5 watts.

Tr1 (BFY50) is in a T05 can and this is connected directly to the collector which in this circuit is +12v. Make sure the can does not contact the sides of the container.

Tr2 (2N 3055) is in a T03 can and again is connected directly to the collector. This transistor can be bolted directly to the metal case of the unit thus avoiding the need for insulation bushes and washers, the case acts as an effective heat sink.
Note that the case is connected to the negative terminal of the pump motor and earth.

Vr1 is a standard carbon track 100k log pot Anti-log or linear pots will work OK.

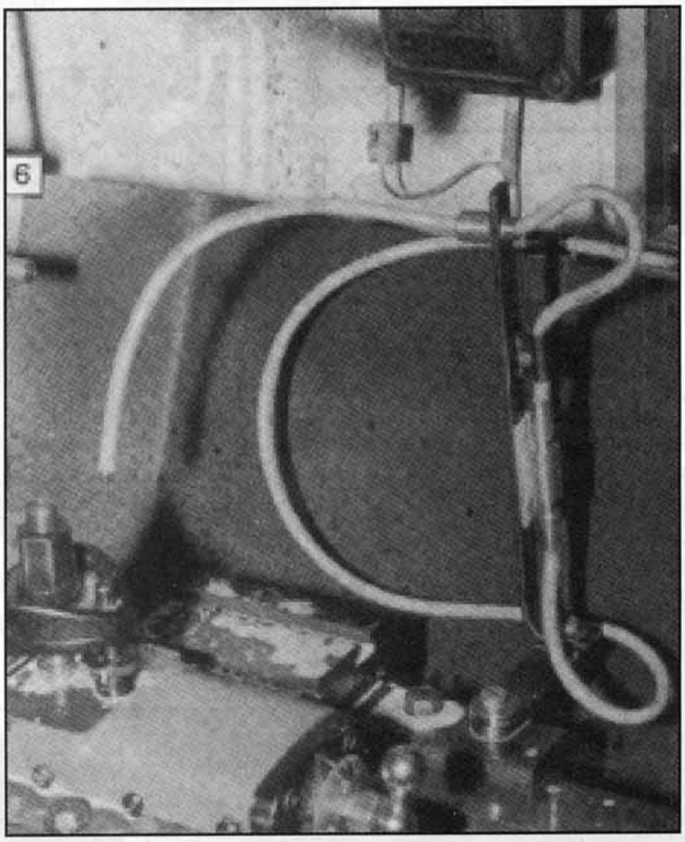
The indicator lamp is optional but is useful and looks nice when lit.

R4 is selected according to the voltage/wattage of the lamp. A LED indicator could of course be used with a suitable series resistor. Due to the small number of components used it is not necessary to use a circuit board, the components can be strung between their own tags and soldered, Vr1 - Vr2 - S1 have three tags each and the terminal strip T1 provides 7 more anchor points.

No fuse is shown but a line fuse of 5 amps rating should be included in the +12 volt line especially if the supply if drawn from a car battery.

If a mains powered 12 volts supply is used make sure the output fuse is not rated too high. ●

Model Engineer 168 74 (1992)



6: The hose is kept in position by a length of welding wire. Note the "No volt" release switch on the wall.

Sine Bar.

A Sine bar is not everybody's cup of tea! It is a most useful device for determining tapers accurately and the concept is simple. Ives' article describes a model which is 5 in. long (a most useful size), with a good provision for holding down. The concept is well presented. Lamma's more expansive treatise on a larger sine table should find good following among those with milling machines. It does save space in a machine of restricted headroom, as the tapered bed comes down very close to the machine table.

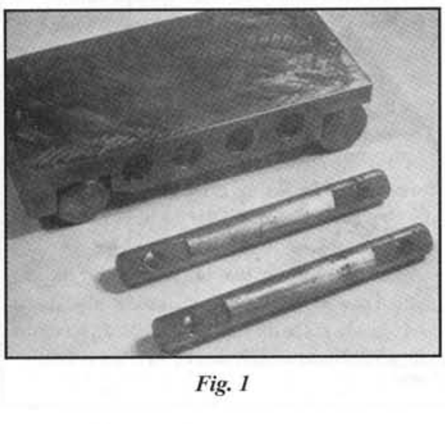


Fig. 1

A SINE BAR FOR THE MILLING MACHINE

by E H Ives

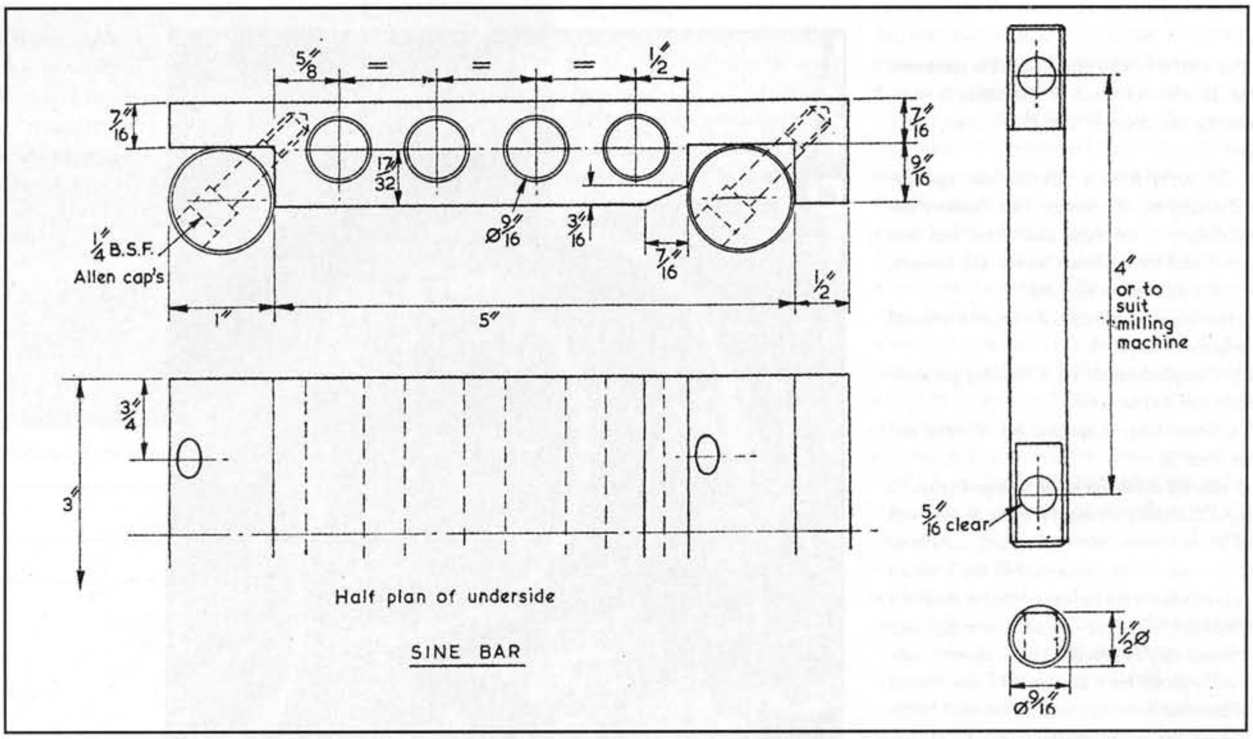
THIS WAS THE OUTCOME. of one of those "impossible" jobs we model engineers get asked to do. "Can you cut a bevel gear similar to the one I have to run on the other end of the same shaft and match with the same crown wheel but with two less teeth?" said a friend.

First reaction was to say "No!" but later I promised to see what I could do. A search through my M.E. card index revealed an article by R. S. Minchin in November 1964 and another by D. J. Unwin in October 1971 and armed with these and a pocket calculator, I spent an evening proving that it was just possible if I used the upper limit of the face width for the new bevel. I am able to borrow a dividing head for my lathe, but not for the milling machine, so I had the problem of fixing this to the mill and inclining it to 13 deg. 48 min., the calculated angle. Obviously, I thought, a sine bar is needed. Again recourse was made to the M.E. Index but this time it only revealed one general article on the subject so I had to set to and design one to suit my equipment, although with very little modification it should suit most machines. The result is shown in Fig. 1.

Basically the tool consists of a platform or bar to which are fixed two rollers exactly 5 in. apart. Multiplying the sine of the required angle by 5 gives the height of the packing needed under one of the rollers to produce that angle. The cross-drilled holes take special clamping pins to hold the device to the machine table.

A piece of 3 in. x 1 in. mild steel 6½ in. long is required for the platform and this should be carefully marked out for the clamping holes. Not trusting the drilling machine to drill squarely through the bar, it was set up on the lathe cross-slide and drilled from the chuck using a vee pad in the tail stock to provide the push (Fig. 2). Lightly chamfer the corners of the holes.

The next job is the clamping pins as these are required to hold the bar to the milling machine table for later operations. An odd piece of shafting which happened to be the right diameter provided the material for me but you may have to turn them from ⅝ in. rod. The ends are cross drilled to suit the slots in the machine table and to take my standard set of 5/16 in. BSF studs which, with various tee nuts fit both the lathe and



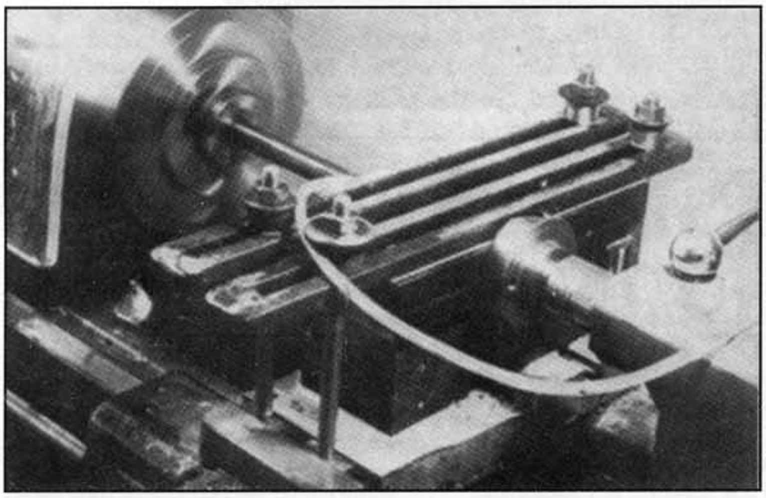


Fig. 2

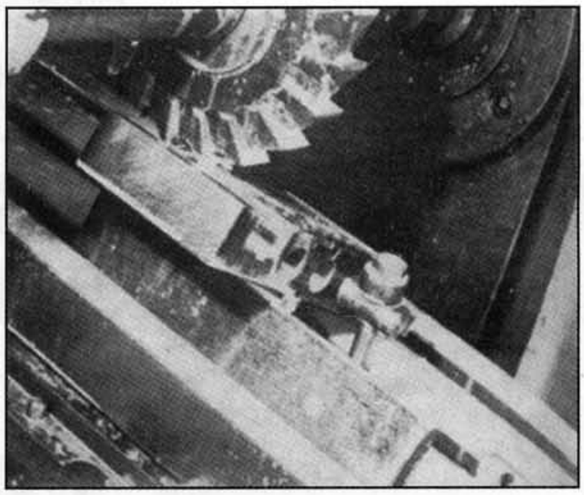


Fig. 3

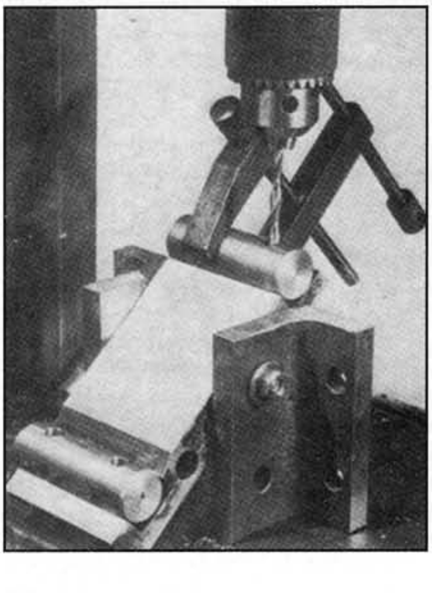


Fig: 4.

the mill. A small flat is milled on each end to seat the nuts.

As my piece of mild steel was slightly bruised on the surfaces, I cleaned these up by flycutting a few thou off both sides before setting the work crossways on the mill and clocking it square. The 5 in. distance between the shoulders for the rollers needs to be spot on otherwise one gets awkward figures to multiply. By removing the swarf guard from the mill I found that with a ¼ in. side and face cutter I could just get enough cross movement on the table to be able to use the index on the slide to measure this at one go. Even so I found the shoulders to be 0.004 in. too long when measured with a dial calliper gauge and so had to add this amount of shimstock. Take note of the vertical height index reading to keep the grooves to exactly the same depth.

The 7/16 in. x 3/16 in. chamfer to the right hand groove in **Fig. 1** is needed when the sine bar is used in the near vertical position so that the packing can clear the underside of the bar. To cut this, a strip of metal is placed in one of the machine slots under the end of the bar to tilt it as below.

Part off the rollers form 1 in. dia. mild steel bar, face and chamfer the ends and cross drill them for the ¼ in BSF Allen cap screws. If you use screws only 1 in. long the counterbores will have to be slightly deeper than shown. Drilling through these into the bar itself may be a problem. I used the set-up shown in Fig. 4. The home-made angle plates that normally serve as a machine vice on the mill were used to set the work to the correct angle. Set the depth stop so that the drill does not quite go through. Tap the holes and bolt the parts together.

The height of the sine bar can now be checked using a dial test indicator on the surface plate. Mine was 0.002 in. out so the surface was again flycut on the mill which corrected it. A scraper was then worked over the surface to frost it. It would have been nice to have had the whole thing hardened and ground, but the limited use to which it is going to be put makes this seem unnecessary.

Cutting the bevel gear (Fig 5), following the instructions in M.E., proved surprisingly easy and only took about half an hour compared with the fortnight of spare time preparing to cut it! The bevel meshed with the crown wheel and the whole assembly (Fig. 6) runs sweetly. Now, while I am in the bevel gear cutting mood, I am preparing the blanks and cutters for the compensating gear on my model Ransomes Sims and Jefferies traction engine so the sine bar will be needed again.●

Model Engineer 142 1093 (1976)

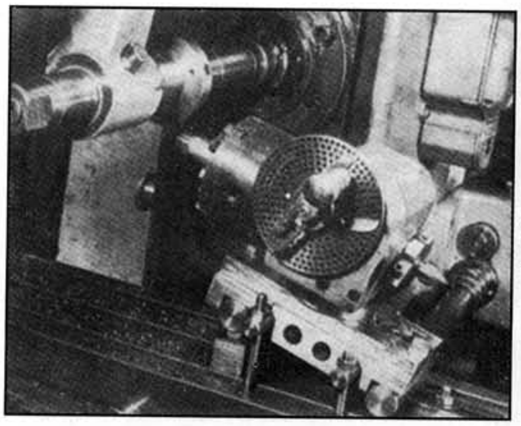


Fig. 5

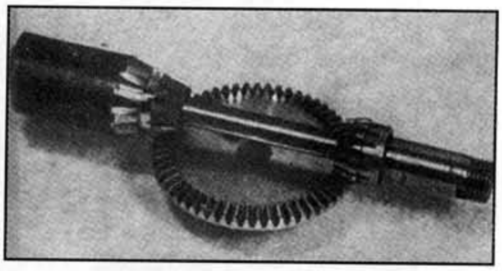


Fig. 6

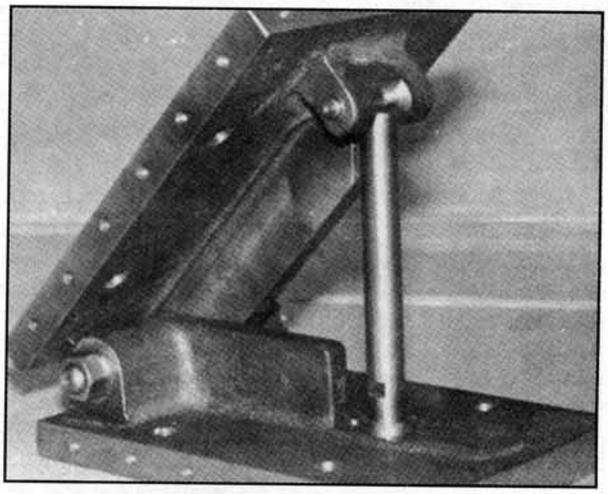
SINE TABLE

A VERSATILE ADDITION TO THE MILLING MACHINE DESCRIBED BY DAVE LAMMAS

From time to time the model engineer is faced with the problem of cutting precise angles on a workpiece. His approach to a task of this nature depends very much upon the equipment available in the workshop.

When facilities are very limited it becomes a question of filing and checking, cross-checking and rechecking-trial and error with a result that can often be less than satisfactory. Even when a horizontal or vertical milling machine is purchased, angular work is usually set in the machine vice and aligned by methods of dubious accuracy. If an adjustable angle plate also forms part of the equipment it is soon realised that a Vernier protractor is required if one is to work to limits closer than the odd degree or so. Such an instrument can cost around £100 and setting work to it can demand two pairs of hands in some instances.

Under these circumstances



1. a view of the finished table

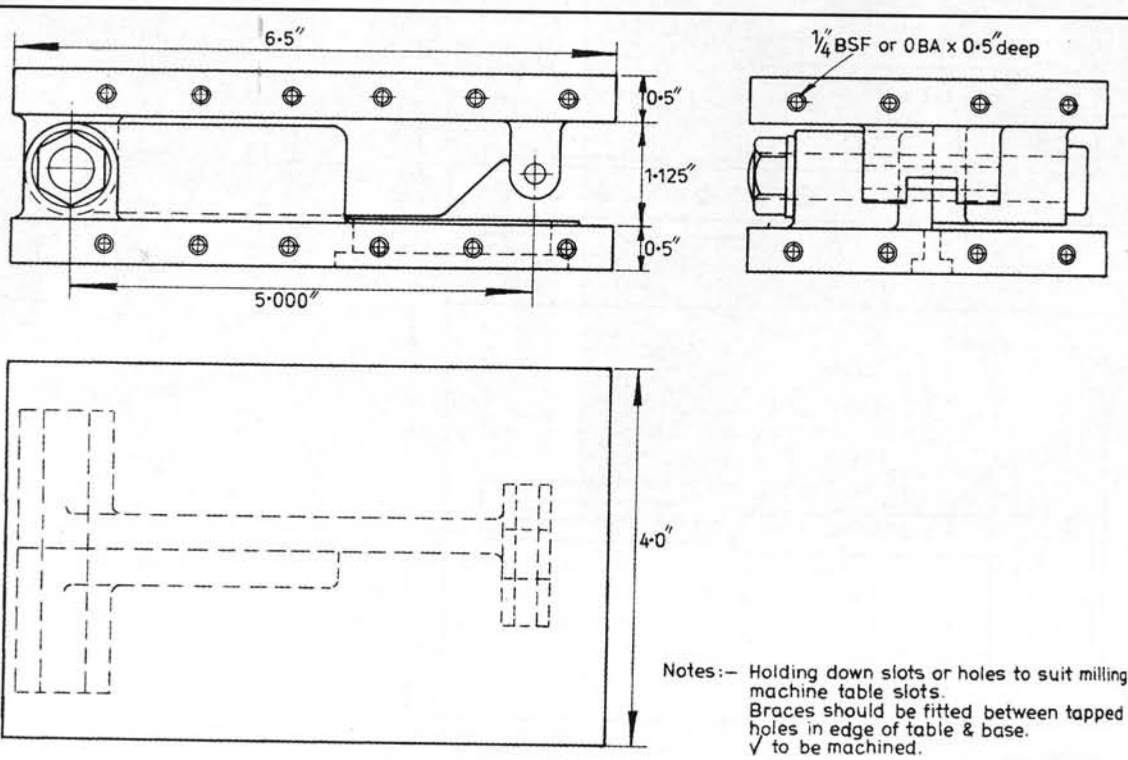


Fig. 1 SINE TABLE, GENERAL ARRANGEMENT: cast iron
Note Bolt & Nut EN8 Steel

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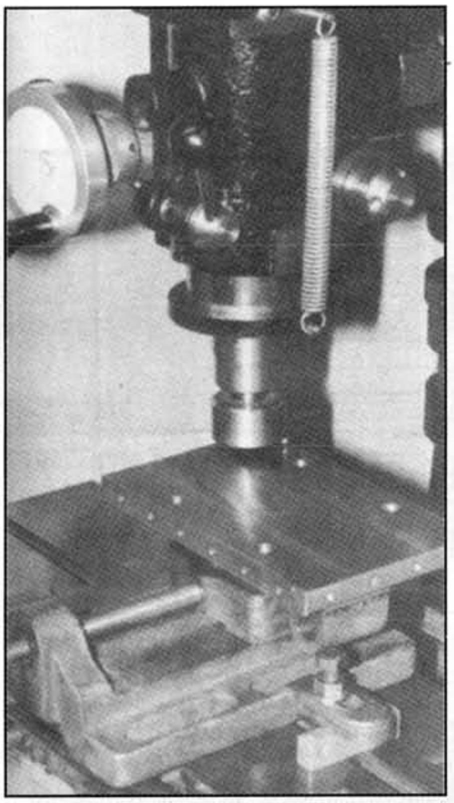


Flycutting the sine table base on the vertical milling machine.

that would one give for a device that would enable the required angle to be precision set almost with one's eyes shut and for a very modest cost as well. When it is found that such a highly desirable article can be machined on the milling machine itself then we are truly in clover. The device to be described has been designed specifically for easy machining mainly by cheap readily sharpened fly-cutters.

