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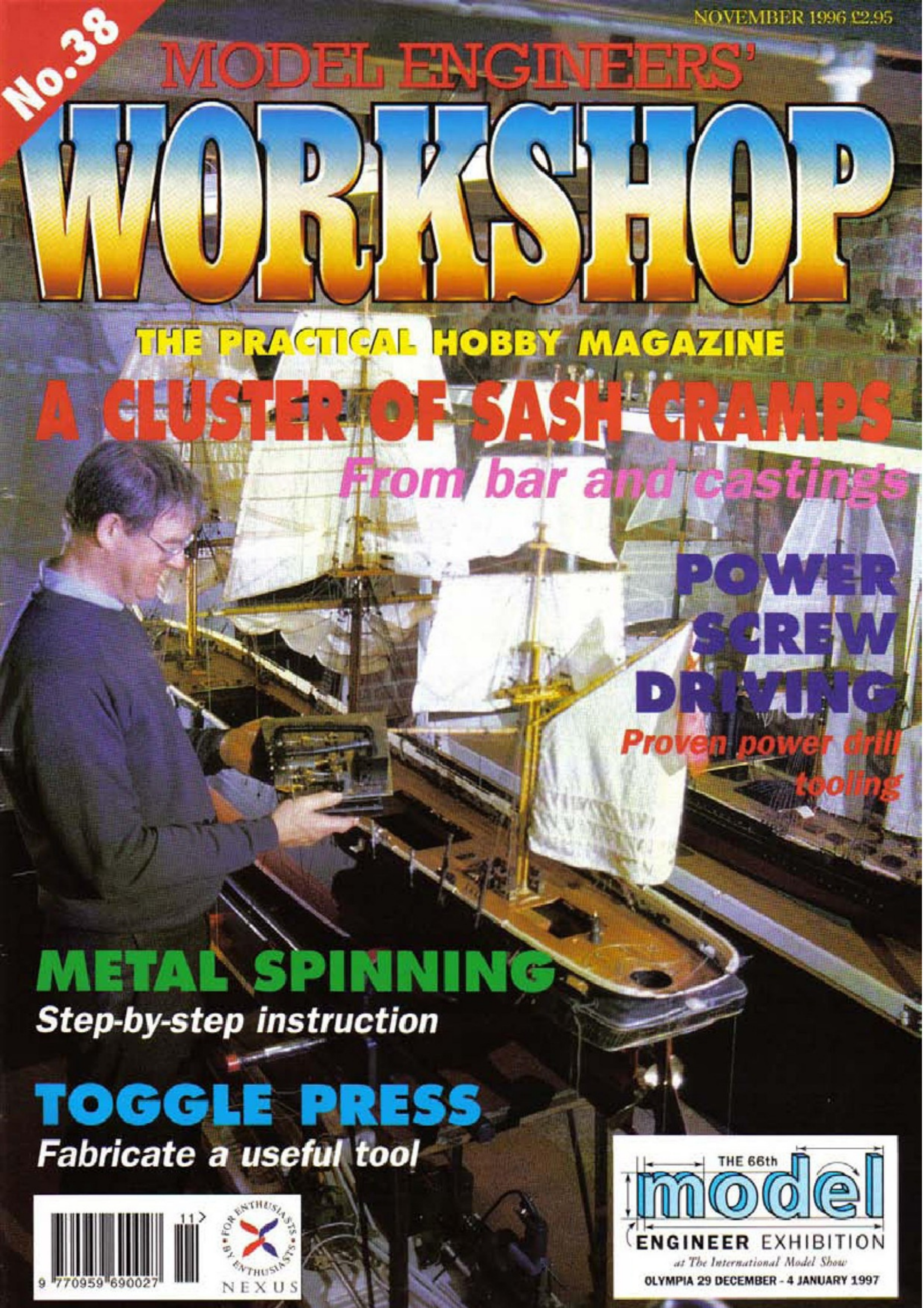
MODEL ENGINEERS' WORKSHOP

THE PRACTICAL HOBBY MAGAZINE



A CLUSTER OF SASH CRAMPS

From bar and castings

POWER SCREW DRIVING

Proven power drill tooling

METAL SPINNING

Step-by-step instruction

TOGGLE PRESS

Fabricate a useful tool

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Issue No. 38

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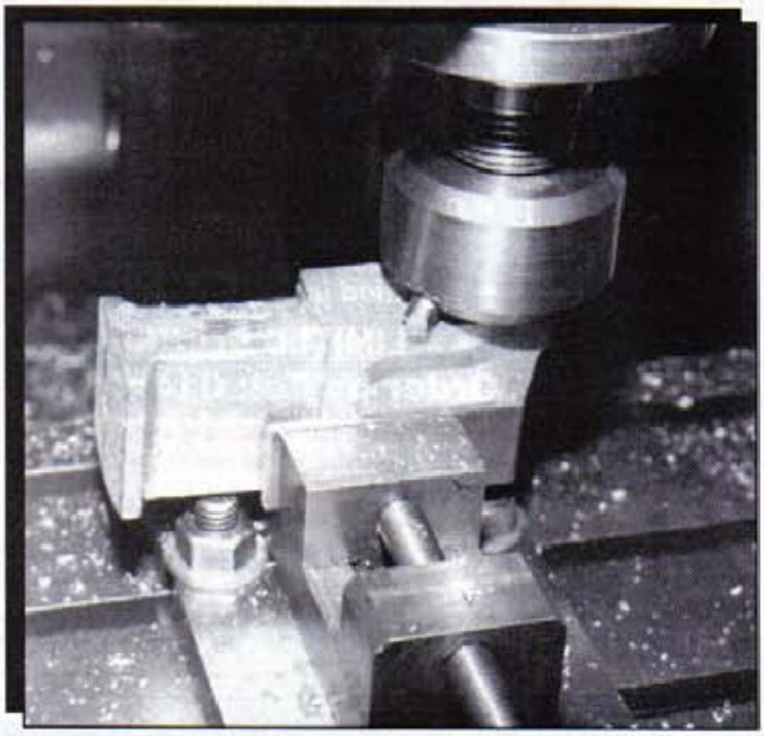
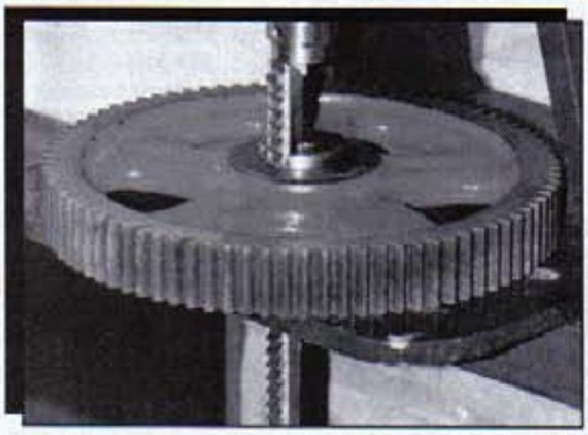


The sash cramps described by David Machin (see page 54) incorporate jaws made from aluminium alloy castings. One of these is seen here being cleaned up by milling.



Facilitating an awkward task, one of the many applications for Alan Jeeves' light toggle press is for keyway cutting. Full constructional details of this useful item of workshop equipment begin on page 22.

On the cover

Will Mowl ponders how best to install the steam plant into the hull of his model of HMS Warrior. A report describing our visit to his 'Shipyard' begins on page 38.

ADVERTISERS INDEX

ON THE EDITOR'S BENCH

As we near the end of the Summer holiday season, opportunities have arisen to spend a few hours in the workshop. This has given me the chance to pick up a few long-standing projects and to edge them a little nearer completion. One has been a bull wheel dividing head for the Myford Super 7, to a design by George Thomas which, in turn was based on one described in *Model Engineer* many years back by Jack Radford, a contributor based in New Zealand. George redesigned this unit to work in conjunction with components from his Versatile Dividing Head, an ever popular design judging from the number seen at exhibitions. Drawings for both of these devices are still featured in the Nexus Plans Service, and castings are available from a number of suppliers.

My version differs slightly from the published design, in that it needed to be modified to accommodate a pair of dividing plates of different dimensions to those specified on the drawings. These plates were acquired from that ever popular source, the club bring and buy sale (unkindly christened by some as the annual rubbish recycling event). To those who are not members of clubs or societies, I can only say that this is one of the highlights of the year, which is anticipated with eagerness by many members. One never knows what exciting find will be discovered, leading to an extravagant bid, backed by the full conviction that the item will form the start of a significant new project. This, of course, will be completed in time for the next *On the Table* night, when it will be greeted with acclaim by fellow members. All too often the reality is that it will be discovered at the back of a cupboard some years later, when it will be dragged along to the next auction, and it will be some other member's turn to inherit it. The hope is that the price received will have kept pace with inflation. Never mind, it all adds to the fun, and now and again, something worthwhile emerges.

Another of the projects has been a highly detailed marine boiler. One of the objectives when designing this was to follow the trend of higher fidelity to prototype practice than is often adopted with many small boilers. A feature is the use of four and eight bolt flanges for boiler fittings and pipe connections, in place of the more familiar nut and nipple type. When properly proportioned, these have adequate strength, as frequently demonstrated by that master model maker, the late Roy Amsbury. If scale demanded a ring of 16BA studs, washers and nuts, then that was what he fitted. No over-size commercial set bolts for him. I recall visiting him one evening, and finding him in his workshop, with his watchmakers' lathe set up on the bench, sorting through a pile of watch gears. He was looking for something suitable for the vacuum gauge he was making for the 5in. gauge Great Western De Ghlen compound. When I examined the backplate for this (no bigger in diameter than a new penny), I was astounded to see that it contained two pipe connections. The instrument was to be one of the duplex unit, with two complete mechanisms in the one case! This is far smaller than I have ever dared attempt, but Roy's writings in *Model Engineer* remain with us, to show that it is possible, and to encourage us.

My still over-size efforts have caused me to work with fastenings of 10 and 12BA. I confess to having started with commercial items, but these are introducing a few problems. Apart from being able to see them at all, I find that, although the available 12BA nuts have the British Standard hexagon size, most of the bolts on sale now have 2.5mm across flats heads. Although these are only about 10% too big (about $8^1/2$ thou.), the difference is quite noticeable, especially on a narrow flange. Studs and nuts are an answer in some places, but these are of no help when the proper fastening is a bolt and nut. Finding the correct size of hexagon stock now seems to be very difficult, as predicted by Tom Walshaw in his lectures on metrication.

Another elusive item is the 12BA open ended spanner. Tubular spanners or nut runners are readily available in these smaller sizes, but for the other types, it seems to be a case of having to make ones own. I did have a bit of luck at the Dorset Steam Fair when, in the auto-jumble I discovered high quality 10BA/12BA long tubular spanners, still in their protective coating and 1943 packing, all for £1 for a box of twelve!

Gas-Air Torches

One of our correspondents, Will Noble of Forres, Morayshire, (see Scribe a Line) enquires about the availability of blown gas-air torches for heating components in the workshop. I recall when these were a common sight, fuelled off the domestic town gas supply. Our school workshop housed a fearsome example, which would set the coke in the forge crackling within seconds. These seem to have been superseded by the self-blown propane or butane torch, and coal gas has, of course, been replaced by natural gas in the 'town' supply. A number of readers have asked for information on gas torches for such jobs as silver soldering and brazing, so an article is in preparation. This is based on the use of liquid petroleum gas fuelled devices, but if anyone has experience of re-jetting a coal gas torch to run on natural gas, or even of constructing a successful unit from scratch, I would be pleased to hear from them.

The Olympia Exhibition

As mentioned in Issue 37, preparations are now in hand for the forthcoming International Model Show, which will include the 66th Model Engineer Exhibition. It takes place from December 29th to January 4th, and entries for both the competitive and loan sections are invited. Once again, I hope that readers of *M.E.W.* will support us as they have in the past, and it would be nice to see plenty of examples of tools and equipment constructed from designs which have appeared in these pages.

Good news on subscriptions

UK readers of *M.E.W.* will be able to benefit from new subscription rates which take effect from November. The new rate will be £15.70 for six issues, a reduction of £2. The address of our subscriptions department is given on page 4 of this Issue.

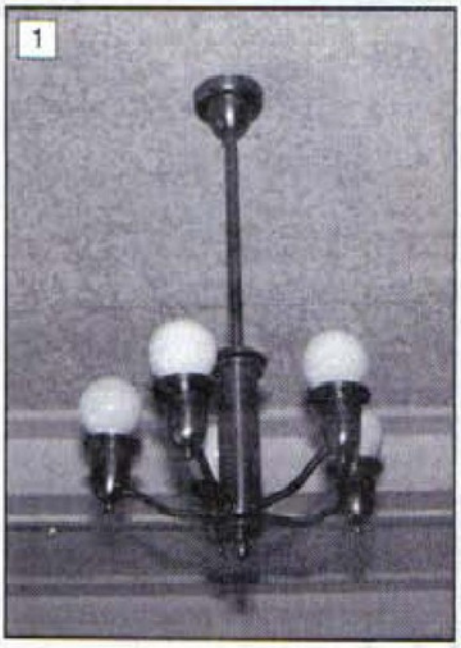
Copyright of designs

In our last Issue, we published an article by David Penney on a clock pinion mill which he had constructed. David mentioned in his article that this unit was a modified version of a machine which used to be marketed by one of our advertisers, Chronos Limited of St. Albans. They no longer make this machine, and indicated that they were happy for us to publish the article. We have been asked to point out by Mr Eliot Isaacs that the original design of the Chronos version was prepared by him when he was involved in that Company.

In common with all designs published in this magazine, permission for manufacture by readers is given on a one-off basis only, as long as there is no commercial implication. Should anyone wish to manufacture any published design for commercial purposes, then agreement must be reached with the holder of the copyright.

METAL SPINNING FOR THE BEGINNER

Australian contributor, Philip Amos decided to learn the techniques of metal spinning. He started by searching for any literature on the subject, then investigated the theory. His subsequent practical experiences are recounted here.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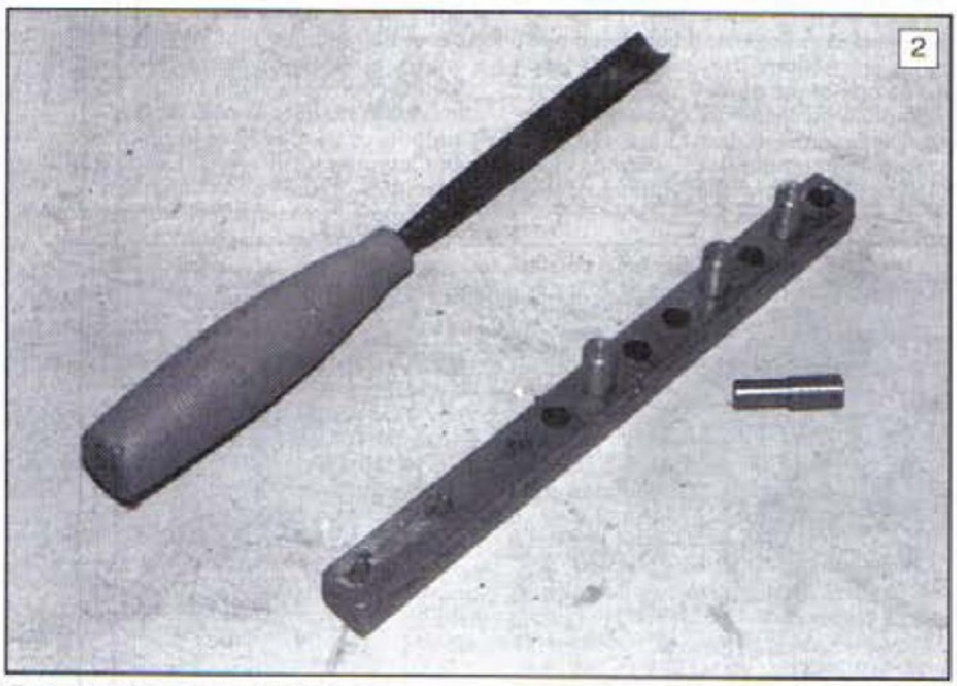

2

Tool rest with pins; wood gouge


3

Tools - 6 & 12 mm spherical roughing, planishing, graver, backstick

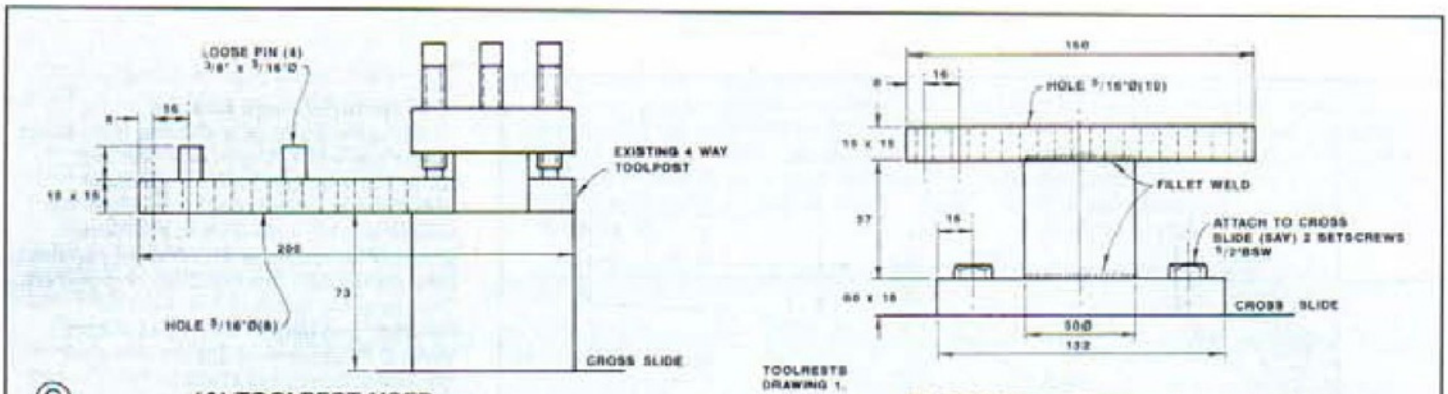
Very few model engineers would have access to deep drawing press facilities, and even if they did, they would seldom find it worthwhile to make up the necessary punches and dies to produce a few long, hollow sheet metal objects for some project. If the depth of the job is not too great - say half its diameter, then the traditional sheet metal techniques - hollowing, raising, or sinking (see reference 4) - can be used. These are slow and tedious.

Thus in commercial workshops, as well as in model work, the fairly ancient practice of metal spinning is adopted. In essence, this involves rotating a disk of metal in a lathe at high speed, and forcing it over a former, by pressure from a hand held, smooth, hard steel tool, levering about a pivot on a slide rest.

Recently I had a need for some sheet metal brass cup shaped pieces, to make light fittings to match others in our house, which are about 75 years old **(Photo 1)**, and thus had to develop the metal spinning skill. I consulted all the books in my workshop library, and found some information in references 1 to 5. Later, I remembered something some years back in *M.E.W.*, and identified reference 9. With the aid of Lautard's index of *M.E.* from 1920 to 1988, my own copies of *M.E.* from 1988 to 1996, and references found in some of the *M.E.* articles I looked up covering 1898 to 1920 in the NSW State Library, I identified some 12 items in *M.E.* on metal spinning. Some of these were merely queries, some irrelevant and some quite superficial. However several were very informative, and are listed as references 10 to 13. I also found some books on metal spinning in the State Library, but these were of limited help. No doubt there are other general books on sheet metal work, with information on spinning, but I was not able to search this out.

Almost all the references warn of various problems, pitfalls and difficulties, but do not give many suggestions about avoiding these, or dealing with them when they are encountered. More or less "have a go and you'll learn by experience".

I had started my project using the Wakeford (Ref. 4) information, which was



(A) TOOLREST USED

(B) POSSIBLE T-REST ALTERNATIVE

most helpful, and later progressed it with assistance from the Jeeves article (Ref. 9, also of great help). However, I found myself in various difficulties, and so set out on the Library search and some contemplation of what was actually happening in the workshop.

Authors such as Wakeford, Jeeves and Lammas (Ref. 13) are obviously expert in this field, although their articles are somewhat generalised. I hope this present one is sufficiently specific to address all the problems I encountered, and how I learnt to avoid some and correct others.

Safety

With a piece of sheet metal whirling around at high speed in the lathe, a careful approach is essential. A leather apron is desirable. Safety glasses or goggles, or a face mask, is essential. I am ambivalent about leather gloves - I just don't like gloves near rotating machinery, so I don't use them.

Equipment

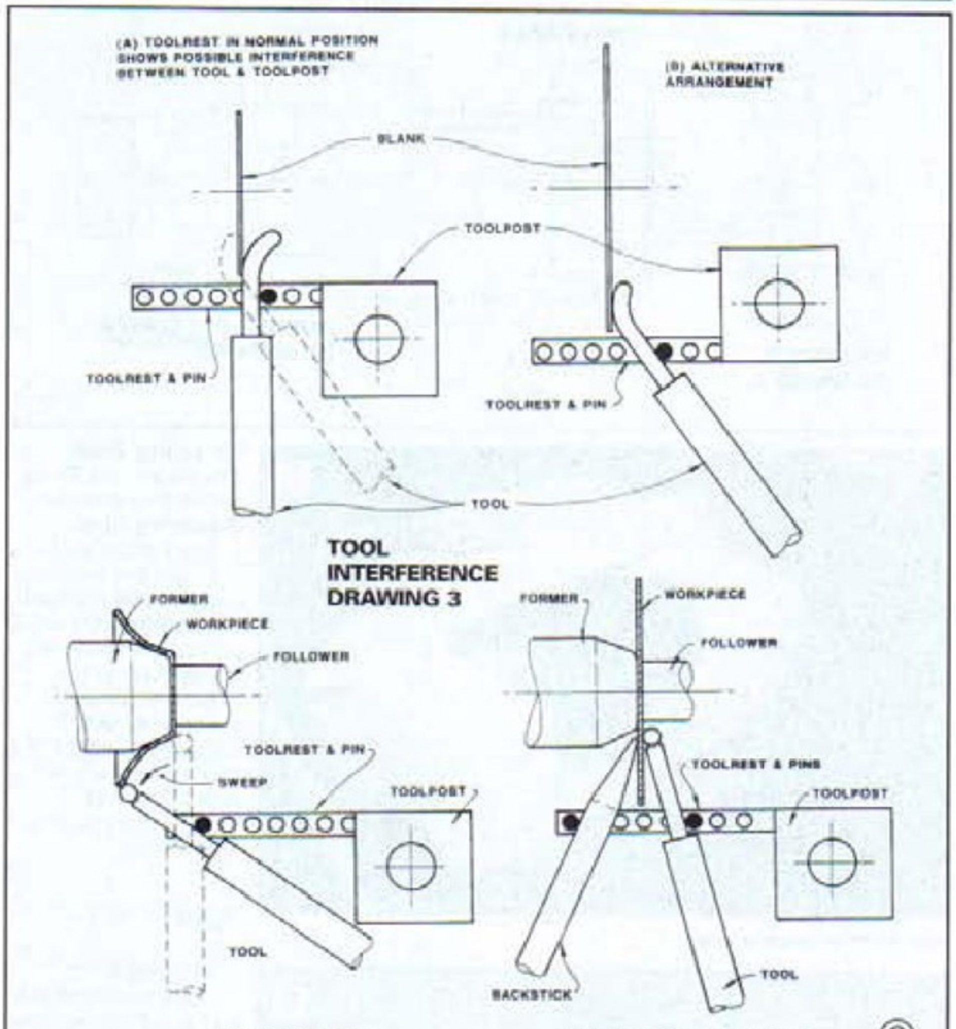
A lathe with strong headstock bearings is needed, and with a reasonable amount of power. Mine is 6in. centre height, with taper roller bearings in the headstock and a 1hp motor. Speeds suggested in the references are 1300 rpm for aluminium alloys, 1000 rpm for brass and copper, and 700 rpm for steel. A rotating tailstock centre is also needed. If necessary this can be home-made (Refs. 4,9,10).

Tool Rest

The pivot support for the tool can be a simple length of steel bar, with holes and pins, fitted in the lathe toolpost as indicated in Ref. 13, which I adopted, or it can be a special T-rest, similarly with holes and pins, which replaces the complete lathe topslide (Refs. 4 and 9).

The pins should be shouldered to fit the holes in the bar without dropping through, and their height above the bar should be at least equal to the maximum diameter of the tools used. In my case the bar is 15mm x 15mm x 200mm; the 8 holes are $^5/_{16}$in. diameter spaced at $^5/_8$in. The pins are $^3/_8$in., reduced to $^5/_{16}$in. diameter, and project $^5/_8$in. above the bar. I made four pins, but usually only two are required. **(Drawing I(a) and Photo 2).**

If the items to be made are relatively small, this bar-in-the-toolpost arrangement is quite satisfactory, but if

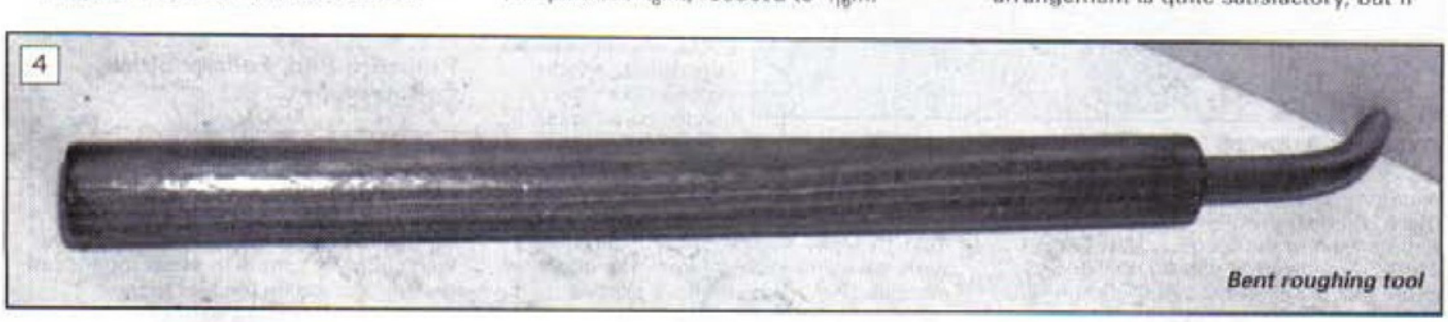


TOOL INTERFERENCE DRAWING 3

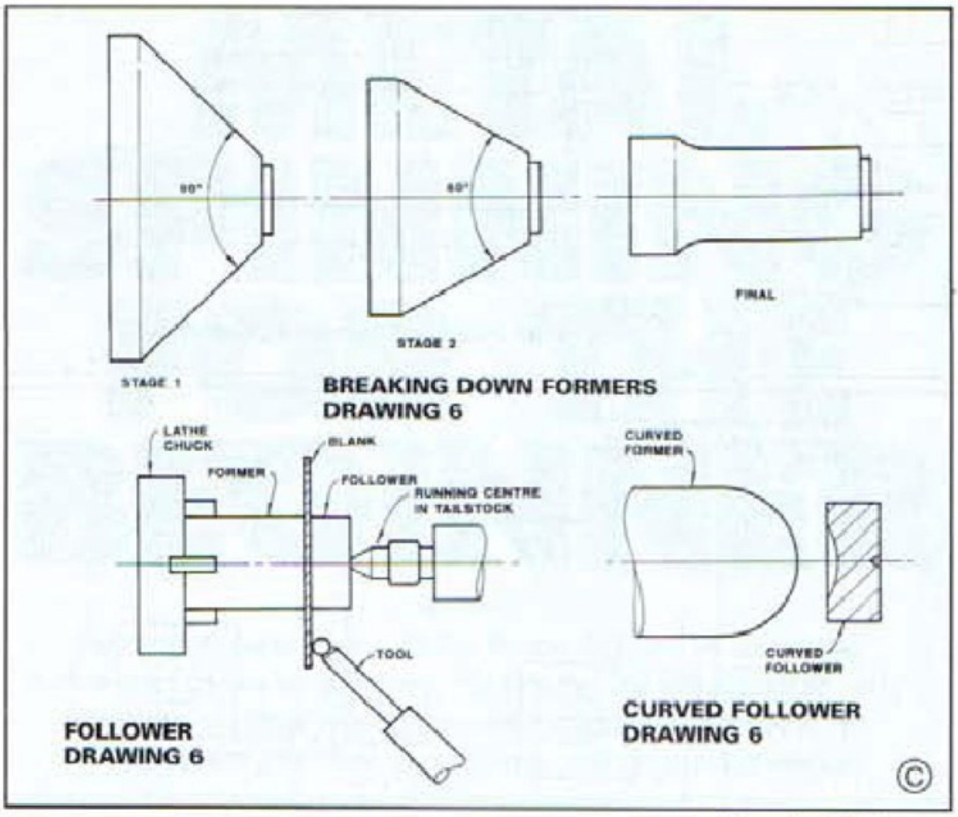
TOOL SWEEP DRAWING 3

USE OF BACKSTICK DRAWING 4

4



Bent roughing tool



BREAKING DOWN FORMERS
DRAWING 6

FOLLOWER
DRAWING 6

CURVED FOLLOWER
DRAWING 6

Fire brick annealing cave

Blank after hollowing

wider sweeps of the tool are necessary, there can be a problem of the tool or handle fouling the toolpost **(Drawing 2(a))**. Sometimes, it will be possible to avoid this problem by mounting the tool rest on the operator's side of the toolpost **(Drawing 2(b))**. Otherwise, the T-rest would be preferred **(Drawing I(b))**.

The height of the tool rest bar should be such that the tool can comfortably work on the centreline of the former, or be angled down somewhat. Ref. 11 suggests applying the tool to the work at about 7 o'clock looking towards the headstock.

Tools

a) Length

The recommended tool length varies from 12in. with a 24in. handle (Refs. 3 and 9), to conversion of an old chisel, 6in. with 6in. handle (Ref. 2). What is needed is the ability to pivot the side of the tool on the pin in the rest, and sweep the whole of the blank **(Drawing 3)**. Thus the blank radius plus about 1in. might be an appropriate length exposed from the handle. If you want to operate the tools in the traditional fashion, with the handle under your right armpit, it will probably require a handle length of 18in. to 24in.—say overall 36 inches. My tools have 3in. exposed from 1in. diameter handles 12in. long, and have proved satisfactory for my project.

b) Materials and Shapes

My spinning tools are made from silver steel - one each of $\frac{1}{4}$in. and $\frac{1}{2}$in. dia., turned to a ball end with a spherical turning attachment, and two of $\frac{1}{2}$in. dia. forged to a bent shape and a flattened shape **(Photos. 3 & 4)**. All were polished, then hardened right out, then re-polished. The tools are inserted 2in. into the handles, and held in with epoxy resin. Various references suggest bronze or hardwood tools, but I doubt their efficiency.

In addition to the spinning tools, I made a graver by grinding a piece of 5mm square high speed steel at a 45deg. angle across one corner, and silver-soldering this into a hole in the end of a piece of $\frac{1}{2}$in. diameter mild steel — again exposed 3in. from a 12in. handle. A backstick was made from a piece of $\frac{3}{4}$in. diameter wooden dowel by cutting it to a 2in. long wedge shape at one end. Its use is shown in **Drawing 4**.

Formers, Mandrels and Chucks

These terms are interchangeably used by different authors. If many items are to be made to the one pattern, it may be best to make the former from mild steel, with a polished finish. Its dimensions and shape should correspond to the inside of the required finished article. However, for general work hardwood seems to be perfectly adequate.

Depending on the shape, the former may be made with its own chucking piece incorporated, to allow it to be held in the 3 jaw lathe chuck. Alternatively, it may be arranged to attach to a separate chucking piece. I have used both practices for various items of my project.

References 5 and 9 draw attention to the use of one or more 'breaking down' formers, as part-way operations towards production of a deep article. **Drawing 5** shows this concept. In my case, I used one 60deg conical breakdown former towards the making of the cup shaped articles, as suggested in Ref. 9.

Refs. 2,4,5,9 & 10 mention the use of formers which can be dismantled into a number of pieces, to remove from a finished part which is smaller at the 'mouth' than towards its closed end. I have not tried this technique, but it seems self evidently practicable.

Later I shall discuss removing work from a normal former, which is not always easy to do, but there are some things which can be done to facilitate later removal. When it is acceptable to the design, shoulders on the former should be generously radiused and cylindrical parts might have some draft (as for casting).

Pressure Pad, Follow Block, Follower

Again, these terms are used interchangeably by different authors. Its function is to hold the blank firmly against the end of the former, so that the blank is both held in axial alignment and rotated with sufficient torque to offset the friction loading applied by the tool to the workpiece. **(Drawing 6)**.

In the simplest case, where the end of the former is a flat, perpendicular to the lathe axis, the follower is similarly flat. If there can be no hole in the workpiece, then the follower must exert sufficient pressure on the work against the former, so that friction drive can rotate it. Some authors suggest the use of a piece of emery cloth between the former and blank to enhance this drive.

A blank with no centre hole should be roughly centralised axially between former and follower, with minimal pressure applied to the latter. With the lathe rotating very slowly, a piece of wood applied radially to the blank can be used to centralise it. Full pressure must be applied to the follower before the lathe is run at full speed for the spinning operation.

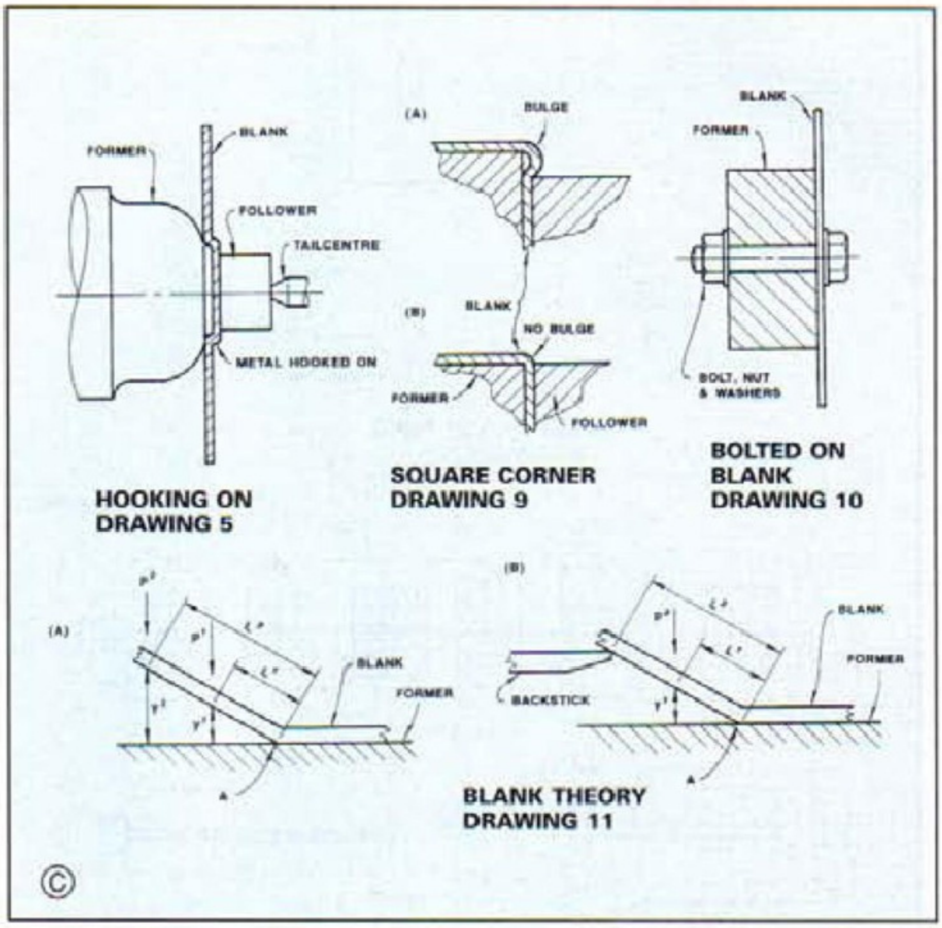
When there is no axial hole in the blank, there is sometimes a step in the former, and when this is enveloped by the blank it is said to be 'hooked on'. This prevents radial movement from then onwards **(Drawing 8)**.

If the end of the former is curved e.g. hemispherical, then the follower must be similarly hollowed out to match the curvature **(Drawing 7)**.

Some authors suggest using just the running centre pressed directly against the blank, but I have had no success when trying this. I have used a small diameter steel follower, centred on one side, and with an axial rod on the other to engage a hole in the blank and in the former, to ensure a positive drive to the blank. I have also used with this, an internal/external star washer between follower and blank. This has proved very effective, although it leaves tooth marks on the blank. Once sufficient blank material has been moved along the former to produce adequate friction to rotate the blank against the load of the tool, then the star washer is no longer needed and may be removed.

If a dead square corner is being attempted around the end of the former, then the diameter of the follower must be the same as that of the former, otherwise bulging on the end is likely to result **(Drawing 9)**.

Where a substantial hole in the job can be tolerated, the follower can be dispensed with if the blank can be through bolted on to the former. It is preferable still to put a centre hole in the bolt head and to use this with the tailstock running centre for support for greater stability and to avoid



HOOKING ON
DRAWING 5

SQUARE CORNER
DRAWING 9

BOLTED ON
BLANK
DRAWING 10

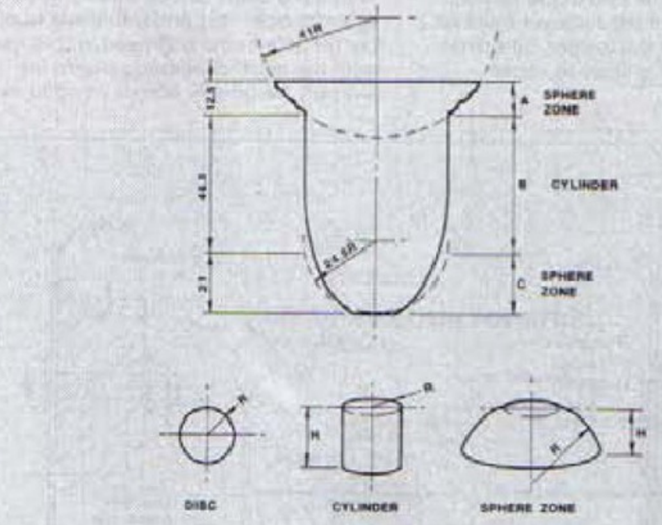
BLANK THEORY
DRAWING 11

Cup Shape Statistics   Surface Area = 13616 = "A"

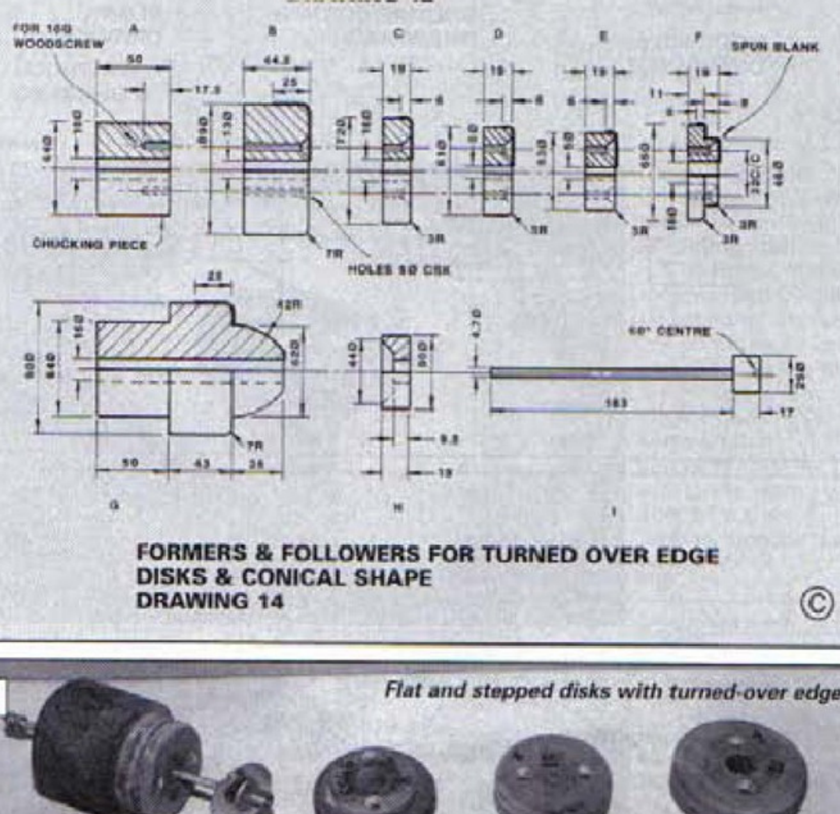
Blank No	Blank Diameter	Blank Area	Cut Off Dimensions Thick.	OD	I.D	Width	Area	Final Net Area	% Less Than "A"	Remarks
1.	180	25457	(i) 1·25	180	155	14	7370			Periphery Method.
			(ii) 1·15	149	130	11	4823			
			(iii) 1·05	128	108	14	5192			
			(iv) 0·85	95	71	19·5	5087			
					Total		22472	2985	78	
2.	132	13690	(i) 0·85	131	100	18	6534			Equal Areas Method.
			(ii) 1·00	103	80	18	5176			
					Total		11710	1980	85	
3.	110	9507	0·75	105	70	23·5	6463	3044	78	Earlier Experience Method.
*4.	100	7857	0·90	76	70	11	2524	5333	61	
5.	100	7857	0·93	75	70	9·5	2165	5692	58	
6.	100	7857	1·05	74	70	5	1131	6726	51	
7.	100	7857	NIL					7857	42	

* 2nd attempt – 1st cracked: see photo

DRAWING 13



CUP BLANK AREA
DRAWING 12

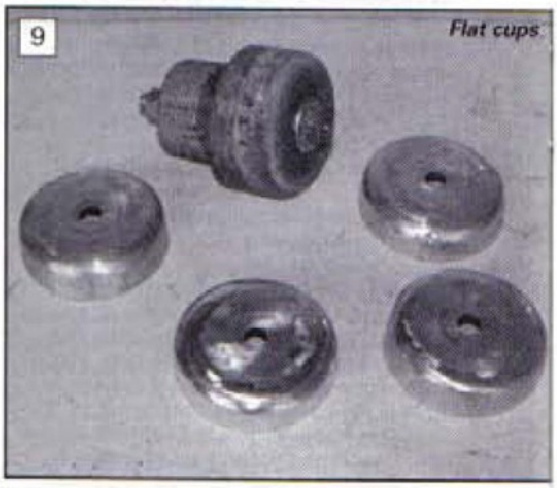


FORMERS & FOLLOWERS FOR TURNED OVER EDGE DISKS & CONICAL SHAPE
DRAWING 14

7 *Flat and stepped disks with turned-over edges*

Conical shape

8



9 *Flat cups*

undue strain on the headstock **(Drawing 10)**.

Theory

To take up a new form, the material must plastically deform; it must be stressed to exceed the elastic limit or it will merely spring back. That is it must exceed the yield point for steel or the proportional limit for non-ferrous metals.

For those who would like to understand some of the theory behind this, Appendix I contains the necessary calculations.

What are we to deduce from all this figuring?

I. It is important to progressively make the blank lay along the former from the centre outwards, in order to reduce the length we are trying to deflect.

II. The backstick magnifies the deforming force applied to the blank where it contacts the former.

III. The outer part of the blank is best kept radial as the work progresses, in order to allow access for the backstick for as long as possible.

Blank size

The maximum disk OD is limited by the centre height over the lathe bed, but also by the need to be able to position the tool pivot support in a suitable location. This latter requirement will be affected by the distance towards the operator that the cross slide can be retracted.

Most of the references warn against excess diameter for the blank, as any unnecessary metal hinders the movement of the material and also leads to crinkles and ripples in the workpiece, reverse bending (curling at the edge) and edge cracking.

As a starting point for determination of the blank diameter, various of the references suggest using the axial periphery of the finished workpiece, measured for example by a piece of soft copper wire bent axially around the former and then straightened out for measurement. For deep workpieces, this yields a value much too high - refer to the example below.

Ref. 7 mentions the theories of Equal Volumes and Equal Areas. It is self evident that the volume of the material of the job at the finish must be equal to the volume of the blank at the start. In the home workshop situation, it is hardly possible to assess accurately the degree to which the thickness of the material will be increased (unlikely) or decreased, so for this present exercise, it is assumed constant. For this assumption, the surface area of the finished job will equal that of the blank at the start. As will be shown below, the action of working the metal down to conform to the shape of the former does, at the same time, significantly reduce its thickness.

