because it is in the best condition. **Fig. 1** should illustrate this.

A proprietary chaser is provided with a tang, like file, onto which can be forced a handle. Our chaser too will require a handle but will not have a tang as such, only a parallel shank. All that is needed is a piece of wood, aluminium, or whatever, drilled to be sliding fit over the shank. The two are simply super-glued together. This done prior to grinding away the unwanted metal as it provides a good grip while the grindstone does its work.

When the surplus material has been removed, that left should resemble a thread chaser. The cutting edge is largely backed off and all that is needed to sharpen it is to grind, or stone, the flat surface at the top which forms the cutting rake. Even if the cutting edge to be saved is chipped, provided the damage is not in the centre, it can be ground out, as the length over the teeth will have to be shortened to become a practical cutting tool.

Having obscured the identification marks, I always identify my chasers by marking the number of threads per inch and the thread form on the handle, either by stamping, or on wooden handles, painting and then varnishing the whole handle. Thread chasers are simply sharpened by grinding (or stoning) the top face causing the tops of the threads to become sharp (**fig. 2**)

If the tap was made from HSS its temper will not have been affected by the grinding away of the surplus material. However, if the tap was made from high carbon steel the temper will almost certainly have been drawn by the heat generated, as a result, it will be necessary to anneal, re-harden and temper it.

Great care should be taken during the grinding operation and standard safety precautions observed. That is to say, eye protection should be worn as well as a face mask. Fingers should be kept well away from the grindstone, and constant awareness of the fact that the job can get exceptionally hot should be borne in mind.

ON THE CHEAP

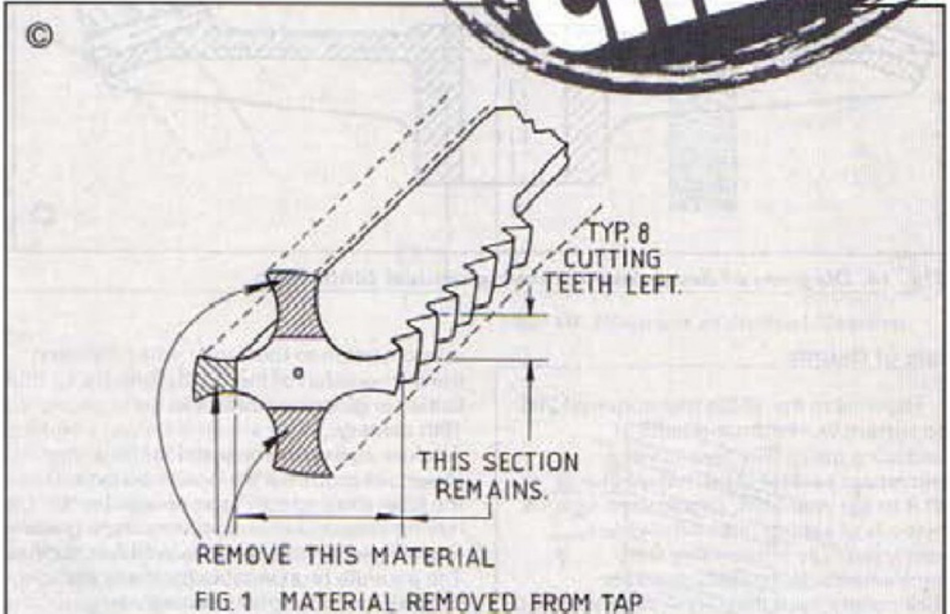


FIG. 1 MATERIAL REMOVED FROM TAP

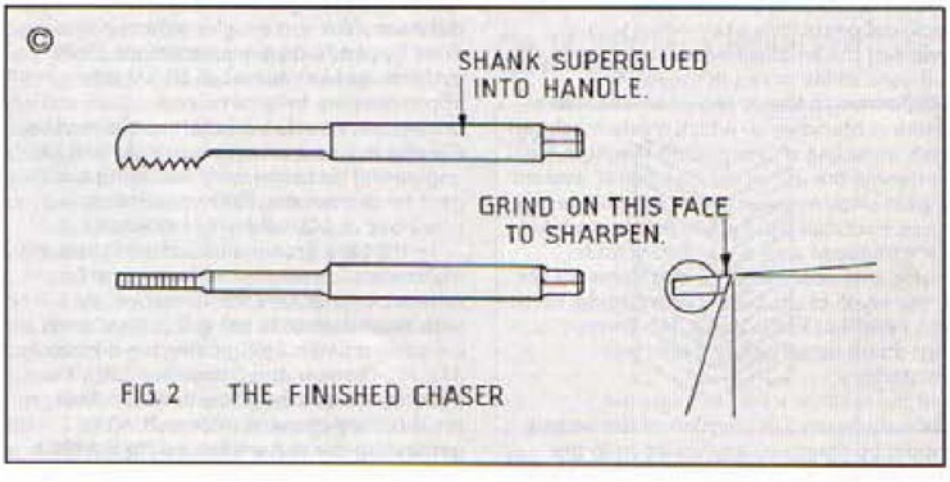


FIG. 2 THE FINISHED CHASER

TRADE COUNTER

Useful brushes

Frost Auto Restoration Techniques Ltd. have introduced a set of brushes which they suggest to be an essential item when rebuilding engines. They consider that the use of these brushes in cleaning the various oilways etc. will do much to guard against engine failure. At only £5.99 + £1.50 p&p, this is a small price to pay for such a safeguard. The set consists of four sturdy nylon brushes, 7/32, 1/4, 7/16 and 5/8in. diameters.

Of more interest to the majority of readers is their being used to clean out tee slots and other difficult to clean items. With the handle bent at about 30 degrees close to the head, they can be fully inserted into the slot and drawn along. This makes an excellent job of removing the smaller particles of swarf, after having first removed the bulk with a scraper. The large one (5/8in.) is about right for the size of slots on the small mill/drills (typically Hobbymat BFE65) and the 7/16in. for the tee slots in a lathe cross slide. The brushes could also be useful for other cleaning jobs in the workshop. The smaller brushes would no doubt clean out internal screw threads.

The larger brush is a little small for the larger tee slots, but will work if one side of the slot is cleaned at a time. Surprisingly, brushes of this type have been available in the past, and maybe also now, for use as hair brushes, albeit with shorter plastic covered handles. These can still be bent as indicated above and at around 1in. diameter will very effectively clean a large tee slot at one pass.

Frost Auto Restoration Techniques Ltd. are at, Crawford Street, Rochdale, Lancs, OL16 5NU. Tel 0706 58619 Fax 0706 860338.

Converter runs three phase motors on single phase supply

Hobbyists buying secondhand machinery, only to discover that the three phase motor cannot work on their single phase supply, have opened up a new market for ABB Industrial Systems.

Power Capacitors Ltd. in Birmingham is using ABB Industrial System's ACS 200 frequency converter to convert 240V single phase current to 240V three phase. Apart from hobbyists, sales are now reaching small businesses, operating a variety of machinery from lathes and milling machines to irrigation pumps and multi-motor sewing machines.

"Trying to keep abreast with technology, we found out about the ACS 200 from ABB through ABB distributor STS in Coventry," says Power Capacitors' Sales Director, Peter Moss. "The ACS 200 gives you the option of single or three phase input, while delivering three phase output. Apart from conversion, it has many other features, including electronic variation of speed, which is particularly useful for precision metal work at low speed. The price of converters is such that it is a cost-effective solution."

Installation of three phase current in the workshop can set you back £1000 or more. Alternatively, replacing the three-phase motor with a single phase motor can prove impractical, as these motors often have insufficient torque for the application and may not fit in the available space. For these reasons, converting single phase current into three phase is an attractive solution and frequency converters are proving to be a cost-effective technique.

The output of the ACS 200 is not dependent on the power supply, which can be single phase or three phase. Output is always 240V three phase. The converter controls the speed of a standard squirrel cage motor and operates over a wide power range at high efficiencies. This is achieved by converting the mains supply to direct current (DC) and then inverting it to alternating current (AC) at a variable frequency and amplitude. The speed of the motor varies with frequency. The frequency converter incorporates all necessary motor protection and control and should be connected directly to the motor terminals.

Features of the ACS 200 include motor start and stop, emergency stop, electronic variation of speed from zero to twice normal speed, forward/reverse, digital display of motor speed and other functions. All functions are displayed and controlled on the front panel, which is detachable and can be fitted to the machine it controls.

While machines with mechanical gearboxes can still use the facility of speed variation with the converter, for the purpose of motor cooling it is recommended that the gearbox be used for major speed variations and the converter for fine-tuning.

ACS 200 frequency converters start under £200.

Full details are available from: Mr Peter Moss, Power Capacitors Ltd., 30 Redfern Road, Tyseley, Birmingham B11 28H. Tel: 021-7082811; Fax: 021-7654054.

Our cover picture on this issue depicts Anthony Porter, model engineer for over 30 years, converting single phase current to three phase for his lathe, using ABB Industrial Systems' ACS 200 frequency converter. In addition, this gives him the facility of electronic speed control. "The ACS 200 helps me to manufacture fine details to small tolerances and it also saves time as I don't have to use the lathe's gearbox to the same extent," says Porter.

Black-It review update

In issue 22, page 57 we reported on "Black-It", the process for blackening steel components. To recap, two sets of samples were produced, four parts in each. One set were given one length of treatment, while the other were given a longer time, supposedly giving a greater level of protection. The end result was to give each sample a pleasing black finish.

The two sets were re-arranged, this time each containing two with the lower level and two with the greater level of treatment. One set was hung up in a greenhouse, the atmosphere in here being very humid at times. No further action, such as a coat of oil, was taken to protect the parts. The parts were frequently fingered whenever I went into the green house.

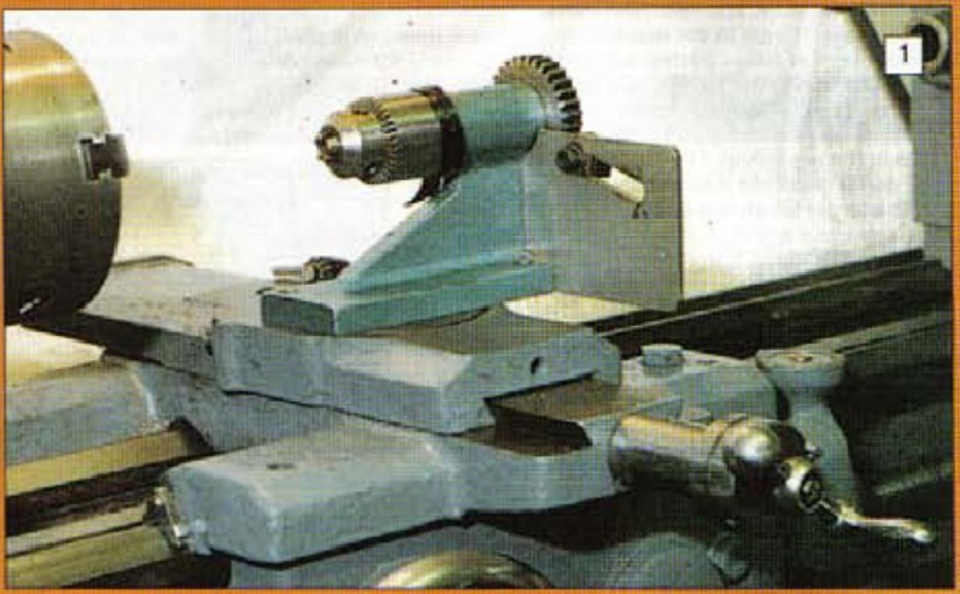
The other set were hung in an open top jar. This having a few inches of water in the bottom in which salt had been dissolved. The parts were dipped into the solution just once and then left hanging above it, but still in the jar. This was also placed in the greenhouse. Not surprisingly, this test proved too much and within a matter of a few weeks signs of rust were very evident.

However, the other samples, now having been in the greenhouse for over a year, are still in good condition. Those with the lesser treatment showed just the very slightest sign of rust,while those with the longer treatment are almost as new. Within the workshop, and with the slightest film of oil, it would appear to be able to withstand being touched by the fingers, such as with machine handles and the like, without any rusting whatsoever. It is therefore a good method of protection, as well as its benefit of improved appearance.

Black-It is supplied by Pixel-Plus, Nailstone, Nuneaton, Warks, CV13 0PZ. Tel 0530 262565.

DIVIDING ATTACHMENT FOR A BOXFORD LATHE

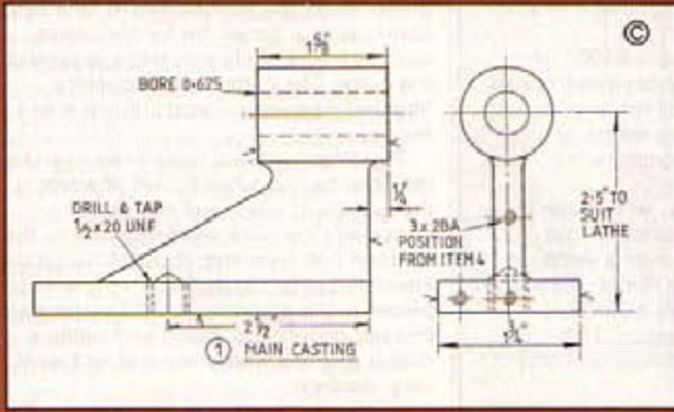
This simple indexing device, intended for use on a Boxford 4¹/2 in, lathe, is made using a readily available casting. The article is by A. W. Shirras

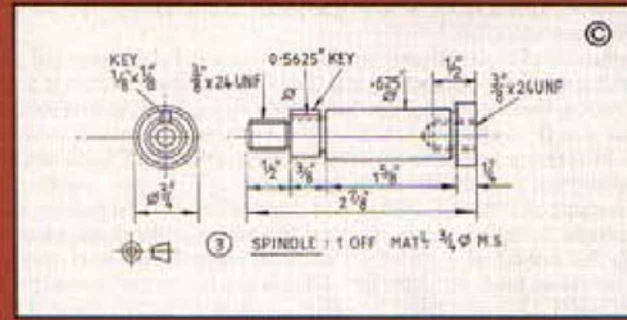


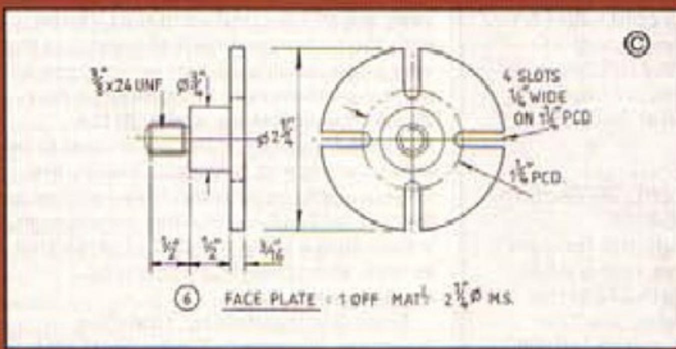
1: Completed attachment set up in the lathe parallel to centre line.

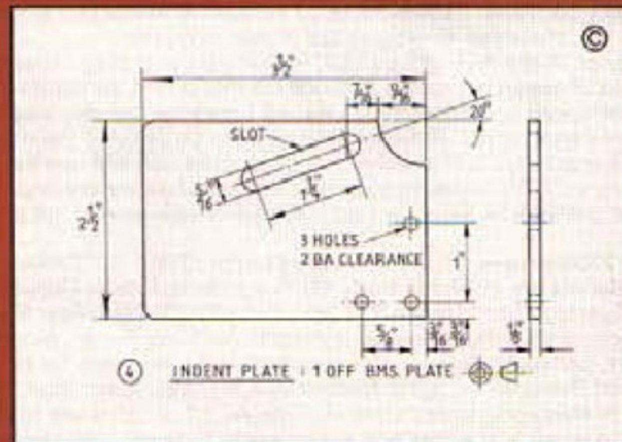
The motivation for making this attachment was originated by necessity. As a beginner to the hobby of model engineering some years ago, and during the building of a simple steam locomotive, I soon became aware of the difficulties involved in the manufacture of components requiring equally spaced holes around a pitch circle.

Stuffing glands, circular flanges for steam domes, regulator flanges etc., were some typical items needing such treatment. Not having a milling machine or rotary table, I was forced to consider making a simple indexing device which could be quickly and easily attached to my elderly 4 ½in. Boxford lathe. I had intended making an instrument makers vice, for which I had obtained the casting from The College Engineering Supply. This had been lying around for some time, as other projects had taken priority, until the idea occurred to me to use the casting as the basis of a simple indexing attachment. On trying the casting on the cross slide with the top slide removed, I decided that, with a little machining, its centre height, and that of the lathe, could be made to coincide. By introducing a spindle, free to rotate in a hole in the boss, it would be possible to fit some form of indexing device at one end and a workholding device at the other. Indexing could be achieved using a lathe change wheel, and workholding by using a redundant chuck from a power drill. Securing the device to the lathe was achieved using a standard profile Boxford top slide spigot. This









allows the device to be mounted with the axis at right angles, or parallel, to the lathe bed, or at any desired angle. **Photo 1** shows the attachment set up on the Boxford lathe.

Machining the casting (1)

I do not propose to go into great detail over the machining of the casting. This was described in a recent article (*M.E.W.* No.18). There are however two operations which need taking into account:
a) The amount removed from the base should ensure the final vertical height, base to boss centre, to be 2 ½inches.
b) Tapping the ½ x 20 TPI UNF thread should be done at this stage.

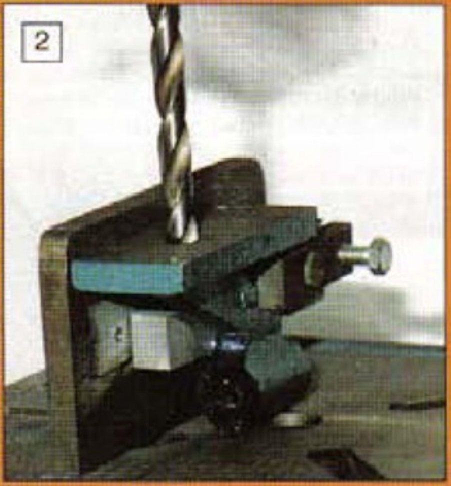
The hole should be slightly more than 1/2in. deep. **Photo 2** shows the drilling operation. Do not worry if the tapping hole breaks into the support web, which after all is only 3/8in. thick. To ensure alignment (right angles to base) of the tapped thread, it is best to use the tap in the chuck of the drilling machine at the same set-up as for drilling, rotating the chuck by hand.

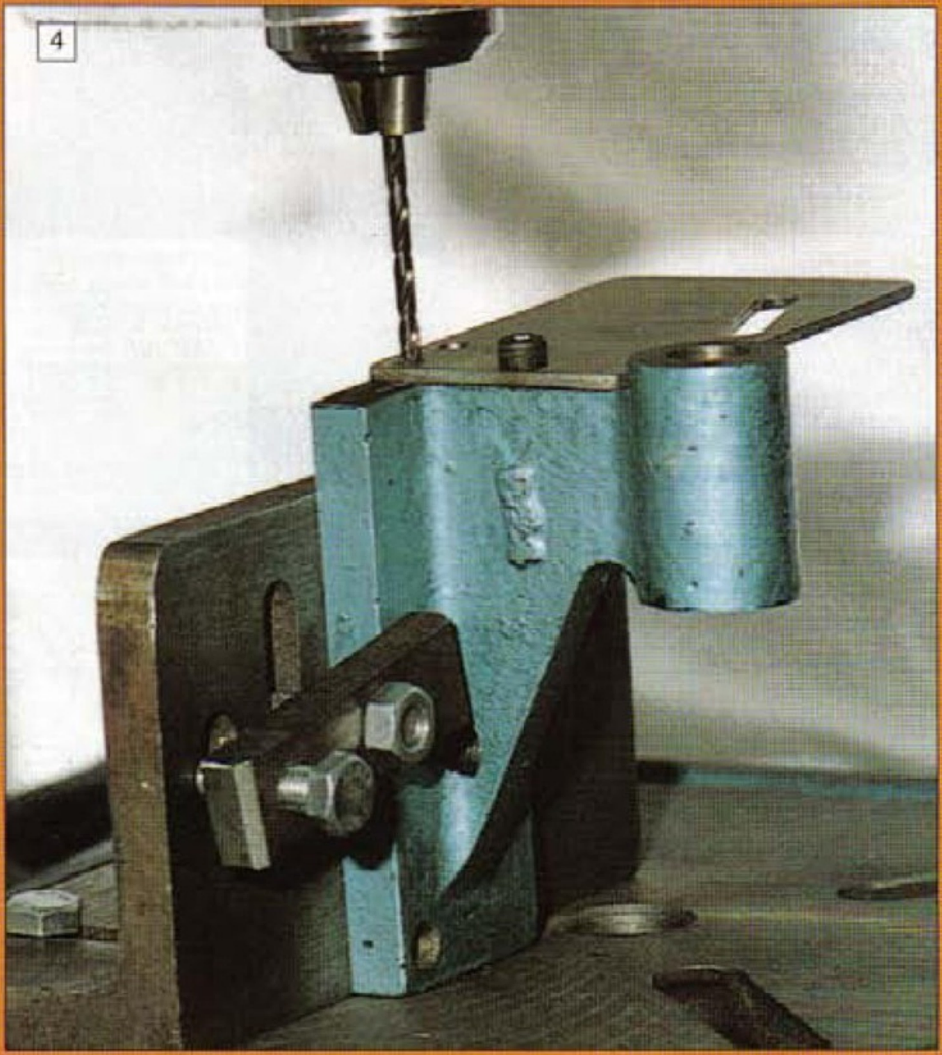
Machining the spigot (2)

Place a piece of free cutting MS 1 1/2in. dia. x 2in. long, in the lathe chuck and turn the ½in. dia. x 1/2in. long part. Make a small recess to facilitate the forming of the 1/2 x 20 UNF thread. The external diameter is now turned to 1.375in. and the 1/2in. diameter screw cut 20 TPI and finished off with a UNF die held in tailstock die holder. Before the 60deg. angle can be machined it was necessary to turn up a simple jig held in the 3 jaw chuck. Any suitable scrap of steel can be used. Having faced the end, centre drill, drill and tap ½ x 20 UNF using a tap held in the tailstock chuck. The jig complete, the spigot was now screwed into place ensuring that the shoulder fits tightly against the jig face.The final operation is to set over the top slide by 30 deg. to give 60deg. included angle. Using a specially sharpened tool the angle was machined, checking the 0.1in. dimension with a Vernier. The end is now faced to give a size of 0.085in. This completes the spigot which is removed from the jig and screwed tightly into the already tapped hole using Loctite or similar as a retaining compound, making sure the shoulder finishes tightly against the base.
The casting is now ready for fixing on the lathe. Remove the topslide and position the casting so that the axis is parallel to the lathe axis and coincides with the centre line of the lathe. With a centre drill in the headstock chuck, the boss is centred using the support of the tailstock barrel. This is followed with a pilot drill and then step drilled to 19/32 inch. This allows finish boring to 0.625in. diameter using a boring head or similar. If not available the hole can be finished with a 5/8in. drill, making the spindle diameter to suit. **Photo 3** shows the hole the topslide and position the casting so that the axis is parallel being drilled.

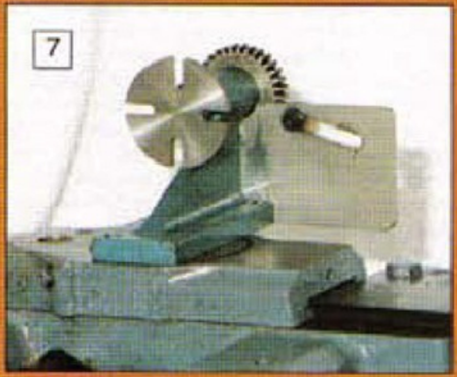
Machining the spindle (3)

The spindle is next machined from a piece of freecutting MS ¾in. diameter and approximately 3 ½in. long, sufficient to be secured in the 4 jaw chuck. Having tested for concentricity, one end is faced and centre drilled. Now, still held in the 4 jaw chuck but with a projection of 3in., the outer end is supported by the tailstock centre. The ⅜ in. diameter is turned a distance of ½in. ready for forming the ⅜x 24 UNF thread. The 0.5625in. diameter is now turned checking until a close sliding fit is achieved between the diameter and the hole in the lathe change wheels. Finally the 0.625in. diameter is turned for a length of 1 ⅝in. and checked by offering up the bore in the base casting. If the hole has been drilled, 10-15 thou. should be left on the spindle diameter and gradually reduced until a close sliding fit is achieved. (*Note. If a hole is drilled without a pilot, or a relatively small pilot, and the drill is badly sharpened causing it to drill oversize, that the hole size will however reduce to drill size at the end the drill breaks through. Do bear this in mind, or else you may end up with an undersize spindle if you check using the wrong end. Ed.)* These operations completed, the 3 recesses 1/16in. wide are machined at each shoulder to allow thread cutting and close fitting of





2: Drilling the 8.5 mm hole for 1/2 x 20 UNF thread. Tapping is done in the same manner.
3: Casting being drilled prior to boring. Note tailstock support.
4: Drilling 2BA tapping hole using indent plate as a guide.



5: Assembled attachment with 36T change wheel in place.
6: Some of the locomotive components made using the indexing attachment.
7: Attachment with faceplate set up in the lathe.

shoulders to mating parts.

The spindle is now removed from the chuck and reversed, centred and held on the 0.625in. diameter (packing should be used between jaws and workpiece to protect the finished surface.) The 3/4in. diameter is now finished to a length of 3/4in., centre drilled and bored tapping size for 3/8 x 24 UNF thread. With the tap held in tailstock chuck the thread is now formed 1/2in. deep. Finally the 1/8in. wide keyway is machined using a vertical milling machine or lathe milling attachment. Good results can also be achieved by mounting a parting tool, or similar, on its side in the tool post at centre height, and cutting the keyway by moving the saddle. It is important not to try to remove too much at each pass, 2-3 thou. being a reasonable amount. When the required depth has been reached the keyway can be checked for fit using a piece of 1/8in. thick BMS.

Indent plate (4)

The indent plate was made from a piece of 12G bright steel plate. The plate, 3 1/2 x 2 1/2in., was marked out and the 5/16in. radius relief to clear the boss in the casting removed by drilling a series of holes and filing to shape. The slot to accommodate the indent was formed by drilling a line of 5/16in. diameter holes and filing out the waste.

Three holes were drilled 2BA tapping size and one hole marked through to the casting from the plate after carefully positioning this. This hole was drilled to a depth of 5/16in. and tapped 2BA. Open up the one hole in the plate and assemble by one 2BA cap screw so that the remaining two holes can be drilled and tapped similarly. **Photo 4** shows the set up for this operation. The plate could be reversed and a fourth hole drilled and tapped. The plate could then be mounted either way, which may prove useful for some set-ups.

Indent (5)

The indent was made from a 1in. length of 1/2in. square brass. After marking out, the rebates were machined using an end mill. The 5/16in. dimension was left a little over size to allow for final fitting in the index plate slot. A half round file was used to form the curves on the end and a hole tapped 2BA, 5/16in. from the other end. A 2BA cap screw, with a washer under the head was used to secure the indent to the indent plate.

Assembly

The assembly was completed using a 36 tooth wheel from the lathe change wheels and is shown in **Photo 5** ready for use on the lathe. The 36T change wheel is ideal giving the most commonly used divisions i.e. 2,3,4,6,9,12. Other lathe change wheels can also be used if required; a 60 tooth wheel may be found useful.

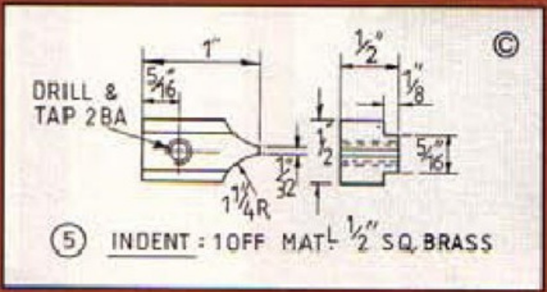
Faceplate (6)

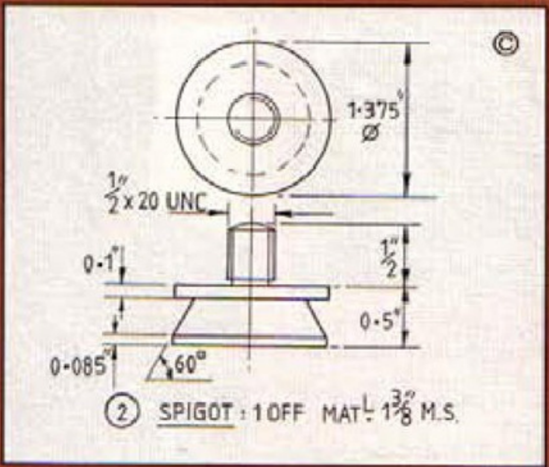
With the 3/8in. drill chuck, some of the smaller items in **Photo 6** were manufactured using a special mandrel. For the larger items the chuck was unsuitable so the manufacture of a faceplate was undertaken using a piece of freecutting MS, 2 1/2in. diameter by 1 1/2in. long. This was chucked in the 3 jaw chuck, faced and turned down to 3/8in. diameter for 1/2in.. The 3/4in. diameter was now turned for a length of 1/2in. and a small undercut 1/16in. deep formed at the shoulder in preparation for forming the 3/8 x 24 UNF thread. Having formed the thread a simple jig was made and tapped 3/8 x 24 UNF to take the faceplate thread. The incomplete faceplate was now screwed firmly into the jig and the 2 1/4in. diameter and 3/16in. thick finish turned. The faceplate and indexing attachment was then fitted up in the lathe with its axis parallel to the lathe bed and with a centre drill in the headstock chuck, 4 holes were drilled equidistant (9 tooth spaces). With a 1/4in. drill, the 4 centred holes were drilled right through. The plate was removed and the slots formed by hacksawing and filing. **Photo 7** shows the attachment with faceplate ready for use. For those who have a tee slotted cross slide, a centre support for long shafts could be made, perhaps using a second casting, so that both ends of centred rods could be set up ready for milling slots or grooves parallel to their axis.

Most of the attachment's components can be varied to suit individual requirements, and the basic design adapted to other lathes of similar centre height.