The setting bars which guarantee the correct angle are easily made and measured using the lathe. Furthermore it is constructed from two solid iron castings to ensure rigidity under the stress of normal milling operations. Bolt holes or slots can be arranged to suit any pattern of milling table, with similar scope for work holding.

General Arrangement Fig. 1

Figure 1 shows the general arrangement of the Sine Table, it will be seen that it consists of a base to which is pivoted, by a substantial bolt, the table itself. Attached to the table on the same centre-line as the pivot bolt is a setting pin, the height of which from the base determines the angle of the table. The slot in the base directly below the setting pin accommodates a bolt to hold the length bar upright under the pin. The length bar remains clamped in place during cutting, thereby giving additional support. Braces may also be attached between table and base using holes tapped in their edges. These tapped holes serve to secure stop plates, alignment aids or clamping surfaces as required. Since the table surface will be machined after assembling to the base, parallelism is automatically attained. The large central web on both base and table help alignment as well as giving support.

The Base Fig. 2

After removing any remaining flash or obvious protrusions with the grinder or files the base casting should be set up upside down on the milling table. Either hold it by the web in the machine vice if the latter is large and rigid enough or set up on packing. Use machined packing pieces and small screw jacks with a clamp bolt to each. Fly-cut the surface, removing only one bolt at a time and replace it before removing the next one. Set the fly-cutter to sweep as large an area as practicable consistent with cutting speed requirements, power of the machine and clamping arrangements. For a high speed steel cutter having one inch sweep diameter, 200 to 300 revs per minute would be suitable, a Tungsten Carbide tool could run at twice this speed. It is best to take a roughing cut to remove the skin then use a freshly sharpened tool for a finishing cut of about ten thou.

Since it is very desirable that all edges are machined square this operation can be performed without upsetting the clamping arrangements. If end mills are considered expendable, or the means of sharpening them on the periphery is to hand, go ahead and mill all around taking a deep enough cut to get below the casting skin. If not, then the edges may be fly-cut by clamping vertically to an angle plate with the lower edge resting on a parallel or directly on the milling table.

In order to machine the bore an angle plate should be mounted on the milling machine table with the freshly faced surface of the base in contact with it and the long edge horizontal. Use a d.t.i. to set the angle plate parallel to table travel. Again using the fly-cutter, face boss and web surface to a good finish

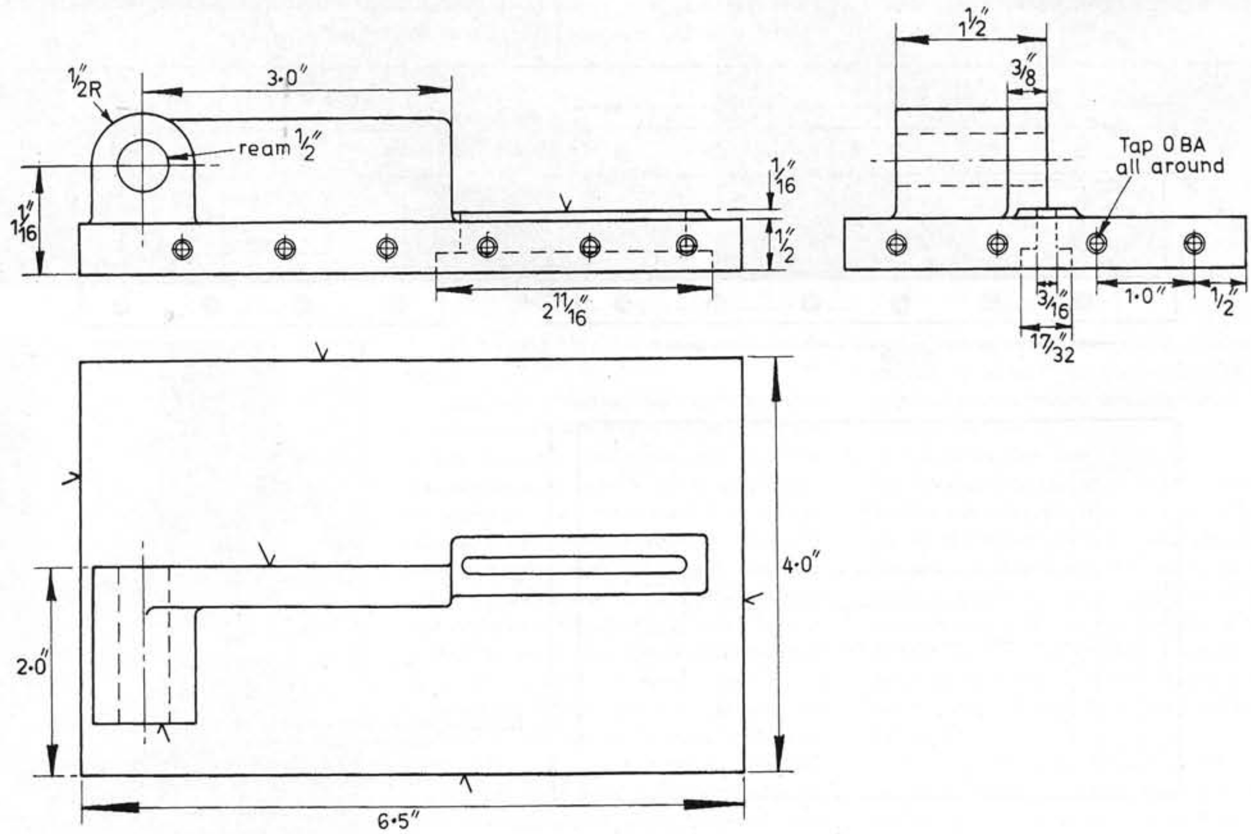


Fig. 2 SINE TABLE FOR MILLING MACHINE

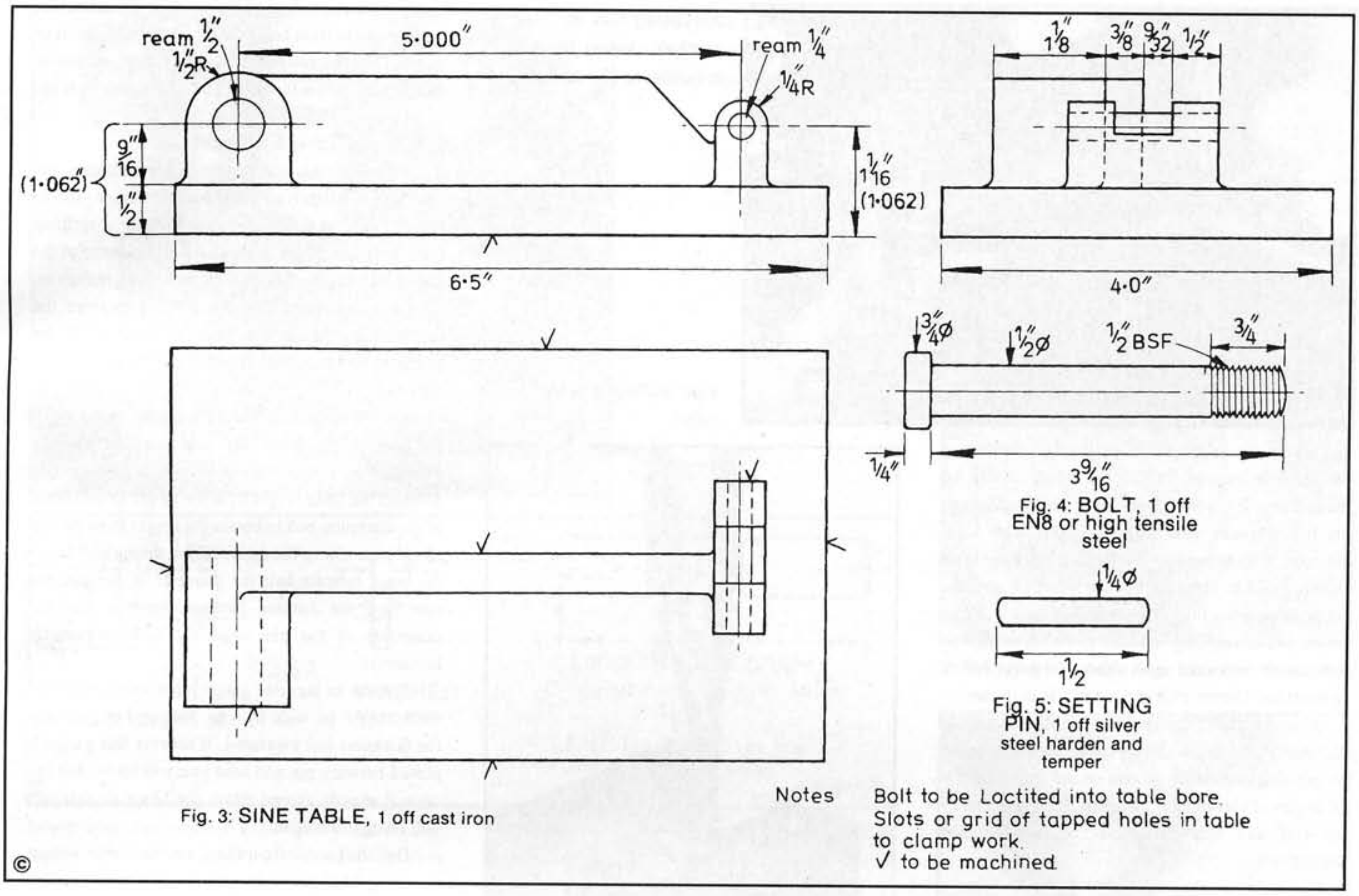


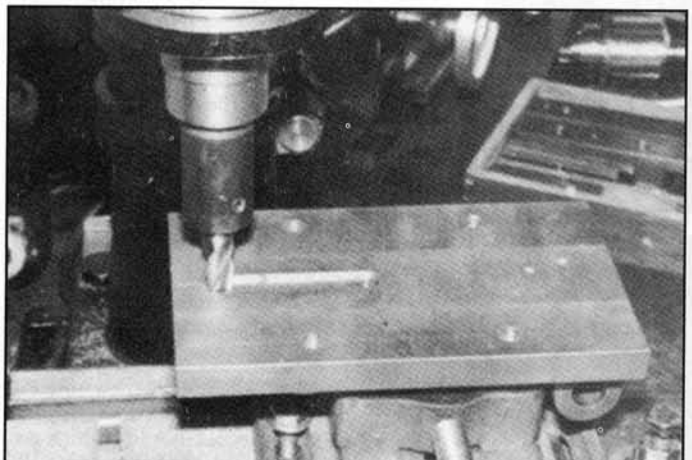
Fig. 4: BOLT, 1 off EN8 or high tensile steel

Fig. 5: SETTING PIN, 1 off silver steel harden and temper

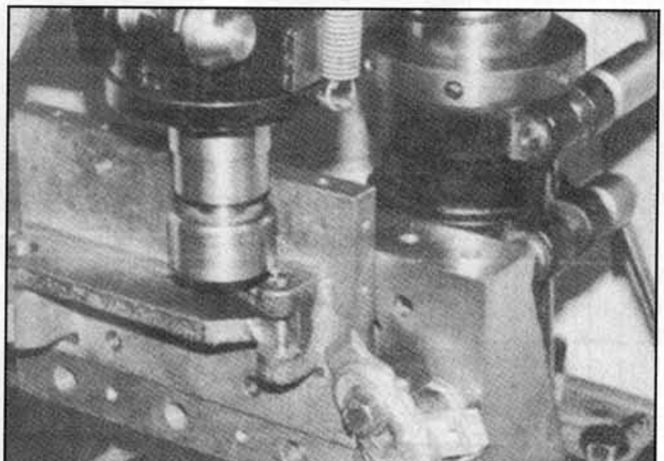
Fig. 3: SINE TABLE, 1 off cast iron

Notes: Bolt to be Loctited into table bore. Slots or grid of tapped holes in table to clamp work. √ to be machined.

Using the vertical milling machine to slot the base.



A very substantial mounting fixture was used to support the casting whilst the table web was flycut.



before marking out the centre of the bore, checking that the table casting boss will have about one sixteenth of an inch clearance on completion.

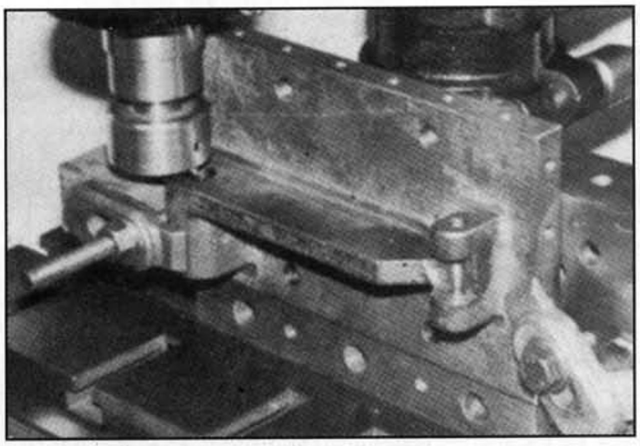
Holding a sticky pin or pointed rod in the chuck, centre the miller spindle over the centre-pop by manipulation of table and cross feed handles. Centre and drill through ⅜ or 7/16 in. diameter, use a boring head to enlarge the hole to some 5 to 10 thou below nominal size, then ream ½ inch. If a reverse spotfacing cutter forms part of your equipment the lower face of the boss may be dealt with at the same setting. Otherwise a normal spotface cutter, or large pin drill, can be used at a later stage.

The tapped holes around the edges may also be completed whilst set up, or the drilling machine be employed if preferred.

The next job is to mark out holes or slots to coincide with the milling machine table slots and also to mark the slot for the length bar bolt. The centre-line of this slot must be a continuation of the machined web surface, place the rule in contact with the latter and scribe along it. Fly-cut the slot facing before slotting. Afterwards invert the base to mill the recess for the bolt head.

The Table Fig. 3

After dressing any obvious imperfections, clamp the casting to the angle plate mounted on the milling table as before. Face web and boss and also the end of the smaller cross rib. Mark out the centres for bolt



Flycuttng was the method chosen for machining the table leg.

and setting pin as accurately as possible, centre-pop for the bolt but not for the pin which should be marked only by cross-lines. Centre the spindle over the bolt position then drill, bore and ream ½ in diameter. With the cross feed locked, index the table exactly 5.000 in. checking that the spindle is over the pin position cross-lines. This guards against indexing errors, if a discrepancy is found run back to the bolt bore, insert the reamer again or a turned gauge before re-indexing. Centre, drill and ream ¼ in diameter.

Clamp the table upside down to mill away part of the small cross rib which will allow the setting pin to be exposed sufficiently to rest on the length bars at all angles of elevation of the table. See Figs. 3 and 9 for end and side elevations of this cutaway respectively.

Clamping Bolt Fig. 4

Since this bolt needs to be tightened well if rigidity of the table is to be maintained, it ought to be made of something better than mild steel. A medium carbon steel such as EN8 or one of the high tensile steels would be suitable to obviate deformation of the threads.

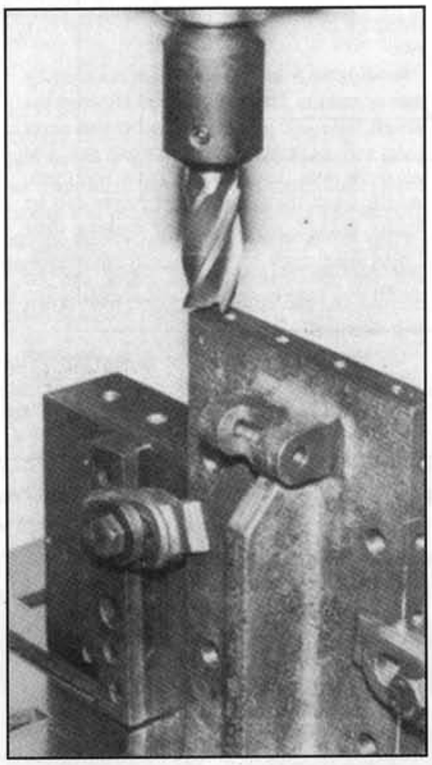
Start with a 4 in. length of ¾ in. dia. material by centring one end. Holding the other end in the chuck, provide tailstock support and turn to a close fit in the reamed holes with, if possible, a fine polished surface. Screwcut the end ½ in. BSF for ¾ in. length, being careful to grind the tool to correct angle and set it square to the axis of the work. It is probably the best policy to make the nut first, also from EN8 using it as a gauge for the bolt thread. They should fit freely but without any slackness. Reverse in the chuck to part off and face the head.

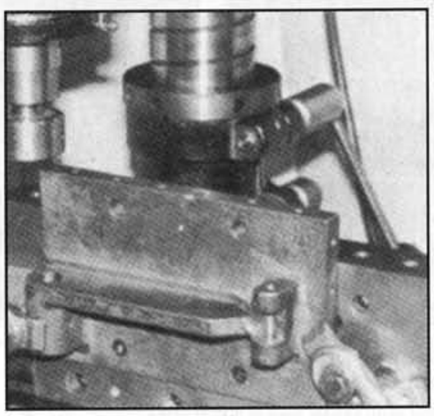
Assemble the bolt into the table casting using high strength retainer grade of Loctite (638) or similar material, wipe away any surplus from bolt shank or boss, place a faced off length of 9/16 in. bore pipe over the bolt then clamp up tight with washer and nut before the liquid sets. This procedure ensures that the bolt head takes the axial load whilst the Loctite prevents rotation.

Setting Pin Fig. 5

The setting pin is a 1½ in length of ¼ in. dia. silver steel. Face the ends with a light chamfer before hardening and tempering to very pale straw colour. To carry out this operation wrap several turns of steel wire around the pin, bending the end underneath so

End milling a table edge.