Consider the cup shaped example in **Drawing 12**, which is to be spun in 1.2mm (18 SWG) brass. To calculate the finished job surface area will require some approximations - it can be thought of as two pieces of spheres joined by a cylinder. Useful area formulae from Ref. 14 are -

Disk	πr^2
Cylinder	$2\pi rh$ (for curved surface)
Spherical Zone	$2\pi rh$ (for curved surface)

For the example -

Part a (zone) $2\pi rh = 2 \times {}^{22}/_{7} \times 41 \times 12.5 = 3221$

Part b (cylinder) $2\pi rh = 2 \times {}^{22}/_{7} \times 24.5 \times 46.5 = 7161$

Part c (zone) $2\pi rh = 2 \times {}^{22}/_{7} \times 24.5 \times 21 = 3234$

Total A = 13616

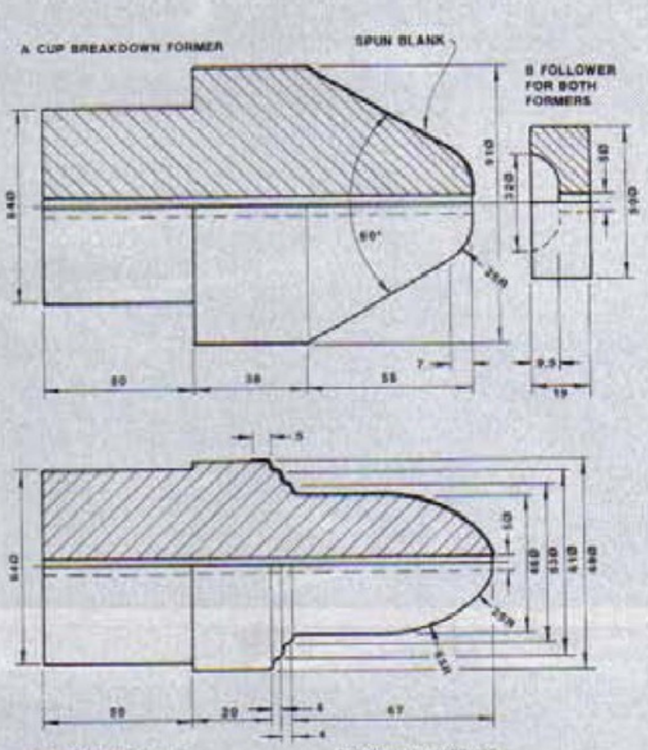
The equivalent area of a disk = πr^2

Thus $r = \sqrt{(13616/\pi)} = 66$

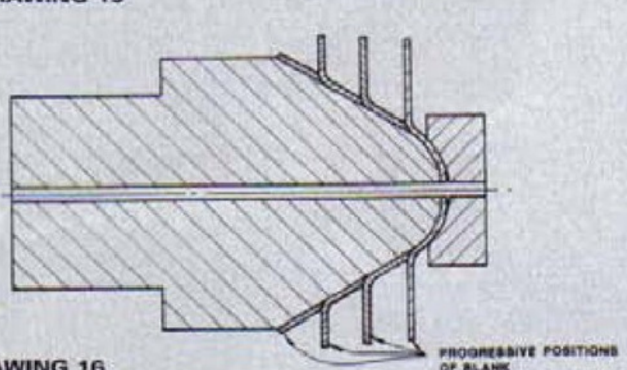
Using a copper wire to measure the periphery p = 96. This yields a disk diameter = 96 x 2 = 192, for which the area = 28965. This is more than double the total area A arrived at above.

On the actual job, I started with 180mm diameter, and in the course of the operation sawed off, in turn, annular rings of dimensions as shown in the tabulation (including the final trimming operation) - all curved in section. The areas of these rings are computed as mean diameter times width by π. The results are tabulated in **Drawing 13**. The tabulation shows that the pieces cut off form a significant part of the total blank, and the final job area has only been achieved by considerable thinning taking place.

Nevertheless, in my view the equal areas method recommends itself as the way to go. If there is only one item to make, then the use of the equal areas method will ensure that at least there is sufficient material in the blank to do the job, but probably some will have to be trimmed off at the finish to bring the job to size. However if several items of the same pattern are to be made, it is possible to try progressively smaller blank diameters, each depending on the experience with the previous size. In my case I needed seven of these cup shapes. My first try, using the axial periphery method, yielded a blank diameter of 192mm, but I decided that 180mm would probably be more than sufficient, and so it transpired! The next one tried was 132mm diameter from the equal areas method, which also proved excessive. The third was 110mm, and the remaining four were all 100mm. These results are included in the tabulation, to



DRAWING 15



DRAWING 16

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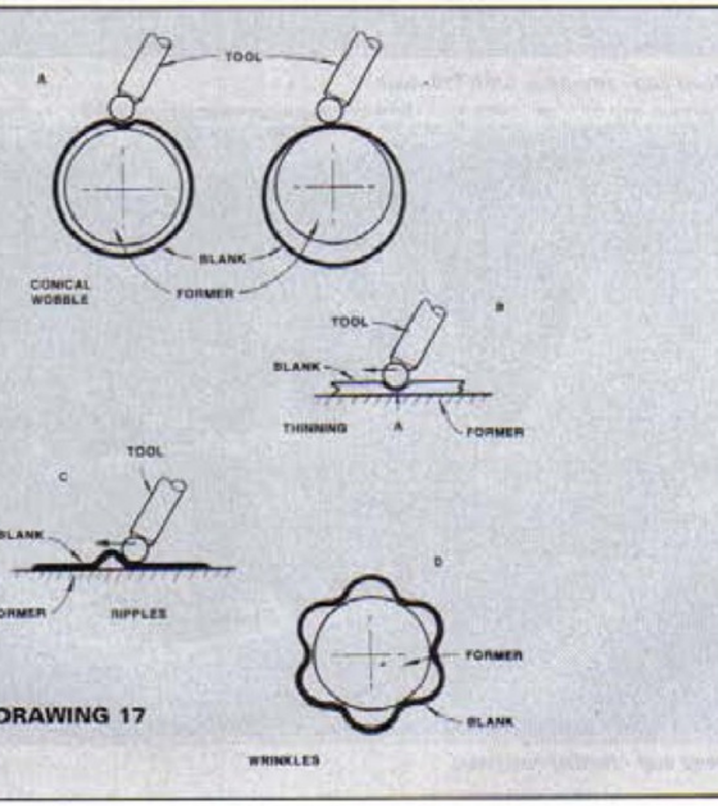

DRAWING 17

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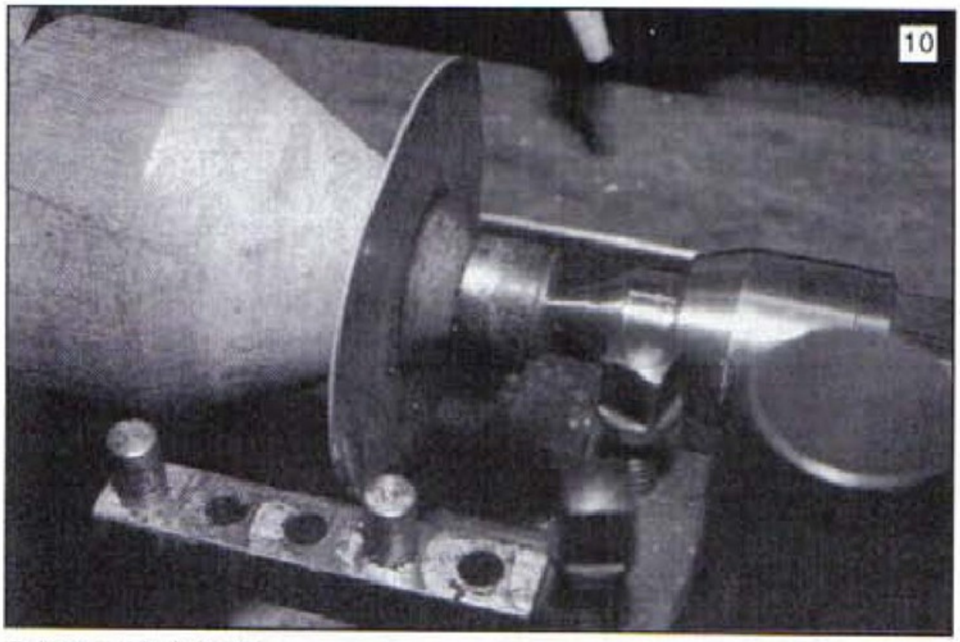
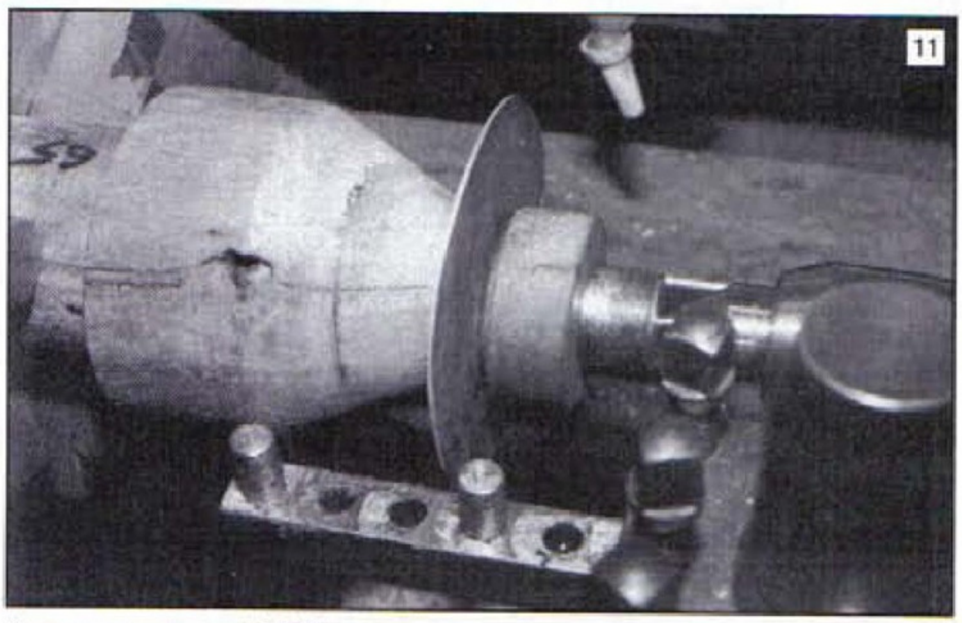
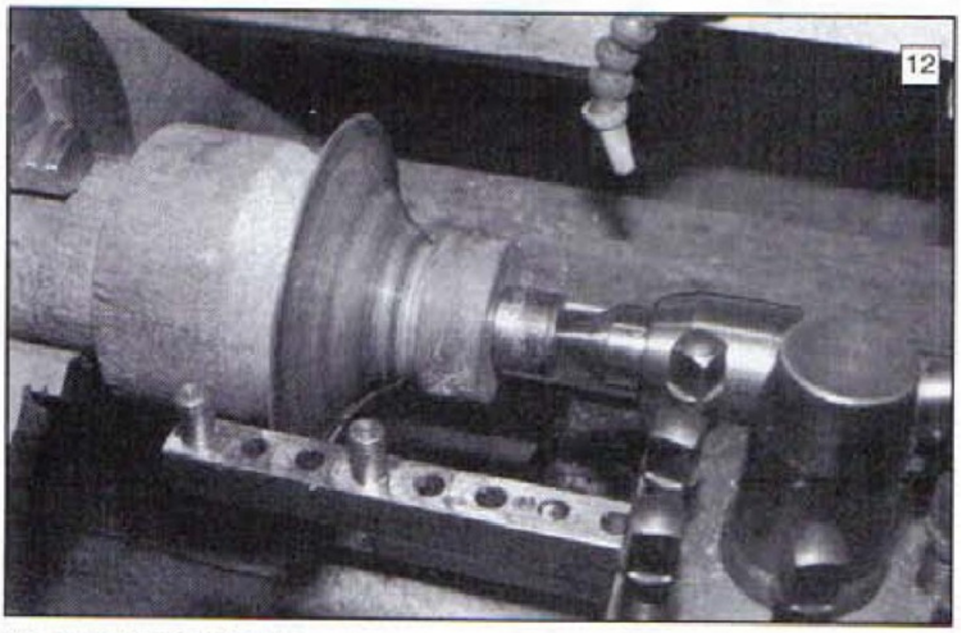


Deep cup - blank at start



Deep cup - progress with follower



Deep cup - further progress

demonstrate the point. Clearly there has been a great reduction in thickness for these reduced diameter blanks to be worked out to form the final job shape, although the measured thicknesses of the cut off pieces cannot accurately reflect the true thickness of the remaining part of the blank.

The seventh item was made from a blank from a different sheet of raw material, and although worked and annealed the same way as the others, it did not stretch as much, and only just made it to the final axial dimension. Thus it is suggested, to avoid disappointments, only use diameter reduction experience for material coming from the same sheet. Regard material from a new sheet as starting again —in this case, I would revert to the equal areas 132mm diameter.

Material Thickness

Various references suggest a useful range of material thicknesses from 1.6mm (16 SWG) to 0.5mm (26 SWG). Metal thinner than 0.5mm seems to tear easily. From my experience with 1.2mm (18 SWG) brass, I would suggest that the thickest used be 0.9mm (20 SWG), as it is very difficult to make the thicker material flow when a deep job is being made, despite frequent annealing.

Annealing

For successful spinning, the material must be in a soft state. Brass, copper, aluminium alloys and steel undergo work hardening to a greater or lesser extent, so it becomes necessary to frequently anneal the material for the spinning process to continue. Ref. 2 states "in no time at all, the disk will refuse to play - so knock off and re-soften". While it may be tiresome to have to continually dismantle the workpiece from the former and carry out the annealing, it is an essential part of the spinning process.

Brass, copper and aluminium alloys can be annealed by bringing to dull red heat, then plunging into water. Some references suggest delaying the quenching until the piece is no longer red. Because the actual rate of cooling is not important, it is not necessary to have the whole of a large workpiece red at the same time - sometimes difficult to achieve - as long as each section has reached red heat, all should be well. Steel must be heated bright red and allowed to cool slowly e.g. overnight in the furnace after it has been turned off, or in the ashes of a fire. This obviously prolongs the overall spinning process immensely.

In my case, I made up a small cave of fire bricks **(Photo 5)** -and used a Primus LPG torch with its largest nozzle. I also had a laboratory methylated spirit lamp as a pilot flame for convenience, and used a pair of Multigrip pliers to pop the workpiece in the water tank (an old baking dish).

Typical annealing times for the 1.2mm brass items were 1 to 3 minutes depending somewhat on the shape of the job at that stage, and also on how hot the fire brick cave was. $1\frac{1}{2}$ min. would be the most common for the annealing heat and quench process.

For the cup shaped job described in this article, the time taken for each phase of the operation was of the following order :-

Phase	Operation	Av. No. of Annealings	Av. Elapsed Time for Phase (min.)
I	Hammer hollowing blank centre for follower	5	15
II	Spinning on breakdown conical former	13	70
III	Spinning to finished shape	77	17
		35	162

With the most common annealing time of $1\frac{1}{2}$ min., annealing took about 53 min. in a total of 162, or about $\frac{1}{3}$rd, to compare with $\frac{2}{3}$rds working the metal.

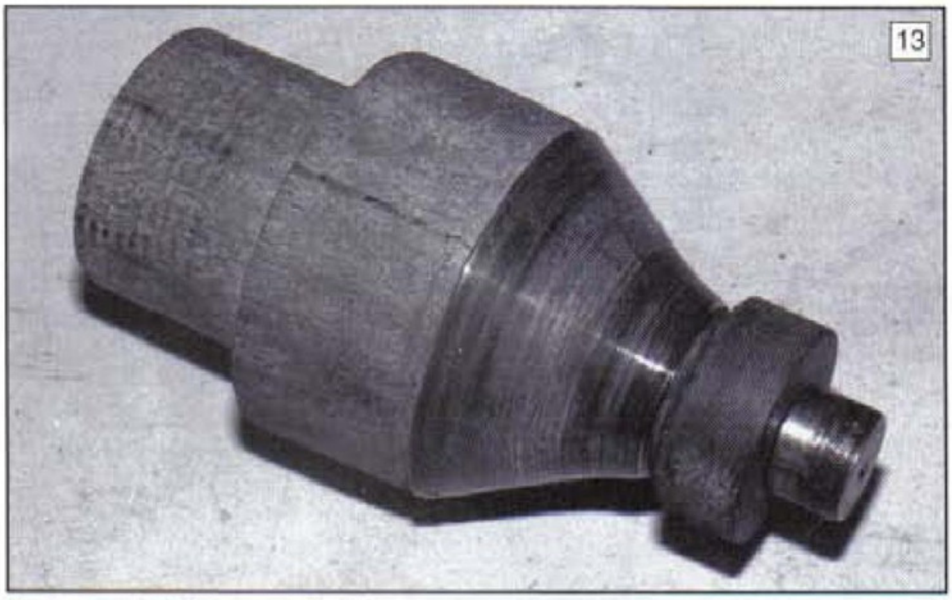
As it is hard to judge the temperature of aluminium alloys which can easily go from normal cold appearance straight to melting collapse, Ref. 4 suggests rubbing bar soap on the aluminium and heating it until the soap goes black—then allowing it to cool. Ref. 5 suggests using a smoky oxy-acetylene flame to cover the workpiece with soot, and then to heat it until the soot burns off. After cooling it is claimed it will then be dead soft. Note that aluminium alloys age harden, so if it is not proposed to continue work on the softened piece at once, it should be placed in the family freezer, which will delay the age hardening process.

Lubricants

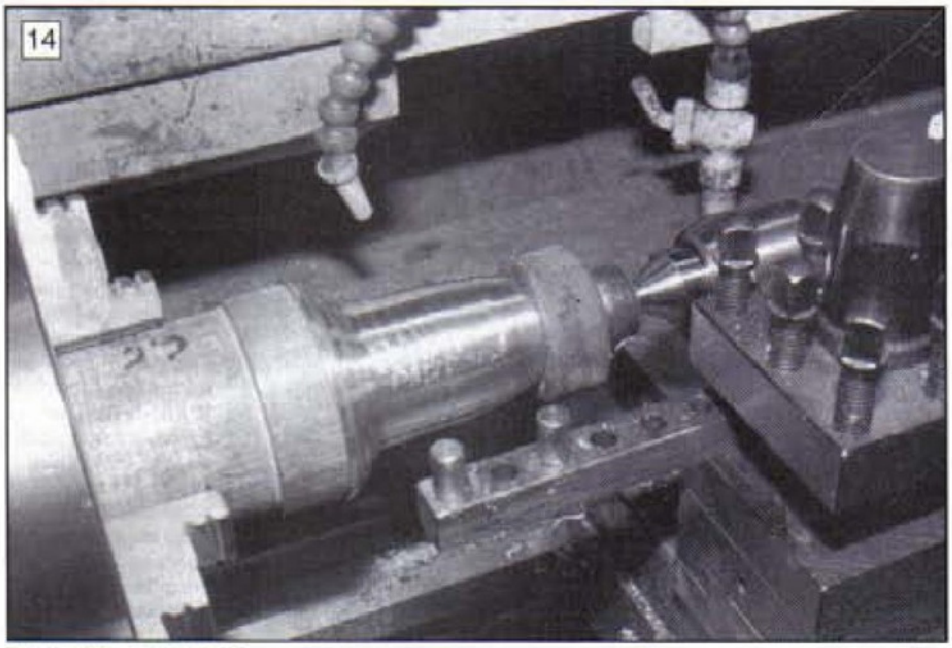
To stop the tool tearing the workpiece, a lubricant must be used. Various references suggest tallow, grease, beeswax, soft soap, laundry bar soap etc. I have tried grease, but found that it was flung around excessively, and so eventually settled on bar soap, which seems quite satisfactory.

Technique

For my project, I needed five items in 0.5mm (26 SWG) brass, and eleven items in 1.2mm (18 SWG) brass. For the 0.5 mm items, three were flat disks with a turned over lip, one was a stepped flat with lip, and one was a rather fancy conical shape **(Drawing 14 and Photos. 7 and 8)**. The only one with a critical dimension was the stepped flat disk, where the step had to fit reasonably closely inside a brass tube on assembly. For the 1.2mm items, four were shallow flat cups, with generously rounded corners **(Drawing 14 and Photo. 9)**. The other seven were deep conical cups **(Drawing 15 and Photo. 15)**. I made hardwood formers for the various disks, interchangeably mounted with two wood screws on a cylindrical hardwood chucking piece, and each was finish machined, in turn, in place on this mounting cylinder. Likewise hardwood formers were made for



Deep cup - breakdown completed



Deep cup - completion

All seven deep cups

Three branch light

the cup shapes, including a breaking down former for the deep cup - these mostly included their own integral chucking pieces. Cardboard templates were used to check shapes, and normal wood turning methods used mainly with the gouge shown in **Photo. 2**. Some items were to have centre holes $^5/_8$in. dia., some $^1/_2$in. dia., and others $^3/_{16}$in. diameter. Suitable length clamping bolts were used for the $^5/_8$in. and $^1/_2$in. hole items, to hold the followers in place, each bolt having its head centre drilled to accept the running centre support. In the case of the $^3/_{16}$in. holes, such an arrangement was too weak, so instead, a piece of $^3/_{16}$in. steel rod was silver-soldered into a boss $^5/_8$in. long and 1in. dia., the end of which was also centre drilled. This was held in place by the running centre, and proved quite satisfactory **(Drawing 14 item I)**. For the cup shaped jobs, the first phase was to hollow the centre of the blank disk using a 22oz. ball pein hammer and the follower as a 'doming block' **(Photo. 6)**. The follower soon split, so was PVA glued together and supported with a hose clamp tightened on its periphery. After hollowing, the disk would then fit the former and follower, with further shaping by spinning. Phase two was spinning the blank to the shape of the breakdown former, and phase three, spinning to the final finished shape.

Photos. 10 to 15 show this sequence. In the actual spinning operation, the tool is used in lever fashion, with the tool rest pivot as a fulcrum, and is swept from the tailstock end and centre of the disk towards the headstock end and outer edge of the disk in a continuous motion. It thus applies pressure to the workpiece in both axial and radial directions. Most authors recommend this action, but some warn that it will lead to "folds that are almost impossible to remove" and "always start to exert the tool pressure from the outer edge of the disk" (Ref. 1). In my experience, this is quite wrong. It is essential to progressively make the blank enfold the former from the tailstock end, as shown in **Drawing 16**. However, at all times during this progression the 'sweep' of the tool must run to the outer edge of the disk, and with the use of the backstick for as long as that can be accommodated, if ripples and wrinkles are to be avoided. What we are trying to do is to locally distort the blank to reduce its diameter, as shown in **Drawing 17(a)**. If the blank is not firmly in contact with the former at the tailstock end, the whole blank can wobble, as shown in the drawing, and nothing is achieved. When the final shape is achieved, and the workpiece closely envelops the former, it is often difficult to remove. Reference 12 suggests running the lathe with no follower in place, and using a flat tool under the work and over the tool rest, to exert pressure and ease the work away from the chuck end. When the work comes loose, stop the lathe.

Trimming

When the workpiece has finally reached the desired shape of the former, it will usually have an uneven edge. If the required axial dimension is not overly critical, this edge can be trimmed by hand use of the graver, supported on the tool rest. More precision can be obtained by using instead a normal pointed lathe tool (e.g. 60deg. threading tool) mounted in the normal tool post on the top slide and cross slide. A parting off tool should not be used, as this will tend to tear the material and can destroy the workpiece.

Problems

These may be categorised as cracks, ripples and wrinkles.

Cracks usually happen radially, at the outer edge of the blank when it is stretched too much without annealing often enough. Its incidence seems to be lessened by initially making the blank edge smooth, thus eliminating stress raisers. The only cures seem to be cutting off the offending zone of the blank, or repairing by silver-soldering or welding when the job is complete, and then dressing back to size. Cracks can also occur circumferentially when longitudinal pressure from the tool is applied too enthusiastically, especially if annealing not carried out at frequent intervals **(Drawing 17B)**. Besides thinning at point A when the material is soft, it can also crack there after it has work hardened **(Photo. 16)**.

Ripples occur when the spinning action does not sweep far enough out on the blank, or if the material further outboard has been worked before the inboard segment has been made to lie down on the former **(Drawing 17C)**. Ripples can sometimes be spun out, but otherwise hammering (7oz. hammer) with axially glancing blows against an anvil beak inside the job, or against the former, usually remove them. In either case, annealing is a prerequisite. Wrinkles occur when attempts are made to spin out wide ripples. The material is selectively forced down on to the former or stands proud **(Drawing 17D)**. The only remedy for this trouble seems to be the hammer and anvil technique. Again annealing is essential. If there is a mounting hole at the centre of the blank it will be found to increase in diameter as the work continues. If the job clatters about in the early stages, before it has been, at least, in part bedded down on the end of the former, it may also tear at this place. This enlargement is hard to prevent, and must be repaired at the completion of the job.

Conclusion

In due course, all the spun items were completed and silver-soldered or mechanically joined together to form one three branch centre light fitting and four single branch wall brackets **(Photos. 17 & 18)**. Quod erat faciendum (Which was to be done). They seem to satisfy the distaff side of the household.

The "have a go and you'll learn by experience" advice is certainly true, but the learning is probably faster if some actual detailed information is available, and if the operator is quite sure what is being attempted. Having fallen into most of the traps and pitfalls, I feel that the recounting of this saga may be helpful to others headed down the same track.

Appendix 1 The theoretical calculations

To get an idea of what is happening during the spinning process, consider an (over) simplified picture of the blank and former as shown in drawing 11(a) which is like a cantilever beam fixed at A.

From Ref. 14:

Deflection y of a cantilever beam loaded at its free end

$$y = PL^3/3EI \qquad \text{(i)}$$

where
P = load applied
L = length of beam
E = modulus of elasticity
I = moment of inertia of beam section
c = distance of extreme fibre from neutral axis

Bending moment M at support A -

$$M = PL \qquad \text{(ii)}$$

Stress S in beam at support A -

$$S = Mc/I = PLc/I \qquad \text{(iii)}$$

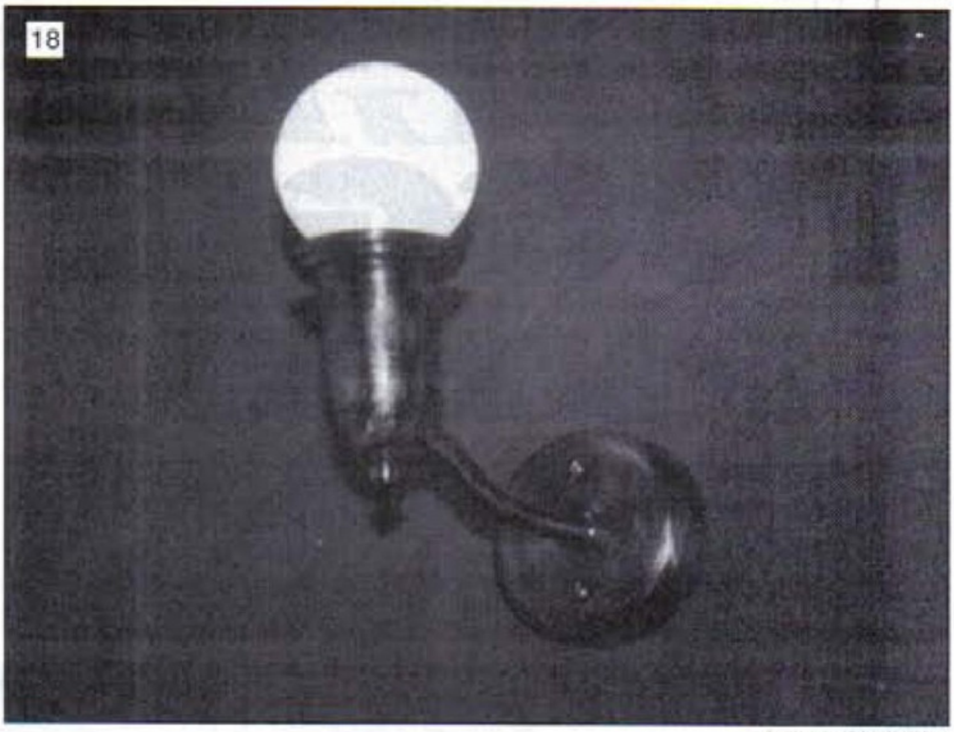
From which it is seen that the stress at the support is proportional to the length of the beam, but the deflection at the end of the beam is proportional to the cube of the length.

In the diagram, suppose that a load P1 applied at a distance L1 from the support is just sufficient to deflect the blank until it contacts the former (i.e. y1 becomes 0), and also suppose this is just sufficient to cause the stress S1 at the point of support A to exceed the material's elastic limit,

then $y_1 = P_1L_1^3/3EI$

$M_1 = P_1L_1$

and $S_1 = P_1L_1c/I$



Wall bracket light

Now contemplate instead, applying a load twice as far out along the beam. The load P_2 necessary to deflect the blank twice as far (y_2) will be

$$y_2 = P_2L_2^3/3EI$$

Rearranging terms we get

$3EI = P_1L_1^3/y_1$

and also $3EI = P_2L_2^3/y_2$

As $L_2 = 2L_1$ and $y_2 = 2y_1$

then $P_1L_1^3/y_1 = P_2(2L_1)^3/2y_1$

Therefore $P_2 = P_1/4$

Bending moment $M_2 = P_2L_2 = P_1 2L_1/4$

$= M_1/2$

which, by definition above, is only half that necessary to exceed the elastic limit for the material.

Let us now consider the use of the backstick to provide 'outboard' support of the blank in drawing 11(b). This is like a cantilever beam also supported at its free end.

Again, from Refs. 14 and 15:

For a load P in the centre of the beam, the bending moment M at the fixed end A

$$M = 3PL/16 \qquad \text{(iv)}$$

and deflection y at the centre -

$$y = 7PL^3/768EI \qquad \text{(v)}$$

so $y_1 = 7P_3(L_2)^3/768EI$

$= 7P_3L_1^3/96EI$

Rearranging terms -

$3EI = 7P_3L_1^3/32y_1 = P_1L_1^3/y_1$

therefore $P_3 = 32P_1/7$

and $M_3 = 3P_3L_2/16$

$= 3 \times 32P_1 2L_1/16 \times 7 = 12M_1/7$

This is nearly double the previous (unsupported) bending moment at A, so the deforming stress is easily attained.

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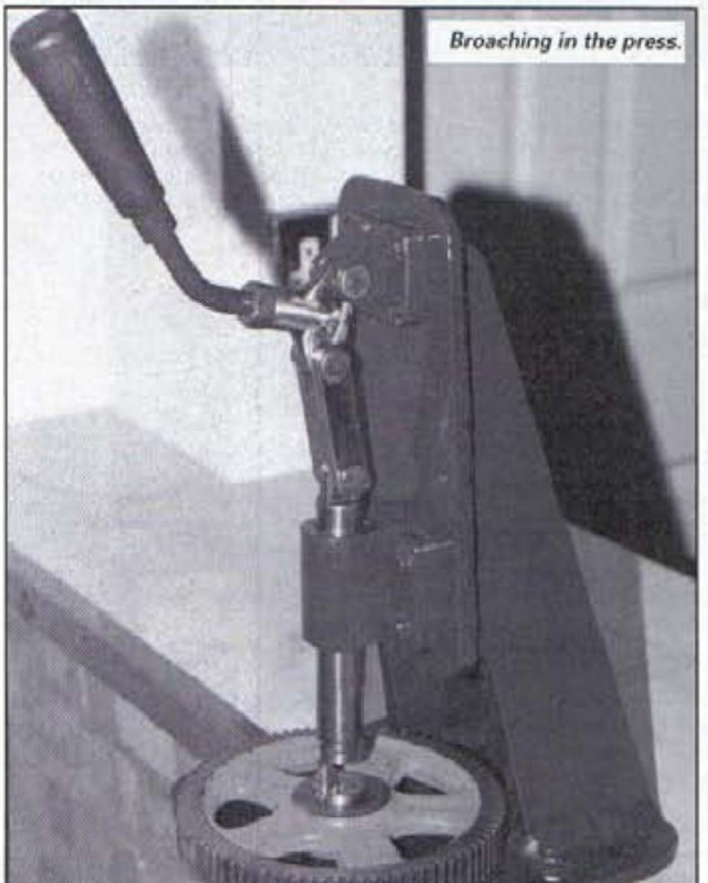
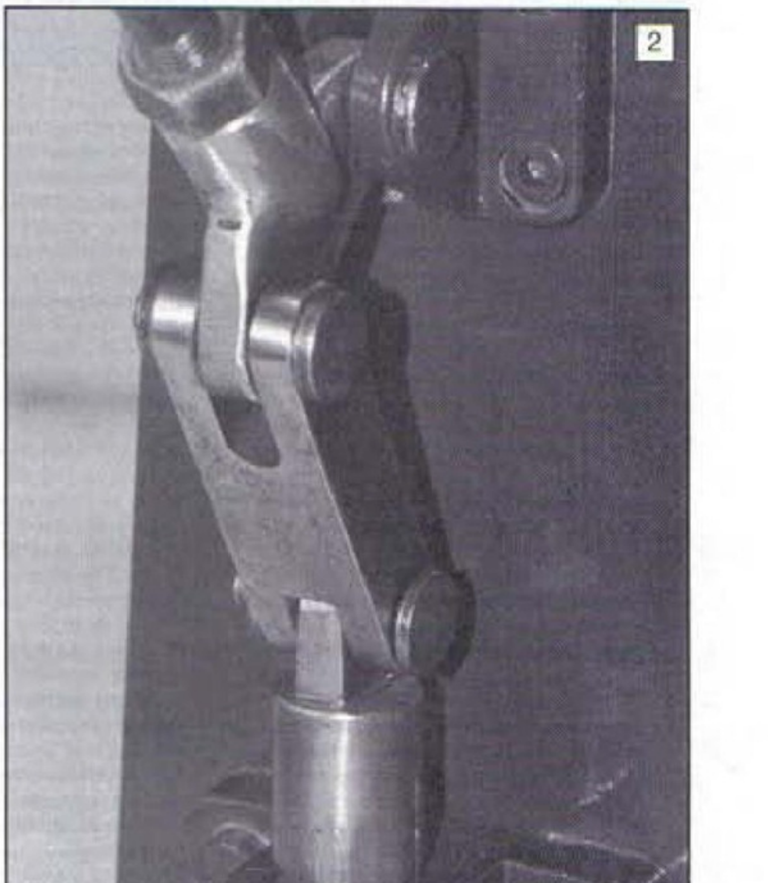
A LIGHT TOGGLE PRESS

Readers who have studied earlier articles by Alan Jeeves have asked for details of the toggle press which has appeared in a number of photographs. We are pleased to be able to make available the details of this simple but practical tool.

Clearance hole and clamp stud holes in base.



Broaching in the press.



Close-up of toggle joint showing three pivots.

If you were to find yourself left with a little surplus time over the Christmas break, you may feel inclined to have a go at making this quite useful, light duty toggle press as an addition to your workshop equipment. Intended primarily for use as a convenient mandrel press to complement the centre lathe, it can also be employed to good advantage for alternative duties, including broaching small keyways and for sensitive press work for model making situations, where a heavy press may easily cause more injury to the work than good. Neat in appearance and delightfully simple to use, this press is not difficult to make in a moderately equipped workshop, and may be readily modified to suit the individual requirements of extraordinary workshop activities. A 3 1/2in. centre lathe plus a mill/drill and a small welder will deal with the project adequately.

This tool is intended for bench mounting, and started out life as a Technical College exercise, the object being to expertly fabricate the main frame and to weld it without distortion. However, the welding may prove to be a little difficult for home workers, so an alternative screwed frame construction may be used, thus avoiding any distortion caused by welding- **(See Figure 2A)**.

The Toggle Joint

The toggle joint, knuckle joint, or genou joint (from the Latin genu - knee) is a system of levers and pivots which are connected together in a certain configuration, so as to bring about a mechanical advantage by easily converting horizontal movement into vertical movement or vice-versa.

This system was utilised to admirable

effect in 1885, when Hiram Maxim (1840-1916) employed a toggle arrangement to develop the action of the world's first self loading machine gun. In the early 1890's, Hugo Borchardt (c1850-1921) applied a more compact toggle action to a self loading pistol and by the late 1890's, Georg Luger (1849-1923) had improved the toggle action for use in what was destined to become one of the world's most infamous handguns of all time - the 'Luger'.

The principle of the toggle joint is illustrated in **Fig. 1.** Pivot D is a fixed point, Pivot F is not a fixed point and is connected to Pivot D by a lever. Pivot F is, in turn, connected to pivot H (also not a fixed point) by a second lever. If the dimension b is reduced by moving pivot F in the direction of the arrow, then the distance DH is increased. As the dimension b is increased, so distance DH is reduced. That is to say that the distance between fixed point D and pivot H can be regulated by the manipulation of pivot F.

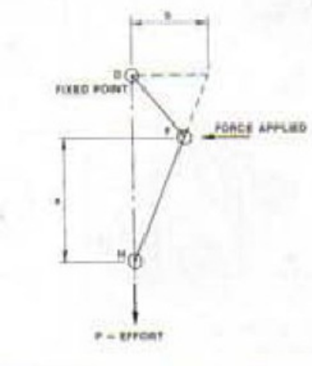


FIG. 1. THE TOGGLE JOINT

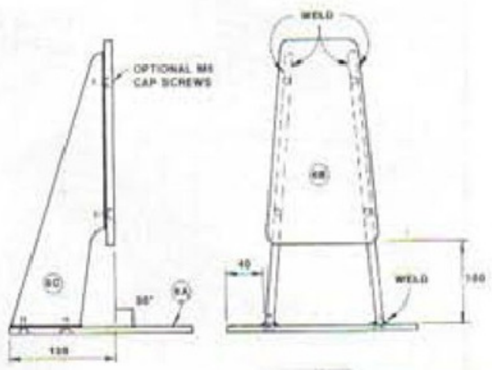


FIG. 2A. ASSEMBLY OF MAIN FRAME

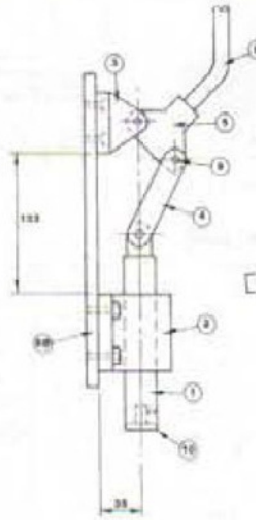


FIG. 2B. ASSEMBLY OF LINK & RAM COMPOMENTS

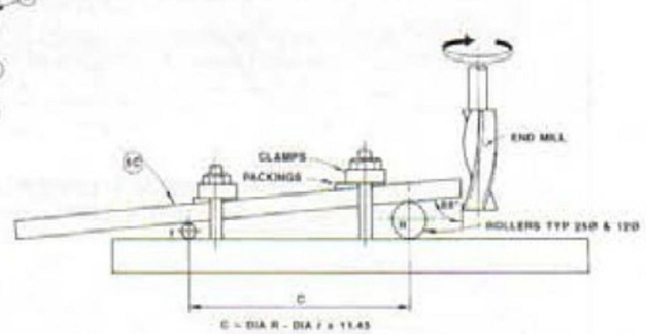


FIG. 3. MILLING FRAME PILLAR

The Links

In this particular example of the toggle joint, we have two links (or levers), and they are of unequal lengths (between hole centres). The shorter link is used as the upper link (item 5), and the longer link is used as the lower link (item 4) For this application, the ratio between the link lengths is approximately $1\frac{1}{2}:1$, to give a good action to the press. Increasing the length of the lower link or decreasing the length of the upper link has the effect of shortening the stroke of the ram. However, altering the length of only one of the links will, of course, alter the chosen ratio. If it is necessary to increase or decrease the stroke of the ram, a better arrangement is to amend the length of both links by the same proportion. Thus if the upper link is increased by a distance of 20mm then the lower link is accordingly increased by a distance of 30mm ($1\frac{1}{2}$ times).

The length of stroke may be calculated by analysis of the triangles shown in Figure 1. Assuming that the top limit is when the upper link is horizontal and the end of the stroke is reached when both links are vertically in line, our example produces a stroke of approximately 60mm.