Casting supplier

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



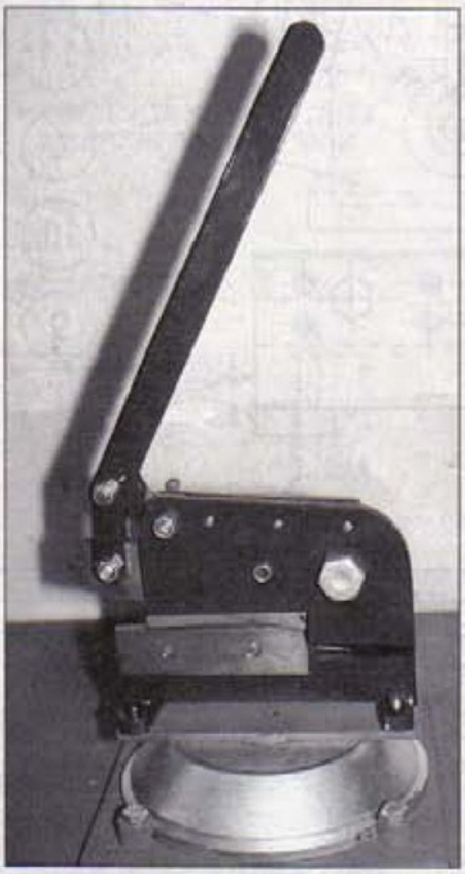


MAKING A HAND SHEAR

This design for a hand shear has been established and the article provided by Terry Gould.

The hand shear has been with us for many years, but is the one tool I rarely see in the home workshop, possible because its uses are limited. I have never had much call for one myself, that is until I had made this one. Two reasons brought it about. First, I was looking for something different to make. Second, I had two off cuts of SABEN KE 672 alloy tool steel, which were suitable to make the shear plates.

The makers of shears sell spare shear plates. A set for a 4in. guillotine being about the same price as an 18in. length of KE 672. I mention this as it may be easier to obtain a ready made set than to obtain a piece of suitable steel. Also, not everyone will have the facility to harden these. The dimensions for the bottom shear plate(5) permit all four long edges to be used as cutting edges by turning over and turning end to end. I did not harden the shear plates until construction was complete, in case alterations had to be made. Hardening and tempering has been covered before so I will not cover it here.



The completed shear. See also photo on front cover. The swivel base on which it is mounted was described in issue 18 page 46.

The Main Frame(1)

The lower section was made from two pieces of 2 x $\frac{1}{4}$in. bar welded together, as I had no way of making the recess for the bottom shear plate. Weld preparations were made so that the welds could be cleaned up for a better appearance. If a milling machine is available this part can be made in one piece.

The upper section is straightforward, the drilling can be done before or after welding. The hole for the shear bush(8) may be left till later as this is best positioned from the shear plate.

The mainframe has an off-set in it, getting this right is about the only important part in the construction. To reduce the distortion that welding creates, care has to be taken when welding the upper and lower sections together, as these must be both in line with, and parallel to, each other. This will be easier to achieve if the parts can be clamped to a substantial flat surface. Clamp the upper section directly to the flat surface, with the lower section being raised on packing and also clamped. The correct height for the packing being the thickness of both shear plates. However, any error must be on the plus side as the six screws in the lower portion only permit adjustment in this direction.

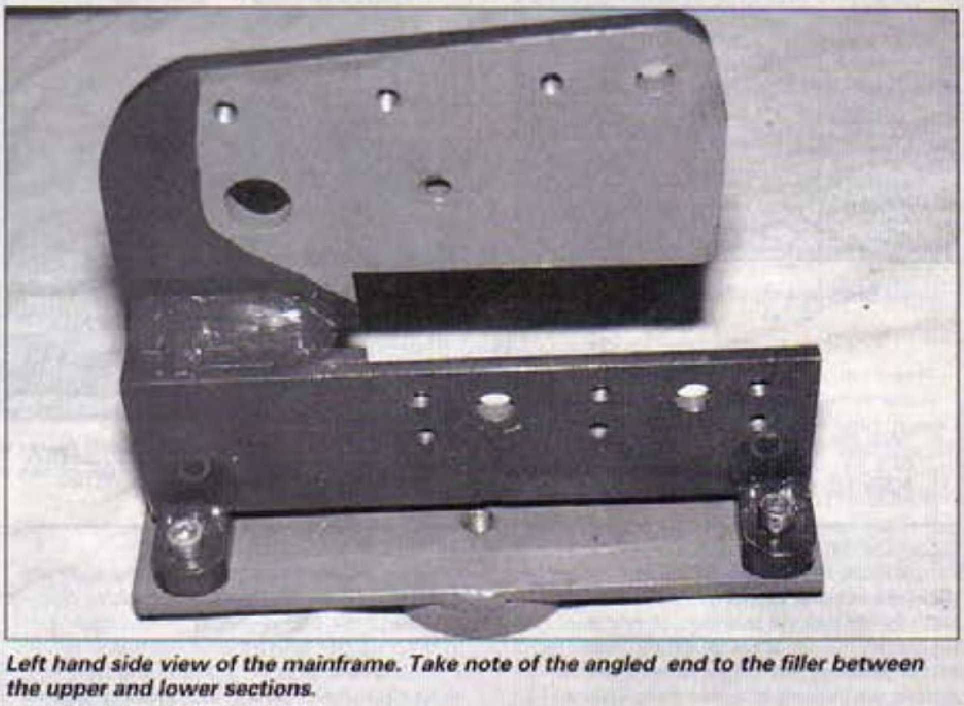
The filler between the upper and lower sections should be shaped with a diamond cross section as shown on the drawing, he thickness being as demanded by the above set up. The $\frac{3}{8}$ in. dimension on the drawing is for reference only. Only make a small short weld on one side to start with. The mainframe is then turned over and clamped again and a full weld put on the second side. Reverse and set up as in the first instance and fully weld the first side. Weld the mounting feet on to complete the main frame,

After welding, the best way to check the main frame is to fit the shear plates. Some distortion of the frame can be catered for by using the six bolts in the lower part to adjust the bottom shear plate.

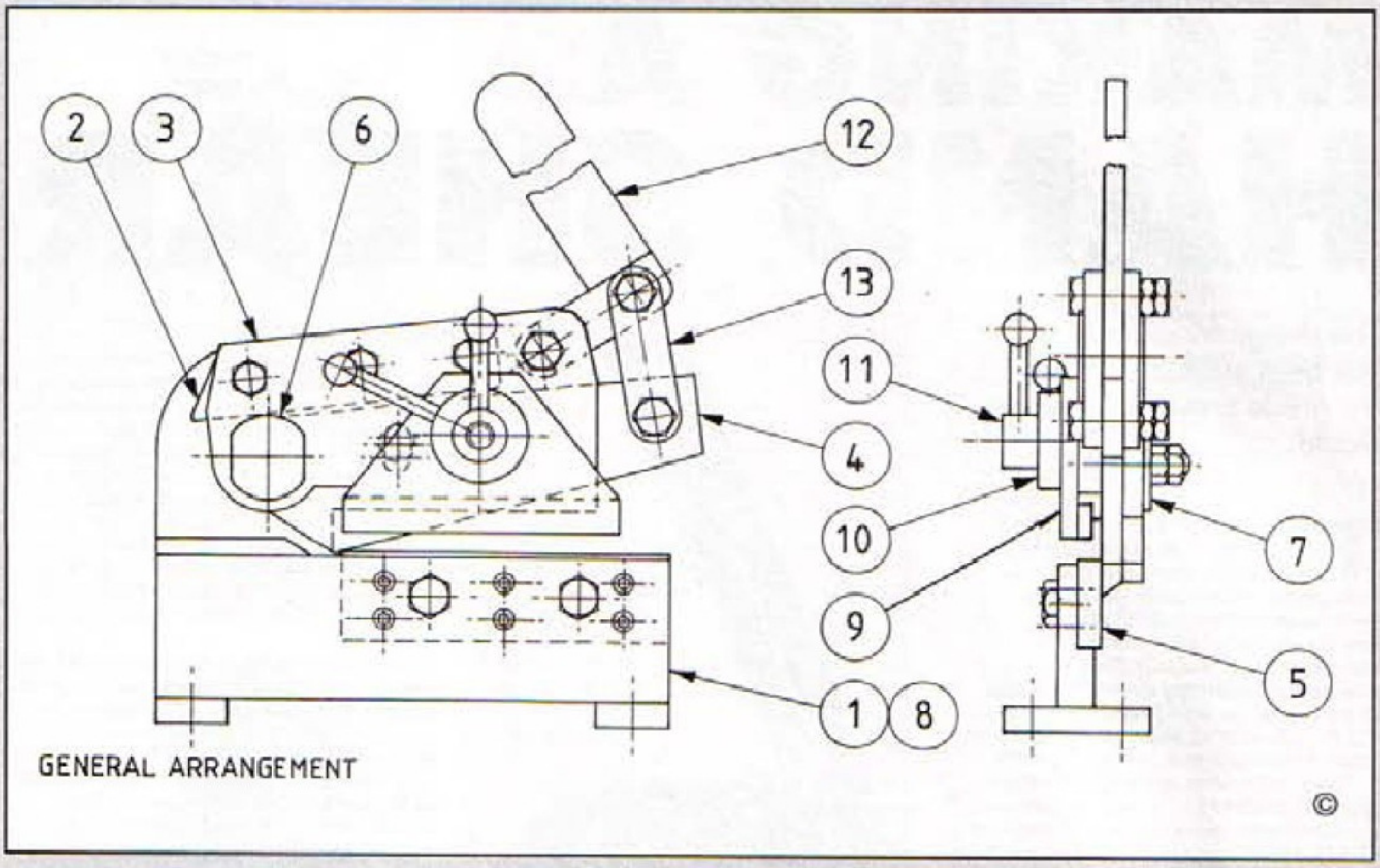
Make the packing strip(2), which should be the same thickness as the top shear plate(4), and temporarily fit both to the mainframe. Mark the hole position for the shear bush through the shear plate. For this bush I used a drilling guide bush, which was $\frac{1}{2}$in. diameter, the hole being drilled $\frac{15}{32}$in.

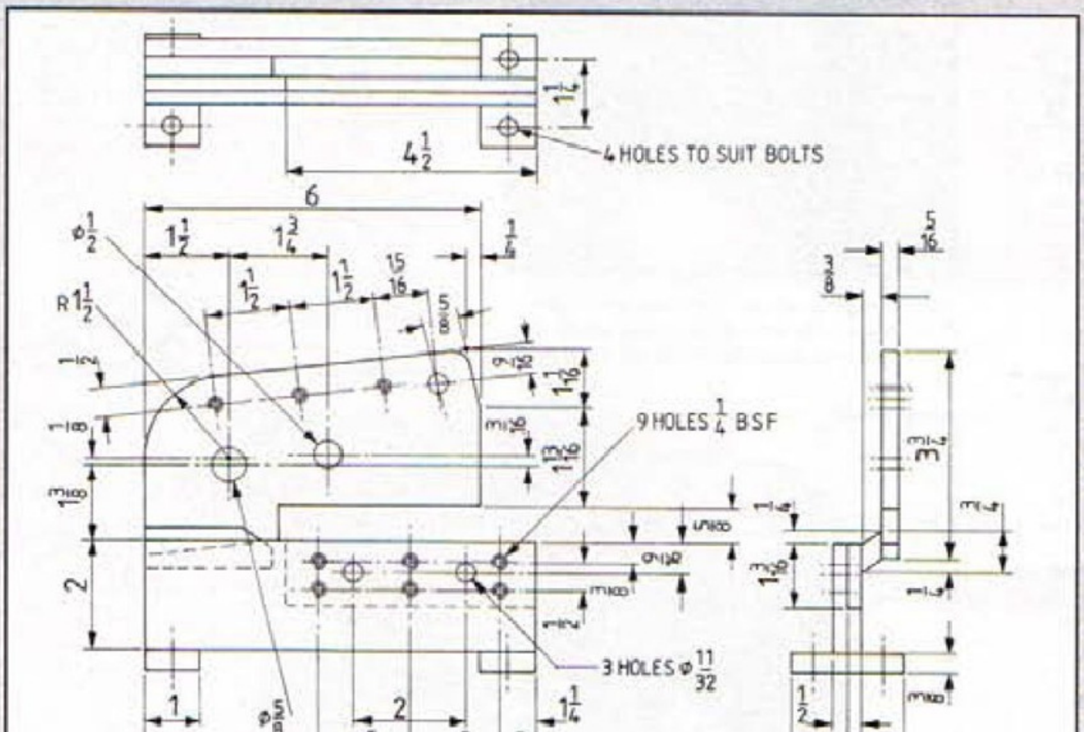
I had to use a file to enlarge the hole a little. The bush was pressed in using the vice. I have not tried it, but imagine a bush made from silver steel would do. It would be better to make the bush to suit the hole size rather than the other way about, as I did.

Make the side plate(3) and fit to the mainframe, transfer the position of the shear bush hole to this plate. Note that the shear bush hole becomes a slot in this part. Before removing the side plate also mark



Left hand side view of the mainframe. Take note of the angled end to the filler between the upper and lower sections.





the position for the cam stud. This must be 13/16in. above the top of the lower shear plate to ensure the locking action operates satisfactorily. The cam stud hole is drilled and countersunk on the inside. Weld the stud in around the counter sink. This weld must be finished flush as it will be against the shear plate. As this stud needs to be square to the plate, (this is not an easy item to hold square and weld at the same time) it should be made a tight fit in the hole or a short thread put on the end and the hole tapped to suit.

The shear plate pivot (6) is a simple turning job.

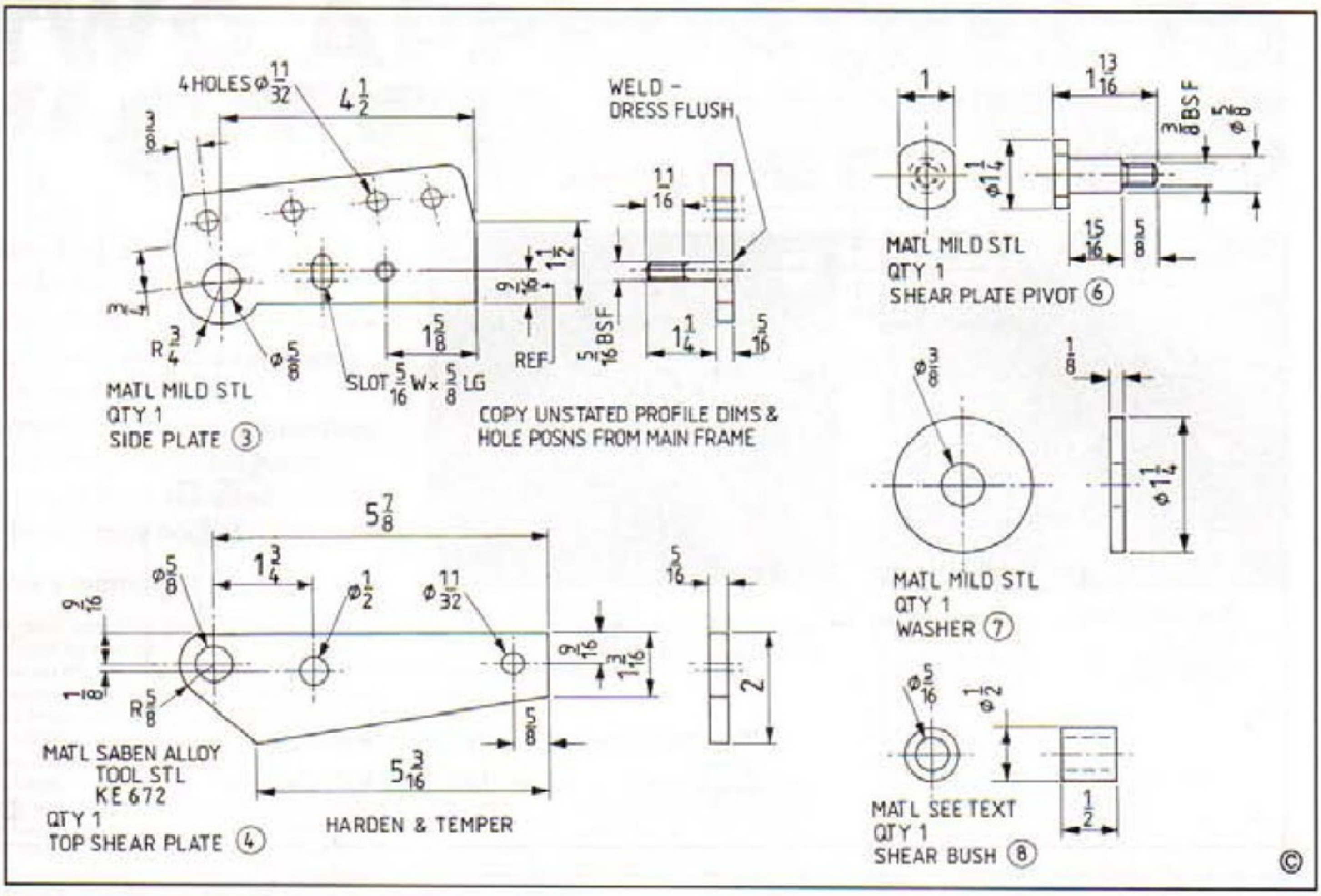
Handle (12) and links (13) are also quiet straightforward. The pivots are 5/16in. bolts with locknuts. Do use bolts, these having straight shanks, and not be tempted to use screws, which, being threaded all the way down will soon wear.

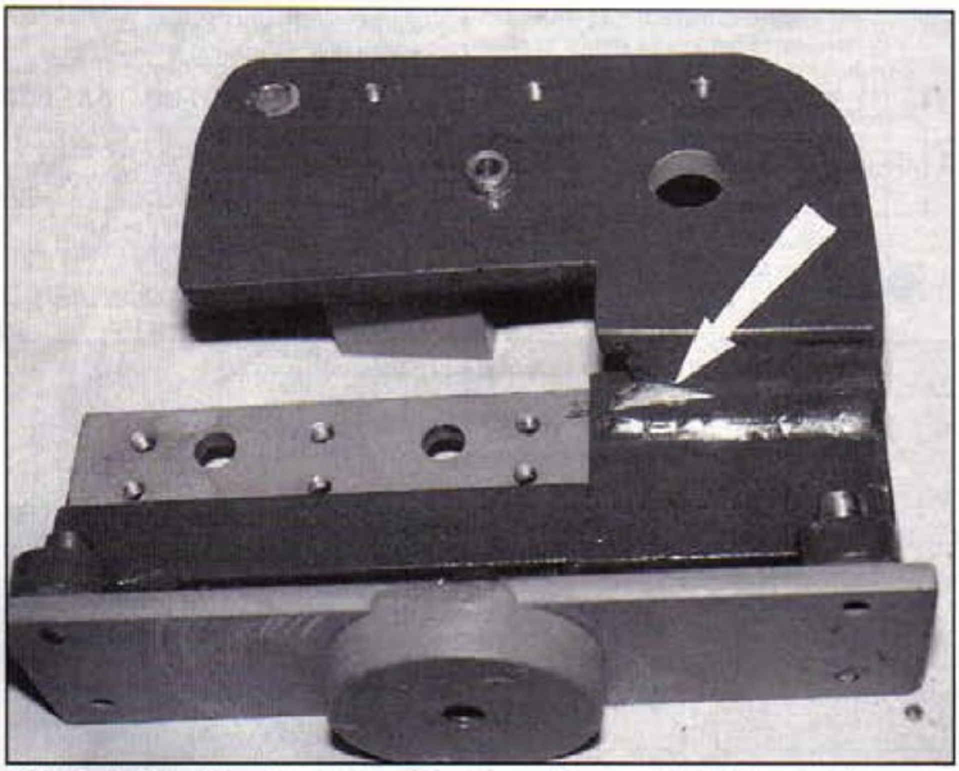
Once all the parts are assembled, test the top shear plate, this needs to be free to move up and down but not sideways. If there is any sideways movement, the thickness of the packing strip will have to be reduced. On the other hand, if its too tight some packing may be needed. Make sure that any tightness is not being caused by the shear plate pivot.

To adjust the bottom shear plate, bring the top shear plate down to its lowest position and then bring the bottom shear plate across to it. Do this by screwing in the top three adjusting screws, followed by the bottom three. Do not put too much pressure on the bottom three as these will throw the shear plate out of line. The two retaining bolts can be tightened up. Do not expect to get it right first time.

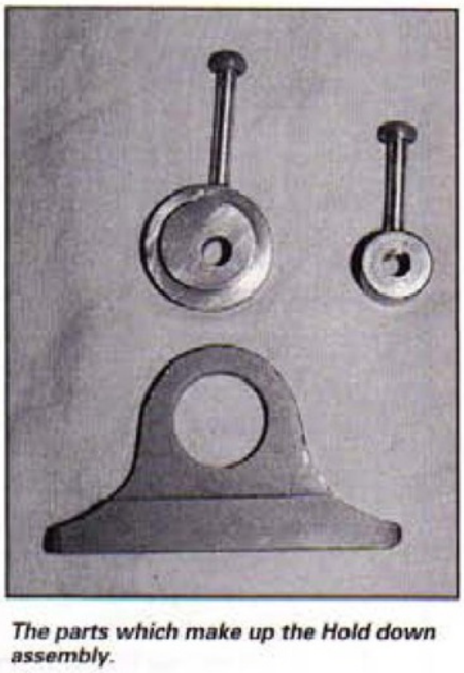
To check that the shear plates are in line, I shear strips of paper. If the start of the cut is good, the middle is torn, and the last part ends up folded over, this shows that the shear plates are not in line and need to be tightened up on the front edge.

The hold down assembly comprises the Hold down foot (9), Cam (10) and Cam lock





Right hand side of frame from below. Note the notch (arrowed) which I had to file to allow the material being sheared to pass more easily without having to bend it too much to clear this point.

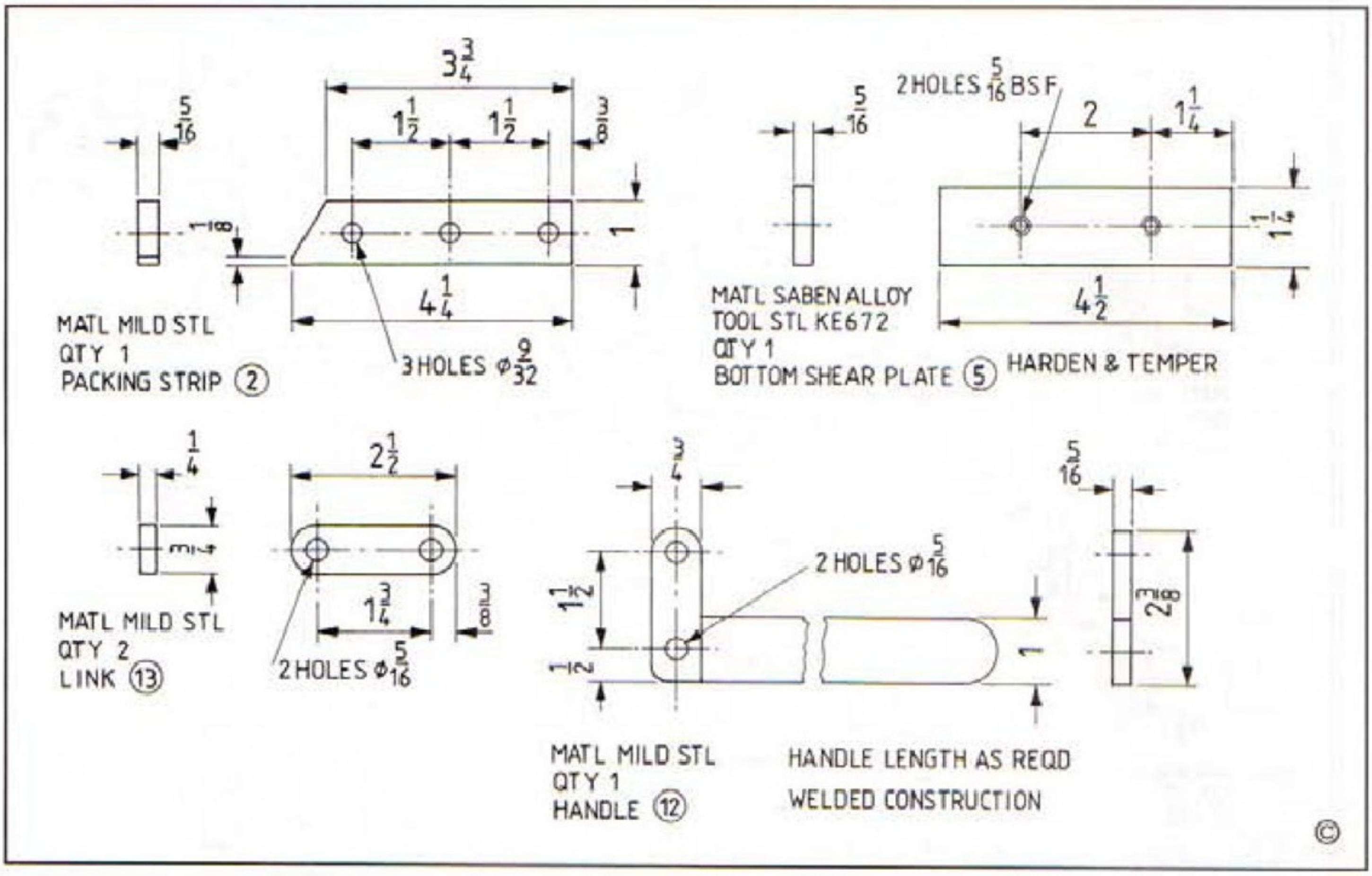


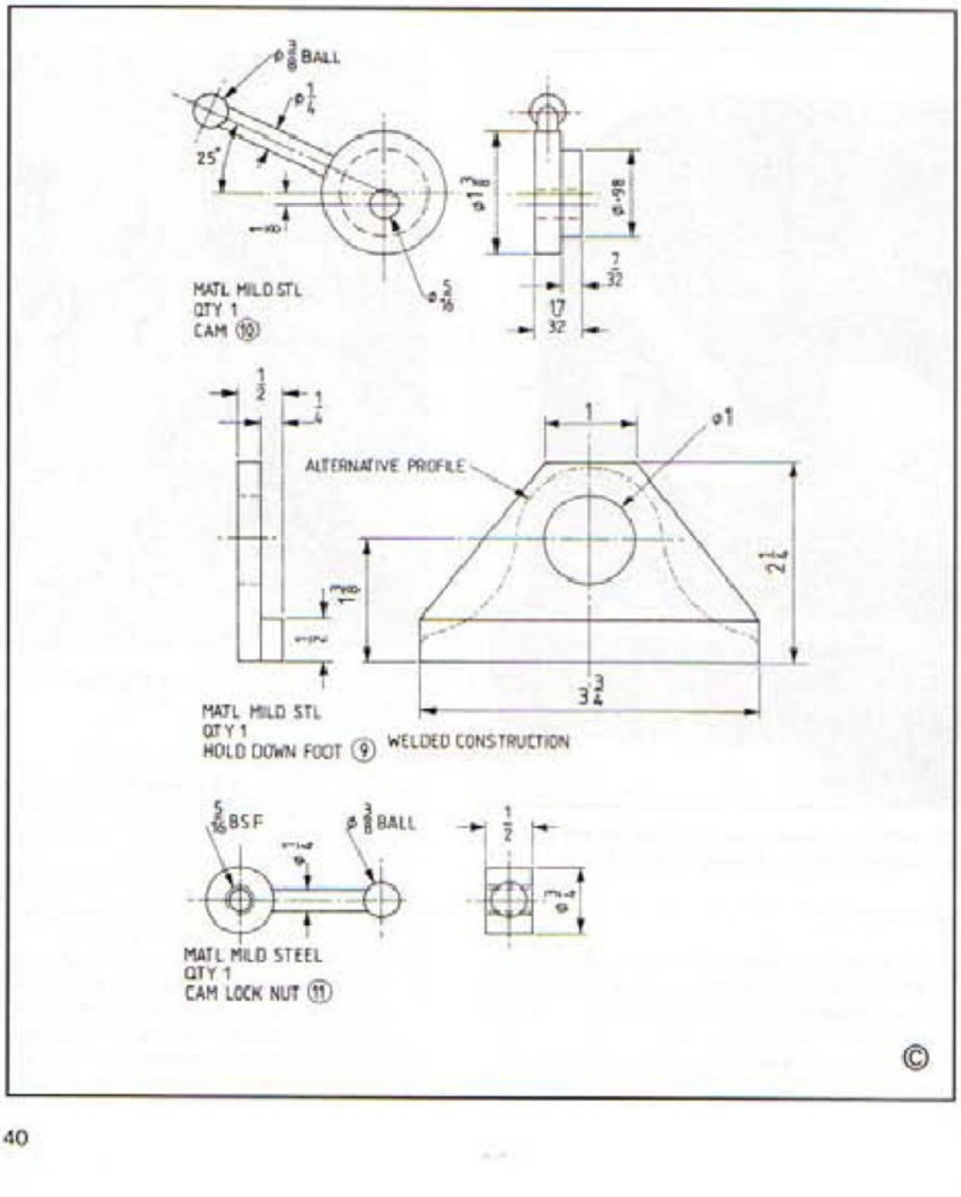
The parts which make up the Hold down assembly.

nut (11). The foot is made from 2 x ¼in. MS bar. There is no need to make it a fancy shape as I have done, The 1in. hole was produced by holding the foot in the 4 jaw and boring to size. The eccentric cam is a simple turning job as is the cam lock nut and need no detailing. The handle positions for these were left until they had been assembled, so that the best position for them could be found.

The hold down foot was made to suit my needs. However, the foot will not suit ever ones needs due to the limited travel that the cam has. If it is intended to shear material above 3mm thick this hold down foot will need to be changed to give the eccentric cam more movement.

For the operating handle(12) it is best left to the individual to choose a length that suits their needs. The handle of my guillotine is 12in. long, on the short side, but gives enough leverage for most of my needs, which is to shear brass and aluminium. I keep an extension tube for when I need to shear thicker material. It pays to keep the shear plates lightly oiled.





While I find the guillotine strong enough for what I shear, I think that the guillotine would benefit from a stronger mainframe, by making it from thicker material.

The time spent on making the guillotine has been worth while, simple to make and it does not take up to much room. For a tool that I had in the past considered not worth having in the workshop, it comes in vary handy. This may only be a small version, but there is nothing to stop it being scaled up.