The long edges of the table were machined by flycutting.

that the pin cannot fall out. Leave a foot of wire extending vertically as a handle and bring the pin to an even cherry redness in the gas torch flame. Quickly lower it into a tin of cutting oil and water emulsion, moving it up and down until cold. Very lightly polish with fine abrasive, place on a sandbath heating gently from below until a light golden colour is seen. Tip the pin into cold water, dry and polish then Loctite it into the small end of the table casting.

Machining Table Surface

Assemble table and base as in Fig. 1, tighten the clamping bolt lightly so that the table becomes stiff to move. Place on a surface plate and use a scribing block or height gauge to check when the centre of the clamping bolt and the centre of the setting pin are on the same horizontal line. To do this measure the height from the surface plate to the top of the clamping bolt head then subtract half the diameter of the head.

Next measure from the surface plate to the top of the slot in the base (this distance can also be measured by micrometer or Vernier calliper gauge). Subtract the latter height from the height to the centre of the clamping bolt to obtain the height from the top of the base slot to the centre of the setting pin. From the latter subtract half the diameter of the pin, we now have the distance between the base and the underside of the pin when the table is exactly horizontal.

Prepare an accurate gauge piece from mild steel measuring ½ in. wide by 1 in. long and of precisely the thickness just measured. Whenever this gauge is placed between pin and base you will know that the table is exactly zeroed. Mark the block so that you will recognise it again.

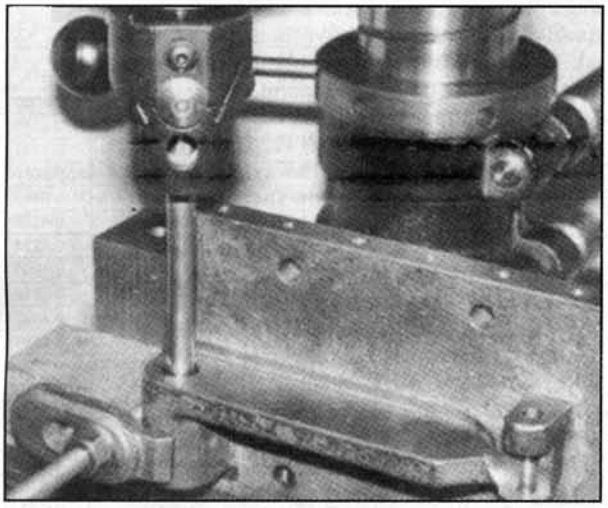
Bolt the base to the milling machine table, setting one long edge parallel to table travel using a d.t.i. Lower the sine table so that the setting pin rests firmly on the gauge block then fully tighten the clamping nut. Additional support can be given if a large "G" cramp is used horizontally to clamp the two central webs together. The table top and edges may now be fly-cut and end milled as for the base casting. Work to the same dimensions as the base.

If using the milling machine for drilling it would be as well to mark out and drill the table if tapped holes are to be employed to take workholding studs. Check that such holes or slots are clear of bosses and ribs. The final operation on the table is to drill and tap the holes around the edges.

Length Bar Bolt and Washer

Centre a length of ½ in. square mild steel in the 4-jaw chuck, turn down a ⅝ in. length to 3/16 in. dia., thread 2 BA for ⅜ in. length then round the end to give 11/32 in. length of thread. Part off to leave the square head 9/32 in. thick (Figs. 6 and 7).

The washer should be made from ⅝ in. dia. silver steel. Face the end, chamfer lightly, centre and drill 3/16 in. diameter. Although the nominal thickness of the washer is 1/8 in. its actual precise thickness will depend on the measurement you obtained between the setting pin and the base. If you have mislaid or forgotten the dimension don't panic, just measure with a micrometer and setting block which you remembered to put in a safe place! Subtract 0.25 in. from the micrometer reading to get the exact washer thickness, then part off and face to that size. To get the faces parallel place a ¾ in. dia. stub of brass or steel in the chuck, turn down to 3/16 in. dia. for ⅛ in.



Boring the table pivot hole, using a boring head on the milling machine.

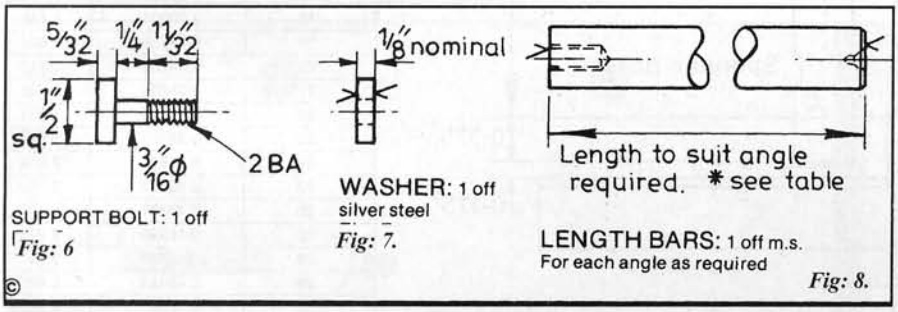


Fig: 6 *Fig: 7.* *Fig: 8.*

length with sharp corner and a true shoulder. Use superglue to fix the washer to the mandrel after first lightly countersinking the hole. Press the washer firmly and squarely onto the shoulder whilst the glue sets. Take very light facing cuts, using the topslide dial to measure progress. Remove mandrel from chuck, heat to remove the washer which is then hardened and tempered as for the setting pin.

Length Bars (Fig. 8)

A different length bar is required for each angle that has to be set. It is not necessary to make up a complete set of bars for every possible angle (which could run into hundreds). They are so easy to make that one can be turned as each job arises.

However, when made they can be marked with the angle and retained for future use.

The method of calculating the length will be dealt with later, for the moment we shall just consider the method of manufacture. A length of ½ in. dia. mild steel bar is faced at one end, centred, drilled and tapped 2 BA for a depth of ⅜ inch. The other end is also faced off and centred to avoid the possibility of a pip at the centre giving a false reading. This end is then carefully faced away until the exact calculated length is obtained.

An accuracy of one thou or better is readily machined. The length may be checked in several ways depending on the facilities available. The simplest measurement is by means of a Vernier calliper gauge, the maximum length of bar needed for the largest angle is under four inches. If a set of micrometers up to four inches is possessed, measurement is again simple. If neither of these is to hand the lathe itself can be utilised as a measuring device, particularly when the leadscrew is fitted with a graduated handwheel. Otherwise the cross slide or topslide index collars, with suitable stops, can be pressed into service. One should never be stuck for accurate measurements of considerable length when the workshop contains a lathe.

Calculation of Length Bar Dimensions

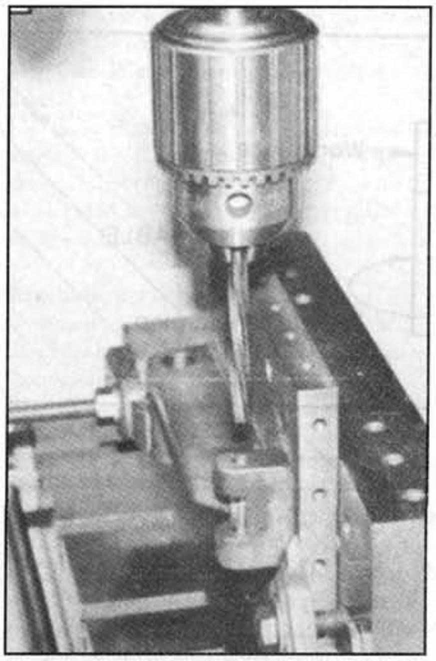
Reference to Figure 9 will reveal the presence of a triangle formed by the points A, B and C. The length of the hypotenuse AB is constant at exactly 5.000 in whatever the angle of the table. As the angle is altered the dimension of the side BC changes-it is this changing height that we use to set the angle. The distance AC also changes but does not enter into the calculation, the presence of the slot in the base allows for this change.

A table is provided for length bars to suit all whole number angles from 1 to 45 degrees. However, if fractional degree angles are required a simple calculation is needed if excessively detailed tables are to be avoided.

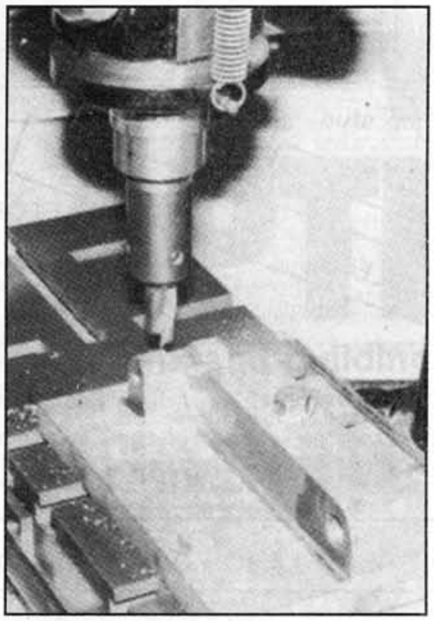
It will be seen that the length BC is measured from the centre of the setting pin but the length of the height bar is measured from the circumference of the pin. The radius of the pin must therefore be subtracted from the height BC, i.e. BC minus 0.125 inch.

At the same time the length bar is longer than BC by 0.375 in. at the lower end, so 0.375 must be added to the length BC. Subtracting 0.125 in. and adding 0.375 in. is obviously the same as just adding 0.250 in. to the length BC. This is the reason why we so carefully made the washer to leave exactly 0.250 in. between the base and the setting pin. 0.250 is an easy number to remember and add.

The relationship between an angle of a right angled triangle, its hypotenuse and the side opposite the changing angle is given by:



9. Reaming the table lug. Note the rigid set-up.



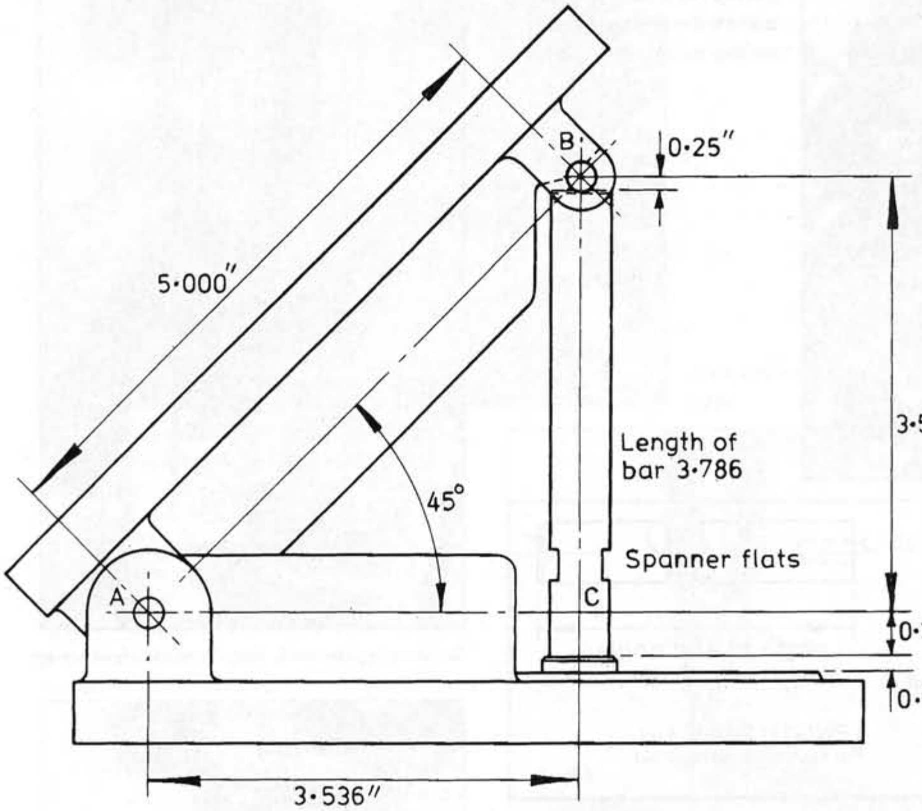
10. Relieving the table lug by use of a slot drill.

$$\text{Sine of angle} = \frac{\text{opposite side}}{\text{hypotenuse}}$$

written for short as: $\sin A = \frac{BC}{AB}$

The Sine of an angle is merely this ratio of two of the sides of a right angled triangle.

Any mechanics or engineers pocket book will be found to contain tables of sines for all angles. If it is desired to set the device to an angle of say 20 deg 20 min, just look up the sine of that angle-it is found from the table of natural sines to be 0.34748 -



SINE TABLE FOR MILLING MACHINE Fig. 9

Example

$\sin 45° = \frac{BC}{AB}$ Sin 45° = 0.7071 from table

$0.7071 = \frac{BC}{5}$ ∴ BC = 5 × 0.7071 ∴ BC = 3.5355

Diameter of pin at B = ¼ & radius of pin = 0.125 to be subtracted from BC, also height from washer to point C = 0.375 to be added to BC.
For any angle find height BC from table & add 0.250 to it for length of bar.

Angle degrees	Sine	Height BC
0	0.00000	0.0000
1	0.01745	0.0873
2	0.03489	0.1745
3	0.05233	0.2617
4	0.06975	0.3488
5	0.08715	0.4358
6	0.10452	0.5226
7	0.12186	0.6093
8	0.13917	0.6959
9	0.15643	0.7822
10	0.17364	0.8682
11	0.19080	0.954
12	0.20791	1.040
13	0.22495	1.125
14	0.24192	1.210
15	0.25881	1.294
16	0.27563	1.378
17	0.29237	1.462
18	0.30901	1.545
19	0.32556	1.628
20	0.34202	1.710
21	0.35836	1.792
22	0.37460	1.873
23	0.39073	1.954
24	0.40673	2.034
25	0.42261	2.113
26	0.43837	2.192
27	0.45399	2.270
28	0.46947	2.347
29	0.48481	2.426
30	0.5000	2.500
31	0.51503	2.573
32	0.52991	2.650
33	0.54463	2.723
34	0.55919	2.796
35	0.57357	2.868
36	0.58778	2.939
37	0.60181	3.009
38	0.61566	3.078
39	0.62932	3.147
40	0.64278	3.214
41	0.65605	3.280
42	0.66913	3.346
43	0.68199	3.410
44	0.69465	3.473
45	0.70710	3.536

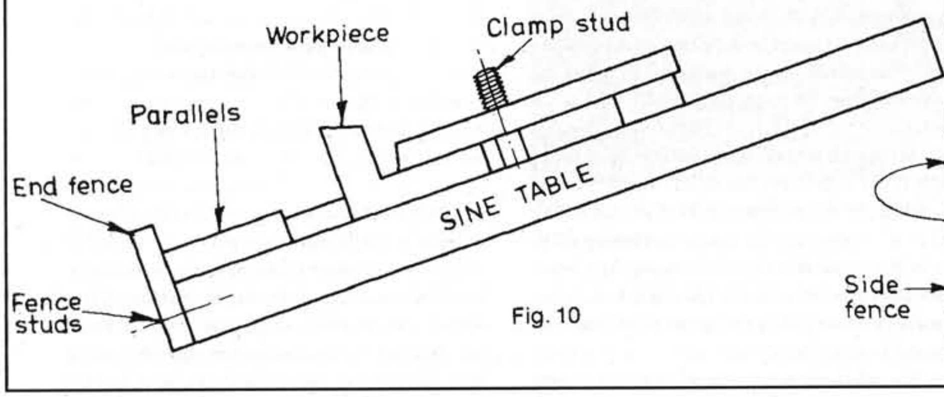
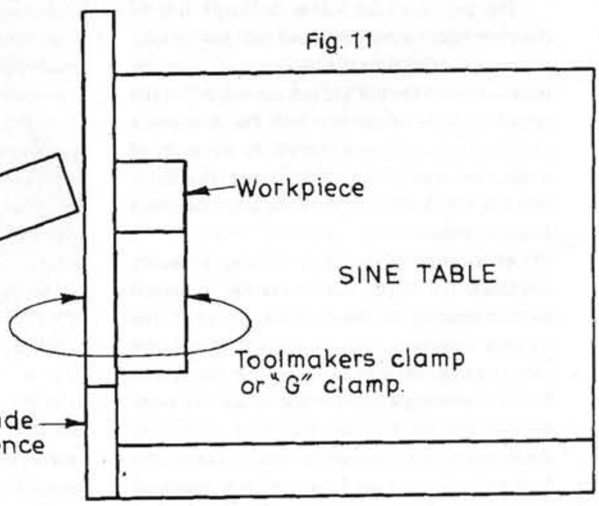


Fig. 10

Fig. 11



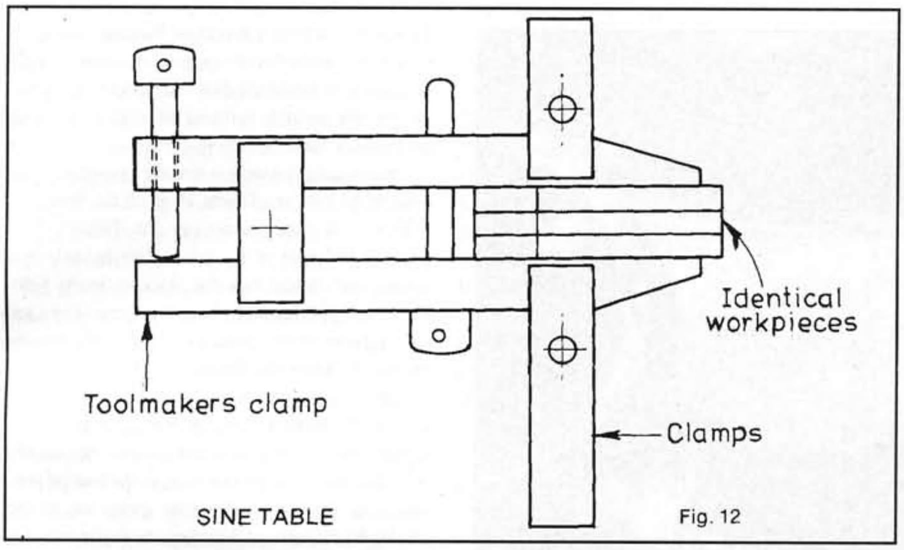
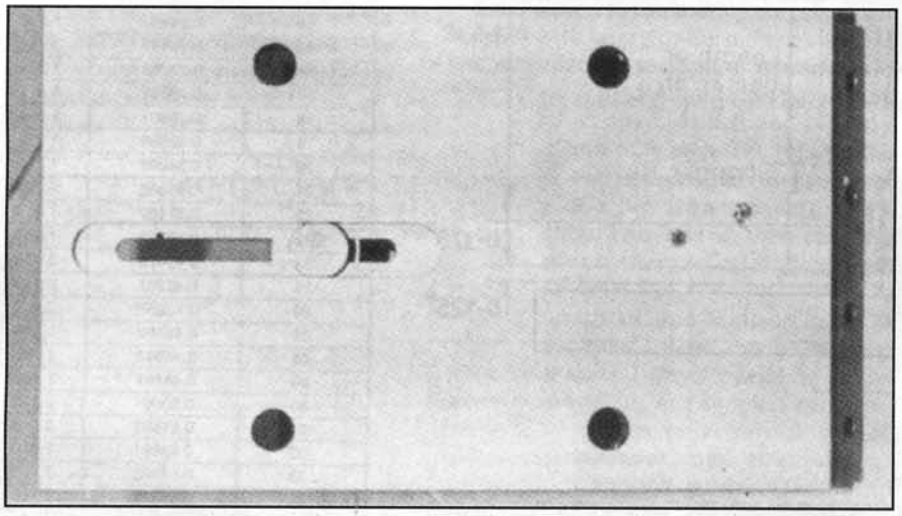


Fig. 12



multiply by 5.000, which gives 1.73740, and then add 0.250. 1.7374 plus 0.250 = 1.9874 this is the length of the bar, in inches, for an angle of 20 deg 20 minutes.