Calculating the efficiency

It is difficult to actually calculate the efficiency of this press because of the fact that the efficiency of the toggle joint varies as distances a & b (Fig. 1) are constantly changing as the joint operates, quite unlike the rack and pinion type of press, where the force remains uniform throughout the stroke of the ram. However, some idea of the forces involved can be estimated using the following formula:-

effort (P) = $^{Fa}/_{b}$ (Fig. 1)

experiments have proved the press to

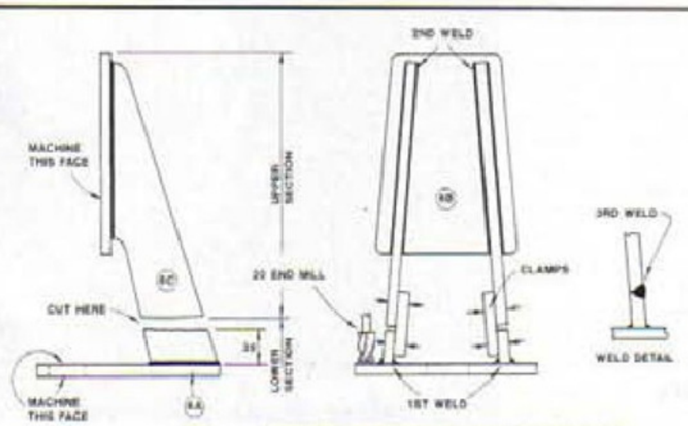
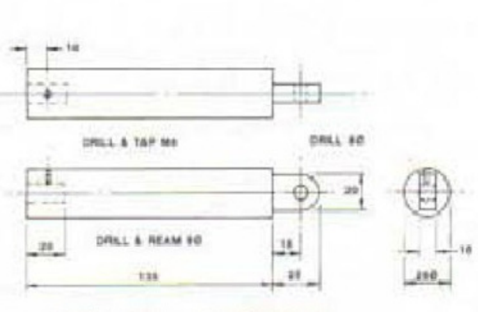
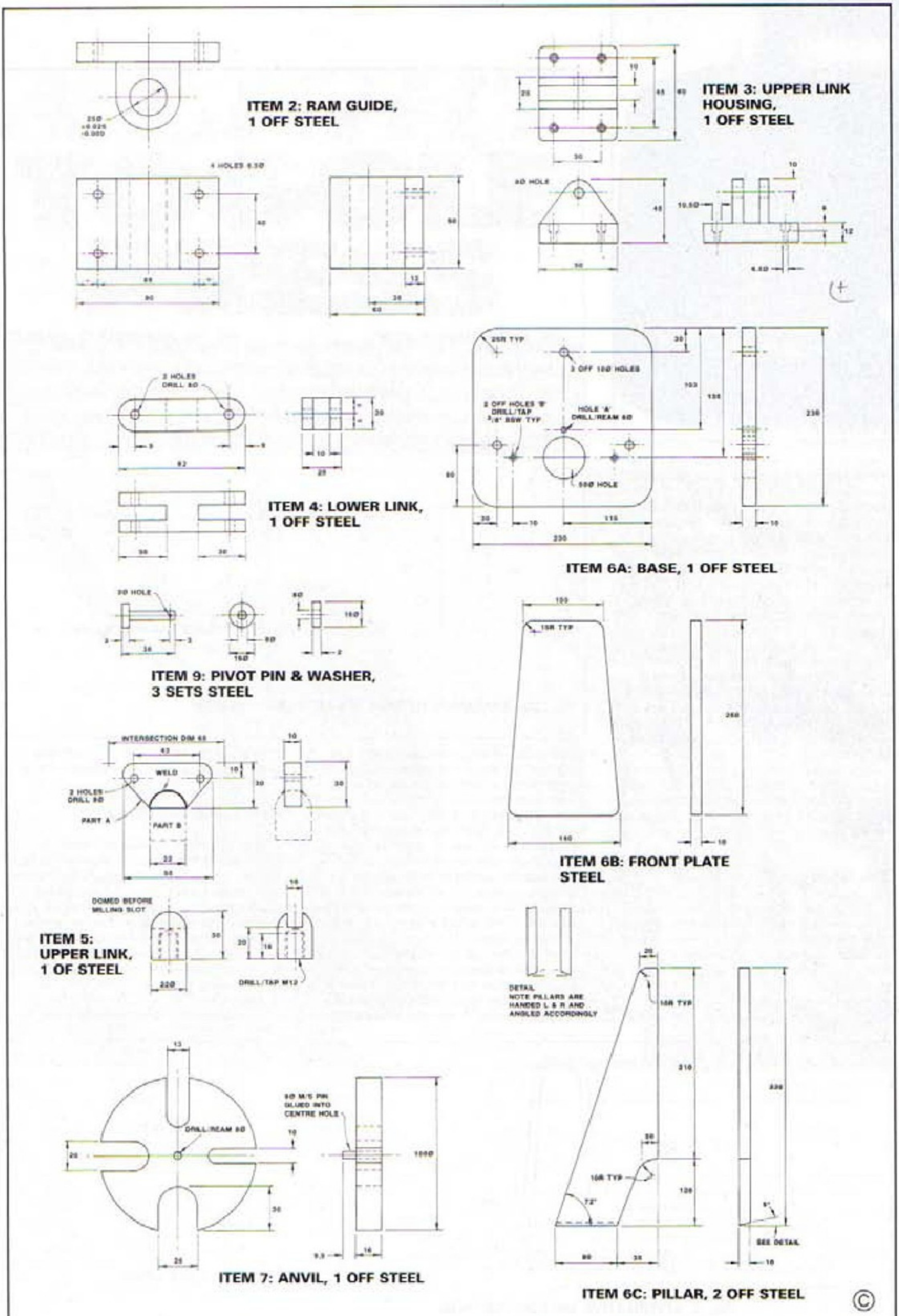


FIG. 4. ALTERNATIVE WELDING METHOD



ITEM 1: RAM, 1 OFF STEEL


ITEM 2: RAM GUIDE, 1 OFF STEEL
ITEM 3: UPPER LINK HOUSING, 1 OFF STEEL
ITEM 4: LOWER LINK, 1 OFF STEEL
ITEM 6A: BASE, 1 OFF STEEL
ITEM 9: PIVOT PIN & WASHER, 3 SETS STEEL
ITEM 6B: FRONT PLATE STEEL
ITEM 5: UPPER LINK, 1 OF STEEL
DOMED BEFORE MILLING SLOT
DRILL/TAP M12
DETAIL
NOTE PILLARS ARE HANDED L & R AND ANGLED ACCORDINGLY
ITEM 7: ANVIL, 1 OFF STEEL
ITEM 6C: PILLAR, 2 OFF STEEL
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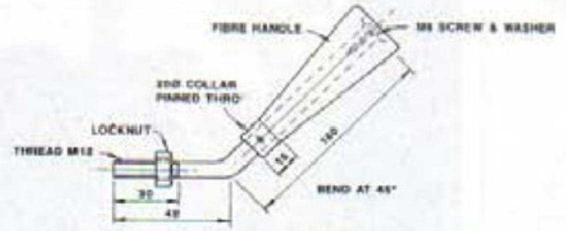
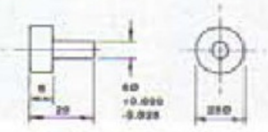
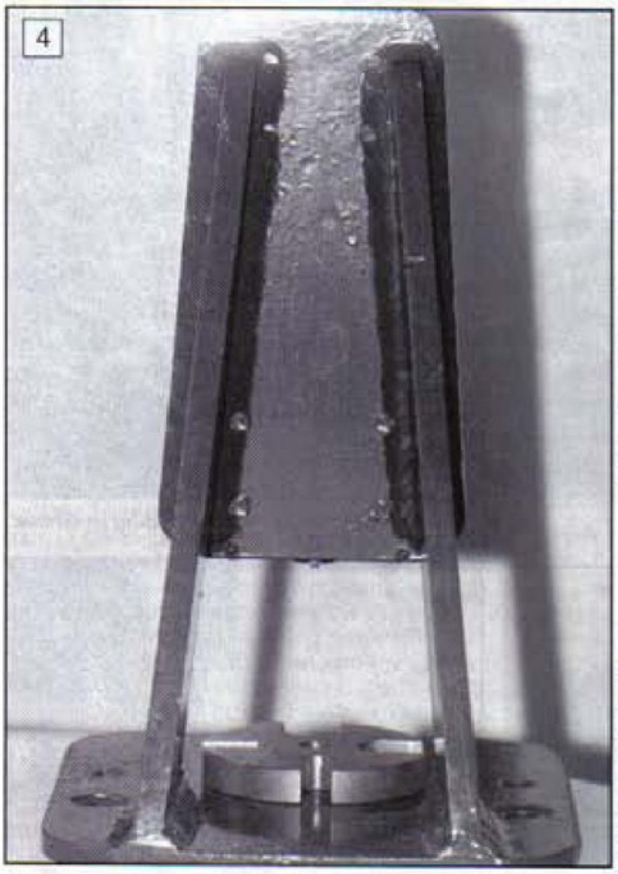


ITEM 8: HANDLE, 1 OFF 12 ϕ STEEL

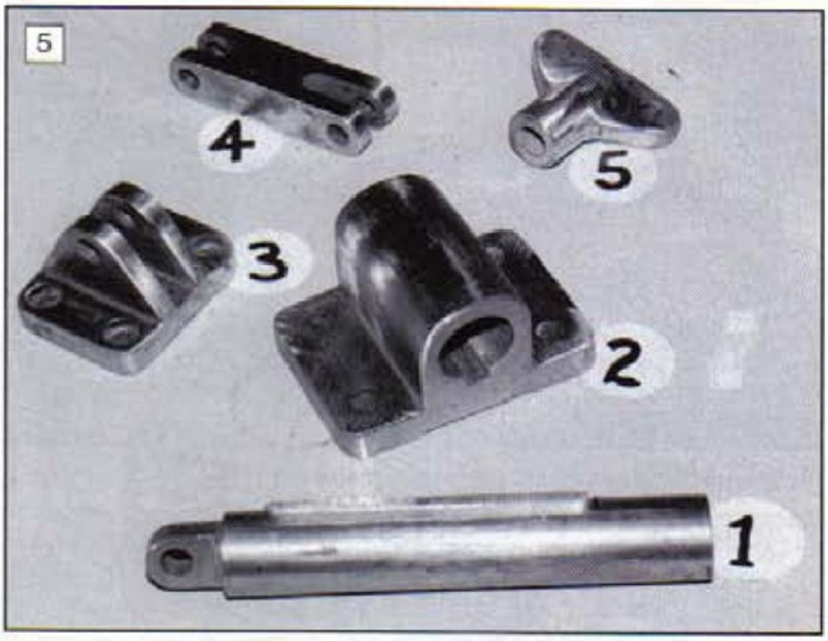


ITEM 10: RAM TIP, 1 OFF STEEL



Main frame shown from rear.

Milling the flats on the ram.



The component parts.

be capable of punching a 4mm diameter hole through 0.75mm thick mild steel, a feat which requires a force at the punch of 0.37 ton (377 kg). This means that a force of around 0.185 ton (188 kg) is required at F when the punch starts to work, if a = 60mm and b = 30mm.

The press may therefore be classed as having a 1/3 ton capacity, sufficient for light duties in the workshop.

The Main Frame

The main frame may well be the best place to begin construction, as this is the largest part of the press, and deals with the heaviest pieces of metal, getting them nicely out of the way. The frame is made up using 10mm thick mild steel plate, which is quite substantial enough for a press of this type. It is fabricated from four individual pieces of metal which, when assembled, must have a front plate which is square to the base plate **(Fig. 2A)**. Before assembly though, the large clearance hole (50mm dia) can be machined into the base plate, as can the clearance holes for the bench mounting screws. A hole can also be drilled and reamed (hole A) for locating the anvil (item 7) which will revolve under the press ram. A couple of tapped holes are provided for the workpiece clamps (holes B), the thread of which should be made to suit the screwed studs of your own workshop clamp set. The mounting screw holes in the front plate, which are for securing the ram guide and toggle assembly, can be drilled after the mainframe has been built, thus making certain that the central axis of the ram is in true alignment with the centre line of the large clearance hole in the base. The two upright pillars (item 6c) must be 'handed' in respect of the edge which mates with the base (see sketch), and a good way of machining the 5 degree angle is by setting the plates up on the milling machine table, and side cutting with an end mill **(Fig. 3)**.

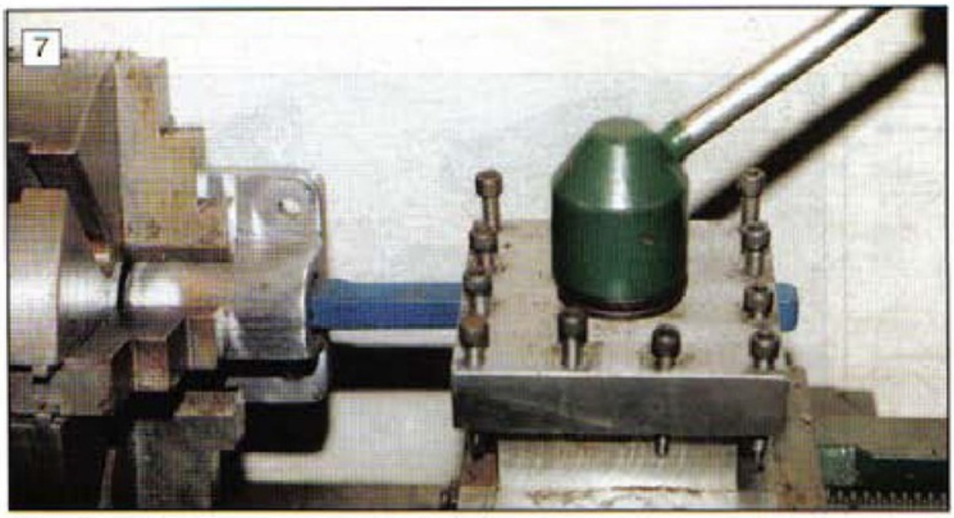
Another method of welding the main frame fabrication is by actually cutting the two pillars in two and welding one portion to the base and the other portion to the front plate, with the joint where they have been parted clamped **(Fig. 4)**. The base and the front plate can be machined flat (after welding) in the milling machine as two separate jobs. The cut joints are then weld prepped and welded back together again whilst the machined surfaces stay flat.

The Ram and Link Assembly

The component parts of the ram and link assembly can now be manufactured, and all of these are made from mild steel. The ram (item 1) may be made from bright drawn bar, and is drilled and reamed at the nose end to accommodate the ram tip (item 10). If the tip happens to become damaged during use, it is an easy matter to make a new one to replace it, as opposed to making a whole new ram from scratch. Limited press tools such as small punches can also be made to fit the ram nose.

It will be seen from the illustrations that the ram is fitted with a long key, and the ram guide is slotted accordingly to form a keyway. This arrangement is not strictly necessary, being built into the design for the exercise of forming a key and keyway by the student. It may, therefore, be omitted. The flat for the lower link connection is a simple milling job, and is easily drilled for the pivot pin.

The ram guide (item 2) is made from a rectangular block of material, and can be bored for the ram in the lathe or the mill/drill. The ram needs to be a close sliding fit within its guide, especially so if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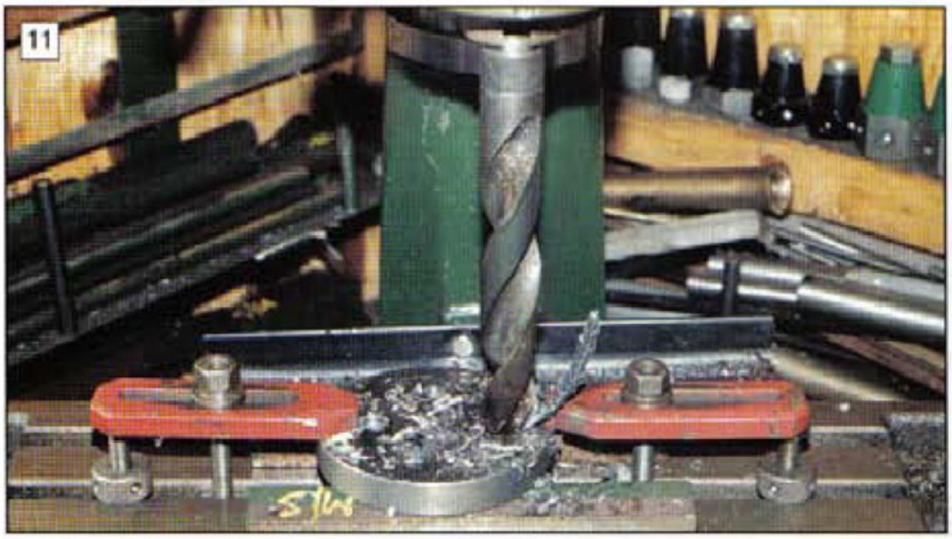
The ram guide may be bored before or after shaping.


8

The upper link housing in the milling machine.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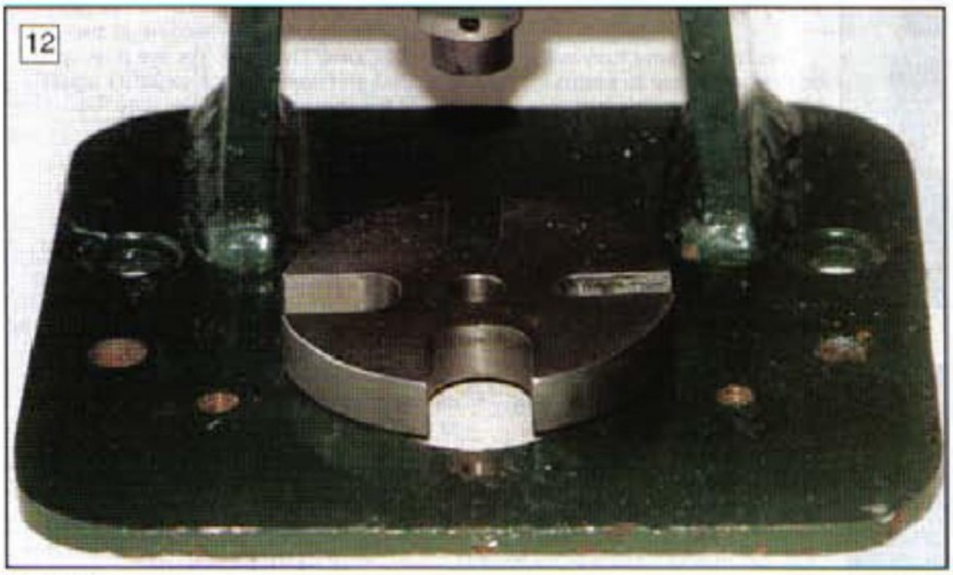
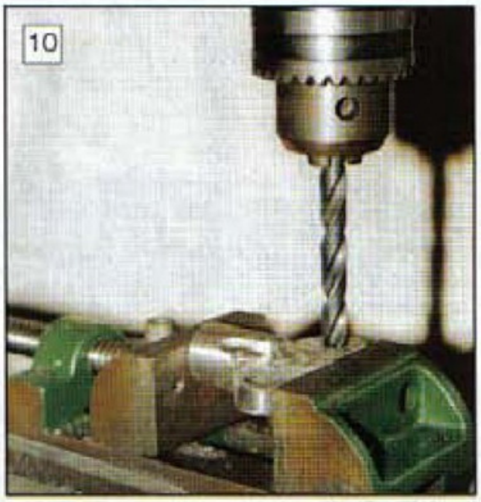
Drilling the anvil blank in the mill/drill.


9

The lower link in the milling machine.


12

The anvil.


10

The upper link welded and being drilled.

small punches are to be used, and if a reamer is available so much the better. The block is now milled to shape and the mounting holes are drilled.

The upper link housing (item 3) is another milling job, being finished off with the file and drilled for the mounting screws. Milling again is the order of the day for the lower link (item 4), which must have enough clearance in the slots for it to operate freely.

The upper link (item 5) is made in two pieces and welded together. The tapped hole is for the handle to screw into. Neither the handle nor the pivot pins need special instructions.

The Anvil

A useful attachment for the press is item 7, the circular rotating anvil, which has four stations consisting of slots of varying widths. These slots may be whatever size the maker wishes. When in use, each slot can, in turn, be positioned directly below the ram and provides a shoulder against which to press, there being a way through for any long items below the anvil. It is completely removable from the press in order to allow larger jobs to be placed straight onto the base.

The anvil blank is turned from mild steel and both faces should be parallel. The central reamed hole can be formed whilst the piece is still in the lathe. A session on the milling machine will take care of the four slots, which can be marked out and drilled in the mill/drill to form the radius, before opening out to the finished slot width. The anvil is simply located on a central dowel pin which is 'superglued' into the reamed hole.

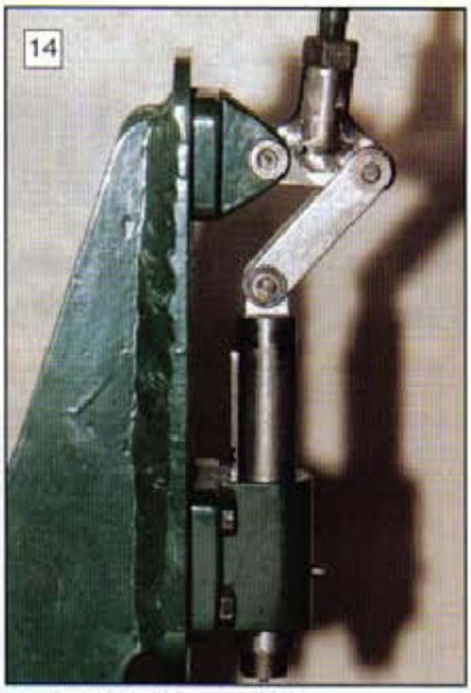
Assembly

By referring to **Figure 2B**, all the separate component parts can be assembled to form the toggle joint and ram, and the assembly placed onto the front plate, with the press lying on its back. The eight securing screws can be marked through after first ensuring that the ram is at 90 degrees to the base, looking from the front, and also that the assembly is positioned in the vertical centre of the front plate. The ram should, therefore, be directly above the 50mm diameter clearance hole in the base. The hole centres must be accurately determined and carefully centre punched for drilling. Care must also be taken to see that the holes are tapped square.

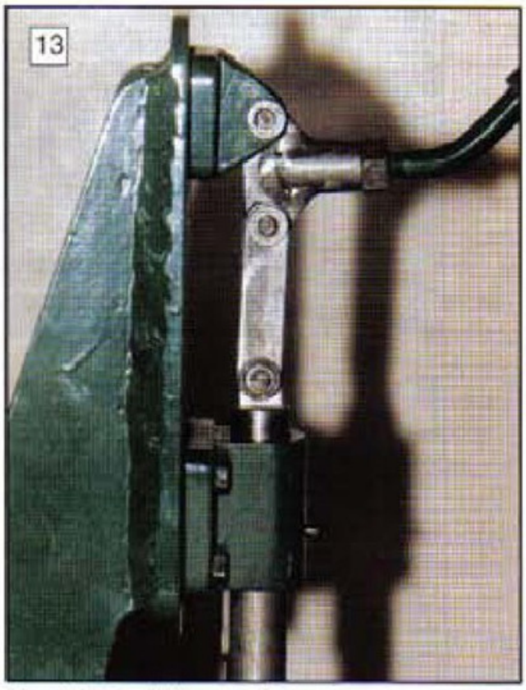
The screws are dropped in and tightened and checks made to confirm that the ram is square to the base in two planes. This done, the machine can be dismantled for painting.

Using the Press

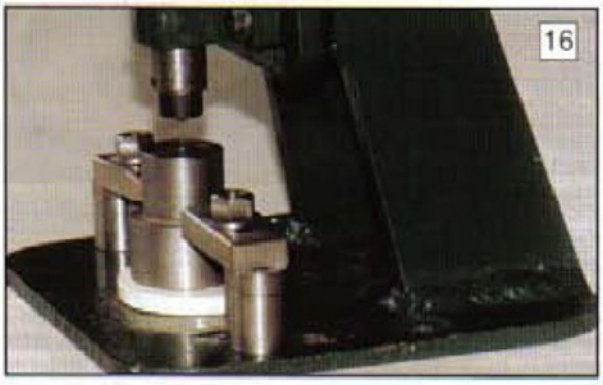
The press may be bolted to the workbench for use in the workshop. As already stated, it is not a heavy duty unit and when operated by the average man, the press described here delivers a force of around $^1/_3$ ton at the ram. The stroke of the ram is 60mm, and the maximum height of the ram above the base (without anvil) is 100mm. Such operations as pressing in bearings and bushes squarely (or removing them) and inserting dowel pins can be carried out with or without the anvil fitted. When press tools are used, perhaps for punching small holes, the die can be clamped to the base by utilising the tapped holes (holes B) to locate the screwed studs onto which are placed the clamps. As a footnote, it should always be remembered that when using a press, as with any other machine, particles of metal can be propelled at high velocity if something goes wrong. Although not immediately obvious, when carrying out press work, eye protection should always be worn.



Toggle joint with ram at high.

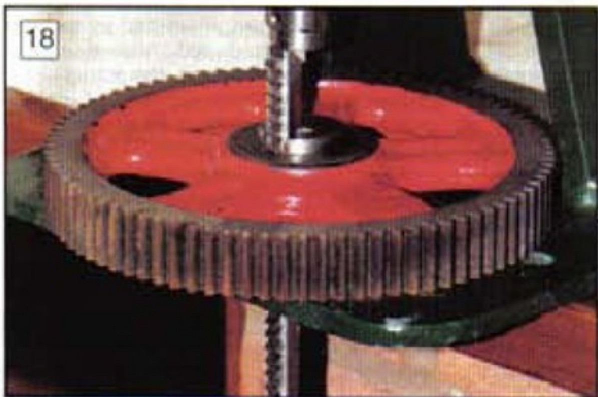


Toggle joint with ram at low.



A simple punch and die utilising clamp holes.

Mandrel press.



Broaching a keyway in a gearwheel

Alternative welding method (Fig. 4)

1. Cut pillars (item 6C).
2. Accurately clamp pillars back together.
3. Set complete mainframe up and tack weld 1st & 2nd welds.
4. Ensure front plate (item 6B) is square to base.
5. Complete welding on 1st & 2nd welds.
6. Remove clamps and part upper & lower sections.
7. Machine base plate (item 6A).
8. Machine front plate (item 6B) - front plate can also be machined after all welding has been completed.
9. Prepare pillars (item 6C) for 3rd weld and clamp together upper & lower sections ensuring squareness.
10. Tack weld 3rd weld and recheck for squareness.
11. Execute 3rd weld.

This press has its own stand.

A FRICTION SCREW DRIVING UNIT

Faced with a labour intensive task, Ted Hartwell set about designing and making this ingenious attachment for his hand held a half inch variable speed electric drill

During an earlier construction project, it was necessary to drive a considerable quantity of 3 and 4in. wood screws, to secure the structural members. Following the abortive use of a spiral drive screwdriver and a carpenters brace, resort was made to a portable drill, fitted with the appropriate Posidrive/Superdrive bit. The result was tolerable, but lack of adequate control resulted in difficulty in terminating the driving home of the screw at the precise point necessary, and with frequent damage to the screw heads making subsequent final adjustment difficult. A number of screws were also 'twisted off' in the process, possibly due to their suspected far eastern origin.

A further, similar project therefore triggered consideration of an improved method, having better control of both torque and drive termination. In view of the 'one off' (again!) nature of the project, a professional torque controlled powered screwdriver could not be justified on the grounds of expense, and at that time there appeared to be no suitable drill attachment on the market. The outcome was the construction of a friction cone unit, where the applied pressure controlled the torque and, when backed off, the actual drive termination.

Design parameters

A simple pressure controlled cone clutch seemed the obvious solution, the body diameter of which needed to be small enough to hold in the left hand for support—the size of a whisky tumbler being a typical example! It also seemed desirable to keep the overall length to a minimum of say 6 inches.

Without any specific information on the torque, speed and axial pressure likely to be required, the following assumptions were made:-

Speed—maximum say 600 rpm. (50% of low drill speed).

Torque—based on $^1/_4$in. diameter mild steel being capable of transmitting 1/8hp at 600 rpm, this seemed a fair starting point.

Axial pressure—possibly 20lb.

To ensure positive disengagement, a cone angle of 15deg. per side was adopted but, with the foresight of hindsight, $12^1/_2$deg. would probably have been a better decision. The cone materials initially used were of steel (En 8) and phosphor bronze, based on the writer's experience in the replacement of synchromesh gearbox cones, being thought less likely to 'pick up', and having a dry kinetic coefficient of friction of about 0.2. The static coefficient is naturally higher, but which one is relevant depends on whether the load is applied prior to starting the drill or subsequently, i.e. with the clutch slipping.

The Component Parts prior to Modification.

Basic calculations

The two principal laws of friction state that the amount is directly proportional to the pressure applied to the contacting surfaces and their coefficient of friction, while the actual area has no (or minimal) effect.

The horsepower transmitted by a cone clutch is therefore, directly related to the mean radius of the cones, the actual contact pressure, the coefficient of friction and the speed of rotation, summarised by the following formula:-

(Mean Cone Radius in inches x Coefficient of Friction x Contact Pressure in lb x rpm)/63025

(63,025 being comprised of 33,000 x 12 x 2 x 3.1416).

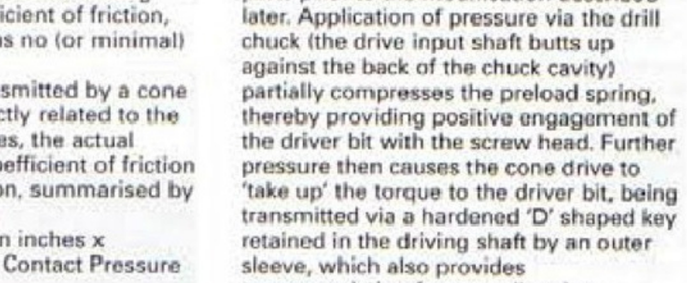
The next stage was to sketch the proposed clutch unit based on the 'envelope' outlined earlier, material available, the use of spiral drive screwdriver bits and a $^1/_2$in. dia. input shaft.

From the resultant clutch dimensions, a trial calculation of the horsepower likely to be transmitted at 600 rpm. and 20 lb. axial pressure came out at 0.115!

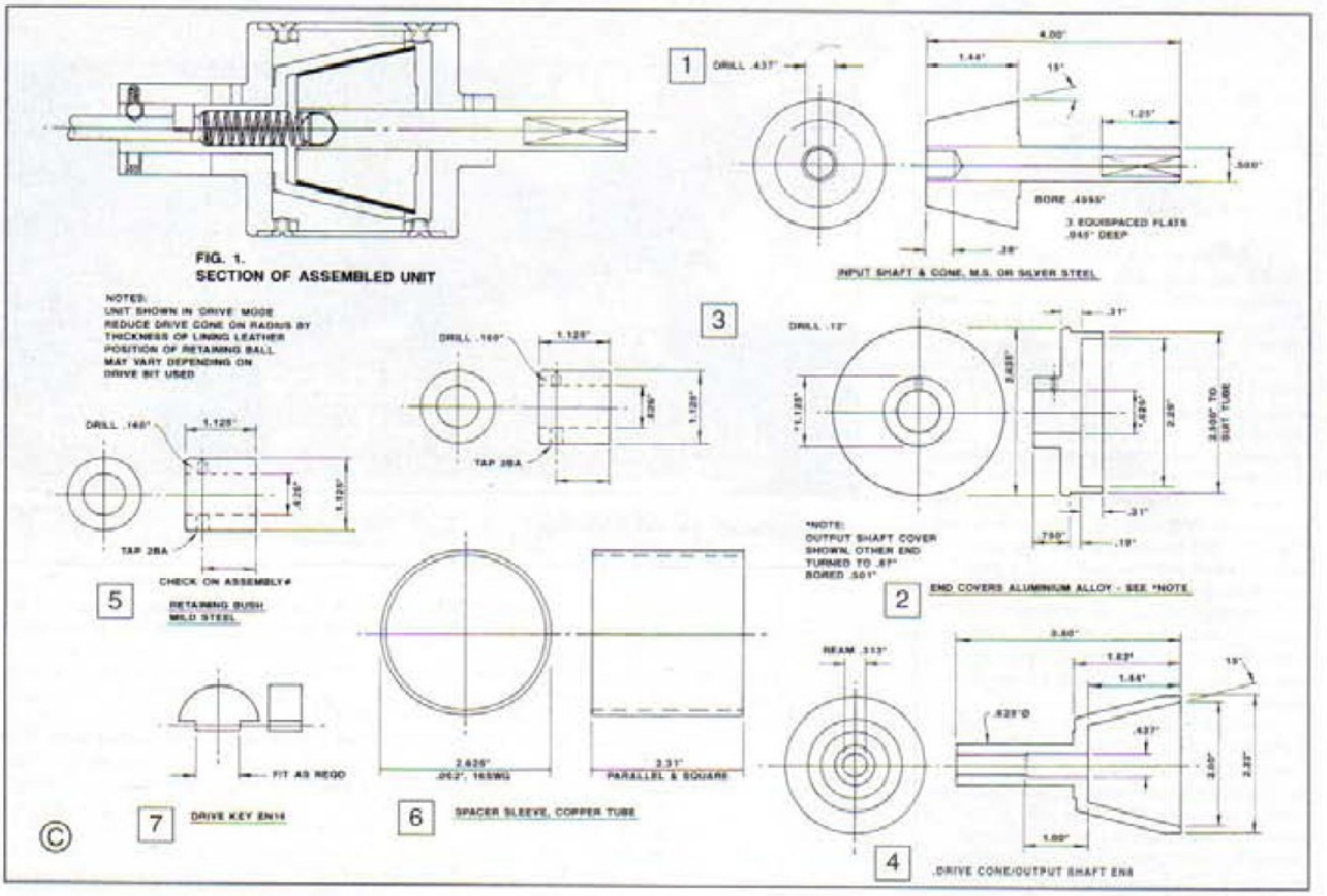
Similar calculations in respect of the torque gave approximately 1lb.ft. i.e. about 2lb. force on a typical carpenters brace.

Principle of operation

Figure 1 shows the assembled unit in section, while **Photo1** is of the component parts prior to the modification described later. Application of pressure via the drill chuck (the drive input shaft butts up against the back of the chuck cavity) partially compresses the preload spring, thereby providing positive engagement of the driver bit with the screw head. Further pressure then causes the cone drive to 'take up' the torque to the driver bit, being transmitted via a hardened 'D' shaped key retained in the driving shaft by an outer sleeve, which also provides accommodation for a small spring pressurising a ball to secure the driver bit. Speed of rotation is controlled by the drill,



The 'blued' Bore of the Driven Cone (the Driving Cone can just be seen on the top right hand side).



with termination of drive effected by a reduction in axial pressure prior to switching off the drill.

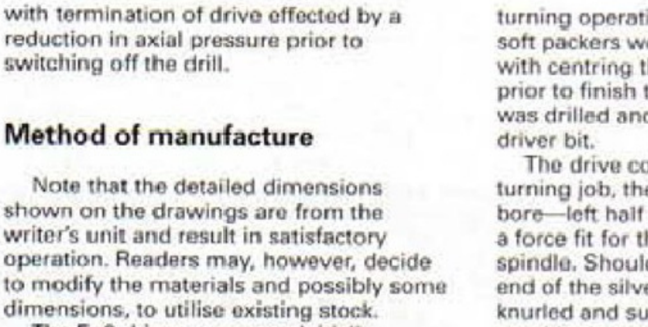
Method of manufacture

Note that the detailed dimensions shown on the drawings are from the writer's unit and result in satisfactory operation. Readers may, however, decide to modify the materials and possibly some dimensions, to utilise existing stock.

The En8 driven cone was initially roughed out to provide a finishing allowance on the $^5/_8$in. nose diameter. Following reversal in the four jaw chuck, the internal cone was drilled and bored to an angle of 15deg. per side, subsequently drilling the nose section for the preload spring. Initially, the outside diameter of the cone was intended to be parallel but, in an effort to reduce weight, turned to a similar angle of 15deg., leaving a $^1/_4$in. wide land for chucking purposes when reversed to finish turn the $^5/_8$in. diameter. In order to avoid the risk of distortion during this final turning operation, light jaw pressure and soft packers were used, in conjunction with centring the end for tailstock support prior to finish turning. Finally, the nose was drilled and reamed $^5/_{16}$in. to accept the driver bit.

The drive cone is a straightforward turning job, the only critical area being the bore—left half a thou undersize to provide a force fit for the silver steel drive input spindle. Should disaster strike, the inserted end of the silver steel can be coarse knurled and subsequently turned to provide the essential interference. The writer does not favour cross pinning, and has no relevant experience of engineering adhesives in this type of situation.

The angle of the cone was checked against the driven cone using a thin film of engineer's blue but, in its absence, lead pencil lines drawn parallel to the bore can give a similar indication of fit **(see Photo 2)**. To avoid any risk of 'bottoming', the cone was left $^1/_8$in. proud (this dimension being maintained after subsequent reduction in diameter and facing with leather).



The three Drive Flats being Milled - Note method of Indexing

In view of the heavy duty of the attachment, three flats $^3/_{64}$in. deep were milled in the drive shaft—**see Photo 3** —to give a positive drive. Indexing for the above was simplified by fitting a hexagonal bush to the spindle, secured by a socket head grub screw, with a parallel between the vice bed and the underside of the workpiece to enable the three identical flats to be machined without resetting the milling spindle.

The drive key slot was next milled to a depth of little less than half the diameter, to avoid working outside the vice jaw support (and excessive weakening of the output shaft) **(Photo 4)**.

The drive key is turned and parted off from a piece of En16 or En24, the writer's being made from 1in. dia. rear axle shaft, and subsequently step milled to fit flush while providing the drive to the bit, followed by quenching in oil from red heat.

The hole for the retaining ball bearing was then drilled in the output shaft—in line with the drive key slot—and at the correct distance. The use of a 90deg. drill point angle is suggested, to form a small restraint by not completely breaking through to contain the ball when the driver bit is removed or changed. The $^5/_{32}$in. retaining spring hole for the short compression spring was subsequently drilled to match, using the dead stop on the drill press in conjunction with a ten thou feeler laid on the drill vice bed, to avoid accidental breakthrough. Finally, the entry hole was tapped 2BA for the socket head grub screw.

The housing consists of a pair of aluminium alloy end covers, spigotted to fit the bore of a piece of copper tube which has both ends faced parallel, secured by 4 x 2BA countersunk screws at each end. The tube length should be sufficient to provide a minimum of $^3/_{16}$in. end float for cone release clearance.

Assembly

The assembly is straightforward in the extreme; the only slightly difficult part being the compression of the spring when fitting the outer sleeve to the output spindle containing the retaining ball bearing.

The initial trial

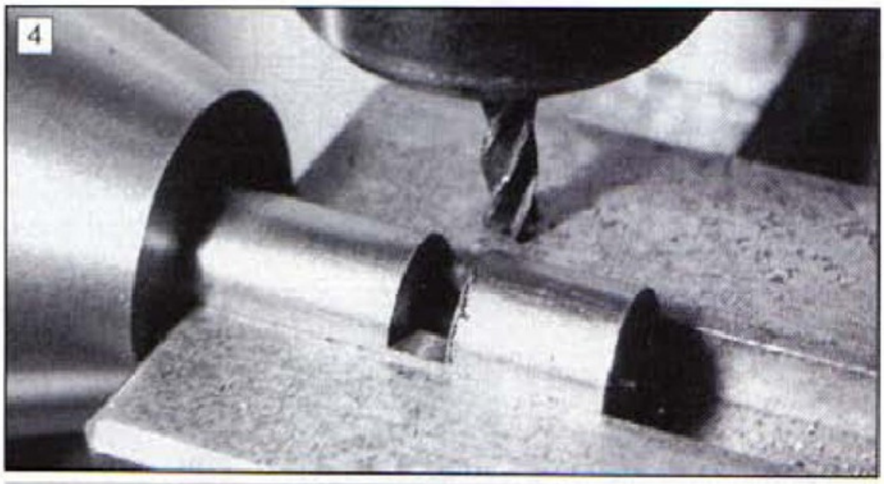
A number of test screw insertions were carried out, both with and without pilot holes, in a piece of softwood similar to that to be used in the structure. While the results were broadly satisfactory, the operation was a little harsh, with the transmitted torque being below expectations. When stripped down, 'hard lines' were evident on the mouth of the driven cone. Careful grinding in did not effect any appreciable improvement.

The conclusion arrived at was that the copper spacing tube, being unmachined in the bore, did not maintain adequate alignment of the two end covers and, therefore, the cones themselves.

Two solutions appeared feasible—either to make a new spacer tube piece, with the bore and ends machined at one setting, or to face the driving cone with leather.

Absence of suitable material dictated the latter option, leading to the careful reduction of the driving cone by 0.030in. on its radius to accommodate a piece of leather of similar thickness, the 'apparent' increase in thickness due to the cone angle being deemed sufficient to allow for its compression in service.

The leather was then cut out to the developed shape and secured to the cone surface, flesh side outermost, by Araldite, followed by insertion into the driven cone for clamping purposes. Gentle heat was applied to soften the Araldite for even distribution and to hasten the hardening process. This latter move had a minor disadvantage in that the subsequent separation of the two cones was only achieved with some difficulty, due to the seepage of the adhesive onto the 'working' surfaces. Following trimming of the leather to tidy up the edges, the unit was re-assembled for further tests.



Milling the slot for the Drive Key

CUTTING/PARTS LIST.

Drive Cone and Shaft	2" of 2.25" BMS 4.12" of 0.5" dia. S.S.	Can be made as an integral item from 4.5" of 2.25" dia. En 8.
Driven Cone and Shaft	3.62" of 2.25" dia. En 8.	
Retaining Bush	1.5" of 1.25" BMS.	
End Covers	3" of 2.75" dia. Aluminium Alloy.	Optionally Brass or Mild Steel (if fitted with Bronze Bushes).
Outer Sleeve	2.5" of 2.62" o.d. x 16 s.w.g. Copper Tube.	Alternatively Brass or Mild Steel Tube machined as necessary.
Preload Ball	0.4375" dia. Ball Bearing.	
Preload Spring	0.437" dia. x 1.5" x 0.032" Compression Spring.	Spring strength may need to vary with the application, i.e. the size of the screw.
Drive Key	1" of 1.25" dia, En 16 or En 24.	Quench in oil from red heat following final fitting.
Clutch Facing	Piece of Leather approx. 0.032" thick.	
Retaining Ball	0.1875" dia. Ball Bearing.	
Retaining Spring	Piece of 0.15" dia. Compression Spring.	Strength sufficient for Ball to retain Drive Bit in position.
Retaining Bush Grub Screw	2 B.A. x 0.25" Socket Head Grub Screw.	
Outer Sleeve Fixing Screws	8 off 2 B.A. x 0.25" Brass or Steel csk. Screws.	Shorten those for input end as necessary.

Final outcome

Using similar methods to those employed earlier, the behaviour of the unit exceeded all expectations, both in torque transmitted and speed of disengagement. The whole sequence was smooth in the extreme and, following further dismantling, no evidence of any scoring or of damage due to any rise in the temperature during operation.

It is impossible to predict the life of the leather lining in service, but its widespread use in earlier days would suggest that it will outlast the duration of the project by a comfortable margin—possibly a total of several thousand cycles before needing attention. The unit is, of course, 'self adjusting'.

The bonus due to the change to a steel/leather combination was in the improved coefficient of friction—certainly 50% if not 100% better than steel and bronze, i.e. a theoretical output in the region of 0.2 hp at 600 rpm, with a torque exceeding 2 lb.ft.


The complete atachment

Safety

It is essential that the above attachment, being restrained by the left hand in normal use, does not present a safety hazard. The following suggestions should help to avoid any risk of personal injury:-

1) Radius all edges likely to come in contact with the hand.

2) Ensure that the end cover retaining screws, together with the grubscrew on the drive end are fully flush.

3) Regularly (but sparsely) oil the end cover bearings to avoid seizure.

4) Before using, establish a stable body position with a firm foothold, especially if working above ground level.

5) Use an industrial glove on the hand holding the device.

6) Do not, at any time, lock the drill switch in the 'ON' position.

A SET OF SUPER SOFT JAWS

Holding soft or delicate work securely, yet without damaging previously finished surfaces often presents a problem. J. Neave offers his solution.

The original purpose of this set of Super Soft Jaws was to enable relatively soft materials, such as copper and plastic tubing to be gripped tightly enough to be machined, without distorting the tube being turned, which often happens when trying to use a standard 3-jaw chuck for this purpose. However, this set of jaws has also proved to be very useful for holding wooden, plastic or Tufnol items for machining, should this be necessary. It has also been invaluable for metal turning when the item concerned already has a finished outside dia. that must not be marked or damaged in any way. In fact these jaws now seem to be a permanent fixture on the machine!

The diameters selected for this design were chosen to try and cover as wide a range of circumstances as possible. They are as follows:- The outside dia. of the alloy jaws will fit into a 175mm (6.9in.) dia. recess: The recess in the front face of the alloy jaws will fit over a 165mm (6.5in.) dia. spigot. The removable flange will fit over a 90mm (3.5in.) dia. spigot. Extra removable flanges could be made up to about 127mm (5in.) internal dia. if required: the centre bore is 38mm (1.5in.) diameter. Obviously, these figures could be varied to suit individual requirements. Item 2, the removable flange, could be one of a series, each having a different internal bore dia. to hold various sized components. These removable flanges could even be made of hardwood or possibly Tufnol for one offs or short runs.

1

The machined front face of the alloy jaws before separation. The recess, the centre bore and the counter-bored holes can be seen. The eight small tapped holes in the recess are from previous use of the material, which has been recycled. The spare set of outside chuck jaws has been annealed, machined to the correct height, drilled and tapped.

2

The machined rear face of the alloy jaws, showing the grooves to match the spare set of chuck jaws. The grooves separating the three jaws have been partially cut on a lathe, to be finished later on a milling machine.

This set of jaws was designed to match a Pratt-Burnerd 160mm (6in.) 3-jaw chuck, and some dimensions would obviously need modification to suit chucks of other manufacture.

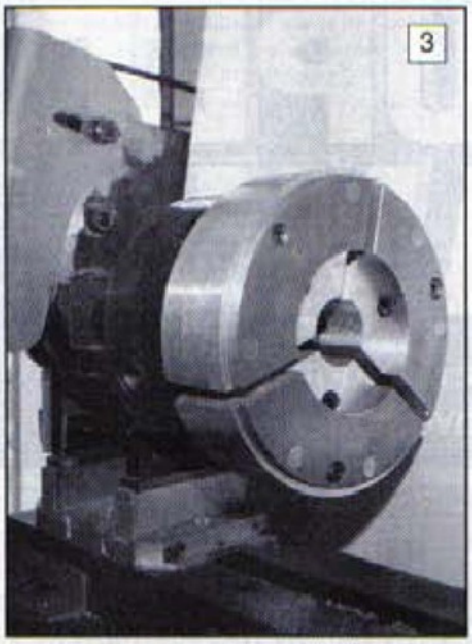
As this chuck was supplied with a spare set of outside jaws, these were softened and used as a mount for the Super Soft Jaws. Alternatively a manufacturer's set of soft jaws could be used. These can usually be obtained for most chucks in the soft condition, ready for machining.

Item 1. Alloy Jaws

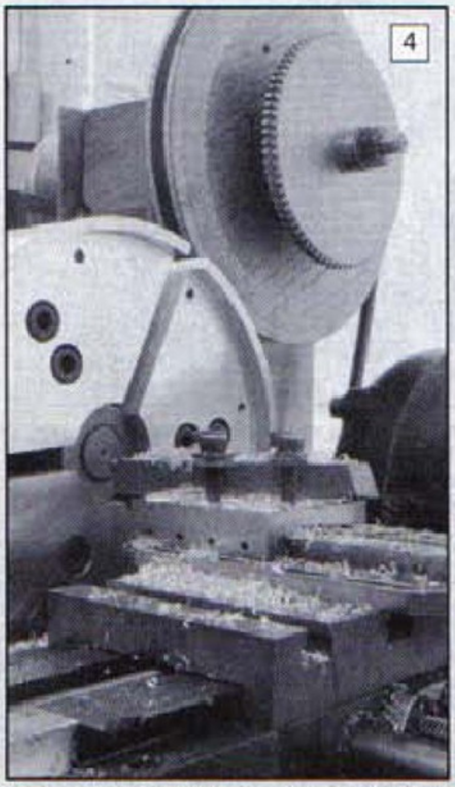
Material:- Aluminium Alloy, 1 off.

Turn the outside dia. to 175mm (6.89in.), face both ends to the overall length of 48mm (1.89in.). Machine the 165mm dia. x 8mm deep (approx. 6.5in. dia. x 0.312in. deep) recess on the front face. Bore the centre hole 38mm dia. (approx. 1.5in.).