The makers of SABAN alloy tool steel are. Sanderson Kaser Ltd. Sheffield, S9 2SD.

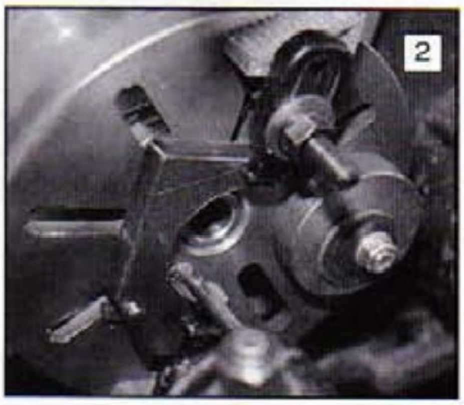
QUICK TIP

Useful containers

The dished bottom of drink cans, if cut off using an old penknife, makes an excellent receptacle for small components, a finger full of grease, or a mixing palette for small quantities of paint (no corners like an ordinary lid).Together with the top of the can it goes into the dustbin after use . The sides are an excellent source of alloy material around 0.005in. thick, which can have many uses. Packing for lathe tools and making small pressings to name but two. Norman Reeve

TWO APPROACHES TO "C" SPANNERS

Operating a device with a tommy bar is often far from satisfactory, as Derek Walters and John Noakes discovered. Both have opted for "C" spanners making the operation more acceptable and safer also, but have adopted differing approaches.



Derek's method

The collet chuck on the Hobbymat mill is operated by two 6mm dia bars. I used the same on my own design but found on occasions the nut could only be moved by a blow from a hide mallet. Not being keen on shocks to a small machine, I decided to make a pair of "C" spanners.

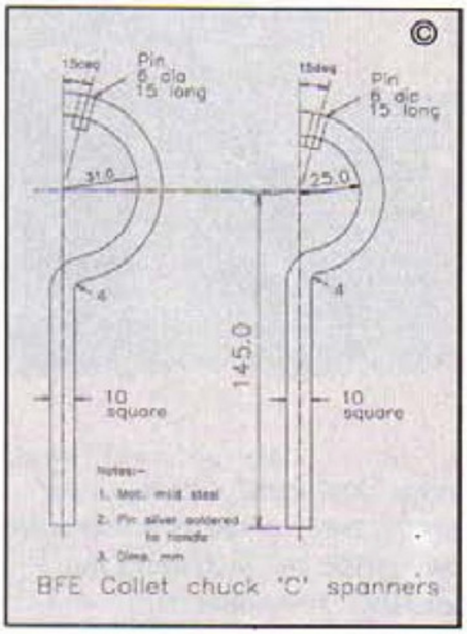
Materials were cut on my *M.E.W.* bandsaw, and the heads marked out and the radius centre popped, see **photo 1**. The head was set up on a pair of parallels on the faceplate, and positioned using the tailstock centre to align with the centre of the radius, then clamped up, checking with a tool in the toolpost that it followed the radius line. The dead stop was set to prevent the tool touching the faceplate.

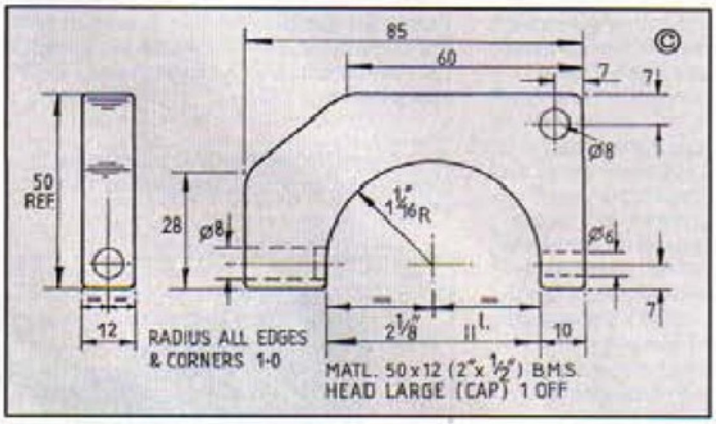
A hole was then drilled, first a centre drill followed by a series of drills up to 3/4in. diameter. A balance weight was added as **photo 2** and the radius machined with a boring tool. The mouth was filed and holes drilled. The handle was turned a good running fit and cross drilled for a hanging loop. Individual parts are not fixed together as this will permit them, if required, to be interchanged with other sizes. The bodies marked with their size, and the job was done.

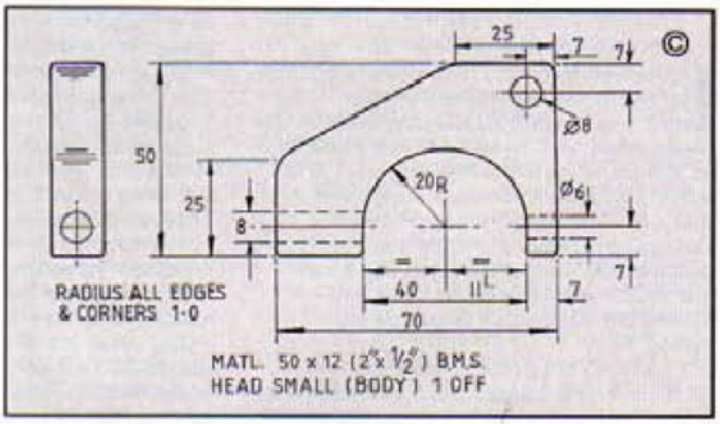
And from John

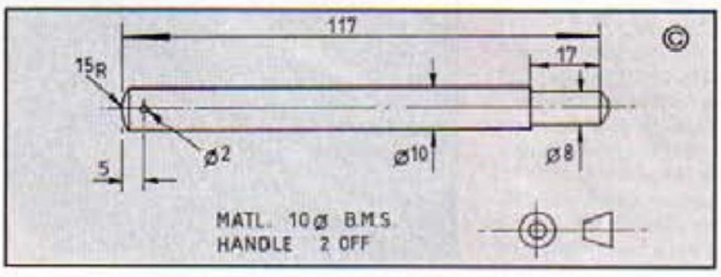
I found it difficult to adequately tighten the BFE collet chuck using the tommy bars supplied. On occasions, the cutter moved and spoilt the job in hand. About three years ago I made a pair of "C" spanners and have had no further trouble.

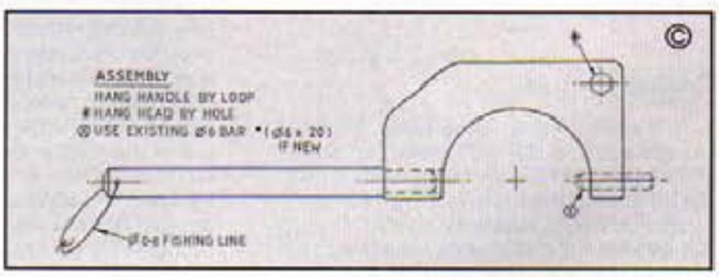
Spanners for the two diameters are made of 10mm square mild steel with 6mm dia pins silver soldered into place. The bar was heated and bent round formers of suitable diameter, the end of the curved portion being left long while bending took place and then cut to length. This ensured the curve was smooth to the end. The critical dimensions are those of the pins and large bends. A snug fit will ensure the spanners are safe and will not slip in use.

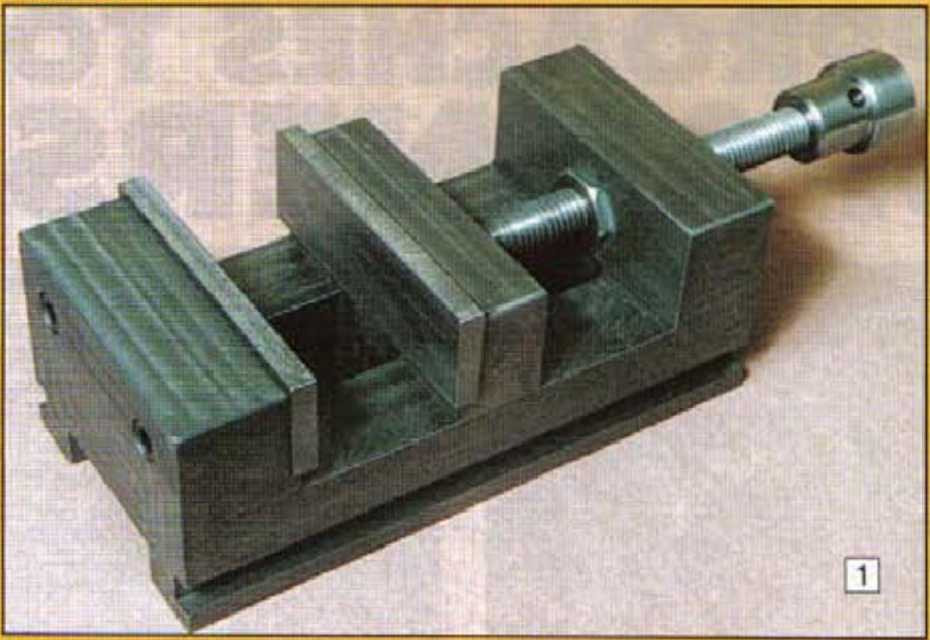












A TOOLMAKER'S VICE

John Steel concludes this series on the early projects in his new workshop by describing the making of a rather nice toolmakers vice.

In the article relating to the boring head for the BFE65 Hobbymat milling machine, I explained the reason for it being made was to enable a large hole to be produced in the toolmakers vice I was in the process of making. The vice was made from castings supplied by The College Engineering Supply, their part number 509. This is a substantial, medium size vice, main dimensions 150 x 74 x 58mm, the completed vice can be seen in **photo 1**.

I followed the general scheme set out on the drawing supplied, but made some small changes for ease of manufacture and use.

Design changes

The main change to the design was to the main screw. This is detailed on the drawings as M16, with the internal thread cut direct into the main casting. Neither operation was possible using my limited equipment. I will not go into detail as this was covered in the boring head article, but the final arrangement was to use a piece of M12 studding and a nut as an insert for the internal thread. The nut was turned down to 18mm diameter over most of its length and fitted into a plain hole in the main casting using adhesive. A short portion of the hexagon was left on the nut as a flange to take the tightening pressure, the adhesive was there just to hold the nut in place when the pressure was released. This arrangement can be seen in close up in **photo 2**.

Another change was the inclusion of slots along each side to make provision for clamping the vice to the milling table. These slots are seen in photo 1, and being put to use in photo 6. **Sketch 1** shows the principle of the clamps, which were made to suit precisely the size of the vice and the spacing of the tee slots. One other minor change was to make the jaw keep plate longer than the jaw. The jaw is quite short, which is not ideal when it comes to limiting jaw lift. I considered obtaining a larger block of cast iron to make a longer jaw, but this would limit the vice's capacity. As a compromise, the keep plate was made to project in front of the jaw. This had the same effect as that of using a longer jaw, though not being clamped to a jaw at the front end made it more flexible, so the improvement was only partial. **Photo 3** shows this arrangement. It did have the disadvantage of closing the gap unless the vice was opened wide, and so

1: The completed vice.

made it difficult to clear any swarf fully.

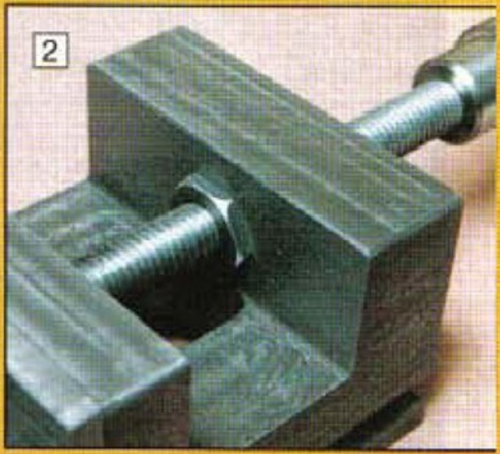
There have already been a number of articles in *M.E.W.* on machining a vice and the need for accuracy, it would seem, as a result, inappropriate to go into detail regarding the operations in making this one. I will therefore go briefly through all the operations in sequence, and give more detail where considered appropriate.

Machining the main casting

A start was made by machining the base of the main body, but before this was done, the top of the fixed jaw and the rear upright were dressed with a file and checked on the surface plate to ensure there was no rock. This was essential as, had there been, the casting would become distorted by being clamped on to the machine table. The result would be that the machined surface would not be flat when removed from the machine. The casting was set up on the milling machine table as in **photo 4**. Pieces of card were placed between the casting and table to help protect the table from the rough casting, also to compensate for any minute error in flatness that may not have been detectable when tested on the surface plate. The base only was machined at this stage. After removal, the machined surface was checked against the surface plate and found to be satisfactory. An angle plate was then mounted onto the machine table, and the vice casting onto this, as in **photo 5**.

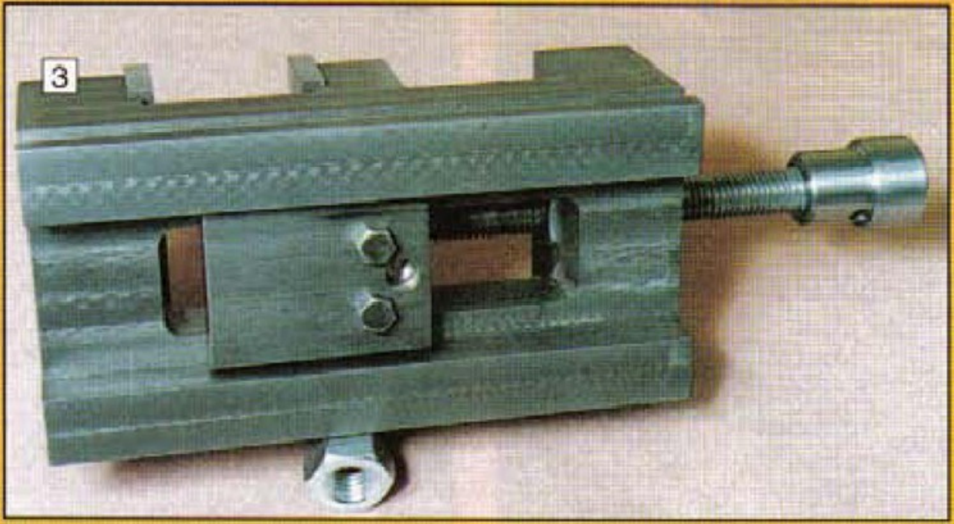
The first side was machined all over and the slot also made at this stage. Whilst the slot should be parallel to the base, a high degree of accuracy is not necessary. Therefore, to position the angle plate sufficiently accurately for the task, a square was used, registering off the front face of the table and the side of the angle plate. With the first side complete the second side was machined in the same manner. However, the two sides should be reasonably parallel, and to ensure this was so, a parallel was placed between the side already machined and the machine table. Before the casting was fully tightened onto the angle plate, care was taken to ensure the casting was in contact with the parallel along its length.

2: A turned down nut was used as an insert to avoid the requirement to tap the casting.



The next operation was to machine the top of the fixed jaw and the corresponding part at the other end. To do this, the casting was placed on the milling machine table and clamped in position with studs through the central slot. Following this the casting was reversed, generally as in photo 4, but clamped on the already machined surfaces. It was essential that the sides were parallel with the table travel, and this was achieved with the aid of a dial test indicator(DTI). The central slot and the surface on which the keep plate was to slide were machined. At this stage the clamp plates were made so they could be put to use in the next machining operation, as seen in **photo 6**.

The casting was accurately positioned, using a DTI, as for the last operation. In this case the aim is to ensure that the inside



3: The jaw keep plate arrangement.

4: Machining the base was the first major operation.

5: Making the slots for the hold down arrangement, as seen in photo 6.

face of the fixed jaw is at right angles to the length of the vice after machining. The surface on which the jaws slide and the inside of the rear upright were also machined whilst in this position. The angle plate was returned to the milling machine table and the casting set up generally as in **photo 7**, though this shows the second end being machined for reasons that will be explained latter. The casting was set in position with the jaw end nearest the table. As the outer end had not at this stage been machined it had to be just clear of the table. The casting was set upright by the aid of a square. The top surface was then machined. The casting was then reversed, but as the end now nearest the table had been machined it was possible for it to rest on the milling machine table, as seen in photo 7. However, it was still checked with a square, to ensure that it was correctly positioned, prior to machining the other end.

A start on the moving jaw

The tongue of the moving jaw was machined to a close fit in the slot, and to the same thickness as the base casting already machined. I do not intend to elaborate for the requirements have been well covered in previous articles. The keep plate made and fitted, and with a small piece of paper between keep plate and base casting to ensure that it was gripped tightly, the two outer edges were machined as in **photo 8**.

With the assembly mounted generally as in photo 11, but without the clamp onto the top of the moving jaw, the moving jaw was machined to the same level as the other two. To ensure this was achieved, a light skim was taken over the fixed jaw and rear of the casting at the same setting. The clamp was now added to secure the moving jaw more thoroughly and the inside of the jaw machined to take the jaw plate. Again, positioning is important to ensure the two jaw inner faces are parallel. It was now time to make the hole for the tightening screw insert. This was commenced by drilling a 12mm hole as in **photo 9**, after which the moving jaw was mounted onto the base while this was still in position on the drilling machine table. The jaw was held in position with a toolmakers clamp on either side and spotted though using the 12mm drill to establish the position for the screw hole. Machining the rear face of the moving jaw remained to be done and was carried out at this stage, also drilling the hole for the tightening screw and jaw plates, etc.

Soft jaw plates, for both the fixed a moving jaws, were now made and fitted using cap head screws, both fixed and moving jaws being counter bored to suit.

Using the boring head

The boring head was now fitted and the casting mounted onto the machine table as seen in **photo 10**, ensuring that it was accurately upright. The next stage was to adjust the X and Y positions so that the machine spindle was accurately in line with the already drilled hole. This was done using a DTI, but with care, I feel it could have been adequately achieved by eye using the cutter of the boring head. The method of using the boring head was fully covered in its constructional article, so I will not elaborate here.

With the moving jaw assembled onto the main casting it was returned to the milling machine table, as illustrated in **photo 11**, for finishing the jaw plates. Positioning the assembly was done using a square off the front of the machine table and the front face of the vice base. As the vice will be positioned by this method when being put to use, the accuracy should be adequate for all but the most critical operations. The top, ends and inner faces of the jaw plates were now machined.

The turned parts

It was now time to carry out the turning operations which really need little comment. A short length of 12mm studding was placed in the three jaw chuck and an M12 nut screwed onto this. The nut was then turned down to be a close fit in the hole in the base casting, but leaving a

6: Machining the inside of the fixed jaw and the jaw sliding surfaces.

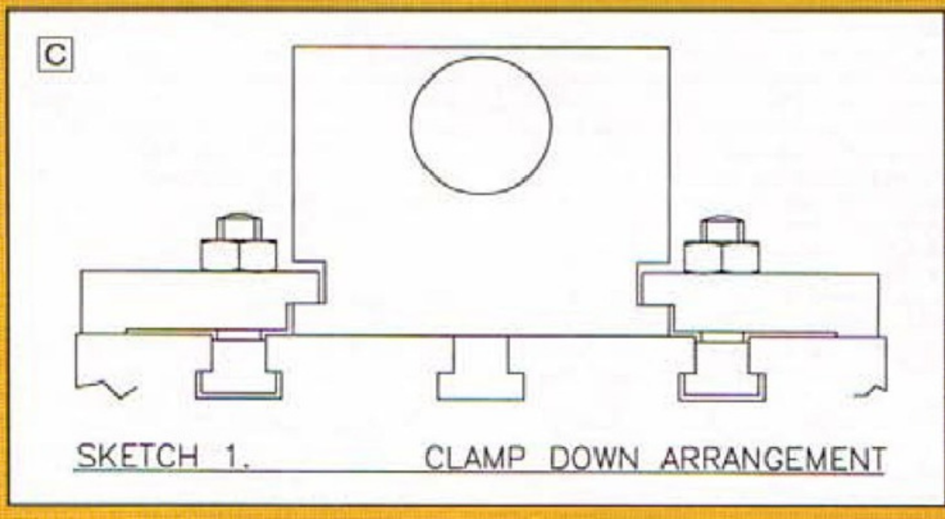
7: Having machined one outer end of the casting the second end is seen being machined.

8: The jaws being brought to the same width as the body.

flange of about 3mm width to take the tightening force. A piece of 25mm diameter bright steel was then used to make the head for the tightening screw, as seen in photo 1. As an M12 tap was not available a 10mm diameter hole was drilled, into which a turned down portion of the stud was to be fixed using a suitable adhesive. For maximum strength of the joint, the hole and turned down portion were made almost to the depth of the head itself. A saw cut was made along the length of the 10mm turned down portion to relieve the pressure as the head was forced onto the stud. However, before this was done the other end of the stud was also turned down to enter the hole in the moving jaw, and a groove turned for the purposes of the jaw withdrawal screw. This screw is the third screw seen in photo 3.

Assembly

The head was fixed to the stud and after the adhesive had set a hole for a tommy bar drilled. All the parts were then generously deburred, and where appropriate, more of a chamfer, as should be visible in photo 2. The parts were then assembled and lubricated on the moving parts, the end result being a vice which will surely fit the bill for many future applications.



9: Drilling the hole for the tightening screw using the largest available drill, 12mm. Note the casting is well anchored for the operation.

10: Using the boring head to open up the hole to take the threaded insert.

11: Finishing the jaw plates, including the mating faces.

CROSS SLIDE BRACKET FOR AN ELECTRIC PISTOL DRILL

Derek Brooks started out with the intention of making a bracket for mounting an electric drill onto his lathe cross slide. He ended up making a number of other very useful items, all described here.

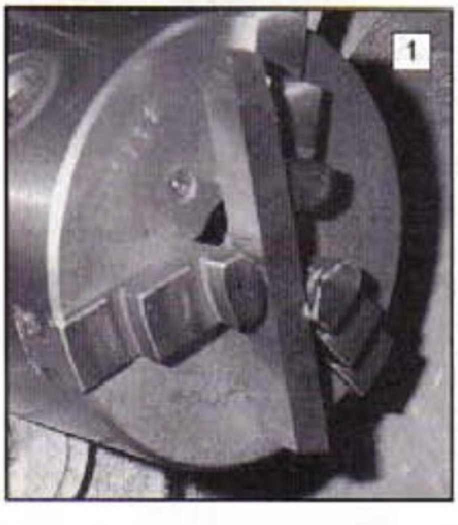
Toolmaking is often a multiplying hobby. In other words, tools make tools, make tools. For anyone just entering this hobby this project can be like that. However, it does leave one with several useful pieces of kit along the way. The main object is to produce a gadget to drill holes round a pitch circle. I am sure many other uses will be found, for example, put a small grindstone on an arbor in the chuck and you have a simple but serviceable toolpost grinder.

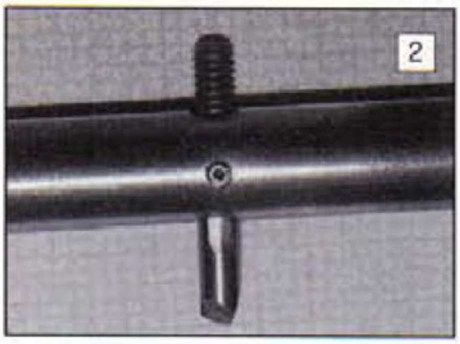
A polishing mop in the drill chuck could be used to give stainless or aluminium a high polish.

As most engineers have an electric pistol drill all that is needed is a means of fastening it to the cross slide of you lathe. Some form in indexing is also required, but more of that later.

Most electric drills have a concentric spigot just behind the chuck. This to fix it into a drill press or to fasten on an extra handle. It is a convenient place to use as a fixing for our purpose.

1: Using a piece of 1/2in. square HSS, mounted in the three jaw chuck as an extempore flycutter.





2: A boring bar, the tool bit is made from a section of a broken slot drill.

Tee Bolts (1)

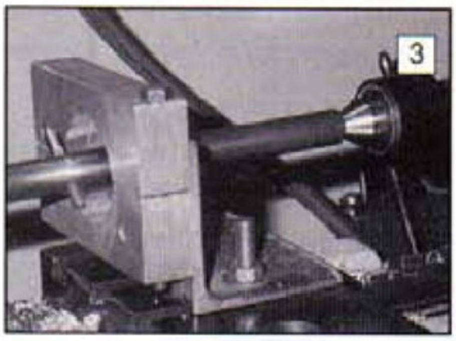
The first thing to make if you do not already have them are the tee bolts. The dimensions that I have given are for a Myford lathe, owners of other makes should modify the sizes to suit their needs.

Angle (2)

The next job is to cut a piece of steel angle to size, and drill two holes to correspond with the tee slot centres of your cross slide. The angle can now be bolted in place on the cross slide. It needs to be set reasonably square to the bed. To do this move the saddle, bringing the still loose angle up to the opened out jaws of the chuck. Then tighten the tee bolts allowing the angle to overhang the edge of the cross slide. The face of the work now needs fly cutting. You could at this point make a fly cutter but you could alternatively just use a piece of square tool steel held in a three jaw chuck. Yes a three jaw, I have often used this method it works well, see **photo 1**. A pass is made past the cutter adjusting the depth of cut with the saddle. It is beneficial to lock the saddle to the bed if possible. The circle that the cutter point describes should be adjusted so that its diameter is slightly larger than the height of the work piece.

Clamps (3 and 4)

Two pieces of aluminium are cut to size and the ends flycut while you have the cutter in the chuck. All that is necessary is to clamp one on top of the other to the cross slide. Two tapping sized holes are drilled in the angle low down. After removing the burrs one piece is clamped to the face and the holes are spotted through, the spots drilled tapping size and tapped. The holes in the piece of angle are opened up to clearance size. The two parts are then fastened together. The upper clamp is bolted to the back plate, but note, this is only at one end. There is a gap between the two clamp pieces. This gap can be temporarily held using a scrap of 16 swg sheet material as a shim. The vertical hole is now drilled at tapping size through both parts. The bottom is tapped and the top relieved to clearance size. Keeping the 16 swg shim in place all the bolts are well tightened, and the whole job returned to the cross slide. The chuck is again used to position it squarely.

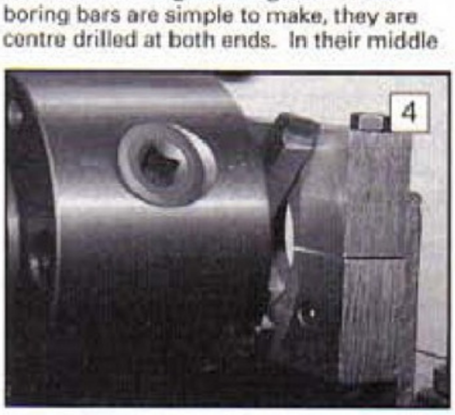


3: Boring the large hole in the bracket, using a boring bar.

The large hole has now to be drilled at centre height so all that is necessary is to put a drill in the chuck and drill it through. Start with a small size and work your way up to the largest drill that you possess. Now this is where, unless you already have one, you will need to make another tool.

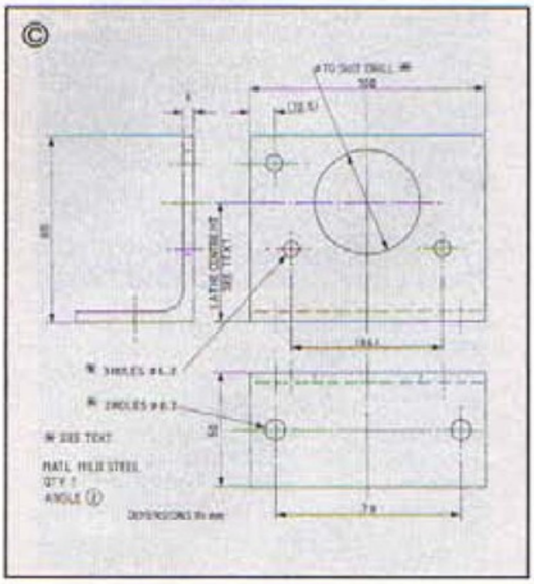
Boring Bar

I have several boring bars, the smallest is ½in. diameter with a very small tool in its centre. This is not very long and, to help keep it rigid, one end is held in a three jaw chuck and the other end uses the tailstock centre. To increase the size of the bored hole the tool has to be progressively moved out a few thou between cuts. At this stage it can be adjusted by eye as no accuracy is required. The only reason you are using this small one is to enlarge the hole to take a larger boring bar. These boring bars are simple to make, they are centre drilled at both ends. In their middle they have a hole bored at right angles large enough to take a piece of tool steel. At 90 degrees to this hole another is drilled and tapped to take a socket grub screw, which locks the tool steel into the bar (**photo 2**). The cutting tools should have a flat ground on them to take the end of the set screw. When sharpening the cutter, don't forget to allow plenty of back rake, to clear the inside of the hole being bored.

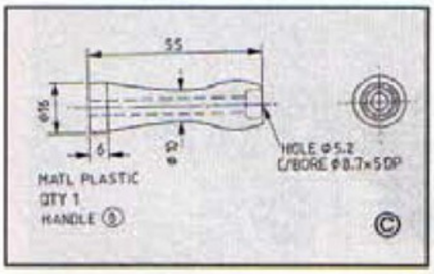


4: Fly cutting the face of the bracket.