Make a photocopy of the table I have given for the height BC in one degree increments from 0 to 45 degrees, varnish the paper then glue it inside the lid of the box of accessories you will wish to make for the Sine Table.

Applications and Use

Figures 10, 11 and 12 illustrate ways in which the Sine Table may be used to machine angular faces on components, together with alternative workholding arrangements. It is worth making side and end fences of various widths. One use for such a fence, not shown, is to clamp sheet metal components outside the table when it will be found that quite large pieces can be dealt with. Long bars may also be clamped to the table so that they overhang the bench when an angled surface is required at the end.

If a small angle plate is bolted at an angle across the Sine Table, compound angles may be machined although the mathematics of calculating each angle involved becomes more complicated. ●

Model Engineer 159 600 (1987)

An underside view of the completed table.

Lathe Saddle Stop

This extract demonstrates a clear improvement of the breed by evolution over the ages. It is one thing to stop the saddle in its path, but a wholly different one to do so safely and automatically. This is by no means a simple subject and the description runs to 16 pages, so I Have had to edit it severely, leaving only the drawings and first few pages of text to whet your appetite.

POWER TRAVERSE RELEASE MECHANISM

FETTLER DESCRIBES AN IMPROVED VERSION OF THE SIX-POSITION SADDLE STOP FOR THE MYFORD, ORIGINALLY PRESENTED BY J. A. RADFORD IN 1970

How it works

The modified mechanism works this way: power traverse is engaged as usual by depressing the Cam Lever, but the Cam is held in the engaged position (by the Sprag on its face engaging the sprung Detent in the Guide Block to its right). It can't be lifted out of engagement until mechanically tripped.

As the Saddle traverses leftwards under power, the Trigger (on coming into contact with a Stop on the Radford bar) is moved to the right and rotates the Rocker (the piece with the slots at each end) which, in turn, withdraws the Detent against its spring. The Detent thereby frees the Sprag, so allowing the Cam to flick into the 'half-nuts disengaged' position under the influence of the strong spring on its left. Study the photographs for a few moments and you'll soon get the idea. The only strain on anything is that exerted by the springs within the mechanism.

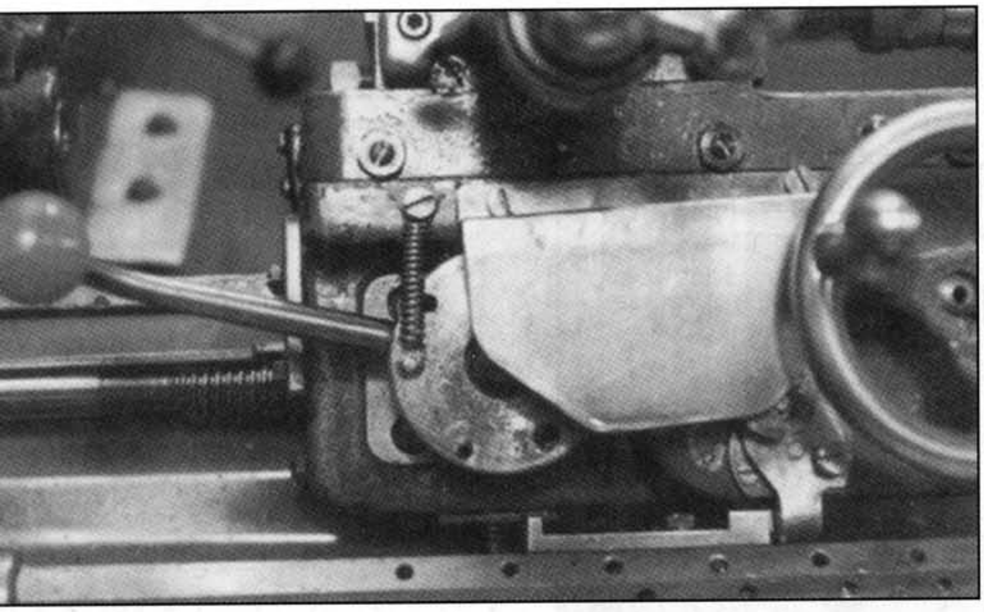
Further points

Again looking at the photos, the surplus holes in the Cam were drilled during the experimental phase, they have no secret significance! The Sprag and Detent are case hardened but the Trigger and Rocker are not. Detent movement is limited by two brass screws just visible at either end of the Guide Block and, when in engagement, the Detent overlaps the Sprag by about 3/32 inch. To prevent swarf entrapment, the whole was covered by a metal shield - that's what the two 'empty' holes are for towards the top of the Saddle Apron.

Disadvantages

It would be less than honest of me to say that the mechanism, although reliable and efficient, had no disadvantages—it had.

The first, and most obvious one, was the inability to disengage the mechanism, once set, by means other than the Trigger. This was to cause me more than one wave of panic until I learned to stop the lathe rather than exert useless energy trying to lift the Cam Lever!

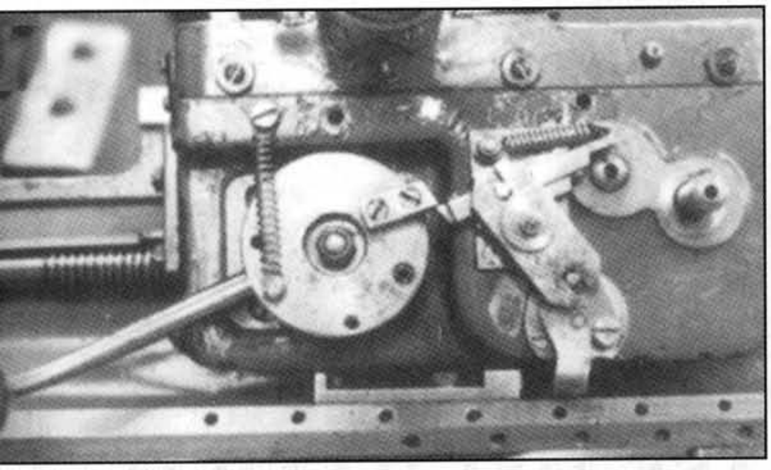


The mechanism ready for use and with cover fitted. A stop can be clearly seen on the Radford Bar below the Apron.

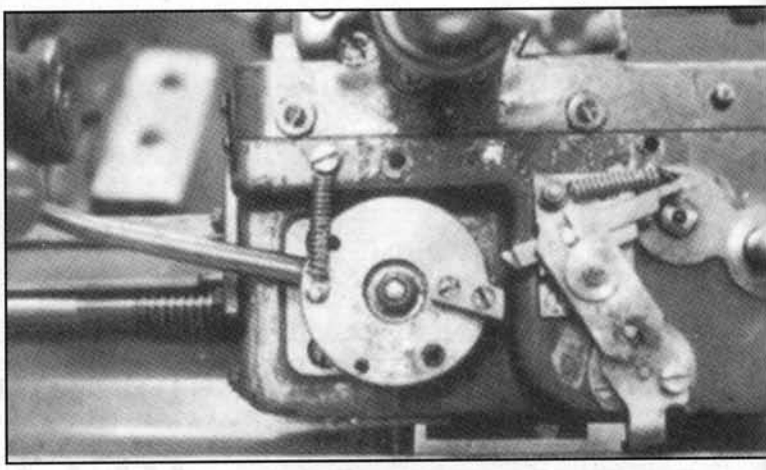
Then it was simply a matter of flicking the trigger back with a screwdriver—okay if you know, but my father had not long since died and hadn't told me that bit. He was probably splitting his sides laughing at me from his Astro-workshop!

When using power traverse for one-offs it was possible to hold the Detent clear of the Sprag by tightening a slotted screw in the Trigger. This engaged a dimple in the pivot plate behind, thus holding the Detent (via the Rocker) in its fully withdrawn position away from the Sprag. Even so, the Trigger could still contact a stop (causing obvious problems) unless the Radford bar was rotated to present a clear face. Also, in this mode, the Cam Lever had to be held in engagement against its return spring when taking a cut under power —not exactly good fun with hot swarf dropping on the back of your hand! Yes, you could unhook the spring but, on the whole, the business of disabling the mechanism for one-offs was inconvenient though undoubtedly the attachment was great for production work.

Surely, I thought, there must be room for further improvement so that I could use it for (say) screwcutting one-offs and turning and screwcutting small batches as when loco building, and yet be able instantly to disable it so as to use— without affecting in any way— the lathe's capacity for ordinary work. This presented itself as both challenge and goal which had to wait until my own retirement.



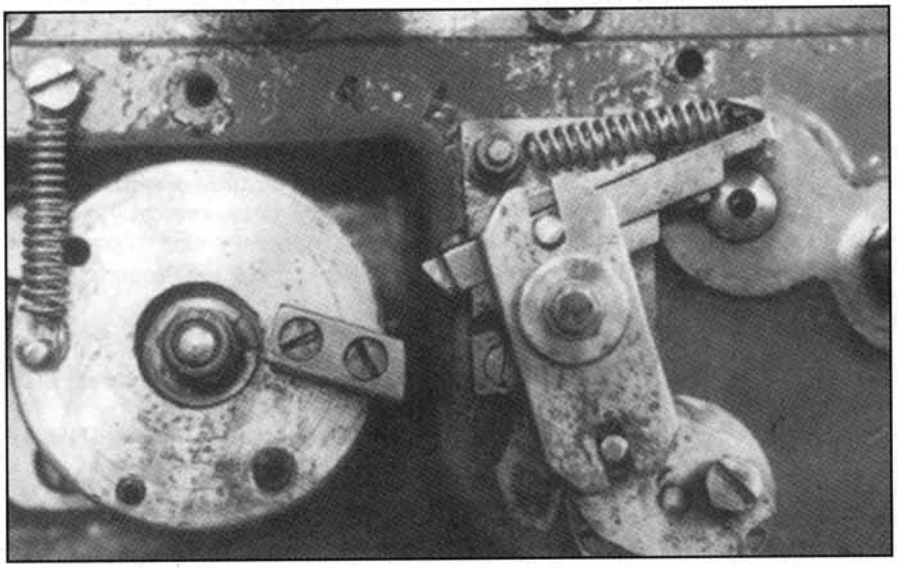
2: With the cam lever depressed, the Detent engages the Sprag, keeping the half-nuts engaged. The saddle now moves left under power until the trigger contacts the Stop and the Radford bar.



3: The trigger has contacted the Stop and withdrawn the Detent This has freed the sprag, released the Half-Nuts and stopped the saddle.

Developments

Things seldom work out as one expects, and an opportunity arose for me to exchange my father's old (and by then very worn) lathe for a new Super 7B with power cross feed built in. I stripped off those attachments I wanted to keep, including the Radford bar, and left the outrigger cross feed for the new owner. The new lathe—it has a long bed too— (well,



4: The Detent is held in the disabled position because the Trigger Screw has been tightened. The Cam lever now operates normally, although still under the influence of the spring on the left.

all tall people like long beds, don't they?) was installed and set up for use.

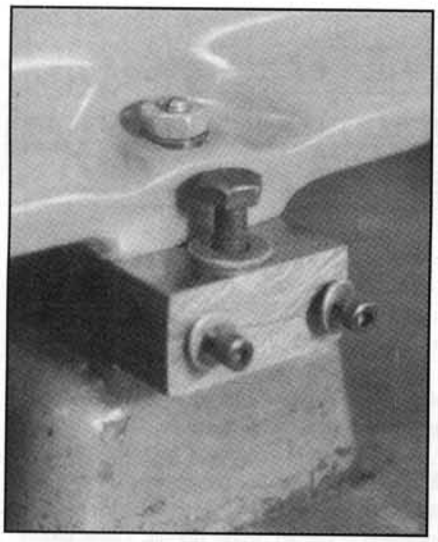
I quickly came to realise that Jim Radford's arrangement can't be fitted directly to the later versions of Myford Super 7 lathe. The Apron is totally different, and the critical measurements between its lower edge and the lathe holding down bolts are such that a degree of adaptation and re-design was called for.

Using the existing Radford bar and the photos that accompany this article I set about the task of further developing the system.

Other Lathes

My advice to those readers with earlier Super 7s, and who wish to copy this idea, is to wait until the end of my description rather than forge ahead using these pictures alone. After all, they really show a prototype. Have a little patience, and then you'll have enough 'gen' to be able to 'back modify' a much improved version.

NEW STOP BAR & RAISING BARS



1: One of the new raising bars ready to accept the stop bar mountings.

When considering how best to fit the Radford bar in correct relationship to the Saddle apron, the idea occurred to me that not everyone would want a six-stop facility. In fact, I had never used all six stops at the same time myself, but with having the Radford bar ready made it was senseless for me not to use it. However, most people I suspect, would probably be satisfied with a two-stop device, and such would be easier to make. I'll give a description of this simpler alternative before going on to describe how to fix either version to the lathe. After that I'll detail the making and fitting of the updated quick-release mechanism. Both versions, as we shall see shortly, are fitted in the same way and have the same alignment. Neither of them will be bolted directly to the lathe.

Don't forget, if you want to make the six-stop Radford bar you should, of course, follow the instructions in Jim Radford's own 1970 articles.

Two position stop bar

This comprises a Bar, three Stops, and two Mounting Brackets. A straight length of ½ in. dia. BMS is required for the bar. The other parts can probably be recycled from material in the scrap box.

Bar

Depending on whether your lathe is the long bed variety, you'll need a piece of ½ in. dia. BMS either 27 in or 36 in long. Turn down one end only to ⅜ in. dia. for ⅜ in. and thread to suit an available nut. You'll need two ⅜ in. bright washers as well.

If you have the facilities, cut a shallow 5/16 in. keyway along the length, starting at 5in. from the threaded end, if not, file a 5/16 in. wide flat instead. Whichever your choice, keep the job neat as it will be in full view. Its purpose is twofold — to help to align the Stops, and to prevent their Clamp Screws from raising burrs which could cause the Stops to jam. A deep keyway is unnecessary, a 50 thou cutter in-feed being enough. That done, the Bar is finished.

Stops

All three must be a comfortable sliding fit on the Bar. Each is cross-drilled and tapped for a Clamp Screw.

The Centre Stop is drilled ⅛ in. dia. to take a ½ in. long silver steel vertical Stop Pin at right angles to the tapped hole. It is also drilled ⅛ in. dia. along its length at the 45 deg. position between the two previous holes. This hole takes a ¾ in. length of ⅛ in. dia. silver (or mild) steel which is radiused at each end and protrudes evenly at both sides. Use Loctite on assembly.

Clamp Screws

Fit a ⅜ in. long x 5/16 in. BSF cap screw to each Outer Stop. The Centre Stop is best fitted with a longer screw (say ⅝ in.) having a larger, knurled (or winged) head to your choice (see photo 2). This will be easier to grip when quickly moving it from against one Outer Stop to against the other when using the system in 'two position' mode. This feature should also prevent erroneous slacking-off of the wrong screw and consequent loss of setting during a batch run. The business ends of the Screws should be flat, particularly if you're not using the keyway idea, to help align the Stops.

Slide the Stops on the Bar and you'll see that the pin protruding from each side of the Centre Stop contacts the End Stops, effectively preventing face-to-face contact. The gap created leaves swarf clearance and minimises the risk of false settings in dirty conditions.

Mountings

Each is assembled from two pieces of 1 x 1 x ⅛ in. (25 x 25 x 3mm) bright steel angle. Discrepancies brought about by the introduction of metric material are insufficient to bother us, so I shall continue to use inch sizes throughout my description. You could weld, braze or rivet the assemblies, but I chose to use bolts, probably because my other hobby is Meccano and I'm used to handling the little perishers! Follow the drawings and dress off the corners to suit yourself. Make sure the holes that take the Bar are the same distance forward of 1⅛ in.), and above (½ in.), the angle on the drawings marked 'Datum', otherwise the Bar won't lie parallel to the lathe bed and will come in the wrong place in relation to the Saddle apron.

Now that these items are finished we must consider how best to mount them. Design changes prevent us from using Jim Radford's method of bolting direct to the lathe. Also, there are advantages (as we shall see shortly) in raising the lathe above its swarf tray or bench top. The Raising Bars so used also provide the necessary anchorage for the Stop Bar, enabling it to be mounted firmly and in correct relationship with the new saddle-mounted release mechanism.

Raising bars

These are hefty and can either be cut from 1 x 2in. (nominal) bright or black steel bar surface ground on top and bottom faces. It is essential that the wide faces are parallel to each other, and that both 6½ in. long bars are the same thickness. Ideally they should be surface ground parallel as a pair, but good true flat bright steel should do. The precise thickness is of little consequence. Make sure one end of each is absolutely square for the Mountings, the other end and sides don't matter. Mark out and drill the through holes as per drawing. Tap the third hole in each (at whatever 5/16 in. thread you choose) to take set bolts for holding the Mounting Brackets. The end holes are best spotted through from those on the Mountings, noting that if you are using Jim Radford's drawings, those in the left bracket are at 1½ in. centres, and those at the right (of which only the left two are used) are at 1¼ in. If you are making either Stop Bar attachment from scratch, 1½ in. centres for both (as per my drawings) would be better. Tap these holes while you can get at them.