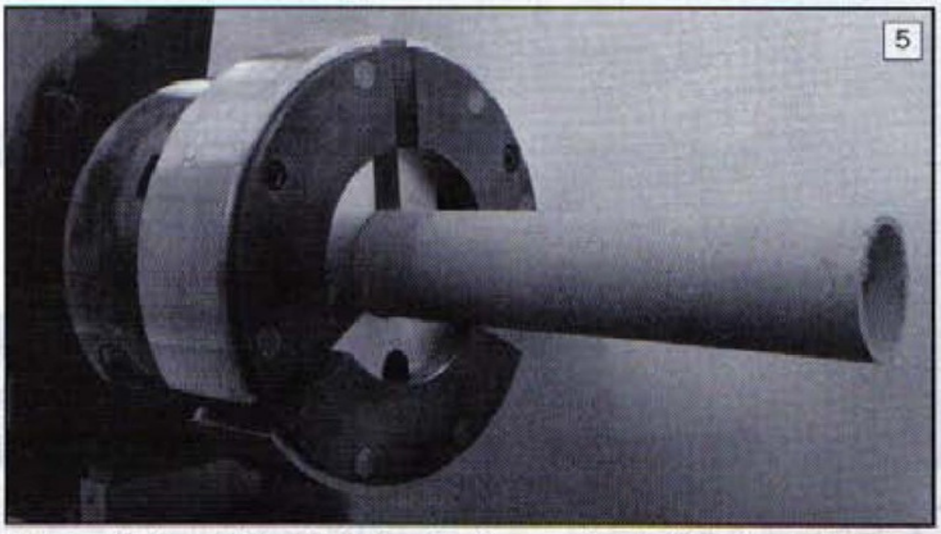
On a milling machine (if available), set up on a dividing head and mill the three 19mm wide x 11mm deep x 76. 4mm radial length grooves on the back face. The 11mm depth dimension of the grooves controls the amount of engagement on the existing chuck jaws. On the chuck used in this instance, the dimensions shown gave a nominal clearance of 1mm (40 thou) between the chuck face and the back face of the new jaws (See reference dimensions shown on the assembly drawing). Obviously, for chucks of other manufacture, these dimensions may need changes to achieve this result. These grooves must be accurately positioned and a good fit on the



The completed jaws are shown on the chuck mounted in a lathe, with the removable flange in position. It can be seen that the removable flange can easily be replaced by alternative sets of flanges with different bore sizes.



The completed alloy jaws set up on the lathe. The centre bore is in use, so the removable jaws are not required for this operation.



The completed assembly on the lathe, using the centre bore to hold a length of plastic tubing ready for machining.

chuck jaws. At the same setting from the back, drill the 6 x 8.5mm dia. holes, three holes on an 80mm PCD and three on a 116mm PCD, (this should ensure that they are on the centre line of the grooves).

Reverse in the dividing head and pick up the holes from the front face, and put in the six counterbores 14mm dia. x 9mm deep. Make sure the screw heads are under the face of the material. At the same setting, put in the three tapping holes for the M6 holes, 5.1mm dia. tapping drill by 15mm deep, equi-spaced on 150mm PCD. Tap the three 5.1mm holes M6 by 12mm deep.

The next operation on Item 1 would be to separate it into three sectors by cutting the three 10mm slots through to the 38mm dia. centre bore. However, this operation is best left until Item 2 is ready for the same operation, and machine the two items at the same time. After the items have been separated, the 3mm radius, where the 38mm dia. centre bore adjoins the 10mm radial cut, can be filed on.

Item 2. Removable Flange.

Material:- Aluminium Alloy, 1 off (or as required)

Turn the outside dia. 165mm, to be a slide fit in the recess in Item 1. Face to 12.5mm (0.5in.) thickness if necessary. Bore the centre hole 90mm dia. (approx. 3.5in.). Drill the three 6.5mm dia. holes and counterbore them 11mm dia. by 6.5mm deep, equi-spaced on 150mm PCD, to match item 1.

Items 1 & 2

Item 2 can now be placed in the recess in Item 1 and secured with three M6 x 16mm long cap head screws. Cut the 10mm wide slots to separate the segments. Item 1 should be kept aside, with separate segments marked in the order they come off the machine. File the 3mm radii on Item 2.

Item 3. Steel Jaws

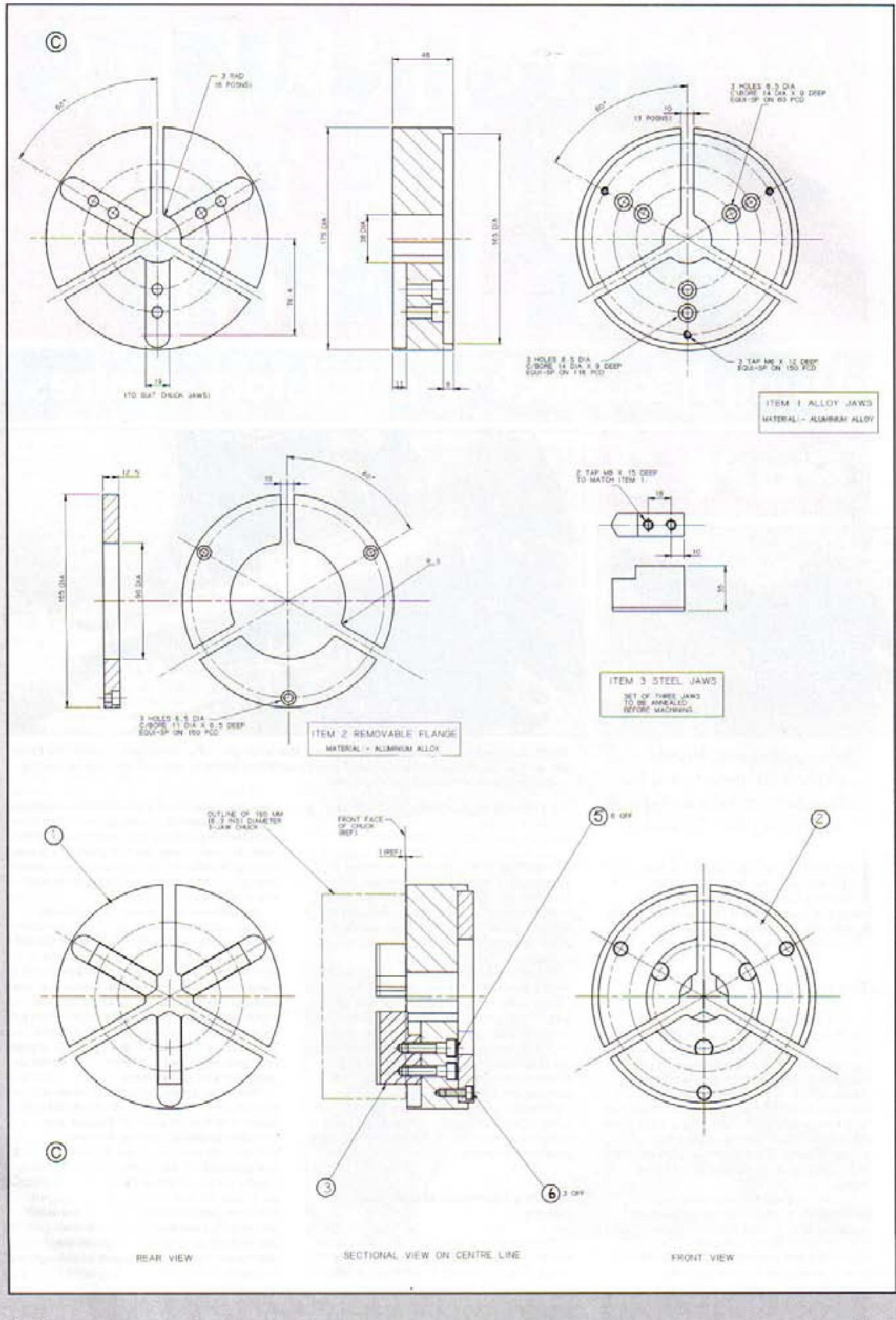
If a spare set of hardened jaws is to be used to mount the new aluminium ones on, they must be annealed before machining. The jaws should be machined to the correct height. To ensure alignment of the soft jaws on assembly on the chuck, the jaws should be put back in the chuck, blued on the machined face and, using a sharp pointed tool, the hole positions marked at the correct radial distance. Remove the jaws from the chuck, mark the centre lines on them accurately and then drill and tap the M8 x 15mm deep holes (tapping drill 6.8mm).

Assembly

The new alloy jaws should now be matched up with their respective machined steel jaws and screwed together using six M8 x 30mm long cap head screws. Each of the new alloy jaws should be stamped with the same number as the steel jaw to which each is now secured. The chuck body should now be screwed on the lathe spindle, and the chuck jaws, with the new alloy jaws secured to them, fitted to the chuck in the normal way. A 38mm dia. test piece should now be tightened up in the chuck to see if it runs true. If it does not do so, carry out any necessary adjustments.

Parts List

Item No	Description	No Off	Material
1	Alloy Jaws	1 set	Al. Alloy
2	Removable Flange	1 set	Al. Alloy
3	Steel Jaws	1 set	Steel
5	Cap Hd Screw M8 x 30 long	6	Steel
6	Cap Hd Screw M6 x 16 long	3	Steel

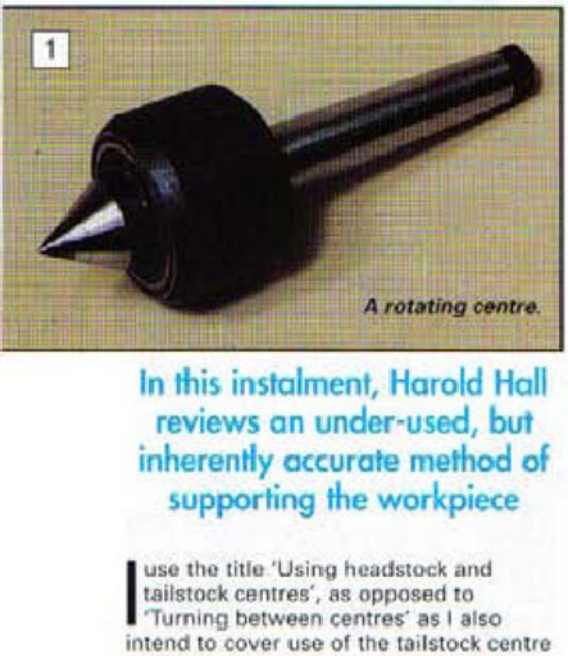


ITEM 1 ALLOY JAWS
MATERIAL:- ALUMINIUM ALLOY
ITEM 2 REMOVABLE FLANGE
MATERIAL:- ALUMINIUM ALLOY
ITEM 3 STEEL JAWS
SET OF THREE JAWS
TO BE ANNEALED
BEFORE MACHINING
REAR VIEW
SECTIONAL VIEW ON CENTRE LINE
FRONT VIEW

A BEGINNERS GUIDE TO THE LATHE

Using headstock and tailstock centres

Part 3


A rotating centre.


The tailstock centre being used to support the outer end of a workpiece held in the three jaw chuck. All diameters and thread were machined while in this set -up, thus ensuring concentricity of the important surfaces.

In this instalment, Harold Hall reviews an under-used, but inherently accurate method of supporting the workpiece

I use the title 'Using headstock and tailstock centres', as opposed to 'Turning between centres' as I also intend to cover use of the tailstock centre to support workpieces held in the headstock chuck.

The centres

Two centres are required, and if headstock and tailstock have identical tapers, as most do, then both will appear the same. This is not the case. At the headstock, both centre and workpiece rotate, while at the tailstock, the workpiece rotates but the centre does not. The headstock centre sees very little wear, but the tailstock centre has a very arduous duty. The headstock centre is left soft, but the tailstock centre must be hardened.

Other centres are available, most commonly, the half centre, as seen in drawing **Sk. 1**. This enables the end of the bar to be faced completely, an operation not possible with a standard centre. However, with a specially sharpened tool, as in **Sk. 2**, it will be possible to get very close. The slight burr left can very easily be removed.

Occasionally it is required to support a spindle that is too small in diameter to accept the centre drill, a common situation for the clock maker. For this, a hollow centre is used, while the spindle has a pointed end. Other centres are available, but are beyond the scope of this article.

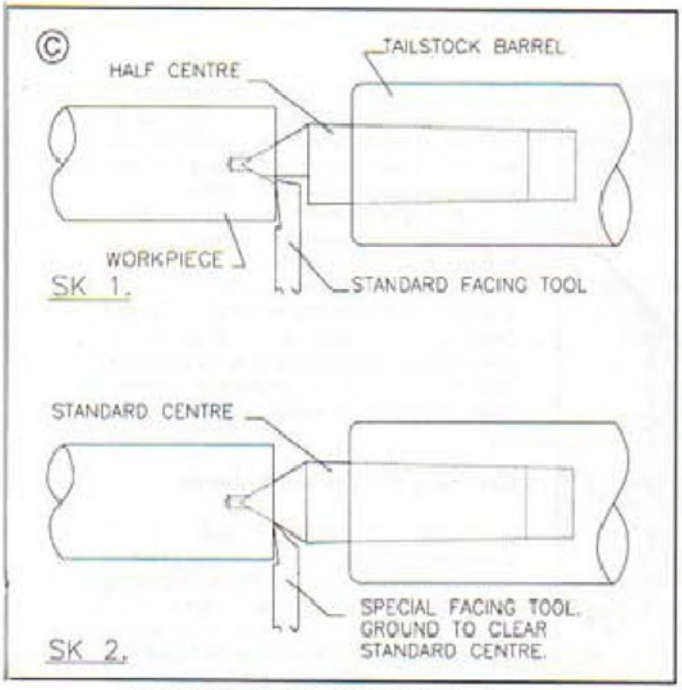
A rather special centre is the rotating centre shown in **Photo 1**. Here, the centre is mounted in bearings that permit it to rotate, making wear negligible. The bearings are loaded, totally eliminating play due to clearances in the individual bearings, as even the slightest shake would render the centre useless. These devices are sometimes made with removable centres, enabling other types to be fitted. An example would be to fit a large diameter centre to support the inner diameter of tubes.

Turning between chuck and centre

The reason for using a tailstock centre in conjunction with a workpiece in the chuck, is that the job is too long, or too slender, to be machined without additional support. **Photo 2** shows an example of a spindle for a slitting saw supported in this way. All machining was carried at the one setting, ensuring that the saw spigot, seen being turned using the parting tool, and the shank, were concentric.

As with many operations, there are hidden pitfalls. Starting with the simplest of situations, where the item to be turned is short, and the centre can be drilled in situ (**Photo 2** is a typical example). In this case, the centre drilling can be carried out without added support, and the drilled taper will be concentric about the lathe's axis. If the tailstock is correctly aligned (more about this later), the centre will then correctly engage the drilled taper without applying any radial force.

Before engaging the centre, it is essential, if a non-rotating centre is being used, that it is lubricated. Ensure also that it is the hardened centre. Advance the centre until resistance is felt and then lock the tailstock. If, when machining, chatter marks occur, advance the centre slightly, as it may be that it is not fully engaged. Another possible effect of the centre not being fully home would be for the workpiece to be tapered, due to the workpiece flexing as a result of the cutting pressure.



Typical combination set. Centring square, top right.

We now come to the most important part of the operation, the need for subsequent readjustment. Both friction at the centre and in the cutting operation will cause a temperature rise in the workpiece, resulting in the part expanding. Frequent readjustment is therefore required to avoid excessive pressure developing at the centre. Lulls in machining, such as coffee breaks, will allow the part to cool down and contract, also creating a need for readjustment.

Wear in the centre-drilled hole will have the opposite effect, that is to loosen the engagement. Normally this will be small, but if the initial centre-drilled hole is poor, may be at a different angle than that of the centre, then some initial effect of wear may be experienced. Do consider the extent of the machining to be carried out, and centre drill to an appropriate diameter.

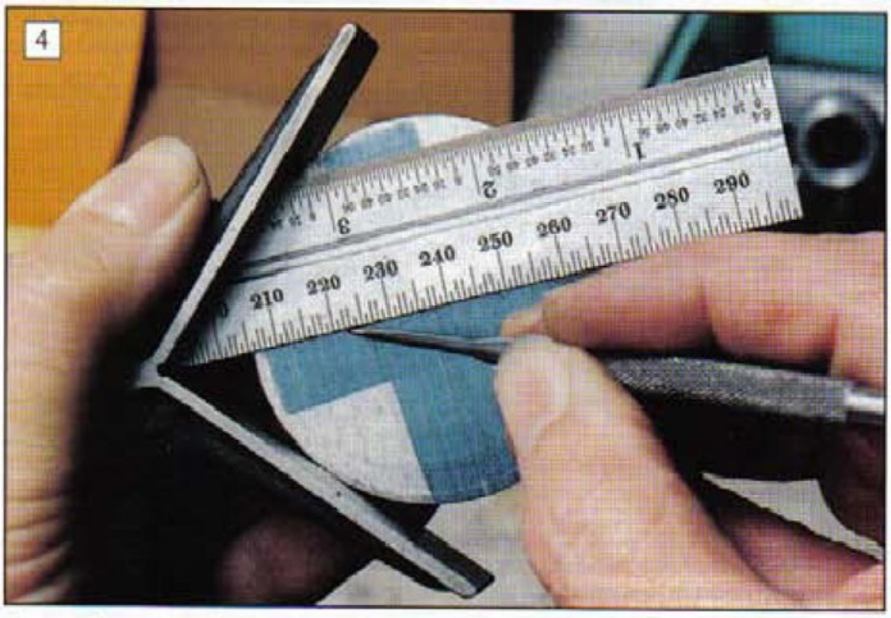
Whilst heat generated due to machining will be spread more generally, that generated by the over-tight centre will be localised at the centre area. Because of this, the temperature can become excessive, the centre tip softened, and the point badly scarred. It is essential to make frequent adjustments and to keep the centre well lubricated to avoid the problem.

Using a rotating centre

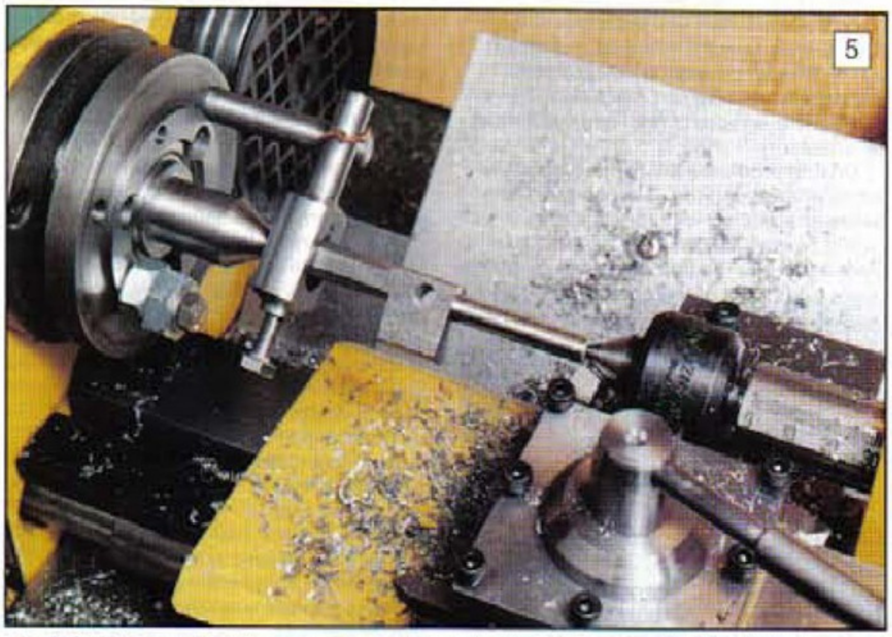
A rotating centre will largely eliminate heat generated at the centre, but that due to the machining operation will still occur. Adjustment will still be necessary, and the extra tolerance of the live centre to the situation should not be exploited. Whilst the centre may tolerate the extra force applied to it by the expansion of the workpiece, the workpiece itself may not. If long and slender the workpiece could become distorted and have a detrimental effect on the accuracy of the finished part.

Centre drilling in situ

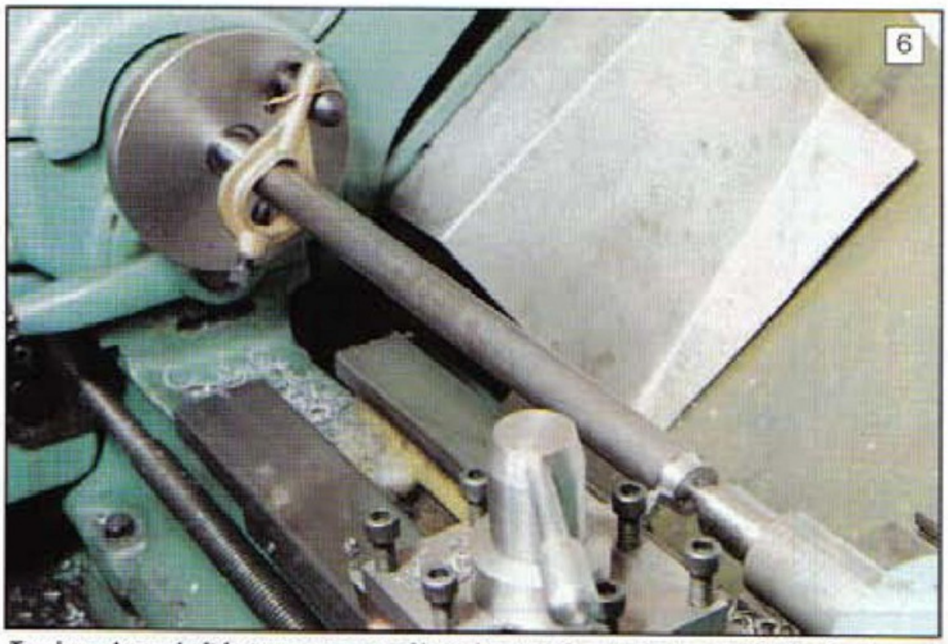
Returning to the method of centre drilling mentioned above. It should be understood that, as the centre drilling is taking place some distance from the chuck, the end of the part is unlikely to be



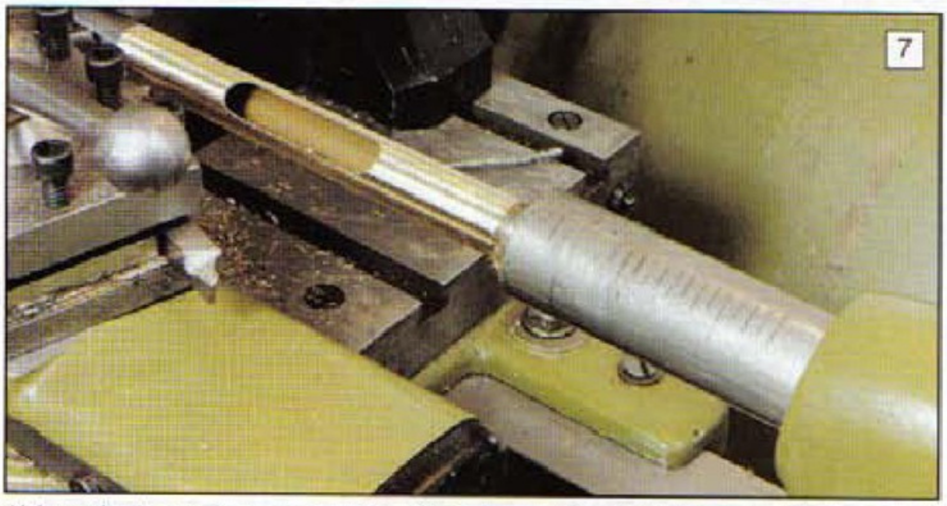
The centring square in use.



The initial stages of turning a small crankshaft. An excellent example of an item for turning between centres.



Turning a long shaft between centres. Note the use of a catch plate and lathe dog for driving the shaft, and the wiring together of the lathe dog and the catch plate pin.



Using a dead centre to support a tube while being machined. Initially wear will be rapid due to the line contact with centre. Frequent adjustment of centre will therefore be necessary.

running true. Often, the material will be bar stock which has still to be machined, so any error may therefore be machined out. If, however, concentricity is crucial, say with an already part machined component, a more careful approach must be adopted.

One method uses the fixed steady. It is worth considering the potential problems before proceeding with the details. It would be easy to assume that, if the part were fitted into the four jaw chuck, and made to run true at the outer end, that applying a fixed steady to this would then be all that is required. Consider how rigidly this concentricity is held. Having arrived at a point where the end is running true, clearance in the lathe bearings, flexibility of the machine, worn jaws in the chuck, and flexibility of the workpiece itself, all permit scope for the jaws of the steady to force the part from its concentric position with the lathe axis. Carry out the following test. Place a length of mild steel in the chuck, say 12mm dia. and projecting some 200mm. See how little radial force is needed to create a movement of say 0.lmm. Even the weight of the bar being held could cause it to drop at its outer end.

The following method, if carried out with care, will achieve concentricity, or at least a very close approximation. Grip the part in the four jaw chuck and make adjustments to ensure the part is running true at the point where the steady is to rest. A small error at the chuck should not cause a problem at this stage. Now apply the fixed steady to the component, taking extreme care not to deflect the workpiece.

It is not unknown for the action of tightening the steady arm to cause the arm to move. To avoid this, tighten each arm only lightly in the first instance, returning to each arm to give it a final tighten. This should largely avoid the possibility of the steady forcing the workpiece off centre. Now place the dial test indicator on the workpiece next to the four jaw chuck and adjust the chuck to make the workpiece run true here also. Follow this by centre drilling the end.

If however the steady has forced the component off centre, however slightly, the centre drill will attempt to find the axis of the workpiece even though it is on the axis of the lathe. This may result in the centre wobbling and the centre drill impression not therefore being in line with the workpiece axis. To achieve that final degree of precision, set the top slide to 30 degrees and with a very small boring tool, skim the drilled taper to achieve complete concentricity with workpiece outer diameter. This final operation should only be necessary in the most critical of instances.

The fixed steady can now be removed and the tailstock centre fitted and engaged. Check again for concentricity at the chuck jaws, making final adjustments if required. With the component running true at both ends, machining can commence.

Centring longer workpieces

Longer parts will always need supporting by a steady at the outer end while being centre drilled. If a steady is not available, the workpiece will require centring away from the lathe. To do this, the centre position must first be found, there being many ways of doing so. If this is a frequently carried out operation, the bell punch is a possibility. Drawing **Sk 3** shows the principle of this device.

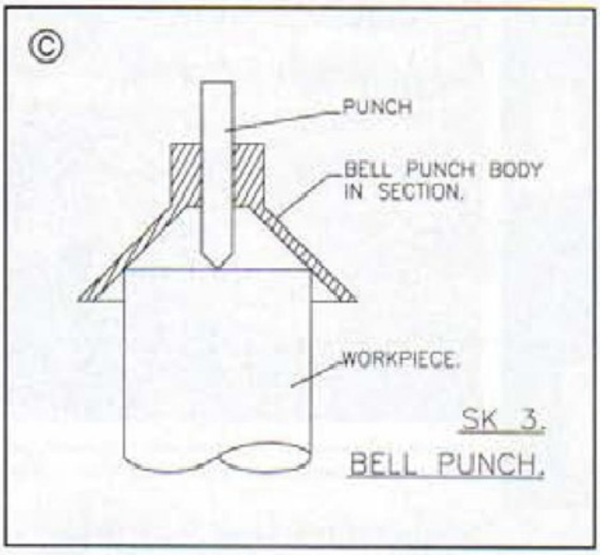
Alternatively, there are many methods of marking the end, all based on the same principle. First, place the workpiece on to the surface plate (two vee blocks may be required if the part has various diameters). Take a surface gauge and set this to the workpiece centre height, though absolute accuracy is not required. Now scribe a line across the end, followed by a second after rotating the workpiece through about 120 degrees. Turn a further 120 degrees and scribe a third line.

If the surface gauge has been set precisely to centre height, all three lines will cross at the same point, this being the workpiece centre. More probably, a very small triangle will be formed, from which the centre can easily be judged.

A similar method requires a centring square of which there are several types. Most common will be that provided with a combination set, as seen top right in **Photo 3**, and being used in **Photo 4**. If not available, making one would be good exercise for the beginner, and projects have appeared in the magazine (Refs. 1 & 2). These are accurate instruments, and two lines at 90 degrees should suffice, but producing three lines at 120 degrees will give a reassuring result.

With the centre found, it remains only to centre drill the end. This can be done on a pedestal drill provided that the part is not too long. If it is, the alternative would be to use an electric pistol drill, but accurately aligning the drill with the axis of the workpiece will present a problem. Any misalignment will cause wear of the centre impression, and frequent initial readjustment may be required. A misaligned centre is not totally taboo, as we will find out in a later article on taper turning.

Probably the best method would be to set up two vee blocks on the lathe cross slide, with the workpiece clamped in them. Adjust the height using packing, while lining it up with the lathe's axis. The component can now be drilled using a centre drill in a headstock mounted chuck. The workpiece could be positioned using a dial test indicator mounted in the chuck, and the marking out operations avoided.



Turning between centres

Turning between centres is an under-used technique, as is evident from the limited examples appearing in constructional articles in this magazine. The reason is probably a lack of emphasis given to its real benefits. Frequently, comment is made regarding it being the method for machining long components. Its major advantage is one of concentricity. Giving it consideration, most readers will realise that once mounted between centres, concentricity will be maintained precisely. It does not matter how often the part is removed and returned to the machine, including turning it end on end. It will also apply if the work is transferred between differing types of machine, say from lathe to cylindrical grinder.

However, one important point must be attended to for this level of precision to be assured, and that is the concentricity of the headstock centre. Should the centre or its socket have blemishes, or not be scrupulously clean when assembled, then the point may not run totally true. Also, any machine has manufacturing tolerances, and the taper bore itself may not be truly on centre. In these cases concentricity will suffer should the part be transferred in any way. We now fully appreciate the advantage of the soft centre that can, after fitting, be machined in situ ensuring the precision required.

Other than causing the workpiece to become tapered, an off-centre at the tailstock will still produce perfect concentricity. However, again there is a proviso, and that is that the centre is a fixed centre. If a running centre is being used in the tailstock, it is essential that it runs true. Most readers will find it obvious that a non true running centre will cause problems with concentricity. However, this assumes that the relation between centre and workpiece remains constant. The centre may, though, slip in the workpiece while machining, causing irregular shaped parts. A running centre that does not run true is therefore of little use, and unfortunately is very difficult to correct.

To recap, the real use of turning between centres is not limited to long components, but is equally appropriate to a short workpiece, where concentricity is important along its length. **Photo 5** shows an excellent example of the principle; here a crankshaft is being machined.

Having explained the purpose, how is it carried out? First, both ends must be centred, and any of the above methods used, depending on which is most appropriate. There is no reason at this stage why, first one end, and then the other, should not be held in the chuck for centring. The crankshaft, being made from rectangular material, was held on the top slide, suitably packed up, and centred using a drill in a headstock mounted drill chuck.

With the part centre drilled at both ends, fit the centres, paying particular attention to cleanliness and to the positions of the hard and soft centres. Check that the headstock centre is running true. If not, and concentricity is important, machine the centre in situ.

If the workpiece is just mounted between centres, it will obviously not drive for a cut to be taken. Some means of driving it is therefore required. This is effected by a lathe dog, mounted on the end of the part and driven by the catch plate, on which a driving peg is fitted. The catch plate is like a small faceplate with a single slot, into which the peg is fitted. **Photo 6** shows the set up. A conventional faceplate will suffice if a catch plate is not available.

While machining, the load placed on the workpiece will keep the dog in contact with the peg. Even so, it is still a good idea to anchor the two together, say tied with a few turns of string or a piece of wire. This will be essential should the cut be intermittent, perhaps when machining a component from square section material.

It is, of course, impossible to machine to the end of the workpiece at the headstock end because of the presence of the driving dog, and to do this the part must be turned end on end. Take the simplest of cases, say machining a parallel shaft. In this case part of the length will be machined in the first position, and the remainder machined after turning it end on end. Concentricity will be spot on if the precautions have been observed. Because of this, it is possible to marry the two machined surfaces with little indication of their being machined separately.

Special circumstances

Mention was made above regarding a large centre for supporting tubes. Few will find the need for one, but most may well require to support a smaller tube using a conventional centre. **Photo 7** illustrates a typical example. When machining commences, wear on the workpiece will be rapid due to the line only contact between tube and centre. To counteract this in part, the sharp edge can be removed with a small half round file or a large countersink. Initial wear will still be rapid but less so. If extensive machining is to take place, or the tube is too large for the standard centre, a plug can be made to fit into the end of the tube, having been drilled to take the tailstock centre.

When using a running centre, a half centre is obviously not a possibility. In this case, if facing up to the centre is required, the running centre will have to be replaced with a half centre for the final facing of the part.

Tailstock alignment

For successful application of the tailstock centre, it must be accurately aligned with the headstock axis. Other than a poorly made lathe, two factors can affect this requirement. Some lathes will be provided with a tailstock that can have its position adjusted. The purpose of this is to enable the centre to be set off axis so that a component mounted between centres will be turned tapered. After having used it for this task it is essential that it is returned to the on-axis position.

The second reason is much more complex and well beyond the scope of this article. Briefly, if the lathe has been installed badly, the bed can be twisted and misalignment of tailstock and headstock may result. The lathe manufacture's instructions with regard to installation should be closely followed. The article on lathe installation in Issue 9 (Ref. 3) is also worth reading.

Items to make

It has already been suggested that a centre square would be an interesting project for the beginner. A more demanding item to make would be a rotating centre. Two designs have been published in the magazine (Refs. 4 &5) that give a good indication of what is required, even if the designs are not followed in their entirety.

The need for a half centre has been explained, but its limited use will no doubt deter many from the expenditure. Making a hardened centre will be beyond the scope of not only the beginner, but also of many more experienced workers. The reason is that ideally, both point and Morse taper should be ground after hardening, and only a few will have the grinding equipment for carrying out this task. If though, fitting the half centre is delayed, using it only while carrying out the final machining of the end face, then a soft half centre should suffice. Another possibility would be to look out for a second hand hard centre and to carefully grind away the end to make a half centre.

References

1. A Centre Square. M.E.W. Issue 11 page 4.
2. First steps, Useful tools. M.E.W. Issue 30 page 23.
3. Aligning a lathe. M.E.W. Issue 9 page 60.
4. Heavy duty running centre. M.E.W. Issue 3 page 70.
5. Rotating centre. M.E.W. Issue 20 page 21.

WE VISIT WILL MOWLL MASTER CRAFTSMAN

The steam powered Sirius has, like the prototype, crossed the Atlantic, but by air rather than on the water.

Will Mowll is a man with a whole host of skills at his fingertips. His forte is building large scale ship models of a particular period, and the design philosophy expressed in his finished models reflects to a great extent his caring approach to those who view his superb models. The editor recently had the privilege of spending a few days with this modeller extraordinaire and here reports on his findings

The model of the Nicholson yacht owned by Will's father-in-law, built by Will.

To appreciate fully the skills of Will Mowll, it is helpful to understand the philosophy behind his approach to modelling. A couple of hours companionable conversation in his comfortable book-lined study, with drawers full of photographs to hand, make it clear that no project is undertaken lightly, and that the objectives are fully understood before work begins. It is also evident that, if it emerges that a current course of action is not likely to result in those objectives being met, then he has no hesitation in stopping, changing course, or even back-tracking, until he feels that things are once more going in the right direction. He often says that, in order to complete one model to his satisfaction, he usually seems to make enough parts for three!

His aim is always to create a model which depicts things as they really were, not in some highly finished condition, in which the full size prototype could never have existed.

He warns against the approach where the modeller, having obtained a can of the paint actually used on the prototype, feels that he is bound to get a result which is a faithful reproduction of the original. Will suggests that this demonstrates a complete lack of understanding of the nature of light and of perspective. Colours always appear less intense as the size is reduced. He suggests that a study of paintings of the subjects to be modelled will pay dividends.

Will's main interest is in ship modelling which, in recent years, has been on the grand scale. A part of the reason for this interest is that he feels that a ship is a microcosm of life, and as a clergyman he has a great interest in people. A vessel of any size is a floating world, where people live, work, eat, sleep, fall sick and sometimes die. All the paraphernalia of life will therefore be present, and all the materials encountered in everyday life will be there.

His advice to any modeller is, whatever the prototype subject, start by understanding its involvement with people, and then it will be possible visualise the effect that needs to be created in order to produce a model which looks realistic.

This approach to modelling has meant that Will has come to feel at home with a vast range of materials. Although giving regard to the material used to manufacture a given part of the prototype, he will choose the material for that part in miniature which will give the desired end performance and effect. The results speak for themselves.

In the beginning

Although having been interested in model making since boyhood, it was music

SS Great Britain at launch. The bubbles under the counter indicate that steam power is about to take charge.

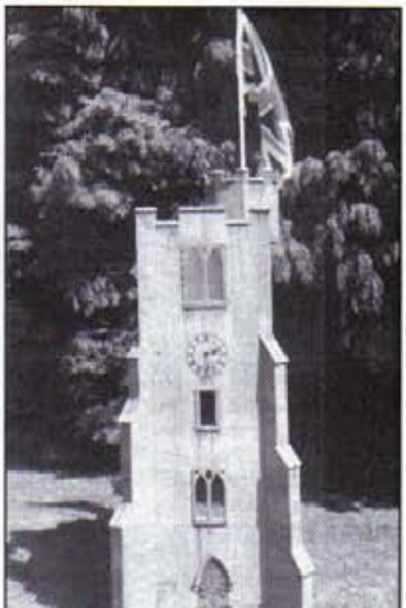
HMS Warrior on flotation trials in a neighbour's swimming pool.

A detail of Warrior's deck

The model of the bell frame and bells.

The builder's model of HMS Benbow, as recovered by the police. Photo. Josh Mowll

Benbow ready to return to her owner.



This church bell tower was built for restoration fund raising purposes.

that introduced a new line in craftsmanship, with the making of guitars in the early 1960s. He considers that being taught how to shape wood by steaming was the start of the move away from simple joinery. Four or five instruments were completed, but he considers that the more difficult part was the making of their cases, because these would go out of shape when split into the two halves. The involvement in musical activities continues, with the family band being in demand for local social events.

Marine modelling

Ship modelling started in 1974, when he made a steam powered model of the tug *Zwart Zee* for his father. This lead to father-in law demanding equality of treatment, with a model of the full size Nicholson yacht which he owned. Will's sons then entered the fray, suggesting that it was all very well for the senior members of the family to be able to play with boats, but what about them? Further projects followed.........

One of Will's guitar students had presented him with a copy of Guy Williams' book, *The World of Model Ships and Boats*, which created an interest in the *Sirius*, the first steam powered ship to cross the Atlantic. The resultant model was powered by a commercial steam plant, and was constructed using the plank-on-frame method, a technique which is still Will's favourite. A problem with sizeable ship models is what to do with them when they are completed. In this case, the solution was provided by an American gentleman, who decided that it would be just the thing to grace the foyer of the offices of his similarly named insurance company in New York.

The building of *Sirius* was the subject of several articles in our sister magazine *Model Boats*, starting a new friendship with editor, John Cundell. Will had, by now become fascinated by the combination of steam and sail, the ships from this period not having modelled too frequently. Discussions on the next project resulted in the suggestion that all the processes used in modelling *SS Great Britain* should be photographed and written up as they took place, resulting in a long running and very informative series of articles, and subsequently, a book. This introduced Will to photography. Prior to this, he says that his only experience had been with a Polaroid camera, but with an inherited Kodak Retinette set to its minimum focusing distance, and with a piece of wood of a similar length to indicate where to place the camera, successful illustrations were produced.

The standard of equipment has improved, and the camera is never far from hand whenever any work is in progress. Will's advice to any model maker is to do likewise. A clear photo is often invaluable when needing to check back on some set-up or machining process. Such photos are also a frequent starting point for a magazine article. Many of the photos for this visit report have been provided by Will himself.

Similarly, a notebook should also be an integral part of the workshop equipment. Always make a note of what you have done and what you plan to do next. Recording where you left off will often save time at the start of the next workshop session.

The *Great Britain* model, also of plank on frame construction and steam powered, won a Gold Medal at the Model Engineer Exhibition of 1982. This was to be followed by the current project, now nearing completion, *HMS Warrior*, also at a scale of $^1/_4$in.:1 foot.

Other projects have, from time to time, interrupted the main theme. One of the most unusual has been a model of the bell tower and bells from one of Will's churches (he tends four country parishes in East Kent, as well as recently having taken on the duties of Rural Dean of his locality). The bells are in urgent need of refurbishment, a task which will require a substantial amount of money. Will has always been of the opinion that a model is an invaluable means of illustrating any mechanism to those who may have little understanding of the subject matter, and this model has made it possible to explain the problems involved during fund raising activities. It also won a Commended certificate at the last Olympia exhibition!

Another ship model which required some tender loving care was a builders' model of *HMS Benbow*, a vessel built in 1885. The model had been badly damaged when it was stolen, but the policeman who recovered it had been meticulous in gathering up as many of the pieces he could find, even some minute fragments. Will undertook the restoration of the model, and was able either to refurbish the damaged items or to create new, using all the fragments to establish their form.

As one would perhaps expect in one of his profession, Will is a social person, attracting a wide circle of friends, who are all willing to offer help when necessary. Equally this help is reciprocated unstintingly. After all, he says, no shipbuilding project of any size was ever undertaken by just one man, or even by one company, so the

The Myford corner. Sitting on the electrical control box is a recently acquired 'prisoner of war' model, which requires the Mowll treatment.

HMS Warrior occupies the centre of the main workshop, with SS Great Britain in its glass case in the background

Difficult to photograph in the narrow section of the workshop is this sock drawer. Recovered from a gents' outfitters, it makes a useful storage unit.

The extension to the workshop houses the other metal working machinery. Security is taken seriously, as can be seen from the manner in which the windows are protected.

Neat storage for finer tools

A DeWalt radial arm saw deals with the heavier section timbers.

The Dremel sander is ideal for fine work.

This neat little drill was discovered, second hand, in a local model engineers' supplier's.

contribution of many people will be required in order to ensure a successful conclusion.

Although Will does not actively seek publicity, news of the sort of projects he attempts are bound to come to the attention of the media, so he has become adept at dealing with it. His fiftieth birthday party was the subject of a television documentary which was shown nationally on ITV on a Sunday lunchtime. The latest item, on Meridian news, covered the launching of *Warrior* in the sea at Seasalter. A brisk breeze made conditions quite exciting, and some of the pictures were spectacular, to say the least!

The Workshop

Will's workshop is established in an extended double garage, which is now L-shaped. Restricted space means that some machinery can only occupy bench space when actually in use, so has to be stowed away at other times. Fortunately, the general nature of Will's modelling activities mean that fairly light, portable equipment can often be employed. The heavier machinery consists of a Myford Super 7 lathe, an Amolco milling machine and an Alpine bench drill. A DeWalt radial arm saw looks after the more substantial pieces of wood, while a bandsaw of the same make and a Hegner fretsaw are used for lighter work.

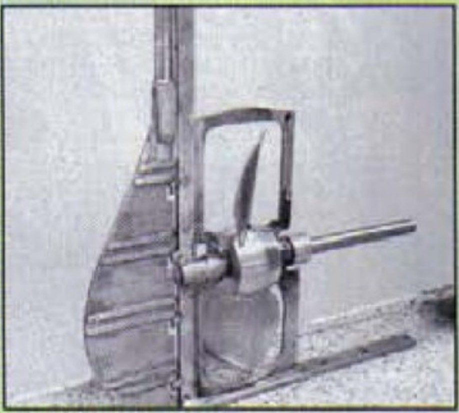
For the very large amount of fine detail, Will has found the lightweight portable power tools to be most suitable, but a look into the less frequently disturbed corners of cupboards and shelves reveals a number which have been abandoned because they have proved to be just not man enough for the job. One which has proved to be outstandingly successful, and on which Will has now virtually standardised is the Dremel brand, which comes from America. Their powerful high speed motors and versatile attachments are extremely reliable. Apart from the hand held drill unit, which can be fitted with a routing attachment or a right-angle drive; the workshop houses a belt/disc sander unit and a circular bench saw. Unfortunately, the latter is now out of production, and the importer has no information of the likelihood of its re-introduction.

A propane torch takes care of silver soldering and also of melting the white metals used for some of the castings. A vast range of hand tools has been accumulated over the years, and can be used to fashion metals, woods, plastics and fabrics with equal facility. One of the more unusual powered items is a rope making machine, which will produce scale representations of a wide variety of types and sizes of cordage from many different sewing threads. Design and manufacture of this device was a significant project in its own right.