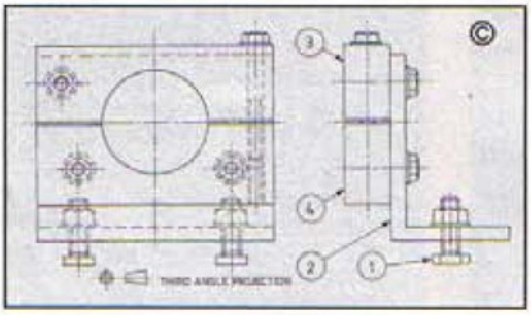
I operate larger boring bars between centres and drive them with a carrier. This is so that the boring bar can be removed and replaced to facilitate measurement of the hole. To measure how far you move the cutter out of the bar, stand a block of metal on the lathe bed and place feeler gauges between it and the cutter, with the cutter at bottom dead centre. By removing



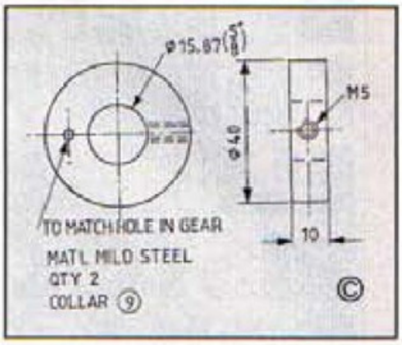
©
MATL MILD STEEL
QTY 1
ANGLE ②
✻ SEE TEXT
DIMENSIONS IN mm



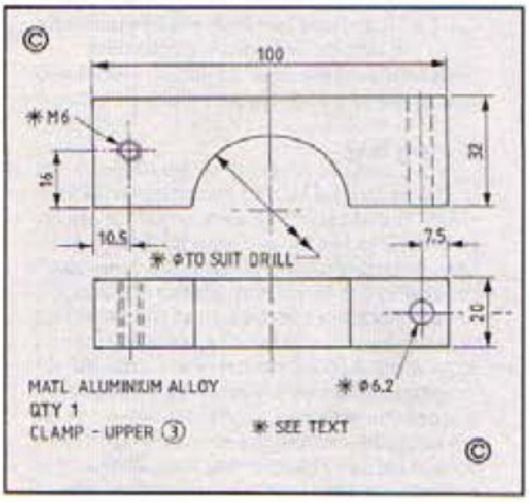
55
HOLE ø5.2
C/BORE ø8.7×5DP
MATL PLASTIC
QTY 1
HANDLE ⑧
©



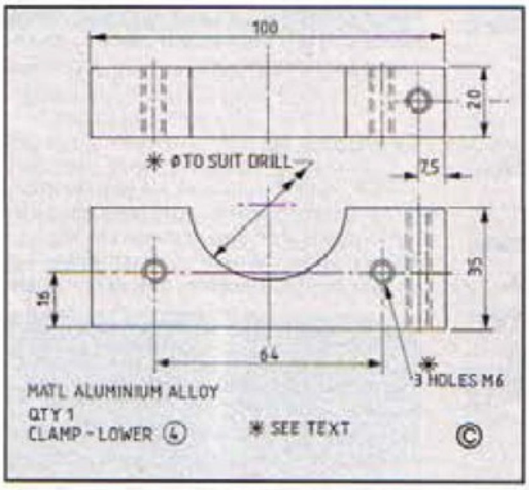
©
THIRD ANGLE PROJECTION



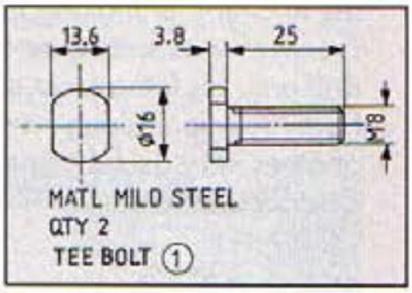
ø15.87 (5/8)
M5
ø40
TO MATCH HOLE IN GEAR
10
MATL MILD STEEL
QTY 2
COLLAR ⑨
©



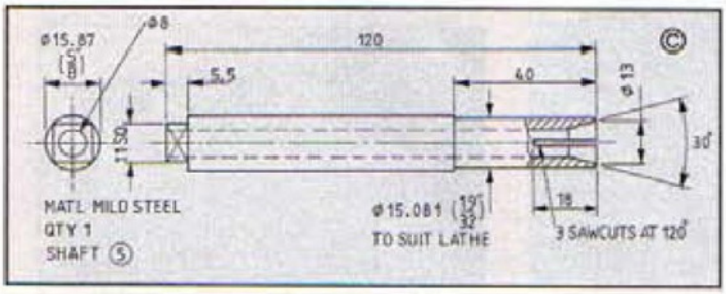
©
100
✻ M6
32
16
10.5
✻ øTO SUIT DRILL
7.5
20
MATL ALUMINIUM ALLOY
QTY 1
CLAMP - UPPER ③
✻ ø6.2
✻ SEE TEXT
©



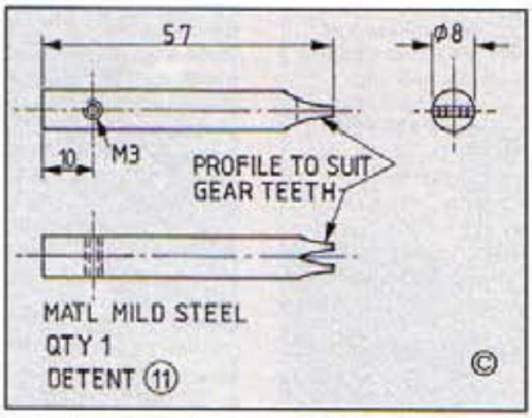
100
20
✻ øTO SUIT DRILL
7.5
35
16
64
✻ 3 HOLES M6
MATL ALUMINIUM ALLOY
QTY 1
CLAMP - LOWER ④
✻ SEE TEXT
©



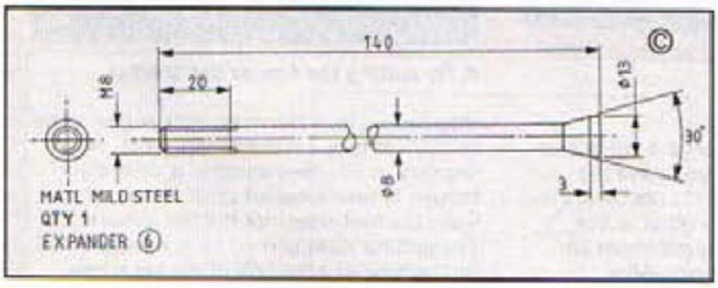
13.6
3.8
25
ø16
M8
MATL MILD STEEL
QTY 2
TEE BOLT ①



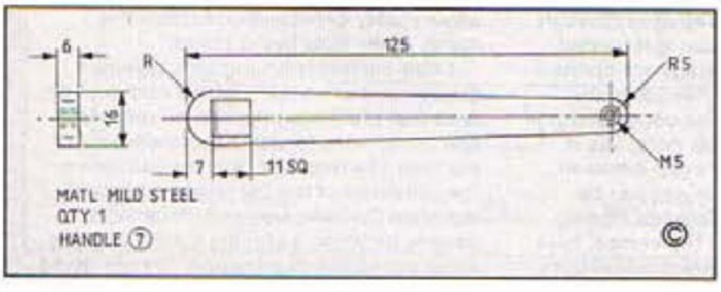
ø15.87 (5/8)
ø8
120
5.5
40
ø13
30°
11SQ
18
MATL MILD STEEL
QTY 1
SHAFT ⑤
ø15.081 (19/32)
TO SUIT LATHE
3 SAWCUTS AT 120°
©



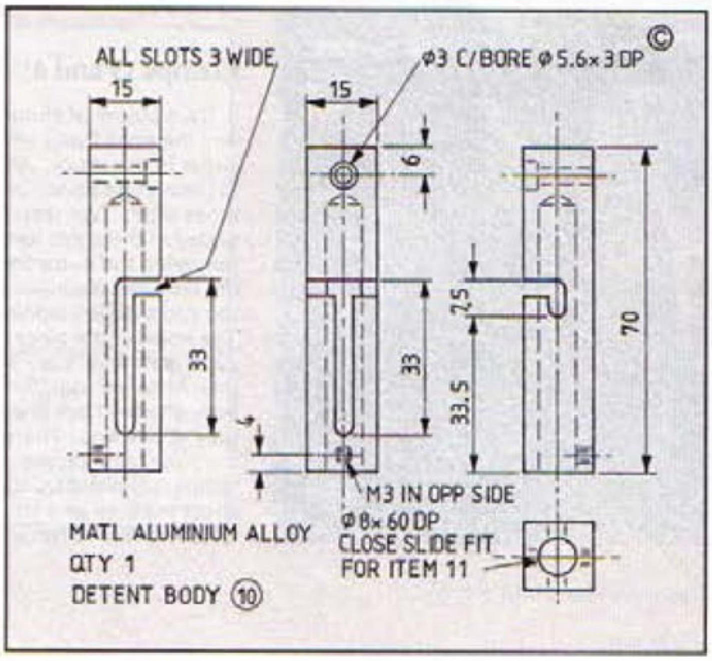
57
ø8
M3
10
PROFILE TO SUIT
GEAR TEETH
MATL MILD STEEL
QTY 1
DETENT ⑪
©



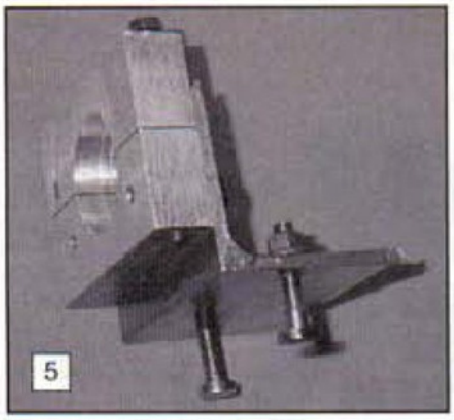
140
©
M8
20
ø13
30°
ø8
3
MATL MILD STEEL
QTY 1
EXPANDER ⑥



6
125
R
R5
16
7
11SQ
M5
MATL MILD STEEL
QTY 1
HANDLE ⑦
©



©
ALL SLOTS 3 WIDE
ø3 C/BORE ø5.6×3 DP
15
15
6
33
33
25
70
33.5
4
M3 IN OPP SIDE
ø8×60 DP
CLOSE SLIDE FIT
FOR ITEM 11
MATL ALUMINIUM ALLOY
QTY 1
DETENT BODY ⑩



5: The bracket, complete with Tee bolts.

some of the feeler shims the tool can then be lowered by that amount. Alternatively, another toolmaking job, make an instrument like a straight micrometer with a flat base to stand on the lathe bed. (*Or the device in issue 23, page 13 — Ed.*) When the hole size is getting close, use the pistol drill itself as a plug gauge and bore until you have a good fit. (**Photo 3** shows the clamps being bored.) The front face of the clamp pieces can now be flycut (photo **4**). This will not only clean up the face but will make it true. Remove all burrs and sharp corners with a scraper or the corner of a piece of tool steel. After removing the 16 swg packing and re-assembling, this part of the job is finished. This can be seen in **photo 5**.

6: The completed handle, seen here with the gear used for dividing attached.

Indexing

As already mentioned, to make holes equidistant round a centre, will need some form of indexing. The simplest way is to use screwcutting gear wheels. A 120 tooth wheel would be ideal, unfortunately, most sets of change wheels do not contain such a large wheel. The next best is the 60 tooth one. This can make divisions of 2, 3, 4, 5, 6, 10, 12, 20, 30 and 60. By giving the detent a concave, as well as a convex, end, all these numbers can be doubled. This gives additionally 8, 24, 40, 120. In other words the detent gives positions at the top of the tooth as well as in the trough by merely rotating it through 90 degrees. Other wheels will give different divisions. On one side of my sixty tooth wheel I have marked every 15th trough. This shows immediately where to put the detent when dividing by four. On the other side it is marked every tenth tooth to give six divisions.

The Mandrel Handle (5, 6, 7 and 8)

The next part is a handle that locks into the hole in the lathe spindle. This in itself is a useful tool to have, it can be used when thread cutting, instead of motor power, so that you do not overrun. I an sure you will find other uses. Just one word of warning. DO not forget to take the

7: The detent engaged in the trough between two gear teeth.

handle out when reverting back to turning the lathe by power; it could give you a nasty rap or do some other damage. Dimensions given are for a Myford lathe.

If you don't have any gears it would be worth purchasing one. A length of $\frac{5}{8}$in. dia. rod is turned down to $\frac{19}{32}$in. This leaves a shoulder so that the shaft can always be pushed in to the same place. To make the 8mm hole through the centre you will need a long series drill. The internal angle is not critical and can be turned using a small boring tool with the top slide offset to the required angle. Leave the top slide offset until the expander has been made. Neat hacksaw cuts are adequate to complete the expanding lock. Three saw cuts at 120 degrees with the hacksaw kept quite flat are better than just two. The knob is turned free hand from a length of plastic rod. A 11mm square hole is filed on the other end of the 5/8in. dia. rod, a suitable square is filed in the end of a 16 x 6mm bar. This is tapered down to 10mm at its other end and has an M5 hole tapped into it to take the cap screw that secures the knob.

Collar (9)

My gears have a hole in their face which can be used to lock them to the collar. The also have a key slot, which would have been used to secure the gear to its stub shaft. Collars with socket set screws are needed to locate the gear beneath the detent. The assembled handle, complete with change wheel fitted, can be seen in **photo 6**.

The Detent (10 and 11)

The detent is like a sprung loaded bolt with one position to hold it open and two slots at right angles to each other to allow it to spring out. It is essential that the bolt be a good fit in the body to keep backlash to a minimum. I have seen these detents fitted in several places; mine is fixed to the

8: The detent engaged across the tooth. This doubles the number of indexing points.

belt cover. Providing the screws that hold the cover to the lathe are kept tight this is a suitable place. **Photo 7** shows the complete assembly with the detent locating between the teeth, and in photo 8 the detent is across the top of a single tooth.

As a result of this little exercise, you are now the proud owner of two boring bars, a mandrel handle, a dividing device and a toolpost drilling or grinding bracket. It shouldn't take much more than a couple of evenings in the workshop to make the lot.

Using the device

To use the bracket it should always be set square as previously described using the chuck jaws. The job to be drilled is

9: Drilling four holes in exact positions on a pitch circle diameter, using the bracket and electric pistol drill. The string around the chuck supports a heavy weight, thus effectively removing any backlash from the set-up.

place in the lathe chuck. The drill chuck is automatically at centre height. The lateral centre can be found using optical centre finder described in the first issue of this magazine. After zeroing the dial the drilling radius can now be wound on the cross slide and holes drilled, the number being selected by the dividing device. I have drilled and tapped my cross slide between each gib adjusting screw and fitted cap screws so that I can lock the lateral movement of the slide. This keeps it firmly in the desired position — don't forget to slacken the locking screws after using the tool.

Other uses

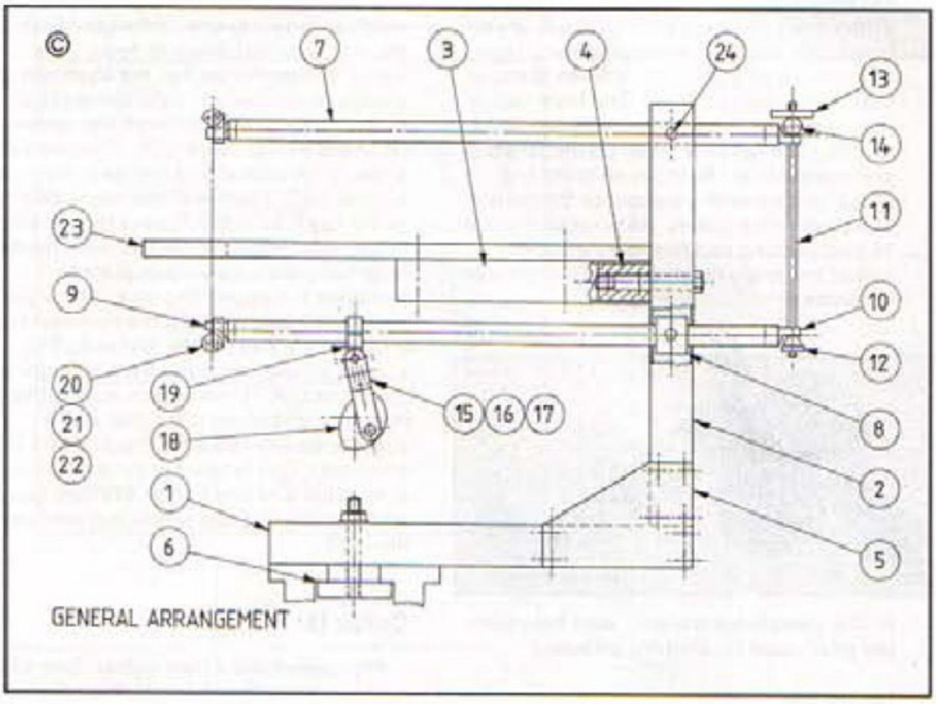
I have used the indexing device for making micrometer dial scales in conjunction with a tool in the toolpost used as a broach. An example of this was describe in my article on the Tool and cutter grinder in issue No. 16. **Photograph 9** reminds you how to use a cord and weight to take up any backlash. In the same way it can be used instead of a knurling tool, by making a cut for every tooth on the wheel. I have also used it to make gripping grooves in prop drivers on model aircraft engines, working the broaching tool radially towards the centre.

Protective finish

To paraphrase the song 'What a difference a paint makes' just one coat of Hammerite to parts that don't have anything fixed to them make the work look much more professional, and of course keep them from rusting.

A FRETSAW ATTACHMENT FOR THE LATHE

Mounting an item on the lathe bed and using the lathe to power it, is both space and money saving, as no bench room is taken up and there is no motor to purchase. Terry Gould uses this approach to make a fretsaw attachment.



The idea for this attachment came from the need to fret the brass dial of a Jubilee Clock. Having made a start with hand fretting, it became obvious this was going to be painfully slow, and prone to frequent blade breakage. Some years ago I had built a fretsaw powered by a small motor, after the fashion of commercial units of the time. It was never entirely satisfactory, and was too fast for metal cutting, hence it spent most of its life under the bench. Eventually the motor was used for another project. Moreover, the thing had to be fixed to a bench in use, took up valuable space (my workshop is 7 x 5ft.) and in short, was a complete "scunner" (Scots word for disgust).

Now of necessity, could I resurrect the machine? Improve it? Even simplify it? The first thing that struck me was that I already had a variable speed drive, the lathe. Secondly, no bench was required if mounted on the lathe bed. Thirdly, for storage, swivel the table to the vertical and hang it on a wall. Photo 1 shows the method adopted. As a bonus, I found the saw could be made to use Junior hacksaw, Padsaw, and Abrafile blades, as well as fretsaw blades. Ideal for long cuts in sheet metal, compared to using a hacksaw.

Construction

Assembly is by fabrication as no welding facility was available; very little machining is necessary, just some turning. No great accuracy is required, though well fitting pivots make for a smoother and quieter action.

The frame

This is of square section mild steel tube, mine from an old metal framed desk. Not much is required, two pieces 10in. long, and one 6in. long. Any section around 1in. square will do. Get the ends nicely square and deburr. Dimensions are given for the ML7 and may need changing for other lathes, as will the method of fixing it to the lathe bed.

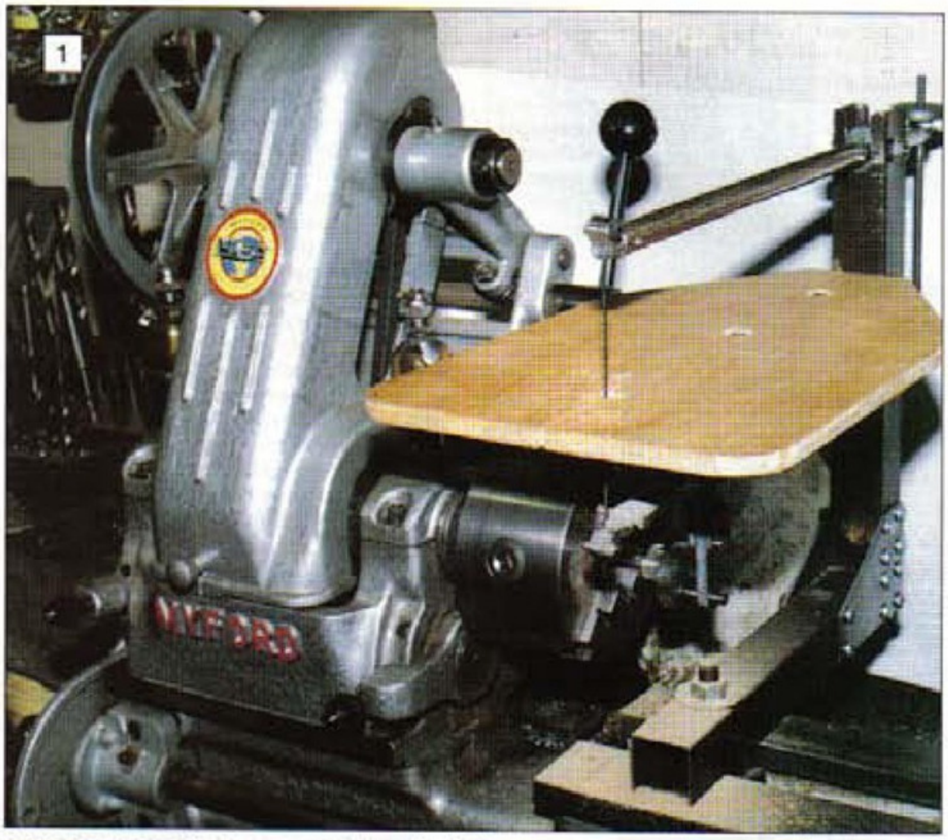
The two side plates (5), are 1/8in. mild steel, and are drilled together. Then use these as jigs to drill the frame base (1) and frame upright (2) for the fixing holes. The parts are held together with eight 2BA nuts and bolts, getting base and upright nicely square. Next decide where the bottom saw-arm hole is to go, as this dimension will have to suit your lathe. The 4 1/2in. dimension suits a lathe of 3 1/2in. centre height, if yours is different, make the adjustment here, up or down. Take note if making changes that you will find the saw tends to lift the material on the up stroke, and needs to be held down firmly while cutting. This will be minimal if the bottom saw arm is horizontal, or raised at the front end, when at lowest point of it's stroke, as this ensures the blade will not move slightly forward on the upstroke.

Mark and drill through to clear the saw-arm diameter, and enlarge the front hole to permit entry of the pivot collar (8). The rear hole only needs to clear any up and down movement, so elongate to allow this. The top saw-arm hole is simply drilled clearance size for the arm and sawn down from the top to form "U" slots. **Photo 2** shows the arm pivots in close-up.

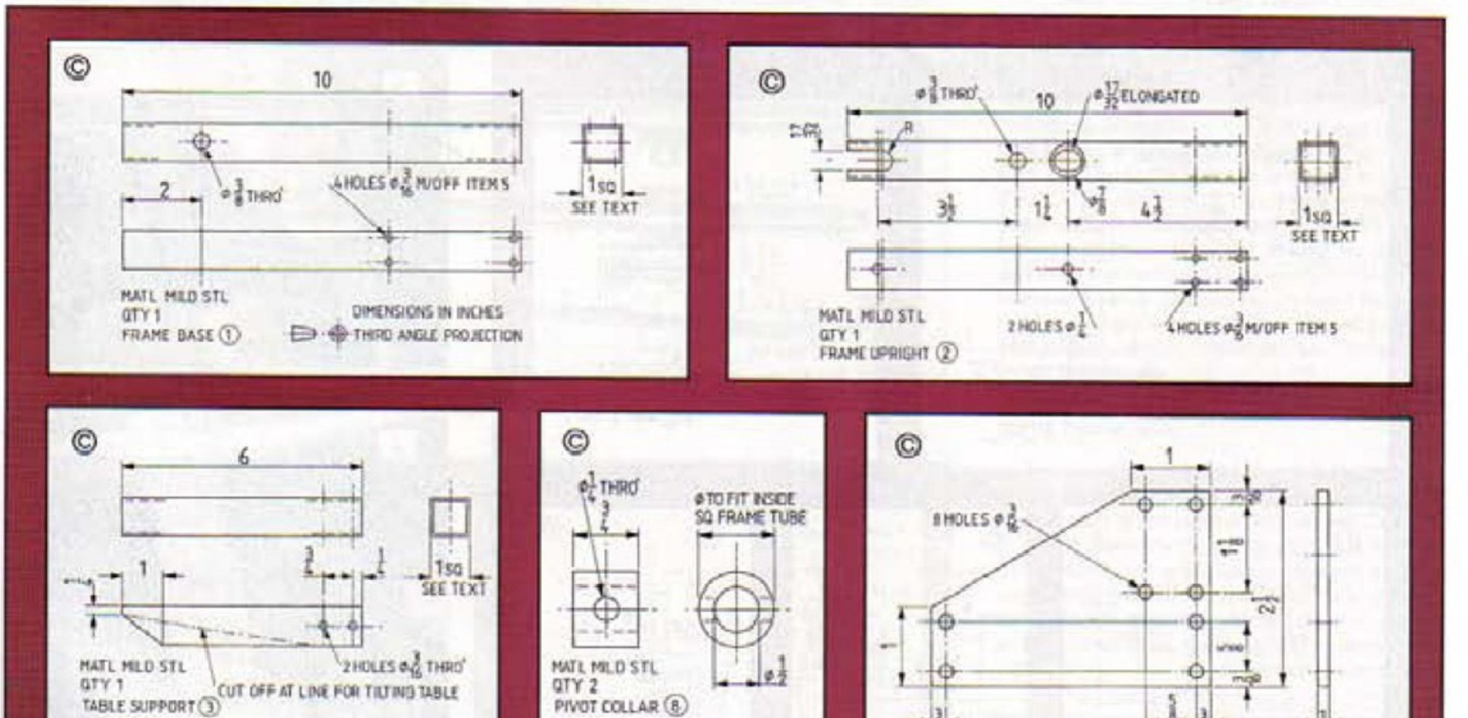
The table support (3) is a 6in. length of the square tube, and the clamp plug (4) made to fit snugly inside this. Cut a 1 1/2in. length of mild steel whose diameter is just less than the diagonal inside the tube. Face the ends in the lathe and drill through 3/8in. BSW tapping size. Counterbore 3/8in. dia., and tap 3/8in.BSW. Machine to square section to fit tightly in the tube. This is best done in the 4jaw, taking measurements with the micrometer so the same amount is taken off each side and the axial hole remain central,. **Photo 3** shows this operation. Insert clamp plug in the tube with one end flush and the threaded part to the inside. Drill and tap four 2BA holes into the plug, and fit four short screws to hold this in place. A 3/8in. hole in the upright, positions the table support arm. Do fit a large enough washer, under the screw head, to spread the compressive force over the width of the upright. This completes the frame, except for the lathe bed clamp (6), which holds the frame to the lathe. This is simply a flat bar to span the gap under the shears and with a length of studding for fixing. For dovetail type shears, a suggested fixing is also shown.

Saw arm assembly

I used 1/2in. dia. tube from the stem of an old standard lamp for the saw arms (7), as it was strong enough and light too. The first model used light alloy, but it tended to bend under tension. It was also prone to crack across the pivot holes, and as a result, required steel inserts, rather defeating the objective of lightness. The lighter the arms are, the less vibration when the saw is running. (Something to do with inertia, they tell me.) Cut two pieces 13in. long, and turn the ends square. Now turn the pivot collars (8), to a diameter to fit easily inside the square tube, and drill and bore to fit firmly on the saw arms. When in position, drill and ream ¼in. dia. for the pivot holes. These hinge on the pivot pins (24). In alignment with this hole, drill two cross holes 4BA tapping size and 5⁄16in. in from each end for fixing the saw and tensioner rests. The saw (9) and tensioner (10) rests. can now be made and fitted, two of each being turned to a tight fit in the arm ends. If the tube has a welded seam, it will be necessary to bore, or file, this away to allow the inserts to enter. Using the 4BA holes as a guide, drill right through the inserts, remove from the arms, one at a time to make sure they go back in the same end. Open up the cross holes No. 27, also one hole in the saw arm, and tap the other 4BA. Deburr inside the tube and refit the plug, fixing with a 4BA Csk screw. The head can be partly countersunk into the tube wall and filed flush to make a neat job, the other end being filed down and lightly peined. Do the other three inserts in the same fashion, then shape the ends as shown in the drawing. Make sure the slots



1: The completed fretsaw mounted on the lathe.



2: Showing how the arms fit on the frame. The pivot collars can be clearly seen.

in the tensioner inserts allow plenty of clearance for the 3/16in. tension rod, or you will have frequent breakages of the rod ends.

The slot for the blade should be just wide enough to accept the thickest blade to be used, likely to be the Junior hacksaw; Abrafile blades are obtainable from Tilgear , 0707 873434; these can be fitted by enlarging or drilling (carefully) the middle of the slot where the cross groove is filed, allowing the Abrafile to pass through.

The tension rod (11) is simply a 6in. length of 3/16in. rod threaded 2BA at each end. The adjusting nut (13), is large enough to be turned easily, and is knurled to give a good grip. The roller (14), is to allow the bearing to rock on the tensioner rest. The bottom end could be done the same way, but I used a dome nut (12) threaded right through, the dome bearing on the rest.