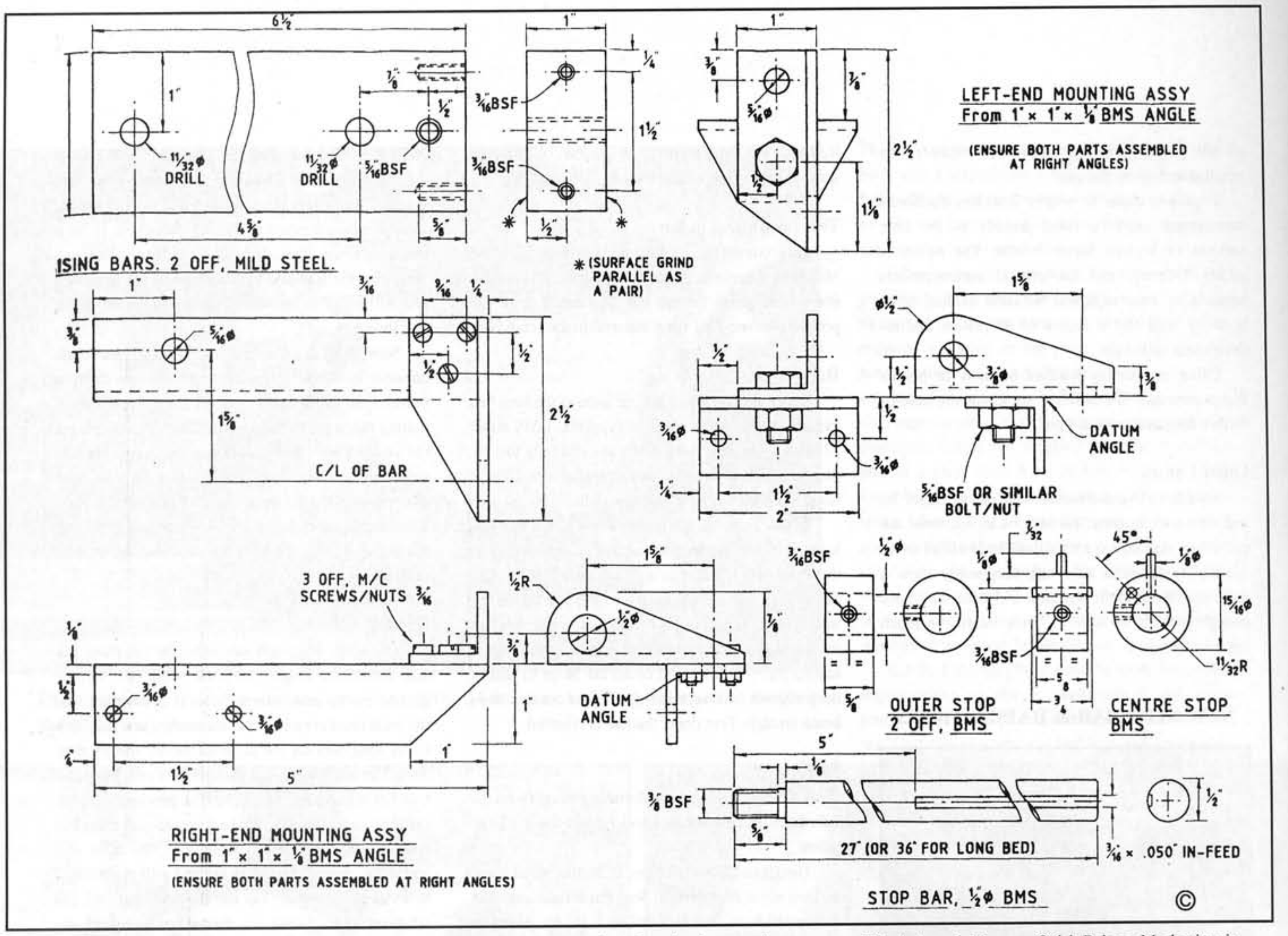
Assembly

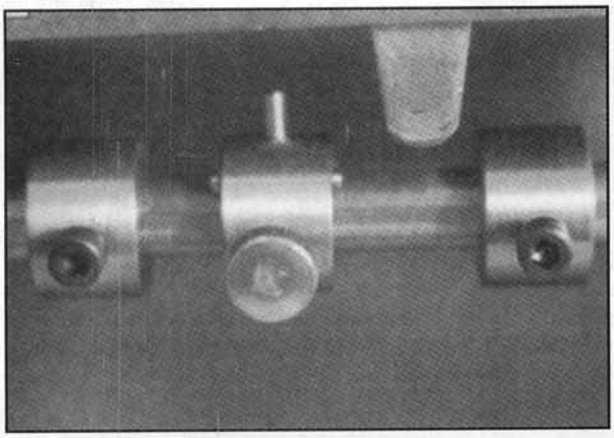
Unbolt your lathe and raise it up on wood blocks (it will tend to tilt backwards due to the weight of the motor). Take out any shims and note where they came from, and clean the feet and mating faces. Slide the Raising Bars in place checking that they're the right way round. Put the shims back exactly where they were, and loosely fit new holding down bolts or studs 1in. longer than those removed. Be careful—make sure the Raising Bars are in alignment, it's fiddly to get them right, but they must be parallel to each other, sit at right angles to the lathe axis, and protrude the same distance from the lathe centre line.

Now's the time to fit your Radford bar and Mountings (or my simpler equivalents). If the Stop Bar rotates freely, you've got things right. Wind the saddle along and check that the Bar lies parallel to the apron edge.

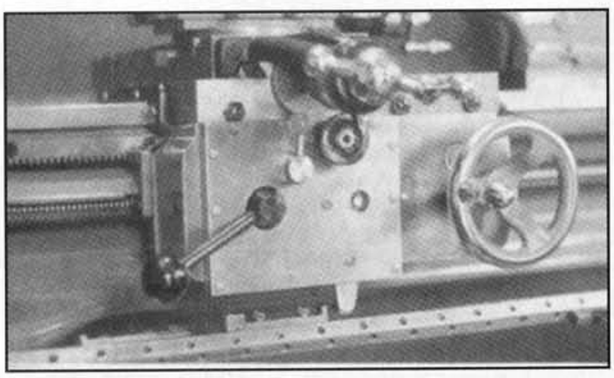
You may find that the back of the Mountings fouls the lathe bed because of paint finish or casting variation, if so, file a little off to clear.

The two-stop Bar should be assembled, keyway facing front, with a washer placed each side of the left Mounting before tightening the nut; the right end





2: The alternative 2-position stops in place ready for use.



3: The new snap-action traverse mechanism fits neatly on the apron above the Radford bar. It is 'set' for use in this photo.

doesn't need to be secured.

As a further check, the front corner of the top (level) flat on the hexagon of the Radford Bar, should lie almost vertically below the Saddle apron front face, whereas the front radius of the two-stop Bar should lie about $^{1}/_{16}$ in. forward of it. Adjust if wildly out, and firm up the fixings.

Now follow the maker's instructions for re-levelling the lathe as you tighten the holding down bolts. You'll probably find that it is as true as it was before—as long as you remembered to put the shims back in the right places—that's why I stressed the importance of the Raising Bars being an accurate parallel pair.

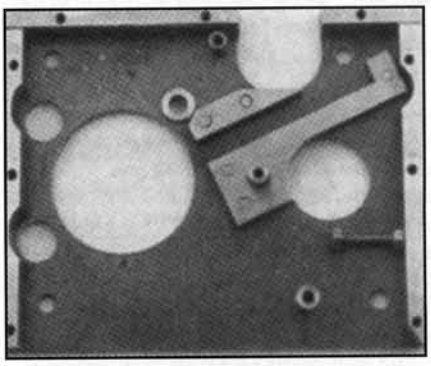
Regardless of the Stop Bar, the Raising Bars provide immediate advantages. The extra inch of height will lessen your 'turner's stoop'. You can get your hand under the bed, the motor, and the change-gear case, making it much easier to clean those places. Also, if you're like me and wear specs, everything seems to be in much better focus. And that's all without modifying the machine in any way!

The Automatic Traverse Quick Release Mechanism is the box of tricks which fastens to the saddle apron. Be assured, this much improved version, while a little more complicated, has none of the drawbacks of the prototype already described.

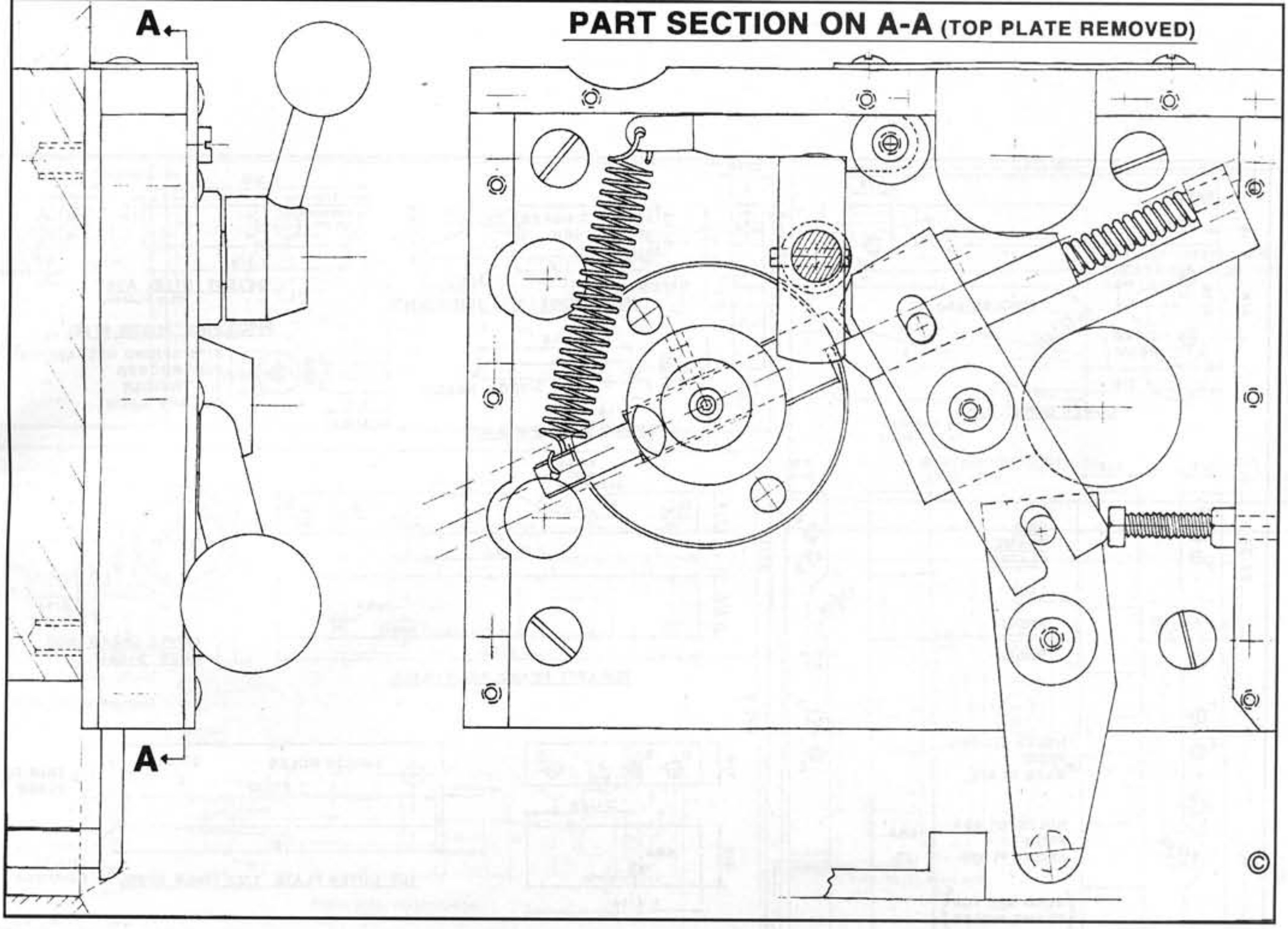
With the possible exception of the front and back plates, I'll be surprised if the rest of the parts can't be made from odd off-cuts already to hand.

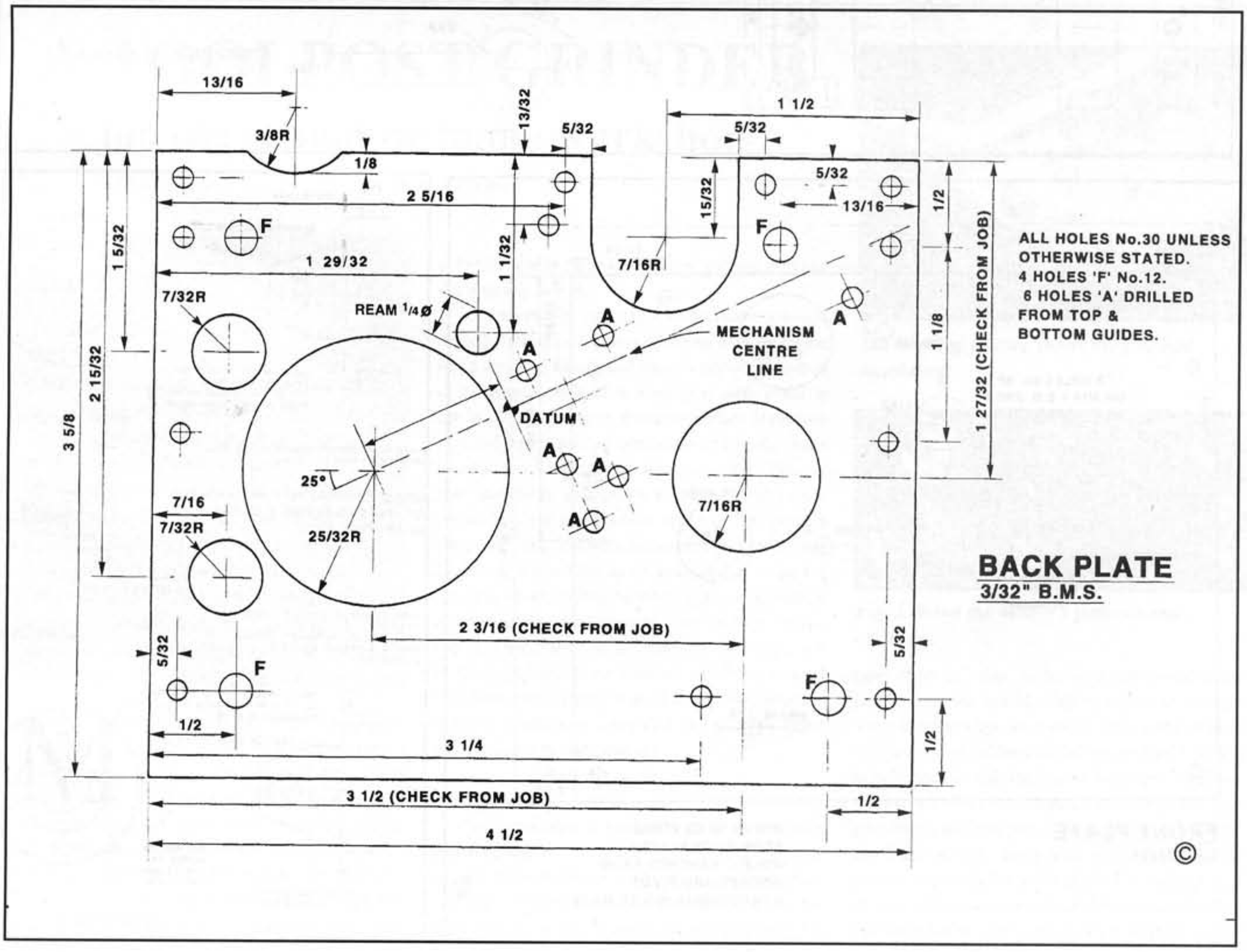
For simplicity, I recommend that you stick to the described sequence rather than leap-frog about as the mood takes you, because very few of the parts can be completed in one go. Where relevant, I have quoted Myford numbers from the Lathe Handbook, so it might be an idea to have yours by you as work proceeds. Having said all that, let's get on with the making. ●

Model Engineer 176 174 (1996)

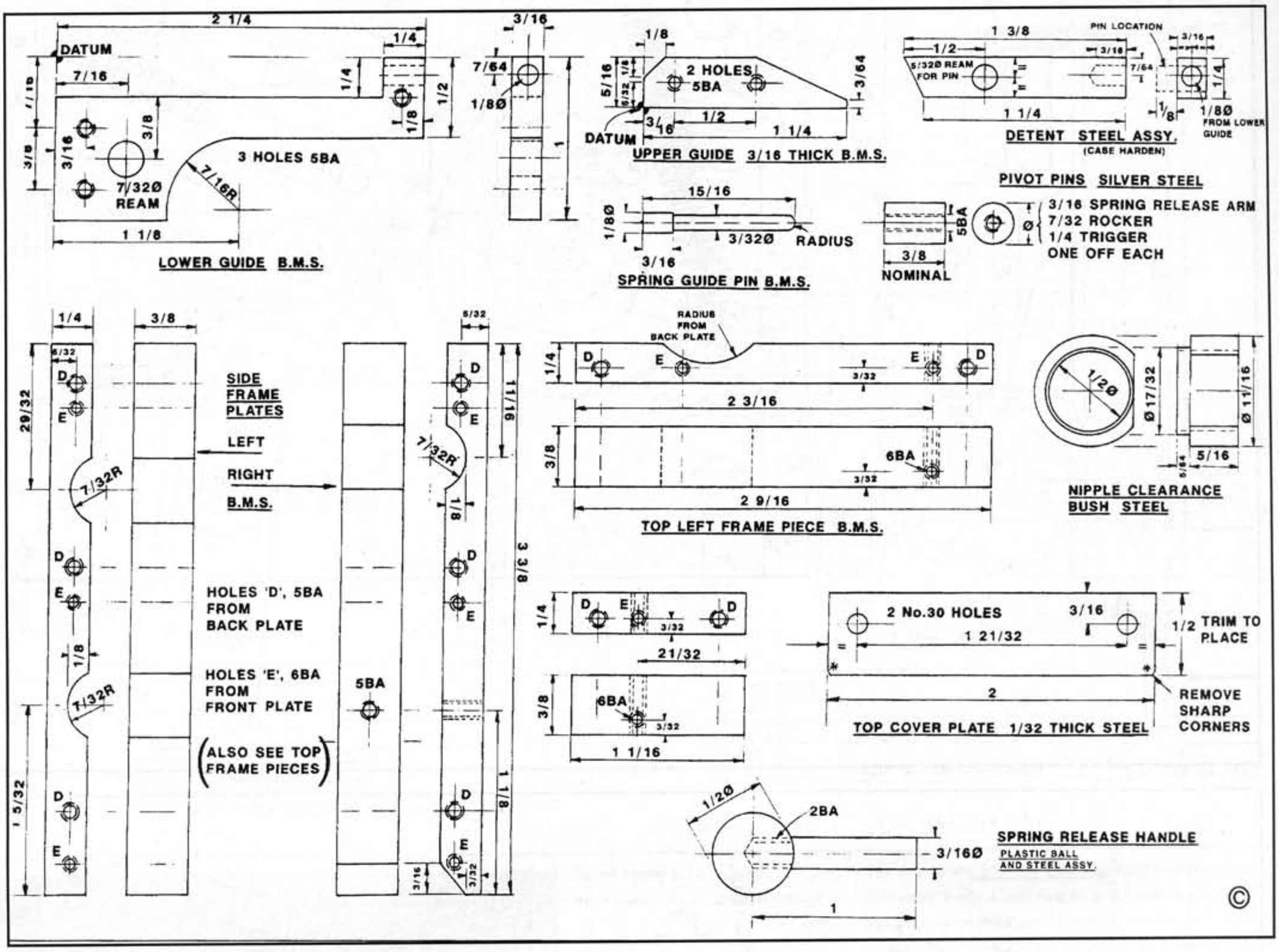


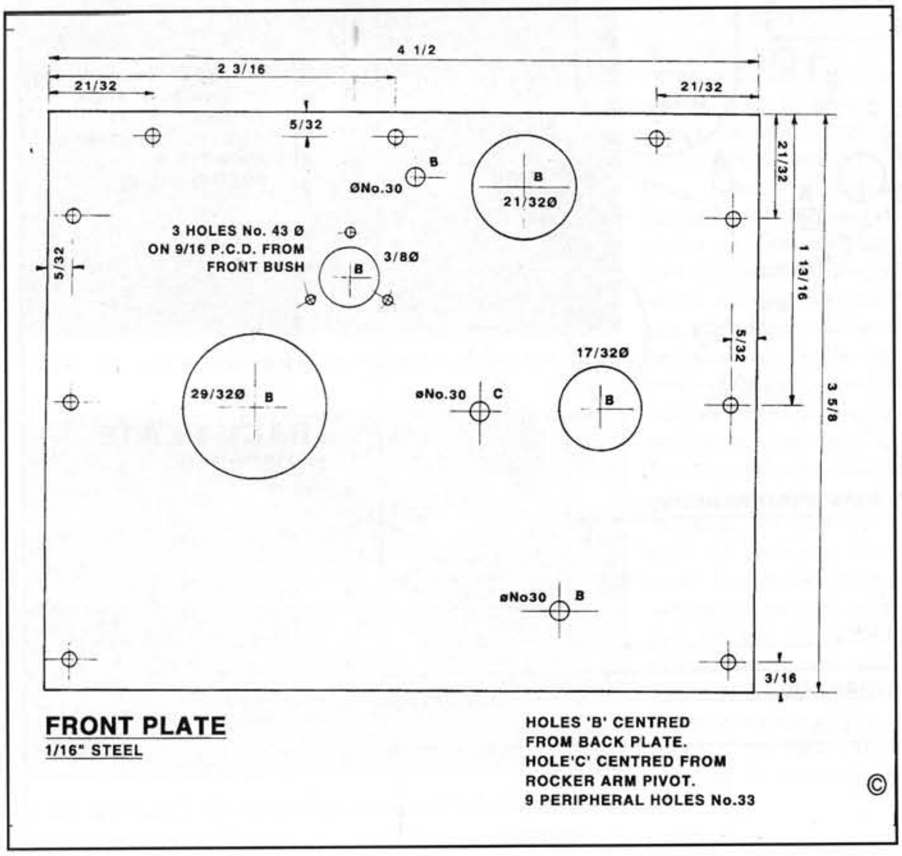
Back plate with all fixed components fitted. The position of the upper and lower guides can be clearly seen, as can the pivot pins, bush, frame pieces and rocker limit screw.