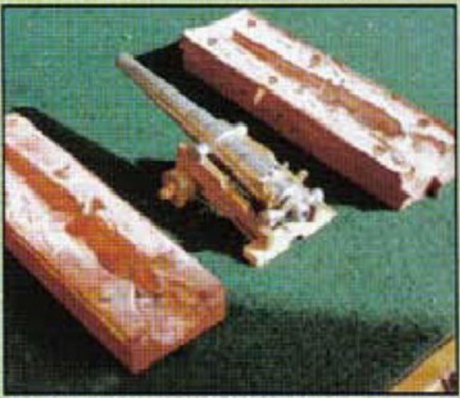
The Processes

It is thought that readers may find interest in a few brief details of some of the processes used by Will in the course of his ship modelling.

This Dremel circular saw has a 4in. blade and its ability to cut accurately makes it a favourite tool, but alas, it is no longer marketed.



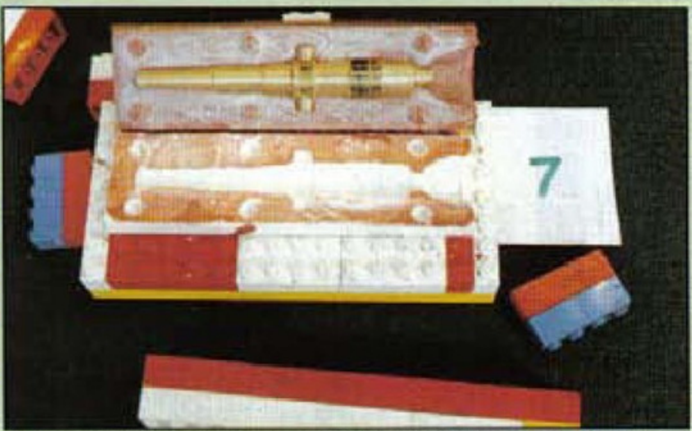
The stern frame for Warrior represents some of the heavier work for the ship models.



The two half moulds flank the finished product.

The ladle contains white metal ready for sand casting.

A sand mould for the gun barrels.



A Lego mould box contains soft plaster for 'oddside' moulding a gun barrel. The pattern is seen embedded in the first half of the silicone rubber mould.

Etching provides an excellent way of manufacturing deck fittings.

Metalworking.

Over the years, Will has acquired all the skills encountered in the traditional model engineer's workshop. The stern frame, rudder and propeller assembly for *Warrior* demonstrates that there are few projects which he could not tackle.

Casting

Models such as *Warrior* often demand the manufacture of multiple copies of some items. For instance, the vessel carries a large number of guns, including twenty-six 68lb weapons, four 40 pounders and ten 110 pounders. The material used for these is a white metal (tin - lead mix), the larger being sand cast, while the smaller were cast in silicone rubber moulds. In the latter process, use is made of an unusual material - Lego. This is used to form the moulding box into which the rubber moulding material is poured.

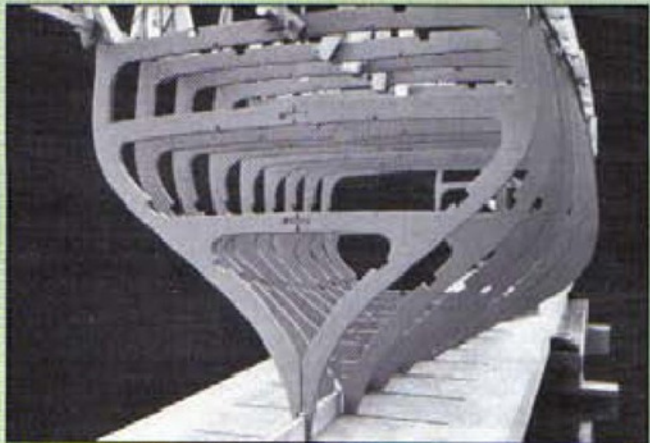
Etching

Much use is made of the etching process when fine detail brass work is to be manufactured. The gratings surrounding the base of *Warrior's* funnels are good examples. Proprietary printed circuit board etching fluids are used, with a variety of masking materials being employed.

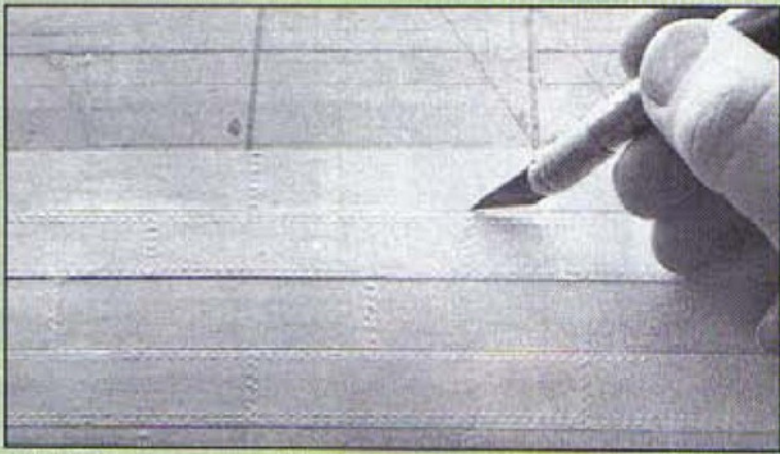
Glass fibre work

Although Will has said that his favourite method of building hulls is by the plank-on-frame process, he realised, as the builders of full-size ships did, that there is a limit to the size of vessel that can be built in wood, if sensible scantlings are to be used. The length of *Warrior's* hull, some 8ft., made it necessary to resort to glass fibre (g.r.p.). The process employed the traditional steps of plug, g.r.p. mould, followed by the hull itself. The plug was a major project in its own right, being constructed as a plank-on-frame unit. This is where the accuracy of the hull shape had to originate, following many hours of research. The plated effect achieved on the hull was obtained by applying gummed paper to the outside of the planked surface of the plug, each piece representing the shape of a hull plate. The riveted effect was simulated by applying a dressmaker's wheel of an appropriate pitch to the sticky side of the paper before applying it to the hull. The mould then took up this pattern, which was successfully reproduced on the hull.

Having constructed the plug, Will sought professional assistance with the g.r.p. work, in view of the size of the task and the fact that the high cost of the material made a

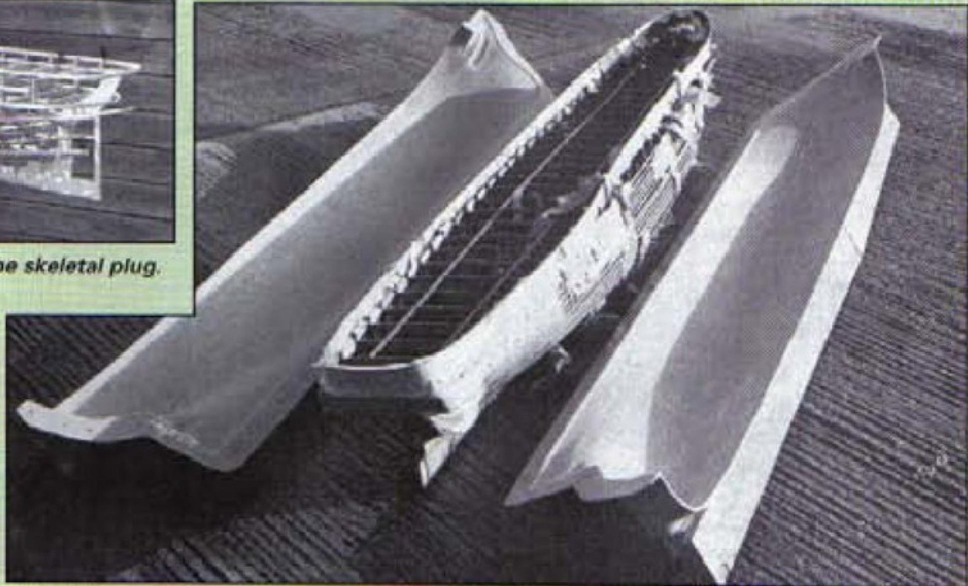


A lot of hard work went into making a plug for Warrior's hull moulding.

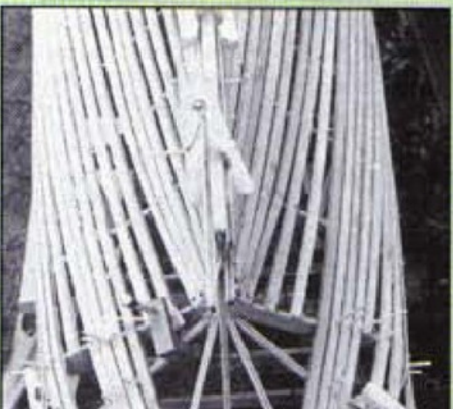


Hull plating is represented by the application of gummed tape.

The hull lines show up well in this view of the skeletal plug.



As the two halves of the mould were removed from the plug, some of the plug surface became detached. No matter - it was soon in the skip.



Planking begins to form the moulding surface.

The plug is prepared for the lay-up of the mould.

Re-inforcement of the hull in process.

'right first time' result highly desirable! Two hulls were, in fact made, so that one could be transformed into a 'half model' for the company who restored the prototype vessel at Hartlepool, and who had been so co-operative in providing information for the model project. It is understood that the half-model is now mounted on the wall of their boardroom, in traditional fashion.

At the end of all this, there was only one practical destination for the plug - the skip. After all that fine work, it was somewhat heartbreaking, but it had to go. The mould remains, so if anyone fancies something to do in their spare time, arrangements could be made!!!!!!!!

Carving

Woodcarving is an essential skill of the shipbuilder, and many small items are produced in this way, using the finest of tools. Sometimes, it is used as a means of patternmaking. *Warrior's* figurehead is a prime example. After carving, the old fellow, who now sits on a small plinth on a bookshelf, was moulded in a soft silicone rubber, and cast in a bronze resin pigment.

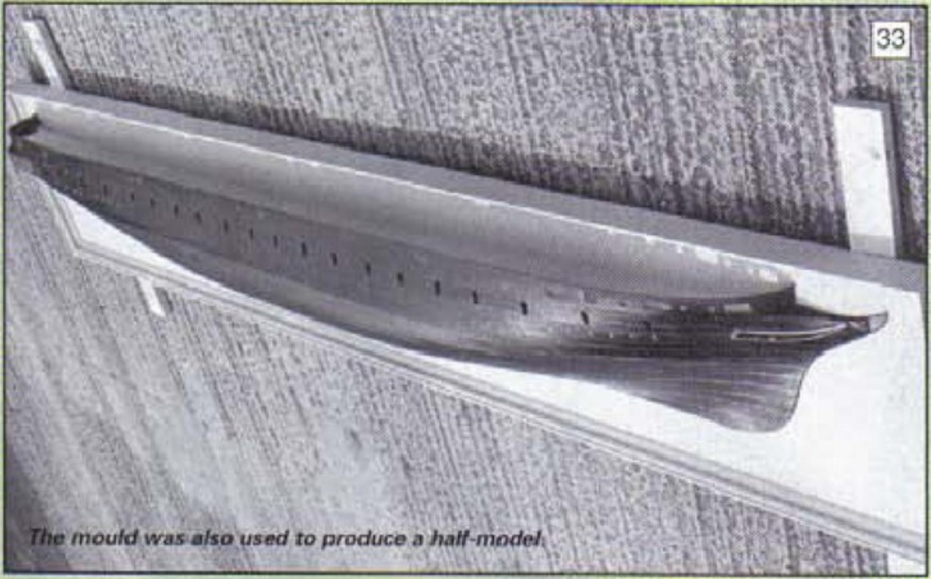
Fabric work

As Will has pointed out, many fabrics were used in the full-size ships. Where wood had to be protected, to avoid chafing, leather was often employed. Sails and cordage formed a large part of the equipment and the skills required to work them were vital. Although the sails for the models have been produced by another member of the family, the workshop often needs to handle the softer materials. The rope making process and equipment have been mentioned, but another subject is the making of flags. This is achieved using thermo-fixable dyes (just like decorating T shirts), which can be painted on to cloth, and fixed by the application of a hot iron.

A Master Craftsman

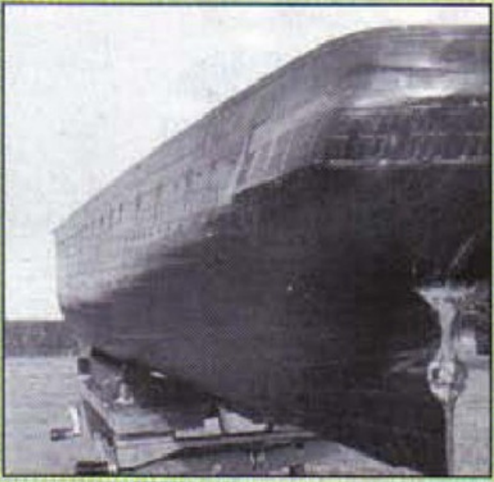
The work achieved on the Sirius project resulted in Will being elected to membership of The Guild of Master Craftsmen in 1979. Subsequently, in 1984, he was elected to Honorary Membership of the Guild, in recognition of his further outstanding work.

His willingness to explore and adopt new techniques and materials in the search to achieve a product which not only appears, but also performs in a manner which represents the prototype, provides an example which all model engineers would do well to emulate. We all look forward to seeing his future work.



The mould was also used to produce a half-model.

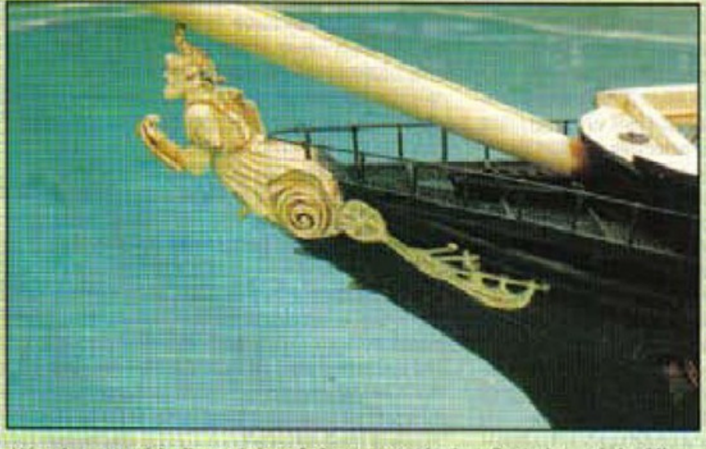
Rope making needs plenty of space!



The fine detail has reproduced well on the hull surface.

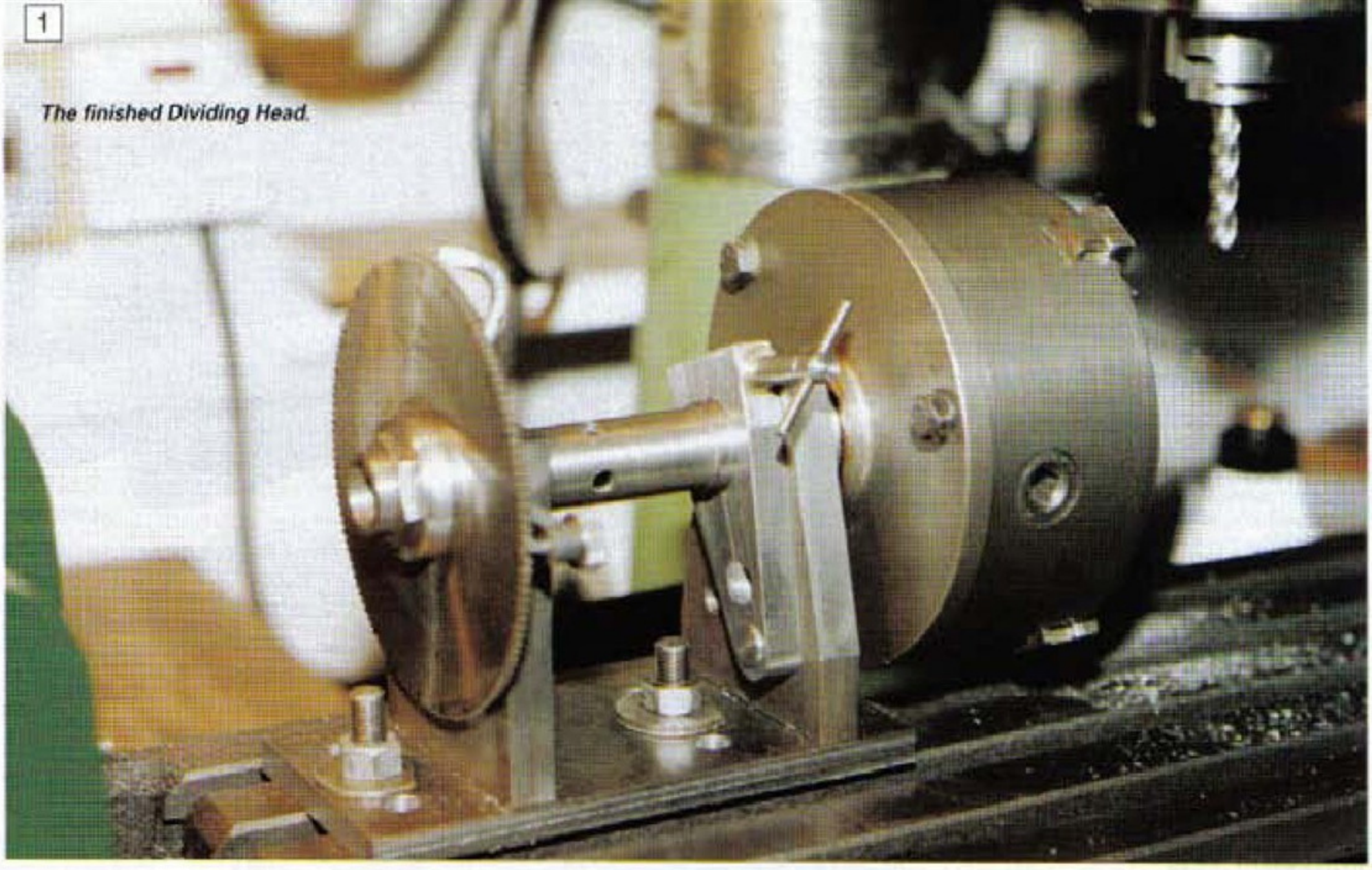
The headstock of the rope making machine.

Carving the pattern for Warrior's figurehead, using a photograph of the full-size version as a guide.



Warrior gets his first sight of the water during flotation trials. His first sniff of the sea turned out to be much more dramatic.

Complex flag designs can be produced using thermo- fixable dyes.



1 The finished Dividing Head.

A UNIQUE DIVIDING HEAD

In recent Issues, we have featured the workshop of Pat Twist. He now describes a dividing head which incorporates a novel feature

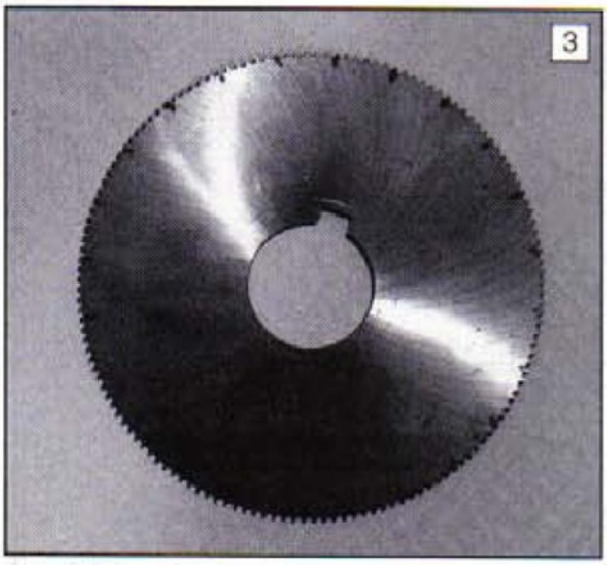
Having made a special tap for a specific purpose, the final job before hardening and tempering was the forming of a square end for the tap wrench.

Up to now, I have always done this little job with a file, using a pair of flanged rollers held in a vice on the vertical slide, on the lathe, but I never did like the idea of filing on hardened rollers, and with unhardened rollers, the rollers could be filed as well as the job. An idea was born, which resulted in this rather unorthodox, but very useful sort of dividing head for use on the vertical milling machine **(Photo 1)**.

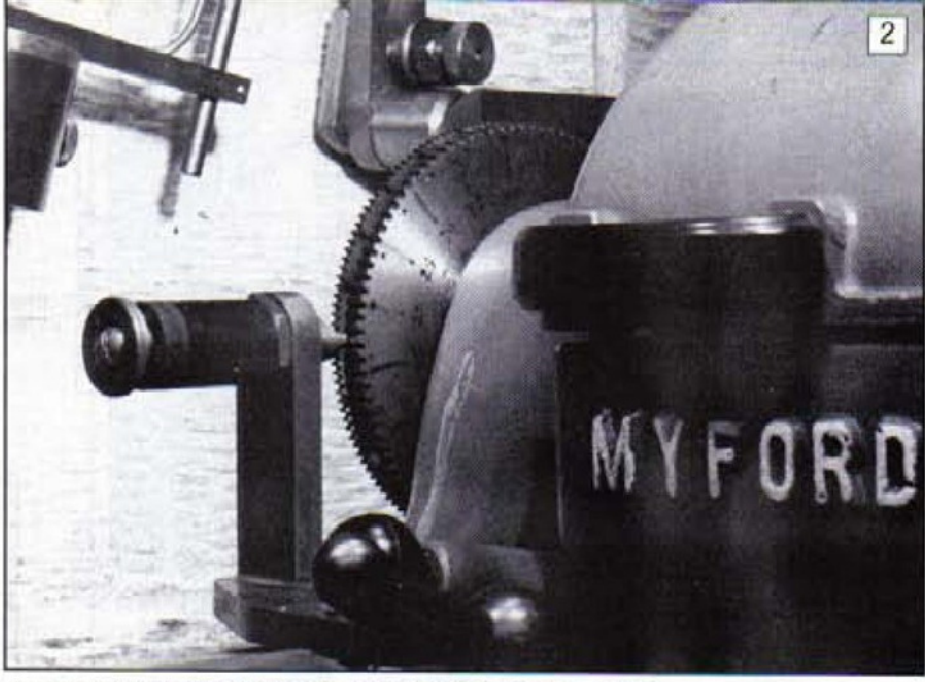
The dividing plates that I used are the same as those I use on the rear end of my lathe mandrel, see **Photo 2**. They depend not on holes in the plates, but on notches round the edge **(Photo 3)**. A detent shaped to fit the notches results in the elimination of any backlash. The plates are made from redundant HSS circular saws, 5in. in diameter, purchased from a saw sharpening company. Originally they were 6in. diameter, but continuous re-sharpening had reduced the diameter to the extent that the hollow ground cross section of the saw had been eliminated.

The 'saw doctors' were happy to dispose of these redundant saws, and I was happy to purchase five for the asking price of a nominal £1 each. They ground off the existing teeth on their sharpening machine and ground in the notches as I requested. I now have plates which have been notched 100t, 144t and 180t, numbers which have been required for jobs which have arisen over the years, and I have two spare saws left. The charge for grinding off the teeth and notching to my specification was £4 each (in 1988). It could well be that a saw sharpening firm in your area would be helpful if you used a tactful approach. If no redundant saws are available, mild steel discs could be turned up and used instead.

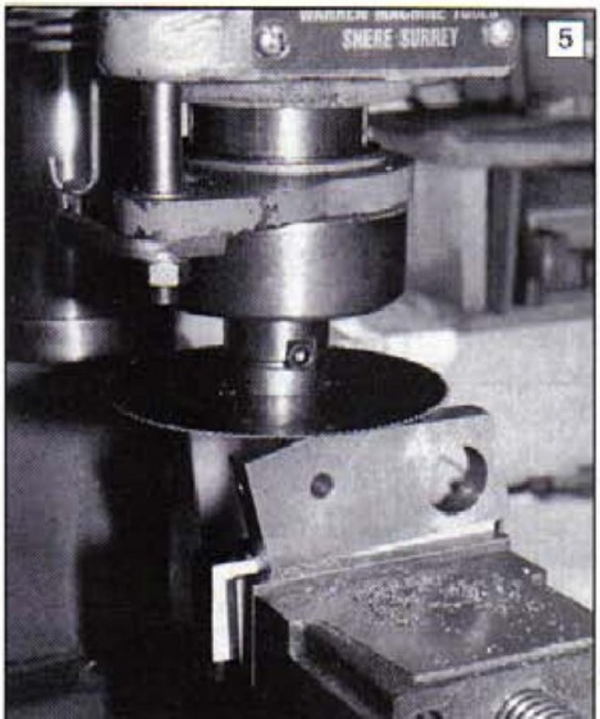
I have found in the past, that when I say that I am a model engineer, and that I make things, practically minded people are quite interested and helpful (maybe it's just my charming manner). I am minded of one foreman who said to me 'Have a look in our scrap skip, we have just discarded an old German photocopier



One of the notched plates.



A notched disc being used on the rear end of the lathe mandrel.



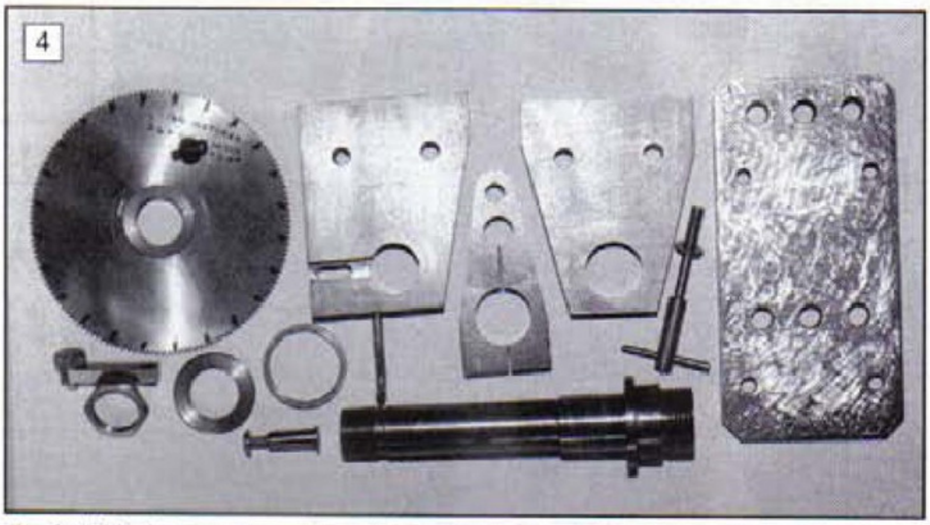
Shaping the uprights, using a saw in the milling machine.

which might interest you'. That lucky find resulted in all that was necessary to construct a power hacksaw that has been invaluable over the years, and was used in cutting off the metal for this present job.

Photo 4 shows all the parts separately.

Base and uprights

The base and the two vertical parts that act as bearings for the mandrel were made from a length of 3 x $^{3}/_{8}$in. black iron that I had; it was put in some pickle to remove the scale, and found to be more or less uncorroded. The base of the unit, however, was slightly bowed along its length, so this was rectified by filing and scraping. The corners were cut off by flycutting on the lathe, and the ends and sides squared off.



The individual components of the Dividing Head, (the mandrel shown however is in two parts, the chuck register is screwed and Loctited to the mandrel).

Six $^{3}/_{8}$in. diameter holes were drilled to suit the Tee slots of the milling machine table. So far, I have only used the centre holes, but the outside holes have been drilled a Tee slot distance apart. The other four holes in the base were drilled later, on assembly of the uprights and the mandrel.

The front and rear uprights were cut off to length in the aforementioned hacksaw, coated with marking-out blue and scribed to the shape in the drawings, the tapered sides being cut off using a circular saw on the milling machine, **(Photo 5)** (note the use of paper between the vice jaws and the job. The work is held much more securely, especially when milling).

The two $^{5}/_{16}$in. dia. holes in each upright, drilled 1in. up from the bottom edge, served two purposes. Firstly, they enabled each upright to be bolted to the lathe cross slide in turn for flycutting to the scribed lines. Secondly, with the two uprights bolted to the faceplate in turn, and with a stub of $^{3}/_{8}$in. dia silver steel in the $^{3}/_{8}$in. reamed hole, they could be centred accurately with a DTI for boring ($^{7}/_{8}$in. dia. for the rear upright and 1in. dia. for the front upright respectively).

Nut, chuck register and disc adaptor

The three parts which were made next all needed threading internally.

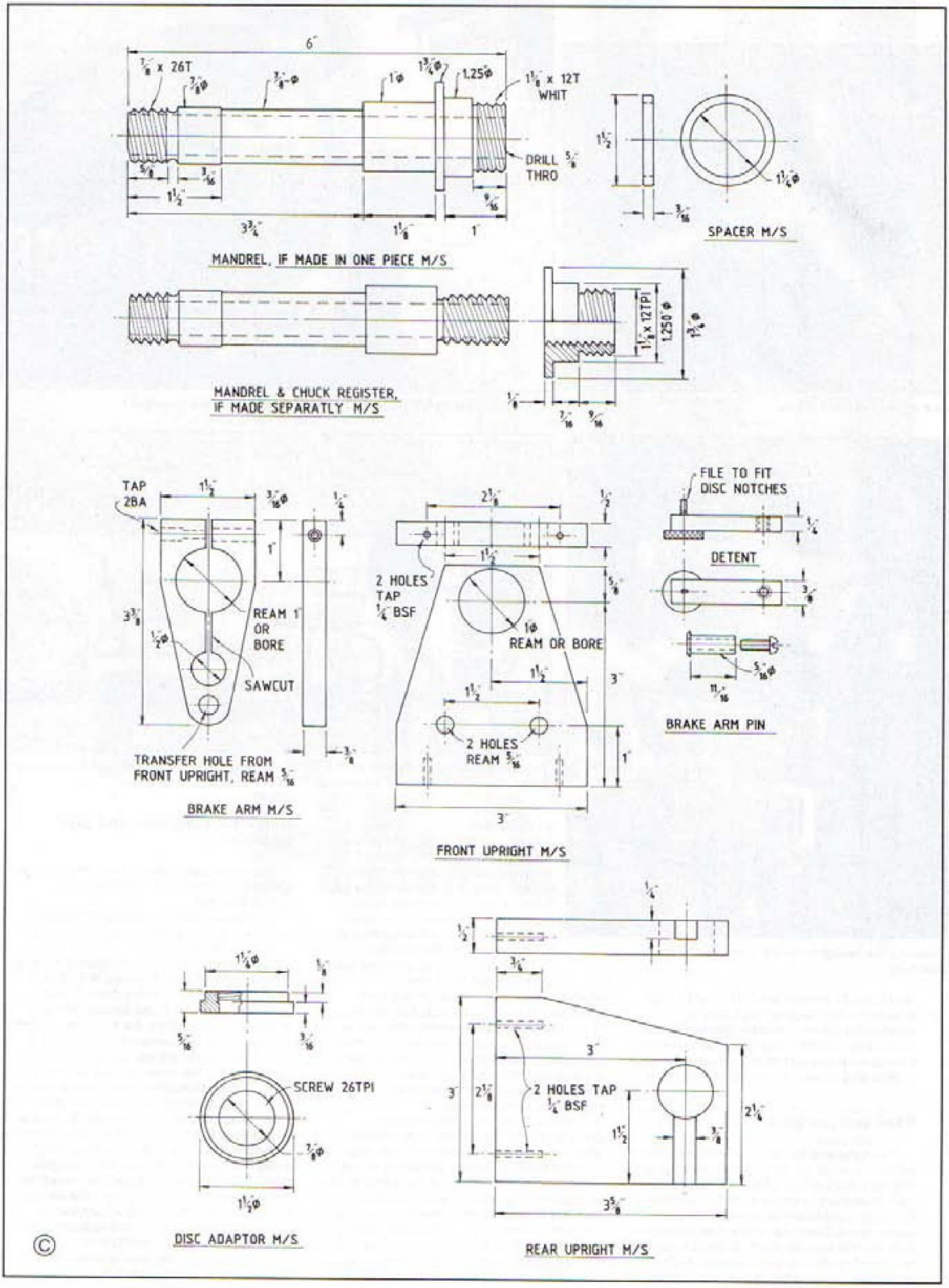
1) A thin nut,

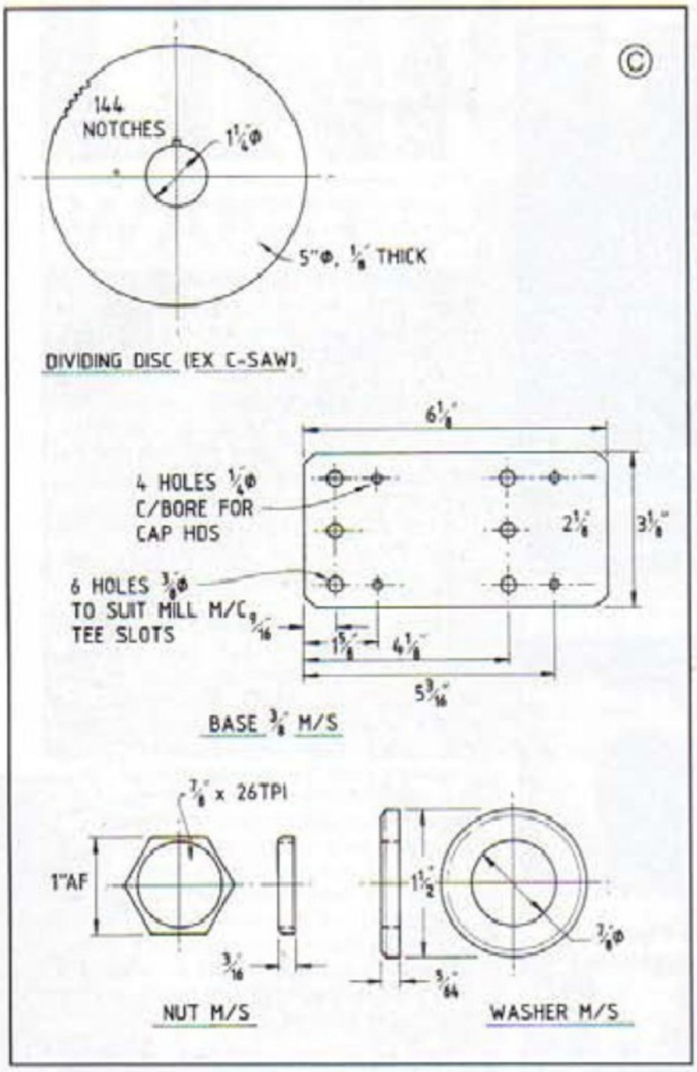
2) The part that the chuck screws on (i.e. the chuck register), and

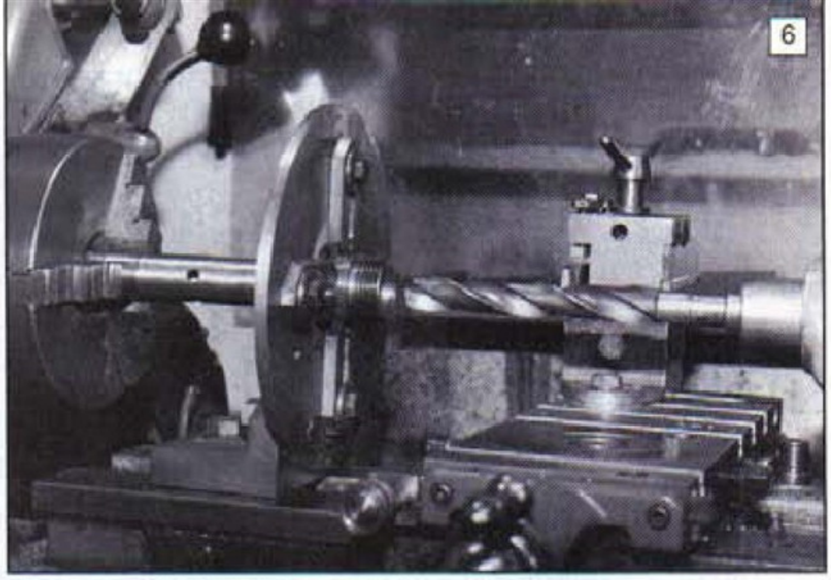
3) The disc adaptor.

I prefer not to have to screwcut female threads if I can help it. A tap is so much easier and quicker. In this case, I used a $^{7}/_{8}$in. x 26 tap that I had bought cheaply at the M.E. exhibition. An external thread is easy to cut by comparison, once you have made a female gauge with a tap. However, if a tap is not available, these three female threaded parts should not be a problem, as all of them are threaded right through, and can be used as gauges later, when the ends of the mandrel are screwcut. The $^{3}/_{16}$in. thin nut could be made from a piece of 1in. A/F hexagon steel, but if the rather large hex. material is not available, put a thread on a piece of $1^{1}/_{8}$in. dia. round. Spanner flats can be cut afterwards on the dividing head when it is finished.

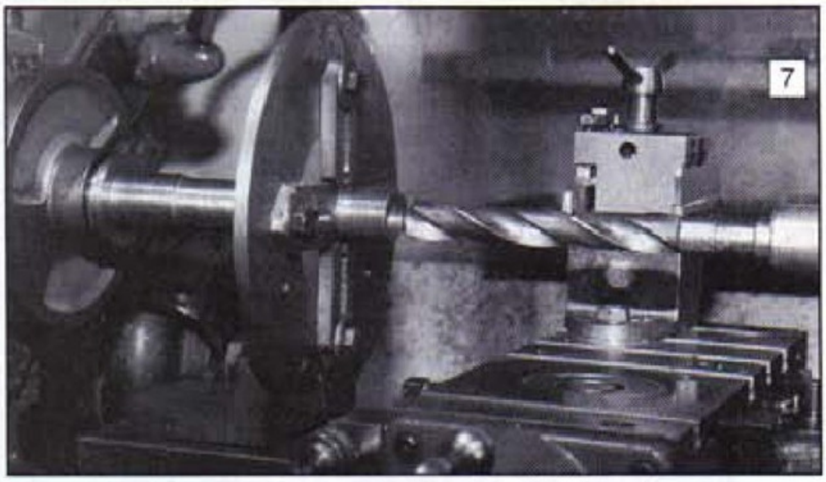
The chuck register was just as easy. With a $1^{3}/_{16}$in. long end of $1^{3}/_{4}$in. dia. mild steel in the lathe, the end was faced,


MANDREL, IF MADE IN ONE PIECE M/S
1.25"φ
1 1/8" x 12T WHIT
DRILL 5/8" THRO
SPACER M/S
MANDREL & CHUCK REGISTER, IF MADE SEPARATLY M/S
1 1/8" x 12TPI
1.250"φ
TAP 2BA
REAM 1" OR BORE
SAWCUT
TRANSFER HOLE FROM FRONT UPRIGHT, REAM 5/16"
BRAKE ARM M/S
2 HOLES TAP 1/4" BSF
1φ REAM OR BORE
2 HOLES REAM 5/16"
FRONT UPRIGHT M/S
FILE TO FIT DISC NOTCHES
DETENT
BRAKE ARM PIN
SCREW 26TPI
DISC ADAPTOR M/S
2 HOLES TAP 1/4" BSF
REAR UPRIGHT M/S
©





Drilling part way through the mandrel.



Drilling through the other half, (note reversed catch plate holding the mandrel register).

then drilled and bored to 0.810in. and threaded right through internally $^7/_8$in. x 26TPI, the same as the nut.

The disc adaptor was also a straightforward part to make. A short end of $1^1/_2$in. dia. mild steel was gripped with about a $1^1/_2$in. protruding from the chuck jaws, so that it could be drilled and bored out to 0.810in. dia., then tapped $^7/_8$ x 26TPI for a depth of $^1/_2$in. The rebate was turned in the end, $^7/_8$in. dia. x $^1/_8$in. deep, and the end faced.

The outside diameter was turned, just sufficient to clean up, then with the parting tool positioned $^5/_{16}$in. from the faced end, the piece was parted off. Worried about parting-off? Just loosen the chuck jaws and push the job further in, until it is protruding only about $^1/_2$ inch. Select lowest speed ungeared (or about 200rpm), plenty of cutting oil and, with only $^5/_{16}$in. depth of cut, the part will drop off. If, because your lathe is a bit old and it starts to chatter, pull the chuck round by hand to remove the chatter marks, and take a further cut.

Mandrel

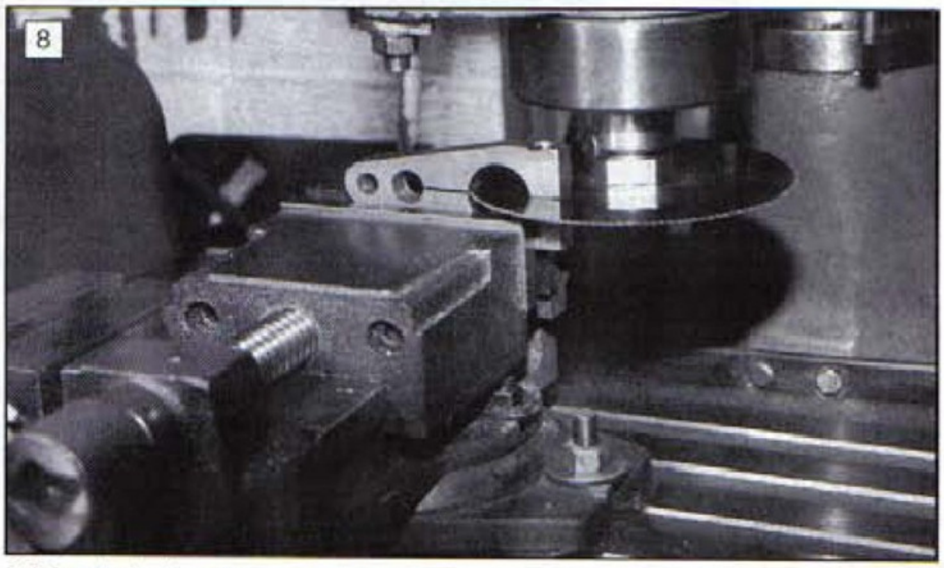
The next job was the mandrel. This required a 6in. length of $1^1/_8$in. diameter mild steel. If you only have 1in. dia, that will do, but bear in mind that with the 1in. dia. cleaned up, the bore in the front upright must be reduced to fit. Held in the three jaw, each end was faced and centred. If your three jaw chuck is a bit worn and inaccurate, it would be better to use the four jaw and use the DTI to get it running true.

Mounted between centres, the bar was turned for $2^1/_4$in. from the tailstock end to 1in. dia. (minus), just to clean up the diameter, further reducing the diameter to $^7/_8$in. for $1^1/_8$in. from the end, this part being screwcut $^7/_8$ x 26TPI. A nice $^3/_{16}$in. run out for the threading tool makes that job easy. The internally threaded chuck register was used as a gauge. A short split length of copper tubing over the threaded end protected the threads from the carrier screw when the job was replaced between centres to screwcut the other end. This time the end was turned to $^7/_8$in. dia for a length of $1^1/_2$in., and again screwcut 26TPI, for a length of $^5/_8$in. Once more, a $^3/_{16}$in. run-out for the threading tool helped to make things easy. The remainder of the bar ($2^1/_4$in) was reduced to a little less than $^7/_8$in. dia., making assembly easier later on. Four $^1/_4$in. tommy bar holes, somewhere about the centre of the bar enable the chuck to be screwed on and off the mandrel register.

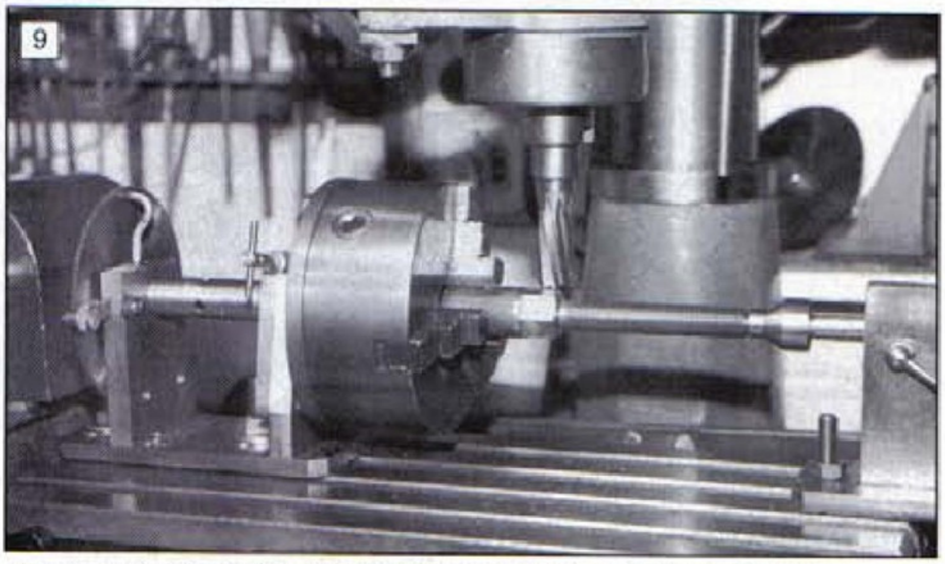
With a drop of Loctite applied, the previously turned chuck register was screwed on to the $1^1/_8$in. length of thread, a tommy bar in the holes being used to get it nice and tight, so that with the split copper tube over the other threaded end and replaced between centres, the chuck register could be turned and screwcut the same as the lathe mandrel. The chuck can now be transferred straight from the lathe to the dividing head, as shown in **Photo 6**. My lathe being a Myford, the chuck register was made to the dimensions shown on the drawing, i.e., 9/16in. length of $1^1/_8$in. x 12TPI Whitworth form. The register part is $^7/_{16}$in. at 1.250in. dia. The remaining bit of $1^3/_4$in. dia. was cleaned up and the sharp edges removed from the corners.