Crank assembly

The crank (18) is built up from a mild steel disc with a 1/2in. press fit shaft. The crankpin I made from 5/16in. rod, threaded and screwed tightly into the disc. Then, holding the shaft in the 4 jaw, got the crankpin running true and turned it to 1/4in. diameter, this ensured the crankpin is parallel to the shaft. This is important to prevent binding when running. As only two chuck jaws will directly hold the shaft, if possible, use two small pieces of steel, say 1/8in. thick, each spanning one jaw and the shaft, to enable the other two jaws to

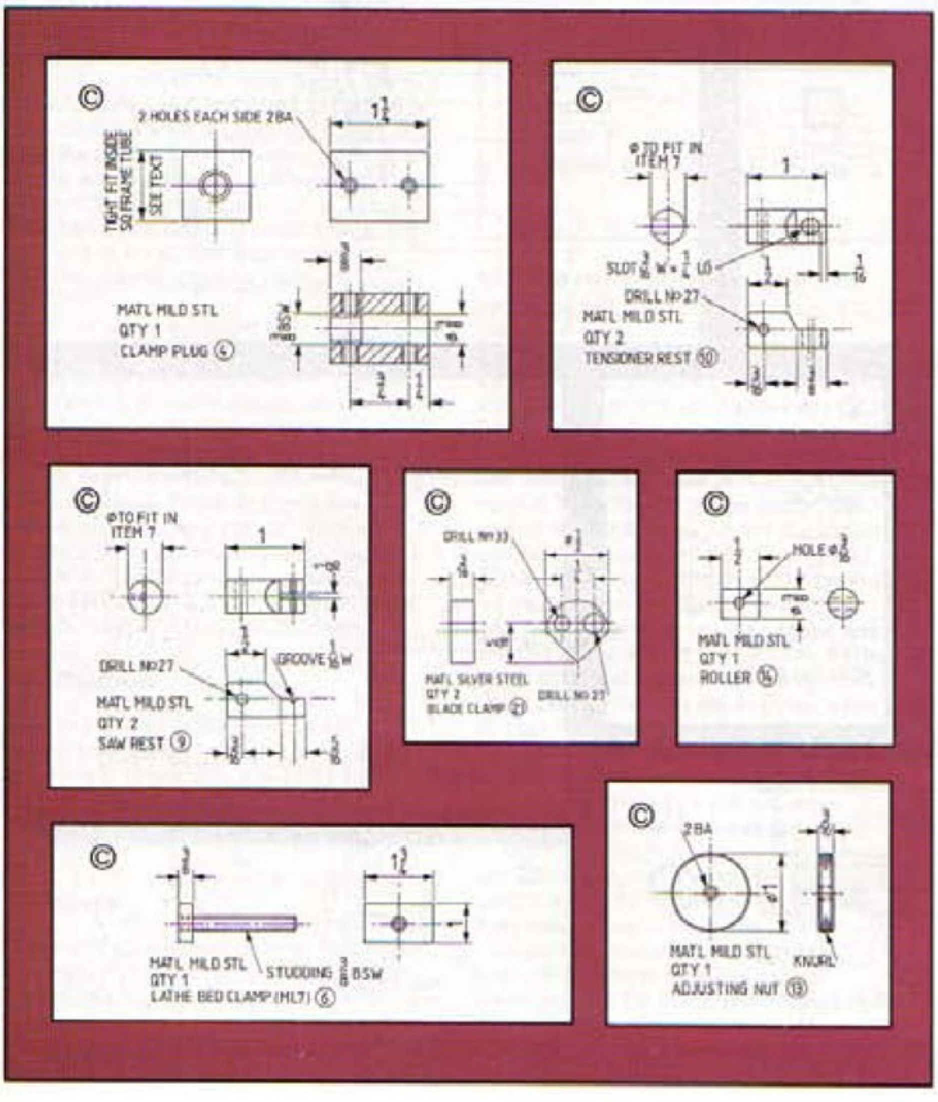
Quick tip

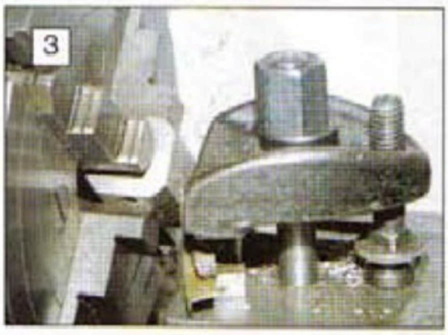
Wood plane on metal edges

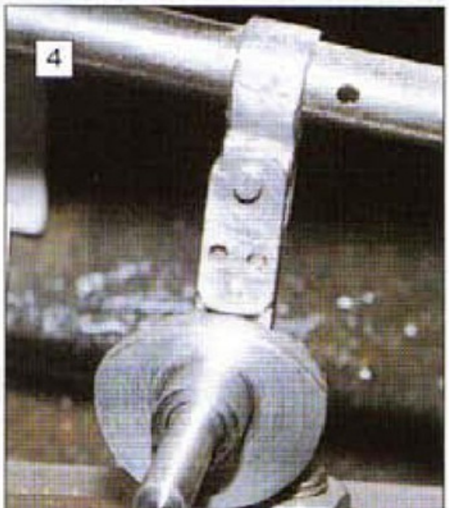
Making gib strips or finishing other edges of brass, copper or aluminium sheet can be done with a wood plane, one with a metal sole. It would be best to make a less acute cutting angle on the blade than that used for wood. This idea was picked up from a shop/bar fitter.

Hugh Beattie

have an effect also. Note the 63/64in. radius on the crank disc is to clear one of the side plates (15 or 16) and this can also be made whilst the crank is still in the four jaw. With the method of holding not being ideal, gentle cuts are required. **Photo 4** shows the need for the 63/64in. radius. Also, while still in the chuck, drill and tap the crankpin end for a 4BA cheesehead screw and washer to keep the crank and connecting rod together. The connecting rod (15,16 and 17) is a bit of an odd job. I had considered making it from solid, even just a single bar, but I wanted to be sure it did not wobble and cause the blade to move from side to side. As shown, it is built up of three parts, the only important thing is to ream the pivot holes parallel to each other, again to prevent binding, and do not have them too tight. If the frame is set up a bit off square, the crankpin may seize, as mine

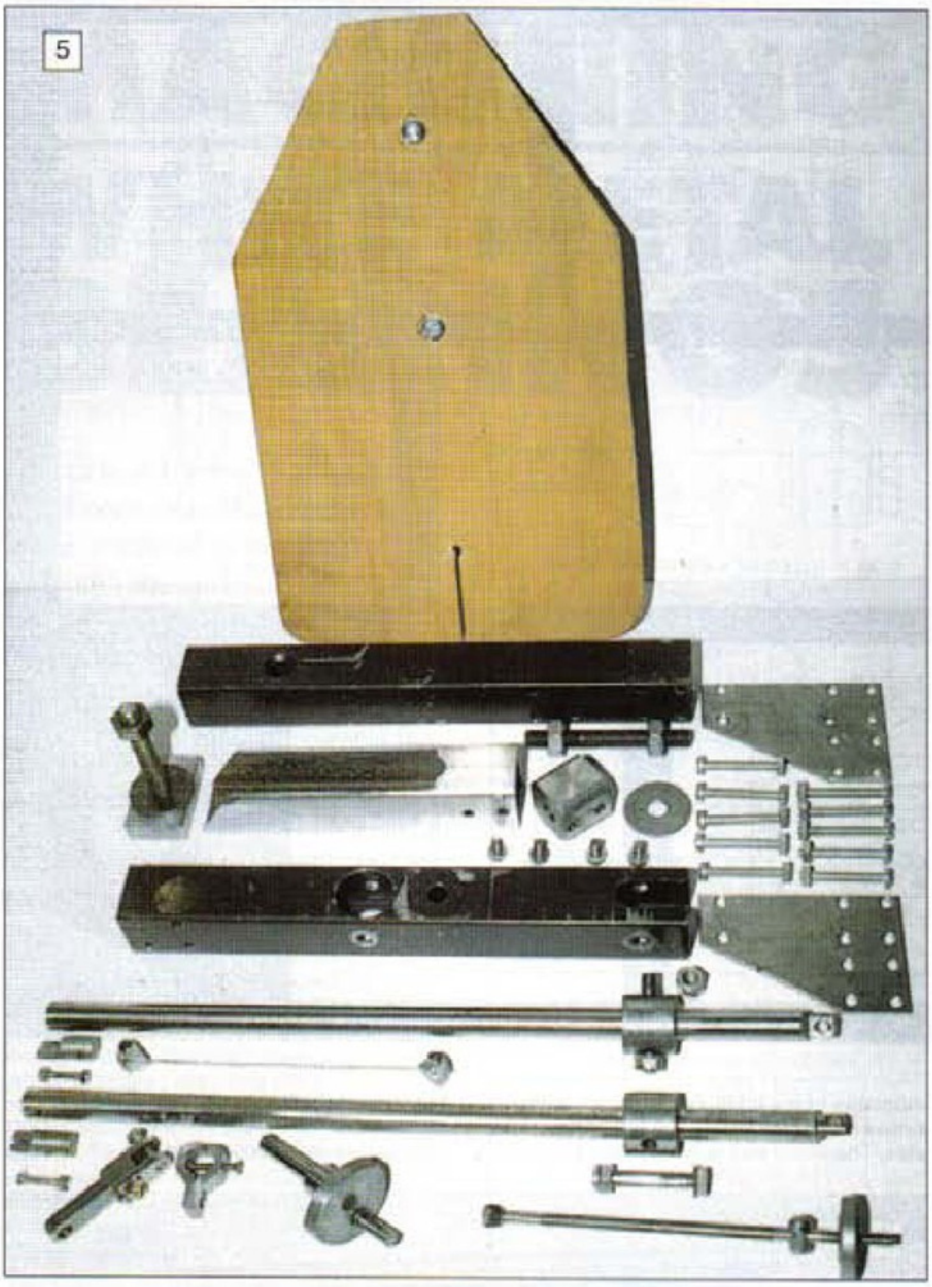




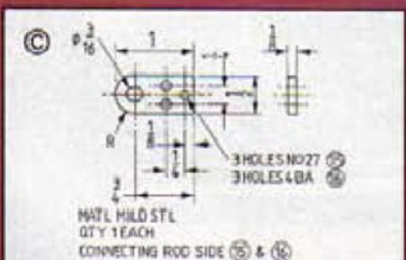


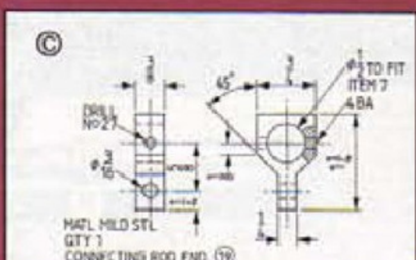
3: Machining the squared insert for the table support arm.

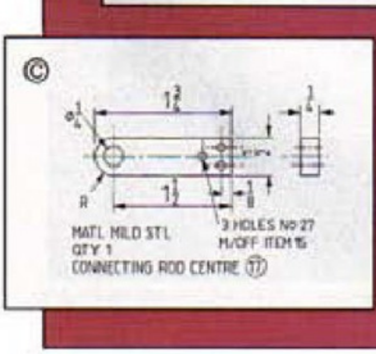
4: Showing why the cutaway is required on the crank disc. The extra hole in the arm is a mistake.

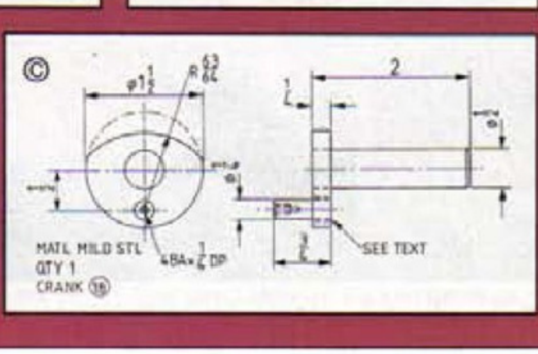


5: Almost a complete set of parts waiting assembly.









did, and a spot of oil now and then helps.

A sketch of an alternative con rod and end is given, one advantage of this is that the 33/64in. radius on the crank is not required. The connecting rod end (19) completes the drive to the saw arm. This clamps on the bottom saw arm. Cut a piece of 3/8in. x 3/4in. bar and set this up in the 4 jaw chuck to drill and bore the hole to fit over the saw arm. Use a piece of packing under one jaw and the end of the bar, and this will let you bore the hole right at the end cutting down the bulk as much as possible. With hacksaw and file shape the piece as shown in the drawing. Fit over the saw arm, and position it by setting up the frame in the lathe, the correct position is directly under the centre line of the lathe. Drill through, and secure to the arm with a 4BA screw, or rivet if you prefer.

Blade clamps assembly

Two clamps (20 and 21) are required, made from 1/2in. dia. silver steel. They are in two pieces, but are first cut the thickness of both halves and drilled with two holes being 4BA. and 6BA. tapping size. They are then sliced in half. One half has the holes opened up to clearance sizes, the other half, the holes are tapped. File the sawn faces flat and clamp together using the tapped holes and suitable screws. Place in the vice and file to the "V" shape. This is the rocking edge to allow for movement of the blade clamp in the groove.

Finally the clamp retainer (22) is cut from a 1/4in. wide strip of 1/16in. mild steel and wrapped round the saw arm in a "U" shape. Clamp a blade in place in the holders and lightly tension, and holding the "U" strap in position, mark the line of the 6BA screw which passes through the clamps. These "U" straps are held in place with longer 6BA bolts, reference to the drawing will make this clear. The 6BA screw is to the rear of the blade, the strap will stop the holder flying into orbit if a blade breaks. It also serves to keep the holder upright when slender blades are being used, as they tend to tilt forward when tightened.

Saw table (23)

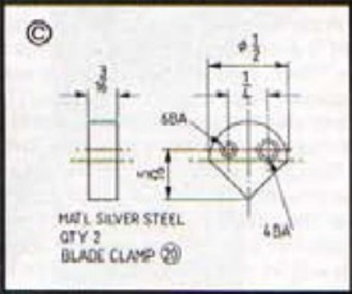
This a piece of 3/8in. plywood, the shape is not important and can be changed from that shown if considered beneficial. Cut the saw slot centrally before the holes are drilled to fix the table to the support arm. I used large headed screws and nuts, (the kind used to assemble lightweight slotted angle frames) the heads being recessed into the table top. It helps to chamfer the

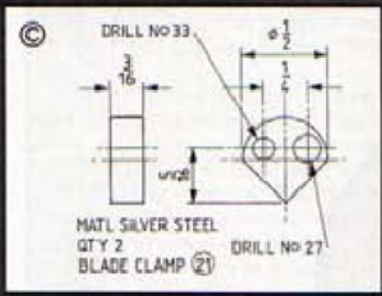
Quick tip

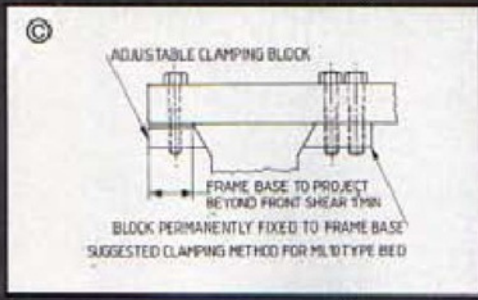
GT85, (WD40 alternative)

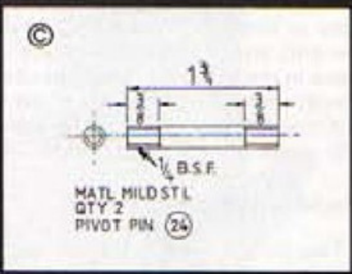
Users of WD40 should get to know about GT85 available at cycle shops. Modern bikes have their chains riveted and are cleaned and lubricated and protected by this product along with sprockets and gear changers. Although dearer the product is superior and is ideal for cleaning and protecting small mechanisms and machines.

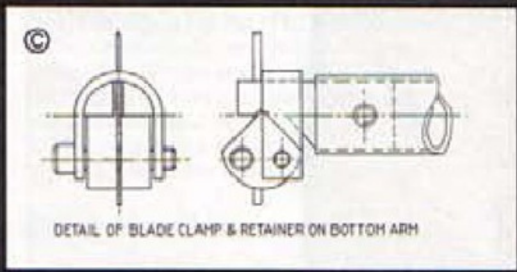
Hugh Beattie

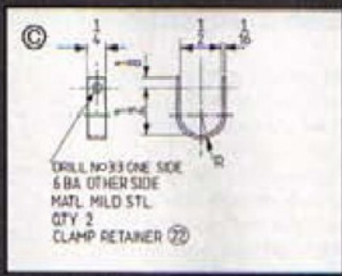


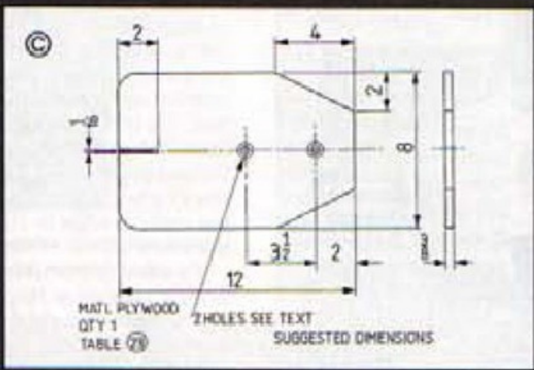


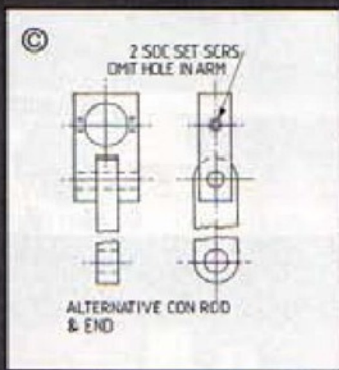












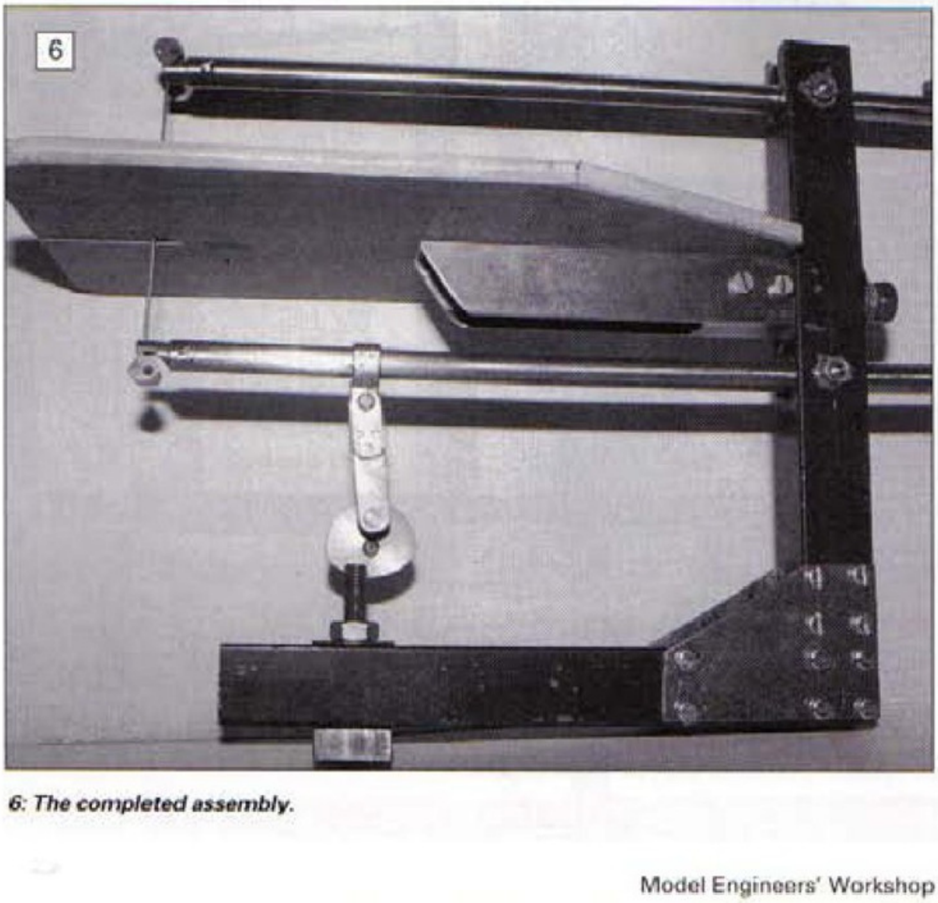
edges of the table, as this prevents material from catching when pushing forward to the saw. If you want to have a really smooth top, glue a piece of Formica type sheet on the surface.

And that is it, with **photo 5** showing the completed parts waiting assembly, and **photo 6** showing the finished saw. Try it first with a Junior hacksaw blade. No clamps are needed for these, simply sit the pins in the cross grooves and tension, Set the lathe at slow direct speed and start up. Check if there is sideways movement when the blade is moving, and if so, it can usually be cured by altering the position of the frame across the lathe. The saw arm frame pivots are best nutted up tight enough that the saw arms are fairly stiff, the sides of the frame tube will squeeze in to effect this. Give all pivot points a drop of oil before starting up to take care of lubrication.

Experiment with speeds and tension, though I found slow direct speed best for metal, higher speeds for wood. Also, when cutting, a touch with a candle against the moving blade makes quite a difference in preventing snatching.

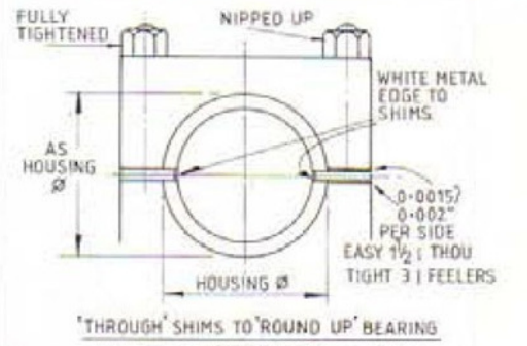
An improvement

After a period of use, it was thought that a stiffening strut would be an improvement, and was made as follows. A piece of the same square tube was cut to fit between the bottom frame and the underside of the table. The top end of the tube is cut out to form a square U shape and the side pieces bent out at right angles to support the underside of the table, held in place with screws countersunk into the top of the table. The lower end is fixed to the side of the base at the front end. This makes a much more rigid work surface and makes it easier to control the cut.



6: The completed assembly.

MACHINING WHITE METAL BEARINGS



SKETCH No.3

This article by Ted Hartwell will be of considerable interest to those involved in engine reconditioning

This article complements that in issue 13 of *M.E.W.* by Fettler who described in detail the relining of white metalled bearings, thereby enabling the home workshop enthusiast to successfully undertake the process.

The following is, therefore, a guide to the subsequent 'fitting up', boring and final assembly of such bearings, particularly for those rebuilding veteran, vintage or classic cars, and who would like to recondition the engine themselves. Crankshaft grinding (and cylinder boring) services are available in most large towns but, as noted by 'Fettler', white metalling specialists are comparatively few in number, providing an incentive to do this work oneself and, being labour intensive, avoiding the substantial cost involved.

The advice given regarding dimensional aspects, i.e. 'nips', clearances etc. is that which the writer has found satisfactory over some fifty years of practical experience, but may differ with manufacturer's and/or club data. Should the variation be substantial it should be queried.

Essential workshop facilities

A lathe with a minimum of 3in. centre height together with a ½in. bench drill and a robust vice will provide the basic equipment, together with a simple connecting rod boring fixture. Line boring of main bearings can present a problem (lathe boring of individual bearings with subsequent hand fitting is possible but not recommended). However, line boring equipment can be improvised which, with care, will give professional results. This equipment will be described later.

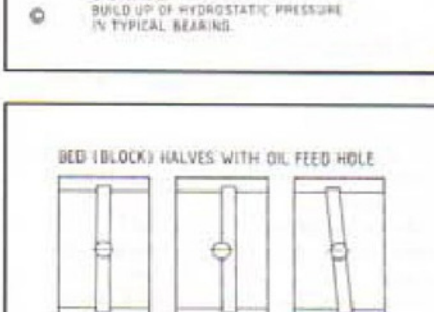
Types of white metal bearings

The following covers the range which the enthusiast is most likely to encounter.

a) Heavy Shell Half Bearings. White metalled bronze or steel shells, with or without flanges, used for main, some camshaft and big end bearings prior to the introduction of 'thin wall' bearings in the mid 1930s.

b) Heavy Shell Bush Bearings. Similar to (a) but unsplit, used for main bearings, particularly in the smaller 'two bearing' engines and as camshaft bearings. Occasionally found in single cylinder industrial engines with overhung crankshafts as big end bearings.

SKETCH No.1
BUILD UP OF HYDROSTATIC PRESSURE IN TYPICAL BEARING



TYPICAL MAIN BEARING OIL GROOVE PATTERNS CRANKSHAFT OIL HOLE IN MID POINT OF JOURNAL IN ALL CASES.

Sketch 2

c) Solid White Metal Versions of (a) and (b) above. Relatively rare - mainly used in small industrial and marine engines.

d) Direct Metalled Main Bearings. White metal cast directly into the crankcase bearing housings - both case and caps. Predominantly found in Ford car engines and Fordson commercial vehicle engines and tractors (pre-World War 2).

e) Direct Metalled Big End Bearings. White metal cast directly into the connecting rod and cap - generally steel, although the Standard Motor Company used aluminium alloy rods for a period.

f) 'Thin Wall' Bearings. Thin shells with an even thinner coating of white metal, of precise wall thickness, fitted to precision machined housings and normally requiring no finish machining. Used for main and big end bearings. Cannot be successfully re-metalled but other recovery methods can be used if replacements are not available, some of these being outlined later.

g) 'Thin Wall' Bush (Wrapped) Bearings. As above but of bush form. Generally used for camshaft bearings and in single cylinder industrial engines. Comments as in (f).

h) Floating Split White Metal Bearings. Precision steel shells lined both in the bore and on the outside diameter with a thin layer of white metal. As far as the writer is aware, used only on pre WW2 Ford and Fordson V8 engines. Cannot be successfully white metalled.

i) Non White Metal Bearings. These include both heavy and 'thin wall' shells lined with leaded bronze, reticular tin and various similar bearing materials, some of which have an additional overlay. Solid reticular tin bearings have been used in a few engines, notably shortly after WW2. These types are not covered in this article.

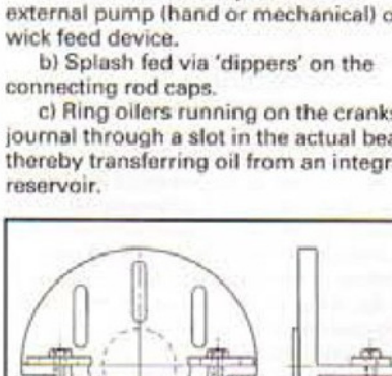
Lubrication systems

The satisfactory operation of all white metalled bearings is dependent on adequate oil being supplied to the actual bearing surfaces. The principal systems used in the older vehicle, light industrial and small marine engines are:

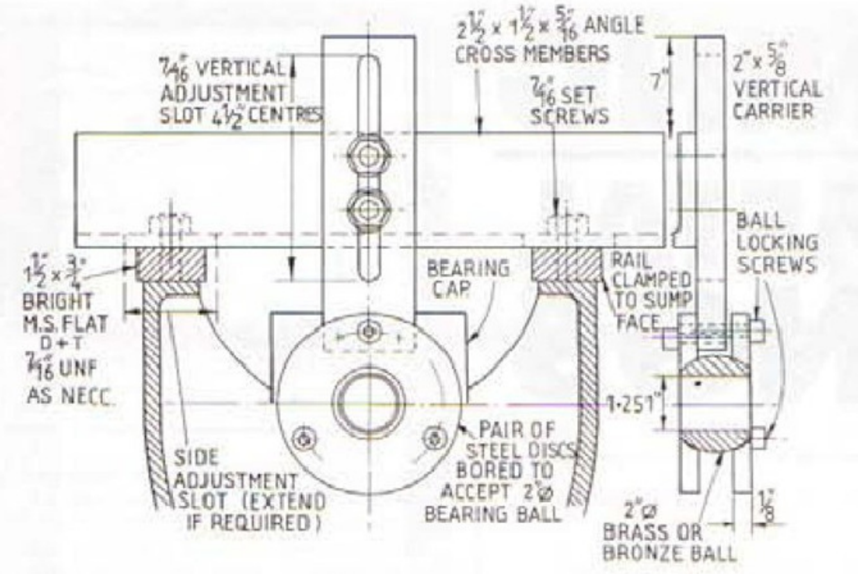
a) 'Total loss' or drip feed via an external pump (hand or mechanical) or a wick feed device.

b) Splash fed via 'dippers' on the connecting rod caps.

c) Ring oilers running on the crankshaft journal through a slot in the actual bearing, thereby transferring oil from an integral reservoir.



SKETCH No.4



SKETCH No. 5 SECTION OF BORING BAR STEADY ARRANGEMENT (FOR CONSTRUCTION DETAILS SEE TEXT.)

©

d) Pressure fed via an internal oil pump.

e) Petroil, i.e. oil added to the petrol. This system is confined to two stroke engines, mostly fitted with ball or roller bearings.

The splash fed and pressure fed systems are those most likely to be encountered, and are described below:-

The splash fed system employs an extension on the connecting rod cap(s) to 'lift' oil from the sump thereby lubricating the actual big end and main bearings via strategically placed pockets and oil holes. Relatively trouble free, subject to the sump oil level being maintained, and which allows dirt and sludge to partially settle out of harms way at the bottom of the sump.

The pressure fed method is that currently used in to-day's engine (but without the 'full flow' filter). Oil drawn from the sump via a simple mesh strainer is pumped by a gear or vane pump into the main gallery normally running the length of the engine, the pressure being limited by a spring loaded valve and with excess oil being returned directly to the sump. The gallery, in turn, supplies oil to the main bearings (together with other feeds via secondary drillings to the camshaft bearings and possibly the timing chain or gears). The main bearings will have one of a variety of grooving systems enabling oil to be provided to the big end bearings via oil hole passages drilled in the crankshaft. Small end lubrication may be augmented by a feed in or on the connecting rod. Proven over many years, but early engines tend to suffer from premature oil pump wear.

Whichever system is employed, the essential supporting oil film is created by hydrostatic pressure due to the rotation of the crankshaft journal as shown in **Sk1**, the pressure being proportional to the unbroken (by oil grooves) surface of the supporting bearing. It is essential, therefore, to faithfully copy the oil groove pattern established by the engine builder and not to introduce modifications without expert advice.

Most heavy shell bearings have mudlets provided at the joint faces to spread the oil across the width of the bearing, to provide a trap for foreign matter and debris and, more importantly in the writer's opinion, to protect the bearing from any tendency to 'close in' at the joint faces with the consequential loss of clearance. Again, these mudlets should be faithfully reproduced in the re-metalled bearings.

Action prior to re-metalling

While adequately covered by Fettler, the following minor aspects may be of additional benefit:-

a) Bearing shells and caps should be numbered to ensure replacement in their original locations.

b) Shims should be retained as patterns, or thick shims for re-metalling on the edges.

c) On the assumption that the bearings will, in all probability, have been previously re-metalled, a witness of the original manufacturer's groove pattern may be visible when the old metal has been removed.

Typical types of main bearing oil grooving are shown in **Sk2**. As a general guide the crankshaft oil hole (where applicable) should align with a full diameter oil groove through 180deg or half the diameter of the drilled hole through 360deg.

Direct metalled connecting rods should, after the removal of the old metal, be checked for ovality (over 0.020in. requiring correction by shims) and for bend and twist as described later, to avoid problems during finish boring.

Bearing preparation, rough boring and oil grooving

On the assumption that the engine being rebuilt has half shells fitted to the mains and possibly the big ends, the suggested procedure is as follows:-

Having cleaned off the protective 'wash' from the backs of the shells, remove the surplus white metal from the joint faces leaving on approximately 1/32in. The *'Millenicut* rasp was the standard hand tool for this, but a flat wood rasp, or coarse file, may be found suitable. Measure the original housing diameter across the joint line, which will invariably be a standard Imperial or metric dimension, then proceed to 'spread' the shells by supporting the backs on a block of hardwood and lightly peen the white metalled surface with a half pound ball pein hammer. The indentations should be evenly spaced which will counteract the contraction of the white metal lining occurring during cooling, allowing the shell to regain its original diameter. Proceed until this dimension is a few thou larger than the size established for the housing.