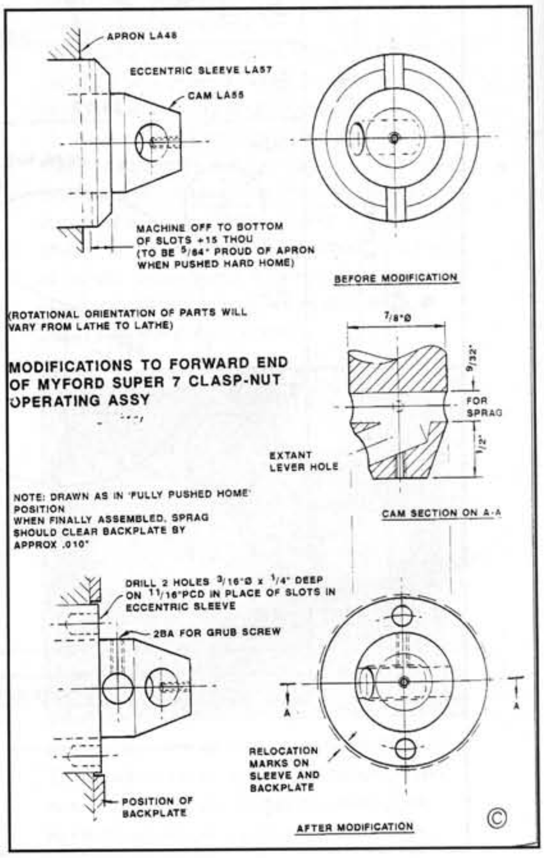


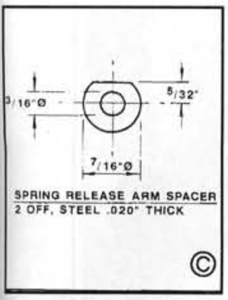


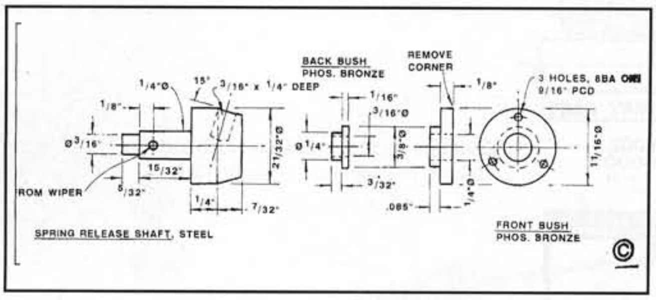
BACK PLATE
3/32" B.M.S.

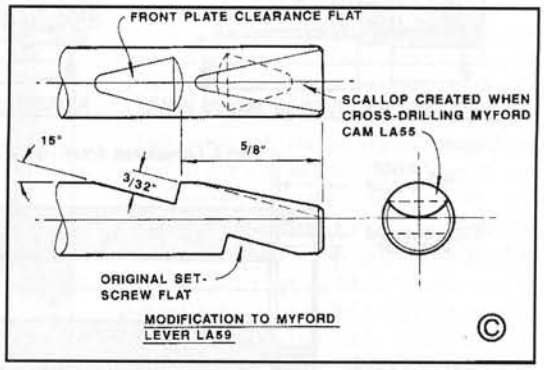

DATUM
LOWER GUIDE B.M.S.
3 HOLES 5BA
7/32Ø REAM
7/16R
UPPER GUIDE 3/16 THICK B.M.S.
2 HOLES 5BA
DATUM
SPRING GUIDE PIN B.M.S.
3/32Ø RADIUS
DETENT STEEL ASSY. (CASE HARDEN)
5/32Ø REAM FOR PIN
PIN LOCATION
1/8Ø FROM LOWER GUIDE
PIVOT PINS SILVER STEEL
3/16 SPRING RELEASE ARM
7/32 ROCKER
1/4 TRIGGER
ONE OFF EACH
NOMINAL
SIDE FRAME PLATES
LEFT
RIGHT
B.M.S.
HOLES 'D', 5BA FROM BACK PLATE
HOLES 'E', 6BA FROM FRONT PLATE
(ALSO SEE TOP FRAME PIECES)
RADIUS FROM BACK PLATE
TOP LEFT FRAME PIECE B.M.S.
NIPPLE CLEARANCE BUSH STEEL
2 No.30 HOLES
TRIM TO PLACE
REMOVE SHARP CORNERS
TOP COVER PLATE 1/32 THICK STEEL
2BA
SPRING RELEASE HANDLE
PLASTIC BALL AND STEEL ASSY.
3/16Ø
©

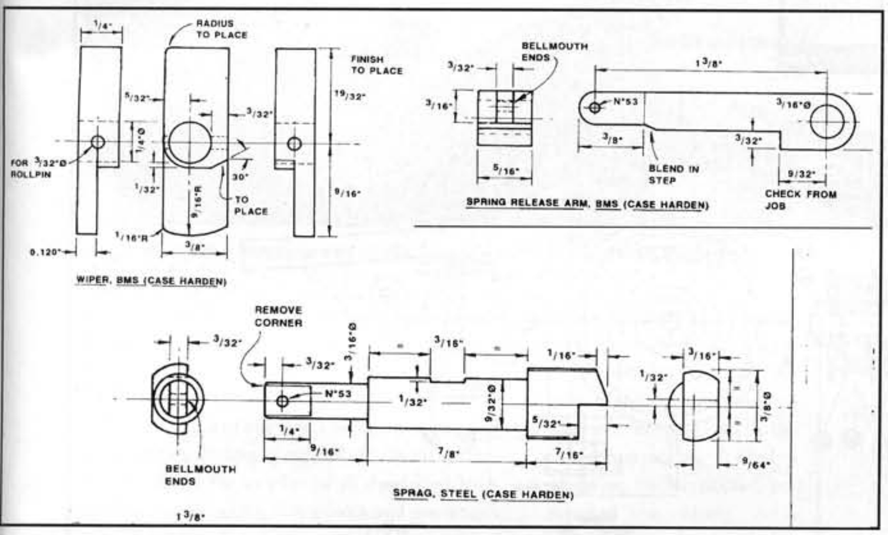

4 1/2
2 3/16
21/32
5/32
ØNo.30
B
21/32Ø
3 HOLES No. 43 Ø
ON 9/16 P.C.D. FROM
FRONT BUSH
3/8Ø
29/32Ø
øNo.30
C
17/32Ø
1 13/16
3 5/8
øNo30
3/16
FRONT PLATE
1/16" STEEL
HOLES 'B' CENTRED FROM BACK PLATE.
HOLE'C' CENTRED FROM ROCKER ARM PIVOT.
9 PERIPHERAL HOLES No.33
©

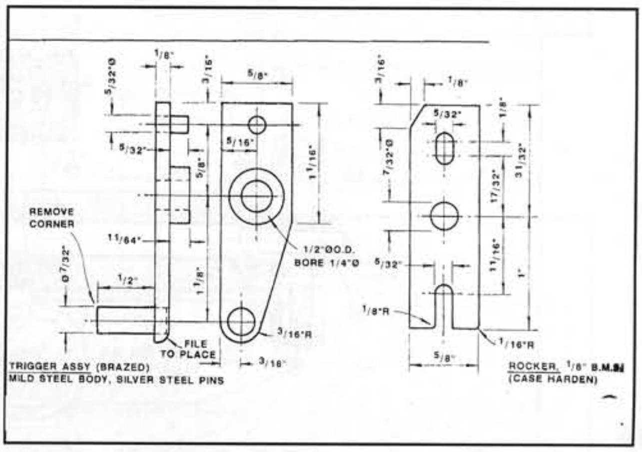

APRON LA48
ECCENTRIC SLEEVE LA57
CAM LA55
MACHINE OFF TO BOTTOM OF SLOTS +15 THOU (TO BE 5/64" PROUD OF APRON WHEN PUSHED HARD HOME)
BEFORE MODIFICATION
(ROTATIONAL ORIENTATION OF PARTS WILL VARY FROM LATHE TO LATHE)
MODIFICATIONS TO FORWARD END OF MYFORD SUPER 7 CLASP-NUT OPERATING ASSY
7/8"Ø
FOR SPRAG
EXTANT LEVER HOLE
CAM SECTION ON A-A
NOTE: DRAWN AS IN 'FULLY PUSHED HOME' POSITION
WHEN FINALLY ASSEMBLED, SPRAG SHOULD CLEAR BACKPLATE BY APPROX .010"
DRILL 2 HOLES 3/16"Ø x 1/4" DEEP ON 11/16"PCD IN PLACE OF SLOTS IN ECCENTRIC SLEEVE
2BA FOR GRUB SCREW
RELOCATION MARKS ON SLEEVE AND BACKPLATE
POSITION OF BACKPLATE
AFTER MODIFICATION
©







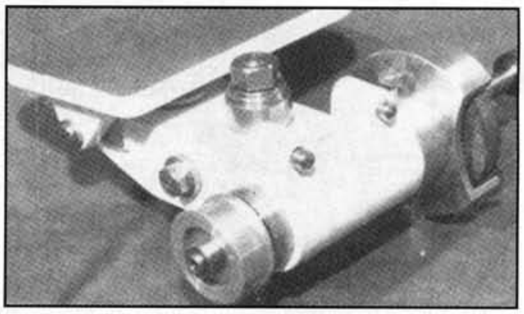




A TOOLPOST GRINDER

for the school or home workshop

by D. H. Downie



The heading picture shows the finished attachment.

Fig. 1 shows the author's patterns and castings.

Grinding Spindle

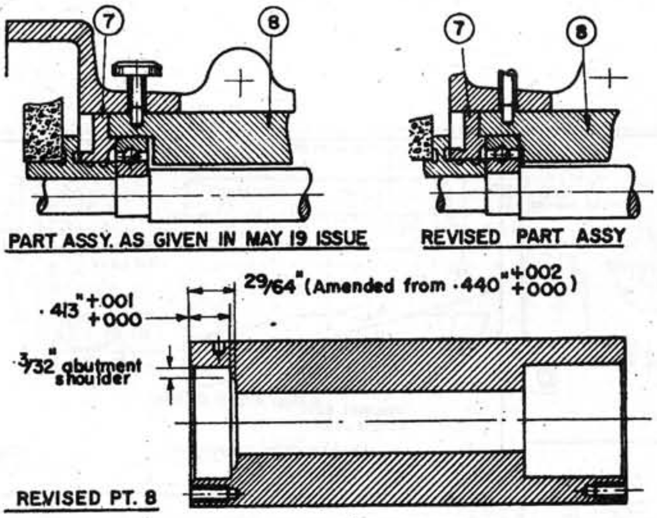
There has always been controversy over the effects which toolpost grinding may have on the life of the lathe, but sensible precautions should avoid doing damage. In the right context, a ground finish is highly desirable and can be achieved with the correct wheels. In choosing the design for publication, I was looking for a spindle with pre-loaded bearings, easy to make with a compact motor drive. Should the constructor wish to source castings for this design, I can help in this direction and I may be contacted through the Editor of Model Engineer.

Mounted on the top-slide, this powerful grinder permits internal and external precision grinding, and within limits small precision surface grinding. You can accurately grind lathe centres, punches, milling cutters, spindles, and small cutters you make yourself, which are always better when finished to size after hardening. The one-fifth horsepower motor of this home-built grinder gives it plenty of power under load to handle a wide range of wheels in varying grits and diameters up to 3 in.

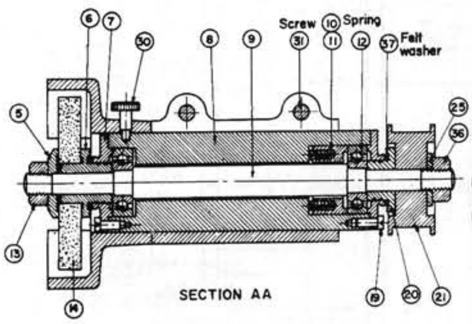
Constructed in accordance with modern practice, the ball-bearing quill allows extremely high speeds for small diameter wheels and ensures smooth operation of the larger wheels when working to close limits. It can be quickly set up on the lathe in place of the tool post and has proved so convenient and useful that I wonder how I managed so long without it. There is little possibility of damage to the lathe if simple precautions are taken whilst operating the grinder. Keep the bed covered between the saddle and headstock; a small flat tin of water directly under the grinding wheel catches the wheel grit and prevents it ricocheting in various directions over the lathe. If your saddle is not fitted with felt wipers, it is a simple job to add these—pieces cut from an old felt hat secured with brass facing plates. A good clean-down when the grinding operation is completed and you can forget any worries as to lathe damage.

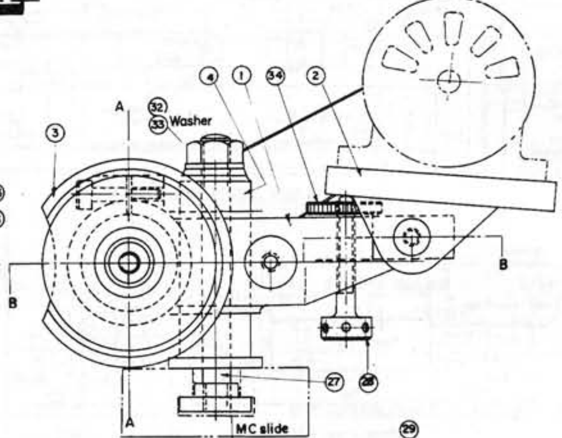
The patterns

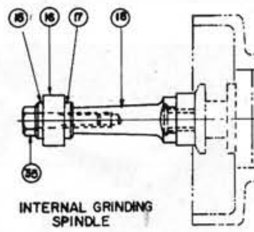
No special skill is needed to make these simple patterns, and for a "one-off" job no special kind of wood is required. Small scraps of wood may be glued together to obtain necessary thicknesses. From the moulding line on the drawings, leave a little draft, i.e. taper of about 2 deg., to facilitate withdrawal of the pattern from the mould. Slightly radius all external sharp edges and line the corners where surfaces meet with some ⅛ in. radius fillet leather or wax. Polyfilla paste rubbed in with the ball of the finger will serve just as well. When dry, smooth the patterns with fine glass paper, give two coats of shellac; again, when dry and hard, smooth down with steel wool and the patterns are ready for the foundry. The castings may be specified in cast iron or high duty aluminium alloy. I prefer the alloy, since it machines beautifully, higher

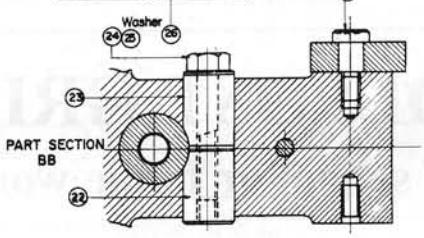


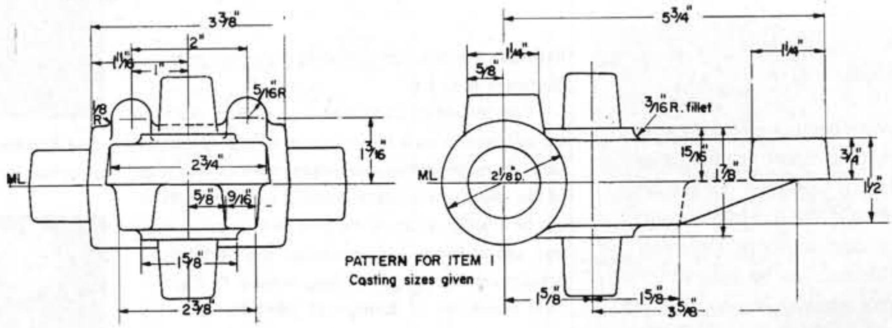
Bearings used are Skefco No. 6200
Authors modification to section AA



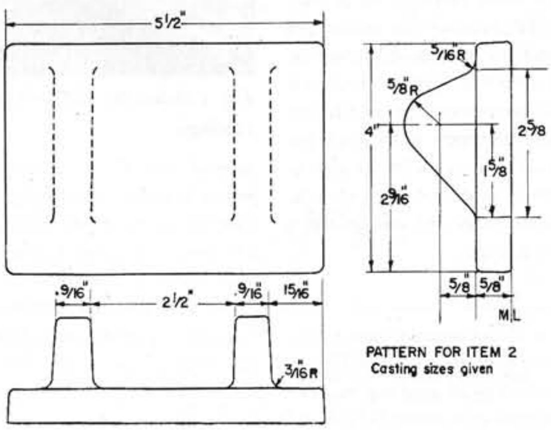




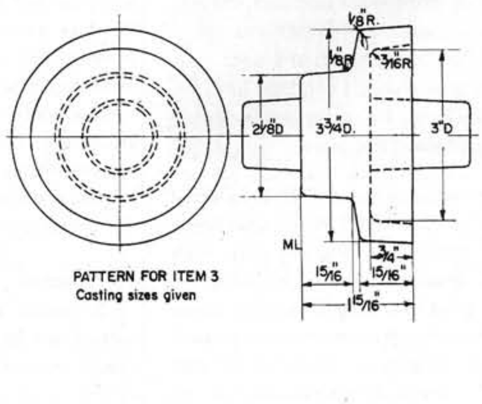




PATTERN FOR ITEM 1
Casting sizes given



PATTERN FOR ITEM 2
Casting sizes given



PATTERN FOR ITEM 3
Casting sizes given

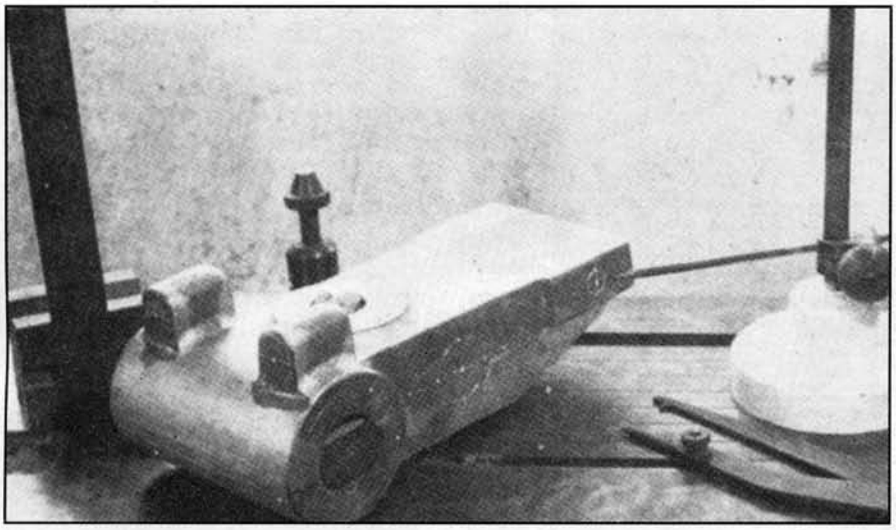
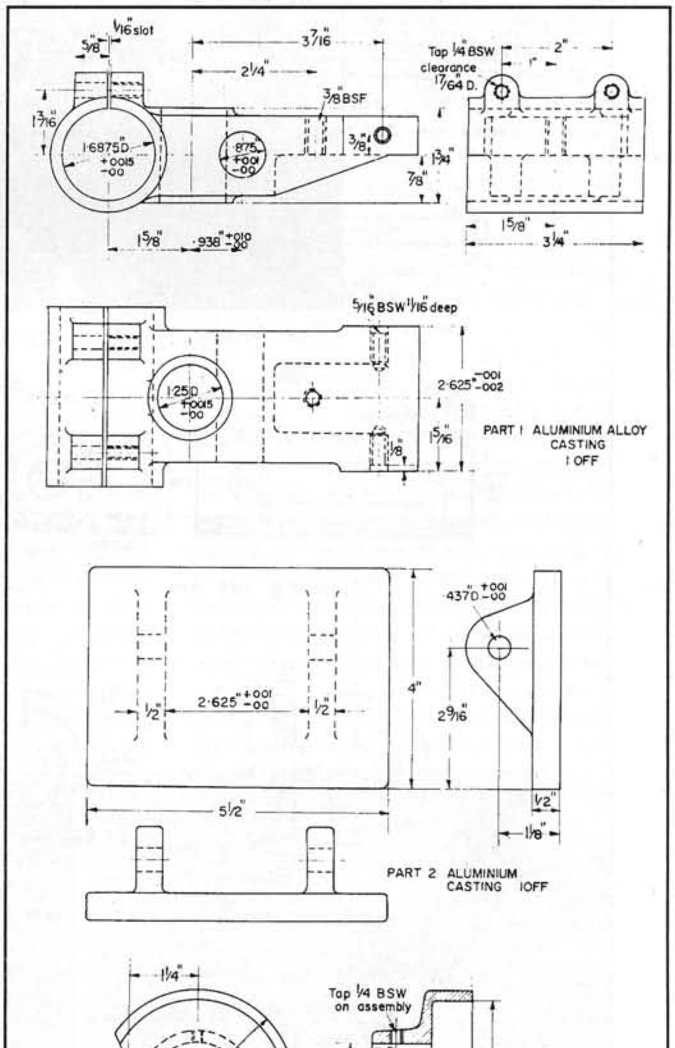


Fig. 2 shows the marking out of the locations for drilling and boring.

each end of the casting to coincide with the headstock and tailstock centres. Mount a boring bar in the chuck and commence boring for the quill sleeve. The cut can be increased by offsetting the bar a little, or the tool may be slightly loosened and tapped out a little for each cut. Once the cored hole is cleaned up, you can check if you have fairly equal thickness of metal around the hole, and if not the necessary adjustment of position can be made before proceeding to bore to the finished size of 1 11/16 in. diameter. Some care is needed in adjusting the cut to the final dimension. This can be checked by inside callipers set from a micrometer. With the boring completed you can easily face the ends with a boring bar and tool held across the chuck jaws. When one end is faced, turn the casting end for end and machine the second face.