While turning and screwcutting this part, it is convenient to be able to slip it out from between centres to try it on the chuck. Better still, use the face plate instead of the catchplate for between-centre turning, then the catch plate can be used to act as a gauge when screwcutting the mandrel nose thread.

To face up the tailstock end of the bar, a half centre was not necessary, as the next and final job was to drill right through the bar $^5/_8$in. dia. I used the fixed steady to support the outer end of the bar



Slitting the brake arm.



Showing a hexagon head being milled on a special bolt, the ball end of which is supported by a tailstock, fitted with a female centre. Note the detent located in the notched plate.

The tailstock referred to in Photo. 9 (This was made later).

when drilling, and drilled half way through (3in.) **(Photo 6)**, then reversed to drill through from the other end. This time, I supported the $^{7}/_{8}$in. dia. in the fixed steady, whilst the mandrel nose thread was entered into the partially unscrewed catchplate thread **(Photo 7)**. It worked fine that way, and avoided any risk of damaging the mandrel register by clamping in the chuck jaws.

The few remaining parts were quite straightforward. The spacer is virtually a $^{3}/_{16}$in. thick washer, $1^{1}/_{2}$in. outside dia, $1^{1}/_{4}$in. inside dia, and fits over the $1^{1}/_{4}$in. dia. of the disc adaptor. The washer that goes under the thin nut is $1^{1}/_{2}$in. outside dia., $^{7}/_{8}$in. inside dia. and $^{5}/_{64}$in. thick, chamfered on one side.

Detent bar

The detent bar slides in the slot milled in the rear upright. It is an $1^{3}/_{4}$in. length of $^{3}/_{8} \times ^{1}/_{4}$in. mild steel with two 2BA tapped holes through the $^{1}/_{4}$in. thickness. One is $^{7}/_{32}$in. from one end for the detent itself, and the other is $^{1}/_{4}$in. from the other end. This is for a 2BA screw with a crimped thin steel washer to retain the detent bar in the slot. To prevent the screw undoing itself, I deformed the thread a little. The actual detent that locates in the notches of the plate is a short end of $^{1}/_{2}$in. dia. silver steel, turned down and screwed 2BA for $^{1}/_{2}$in., and knurled for $^{1}/_{8}$in. on the $^{1}/_{2}$in. dia. before parting off. It was possible to hold the threaded part gently in the three jaw to 'pretty-up' the parted off end.

Brake arm

The brake arm is a piece of $^{3}/_{8} \times 1^{1}/_{2} \times 3^{7}/_{8}$in. long steel. Held in the four jaw chuck and a hole drilled and bored out centrally to the same size as the hole in the front upright and at 1in. from one end, the tapered shape could be cut on the milling machine in the same way that the two uprights were shaped. The $^{1}/_{2}$in. dia. hole was drilled centrally, as shown on the drawing, and with the job held on edge in the drilling machine vice, drilled No 22 and tapped 2BA for the mandrel lock screw. Now, I know that you cannot tap 2BA for a depth of $1^{1}/_{2}$in. without a special tap, so having drilled right through 2BA tapping size, open up to $^{3}/_{16}$in. for more than half the depth, say $^{7}/_{8}$in., then the tap will be able to cope with the $^{5}/_{8}$in. or so of the threading.

Again in the milling machine, I saw cut through the 1in. dia. hole, right into the $^{1}/_{2}$in. dia. hole **(Photo 8)**. The screw that clamps the brake arm to the mandrel is a $2^{3}/_{4}$in. length of $^{5}/_{16}$in. steel, turned down and threaded 2BA for $^{1}/_{2}$in., with a similar length of $^{1}/_{8}$in. dia. as a tommy bar. To drill the $^{5}/_{16}$in. hole at the end, the mandrel was slipped into the front upright, then the brake arm put on the mandrel as well, so that the hole could be transferred through from the upright.

A tight fitting pin, turned from $^{3}/_{8}$in. dia. bar, to $^{5}/_{16}$in. for a length of $1^{1}/_{16}$in. was drilled and tapped 2BA for a screw which holds the brake arm tightly in place against the upright.

Assembly

To assemble all the bits, the front upright and the brake arm were pressed along the 1in. dia. of the mandrel, tight up to the chuck register, then the brake locked by using the tommy bar. The rear upright was slipped on to the $^{7}/_{8}$in. dia. of the mandrel, with the detent slot facing away from the chuck end. With the disc adaptor threaded on the end of the mandrel, stepped side outwards, the notched disc sits on the step, the spacer goes on next, then the washer and lastly the nut.

Standing this assembly on the base, with the centre of the front upright $1^{5}/_{16}$in. from the end, I made sure that the rear upright was also in line with the base sides. Scribing along the base on either side of the front upright, (giving two lines on the base, $^{3}/_{8}$in. apart) set the position of two $1^{7}/_{64}$in. holes, ($^{5}/_{16}$in. BSF tapping size) mid-way between the two scribed lines. Transferring the $1^{7}/_{64}$in. holes through the base into the bottom of the upright, located the $^{5}/_{16}$in. BSF tapped holes. The $1^{7}/_{64}$in. holes in the base could now be opened up to $^{5}/_{16}$in. and counterbored for the cap head screws that hold the upright to the base.

The same technique was adopted with the rear upright. Although the holes are shown dimensioned on the drawing of the base, it is better to leave these four until the assembly stage, as described. The last job was to shape the part of the detent which protrudes through the detent arm, so that it fits the notches, without any shake **(Photo 9)**.

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WANTED

● For Unimat SL (Spindle thread 12mm x 1), 3 jaw s/c chuck, collet nut and collets, plus any other bits for Unimat.
D.Newman. Tel 01255 830411 (Clacton).

● 6in. Four jaw independent chuck. Any decent make in good condition. Backplate not required.
Tel. 01252 874515 (Hants).

● Adjustable angle plate, approx. 6 x 6 inches.
Tel 01322 330556 (Kent).

● Set of external chuck jaws for 3.375in. Ace Roto Record self centring chuck. Jaw width 0.432in. (7/16in.).
Tel. 01628 31869 (Berks).

● *Simple Model Locomotive Building*, M.A.P. book on LBSC's *Tich* plus any book, plans or literature on *Simplex*. Reasonable price paid.
Joe Lloyd, 3 Leafield Avenue, Longwood, Huddersfield. HD3 4TW.
Tel. 01484 654 557.

● Magneto Rewinding. With reference to the Coil Winding Machine described in *Model Engineer* (July & August), I would like to get in touch with anyone who has built one or who can offer practical advice on procedure, materials or suppliers.
J.A.H. Wallace, The Little Grange, Napleton, Kempsey, Worcs. WR5 3PY. Tel. 01905 820341

● Tangye lathes. Does anyone have any information on these machines or their manufacturer?
Noel Hendry, PO Box 11, Ruakaka, Northland, New Zealand.

● For drill grinder, Model 2B 10 made by Z. Brierley Ltd. of Llandudno, North Wales, information on the loose drill sizing gauge and the separate setting piece. (The manufacturer is no longer able to supply these details).
P. Bridgeway, 59 Glan Rhyd, Coed Eva, Cwmbran, Gwent. NP44 6TY.

● Information relating to hand operated planing machine made by Hesketh Walker, Liverpool. Table size 6in. x 13in. Cross feed index mechanism partly missing, so information which will help me to make or obtain the missing parts would be welcomed.
K. J. Denner, 69 St. Michaels Rd., Paignton, Devon. TQ4 5LU. Tel. 01803 525020.

● Information on a 4 1/2in. B.G.S.C. lathe by James Spencer of Hollingwood, Manchester.
H. C. Jones, 28 Bath Road, Bradford-on-Avon, Wilts. BA15 1SW Tel. 01225 5266.

● Any equipment for G.H. Alexander Toolmaster milling machine (e.g. Overarm, arbor support, vertical head, collets and adaptor, feed change gears, angular work table).
Stephen Tresidder, 17 Station Road, Carnhell Green, Camborne, Cornwall. TR14 0LY.

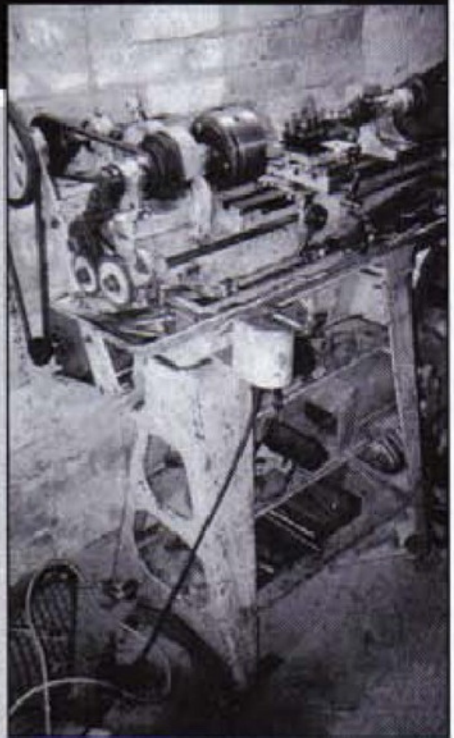
● Does anyone have a Monarch Series 60 toolroom lathe? I'd very much like to look at one and take some measurements. (Might even buy, if it is for sale and I could afford it!)
Bob. Tel. 01733 233279 (Peterborough).

● Information to help with rebuild of Portass lathe (Overall length 26in., length of ways 14 1/2in, width of ways 3 1/16in., back geared and screwcutting).
D. Robinson, 83 Elm Tree Road, Lower Bredbury, Woodley, Cheshire. SK6 2EG.

● Instruction book, Parts List for Colchester Chipmaster lathe. Good photocopy acceptable. Exchange for cash, M.E. magazines, model rail books, engineering books, small workshop items. Will copy and return if you prefer.
W. Millar, Fernie Schoolhouse, By Cupar, Fife. KY15 4NA. Tel. 01337 810258.

● Information on elderly Myford lathe 3 1/2in. centre height, 26in. gap bed. A2 cast in bed. Serial No. D1130.
D.Warren, 3 Cromwell Road, Camberley, Surrey. GU15 4HY. Tel. 01276 63188.

● Operators Manual / Parts Book for a Robot Surface grinder, Serial No. 5099, manufactured by Robaczyski Machinery Corporation, Brooklyn, New York. A mechanical machine (not hydraulic) with powered X and Y axes. Possibly a '40s Lease Lend machine.
Also, does anyone know a source of 1/4in. 90deg. push-in and 3/16in. straight push-in flip flap oil cups?
Geoff. Culmer, 119 Berengrave Lane, Rainham, Gillingham, Kent. ME8 7UJ. Tel. 01634 360473.



● Does anyone know how to remove the top plate from an aged Rollei 35 camera? I have removed screws and levers, but the plate, although loose, is still held by the eye piece bezel and the rewind clutch shaft.
Graham Compton, Bridge Farm, Hognaston, Derbyshire. DE6 1PW. Tel. 01335 370233.

FOR SALE

● Set BSF taps and dies, 3/16in. to 1/2in. 18 items in wooden box (but not fitted). £50
Tel. 01253 354478 (Blackpool).

● 60 Schaublin type collets, 13mm dia. £40
Geoffrey Ford Tel. 01432 357460 (Hereford).

● Incomplete 48+ piece Imperial set of British made Slip Gauges. 7 missing pieces under 0.07in. Very nice hardwood box.
Tel. 01895 236203. (nr. Heathrow).

● Vacuum pump. Needs 1/4hp motor. £30 plus carriage.
94 Park Crescent, Erith, Kent DA8 3DZ
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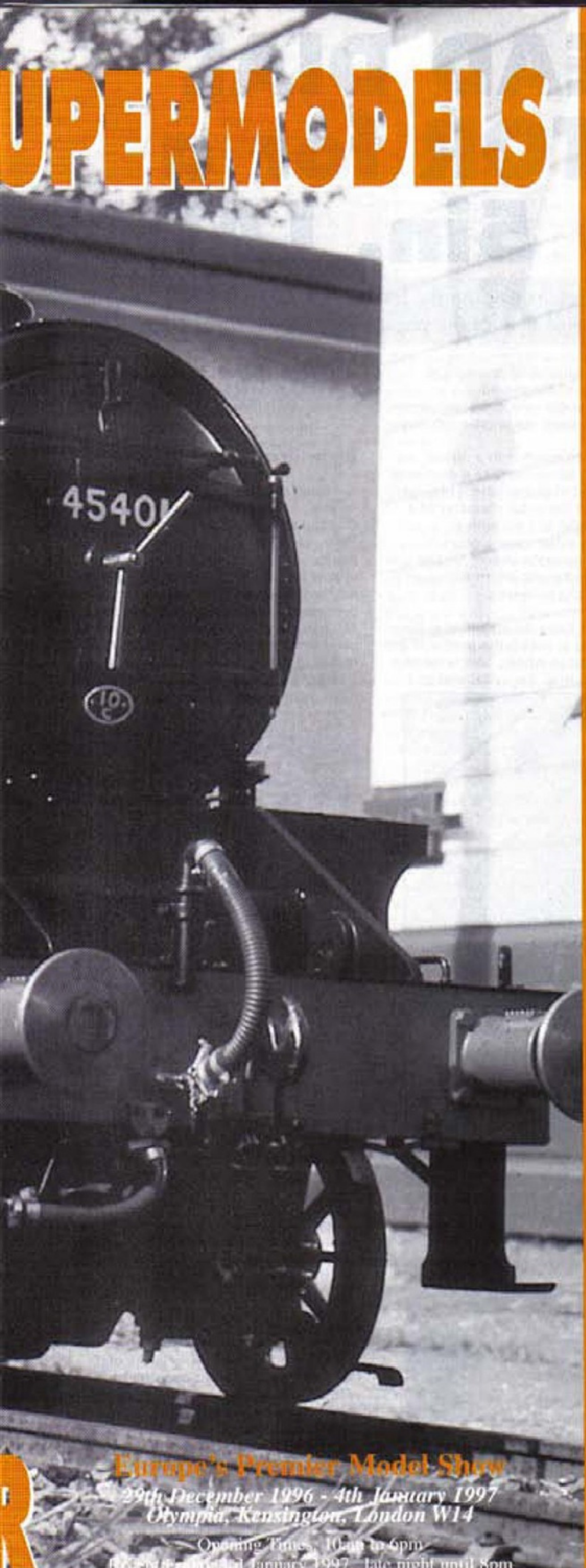

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A THREAD DIAL INDICATOR for a BOXFORD 5in. LATHE

An indispensable piece of equipment when screw cutting on the lathe is a thread dial indicator. Mark Figes describes the manufacture of one for the popular Boxford lathes.

This simple, but near essential accessory is designed in a simplified form, to suit Boxford lathes with an 8TPI leadscrew (basically, models ME10, AUD, BUD and CUD). The most difficult part is, of course, the gear which meshes with the leadscrew, so, although information is given for those wishing to cut their own, arrangements have been made with Niel Hemingway to make them available ready cut.

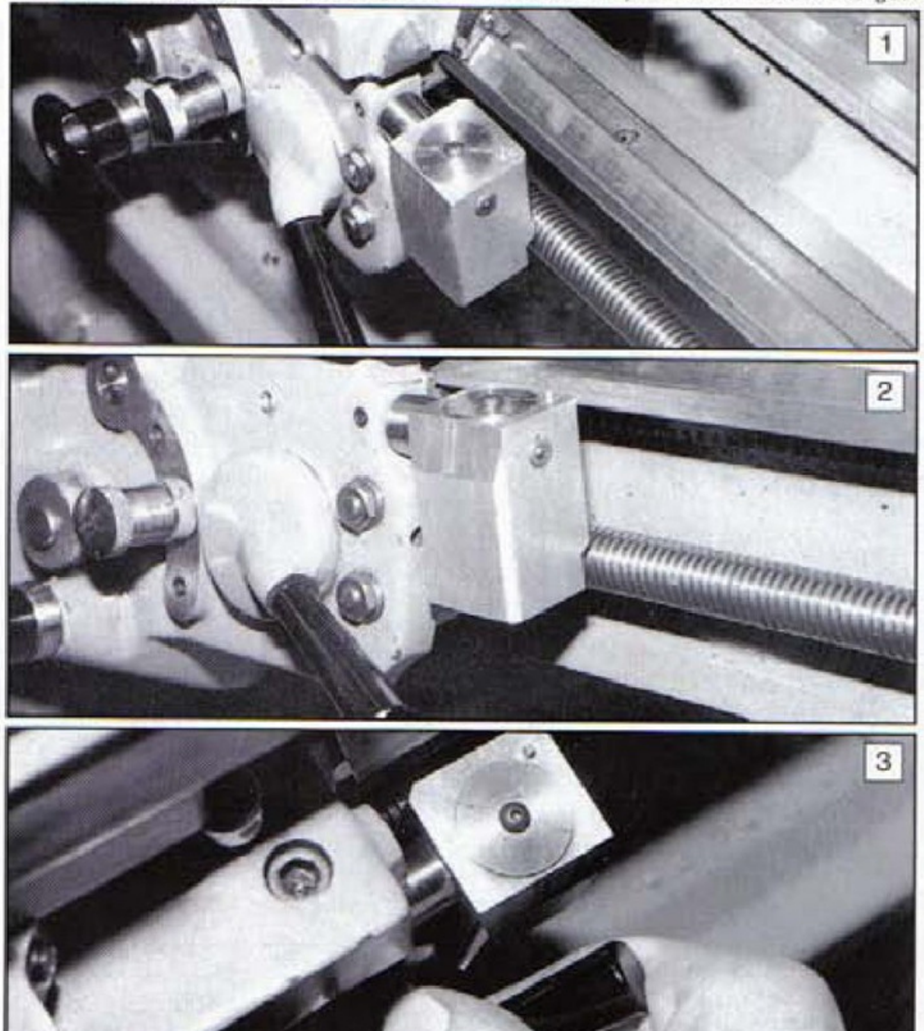
Gear

It will be noticed the gear is a slack fit when tried against the leadscrew, as the only load involved is driving a dial. This obviates the need to either cut the gear or to mount the indicator at an angle to match the helix of the thread.

If you wish to cut your own gear, there is a way which does not involve too many complications.

As we want to mesh with a thread, we need a circular, as opposed to a diametral pitch. After a bit of investigation I found that a gear with the outer diameter of a circular pitch gear, but cut with a diametral pitch cutter gave a good solution. No drawing is shown for the gear, as all the relevant information can be found from the following specification:-

If you do not have the specified cutter, grind a flycutter to match the profile of a 28T Myford change wheel. This is made a lot easier if you hold the cutter and gear together on a sheet of glass for profile checking. A bit of patience and an oilstone will give a good result.



Three views of the completed thread dial indicator in position on the lathe.

Body (Item 1)

Mount the body material to run true to its axis in the four jaw, face off and centre. Drill right through $\frac{1}{4}$in., then open up to $\frac{15}{32}$in. dia, clearing frequently, to prevent wandering. Bore out to about 10 thou. undersize before reaming (back gear advised). A machine reamer is to be preferred, and plenty of straight cutting oil will help. Set a boring tool that will work comfortably in the bore to open out the recess in the end, not forgetting the clearance for the thrust face, which should have a good finish.

Gear Specification

Material	**Brass**
No. of teeth	**32**
Outside Dia.	**1.3528in.**
Thickness	**1/2in.**
Bore	**0.375in.**
Cutter	**20 DP No. 4**
Cut depth	**0.086in.**

The next job is to prepare the spindle material, as we'll use it as a mandrel first. Cut over length, face off both ends and deburr. Clean the bore of the body and stick the spindle in from the gear recess end with a drop of super glue, with the spindle just protruding from the top face of the body.

Grip the spindle in the three jaw, lightly centring the end and bring up the tailstock. Face the body off to length, thus ensuring that the faces are true to the bore. Turn off the corners so that each 'flat' is about $\frac{3}{16}$in. wide. As well as giving a better appearance, the absence of sharp edges on any machine is a bonus.

Here's the cunning bit; heat the body gently with a gas torch to about 200deg C, then you'll be able to pull the mandrel out. Handy trick that!

Dial (Item 3)

Still with the four jaw, grip the dial blank, which is best cut over thickness, with at least $\frac{5}{16}$in. protruding. Turn the spigot, centre and drill $\frac{5}{32}$in. diameter. Counterbore the $\frac{5}{16}$in. dia., and finish the flat bottom to depth. A slot drill is a handy tool for one-off counterbores.

Reverse the work and set to run true, with clearance behind the flange. A $\frac{1}{2}$in. washer over the spigot will also ensure there is no 'swashplating'. Face off the flange to thickness, with a good finish, and bevel the edge slightly. Break all sharp corners.

The dial requires 8 equal divisions. If you have dividing gear, fine. If not, you can use the chuck jaws. Lay a piece of say 2 x $\frac{1}{4}$in. flat bar across the bed. Set a chuck jaw vertical with a try square off the bar. Set a small screwcutting tool on its side, at centre height. Manipulate the cross and topslides to incise a mark $\frac{3}{16}$in. long, about 5 to 8 thou. deep, then rotate the chuck until the next jaw is in position and repeat, for four marks.

If you've a combination set, set one jaw at 45deg. If not, a drawing board type set square is as good. Mark a line as before, but only $\frac{3}{32}$in. long. Repeat for the remaining lines.

Stamp the four numbers ($\frac{1}{16}$in. or $\frac{3}{32}$in. stamps) against the longer marks. By laying the punch on its side in the tool post, you can keep it square i.e. no drunken figures. Index the chuck to bring the work in to position under the punch, the actual position is best set by eye. 'Eyeball engineering' usually gives the best results, as the width of the figures varies.

What we've got now probably looks a bit of a mess, so how to make it look good? Set up your three jaw and grip the dial by the spigot; run at about 350rpm, and hold a piece of brass strip against the face. This removes any 'curlies' and doesn't scratch the face. With a fine (about No. 4 or No.6 cut) flat faced Swiss file, well doused in coolant, hold it flat against the face (mind your fingers on the chuck jaws!) to remove the 'heave' around the punchings and lines. Clean the file regularly, to prevent pinning. With plenty of coolant, this gives you a nice grained surface. I would not use emery cloth, as it destroys the sharpness of the images.

Spindle (Item 2)

Returning to the material which we used as a mandrel for the body, set up, face and centre. With ample protruding from the chuck and with support from the tailstock, machine all the diameters and lengths in one setting. Drill and tap 4BA in the top, then break all corners and deburr, before parting off.

Mount (Item 4)

An easy bit. When you've turned the long spigot, put it in the hole in the apron (just above the halfnut lever. On older lathes, it may need cleaning out!) and nip the grubscrew, just to check that the relief groove is in the right place before you turn it.

Finishing the body

Mark out and remove the cut-out to clear the leadscrew. I used the milling machine, but the vertical slide is fine. Set-up square to the mandrel and remove the bulk, then rotate the vertical slide to cut the angle with the side of the end mill. Reset and mill the chamfer. Drill and ream the $\frac{3}{8}$in. mounting hole and the $\frac{3}{32}$in. hole for the fiducial pin, which is simply a short length of brass or steel, rounded over.

De-burr thoroughly (inside and out) and clean up, with files and emery cloth, all the side faces, but not the ends. Wash carefully in solvent to remove all oil, swarf and grit.

To press in the Oilite bushes, turn a spigot a slack fit in the bore of the bushes on the left-over bit of spindle; some depth marks are handy too! Use this as a pusher. Slide the spindle and gear into the body and fit the dial, holding the assembly between finger and thumb, so that the gear is up against its thrust face and the spindle shoulder. With feeler gauges between the underside of the dial and the body, determine the gap, then subtract 2-3 thou. from this figure. The answer is what you remove from the top end of the spindle in the lathe to keep the dial square.

Clean the gear seat and gear bore with Loctite cleaner (cellulose thinners is a good alternative). Do not touch the mating surfaces before applying Loctite Retainer to the mating surfaces. Slide the gear into position and put aside, standing vertically. Loctite in both the fiducial pin and the mount.

When the Loctite is set, (2 -3 hours is handling time, full strength after 24 hours) wipe off any excess, reassemble, just nipping the cap screw, with good clean grease in the top of the body. Apart from lubrication, this will help keep coolant out of the works.

Setting up on the lathe

Engage the half nuts. Slip the mount in to the apron, bring the gear to mesh on the leadscrew (not over the keyway) and nip the grubscrew.

With the leadscrew drive engaged for right hand thread cutting, rotate the chuck by hand to remove backlash. While holding the gear underneath steady, rotate the dial until one of the numbered lines is aligned with the fiducial pin and tighten the cap screw. Run the lathe and engage the half nuts on a mark a few times to make sure that the dial is in the right place. Adjust if necessary.

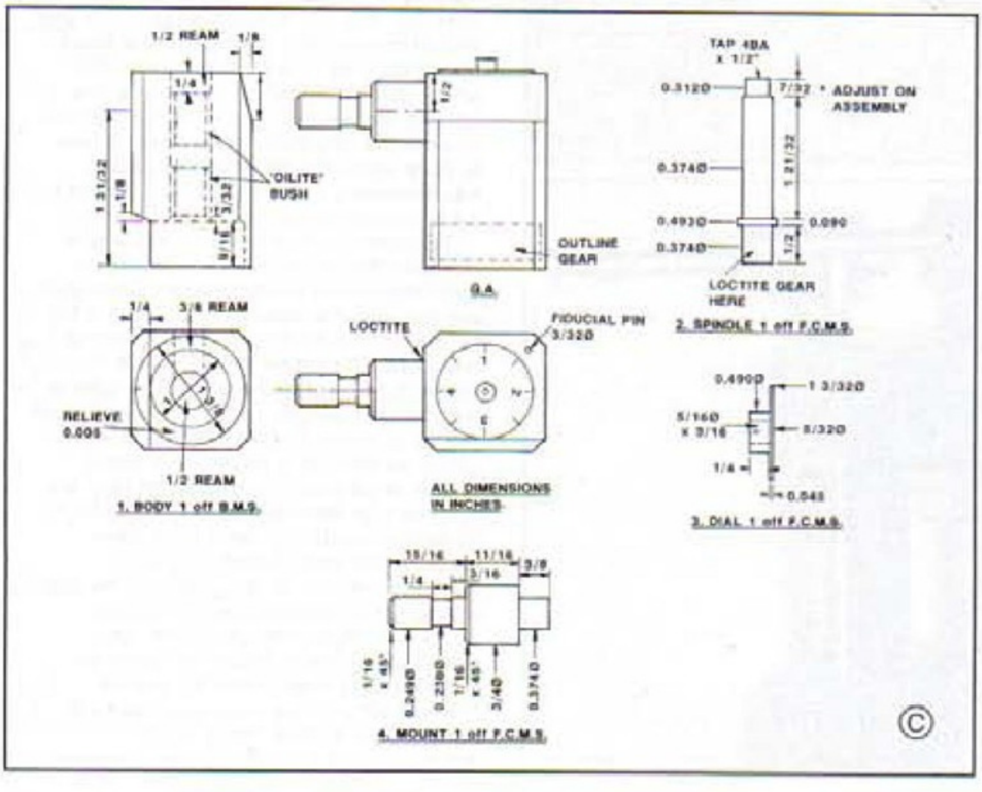
Taming the beast!

You could make a copy of the following, cover it and stick it inside the gear cover of your lathe. Put it in a plastic bag to keep the oil ands grease from your fingers and the gears off the paper.

Supplier

Kit of parts available from:-

N.S. & A.Hemingway,
30 Links View,
Half Acre,
Rochdale,
Lancs OLI 1 4DD.
Tel 01706 45404.



Using the Thread Dial Indicator

Even numbered threads:- Close half nuts at any line on dial.

Odd numbered threads:- Close half nuts at any numbered line on the dial.

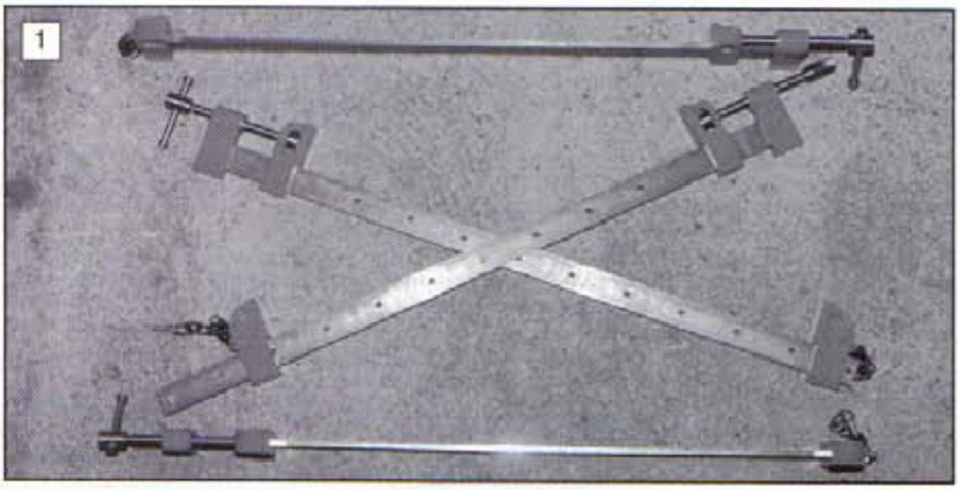
Half numbered threads e.g. 11$\frac{1}{2}$:- Close half nuts at any odd numbered line.

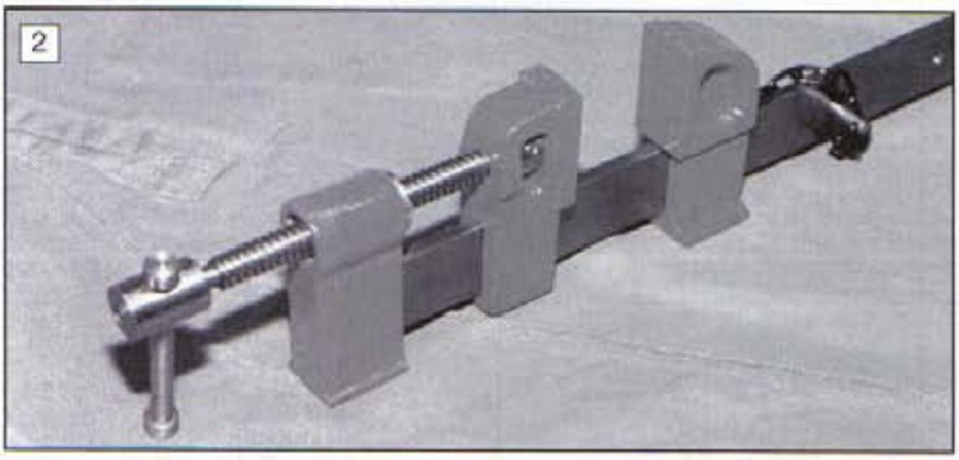
Quarter numbered threads e.g. 4$\frac{3}{4}$:-Close half nuts on the original starting point only.

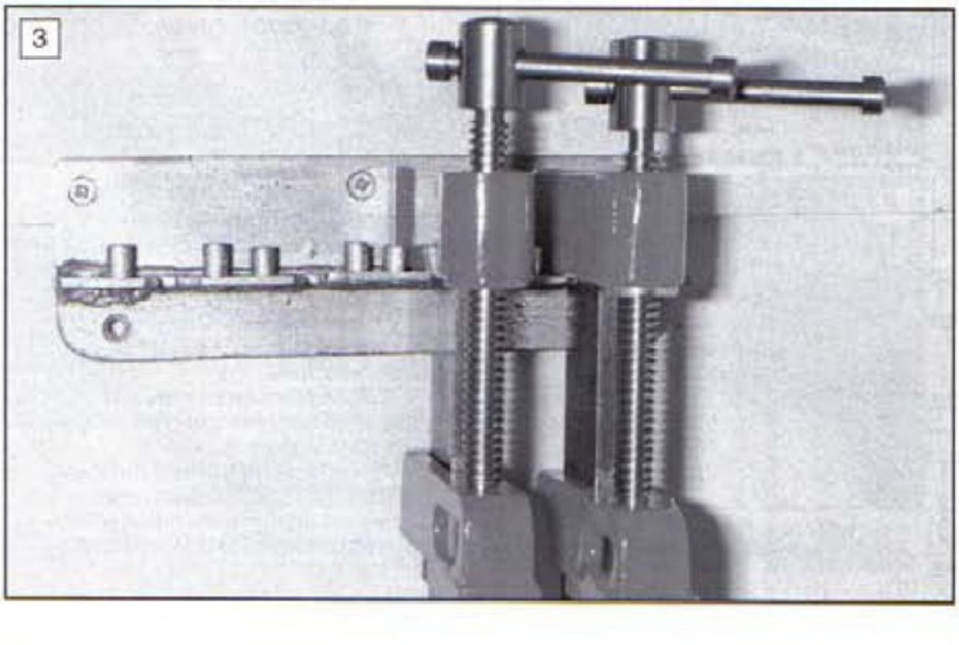
Metric threads:- When cutting metric threads on an imperial leadscrew with conversion gears, DO NOT DISENGAGE THE HALF NUTS.

A CLUSTER OF SASH CRAMPS

Most of us get involved with woodwork at some time. David Machin describes the manufacture of a tool which may prove to be of use on those larger jobs. A part of the project is the machining of a square thread, for which he gives detailed instructions.





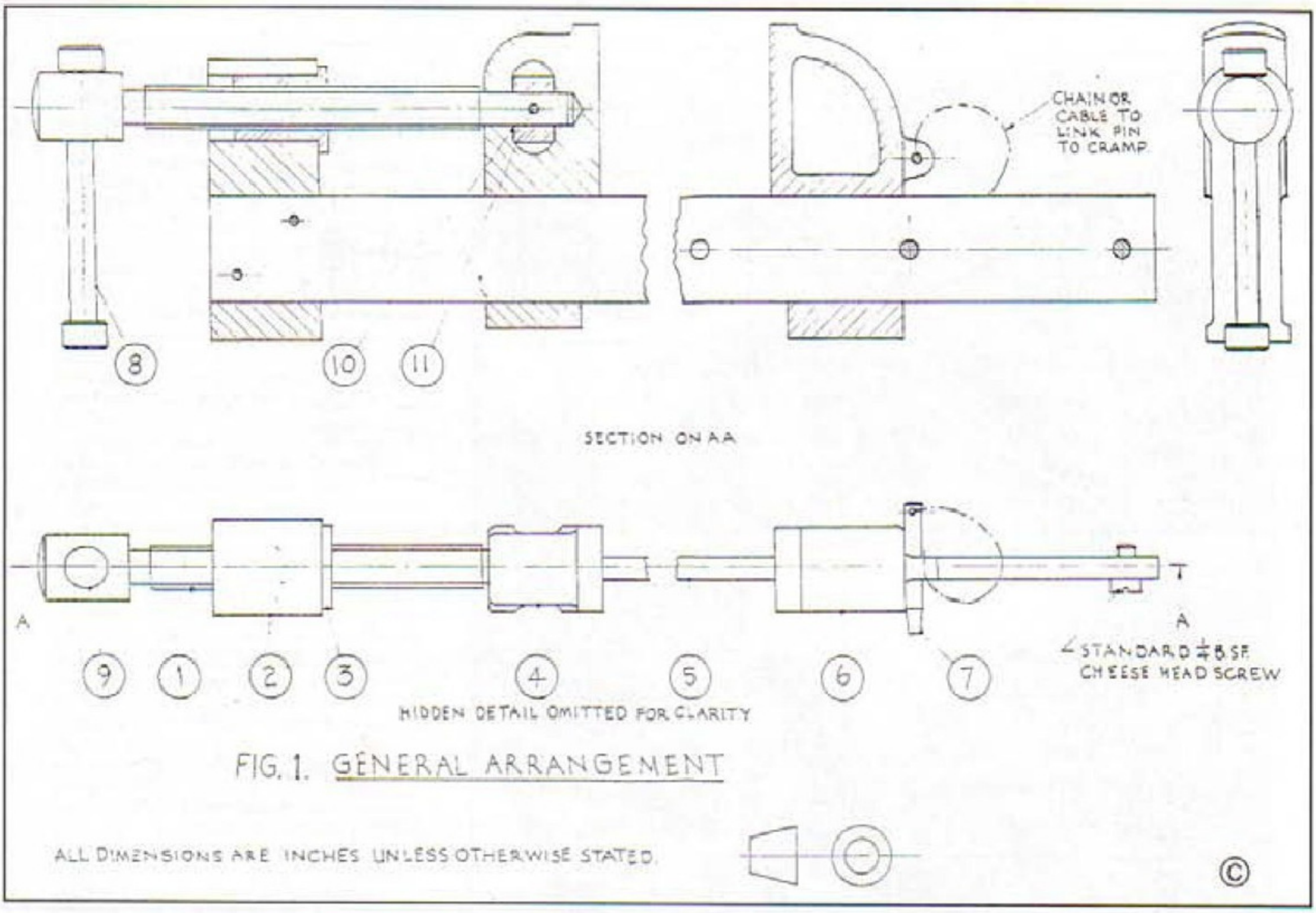


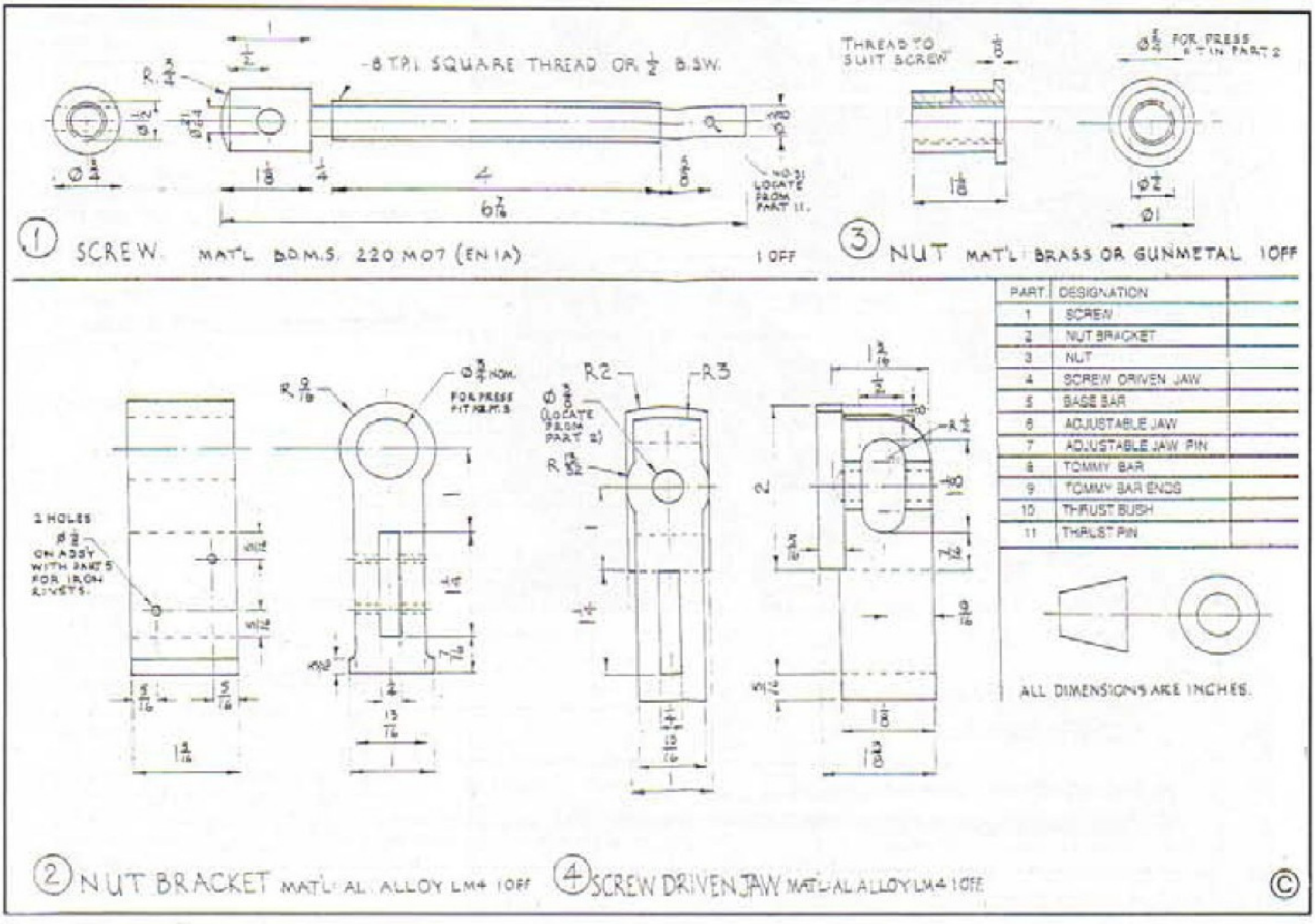
Recently, I had to do some woodwork. This really needed some sash cramps to hold the parts in close contact until the glue set. I managed without, but resolved to make some for future use. Incidentally, sash cramps can also be used on occasion for holding large metal components together for a fastening process, particularly where alignment of parts is important.

It occurred to me that sash cramps could be useful to other *M.E.W.* readers, hence this article. Sash cramps can be fabricated, but the work is more quickly completed from castings. These are available from N.S. & A. Hemingway, together with other materials, if required. Although I shall only describe the making of one cramp, most jobs require at least two, if not more. I have made four - a veritable cluster of cramps! The finished ones are shown in **Photos 1 & 2**. A suitable and safe wall rack is also shown in **Photo 3**. As regards length of cramp, only you will know what jobs are likely to crop up. Bear in mind, also, that two cramps can be bolted together to obtain nearly twice the length of one.