Carefully file the remaining metal from the joint faces, barely down to the actual shell, and finish by firmly rubbing these faces on a sheet of coarse emery cloth placed on a flat surface, such as a piece of plate glass (or an old mirror). Drill through any holes, taking care not to enlarge these beyond their original diameter.

Note. Some of these holes may be 'blind' or elongated.

Prior to rough boring in the lathe, measure the shell diameter at 90deg. to the joint line. Should the ovality exceed 0.020in., two pieces of metal shim will need to be trapped between the joint faces to 'round up' the bearing before pairing the shells with a Jubilee clip. The bearings can now be rough bored in the four jaw chuck, leaving about 1/16in. in the diameter for subsequent finish boring. The main journal thrust (flanged) bearing and any connecting rod shells should also be faced evenly to width, again with 1/16in. allowance (1/32in. per face).

Oil grooving can subsequently be carried out in the lathe as follows:

a) With offset annular grooves, by staggering the shells in the four jaw chuck - again with the help of a Jubilee clip.

b) With grooves in the bed (block) half only, by pairing these particular halves for grooving.

c) With orbital grooves, by tilting the paired bearings in the four jaw chuck using tapered packing pieces under two of the jaws and setting the area to be grooved true.

Refitting the prepared shells to the bearing housings (and connecting rods)

Four essential conditions need to be achieved during this work:-

a) The bearing shells must be adequately supported or 'bedded in' to the housings to avoid flexure and the possible resultant formation of fatigue cracks in the white metal lining.

b) Where bearings are appreciably oval on the backs, shims must be fitted to round up the bearing in its housing. In extreme cases failure to correct this situation can lead to the finished bore breaking through the lining to the actual shell. Connecting rods that have been 'pulled down' (or their centres shortened) to average out this ovality will result in a reduced engine compression ratio.

c) Adequate, but not excessive, nip or in to-day's parlance 'crush' (previously associated with a preparatory process in the nipping up of Rolls Royce bearings employing Halls metal). Failure to achieve an acceptable nip will lead to bearing movement and affect heat transfer, while excessive nip may lead to premature failure.

d) Ensuring that the big end bolts and main bearing studs have not been previously stretched and thereby weakened. Tell tale 'waisting' is easily recognisable, and any suspect components should be replaced, studs and bolts by those machined from say En 16 or En 24 steel and nuts replaced. Black 'high tensile' bolts are not recommended.

Shims

These are employed in the following basic situations:-

Original Manufacture a) Several thin (two thou) shims for subsequent bearing adjustment, generally on direct metalled connecting rods and main bearings. (Ford and Fordson were typical). b) Thick (1/8in.) plate shims, some with white metalled edges, employed when connecting rods and bearing shells were produced in one piece and subsequently split by cutting through the joint line. (The Rolls Royce Ghost engine is typical). **Note** a) and b) may be combined.

Rebuilding

a) As 'half' shims between the housing faces to round up the housing when new shells are fitted. b) As 'through' shims to round up both the housing and the bearing when rendered oval by earlier refitting or poor workmanship. This type of shim is also employed to round up direct metalled connecting rods and, occasionally, direct metalled main journals for the same reason. Through shims can range from about twenty thou to 1/8in. or even 3/16in. in thickness. Due to the difficulty of white metal edging the thinner material, half hard aluminium can be employed which will bore reasonably well with the white metal.

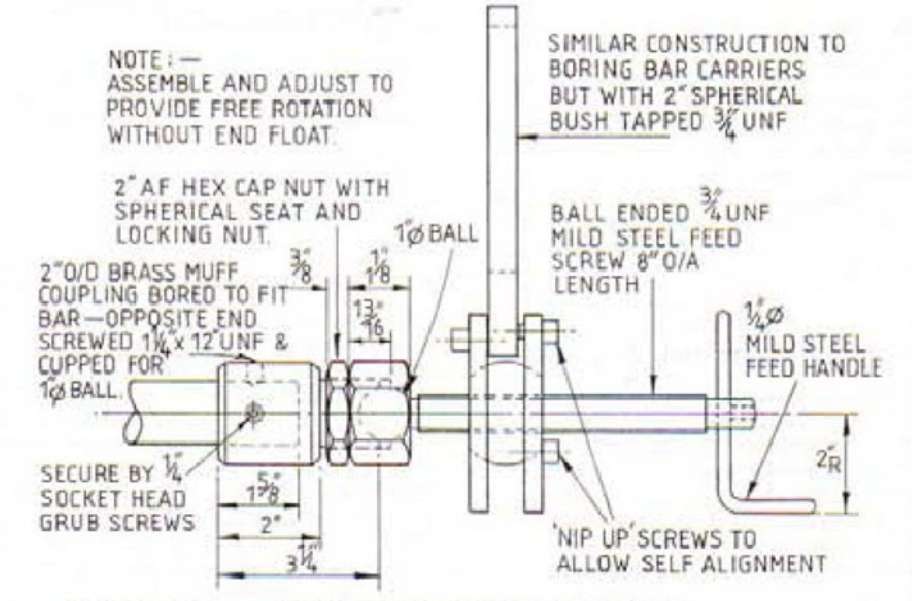
While connecting rods can be mudletted with the through shims in place in the fixture described later, both aluminium and white metal edged shims should be relieved to match any mudlet pattern subsequently machined in main bearing shell edges.

When through shims are employed on shell bearings, it is essential that the nip is evenly disposed between both bed and cap halves. Should the shims be less than 1/8in. in thickness, nipping plates must be employed, consisting of say 3/16in. gauge plate of suitable dimensions drilled to take the stud or bolt of the bearing. Finally, following finish boring, care should be taken that shims are replaced in their original locations during fitting and assembly.

The nipping-up process

Having checked the faces for flatness, lightly blue the housing bore, refitting the prepared shells and tighten the retaining nuts, with an appropriately set torque wrench. Slacken the nut(s) on one side of the bearing and lightly re-nip. Using feeler gauges, check this side which should accept a three thou feeler but not one of four thou. Progressively remove metal from the bearing cap, checking alternate sides of the bearing until these conditions are achieved, meanwhile examining the blue marking transferred to the back of the shells and removing any high spots to give a minimum of 80% surface contact.

Shells which have been fitted with through shims should, unless these shims are 1/8in. thick or more, be nipped up using the plates described above. The nip should be evenly distributed between the top and bottom halves, accepting a feeler of one and a half thou but not one of three thou - a 'sticky' two being the objective - see **Sk3.**



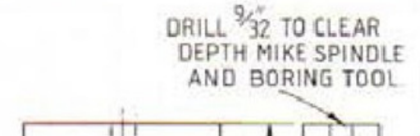
SKETCH No.6 HAND FEED ARRANGEMENT FOR LINE BORING DEVICE.

Direct metalled mains and big ends

Both of these, after checking the flatness of the mating faces, need only be tightened to the correct torque (using shims where necessary) prior to rough and finish boring.

Bush bearings

These can be rough bored and oil grooved in the lathe in a similar manner to that described for shell bearings, but may be found to be slack in their housings in which they should be a light press fit. While new over length and over size bushes can be made, metalled and subsequently rough bored, finish turned and parted off to length, the original bushes can often be recovered by knurling. With the rough bored bush supported on a mandrel, coarse diamond knurl the surface, but not necessarily to 'full form'. A light cut will then achieve the requisite interference, while still providing about 75% surface contact.



SKETCH No.7

BORING TOOL SETTING BLOCK
1" BRIGHT MILD STEEL OR
1" GAUGE PLATE H+T

In line boring of main bearings

While half shell bearings can be finish bored individually in a pre machined (back size) half housing (itself white metal lined) in the lathe, the subsequent fitting is a highly skilled and lengthy process and which also calls for precise rounding up of the paired bearings by shims. A typical fixture is shown in **Sk 4** which can also be used for rough boring and some oil grooving.

It is suggested, therefore, that the enthusiast may prefer to construct a simple hand operated line boring rig which will produce professional results. A rig of this type is described below, with constructional sketches provided in **Sk's. 5 and 6**.

The line boring fixture

This consists of:-

a) A pair of 1 1/2 x 3/4in. BMS rails of suitable length, tapped at intervals or to suit the selected positions of the cross members.

b) A minimum of four cross members (five will be required for six cylinder four main journal engines), cut from 2 1/2 x 1 1/2 x 5/16in. steel angle, as shown in the sketch.

c) A minimum of four vertical bearing carriers of 2 x 5/8in. BMS to which are attached by bolts pre-machined 5/8in. thick steel discs. A second set of discs, each secured by three socket head cap screws, retain the 2in. brass or bronze balls forming the boring bar bearings or, in one case, the feed nut.

d) A boring bar consisting of a suitable length of 1.250in. diameter precision ground steel bar, cross drilled 5/8in. and tapped at one end for the handle. This bar should also be cross drilled to take ¼in. round HSS tool bits, and drilled and tapped 5/16in. UNF. for clamping screws. It may also be considered an advantage to tap the lower end of the tooling holes 5/16in. x 26 TPI for tool adjustment.

e) A feed device, secured by two screws dimpled into the boring bar, and providing a positive hand feed via the tapped 2in. ball in the vertical carrier.

Finish boring the main bearings

Note. While many engines are of monoblock construction, those with separate crankcases should have the cylinder block(s) bolted to them prior to setting up for boring.

A pair of aluminium or scrap white metal collars, bored to fit the bar and turned precisely to the bearing back size, are initially fitted to the end bearing housings. This is followed by clamping or bolting the two 1½ x ¾in. rails to the side sump faces. The boring bar can now be entered into the collars together with the vertical supports spaced to adequately carry the bar but leaving room at each bearing position for tool setting and bore measurement.

The cross members can now be fitted and the total assembly progressively tightened, followed finally by the three ball locking screws in each of the vertical carriers. Partial withdrawal of the bar from each end will allow the alignment to be checked and any minor adjustments made. The setting collars can now be removed, replaced by the end bearing shells and the alignment rechecked. Assemble the feed unit and fit the operating handle.

Boring can now proceed; an assistant may be necessary to turn the handle! The boring tool should have an included angle of about 60deg., top rake of 8deg. and a small (0.020in.) 'curved flat' at the tip. An initial cut should leave about ten thou in the bore for finishing. While the tool can be set by its adjusting screw, a simple block **Sk 7** will enable a depth micrometer to be used for incremental cuts. Carefully check the finished bores with a pair of toolmaker's callipers followed, if all appears well, by the use of a telescopic gauge when the bar has been withdrawn. A further thou is much easier to remove by boring than by hand scraping!

Suggested clearances

A bare one thou total clearance will enable the crankshaft to be rotated but one half to three quarters of a thou per inch of diameter is generally regarded as that necessary for satisfactory operation without excessive running in.

Finishing operations

With the feed unit described, bearings other than the thrust, can be chamfered or radiused at the mouths, but it is suggested that the actual thrust be only just cleaned up on one face. This bearing can then be clamped on a suitable turned (tubular) stub and faced to length, again with the requisite chamfers or radii. A piece of thin card wrapped around the stub will avoid damage to the bearing bore. End float or clearance is generally accepted to be between three and four thou.

The final machining operation is that of mudletting, which can be carried out on a ½in. bench drill as shown in **Sk 8.**

Direct metalled cylinder blocks

These are generally of Ford or Fordson origin and require special equipment for line boring. (Model T Fords used to be 'cast to size' using a black leaded mandrel of crankshaft diameter). This is not illustrated but the reference points are the front camshaft bearing, the sump joint face and the rear oil retainer housing. The basic line boring fixture can be used but with a special boring bar plate registering in the front camshaft bore, a collar in the rear oil retainer and levelling the bar relative to the sump joint face.

Finish boring of the connecting rod big ends

Two basic options are available for big end boring. Those who have access to a larger lathe, and prefer to see the workpiece rotating, may decide to use the type of fixture shown in **Sk 9,** which is self explanatory. However, for those with smaller lathes, a boring rig capable of being constructed and used on a 3in. lathe is described below:

The boring fixture

Dimensions are not provided for this, enabling it to be made to suit the lathe employed and the job in hand, although the basic design will permit it to be used on similar connecting rods without significant alteration.

The fixture shown in **Sk 10** consists of a fabricated (bolted) angle plate of 4 x ½in. BMS members to which are fixed two side plates of 3in. x ⅜in. steel by ¼in. socket head cap screws. The base of the 'angle plate' is drilled to suit the cross slide slots, thus allowing the rod to overhang the headstock edge of the slide, should this be necessary.

The top of the vertical plate is provided with a slot to accept a ½in. shouldered stud carrying a pair of cones to centralise the small end bore. Lateral adjustment of the rod is by purpose made spacer washers or by threading the inner cone. The actual big end is held by a pair of ½in. diameter 'slugs', with pressure to the sides of the rod being provided by two clamping plates. Additional lateral support is given by two further screws, one tapped into the vertical plate, the other fitted to a 'drop in' latch plate, carried on two grooved pillars bolted to the face of the vertical plate.

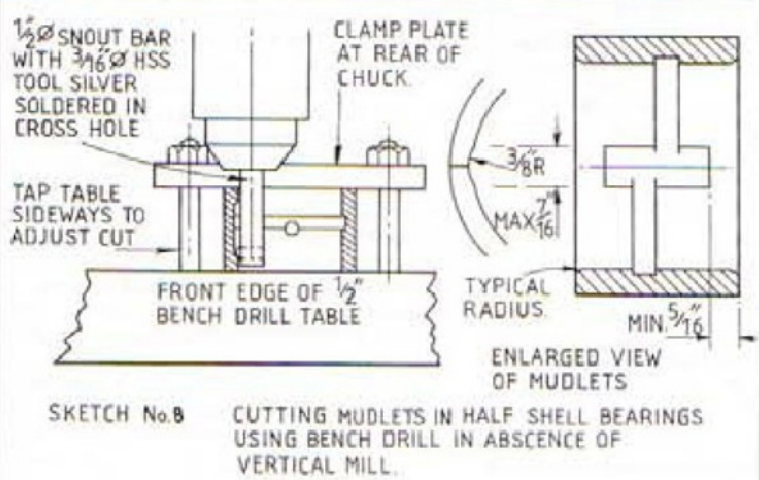
When in use, the jig should be set square to the lathe axis and only light pressure applied to the rod by the clamping screws to avoid distortion to the big end.

The boring bar is provided with a taper to fit the headstock spindle bore, and is centred at the opposite end for tailstock support, both when being turned to 1.250in. (in common with the boring bar for line boring) and in subsequent use. Alternatively, the boring bar can be made from a piece of the 1.250in. ground bar obtained for the line boring fixture, carefully centred by the use of the four jaw chuck and the fixed steady prior to machining the taper. Similar provision should also be made for the use of cutting tools, the tooling holes being spaced at a little over the width of the connecting rod big end, thus allowing progressive rough boring, finish boring and facing of the left hand face. Only the right hand facing tool will need repeated removal and replacing during the machining of a set of four or six connecting rods.

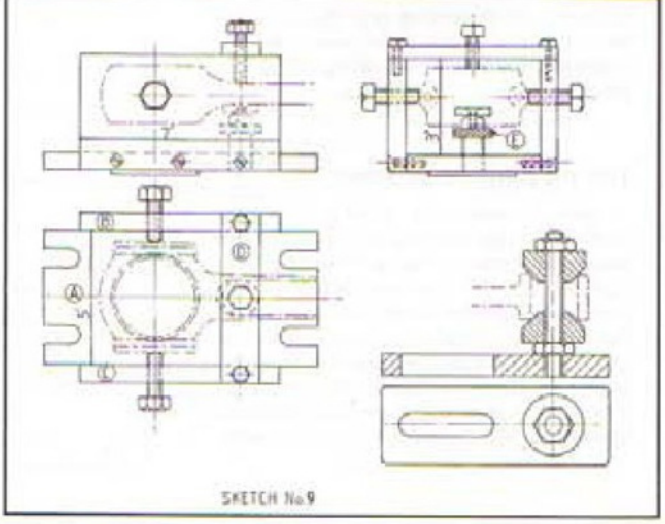
While a similar smaller stub bar can be made for mudletting, that shown in **Sk 8** for use on the main bearings can be used in conjunction with the three jaw chuck.

Setting up and boring the connecting rod big end

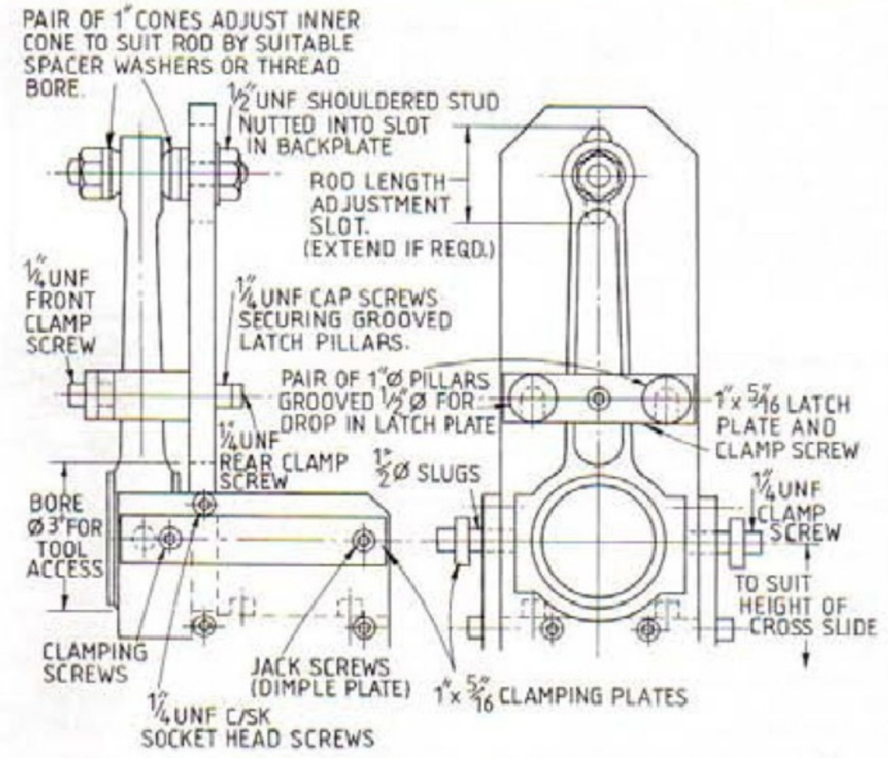
The rod centres (small end to big end) will originally have been a standard



SKETCH No.8 CUTTING MUDLETS IN HALF SHELL BEARINGS USING BENCH DRILL IN ABSCENCE OF VERTICAL MILL.



SKETCH No.9



SKETCH No.10 GENERAL ARRANGEMENT OF CONN. ROD BORING FIXTURE FOR 3½" LATHE
FOR CONSTRUCTIONAL DETAIL SEE TEXT

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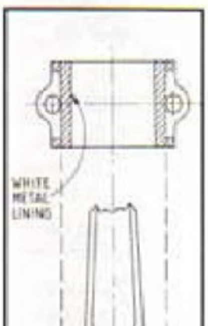

METHOD OF PROJECTING JOINT LINE PRIOR TO B/E BORING
SKETCH No.11

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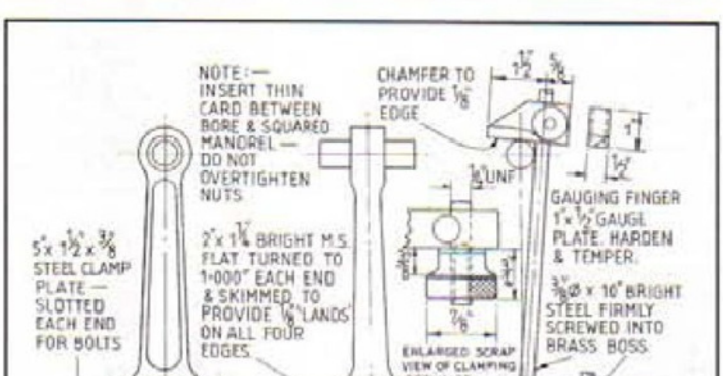

SKETCH No.12 CONNECTING ROD ALIGNMENT DEVICE

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Imperial or metric dimension. In all probability direct metalled rods will not have had appreciable metal removed from the rod half faces, enabling the centres to be established by direct measurement. However, those fitted to shells are more accurately checked from the crown of the rod bore. In the absence of a large vernier, callipers and a crisp 12in. rule will give a reliable indication of the original dimension.

The boring jig can then be easily set to a similar distance, particularly if the outer cone diameter has been precisely turned to 1in., when a piece of say ¼in. steel rod, faced to the required length, is used as a setting gauge between the boring bar and the above cone.

On the assumption that the rods have earlier been checked for bend and twist, the cones should be allowed to 'take charge' but lateral adjustment made to bring the lower clamping slugs central with the big end. These should now be gently tightened by the side plate screws, keeping the rod 'upright' by evening out the fore and aft spacing. Finally, the latch plate can be dropped into position, and the lower web faces of the rod supported by the two screws against subsequent cutting pressure, particularly when facing the sides of the big end to width.

Prior to the actual boring the rod will need centralising by the use of the cross slide to provide an even thickness of white metal at the joint faces. Three options are available:-

a) When assembling direct metalled rods, the junction of the metal with the rod can be projected to the side faces by scribed lines **Sk 11**.

b) Alternatively to the above, when the rod face has been 'registered' by the use of a hook tool.

c) With half shell bearings, either by setting up to the previously rough bored diameter, or by the use of the hook tool above using the flange diameter as a reference.

Should there be any doubt regarding the above setting, the rod should be removed following a trial cut, split and the evenness examined.

The actual boring is carried out in a similar manner to that of the main bearings, using say 300/500 r.p.m. and a fine feed. This is followed by combined facing and radiusing or facing and chamfering ensuring that the tools used provide a flat contact face for the crankshaft collars. End float is normally two to three thou.

Note. Some engines had the connecting rods located by the small end bosses with the big ends kept clear of the crankshaft collar faces by a substantial amount. The overall width of these rods was a standard dimension which should be established prior to the removal of the original white metal.

A few connecting rod big ends had annular oil grooves -

Ford again being typical. These grooves can be formed either by 'jacking out' a suitable form tool from the boring bar using a shortened hexagonal key, or by the use of a stub bar, again with a suitable tool, held in the four jaw chuck and using the chuck jaw movement for offsetting. If mudletting is necessary, this can be simply carried out by the use of the mudlet snout bar and by moving the cross slide in the required direction.

Bearing fitting and final assembly.

Prior to commencing this, the crankshaft, if having been reground, should have all oil hole entry and exit points blended into the journal diameters by a small (1/32in.) radius, taking care not to produce local 'low spots' on the journals. The shaft must be subsequently thoroughly cleaned to remove any residual sludge and/or abrasive from the drilled oil passages. Should these have been plugged during original manufacture, these plugs must be removed (by drilling if necessary) and renewed or replaced following cleaning.

Fitting the main bearings

Lightly blue the crankshaft journals and assemble the main bearings, tightening the nuts to the torque used during the boring operation. At this stage, the underside of the castle or slotted nuts should, if required, be carefully filed to ensure that when the appropriate torque has been applied the split pin holes line up with the slots in the nuts. In prestige engines, nuts and their associated studs are also numbered for refitting purposes.

Following a light 'clunk' with a lead hammer (but never on crankshafts fitted with thin wall bearings) on two of the intermediate crank webs, the shaft should turn, possibly with some resistance, by hand. Subsequent removal of the bearing caps and the crankshaft may reveal 'hard' markings near the outer edges of the bearings caused by grinding wheel wear when the shaft was reground by traversing the wheel towards each edge of the journal.

(During original manufacture all journals are 'plunge' ground). These hard marks should be removed by the careful use of a half round bearing scraper. Repeated assembly and light scraping should enable the crankshaft to turn freely and present an overall (80%) transfer of blue marking to the bearing surfaces. Coincidental with the above the thrust (location) bearing must be checked for the acceptance of a three thou feeler around the complete contact face. This clearance should not be such that it accepts a five thou feeler.

Fitting the Connecting Rod Big Ends

This work is normally carried out by holding the flange of the crankshaft in the vice, using vice clams, with the outer (timing end) supported by a bird mouthed wooden prop from the floor, thus allowing complete access to all crankpins. The actual fitting is similar to that of the main bearings, and when completed should allow the rod (without lubrication) to drop from about 15deg. past top dead centre to about 15deg. before bottom dead centre. Again, end float should be checked for the acceptance of a two thou feeler but not one of four thou.

Connecting rod alignment

An essential and frequently overlooked integral part of engine fitting is that of the alignment of the connecting rods, which will have had any major bend or twist corrected prior to re-metalling and subsequent boring.

Having replaced any worn small end bushes (some rods have 'clamp type' small ends), the use of a gudgeon pin and the squared mandrel shown in **Sk 12** will enable any twist to be identified by placing the rod on a pair of parallels on the surface plate. The rod must also be checked for bend or parallelism of the big and small end bores, either by use of the simple gauge finger also shown in **Sk 12**, or by supporting the squared mandrel on a pair of vee blocks on the surface plate and alternately 'clocking' the height of each side of the gudgeon pin projection from the small end. Correction for both twist and bend should be made in the vice, using vice clams and a purpose made bending tool, slotted to accept the web section of the rod and illustrated in **Sk 13**. Alignment in both planes should be within one and a half thou. Finally, the rods should be checked for the centrality of the small ends by, placing each side of the big end in turn on the surface plate, when the difference in small end height above the plate should not exceed 1/16in. A number of engines were fitted with offset connecting rods to match the cylinder bore spacing with the crankpin positions. Such rods can only be checked for a 'rogue' member of the family by the above method, unless the reader is prepared to go to the extreme length of measuring cylinder bore centres and crankpin spacing to calculate such offset. However, absence of piston 'bossing' i.e. positive clearance between the small end and piston boss faces on assembly, will confirm that all is well.

Finally, remove any bruise marks from the connecting rod forging caused by corrective bending to avoid the risk of subsequent failure from fatigue cracks.

Final assembly

Absolute cleanliness is essential, this operation being carried out in an area remote from that used for, say, off-hand grinding or other sources of abrasive dust. All oil hole drillings and pipes should be further checked for freedom from sludge, dirt or any other foreign matter by 'rodding' and/or the careful use of compressed air (safety glasses essential). Pockets in crankshaft throws are particularly suspect to sludge build-up, while certain Morris engines had oil hole drillings in the block intercepted by relieved main bearing studs needing removal to ensure a clear passage for oil. The oil pump should be overhauled where necessary by reducing the end float of the rotating members, or replacing them if appreciably worn. The seating of the pressure relief ball valve should also be examined together with the ball and spring.

At the point of final assembly the housing bores and bearing backs should be clean and dry, but a generous amount of engine oil used in the actual bearings. The writer does not recommend the use of additives either during this process or the running in period, these substances tending to retard the initial bedding in. If felt desirable they can be used following the first oil change with the objective of wear rate reduction.

Notes regarding thin wall pre-finished half shell bearings and bushes

Many Classic car engines are fitted with thin wall bearings which, as noted by Fettler, cannot be successfully re-metalled. Should exact replacements for the engine not be available, the following procedure may be of assistance:

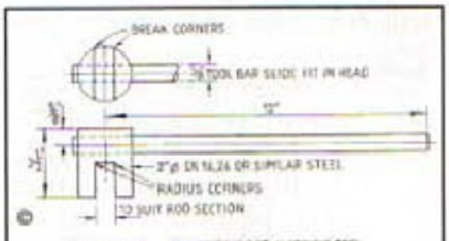
a) Establish the housing diameter, the original wall thickness, length and oil groove detail.

b) Borrow a replacement bearing catalogue from your local dealer to identify

1) A similar bearing of greater length, or

2) A bearing of similar wall thickness but of slightly increased diameter and possibly length. (Wall thicknesses are generally standard, although the Ford Motor Company have adopted 'over size back' shells for recovery reasons). Shells under a) can be faced to the required length on a mandrel using a Jubilee clip, while those under b) can be fitted by filing the butts of each shell opposite the tab to give an even nip of three to four thou.

Particular care should be taken in respect of oil hole positions, although an unwanted hole will probably be blanked off by the housing itself. In the case of b) it is



SKETCH No.13 CONNECTING ROD ALIGNING TOOL

recommended that the resultant bore(s) be measured on assembly and the crankshaft ground to suit to provide the appropriate clearance.

In an extreme situation, both half shell and bush bearings can be made in the home workshop, the writer having used this method to produce camshaft bearings following the boring out of the parent metal (cast iron) bore:-

a) Set a piece of suitable drawn steel tube up in the four jaw chuck and turn to approximately 1/8in. above the finished outside diameter, machining the bore to thirty thou larger than the final (metalled) bore size required. Part off leaving an extra 3/4in. as a later chucking piece.

b) Using a tapered mandrel, line the bore with white metal.

c) Set up the outside diameter true in the four jaw chuck, rough the bore 1/16 in. undersize and finish turn the outside diameter to give a light interference fit in the housing. Finish the bore, allowing the desired clearance, plus the interference on the OD, plus half a thou. Groove if required. Part off to length and drill any necessary holes using a very sharp drill to avoid damage to the white metal lining.

A bush made as above should behave as a pre-finished component.

To make a pair of replacement pre-finished shells, the above procedure can be followed, but adding precisely the same dimension - say fifty thou to both the finished OD. and bore diameters. The resultant bush can then be carefully cut into two with a junior hacksaw, tabs formed and then filed on the butts to provide the essential nip of between three and four thou.

In conclusion

Two important don'ts:- a) Don't fit even a single re-metalled big end unless the engine has been re-bored, the ridge removed from the top end of the cylinder bore or a stepped top compression ring fitted. b) Don't be tempted to build up the joint faces of the shells with white metal to achieve nip. White metal loses half its (compressive) strength at 100deg.C and any such repair is unlikely to be effective over an extended period.