Now turn the casting over and adjust its position so that the holes for the pivot pins that carry the motor table may be drilled. These can be easily lined



speeds can be used and this makes it more suitable for the lighter type of lathe as used by the modeller.

The frame or base casting

The sequence of machining on this is more easily followed if the casting is marked off. On the surface plate, mark out the location of all the drilled holes and bores using your scribing block and machinist's scale. Centre punch and mark with a witness circle all these points. Hold the casting in a four-jaw chuck, set to your marking, face and bore through to receive the toolpost. Reverse the casting and face the other side. If any trouble is experienced doing this, it can be mounted on a stub mandrel turned in the chuck, lightly driven on and then faced. This will ensure parallelism of the faces.

Now chuck the casting on its side, or you can mount against a faceplate, drill and bore, or ream for the stud clamp. Careful setting up is necessary since this hole breaks through into the previously bored hole and it should be by the correct amount of 1/8 in. Now set the casting to one side and proceed with the toolpost, shoe and clamp. This is advised so that the remainder of the machining of the main casting can be conveniently accomplished whilst actually mounted on the top-slide.

Toolpost, toolpost shoe, stud clamp

These are parts 4, 26 and 22 - 23, and are all machined from mild steel stock bar. Mount the material for the toolpost in the chuck. Face and centre one end. Turn accurately to the size given on the drawing, leaving the 3/16 in. flange at one end. Drill right through to 33/64 in. This is a precision machine tool and all parts must be to a high standard of accuracy and finish. Part off or reverse the work in the chuck and face the other end to correct length.

The stud clamp

This is machined in one piece, a nice sliding fit into the clamping hole bored in the main casting. The 5/8 in radius that fits snugly onto the tool post can be neatly filed and fitted by using the toolpost as a gauge and a little high spot blue to get the bearing. Another way is to mount the clamp vertically in your milling slide and with a boring bar in the chuck and a tool set at 5/8 in. radius, scoop out the curve required and to the correct depth. As the photograph shows, I used a somewhat similar method, but mounted the clamp in a machine vice (vice appeared in Model Engineer January 24th, 1963). On the lathe cross-slide and using a boring bar with tool set at 5/8 in. radius, neatly machine the curve required.

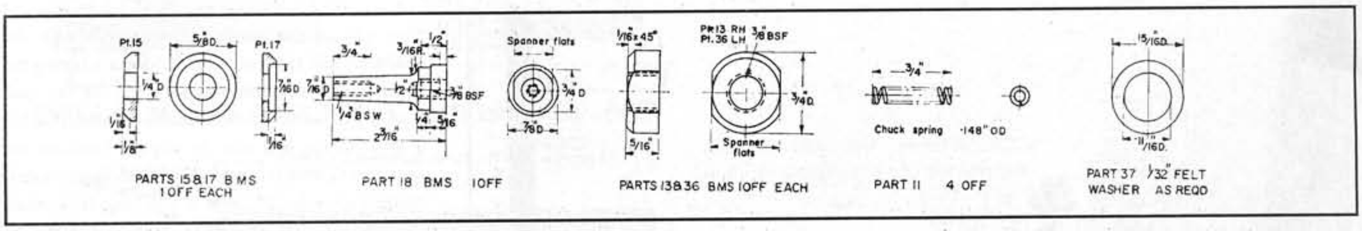
This clamp sleeve, when complete is drilled through 3/8 in. tapping (BSF) and cut into halves. One half is tapped, the other opened out to clearance size.

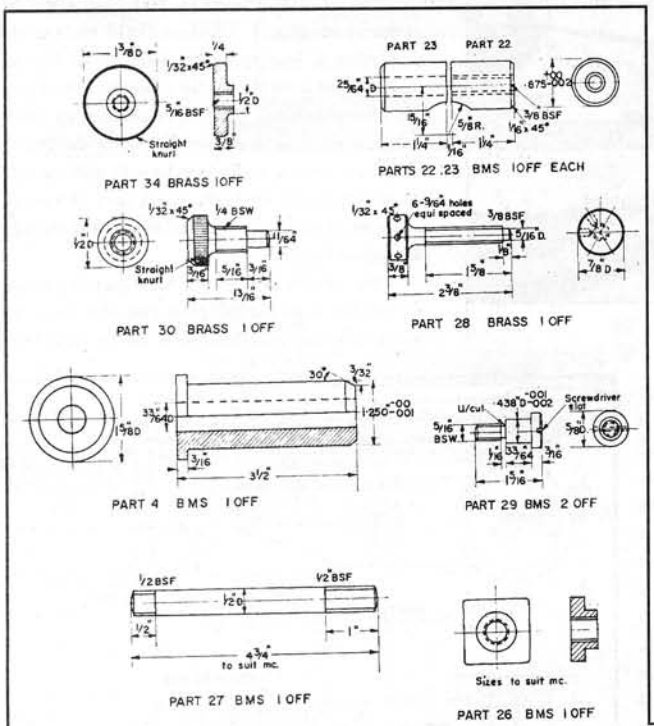
Toolpost shoe

Make this up to suit the slot in your top-slide, a good sliding fit, with a length to make for firm clamping and distribution of load. If your lathe is of the fixed stud type for holding tools, then you will have to make the toolpost to suit your particular lathe.

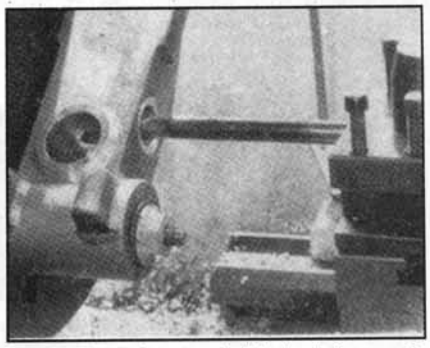
The toolpost stud is made from 1/2 in. b.m.s. screwcut 1/2 in. BSF, and the ends neatly bevelled.

Let us now return to the frame casting. Assemble this together with its toolpost and stud clamp. Mount the casting in its place on the toolrest of the top-slide. Line up the bosses carefully with the centre-line of your lathe. This is easily accomplished by getting the centre dots you have marked at





Casting mounted on faceplate— drill and bore for the stud clamp. Note break-through into main bore.

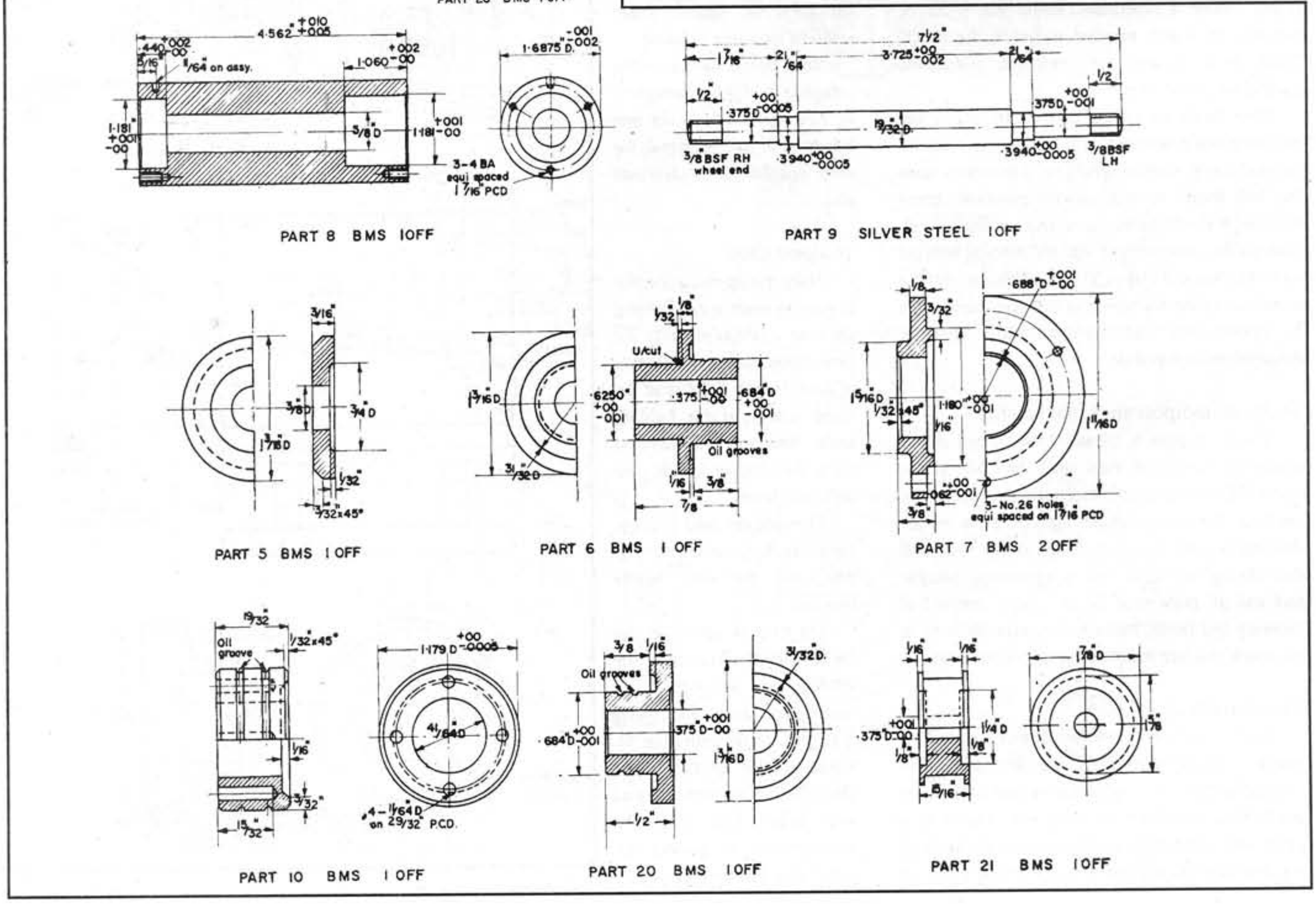


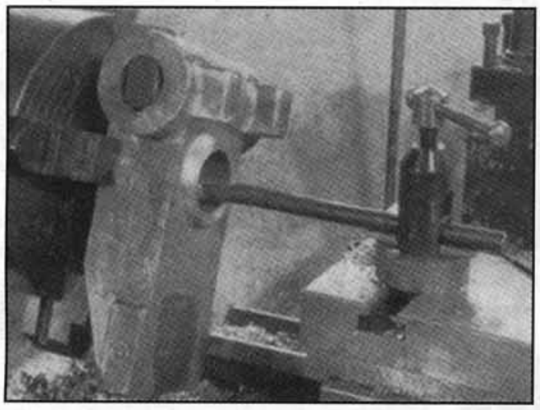
up by a centre drill in the chuck aligned to the centre dot on one side, the opposite centre dot lined up exactly to the tailstock centre point. You can also feed the tapping drill for these holes to the correct depth by using the tailstock handwheel to feed the casting against the drill in the chuck. Then reverse the casting and drill the second pivot tapping hole. These holes are tapped 5/16 in. Whit.

Now by swinging the casting round at right angles and adjusting to the correct height, i.e. lining up with your centre dots, you can drill the two tapping holes and spot face them for the clamping screws. Tap the holes ¼ in. Whit, then slit through the casting. This can be cut in the milling machine or by clamping the casting on the lathe cross-slide and saw cut on a mandrel. It can also be cut by a fine-bladed hacksaw, carefully used to achieve a neat appearance. After slitting, the front portion of the holes can be opened out to ¼ in. clear and spot faced.

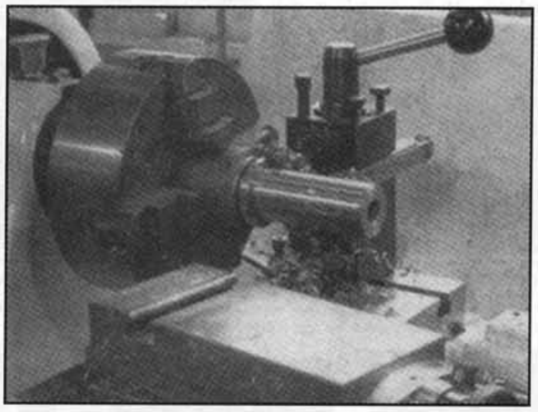
Motor table casting (Part 2)

This provides a hinged base for the motor and so

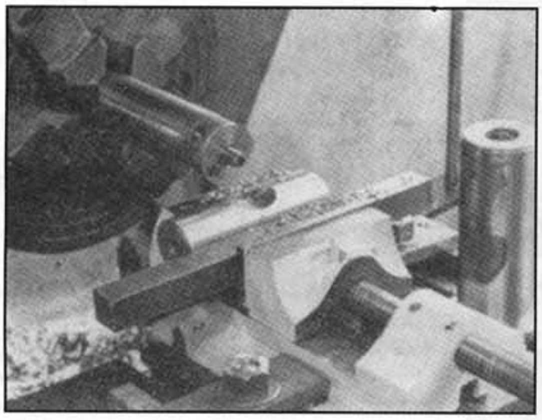




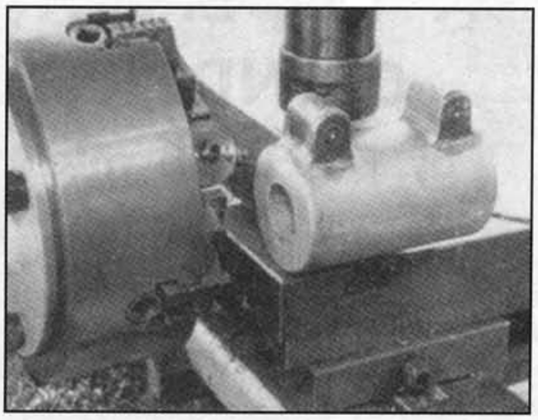
Face and bore to receive the toolpost, reverse and face other side.



Cutting off the toolpost.



Machine the curve to fit toolpost. Post is on right of picture.

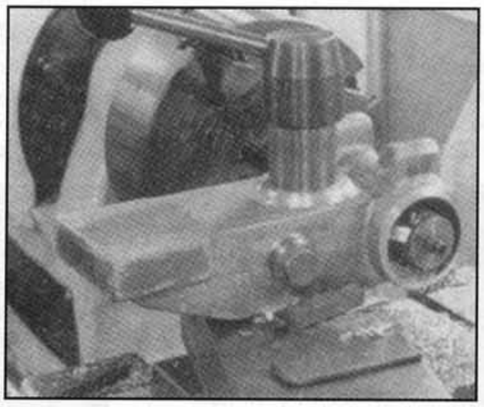


Face ends of casting with boring bar held across the chuck jaws.

gives adjustment for belt tension. It requires little machining. The face and edges may be generally filed flat; machining of the face is quite optional. The holes in the lugs for the pivot pins must be drilled in line for free hinge movement of the table. Mount the casting against an angle plate, lining up the lugs against a try square. Set out and centre punch the position of the hole in the top lug. Drill right through both lugs 5/16 in., then open out to 7/16 in. dia., thus ensuring that the holes are to size to suit the pins.

Grinding wheel guard (Part 3)

Hold by the boss, bore to size and machine the interior. Remove from the chuck, drill and tap for the knurled locking screw. Now mount on a stub mandrel in the chuck, the guard a light push fit, as it can be locked into position by lightly tightening the lock screw against a flat previously filed on the mandrel. Finish the exterior of the guard to a high finish, for polishing and buffing up afterwards. Set out the portion to be cut away to clear the wheel. Drill closely spaced holes against your marking, and after drilling break the piece away and file up neatly to form marking. Draw file the edges to a good finish. Drill the drainage hole; this is necessary to prevent the guard from becoming loaded with water or lubricant when wet grinding.



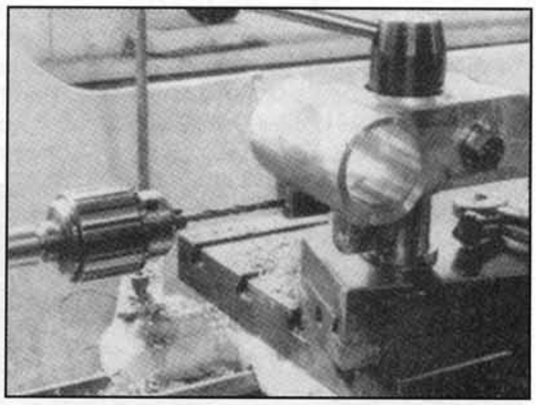
Mount casting on top-slide, bore through for sleeve with boring bar in chuck.