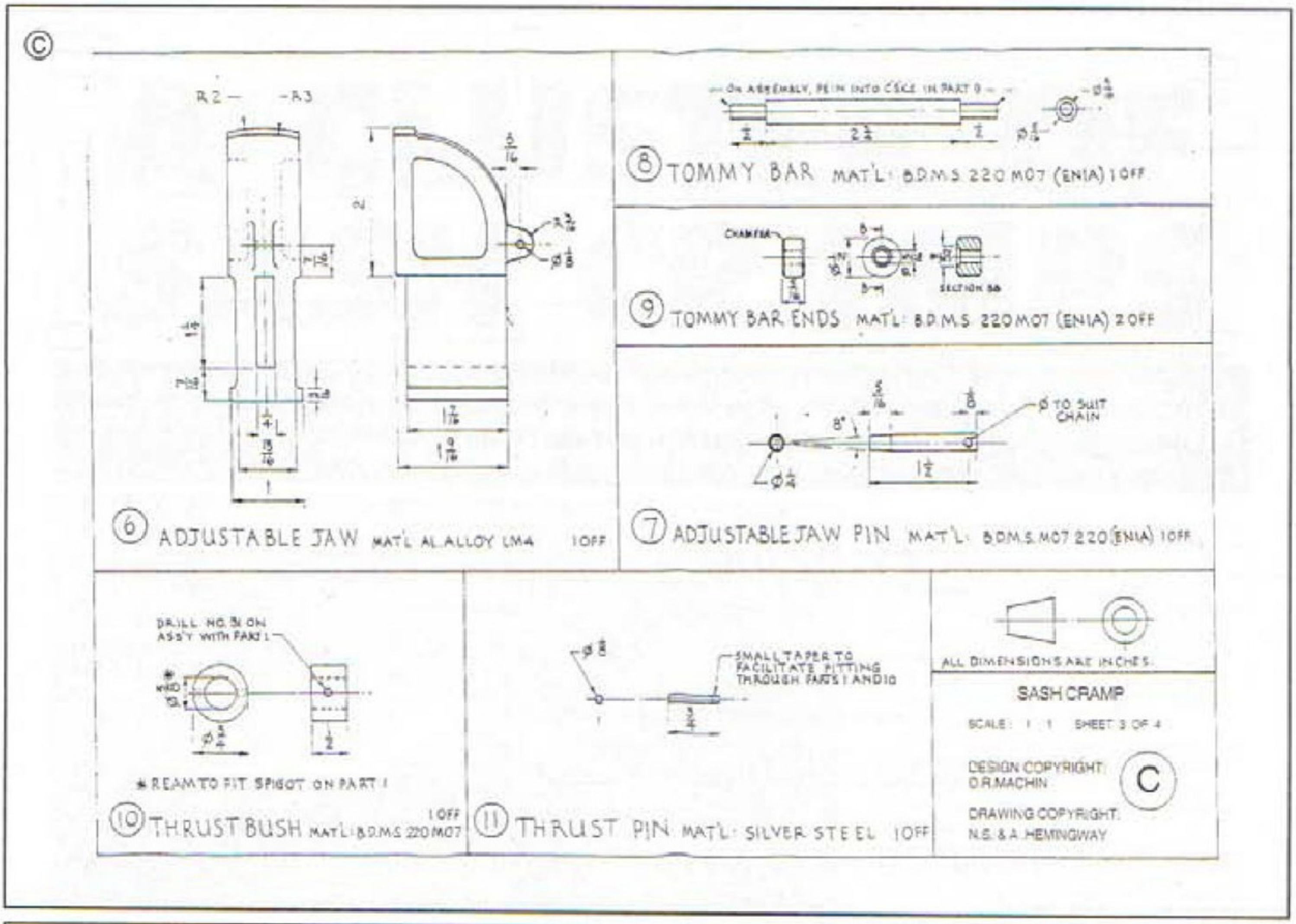
A few words on the design and use. The basis of the cramp is a steel bar of $1\frac{1}{4} \times \frac{1}{4}$ in. section. I have called this the base bar. The nut bracket is riveted to one end of the bar, and through this is fitted the screw. The screw bears against the screw driven jaw which, like a vice jaw applies the gripping force. To oppose this force is the adjustable jaw, which is free to slide along the bed bar for coarse adjustment, but can be held in position by a pin put through holes in the base bar.

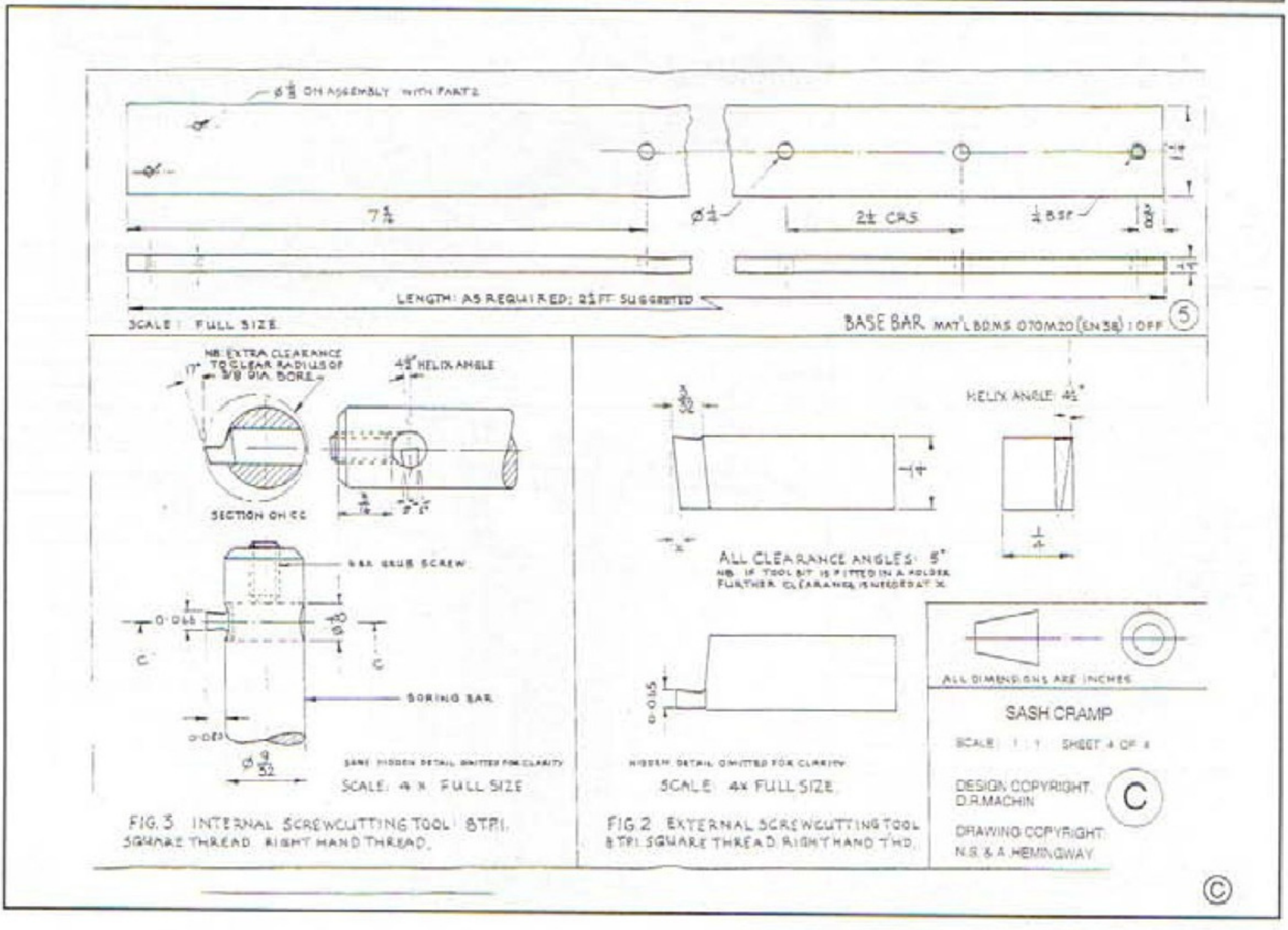
To cramp a job, the adjustable jaw is positioned close to one side of the job and held there by inserting the adjustable jaw pin into the nearest hole. The job to be cramped is then placed between the two jaws. The screw is turned and tightened to cramp the work. The type of work to be cramped could be a number of planks of wood being joined by being glued on their long edges. This could form a large area of wood wider than the original tree from which the wood came. Drawing boards and table tops were made in this way. A main use is in furniture making or repair, where the legs and rail of a table or chair are joined using a mortise and tenon joint, or dowels. Some self- assembly furniture would often benefit from the use of cramps, when hand pressure alone will not produce a close fitting joint.





PART	DESIGNATION
1	SCREW
2	NUT BRACKET
3	NUT
4	SCREW DRIVEN JAW
5	BASE BAR
6	ADJUSTABLE JAW
7	ADJUSTABLE JAW PIN
8	TOMMY BAR
9	TOMMY BAR ENDS
10	THRUST BUSH
11	THRUST PIN


ON ASSEMBLY, PEIN INTO CSCE IN PART 9
8 TOMMY BAR MAT'L: BDMS 220 M07 (EN1A) 1 OFF
CHAMFER
SECTION BB
9 TOMMY BAR ENDS MAT'L: BDMS 220 M07 (EN1A) 2 OFF
Ø TO SUIT CHAIN
6 ADJUSTABLE JAW MAT'L AL.ALLOY LM4 1 OFF
7 ADJUSTABLE JAW PIN MAT'L: BDMS M07 220 (EN1A) 1 OFF
DRILL NO.31 ON ASS'Y WITH PART 1
* REAM TO FIT SPIGOT ON PART 1
10 THRUST BUSH MAT'L BDMS 220 M07 1 OFF
SMALL TAPER TO FACILITATE FITTING THROUGH PARTS 1 AND 10
11 THRUST PIN MAT'L: SILVER STEEL 1 OFF
ALL DIMENSIONS ARE INCHES
SASH CRAMP
SCALE: 1:1 SHEET 3 OF 4
DESIGN COPYRIGHT D.R.MACHIN
DRAWING COPYRIGHT N.S. & A. HEMINGWAY


ON ASSEMBLY WITH PART 2
2¼ CRS
¼ BSF
LENGTH: AS REQUIRED; 2½ FT SUGGESTED
SCALE: FULL SIZE
BASE BAR MAT'L BDMS 070M20 (EN3B) 1 OFF 5
NB: EXTRA CLEARANCE TO CLEAR RADIUS OF 3/8 DIA BORE
4½° HELIX ANGLE
SECTION ON CC
4BA GRUB SCREW
BORING BAR
SOME HIDDEN DETAIL OMITTED FOR CLARITY
SCALE: 4 X FULL SIZE
FIG.3 INTERNAL SCREWCUTTING TOOL 8TPI. SQUARE THREAD RIGHT HAND THREAD.
HELIX ANGLE 4½°
ALL CLEARANCE ANGLES: 5°
NB. IF TOOL BIT IS FITTED IN A HOLDER FURTHER CLEARANCE IS NEEDED AT X
HIDDEN DETAIL OMITTED FOR CLARITY
SCALE 4X FULL SIZE
FIG.2 EXTERNAL SCREWCUTTING TOOL 8TPI SQUARE THREAD RIGHT HAND THD.
ALL DIMENSIONS ARE INCHES
SASH CRAMP
SCALE: 1:1 SHEET 4 OF 4
DESIGN COPYRIGHT D.R.MACHIN
DRAWING COPYRIGHT N.S. & A. HEMINGWAY

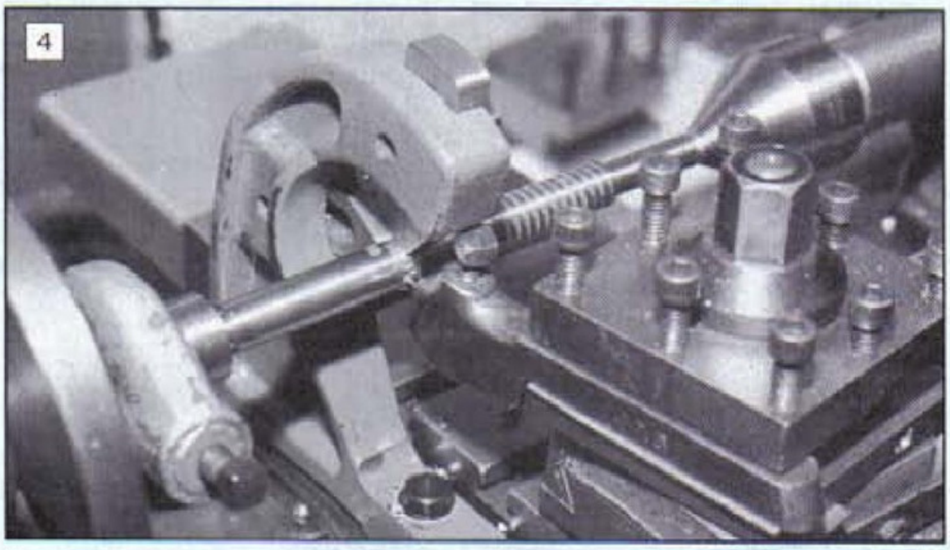
Back to the design; the general arrangement is shown in **Fig. 1**. I have specified aluminium alloy for the castings, mainly because this is easy to work, and quite strong enough for the job. I have also used a separate nut **(part 3)**, made from brass or gunmetal and pressed into the nut bracket. I am sure that this is the better way of doing the job, since the brass or gunmetal is a good bearing material and will give good service. However, since my cramps were finished, I have met up with an old college pal, who made a cramp in aluminium under that wonderful Tutor and Craftsman, T.E. Haynes, as part of his College Teacher Training Course at Sheffield, 34 years ago. This had the square thread **cut directly in the aluminium**. His cramp has been in constant use ever since and is still giving excellent service, so I leave the choice to you of whether or not to make and fit a separate nut.

This will affect the way the cramp is constructed, but I will give instructions for both methods. The choice of thread type is also worthy of consideration. I used a square thread; the alternatives are acme or V threads. A square thread is the first choice because it offers less friction when tightening and slackening. The crest of the thread, being flat, has nothing to rub against, and in fact has to have clearance at this point. Hence, less friction means easier alteration. An Acme thread is really a V thread with a flat at the crest. This creates a little more friction and is used mainly for leadscrews on lathes to facilitate the easy engagement and disengagement of half nuts. The V thread creates the greatest friction, exactly what is required for tightened nuts to stay that way! Pitch for pitch, the strongest thread is the V, because nearly all the flank is used. Having said all that, I appreciate that not everyone will want to make their own threads, and so I have given an alternative which can be bought as threaded rod - called studding. Suitable lengths of $^{1}/_{2}$in. BSW studding can be had from screw and nut suppliers, or even—as I have recently seen—from some DIY stores. They also have a suitable size of chain, which is used to prevent loss of the adjustable jaw pin.

Construction

Now to the making. First, I propose to deal with the production of screw and nut for those who have not done screwcutting before, but would like to have a go. This is because I can refer back to this later, and hopefully make the constructional notes easier to follow. I shall start with the production of the screw **(part 1)**, partly because it is easier to understand what is happening when viewing the outside of the workpiece, and partly because, when screwcutting with a single point tool, it is, arguably, easier and quicker to make the nut fit the screw than the other way round, as opposed to using a tap and die, where the opposite applies.

First, prepare the piece of $^{3}/_{4}$in. dia. bar about 7in. long, setting to run true in 3 jaw or 4 jaw chuck. On the Myford, this will mean about 4in. overhang, since the hollow spindle will only pass a diameter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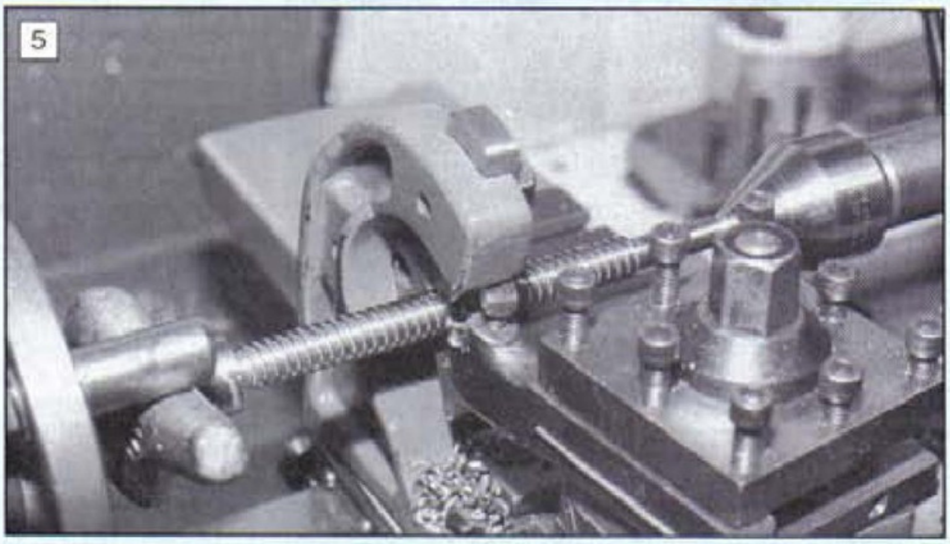
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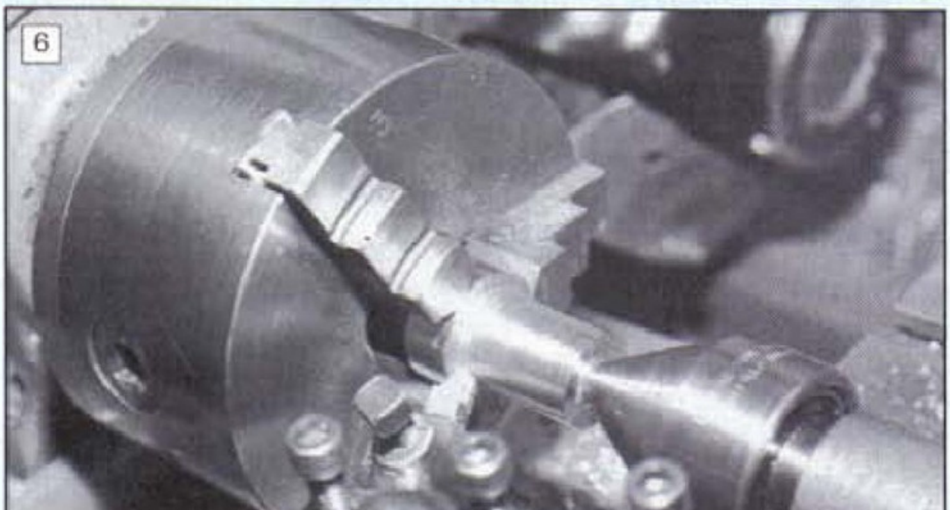
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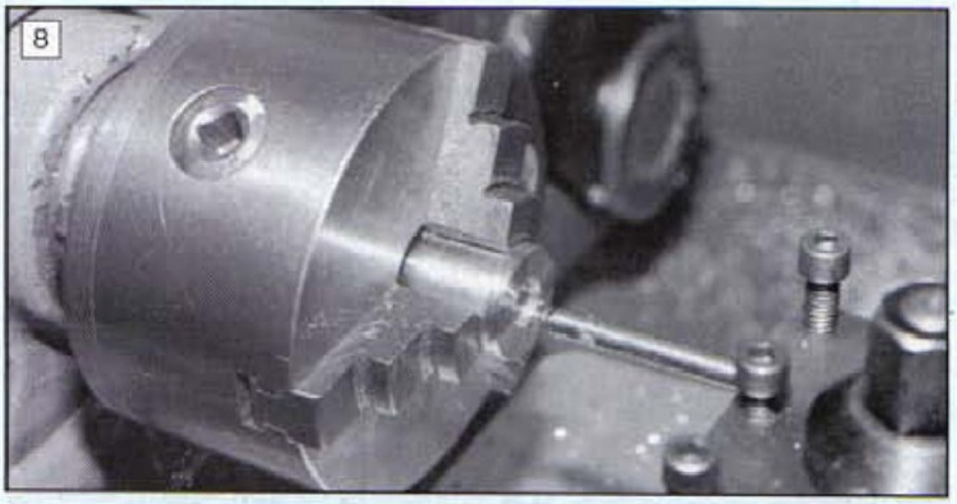
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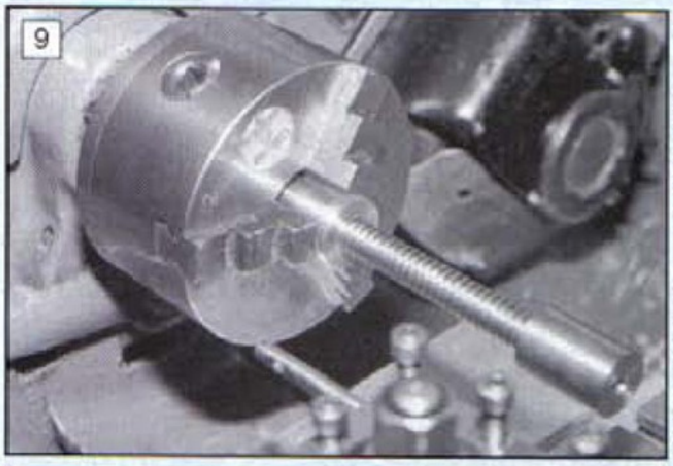
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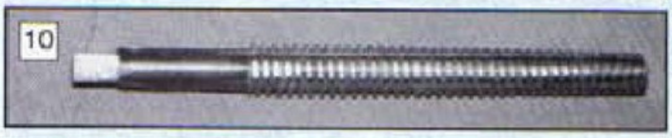
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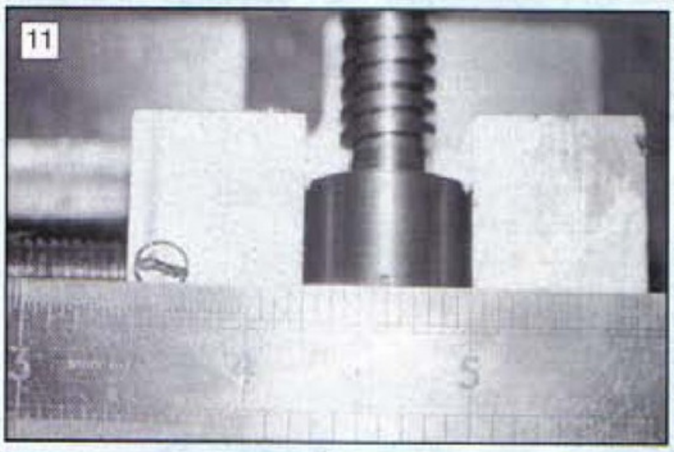
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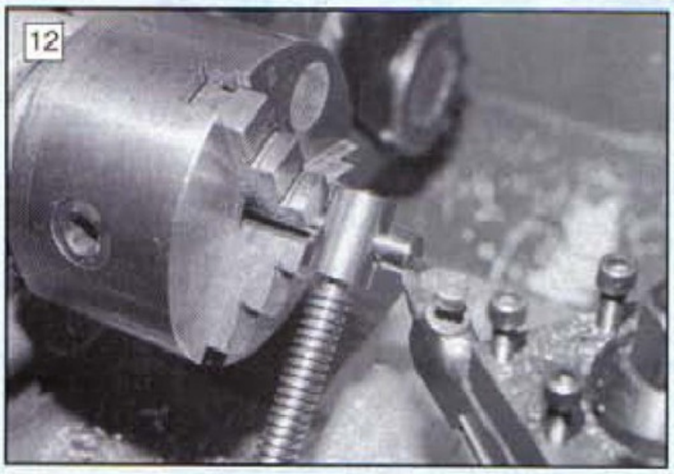
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of $^9/_{16}$in., so take very light facing cuts because of the possibility of chatter. It may be necessary to fit the fixed steady to support the overhang. Centre drill both ends, using a BS 3 ($^1/_4$in.) size, allowing the bar to be set up between centres.

Machine the $^1/_2$in. dia. first, for a length of $5^5/_{16}$in. Aim for as good and fine a finish as possible on all surfaces. Before reaching the required diameter, it is a good plan to check that the lathe is turning parallel, i.e., that tailstock and headstock are in alignment. Don't expect absolute precision; most lathes, even when carefully set up, are a little out, perhaps 0.001in. over the length of the bed. If you find a difference of more than 0.004 in. over the 5in. length, then perhaps some adjustment will be required (refer to the lathe makers' instructions). To complete the preliminary turning, spigot the end to a dia. of $^3/_8$in. for $1^1/_{16}$in. length. This is partly for a 'run in' for the screwcutting tool, and for the location of the thrust bush. To allow a 'run out' for the screwcutting tool at the other end, reduce the dia. here to $^3/_8$in. for a length of $^1/_4$in. This should be cut with a parting tool.

I do recommend the square thread, even if you've never cut one before. After all, if you never have a go, you'll never learn. If it goes wrong, all you'll lose is a piece of steel bar—a small price to pay for a new skill. First the tool to cut a square thread. **Figure 2** shows the shape, admittedly an ideal tool shape. I have yet to come anywhere near the ideal on any that I have ground 'off hand' (i.e., holding the tool in the hand, and grinding on a bench grinder), so don't worry if your efforts are not perfect. I find that I grind too much side clearance, but this isn't any real detriment to the performance of the tool. The shape is a bit like a short parting tool, i.e. clearance on both sides and front with a little top rake. Allowance should be made for the helix angle, but if more than the usual side clearance is ground, this should take care of it. The tool width is critical, and should be ground (theoretically) to half the pitch (0.062in.). In practice it is necessary to add an allowance for clearance. Without it the parts will not fit together, so aim to grind the tool to 0.065in., and use a micrometer to check it.

This may seem a lot, but try a commercial screw and nut of any thread and see what a sloppy fit it is! It is a good plan to grind the tool to all the required angles, but to keep the width over-large and grind the last section very carefully until, with constant checking, the required size is reached. It is easier said than done; I have, occasionally, reached almost the correct size only to overshoot on the next touch on the grindstone! For economy therefore, I always use $^1/_4$in. square tool bits. It may be helpful to complete the final grinding on the front clearance; this is often easier to control. Another helpful strategy is to finish the last few thou on an oilstone. Yet another is to file a tool shape on a bit of softened carbon tool steel (such as an old file) and then harden and temper before use. You may find filing to shape easier.

It is a good plan, before going any further, to make sure that the screw in the lathe carrier is tightened firmly. It would be disastrous if the workpiece slipped while being screwcut!

Now fit the tool at centre height and square to the lathe axis. (My Photo, which I will refer to soon, shows what appears to be the tool out of square to the work. This was deliberately ground to an angle to clear a close shoulder on another job. The actual tool point is square to the work). Fit the travelling steady; which really is essential on long lengths. Without it, it is almost certain that the work will flex away from the tool at the half way point, bend and break the tool. Adjust the position of the tool in relation to the steady by movement of the compound (top) slide, so that the steady will:-

a) traverse the whole length of work piece without biffing a shoulder or catch pin at the headstock end, or the centre at the tailstock end,

b) support the workpiece over as much of the length as possible, remembering that the most important part is the least supported centre area, and

c) ensure that the tool will run in and out at each end without being fouled by a shoulder, centre or anything else. Some compromise may be necessary.

Adjust the travelling steady fingers for close contact with the surface of the spigot to be screwcut.

Set your change wheels (or your

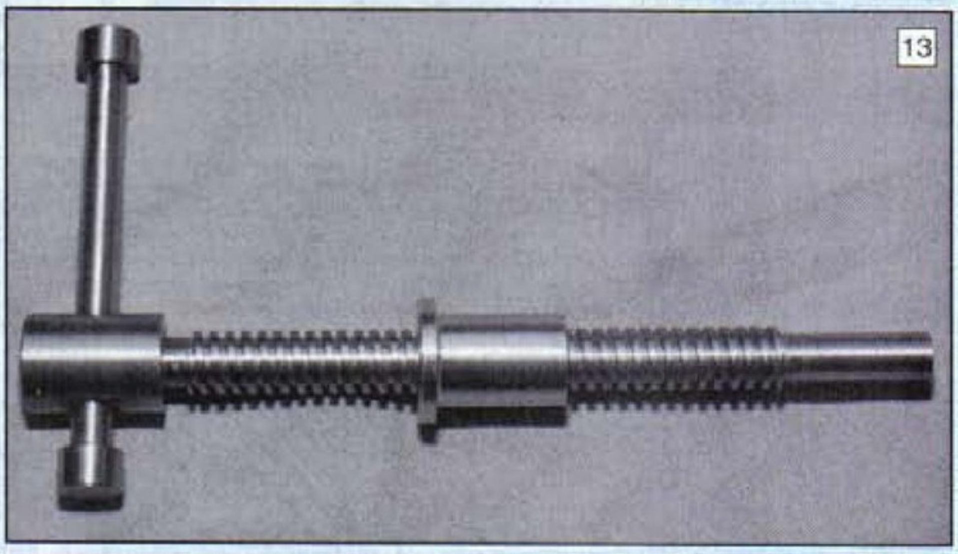
gearbox) to cut 8 TPI. On lathes with this pitch of leadscrew, the gear ratio will be 1:1. See the inside of the gear cover or the maker's handbook for the correct gears to use for your lathe. Use the lowest back geared spindle speed (about 35 RPM on most lathes).

Readers with lathes having 8 TPI leadscrews, such as the Myford, can ignore the next instruction. (This is because the half nuts can be engaged anywhere when actually screwcutting, since the same pitch is being cut on the work as that on the leadscrew). For those who have different leadscrew pitches, I will give the full details.

Back to the instructions. Mesh the thread dial indicator. Set the tumbler reverse to make the carriage move towards the headstock (the opposite will cut a left hand thread). Switch on and move the tool so that the tool tip just touches the work. Zero the index. Retract the tool slightly and move it to the right of the start position (in the 'run in' groove) and in by 0.005 inch. With the machine running, watch the thread dial indicator until a numbered line appears (this is the position for even numbered threads). At this point, engage the half nuts and watch the thread being cut, while applying lubricant. **Photo 4** shows this. As the tool moves into the 'run out' groove near the shoulder, be ready to disengage the half nuts. Retract the tool clear of the work and wind to the start. Put on another 5 thou (total now 10) and take the next cut. Repeat this with another 5 thou at each pass until 60 thou has been taken. The last cut should be at 0.0625in. **(Photo 5)**. This may well just cut into the run-in and run-out portions. Not to worry if it does; it will be an indication that the last cut is deep enough, assuming that these diameters are correct! This completes the external screwcutting, but at this stage I always chamfer the sharp corners at the crest of the thread with a dead smooth file. To do this, move the lathe spindle by hand whilst applying the file to one side of the crest and then to the other. I also remove—with a needle file—the razor sharp section where the thread runs out.

First aid — perhaps it won't be needed

Before moving on, perhaps a word about what to do if the tool breaks due to not being quick enough with the half nut lever; or more likely, as sometimes happens, if the tip of the tool is chipped for no apparent reason. The latter is often not spotted until the next cut is put on. Then, no metal, or little metal will be removed. If this happens, take a careful look at the tool—under a magnifier, if you have one. This will reveal the problem. Don't despair; all is not lost, but I'm afraid a new tool will be needed. Having made and remounted it, don't assume that you can carry straight on, because you can't guarantee that the tool has been fitted in exactly the same position and will follow exactly the same path as before, unless you are very lucky. It is necessary to 'pick up the thread'. To do this, set up and take a cut as before, but make sure that the tool is well back from the work and will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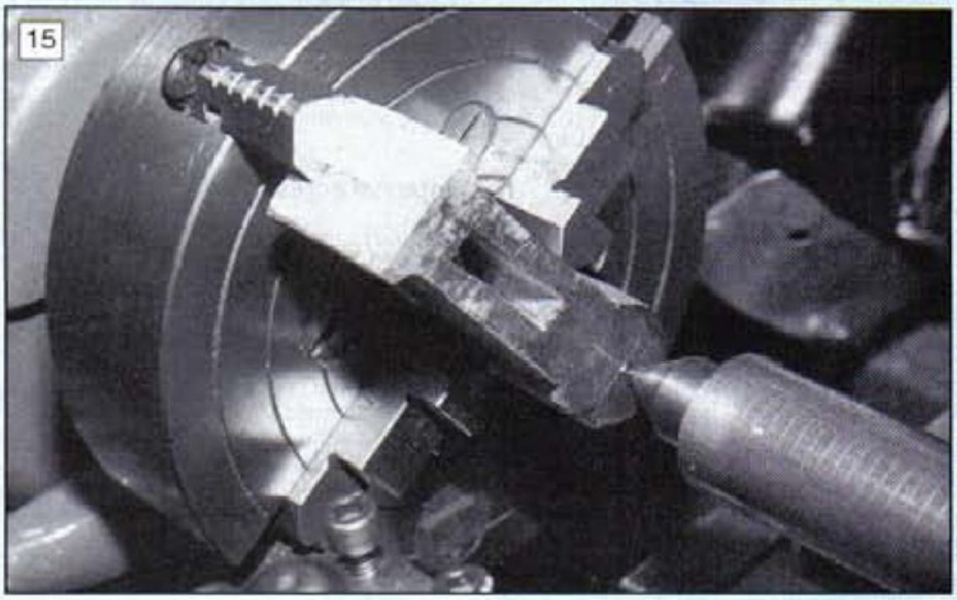
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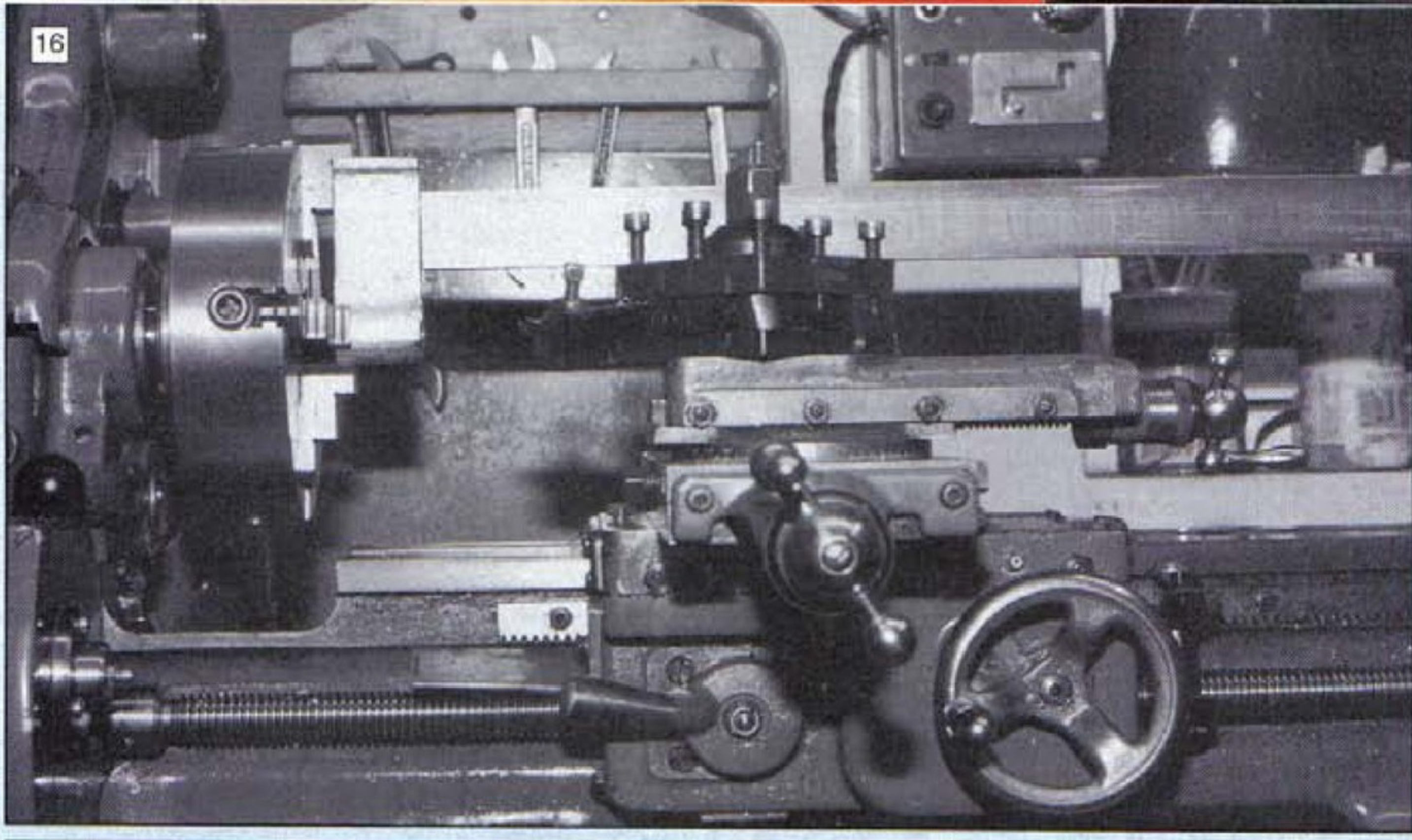
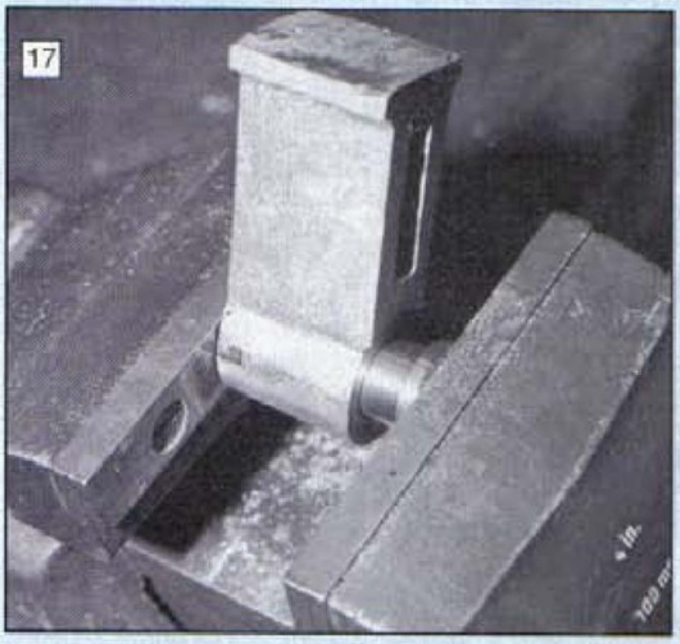
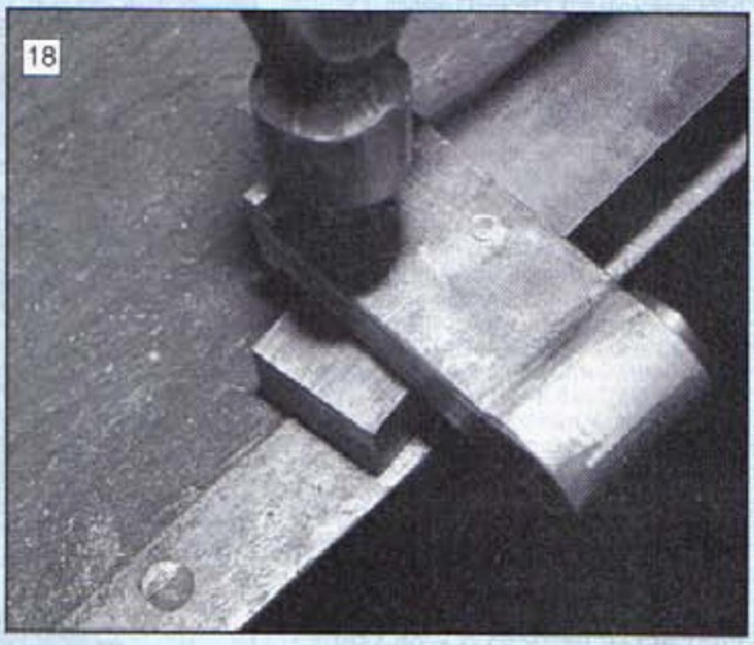






not do any cutting. Then, when the tool has gone past the start point, and is adjacent to the previously cut thread, stop the motor without disengaging the halfnuts. Bring the tool forward with the cross slide, and using the compound slide, adjust the tool position so that it will just enter the previously cut thread. This is the new position in which to continue screwcutting, but *please* remember to touch the outside diameter (uncut part of the thread) with the lathe tool tip and re-zero the index, so that the correct depth of cut will be re-established. For the first cut with a reground tool, it is prudent to go back to the beginning to make sure that you have picked up the thread correctly. If all is well then work up to the depth previously reached, perhaps in 10 thou increments, before continuing with the screwcutting proper. Before leaving the subject, perhaps I should mention one last and maybe obvious, but nevertheless important, golden rule: never disengage the half- nuts during a pass. The tool will almost certainly break. If something goes drastically wrong, it is safer to simply switch off the motor **or** quickly retract the tool, and then disengage the half nuts.

Internal screwcutting

Now to the nut
(part 3). For this, a piece of 1in. dia. brass or gunmetal is needed. Ideally, it would be a good plan to make two from one length of say $2\frac{1}{2}$ inches. Then, one end can be gripped in a 3 jaw chuck while the other end is machined to the correct outside diameter. The piece can then be gripped by the newly completed spigot (with suitable protection—perhaps a single piece of thin card, or shim, drink can sides are excellent, between jaws and workpiece) and a repeat machining completed at the other end. Where only one is to be made, a piece at least 2in. long is needed to be able to grip it adequately, which means quite a lot of waste, or, as in **Photo. 6**, a very short piece is being used to make a nut which has been centre drilled and is supported on a centre. The end should be faced and the outside diameter should be machined to exactly 0.750in. for a length of 1in. At the tip of the spigot, a small reduction to 0.747in. should be made for a length of $\frac{1}{8}$ inch. This is to facilitate the press fitting of the nut into part 2. I find such tasks much easier if the first part (in this case the first $\frac{1}{8}$in.) will fit easily into the bore; the inserted piece is automatically made square to the bore, and pressing in is then easy. To complete this first stage of the nut, it should be parted off and if necessary, the end faced to length. The corner should then chamfered. The nut should now be gripped by the newly completed spigot, with protection between jaws and workpiece. Centre drill

with a BS 5 ($\frac{1}{2}$in. dia.) centre drill, and follow this with a pilot drill of, say $\frac{3}{16}$in. diameter. A properly ground drill, using the correct spindle speed, should drill through truly and not 'wander off', so make sure that the pilot drill is correctly ground. A new one would be ideal. Follow up with a drill of $2\frac{3}{64}$in. dia. and then the $\frac{3}{8}$in. drill. All is now ready for internal screw cutting.

First the tool and its holder or bar. The tool will need to protrude by about 0.080 inch. Because a little clearance between bore, tool and bar will be needed, the bar can't be bigger than $\frac{9}{32}$in. diameter. I usually make the bar from mild steel and fit a toolbit made from a broken drill or centre drill of about $\frac{1}{8}$in. dia., the latter being clamped by a small screw. **Photo 8** shows the tool I used. Once again, the drawing **(Fig. 3)** shows an ideal shape, and my previous remarks on the external tool apply equally to the grinding of the internal tool. The $\frac{3}{8}$in. square shank is sawn down its length, so that it will tighten up on the bar when it is clamped in the tool post. The tool bit is ground in the same way as previously detailed, but since the toolbit can rotate on its axis, the helix angle can be adjusted in this way. Remember that you will be machining the thread on the inside and the helix angle will be the other way this time! Again, make the tool wider than nominal, at 0.066in. and protruding by about 0.080 inch. Any protrusion on the other side should be ground away. Since we are cutting brass or gunmetal, no top rake is required.

These tiny toolbits are very fiddley to deal with, and it pays to make some sort of holder to facilitate grinding. I use a small Eclipse collet chuck, which makes a good holder. An alternative to the above separate tool bit and bar would, of course, be a tool machined and filed from a solid piece of softened high carbon steel, such as silver steel. This would then be hardened and tempered before use.

Set the tool at centre height, with the boring bar reasonably parallel to the axis of the lathe spindle. Make sure that:

a) It will traverse through the bore without rubbing, and

b) That only enough bar is protruding from the square holder to comfortably cut the thread all the way through and give enough time to operate the half nuts lever at the end of the cut (allow about $\frac{5}{16}$in. for this). Next, use the tool as a normal boring tool to take a skim of, say 0.003in. from all along the walls of the bore. A fine feed will be needed. This will true up the bore and provide some clearance at the root of the thread. Take this setting as being the start of screwcutting for depth of cut purposes, and set the index, not to zero, but to the depth required — in this case, $62\frac{1}{2}$ divisions = $\frac{1}{16}$in. (clearance has been taken care of by the skim). Now set up as before for screwcutting:- tumbler reverse; change wheels; lathe spindle speed and thread dial indicator. Position the tool so that it is just outside the end of the bore (Photo. 8). Put on a cut of 0.005in., remembering to move the cross slide hand wheel anti-clockwise to put on the cut (the dial will show $57\frac{1}{2}$ divisions). Switch on and wait for a numbered line on the thread dial indicator. Engage the half nuts and the thread will start to be cut, although you won't be able to see it because it is inside the bore. This is one reason why I suggested that you do the screw first, you can at least see what is happening! You will **hear** rather than see when the cut is finished so that the half nuts can be disengaged. The next bit is vital if the tool and job are to survive to the end of the screw cutting procedure. Move the cross slide handwheel forwards to a reading of, say, 67 (to clear the bore). Using the carriage handwheel, wind the tool out of the nut, to the start position. Now, put on another 5 thou (cross slide reading now $52\frac{1}{2}$ divisions) and repeat the cutting procedure. Continue with another two cuts and then, before taking further cuts, 'work out the spring'. This is necessary because during the cutting procedure the boring bar, being quite slender, tends to spring, i.e., bend under the load of doing the cutting. Thus the indicated depth of cut has not been achieved. This can only be corrected by taking several passes **at the last cut setting**, until the tool removes no more metal. You may be surprised how many passes are needed. Further cuts can then be taken and 'working out the spring' repeated. The last cut (at zero on the index) will also need this procedure. A trial fitting can then be made, using the previously made screw. The nut should not be removed for this, because a further cut or cuts may be needed to achieve a fit, and it would be difficult or impossible to put the nut back in exactly the same position to take further cuts.