The above cannot possibly cover all the situations the reader may encounter, but it is believed that the principles outlined will, with a little common sense and ingenuity, enable other such work to be successfully undertaken. The writer is indebted to the to Hoyt Darchem Limited for the sketches reproduced in **Sk's 4** and **9**. The writer has no commercial connections this Company and all other information contained in this article is based on his own training/experience

TAILSTOCK TURRET

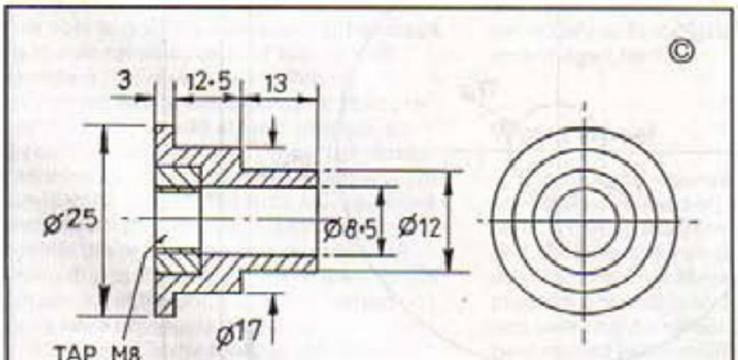
This turret is from B Jackson of Port Elizabeth, Rep of South Africa, and being of simple design, is particularly worth considering.

This tailstock adaptor is the result of a need for a simple tool to speed up the repetitive manufacture of small parts used on an optics lens grinder. **Photo 1** of the complete adaptor shows the four different toolholders needed to do the job. There are no details of these toolholders as the constructor will wish to suit the design to his requirements. The usual splayed turret would have taken much longer to make and, while it may look good, was unnecessary. Parallel positioning was easier and suited requirements of both equipment and materials available. There are various designs of tailstock adapters with splayed toolholders but, for the small machine operator, the very size of the item being worked, seldom, if ever, requires that tools not in use be angled away. It was with these thoughts that the design evolved. Regardless of the choice of toolholder, the principle for it's location remains the same, only the method of fitting to the disc changes. The Jacobs chuck was salvaged from a Black & Decker power drill, while the live and fixed centres, as well as the centre drill holder, were all home brewed.

The only logic in making the adaptor is the sequence of machining the various parts. All machining was done on the lathe on which the device is used, with the exception of hole 'A' in disc 'B' and corresponding holes in disc 'C'.

Construction

You will need an old drill which has a good Morse taper shank. The plain diameter between shank and flutes should not be less than 15mm. First cut off the flutes at the plain section, If it has a tang cut that off too. (a drill chuck arbor with MT2 and B16 tapers would be ideal, such luxury). Next turn up disc 'B', leave a well defined centre mark on both sides. Now make disc 'C' and drill the 17mm dia. hole.



Return to disc 'B' and across one side, scribe a line diametrically through the centre. On this, mark and centre punch positions for the 12 and 15mm dia. holes. Using a 4 jaw chuck, hold disc and centralise on the position for the 12mm hole and drill 12mm. Repeat for the 15mm hole. Now drill the 6mm dia. hole at 'A', using a pedestal drill.

Holding the drill shank in a 3 jaw chuck by the plain section, dress up the small end of the taper. Now insert the drill shank into the headstock taper and turn the plain section, 13mm long, and to a diameter to ensure a "whack it home" fit in the 15mm hole in disc 'B'. Pre-heating the disc helps in this procedure.

Make centre bush 'D', try discs 'B' and 'C' on its related diameter to ensure that there is no play, disc to bush. When I made this bush the only M8 tap I had was less than usable. Rather than a trip to town, some 15Km away, to buy a new tap, I got around the problem by turning the corners off a suitable nut, drilling the end of the bush and pressing in the cornerless nut.

It now remains to locate the toolholder holes. This is the critical part of the whole operation, although it may not seem like it from the following directions. Assemble the discs, centre bush and lock screw. Fit the adaptor to the tailstock, its position, whether towards (photo 1) or away from you, or vertical, (**Contents page photo**) does not matter, as drilling operations are related to headstock centre height. The tailstock must be in line.

Fit a drill chuck loaded with a centre drill, to the headstock, bring up the tailstock with adaptor and centre drill disc 'C'. Back off, remove adaptor, but do not slacken the centre screw. With the adaptor face down and, using hole 'A' as a pilot, drill through disc 'C' 6mm diameter. This is done on a pedestal drill. Now unlock the centre bolt and turn disc 'C' through 90 degrees, tighten centre bolt. Refit adaptor to tailstock, and repeat operations as before. Repeat for the third and fourth positions. You will now have 4 centre positions and 4 6mm dia. holes showing on the outer face of disc 'C'.

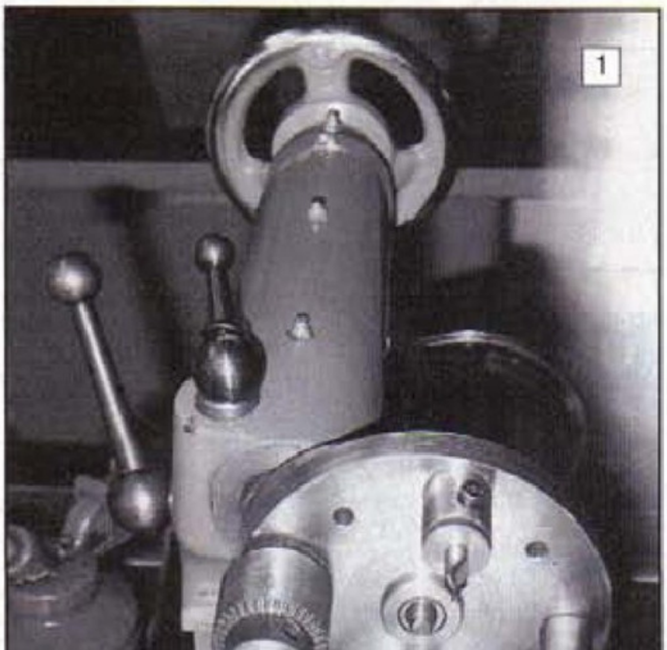
The hole 'A' is used with a 6mm dia. pin to index the turret to the required toolholder to be used. Whatever toolholders are to be used on the adaptor, any hole drilled must be drilled on your

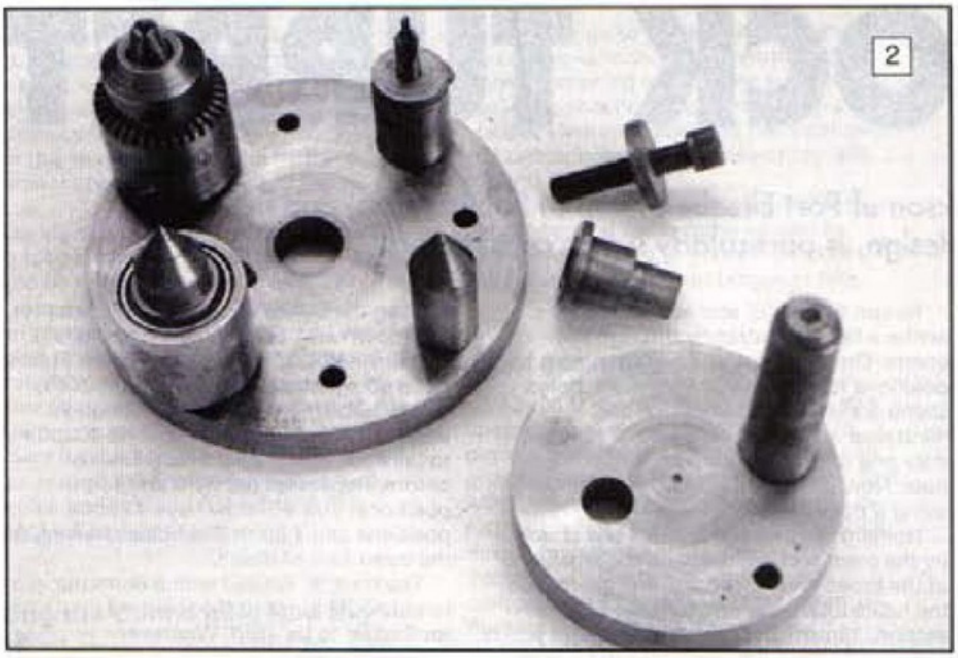
Quick tip

Clear stamped characters

Having stamped a dial with the required numbers, return this to the lathe ensuring that it is running true with negligible error. Skim the surface taking off say half a thou to remove burrs and raised edges. This produces a very professional result.

Derek Brookes

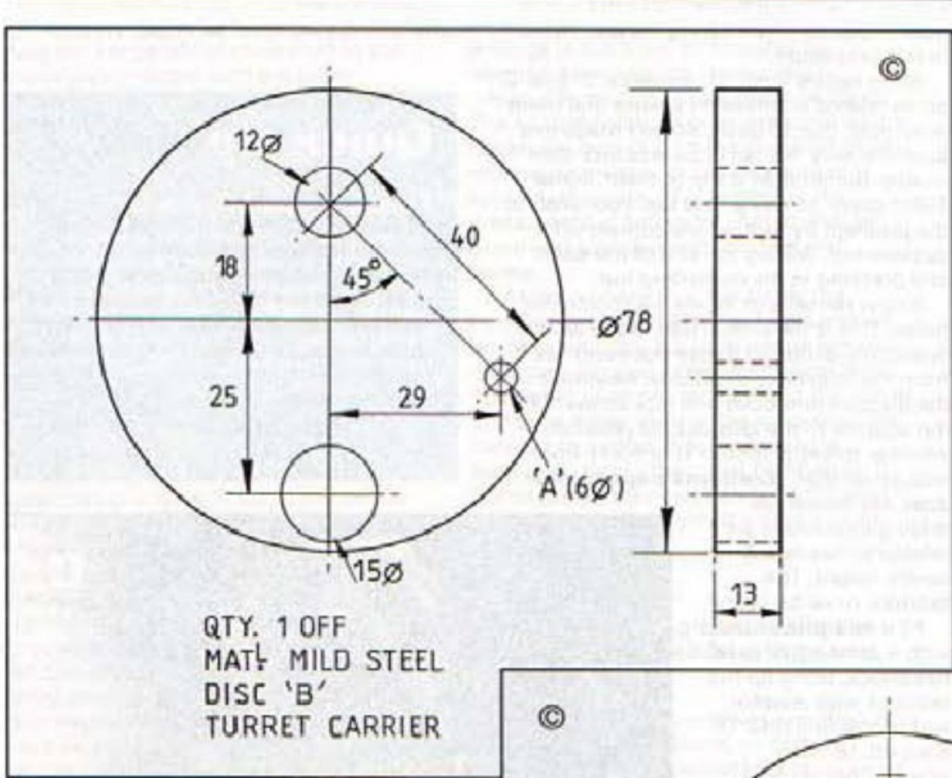


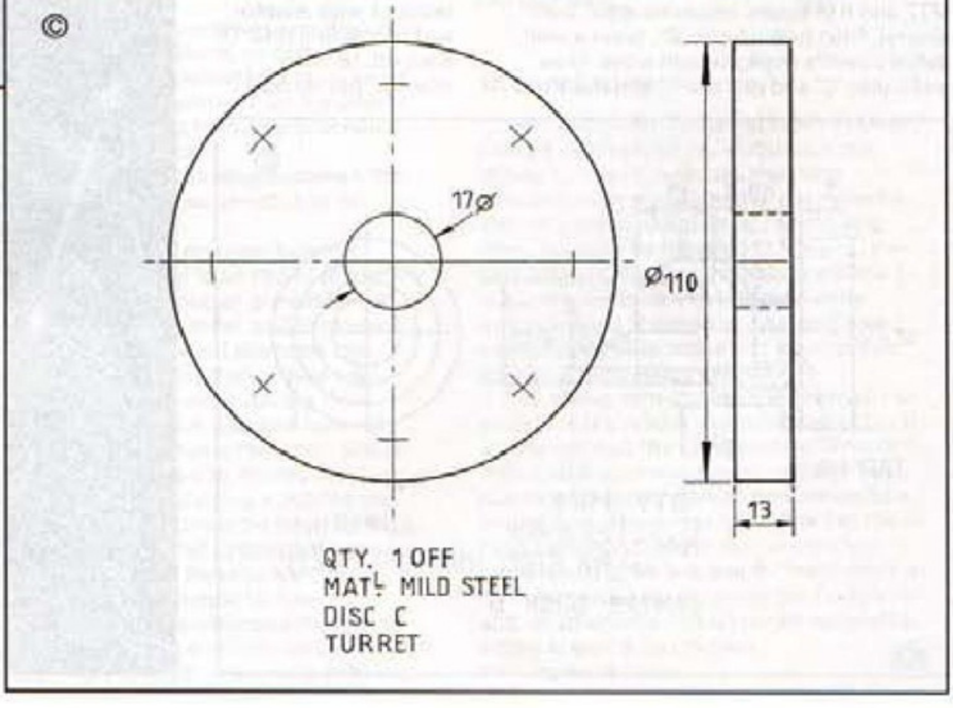


lathe. Even as in my case where a tapped hole was required to fit the Jacobs chuck, the tap was held in the lathe chuck. Only by this method will a true line be held with the lathe mandrel. Lack of dimensions for disc 'C' now becomes obvious, as "on location" centring and drilling is the critical part of the process.

There is nothing unusual about the live or fixed centres, or the centre drill holder; each has a 10mm diameter parallel shank and is a press fit into a 10mm drilled hole in disc 'C'. A small (4mm) socket head screw holds the drill in the centre drill holder. You may note a cap screw in the barrel of the live centre. This, when screwed in will lock the revolving centre. This was done so that after assembly the centre could be trued in the lathe chuck. In use, a grease nipple replaces the cap screw.

Photo 2 shows the finished parts prior to assembly. The 6mm dia. pin for locating the turret is not in the photos, or detailed on the drawings, a simple piece of 6mm bar with a small head for easy fitting and removal is all that is required. The adaptor has proved to be very efficient, having been in use for three years.





Quick tip

Setting screw cutting tool

When screwcutting using the angular approach method, sometimes called the American method. For a 60 deg. thread form set the compound to 29 1/2 deg., and for Whitworth thread forms to 27 degrees. This ensures the full face of the tool cuts, and prevents stepping.

W. J. Vaughans

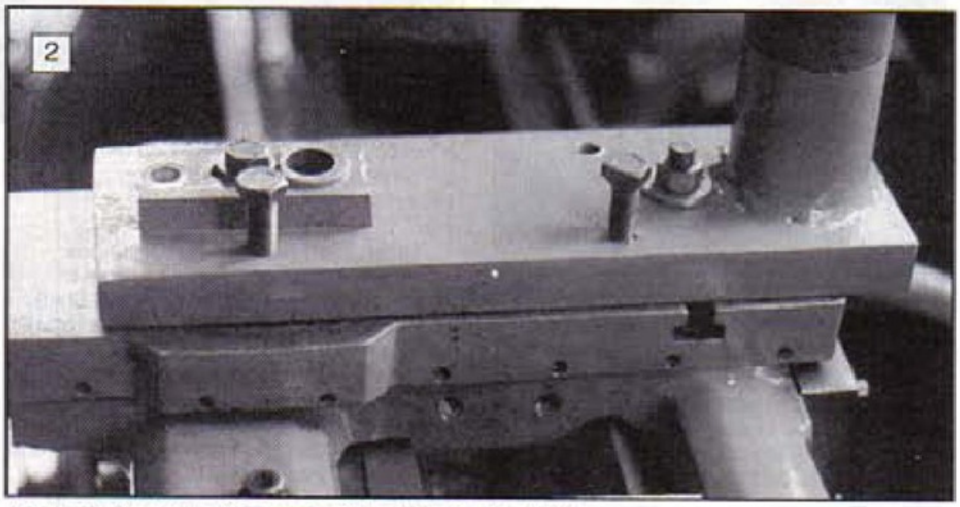
Quick tip

Holding external threads

Small external threads can be difficult to hold for machining. If the thread is standard, an easy solution is to use a suitable split circular die as an accurate threaded collet. Expand the die in its holder, screw in the component, then transfer die and component to the lathe self centring chuck. The job will be securely held without damaging the thread and will run true enough for most purposes. If accurate adjustment or some displacement is required, use the four jaw chuck to hold the die and its contents.

J. Walters

GEAR CUTTING - WITHOUT COMPLEX CUTTERS



2: Base unit mounted on cross slide of the Boxford lathe.

Barry Holt suggests that, unless a gear is to be used in a critical application, there is no need for expensive form tools. He explains the alternative.

While gears used for high speed use need to be accurate, those for lower speed applications can be quite effectively made with a single point cutter. I have, over the past few years, developed a simple method for cutting both spur and worm wheels by this method. My initial attempt came about when my early Howard Rotavator damaged the drive wheel. No replacement was available and I was left with three options:

1. Scrap the machine.

2. Have one made commercially.

3. Attempt to find a way of machining one in the home workshop.

Having nothing to lose but time, I chose option *3.*

With the damaged wheel removed, I was able to gain the necessary dimensions. As the wheel was made of bronze I felt confident that due to its machining properties, and once installed its ability to bed in easily, I could at least produce an acceptable replacement. Whilst the worm had thinned slightly in the centre it was still serviceable, and I could obtain dimensions and a tooth profile from it. I decided against the production of a replacement worm due to the complexity of the remainder of the shaft and that certain parts were obviously hardened.

Although it is the tooth profile that we consider important in a gear, it is in fact the space between the teeth that we cut. Providing we have an original to work from, a single point cutter can be made quite simply to emulate this void and thus produce teeth of the correct profile. To date I have cut only replacement gears, but providing a profile can be obtained there is no reason why this method cannot be employed to cut a variety of gears for all types of work.

It is worth noting that whilst this article covers replacement worm wheels and spur gears, the method of obtaining the cutter profile is from the original gear and differs for both types. In the case of a damaged worm wheel, usually all the teeth are worn and the profile has been obtained from the worm. What this does not allow for is the lead in and lead out of the tooth as the worm passes over it. Therefore when grinding the cutter a radius should be added to accommodate this.

In the case of spur gears, more often than not, the reason for a replacement is due to teeth being broken off. This makes life much simpler as all the dimensions are available and the cutter can be ground accurately to fit the gap between the undamaged teeth.

Worm wheel

For my initial attempt at gear cutting my workshop consisted of, an old modified 4in. lathe, a milling machine and a Tauco bench drill. Producing the single point cutter or gear blank did not appear to present a problem, mounting and driving the cutter and indexing the wheel did. The cutter could be mounted in the milling machine but I would then require an indexing spindle for the blank, that could be angled to provide the angle of the teeth. I was also reluctant to use a single point cutter of the required diameter, without support on both sides.

The second option was to machine the blank on the lathe and fit an indexing unit to the outer end of the spindle for indexing of the gear teeth. This would ensure stability of the blank and as it would not be dismounted between operations, would also ensure concentricity. If I was to use this method, I needed to find a way of mounting a cutter spindle. I wanted to support it at both ends, make it adjustable to provide the angle, and provide a spindle speed compatible with the cutter and material being machined.

My first thoughts were to manufacture a Y shaped support with the cutter supported in between the two arms. If the single arm was round it could be mounted in a block and rotated to the required angle. I would still need to provide a drive assembly and accuracy would be essential in the spindle bearings. It was at this point that the eventual solution became apparent.

As I had a T slotted cross slide on the lathe and a bench drill with a 1 ⅞ in. round column, I decided to develop a means of mounting the spindle and motor assembly on the lathe. If I was able to angle the column, I could achieve the required tooth angle.

The spindle was already motorised with adjustable speeds, and the lower part of the cutter could be supported in an Oilite bearing for stability. The base was made from a piece of mild steel 10 x 3 x ¾in., two holes were drilled on the centre line to mount it on the cross slide. These were filed X shape to allow the plate to be angled. By drilling and tapping a further two holes on one side, the spindle could be

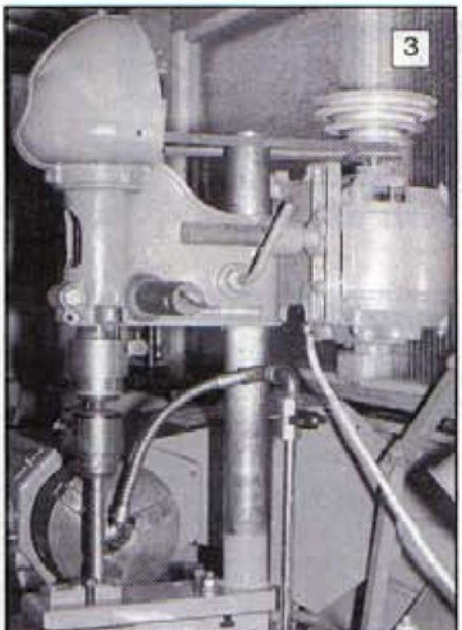
1: Base unit ready for fitting to the cross slide.

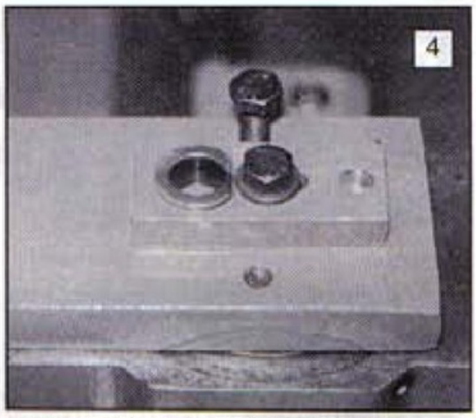
tilted to the required angle. A piece of 1 ⅞in. dia. by ⅛in. wall, steel tube, was cut to 19in. in length and the ends turned square on the lathe. After clamping and checking for square the tube was welded to the base, **photo 1.** Once it had been installed on the cross slide, **photo 2**, and the drill spindle positioned, **photo 3**, the head unit would be locked relative to the column base and a lower bearing provided to support the lower end of the milling spindle. For the lower bearing I used an Oilite bush mounted in a 3 x 1¼ x ½in. aluminium alloy block. This was secured by the front centre mounting bolt of the column base, **photo 4.**

The milling spindle was to be made the same diameter as the root diameter of the worm. This gave the maximum support to the cutter and, when the cutter was fed into the blank, would control the maximum depth of cut, should I attempt to feed it in to far.

An unusual moulding technique

As I was to obtain the profile for the cutter from the worm, I needed to take a mould, and whilst there are many ways of doing this, I feel that my method may intrigue some readers. Many years ago my father gave me some strips of low melting point lead. These look like normal lead but will melt in hot water and cool quickly into solid form. I have used them on many occasions to make a pattern mould and when the work is complete they can be quickly returned to their original state ready for the next time. By melting this onto the shaft, I was able to obtain a tooth profile. (*I am aware of this metal but, having already passed my catalogues and buyers guides onto the new editor, I am unable to quote a supplier for this. Can any reader help? Ed.*)





3: Tauco drill head mounted on lathe.
4: Bearing block fitted to base unit.

The cutter spindle

The next stage was to produce the cutter spindle and cutter. The spindle was made from ½in. bar cut to 4in. long. A ¼in. dia. hole was cross drilled to accept a re-ground slot drill. It was then drilled through its centre and threaded to provide clamping for the cutter **fig 1.** Using the shank of a broken slot drill a single point cutter was ground as in **figs. 2** and **3.** This is the trickiest part of the whole operation and, as it is ground freehand, requires patience and good eyesight. When grinding the tool from a this type of pattern, two things must be borne in mind. Firstly, that the centre of the worm will have the maximum wear and consequently the profile should be taken from an area with minimum contact and wear rate. Secondly, as mentioned earlier, no allowance for lead in and lead out of the worm teeth comes from the worm profile and a radius must be ground into the cutter to allow for this.

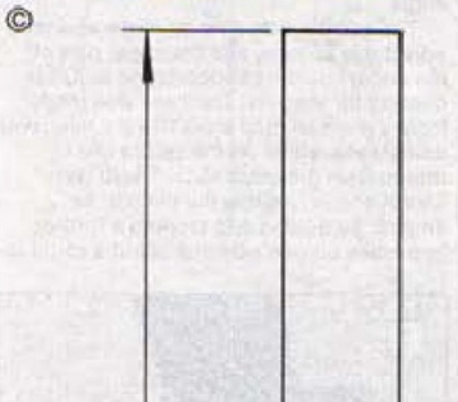


FIG. 1.
SINGLE POINT CUTTER SPINDLE

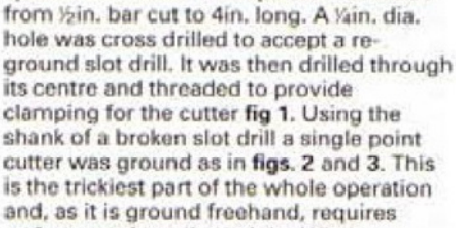


FIG. 2.
SINGLE POINT CUTTER ©

Having completed the adaptations required to cut the teeth, I was able to proceed with the machining of the blank. The boss was turned first and then rotated and centred in the chuck. The remainder of the turning, boring and tooth cutting was carried out without removing the blank, thus ensuring concentricity. Once this was completed the top slide was removed, and the drill column installed. Using a protractor the column angle was set to match the angle of the teeth. This was done by loosening the centre two bolts A & B, **fig. 4**, and adjusting bolts C & D. **Photo 5** illustrates the angled mounting. Since the initial operation, I now use a 1/4in. packing below the column base when angling it, for two reasons.

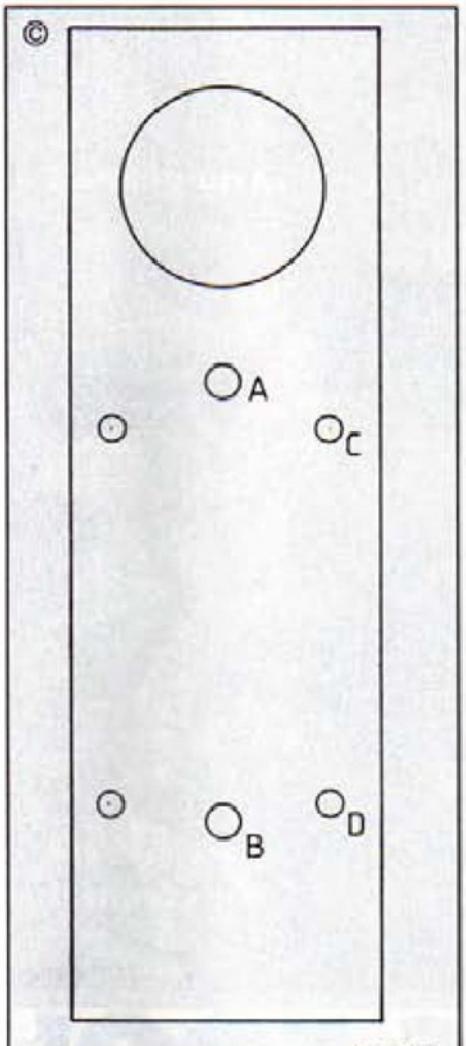
Firstly, it provides a flat constant pressure above the T slot to reduce possible breakage, and secondly, it prevents the adjusting bolts C & D digging into the cross slide and damaging the top face.

The drill head and motor unit were then fitted individually to the column and the cutter spindle inserted into the drill chuck and centralised into the lower support bearing.

It may be worth a few words at this point regarding the use of a pillar drill for fly cutting. The weight of the unit in relation to the lathe bed size and construction should be considered along with the quality of saddle and cross slide. Fortunately the Tauco appears ideal when fitted to a Boxford. Secondly most are constructed to take a vertical load against the bearings and not a side thrust. Although my initial gear cutting was carried out without additional upper support, I have now produced a bearing and a replacement spindle. As the spindle is easily removable in the Tauco, without dismantling the original bearings, I made a bronze bearing nose piece to fit over the quill and a taper for the replacement spindle, **photo 6.** It can be seen fitted in photo 3. On the first few occasions I did not have this to reduce the load on the bearings, but have subsequently found it a very worthwhile addition.

As the cutter spindle was easy to construct and the lower Oilite bearing readily available and easy to replace, I felt that, with limited use and constant lubrication, the wear would negligible and not worth worrying about.

The cutter point must be aligned both horizontally and vertically to the centre line of the gear blank. Once aligned, the saddle



COLUMN BASE FIG.4

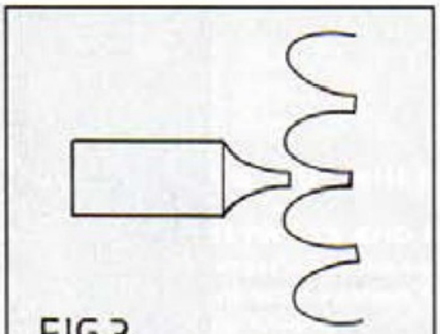


FIG.3.
CUTTER PROFILING ©

remains locked until the operation is completed. The indexing unit was fitted to the change wheel arm and a gear with the correct number of teeth installed, **photo 7**. As I was cutting a worm wheel and the teeth were to be cut with a plunging action, each tooth could be cut to full depth in one operation. A stop was fitted to the cross slide and adjusted to give the maximum depth of cut.

Proof of the pudding

I was now ready to put my theory to the test. With the drill spindle running at its slowest speed, and the indexing unit locked in position the cross slide was wound in until the stop was met. The cutter was then withdrawn, the index peg released, and the spindle rotated to the next tooth position. This sequence was repeated until all the teeth had been cut.

The drill assembly and indexing unit were removed. Any burrs remaining after the tooth cutting were cleaned away and the gear removed from the chuck.

The gear was then assembled into the gearbox and, as I had deliberately left the overall diameter of the blank two thousands of an inch oversize, it was a little tight. I bedded the gear in using a fine grinding compound, ensuring that none strayed from the teeth onto the bearings. Once satisfied with its operation I stripped it again to wash away all traces of the compound. The Rotavator was assembled and continues to operate perfectly some seven growing seasons on from the repair.

Spur gear

My next attempt at gear cutting came about as the result of the purchase of my current long bed Boxford model "C". The back gears had broken teeth and after stripping and pricing up new ones, I decided to cut replacements, The method employed was very similar to that for cutting the worm wheel, but being spur gears the operation varied in four ways:

1. The column was mounted vertically and not angled.

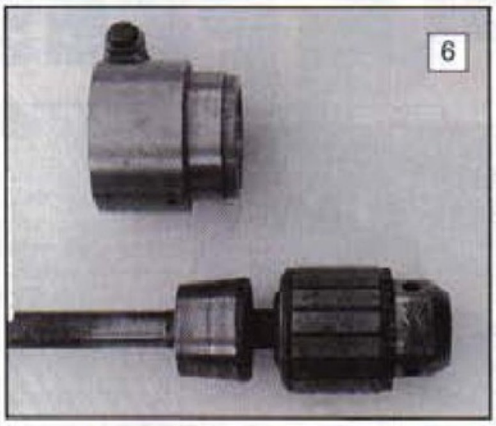
2. The cutter profile came directly from the gap between the teeth and providing the cutter fits perfectly then running clearances are already accounted for.