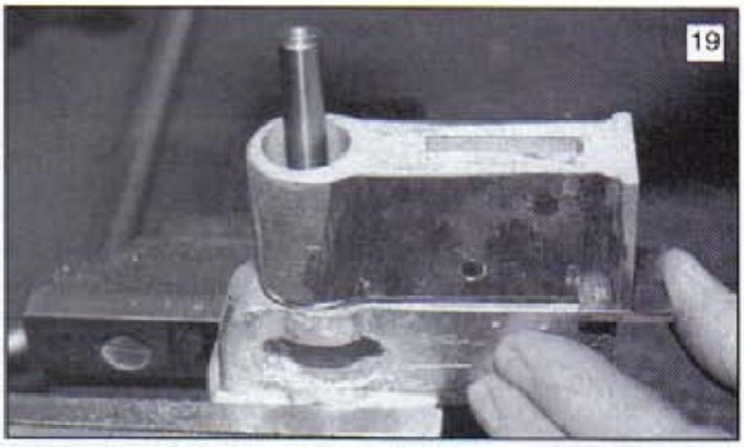
If the screw will not enter the nut, the following may help. Does the $\frac{3}{8}$in. dia. spigot go in? If not, take another light skim of the core dia.(the root of the thread at the original dia. of $\frac{3}{8}$in.) to either:-

a) Provide a little more clearance at the root, or

b) Remove any burr thrown up during cutting. Try the screw again. If the spigot now enters but the screw won't, take another screwcutting cut of, say $1\frac{1}{2}$ thou Try again. If no fit, repeat the skim and screwcutting. If still no fit, look closely at the tool tip.

Is it still as originally ground, i.e., not chipped? Has the tool slipped back in its holder, so that less depth of cut has been achieved than you thought? Take the corrective action in either case. By these means, a fit should be achieved. It should perhaps be said that until an adequate clearance has been achieved between the parts, they will not fit. So, several last, final cuts may be needed to get the parts to fit, though I do hope this won't be the case. **Photo. 9** shows the screw being trial fitted *in situ*.

Now a few words on what to do if the tool chips or breaks (this would be unusual when cutting brass or gunmetal, but can happen). After a new tool has been ground, the basic problem is, as before; picking up the thread. Go through all the pre-cut ritual, as previously described, and position for the first cut as before, but place the cross slide so that no cut will be taken. Switch on and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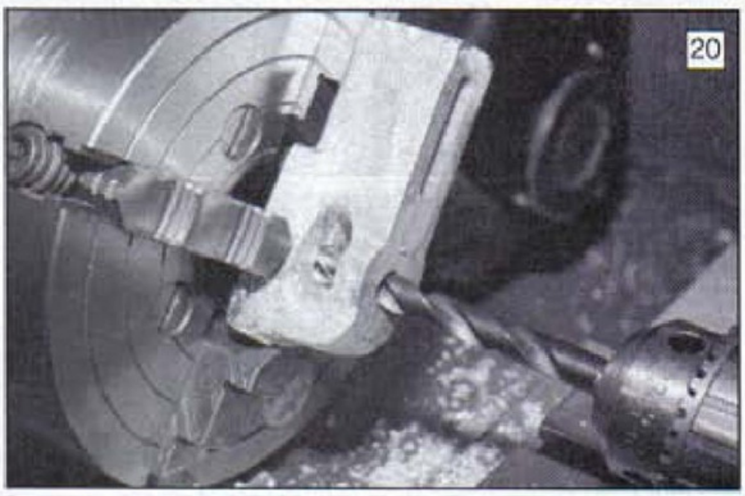
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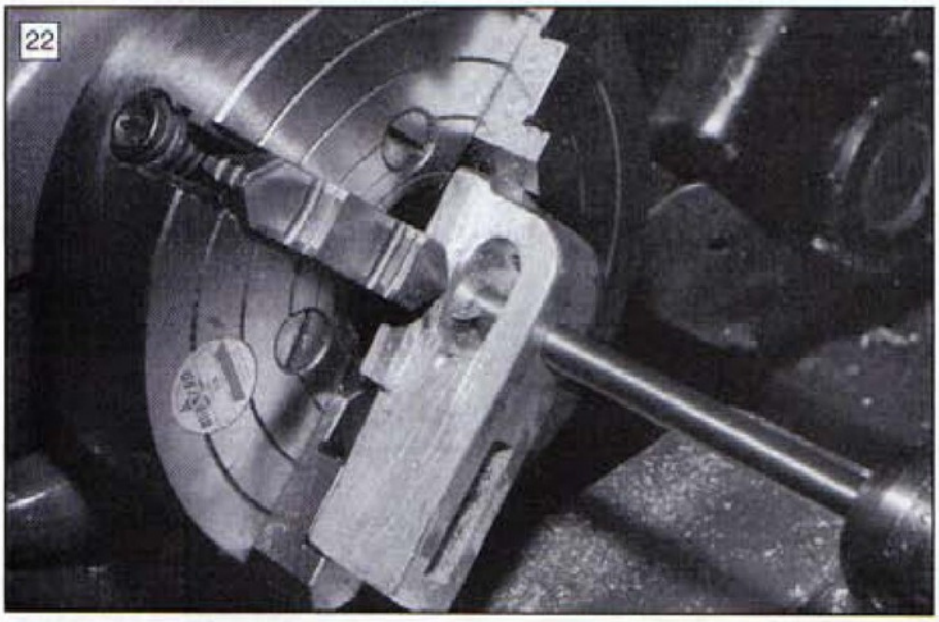

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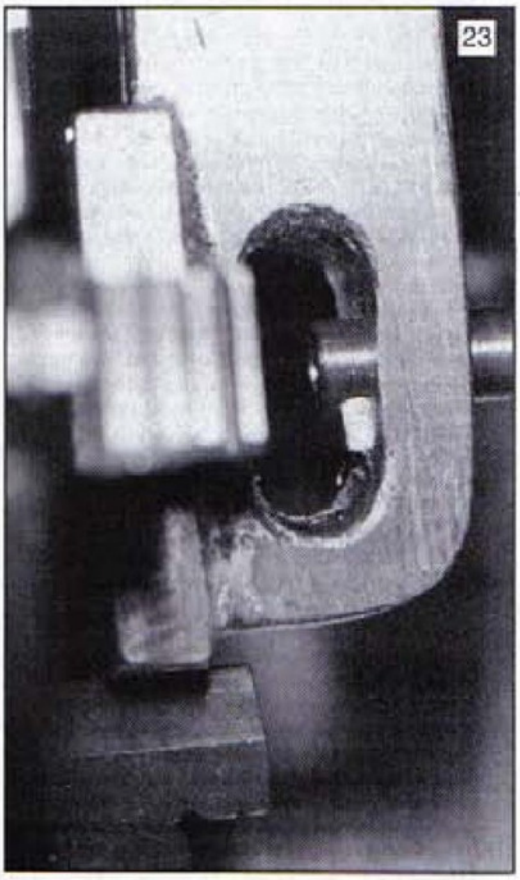

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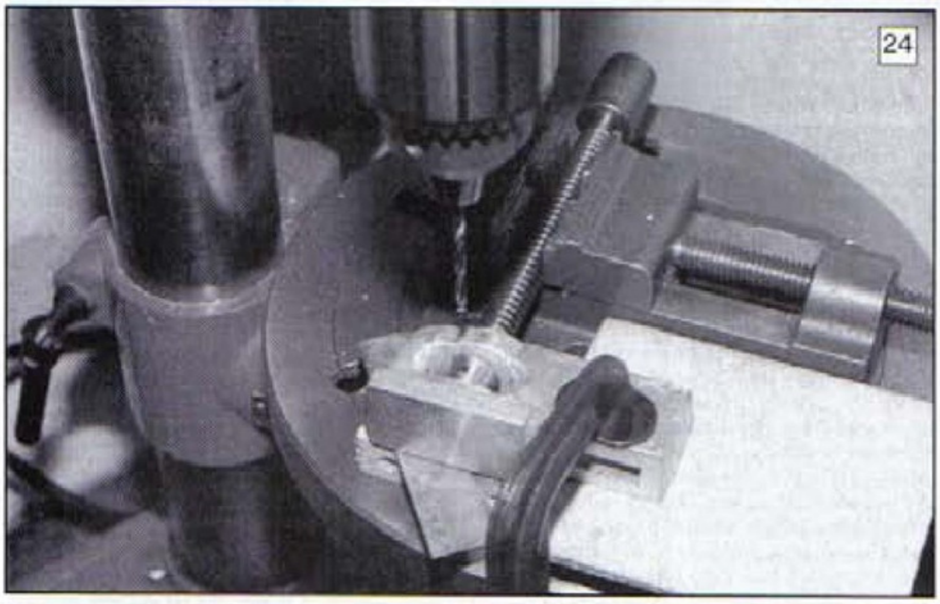

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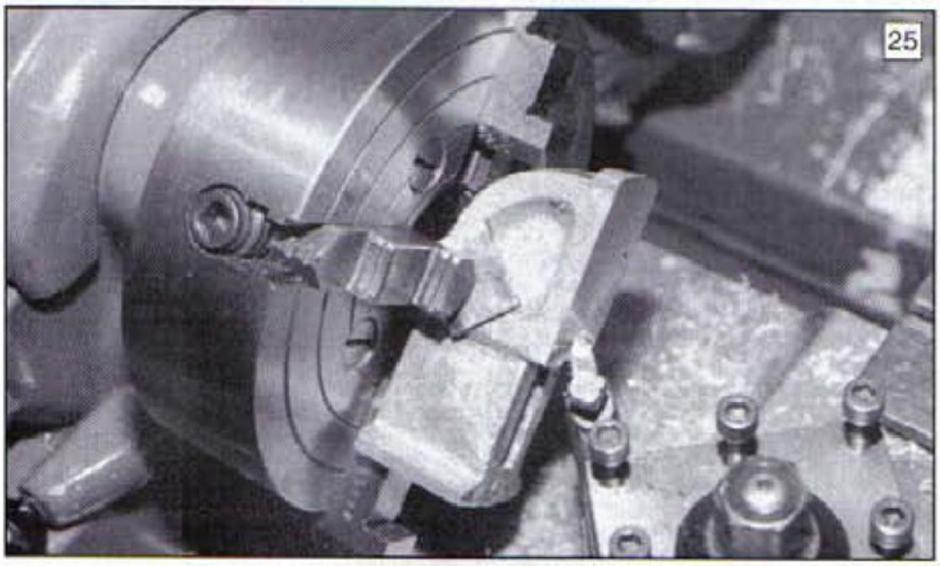

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engage the half nuts on a numbered line. When the tool has disappeared into the bore for, say, $\frac{3}{8}$in., switch off the motor, again without disengaging the half nuts. Move the cross slide hand wheel anti-clockwise so that the toolbit enters the previously cut thread. Some adjustment of the compound slide will be necessary to achieve this. Since you can't see what's happening, this has to be found by feel. As before, move the tool out of contact before winding the bar out, but touch the tip of the tool on to the original bore to find the cross slide 'start point' again. Set the index to $62\frac{1}{2}$ divisions, and as before, incrementally, work up to the point where the tool broke and continue from there, as previously described.

I hope the foregoing is enough to guide you to a successful conclusion and that the complexity of description hasn't put you off. It really is much easier to do than to describe.

Before leaving the subject of screwcutting, it may be helpful to point out that if a number of jobs using the same size of screw are envisaged, a home made square thread tap takes the uncertainty out of the job. This is made by screwcutting a piece of silver steel to the same dimensions as the screw, taper turning the end and milling grooves to provide cutting edges. The whole is then hardened and tempered. **Photo. 10** shows one that I made a long time ago for the finishing of tapped holes for the screws of my milling machine. If you opt to do this, please don't think that this eliminates the internal screwcutting (unless you make a very long length to enable a very small taper to be used). It is almost certain that if you try to form all the thread, the tap will break. It should be thought of as a finishing tool. It will certainly provide a very close fit - ideal for cross slide nuts and screws.

The easy way out

Now, for those who would prefer to use ready made threaded rod or studding. Before starting a description, it may save repeats by stating that great care is needed to prevent damage to the thread during machining operations. So, whenever gripping the thread is mentioned, I hope you will remember to interpose a piece of protective material between gripper and gripped. I find that aluminium sheet, of about 18 SWG

(1.5mm) thickness, wrapped round a thread can be gripped firmly and fairly accurately, so long as only one thickness is used at all gripping points. I will put an asterisk at the necessary places to remind you. Start by gripping* the studding in a vice and sawing off a length of about $6^3/_4$in. to make the screw. Grip* in the three jaw chuck with about 2in. protruding. Face and then spigot to $^3/_8$in. dia. for a length of $1^1/_{16}$ inches. Reverse end for end and grip* as before. Face the end and spigot to a depth just enough to remove all the thread and then take a little more to bring to the nearest $^1/_{64}$in. size, so that a standard drill can be used to drill the boss (or to the nearest drill size that you have). The boss should be made from a piece of bar of $^3/_4$in. dia. and $1^3/_{16}$in. long. This should be gripped in the three jaw chuck and faced. After centre drilling, a pilot drill should be put through to the half way point. The piece is then reversed end for end and exactly the same procedure carried out. Using the pilot drill half way through from each end minimises the possibility of drill wander. Now put an intermediate size drill all the way through before finishing at a size to suit the spigot. The parts can then be washed in meths or similar, and dried before applying Loctite high strength adhesive. The parts can then be assembled and put to one side to cure. An alternative method of joining would be to silver-solder or braze the parts. The snag here is that this will cause black scaling, which is difficult to remove. Recently, I have used neat Harpic to good effect. An overnight soak will usually clean the steel, with only a little more polishing with fine emery required to produce a presentable finish on the plain turned sections, with a wire brush to finish the thread. I got this idea from the pages of *M.E.*

We now have an almost finished screw, which can be completed in the same way as now to be described for the screwcut version.

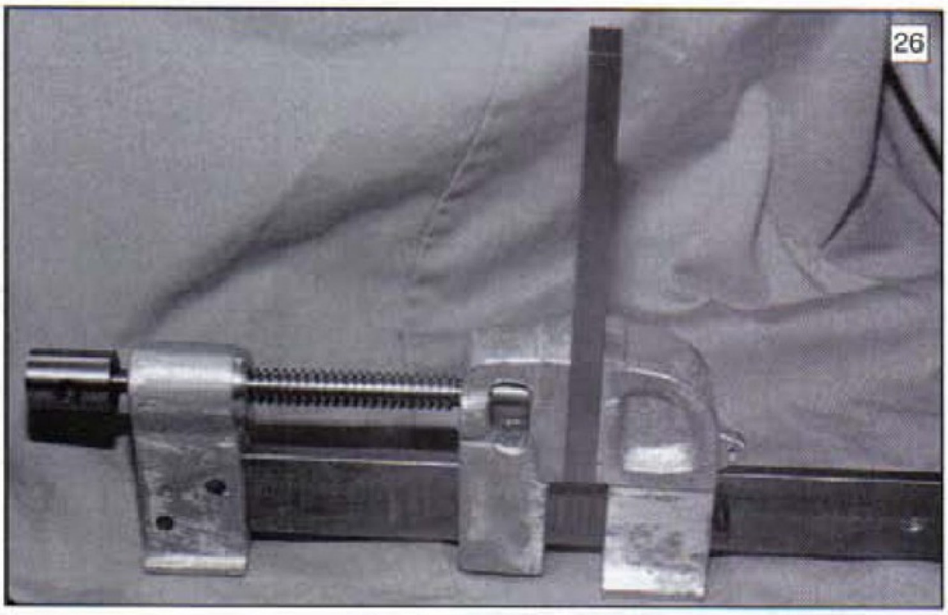
We may as well finish all the parts associated with the screw and nut next. First, a hole has to be drilled for the tommy bar across the large diameter on the end of the screw. It is important to drill this with some care, as nothing looks worse than an out of square tommy bar and an off-centre hole. Mark out carefully lengthwise and centre punch. Grip the piece in a vice and make sure that it is:-

a) level and

b) exactly in the centre as shown in **Photo 11.**

The workpiece can now be pilot drilled and drilled to size normally. At this stage, it is usual to countersink slightly to remove the burr, and then to machine a light skim to finish the diameter and if desired, to machine the end to a curve using a form tool. This is not essential of course—a faced end and a chamfer will suffice.

The tommy bar ends (part 9) are a simple bit of turning as is the tommy bar (part 8). However, the spigots should be made a close fit in the holes of the tommy bar ends. The countersinks are the location for peining over the tommy bar ends, so are important. The parts are then assembled by fitting the tommy bar through the hole in the large dia., and



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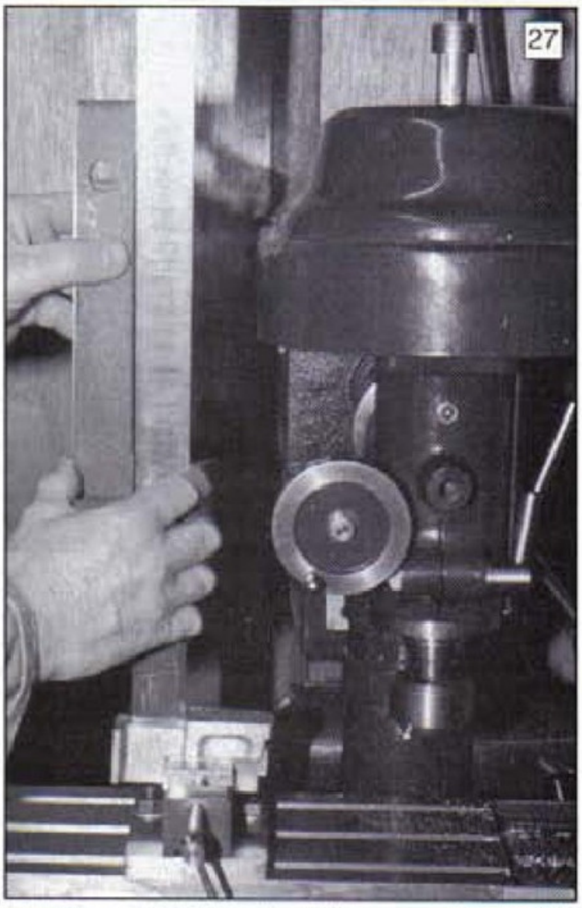
then fitting both tommy bar ends for peining (riveting) the spigots into the countersinks. Finally, face the ends and chamfer after assembly as shown in **Photo 12.** The screw will come to no harm while this is being completed, so long as sufficient clearance is provided to allow the tommy bar to freely rotate. The completed assembled parts are shown in **Photo 13.**

Now to the other parts of the cramp. First, prepare the base bar (part 5). This should simply be a little draw filing on the corners of the long edges, and squaring up the ends. The draw filing shouldn't be overdone, as all we are after is to make the edges safe to handle and to ease the fitting of the cored parts of the casting. Less then $^1/_{16}$in. at 45deg. is all that is required. I use a 6in. dead smooth (the finest available) file for such jobs. I hope that those of you who know this already will forgive me if I state that as a general point of safety, chamfering of all sharp corners should become a standard routine practice. Next, mark out for the holes in the base bar. It is not necessary to have them all the way along, because of the screw traverse and casting widths. I made the first hole position $7^5/_{16}$in. from the end where the nut bracket is to be fitted, and the rest spaced out at $2^1/_2$in. centres, as shown on the drawing. All but one of the holes are drilled $^1/_4$in. dia. for the adjustable jaw pin. Again, as shown on the drawing, at the extreme end, opposite where the nut bracket is to be fitted, a tapping drill is used in preparation for threading $^1/_4$in. BSF to take a screw of any head. This is ultimately used to prevent loss of the adjustable jaw. All holes need to be deburred, of course.



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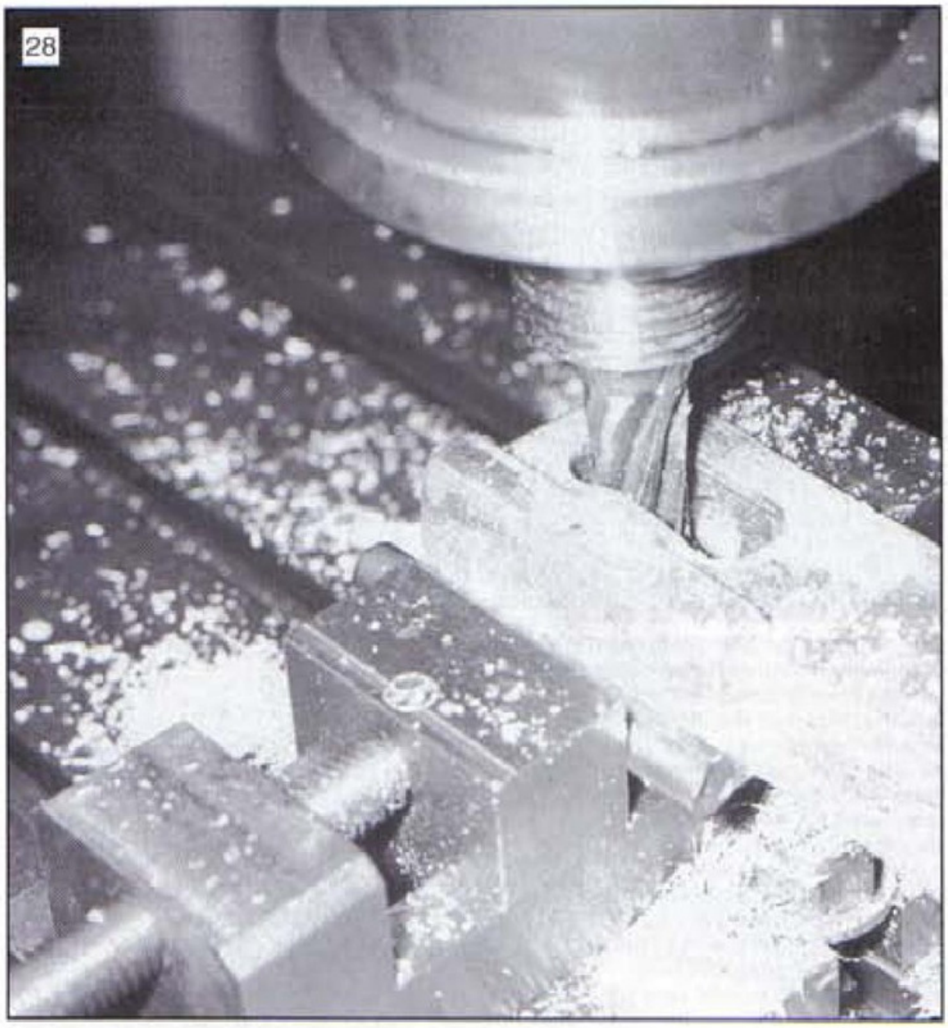
Dealing with the castings

Next we need to look at the castings. If there are any excrescence's of unwanted metal, these should be removed by careful filing. By the way, you may already have found difficulty when using ordinary files on aluminium, because the file tends to 'pin'—little pieces of aluminium get trapped in the teeth of the file and then deeply scratch the surface being filed. Constant use of a file card—a kind of special wire brush—is necessary. To reduce pinning, a Millenicut file is an alternative. This is specially designed for filing aluminium and other very soft metals; it has very coarse teeth but produces a remarkably fine finish. I commend it to you. **Photo 13A** shows the tooth pattern of this type.

The cored rectangular holes need to be made a sliding fit on the base bar. Hopefully, the cored holes will need little filing to achieve this - ideally without shake Don't worry too much if the ideal is not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attained. Commercial sash cramps are quite sloppy. One difficulty will be producing a square corner. The solution is to use a 'three square file' (triangular in section and not, as far as I know, available as a Millenicut in this small size) **(Photo 14)**.

Now to some machine work on the castings. The nut bracket **(part 2)** is first. Apply marking fluid to one of the circular faces in preparation for a little marking out. By careful measurement, find the centre of the circular face and check that it is 1in. from the top of the base bar. Centre punch. Grip the casting in the four jaw chuck so that the marked out face is central to the axis of the lathe. Use a centre in the tailstock to aid the centring, as shown in **Photo 15**. Before tightening fully, enter the base bar and check for parallelism in two planes **(Photo 16)**. Recheck the centring and parallelism until all is well. Grip firmly and evenly with all jaws, and do a final check. I must admit that the gripped area is small, but with small, fine cuts the whole face can be machined flat. The recommended lubricant for aluminium is paraffin. Centre drill and drill a pilot hole. What size to use next will be determined by what thread you're going to use and whether or not you're going to use a bush. For tapping directly into the aluminium, drill tapping size ($\frac{13}{32}$in. for $\frac{1}{2}$in. BSW) and, using a taper tap held by its circular shank in the tailstock chuck, start the tap in the hole. This will ensure that the tap is square to the workpiece. By leaving the tailstock free on the bed the chuck may be turned by pulling on the belt by hand, keeping a firm, forward pressure on the tailstock. If your tailstock chuck won't take the shank of the tap, use a centre in the end of the shank of the tap and turn the tap with a suitable wrench applied to the square end. The tailstock should be fixed for this, and pressure applied by turning the handwheel. Once the thread has been established square to the workpiece, it may be found easier to finish it with the workpiece out of the lathe, using a tap wrench. For a square thread directly into the aluminium, the instructions apply as previously described for screwcutting the nut. For fitting a previously made nut, drill the hole to, say, $\frac{11}{16}$in. dia., and using a boring tool, bring the hole to a dia. of exactly 0.750in. When the reduced $\frac{1}{8}$ in. length of the nut will just enter the bore, the size is correct. Don't be tempted to ream the hole, as this is likely to result in a push fit, not a press fit. If anything does go wrong, then Loctite high strength retainer will do the job, providing the clearance is not excessive.

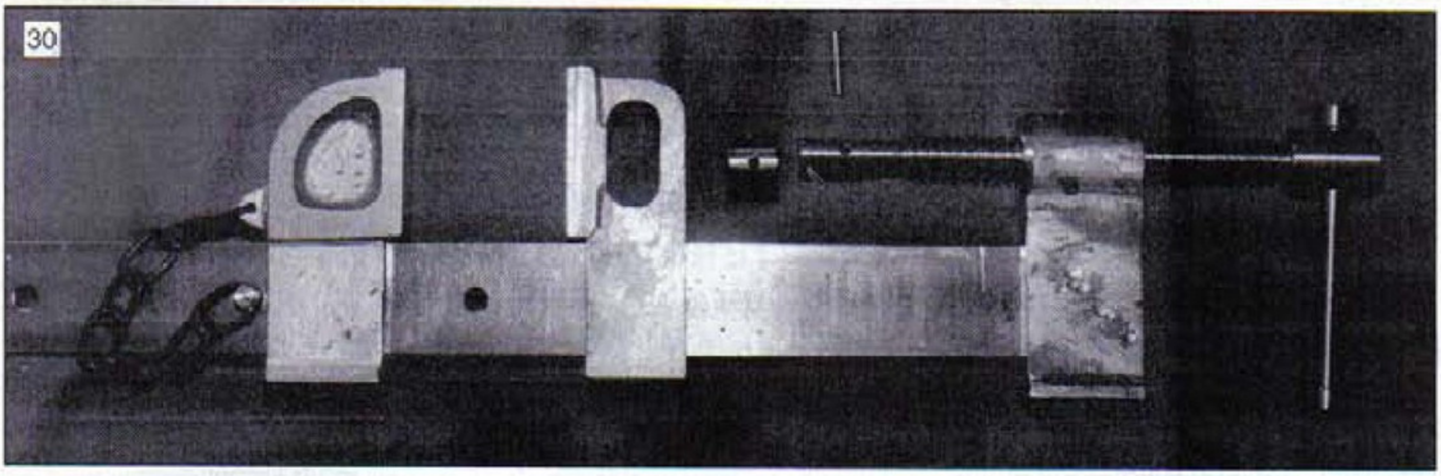
Turned end for end, the bracket can be faced to render the two faces parallel. Using the base bar to square up as before is important, but centralising less so. Reposition in the chuck for machining the foot square to the faces, taking only fine cuts because of the overhang.

The nut can now be pressed into the nut bracket **(Photo 17)**. Don't forget to protect those nicely finished surfaces. Mark out for the holes for rivets.

With the nut bracket mounted on one end of the base bar (where no holes have yet been drilled), drill through the whole assembly. $\frac{1}{8}$in. dia. iron rivets are specified; larger ones could be used, but the type of head is unimportant (I used countersunk).The riveting being completed is shown in **Photo 18**.

In order to get the components to fit each other, it is necessary to make a special transfer centre punch, the use of which will be seen shortly. It can be made from mild steel, and the first task is to turn a length of about 3in. to the core dia. of whatever thread you're using; ($\frac{1}{2}$in. BSW will require $\frac{13}{32}$in. dia., the $\frac{1}{2}$in. square thread will require a little over $\frac{3}{8}$in. dia.). The important thing is to achieve a close push fit in the core dia. of the actual nut The end of this piece can then be taper turned to an angle of about 60deg. to produce a point. The screw driven jaw (part 4) is then slid on to the base bar close up to the nut bracket, as shown in **Photo 19**. If there is any shake between the large faces of the screw driven jaw and base bar then centralise the screw driven jaw on the base bar. Make sure that the two mating faces are parallel to each other (use packing if necessary). Slip the special punch through the core of the screw and give one firm blow; this will transfer the centre accurately to the screw driven jaw. Because the aluminium is relatively soft, it will be easy to mark it using a mild steel punch. The screw driven jaw can now be set up in the four jaw chuck, centring the punch mark. Once again the base bar is used to get the axis parallel with the base bar and lathe. As before, check that all parameters are met before firmly tightening the jaws. The work may now be faced and centred with a BS 4 centre drill before drilling a pilot hole, initially just to break into the cored hole. Open up to $\frac{23}{64}$in. diameter. At this stage, change back to the centre drill to centre the inner face (as yet undrilled). The centre drill may have to protrude out of the drill chuck more than normal to reach the inner face. The reason for doing this is that if the pilot drill meets a face that has nothing to guide the point, this can cause it to wander off centre. Now go back to the pilot and drill to the depth shown on the drawing. Open up as before, and finish with a $\frac{3}{8}$in. dia. drill **(see Photo 20)**.

We now need to make those inner faces flat to enable the thrust bush to meet them squarely. A special tool will be needed. It's a bit like a boring tool and quickly made. The diameter at the end is made a close fit in the $\frac{3}{8}$in. dia. hole, and squarely cross- drilled to a dia. of $\frac{3}{32}$in. dia. near to the end. A hole is drilled down the axis to take a clamping rod. An Allen screw provides the clamping force. I made the toolbit from a broken $\frac{3}{32}$in. dia. drill. This was difficult to photograph, so I have photographed a similar, but larger toolbit, made from a piece of silver steel—the alternative choice to a broken drill. This is shown in **Photo 21**. The cutting edge needs to be straight and as near as possible, square to the bore. Of course, the toolbit is fitted and clamped once the holder is in position inside the casting. The tailstock chuck is then brought up to grip the holder. The tool in use is shown in **Photo 22**. To machine the opposite face, the same tool is used, but the rake and clearance angles are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adjusted to make it cut, by rotating the tool on its axis. **Photo 23** shows the rear face being machined. Before removing the workpiece, if not already completed, take a cleaning cut to machine the outside face, as this will help with the next stage. The screw driven jaw can now be turned round and again gripped in the four jaw chuck. To ensure correct positioning, the previously machined face should be pressed firmly in contact with the face of one of the chuck jaws. A double check for squareness can also be made by fitting the base bar again. A facing cut on the jaw will then complete the machining.

There is still a little work to do: the inside faces, though machined, will probably be pocketed. This means that the machined faces will lie below the surrounding surfaces, and it will be impossible to fit the thrust bush, so a little filing will be needed to overcome the problem. I used a round file, angled slightly away from the machined faces, so that the latter wouldn't be spoiled.

The thrust bush **(part 10)** can now be made, a simple bit of turning. The only noteworthy point is to check that the bush is the correct length, since the machined gap in the casting may be different from the nominal measurement of ½inch.

The next task is to carefully mark out and centre punch the thrust bush for drilling. The bush may then be drilled, but not all the way through, for the reason already given when a gap has to be crossed. This drilling has to be carefully set-up to make sure that the drill goes through the diameter of the work piece and not at a chord. (Refer to the description of drilling for the tommy bar). The size of hole recommended will allow for press fitting a silver steel pin of 0.125in. diameter. Having drilled through one side, the bore should be reamed to deburr. The parts can then be assembled and set up, with packing pieces, on the drilling machine **(Photo 24)**. Align by entering the drill into the previously drilled hole, then drill all the way through.

The thrust pin (part 11) is very simple, merely requiring facing to length and a small taper of about ½deg. turning on one end. Only enough metal should be removed to allow the pin to just enter the drilled hole. I don't think hardening the pin is necessary. As access is difficult when fitting the pin, I used a pin punch with a small supporting block of mild steel under the bush.

Part 6 - the adjustable jaw - is the last piece to be tackled. **Photo 25** shows the set up for machining the face. Note the use of packing pieces to ensure as good a grip as possible.

A word on the preliminaries here. The usual check using the base bar is made for parallelism, but if there is any shake or slop, then the following procedure is needed: with the adjustable jaw gripped in the chuck, remove all play by gentle pressure on the thin edge of the base bar nearest to the jaw face. The long, thin edges of the bed bar should now be parallel with the axis of the lathe. This will ensure that, when in use, tightening pressure will bring the jaw square. **Photo 26** shows a trial assembly with a parallel gripped in the jaws; there should be no gaps.

Back to the adjustable jaw. It only remains to face the foot, once again taking only light cuts for fear of disturbing the setting. The small tab at the rear of the adjustable jaw may now be drilled to receive the chain, which is best fitted after painting.

So far, I have only detailed the making using a lathe and drill for those with only this equipment. On the first one I made, the less important surfaces were finished with a file. This produced a perfectly a usable cramp, and for many this will be the end of the project.

Alternatives using a milling machine

For those with a milling machine, there are other methods available, particularly in producing the faced surfaces on the castings. In **Photo 27**, the adjustable jaw is being set up in a small machine vice. Note the use of a spirit level to ensure squareness (this assumes that the machine table is level—mine is!). **Photo 28** shows an alternative method of machining the faces for the thrust bush. Centring, facing and drilling has been carried out on the lathe as previously described. For accuracy, a piece of round bar interposed between the unmachined face and the vice jaw, so that the machined face is being firmly held against the other jaw, and the slot being machined will be parallel to it. **Photo 29** depicts the same casting being milled with the (lathe) machined face in contact with the miller table whilst producing the jaw face.

Photo 30 is of all the parts prior to


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painting, which is not essential, but does give a professional and finished look. Aluminium, like brass, is one of the difficult metals to paint, due to poor adhesion. I would recommend a zinc chromate primer if you can get it. An alternative would be cellulose primer surfacer. After this, any good brand of paint will do.

I hope this article will encourage you to have a go. Finally I should perhaps mention that, though the drawings are bristling with dimensions, none of the external sizes are at all critical, and you will notice that I have only concentrated on the ones that are important.

My best wishes for your version(s).

Supplier details

Castings and materials for this project are available from N.S. & A. Hemingway, 30 Links View, Half Acre, Rochdale, Lancs. OL11 4DD Tel. 01706 45404, under code H125, price inc. VAT is £26.95 plus p&p, ring for details.

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SCRIBE A LINE

Eye protection in the workshop

From Jim Woods, York

*I read the item on safety equipment from Seton of Banbury, and its reference to safety glasses, on page 32 of Issue 37 with interest. Safety goggles are quite widely available at reasonable cost, and most types will fit over **most** pairs of prescription spectacles.*

For various reasons, I decided a couple of years ago, that I had become fed up with goggles on top of specs. Either the goggles or the spectacle lenses misted up, they made my eye sockets sweat and, being soft, the lens part scratched all too easily, no matter what care I took of them. Before that, of course, I'd assumed that ordinary spectacles themselves offered protection, whether the lenses are glass or plastic. They don't!

For anyone who wears prescription spectacles, any optician should be able to supply a pair of proper safety spectacles to the appropriate British Standard, BS2096. Mine are the wire frame type, with plastic lenses and the side protection shields characteristic of safety spectacles. The lenses should be marked 'BS2096' on the top front of each of the lenses.

If you use bifocals or more than one pair of glasses, get them for near vision, of course. I boobed at first and got them for distance vision, which meant that I could see 12BA nuts only from the other side of the workshop, but couldn't reach them, as my arms didn't correspond in length to the distance involved. Don't forget, either, to get new ones if your prescription changes.

Costs? I paid £61 for my last pair. I thought that expensive at first, but then again I've never heard of eye transplants. I have also heard a (possibly apocryphal) tale of someone suffering an eye injury in their home workshop who was refused sick pay because they weren't wearing safety spectacles.

Another successful Martek conversion

From Harold G. Cohon, Morton Grove, Illinois

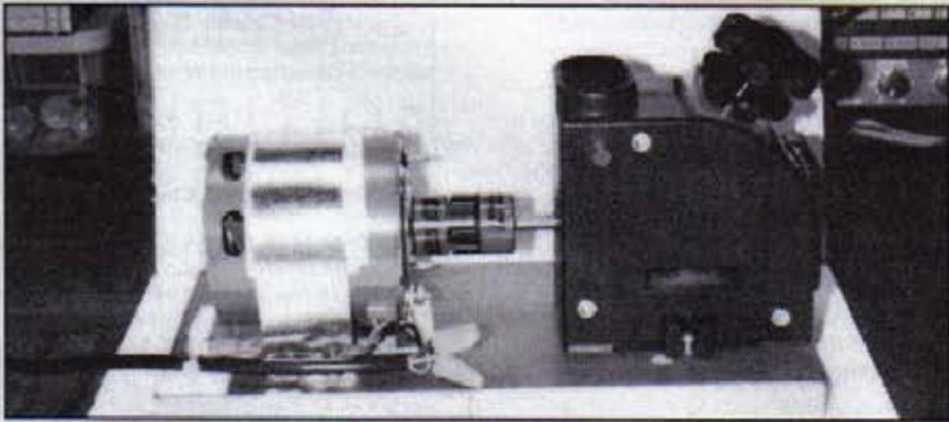
This is in reply to M.E.J. Daniels' letter (Scribe a Line, Issue 36)

I received Issue 35 with the article about the Martek drill sharpener at the same time as an advertisement for Martek from a local supplier. Assuming Alan Bourne would not go through all that if the device did not function, I bought the sharpener.

My assembly differed in that I had a small shaded pole AC motor (approximately 1700 rpm) that worked out just right. Also, I bought Lovejoy couplings, since they were only a few dollars.

The unit is now operational, and I sharpened two drills to test it. The Martek worked as promised and the sharpening appears to be a success. The collets held the drills with no problems. Hopefully this will continue to be the case.

Perhaps Martek have made some changes since Mr. Daniels bought his unit.



Gas-Air Blowtorches

From Will Noble, Forres, Morayshire

A couple of years ago, when I was an apprentice (only a mild exaggeration, honest) I remember being shown how to bend metal without a forge and how to braze together large lumps of metal. The heat source for both operations was a blowtorch. No surprises there, but for the simple fact that these blowtorches did not run on oxy-acetylene or any other such exotic gas - I don't think they exactly trusted we apprentii with such potentially lethal fuels, at least not at that early stage of our training. Remembering some of the pranks we used to get up to, no wonder!!

The fuel for these torches, used throughout our factory, was simple 'town gas'. The combustion was aided by compressed air - not surprisingly, every workshop and machine shop had a compressed air supply. The torches were quite bulky, but I suspect that was more as a consequence of a desire for durability rather than a necessity of function. If my memory serves me correctly, there was an air pressure reducing regulator mounted on the wall, but no regulator for the gas. The one thing I most definitely remember though, was their efficiency. I have also see a short piece of film of two chaps at work in the (Dawes, I think) cycle factory, brazing together frames for their fine bicycles, so ours was not a unique establishment.

I wonder if this type of heat source would not be a far cheaper and simpler solution to all but our true welding jobs. The safety and cost implications of oxy-acetylene have always made me shy away from it's ownership, despite the uses I could put it to. One of my (happily not too close) neighbours destroyed his garage and car, part of an adjacent house, half the windows in a nearby school and very nearly his life after a foolish mistake with a set of oxy-acetylene bottles!

Does anyone know of a specific design, have a source of theory for torch design, or have such a torch which could be inspected. I have had a notion to build one for a few years now, and my one rudimentary attempt at gas torch manufacture was not a success. Yes, I know that 'town gas' is not the same now, but a propane bottle will not be very far from the mark - possibly even butane - and I will bet quite a few of us have one or the other: caravans, camping, gas barbecue etc. I would also hazard a guess that a lot of us have a compressor. Even if it is not fitted with a regulator, one can be obtained for a reasonable outlay. My regulator cost under £20 new, some five years ago, and it is a very competent item, accurately regulating over a range in excess of 60 psi.

An appreciation of help from readers and some useful information

From Joe Lloyd, Longwood, Huddersfield.

Thank You:

Reference my request in Issue 35 for information on the Halifax lathe. I've had many replies and a lot of help. Everybody pointed me in the direction of Acorn Machine Tool Co. Ltd., Egham, Surrey, who were extremely patient and courteous, and more to the point, were able to supply me with everything I required and more. What a lovely lot model engineers are. I have now joined a model engineering club and have had a tremendous amount of help and encouragement. It all started with M.E.W.

Information:

A source for small ball bearings is old video recorders; there are at least two bearings in the head, 8 or 9mm bore and very high precision, and check the little rubber wheels that stretch the tape around the head. Each one has two 3mm bore ball bearing. In fact, if it turns, look inside; you may be surprised what you find. Also, there are many small powerful 12 volt electric motors.

Care over conversion

From M.E.J. Daniels, Fakenham, Norfolk

The article by Philip Amos (Finish & Dimensions or Traps for New Players) in M.E.W. No. 37 really points up the inadequacy of making direct conversions from Imperial to metric measurements in order to be politically correct (and meet editorial diktat).

Can you imagine Tubal Cain calling up a cut of 7.6 millimetres as a roughing cut? In my edition of the Handbook, he calls up 0 3 in., something we can visualise - who can visualise 7. 6 mm? Why not go the whole hog and quote the more accurate 7.62mm?

Please allow your contributors to be sensible and, especially when quoting others, use the appropriate units of measurement.

If all else fails......

From R. Ilsley, Sutton Coldfield, West Midlands

Boy oh Boy! Did your contributor Bill Morris cause me to have a red face? It started with my close attention to his article on the Reference Square. One day, after reading it, we had a problem at work based around H9 tolerances, and the ability of the operators to read standard micrometers to an accuracy of 0.02mm.

I quoted the above article, and told the Quality Control people to use the micrometer properly, with only one click of the ratchet. A delegation arrived, armed with an official Mitutoyo instruction leaflet and the results of a statistical study of the operators.

The manufacturer's leaflet says 1.5 to 2.0 ***TURNS*** *of the ratchet. The study showed that our operators would, on average, be able to measure to 0.04mm. I apologised to the Quality Control and regretted my trust in Bill Morris*

Moral ? Always go to the source material.

Slip gauges—a different approach

From Brian Karavis, Caversham, Reading.

I found the article by Alan Jeeves on slip gauges (Issue 36) very interesting. It set me thinking on how the particular size increments were determined. Were they arrived at over time during the industrial revolution or were they determined by an individual? The similarity between the metric, (which presumably came later), and the Imperial indicates that the system of increments must be fairly optimal.

As the cost of an 81 piece set is so high, I wondered why a smaller set would not suffice. The set could be reduced to only 12 pieces if the required length is determined by adding and subtracting various pieces. The sets for Imperial and metric would be:-

Imperial	Metric
0.1	1.0
0.1001	1.001
0.1003	1.003
0.1009	1.009
0.1027	1.027
0.1081	1.081
0.1243	1.243
0.1729	1.729
0.3	3
0.9	9
1	27
3	81

Using the example in the article, making up 2.1464in. would be as follows. (Imperial stack)

0.1		
+0.1009		
+0.1729	*-0.1001*	
+0.3	*-0.1003*	
+0.9	*-0.1027*	
+1	*-0.1243*	
....	....	
+2.5738	**-0.4274**	**= 2.1464**

The blocks could be arranged in two adjacent stacks. It would not be too difficult to design a block frame capable of holding the stacks and obtaining both internal and external dimensions between the two stack lengths with the use of additional plates.

Working with base 3 numbers in this manner is however rather demanding. The secret is to make up the last three digits first. Tables to aid this could be produced. Making up blocks to obtain the required first two digits is then fairly straight forward.

Considering there would be a cost saving of approximately 85% with a 12 block set, what have I missed?

IN OUR NEXT ISSUE

Coming up in the DECEMBER issue, No. 39, will be:

SIX POSITION LOCKING/CLAMPING ARMS

A novel solution to a variety of clamping problems is brought to us by Tony Skinner.

METRIC PITCHES ON AN ENGLISH LATHE

David Dew shows that the task isn't that difficult.

SHEET METAL FOLDER

This neat device, which can be clamped in the bench vice is described by T. Gould.

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(Contents may be changed)