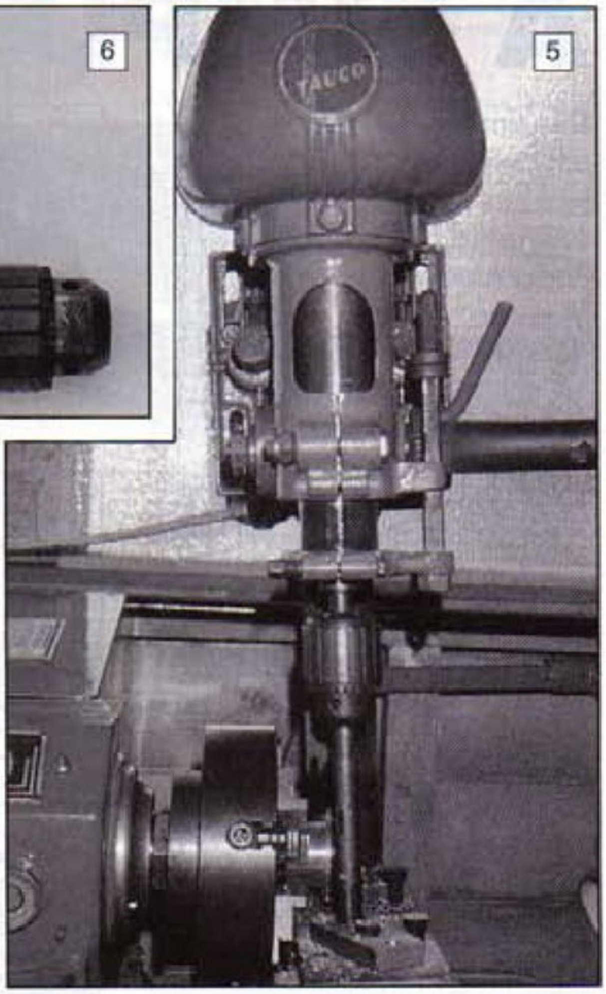
3. The cutter would need to move horizontally through the blank to cut the teeth evenly

4. I felt that whilst the main part of the tooth could be cut in a single pass, it would be better to take a two thou. finishing cut from each tooth.

The cutter was ground to match the profile of the gap between two of the remaining teeth. This time the cutter was allowed to project further from the holder as, unlike the worm wheel, the cutter does not have to match the diameter of the tooth on a mating worm. As the gear did not have a boss on one side, I decided to face both sides to finishing thickness and bore the centre to mount it on the Boxford spindle between the chuck and tail stock of my then current lathe. Once mounted and centralised the blank was brought to its finished diameter. The top slide was removed and the drill mounted as before, except the spindle was vertical and the saddle allowed to slide. The cutter was set to centre height and with the point of the cutter on the outside radius of the blank, the cross slide wound in to full tooth depth less 0.002in. on the cross slide dial. The cross slide was then locked in position.

The indexing unit was installed on the lathe and the first tooth position locked. The saddle was moved away from the blank and the drill switched on. The lead screw half nuts were closed and using the lead screw hand wheel to control the saddle, the cutter was slowly passed through the blank. Once the cut was complete the drill was switched off and the saddle retracted to its starting position (the drill was switched off not only for safety reasons but to prevent the cutter taking away more metal during





5: Angle of drill set by adjusting screws for cutting worm wheel tooth angle
6: Nose bearing and spindle for the Tauco drill.

the retraction operation). The indexing unit was moved to its next position and the cutting operation repeated.

Upon completion of the initial cut on all teeth, the top slide was unlocked and fed in 0.002in. for the finishing cut to be made. This was carried out in exactly the same way as the initial cut but with the drill spindle running at a higher speed. **Photo 8** shows the gear having its final cut taken.

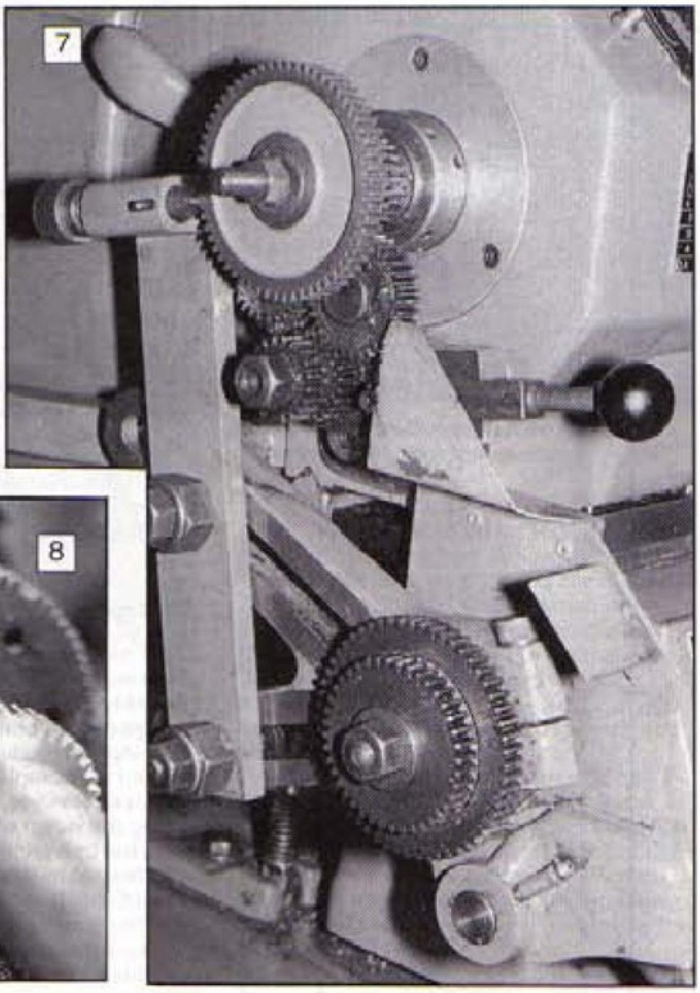
The gears were installed and again being bronze settled down quickly and quietly. Since then I have produced replacement gears for a screw cutting gearbox and a front apron removed from a damaged model "A". Both items have been installed on my model "C" and are running perfectly.

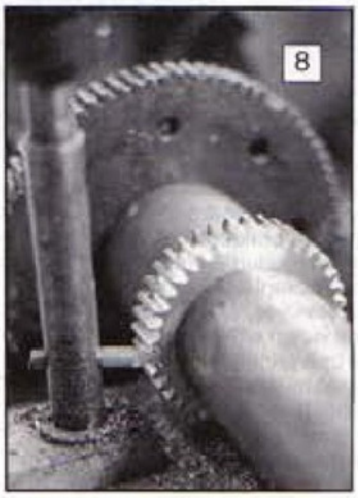
All the tooling has now been amended to suit the Boxford. I have also used the set-up for key way cutting and for cutting six splines on the end of a shaft. But possibly more of that later.

QUICK TIP
Circle to internal square ratio

Want to know the depth of cut to machine a square on a round shaft where the diagonal of the square is the diameter of the circle? Multiply the radius by 0.707, subtract the result from the radius, and that is the depth of cut.

W. J. Vaughans



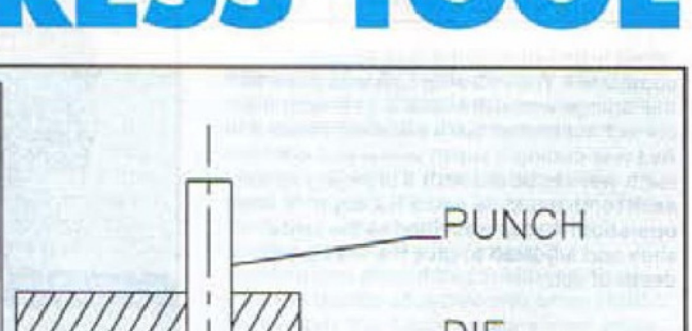


7: Indexing wheel and plunger mounted on outer end of Boxford spindle.
8: Close up of spur gear having final cut taken.

A SIMPLE PRESS TOOL

This simple, but effective, press tool has been suggested by Philip Amos of Mosman, Australia

The series on bench presses (issues 19, 20 & 21) reminded me of a job I had to do some years ago repairing an antique wooden chest. This was covered with painted cloth and edge bound with thin brass angle, some of which had been damaged and some lost altogether. The new angles were formed from brass shim stock 0.4 mm thick and held on with brass upholstery nails. The problem was to make the holes for the nails in the brass. The idea came from the integrated punch and die sets used commercially in gang set-ups in flatbed or brake presses, see illustration. These are used to simultaneously knock a number of holes in sheet metal, usually around its edges. In my case the punch was a length of ground HSS and the die a chunk of mild steel with a hole drilled and reamed to accommodate the punch, with a hacksaw cut at right angles to take the workpiece. The depth of the cut provided appropriate location of the holes at the edge distance "A".

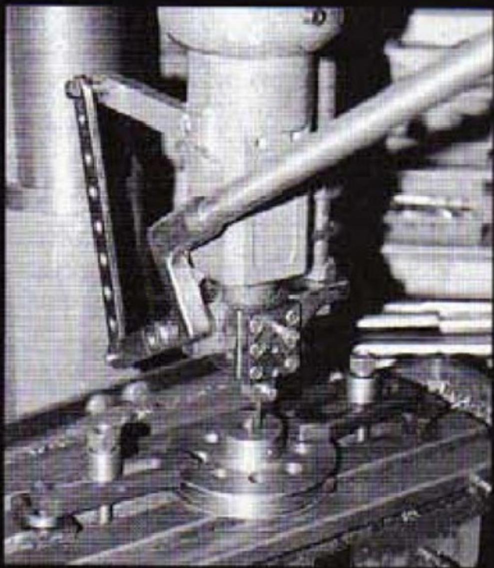


The lower part, the die, was drilled out to provide clearance as suggested in *Machinery's Handbook*, that is, 0.05 to 0.1 times the job thickness per side; in this case about 0.08 mm on diameter.

A sharp whack with a hammer drove the punch through the shim, it could also be used in an arbor or fly press or similar. In most cases the punch could be pulled back up with pliers; otherwise it was bumped back from the bottom with a smaller punch. This is not suggested as the epitome of tool making, but I made about a hundred satisfactory holes to complete the job. It was as quick as lightning and as rough as guts, but it worked well for me.

IN OUR NEXT ISSUE

Coming up in the MAY/JUNE issue, No. 29, will be:



KEYS, KEYWAYS AND HOW TO MAKE THEM

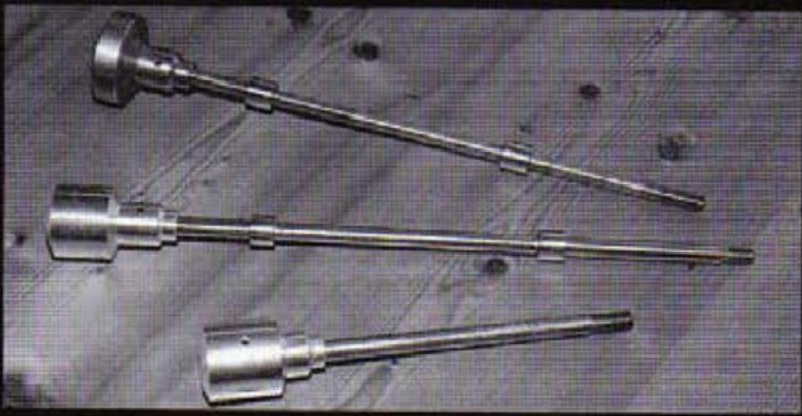
Alan Jeeves reviews the various forms of this basic mechanical device and describes attachment for the Mill/Drill which will aid the cutting of accurate keyways.

USING THE ROTARY TABLE

A few simple accessories can enhance the versatility of this useful attachment.

DRAWBARS

These vital aids to safe workshop practice benefit from a few hours of straightforward machining.



AND MUCH MORE

Issue on sale 28 April 1995

(Contents may be changed)

LINK UP

WANTED

• Wanted for Harrison Horizontal/Vertical Milling Machine
(a) A vertical head.
(b) Change wheels for auto feed.
(c) Manual to purchase or for copying. I will reimburse expenses.
(d) Manual as above but for Elliot 10M shaper.
Mr R Rice, 8 Heywood Road, Tibenham, Norwich, Norfolk, NR16 1NZ
Tel.0379 674233

• Can anyone suggest a source of supply of small second-hand involute gear cutting hobs? All postal or telephone expenses gladly reimbursed.
Mr.A.Craven, "Stanmore", Myrtle Lane, Penymaes Road, Holywell, Clwyd,CH8 7BS. Tel. Holywell 711512

• Can anybody tell me where I can purchase a Main Drive Belt for a Raglan 5in. Lathe. Tel.0543 378651.

• Information wanted on supplier or maker of quick change tool holder fitted to my Myford Super 7. Stamped on the tool holder are the following:-
Tripan -131c- Smid 766.
John Shaw, 12 Palm Close, Liverpool, L9 1AA. Tel.051 521 1346

• Wanted set of four face plate jaws (as illustrated *M.E.W.* November 1994) details and price. Tel. 0983 855 822 or Fax 0983 852 146.

• Can anyone help me with information for the Zyto 3 1/4 in lathe?. Users manual, other literature, source of spares etc. Tel. 0209 214909.

FOR SALE

• ¾HP Electric Motor Single Phase with feet, Cont. Rated including any size of Single Pulley £40. Also a Surface Gauge £5.00. Tel.(Blackpool) 0253 354478.

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Delivery from receipt of payment is normally within 28 days. Only written orders/requests can be dealt with, no personal enquiries or phone orders can be accepted.

DATA BOOK ERROR

Please note that an error exists on page G1 of the Data Book.
The formula for height H should read:-
Height $H = D/2 - 1/2 \sqrt{D2 - C2}$

Ultimately this correction will be published in the Data Book. Meanwhile please correct your copy to avoid possible confusion.

SCRIBE A LINE

Cannon borer on display

From Mr. D. W. Ross of Lewes.

Thank you for a continually enjoyable magazine. Referring to issue 25 and the article on the Large Machine Tool, readers visiting Lewes may wish to know that there is, preserved, and on show in the Anne of Cleves House Museum, a cannon borer identical to that illustrated in figure 2. The long hexagonal section iron bar is driven by a water wheel and is equipped with a boring head almost identical with that in figure 1. The cannon is winched forwards on a sledge arrangement exactly as illustrated. One wonders how they disposed of the swarf!

(Anne of Cleves Museum is at Southover High Street, Lewes, Sussex. Tel: 0273 474620 open every day, except winter period when only on Tuesday and Thursday.)

More tumbler information

Terry Gould has some more interesting observations on the use of tumblers.

The Tumbler. Oh dear. I seem to have woke a few folk up, Tumblers for this Rumblers for that.

Eric Angell, Essex is an interesting one on two counts. The first is the use of nutshells. For a medium, I have heard of this before. The second is, while Mr Angells style of vibro cleaner is made for a special purpose, the principle is very simple to achieve. Time permitting, tests will be carried out. This will use the common 1/2 sheet oscillating sander and/or orbital sander. A simple jig or means of holding the sander up side down, an old ice cream tub being used for the container, Velcro would be used to hold the tub in place.

Before leaving the subject, a brief update on some test results, which have now been confirmed by an industrial user (same company who provided photos of industrial version) it has recently come to light while cleaning some brass components were more difficult to work with, i.e. harder to file/drill, after being in the tumbler, more tests were carried out, some material appears to be harder other times not. The industrial uses confirmed that surface hardening can and does take place, even with mild steel.

Material specification sought

Mr. C. H. de Whalley from Croydon seeks clarification regarding a material specification.

Mr. M. Holben's letter (S.A.L. Issue 25 page 72) could have been much more helpful if he had given us details of steels suitable for use as motorcycle fork spindles and identified the dealers that stock them. Which steel should one specify? It should be machinable (even if only just), have maximum strength, require no heat treatment, and be available in Imperial sizes. I have made many such spindles from half shafts, but mostly used those wonderful unused (ex-armoured car?) ones sold by Whistons years ago for about £1 each. But my stock is exhausted at last, reduced to a few knobbly ends.

Mike Holben replies

In reply to the letter from Mr. C. H. de Whalley. The steel which I use for making girder fork spindles is EN 16 T or EN 16 MT, the later machines slightly better. I obtain all my supplies, of steel, phos bronze and alloys from Messrs Engineering Supplies, Nottingham, 111 Church Road, Burton Joyce, Nottingham NG14 5DJ. Tel.: 0602 312853, who advertise in Model Engineers' Workshop nearly every month along with other material suppliers.

In common with Mr. de Whalley I also miss Whistons for supplies of surplus imperial nuts and bolts etc.

Soft centre with certainty

From Michael Dover of Truro.

Mr. C. T. Owen of Norawal (S.A.L. page 63 issue 26) has trouble recognising Hard and Soft centres.

I had the same trouble until I ground a flat on the small end of the soft centre and letter punched "S" on the flat so formed.

Buy a new pair and treat one as above, end of trouble.

Obvious, when you are told.

This explanation from Frank Tobin of Staines.

From time to time I look through my back copies of M.E.W. to re-read articles that I may have glossed over at the time.

In an article on making a scribing block the writer describing the commercial item shown in the photograph says:- "...(the pillar) has an embellishment on the top, an idea which can be copied if the reader so wishes. It serves no useful purpose".

The embellishment he refers to is a ball turned on the top of the pillar and although its purpose is not obvious it is indeed a clever piece of ergonomic design.

We have all encountered the frustration of trying to fit a drilled object onto a shaft which is a sliding fit for the hole. Get it a tiny bit angled and it will jam. The same object will not jam on a ball of the same size as the shaft.

This is where the pillar ball comes into play. When you are fitting something onto the pillar it first slides onto the ball and is then perfectly lined up for its entry onto the main part of the pillar.

A medal for the man who first thought of it.

Milling on the drilling machine?

Two letters on the subject.

First Peter Annely replies to Chris Ford's letter.

Congratulations on continuing to produce a first rate publication which appeals to people at all skill levels. I particularly liked the article in issue 25 by Malcolm Leafe (vertical belt grinder). The humour was good and the plan easy to follow, mine is well on the way to completion.

Chris Ford's letter on milling safety (S.A.L. issue 25 page 72, which arose from my previous letter) is very pertinent. I perhaps should have mentioned that light milling on a drilling machine causes the drill chuck to fly off, at best breaking the cutter. After losing several cutters this way I modified the drill chuck to make it captive. After eighteen months use it has remained firm.

And from Mike Price of British Columbia.

Chris Ford is, in theory, quite right when he states that "a drilling machine is for drilling holes with, nothing more. milling should not be done on a drilling machine." True, the quill and spindle bearings of your average bench drilling machine are not designed to take the heavy side thrust loads which milling operations entail. But, as amateurs, we very often do things we're not really supposed to do, and provided we take reasonable care and work within the capacity of our machines, we'll get the job done safely. Not every amateur owns a milling machine (an expensive piece of equipment), so, faced with a simple milling job, we use whatever means we have available.

By analogy, one might say "a lathe is for turning, nothing more". However, I think all of us have probably used our lathes at one time or another for purposes that would make the professional blanch - everything from milling to grinding to winding springs - and a well-built drilling machine, even though not designed for the job, will ably perform light, and I emphasise light, milling operations without harm either to machine or operator, provided sensible precautions are taken - Chris Ford's stricture notwithstanding.

Tumbling experience

Derek Walters of Tetbury describes some of his experience using tumblers, both in industry and at home.

I have had experience with the use, design and commercial operation of a tumbler in two firms in which I worked. The first firm made transmission parts and the second was manufacturer of rotating electrical machines.

I designed a tumbler to take casting flash from cast and forged brass carbon brush holders, after which, they were broached for the brushes and drilled and tapped to retain the brush springs and flexible tags.

The tumbling also gave the holders a nice clean matt finish which was universal to all parts. After this they were water washed and hot air dried. Alloy parts such as bearing caps were similarly treated as were small fabricated parts in brass and bronze.

Small fabricated parts in steel requiring minimal machining were frequently so treated, after washing were then treated with a de-watering fluid. I have seen tumblers at machine exhibitions but have never seen a dry running machine, perhaps I have been blinkered! The machine on page 34 I assume from the text is dry running.

You asked for readers experience and I hope that the following will be of interest.

My machine was made to do a similar job to that described above and has proved its value on several occasions as it has cleaned up many small brass castings for a local clock maker and repairer. It was lined using the scrap inner tube from a big lorry inner tube, cut to size and stuck to the walls with a Bostik shoe glue (that was the only glue I had at that time likely to stick it - possibly nitrile rubber). The tube was begged from my local tyre depot. The tumbling medium used is lead shot and water for alloy castings. Worn granite chippings such as used for road re-surfacing for brass and bronze with either water or 'soap water'.

Mild steel balls ¼in. dia. with 'soap water' for steel or C.I., the latter to be treated as described above. These balls can be purchased from any good bearing factor in quantities of 100 lots. I do not favour hard balls. To remove scale from black steel parts I use new granite chippings, re-using them as described above.

A non-flammable liquid is always used to combat any possibility of a dust explosion. There are two drums in use, a round one for polishing and a hexagonal one. My set-up is similar to fig. 5 but driven as in fig. 7 using my hand drill with a home made thyristor speed control, so the final speed can vary 0-150 rpm, the range used is 10-60 rpm.

The round drum was made from ex. ⅝in. thick yellow plastic gas pipe 9in. dia. x 14in. long with rubber lined end plates as fig. 5, the pulley screwed to the end plate as fig. 7.

The machine bed is in fact an old wood lathe, this should appeal to readers, two machines for the price of one, you can still use it for your pattern making.

If you want to clean up nails I would use new granite chippings which should be safe dry tumbled, I would not ever use steel wool dry as we know what can happen to it - bang, especially with dust present, better safe than sorry.

Similarly I would not use steel swarf because of the danger to getting a bit of it under the finger nail when unloading the drum, granite chips are so much safer. Sand varies so much in hardness and grain size that I find it tends to clog and can also cause long scratches, so this has been dropped in favour of the previous mentioned media. By using a water medium the dust is held in suspension as a thin sludge and can be easily washed out.

(The figure numbers referred to in this letter refer back to the original article -Ed.).

Soft jaws

Stan Pettifer of Pentrecwrt states a preference for the use of soft jaws in three jaw chucks.

In reference to the remarks of Jonas Beausang in Scribe a Line issue 22 I have sometimes pondered on the limitations of small lathe chucks so wish to support Jonas's comments.

After the war in 1947 I returned to the Daimler Co, Coventry to work in "The Aero Shop". I was on a chucking Drummond Capstan lathe fitted with a bar feed and a 12in. chuck. I was on short runs, anything from 5 to 500, it was piecework, all items 100% inspection so they had to be right. There was no time to "muck about clocking items" on 2nd operations.

I kept a box with approx. 10 sets of soft jaws for 2nd op. work. It didn't take many minutes to pick up the nearest diameter set, fit them and bore out a few "thou" to exact size and dead true. Jaw life was very good as so little was taken out, also they were double ended.

I have recently retired and am getting one or two bits together to do a bit in a pastime sort of way. If there are such chucks available in say 5in. diameter in my opinion they would be an asset and superior to what is normally available on small lathes. Anyone out there know? (Many suppliers sell soft jaws as an extra? - Ed).

QUICK TIP
Simple depth gauge

To measure the depth of small blind holes, use a piece of screwed rod or a long screw with a nut on it. Simply insert the screw into the hole until it bottoms, then turn the nut until it touches the surface. Remove the screw with nut , without moving the latter, and measure the depth with a steel rule. A more ambitious gauge would be to use a screw with a thimble like a micrometer. To this end it is useful to know that ⅛ in.BSW is 40 TPI, ¼ in.BSW is 20 TPI , as is 3/8in. BSF.

Joe Ginn

Easy metric screwcutting

Arch Gibson of Beachmere, Australia, suggests a method of cutting metric threads which still permits the half nut to be disengaged.

It is definitely possible to cut any metric pitch thread on a lathe with a 8 TPI leadscrew, engaging and disengaging the half-nuts, with the proper set-up and operated in the correct sequence.

Most endorse the use of a single marked thread dial (T.D.) to avoid confusion. Have known the theory of this method from my apprenticeship days (1934-39). This method of screwing metric threads could have been deleted from the apprenticeship course and lapsed into obscurity.

Three main components are required:-

1. A single marked T. D.

2. A 40 tooth gear to mesh with the T.P.I. leadscrew.

3. A lathe saddle stop with an extended adjusting screw.

Depending on the make of lathe most likely the T.D. unit will have to be re-designed to suit the 40 tooth gear. (I have a standard lathe unit and a single marked unit for metric only). The 40 tooth gear which free-wheels on the 8 TPI leadscrew is made from 3 mm (0.118in.) aluminium plate.

To mark the T.D. with any desired metric pitch gear train set up. Run the lathe and engage the half-nuts, leave engaged when the lathe is stopped. Mark the T.D. and unit body with a scriber or a small half round file. By following the details set out below, one shouldn't have any trouble screwing metric threads. It removes the hassle of leaving the half-nuts permanently engaged from start to finish of screwing a thread.

1. With job to size, set up gear train for chosen metric pitch.

2.Replace standard lathe thread dial (T.D) unit with metric thread dial (T.D) unit.

3. For right hand thread, position lathe stop on tail- stock side of saddle, left hand threads on chuck side of saddle.

4.With tool set for screwing and clear of job, start lathe and when T.D. mark and datum mark coincide, engage half-nuts and run lathe until tool is midway between job and tail-stock centre and stop.

5. With half-nuts still engaged, bring the lathe stop up to saddle and firmly clamp to lathe bed.

6. With hand wheel firmly holding the saddle against stop, to test the engagements of the half-nuts (in and out) must mesh freely. Adjust stop screw if required.

7. Disengage half-nuts, run lathe in reverse, with saddle against stop, until T.D. mark is 3 to 4 mm beyond the datum mark to eliminate any lost motion between lathe, spindle and T.D. mark.

8. Set tool for 1st cut, run lathe and engage half-nuts when T.D. mark and datum marks coincide and screw to required length of thread. Remove tool, disengage half-nuts and stop lathe immediately.

9. With hand-wheel bring saddle back firmly against stop. Set tool for next cut.

Reverse lathe spindle until the T.D. mark is positioned 3 to 4 mm beyond datum mark and stop lathe.

10. Start lathe forward and engage half-nuts when T.D. mark and datum mark coincide.

11. Repeat No. 8, 9, 10 until thread is to size.

12. To check thread and with tool well clear, the saddle may be hand wheeled in either direction.

13. Until the job is ready to be removed, the lathe must not be run in either direction outside the confines of the above, otherwise it is possible for things to get out of kilter.

(It took me some time to understand the mathematical reasoning for this method working, but I now feel confident that it does. However, the need for a special thread dial indicator having a 40 tooth gear would seem unnecessary, though one with a single mark will help to avoid confusion. What do other readers feel about this, and do they have any knowledge of the method? - Ed.)

Chain drilling, further thoughts

From Mr. M. R. Dickerson of Quedgeley.

I found Pat Twist's article on chain drilling, M.E.W. No. 25 page 40, most interesting and follow a similar practice myself, except on the second time around I swap the ¼in. drill for 17/64 inch. Any holes still joined I separate with an Abrafile in a hacksaw. With regard to hacksaws, I have three (cheap ones of course) with a different blade in each (teeth per inch), also one with an Abrafile and one with a carbide blade for ceramics. This allows me to have the blade I want ready to hand.

Stainless Steel, cleaning and polishing

Scribe a Line is not just for private readers. Vic Barrott of Medina Art Castings seeks some information.

The article on stainless steel was most useful. Could you or any readers advise on a chemical or electrochemical method of cleaning and polishing 304 stainless steel. We have available a chemical laboratory but need a working recipe.

Also we are trying to find a method, again chemical or electrochemical, of electro stripping (removing the plating) nickel from mild steel and re-plating nickel onto mild steel without using cyanides.

Any formulae or references would be appreciated.

Machining spherical surfaces

David Turner of Derby suggests a delightfully simple way of turning spherical surfaces, convex or concave. It is particularly appropriate to those of medium to large radius.

Ted Hartwell machined the spherical surface for his optical punch (M.E.W. No. 25) using a form tool. Thirty or forty years ago the Model Engineer described a beautifully simple method of machining spherical surfaces that I have often used.

Make a centre punch pop mark in the cross slide and another at the same height in the headstock (or in a piece of steel clamped to the headstock or lathe bed). Next cut a piece of thin rod to the length of the radius to be machined and sharpen each end to a fine point. Support the rod between the two centre pops and adjust the cross slide to bring the rod parallel to the axis of the lathe. Next mount a pointed (or small-radius) tool exactly at the centre in both vertical and horizontal planes. Adjust the top slide so that the tool is clear of the work. Now, while applying a gentle pressure to the saddle handle with one hand, wind the tool towards you. Feed the tool with the top slide and "face" the work. Repeat, always keeping the rod trapped between its centre pops. The rod makes the cross slide and the tool move in a circle. For those wanting extreme accuracy: the resulting radius is equal to the length of the rod minus the radii of each end (if any) and minus the radius of the tool point.

In use the rod is only angled towards the operator. This means that the centre pops can be made with the punch at an angle - pointing away from the operator for the pop mark on the headstock and towards for the other one. The rod can also be pointed lopsidedly (or bent into a shallow S). With both these a total swing of 90 degrees is possible allowing a complete hemisphere to be machined. If more than a hemisphere is to be machined, or if a spherical depression is required, the rod can be supported between the cross- slide and the tailstock.

A tool I have used for finishing wooden balls - but not ensuring exact size - consists of a steel tube with a bore rather less than the diameter of the finished sphere. The cutting edge is formed by the intersection of the bore and the tube end. The end can be either a plane surface, easily sharpened on the face of an oilstone to give a negative rake scraping action, or machined to a cone to give a sharper cutting angle. The tool is held in the hand and moved over the surface of the sphere which may be rotated in the lathe or, as in the case of my wooden balls, held in the other hand. Any part of the ball protruding beyond the spherical surface will be preferentially cut.