The spindle housing or sleeve (Part 8)

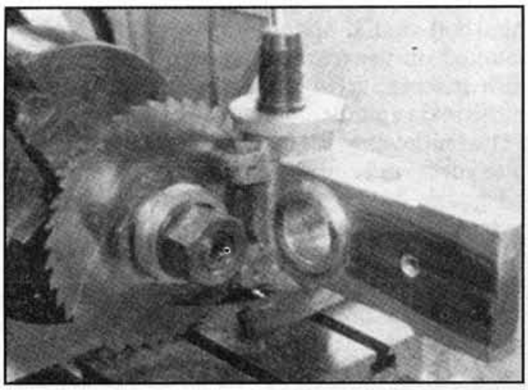
This should be approached with a view to the finest and most accurate unhurried workmanship. If obtainable, heavy walled steel tube can be used, alternatively cut from solid mild steel round stock. Once the outside of the sleeve is machined it must be set dead true in the four-jaw chuck, the other end in the fixed steady. In this manner the bar is held for accurately facing and boring for the ball bearings and boring through the clearance hole for the spindle. When boring the ends for the bearings, use the bearing as a plug gauge for making a firm push fit. Work strictly to the drawing sizes. When one end is completed, including the clearance hole right through, reverse the sleeve and machine the opposite end for the second bearing. Remember that one end is bored deeper than the other since it has to include the preloading piston and its four springs.

The two end caps are a simple lathe job turned from stock bar. Make a spigot an accurate "snap" fit into the sleeve ends. When machining the reverse side of these caps, and indeed all the other small parts, it is better in the interests of accuracy to finish on a turned mandrel. For the satisfactory performance of the grinder all components and mating parts of the housing and spindle must be accurately machined to size, faces parallel and holes true to axis, and of high finish. Before removing the caps from the lathe, using a sharp-pointed tool, strike out the pitch circle for the three screw holes. Work from the outside diameter using your index collar to scribe the line at the correct diameter. Set out the holes equidistant and drill through 4 BA tapping size. Snap the caps onto the sleeving housing and using the cap as a jig, drill the tapping holes ½ in. deep into the sleeve ends. Open out the holes in the caps to 4BA clear afterwards.

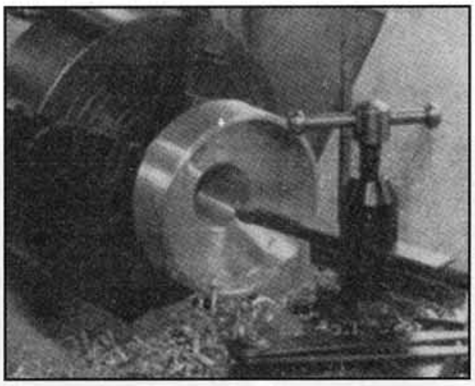
The grinder spindle is made from high carbon steel and silver steel rod is quite suitable. Use oversize material so that the spindle is accurately machined all over. Face the ends to length and centre. Again using the ball bearings as ring gauges, make them a firm push fit on the shaft. The bearing surfaces can be left slightly tight on the micrometer size, and then polished with fine abrasive cloth till the bearings push firmly into position. Remember no finishing is done on the spindle until it has been turned all over close to size. Thread both ends of the spindle, noting that one end is left hand. Cut the



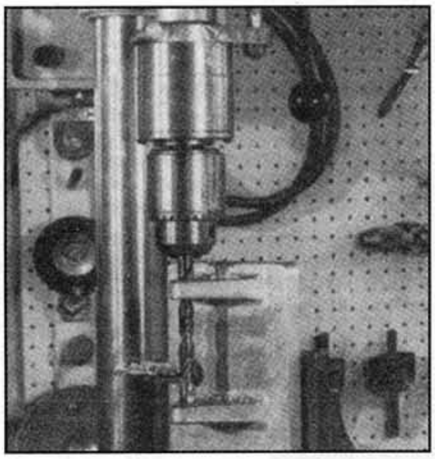
With casting turned over on the toolpost, drill the tapping holes for the clamping screws.



Use a slitting saw with the casting clamped to the cross-slide.



Bore the grinding wheel guard and machine the interior.



Mount the table casting against an angle plate for drilling the lugs.

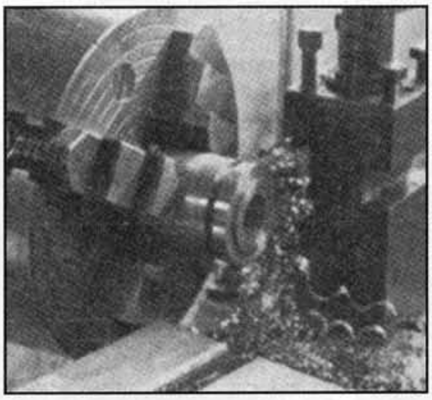
threads in the lathe; this is absolutely essential. You may use a die, but only to finish the thread to size and form. Thread at a slow speed for good results on this tough material. Use sulphurised oil as a lubricant and hone the tool for the light finishing cuts.

The spring-loaded plunger (Part 10)

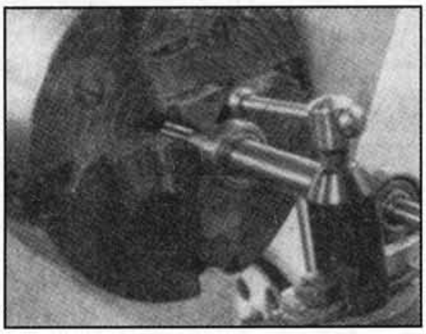
This is machined from mild steel and to a high finish, and one to one and a half thousandths less in diameter than the O.D. of the ball bearings, the bore an easy fit on the spindle. Set out and drill the four holes to take the springs. These holes must all be exactly the same depth. Terry chuck springs meet the need here, and are obtainable at most good tool shops.

At this stage it is best to concentrate on finishing all the other small parts required, especially the flanged sleeve and plate that carry the 3 in. grinding wheel, as this is required when machining the internal grinding spindle.

Turn the pulley for the main spindle exactly as drawing size. This should be from alloy bar. In all, three pulleys are required, two for the motor so that they may be changed over for internal or external grinding as



Strike out the pitch circle of the screw holes before parting off.



The spindle bearings fitted and the L H

required. The diameter of these two pulleys will depend on the motor r.p.m. and some notes at the end of this article are given for your guidance. These two pulleys may be machined from alloy, nylon or fibre material. It is better to finish all the pulleys on an accurately turned mandrel.

The internal grinding spindle (Part 18)

Again, this spindle is made from high carbon steel. The high r.p.m. of this spindle makes it important that it should run perfectly true when mounted on the main spindle, so it is necessary to finish machine it in the actual mounting position on the main spindle.

The following sequence of machining proved quite successful: mount the material in the chuck and rough out to the general shape, about 1/16 in. oversize; drill and tap the outer end 3/8 in. BSF, as on the drawing.

When the sleeve and main spindle are assembled together with the grinding wheel bush and plate, mount the roughed out internal spindle tightly on the end. Hold the opposite end of the main spindle in the chuck and set up dead true. The other end of the sleeve is mounted in the fixed steady. Now you are ready to finish turn the internal spindle actually on the bearings in which it runs when in use. Face the end, then centre drill truly. Finish turn the spindle now with light cuts, and polish to a high finish. Drill and tap the 1/4 in. Whit. hole in the end whilst the spindle is still in the lathe. This is for the screw which holds the small internal grinding wheels.

For final assembly of the project, absolute cleanliness is a necessity; a little high grade light oil may be used on the bearings and the sliding plunger. On no account must grease be used.

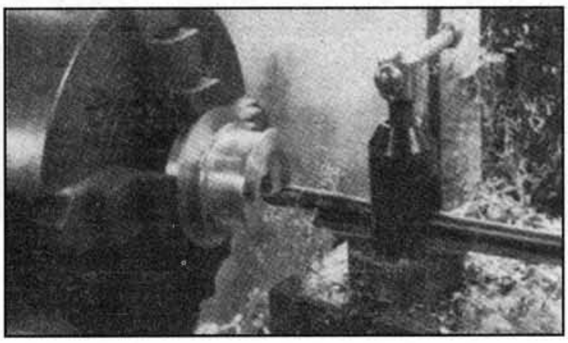
Note that the inner side of the flanged sleeves which clamp the inner races is recessed. This is for the purpose of inserting a thin felt washer. For neatness in fitting, these are best punched out accurately to size. Make a couple of punches from mild steel tube or short ends lying around your shop, and when punching out the two required, add a few for spares. Insert the felt washers in the flange recesses and soak in oil. When assembled, the whole unit is nicely sealed against dirt and moisture.

Cotton or nylon endless belts will need to be ordered through a retailer, and whilst awaiting these, you can use a belt made from cycle rim tape glued with a short lap. This proved quite successful as a temporary measure. An industrial diamond truing stick is necessary for accurately truing up the wheels at intervals or when worn out of truth. A small one is not expensive.

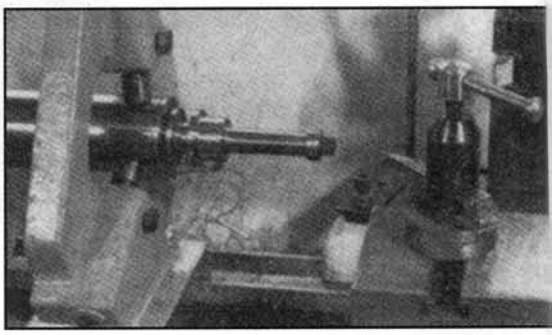
No fixed diameters are given for the two pulleys for the motor. These dimensions will depend on the r.p.m. of the motor fitted. According to your motor speed, do not exceed 5,500 r.p.m. for a 3 in. dia. wheel and 14,000 r.p.m. for a 1 in. dia. wheel. These speeds give efficient working, and do not exceed manufacturers' recommendation.

Builders should be well rewarded for their careful and precise workmanship by the performance of this valuable workshop accessory. ●

***Model Engineer* <u>133</u> 507 (1967)**



Turn the pulley from light alloy bar; fibre or nylon may also be used.



It is essential to finish turn the internal spindle in its actual mounting position on the main spindle.

The Eureka Tool

I suppose that this device is getting to be fairly sophisticated for the present volume, but it enables the model engineer to produce form relief on cutters, especially gear-tooth cutters. All those involved in clock making, I.C. engines or any mechanism using gear teeth will find it both useful and rivetting in its operation. In my own workshop I even set my version up tp amuse the ill informed nosey visitor whose eyes glaze over when gear cutting is mentioned.

THE EUREKA

A continuous form relieving tool for gear cutters

by Prof. D H Chaddock and Ivan Law

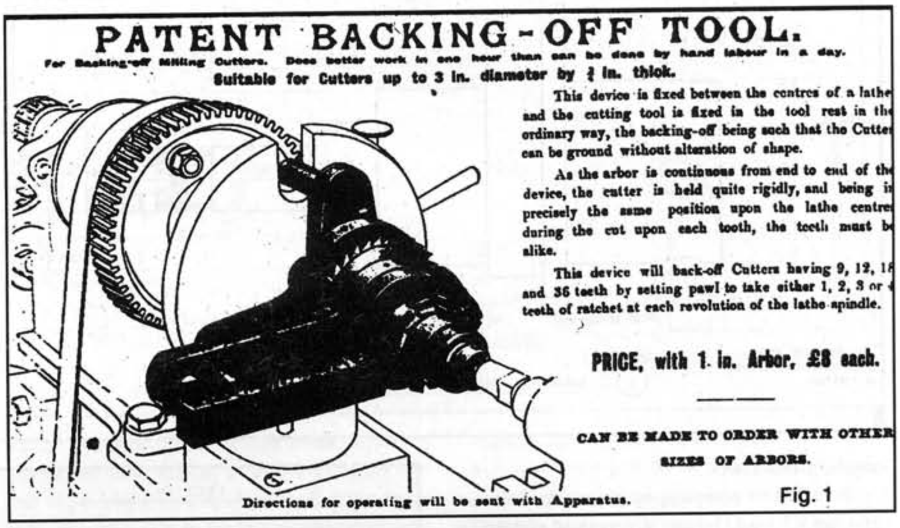


Fig. 1

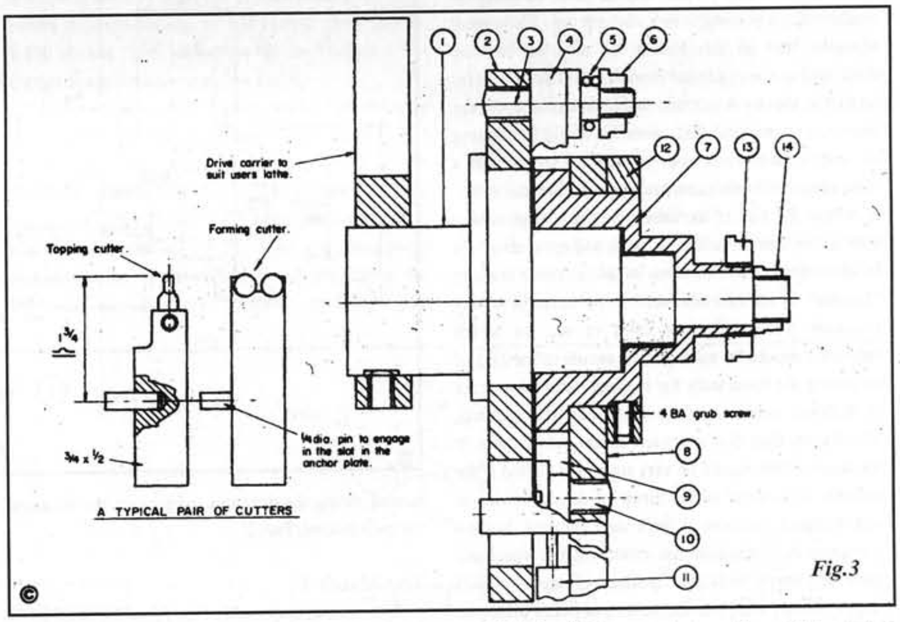


Fig.3

F rom Mr T N Gerrard of New Plymouth, New Zealand came a Xerox copy of one page of the Seelig Sonnentahl catalogue of 1904 **(reproduced in Fig. 1)** of a Patent Backing-Off tool. What was it and how did it work? A hastily convened Brains Trust of George Thomas, Neil Hemingway, Ian Bradley, Tom Walshaw and Ivan Law agreed that although Seelig Sonnentahl were well known German machinery makers, and that George Adams was at one time their U.K. agent, none had ever seen the attachment before. A limited search in the Patent Office library also failed to reveal any trace of a U.K. patent, although there may have been a German one but this was not followed up.

There was, however, a general consensus of opinion that it must be some form of eccentric turning attachment which, rotating continuously between centres in a lathe, indexed each tooth in turn and in addition backed it off by eccentric turning.

The first stage was not too difficult to visualise. If the rearmost plate, which we will call the ratchet plate, were itself mounted on an eccentric but prevented from rotating by an arm engaging a fixed pin clearly visible in the catalogue illustration it would oscillate in respect of the ratchet wheel and a pawl, also visible in the illustration, would alternately gather and index teeth on the ratchet. Of course, there would have to be a back-stop to prevent reverse rotation during the gathering phase, probably at the bottom of the attachment and out of sight in the illustration, and if the throw of the eccentric were made adjustable it could be set to gather 1,2, 3 or 4 teeth for each revolution of the lathe spindle as stated in the catalogue.

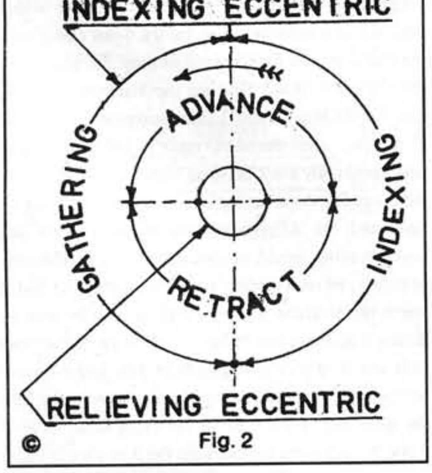


Fig. 2

So far so good; we have got a means of indexing a blank cutter already gashed and attached to the ratchet wheel for 9,12,18 or 36 teeth if the ratchet wheel itself has 36 teeth. But if the blank merely rotates about a fixed centre it will not be backed-off so there must be another eccentric hidden in the mechanism somewhere, the relieving eccentric, which advances the blank towards and away from the fixed form tool as each tooth was indexed. The ingenuity and subtlety of the device became apparent from the "timing diagram" reproduced in Fig. 2 from which it will be seen that as the ratchet pawl is gathering, the ratchet wheel does not rotate but the relieving eccentric will withdraw the blank from the form relieving tool which will then be in the middle of one of the gashes between the teeth. At the end of the gathering phase the ratchet pawl will have engaged a tooth and the continued motion of the ratchet eccentric will start rotating the ratchet wheel and with it the cutter blank. At the same time the relieving eccentric will start to advance the blank towards the form tool and the tooth will be relieved by a combined rotary and radial motion. Once this principle had been grasped it was easy enough to calculate the throw of both eccentrics, both of which must be adjustable to accommodate different tooth numbers and back-off angles and their relative

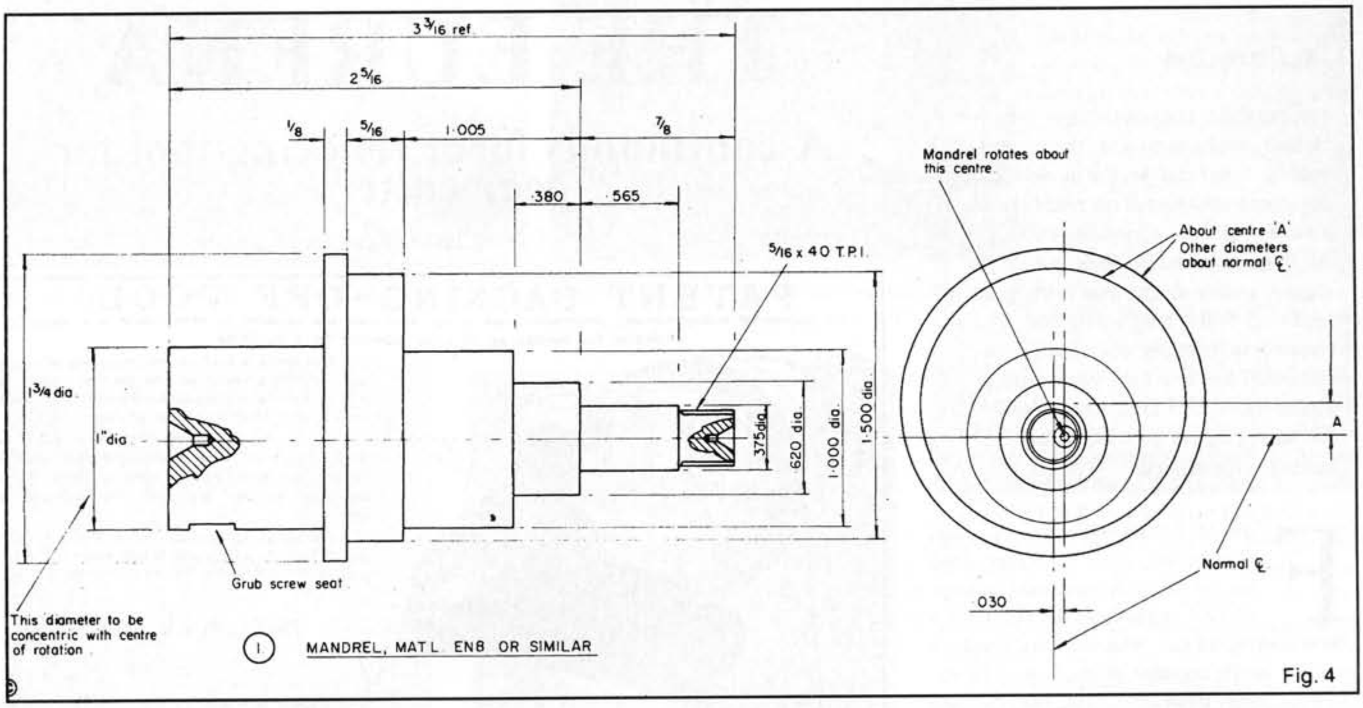


Fig. 4

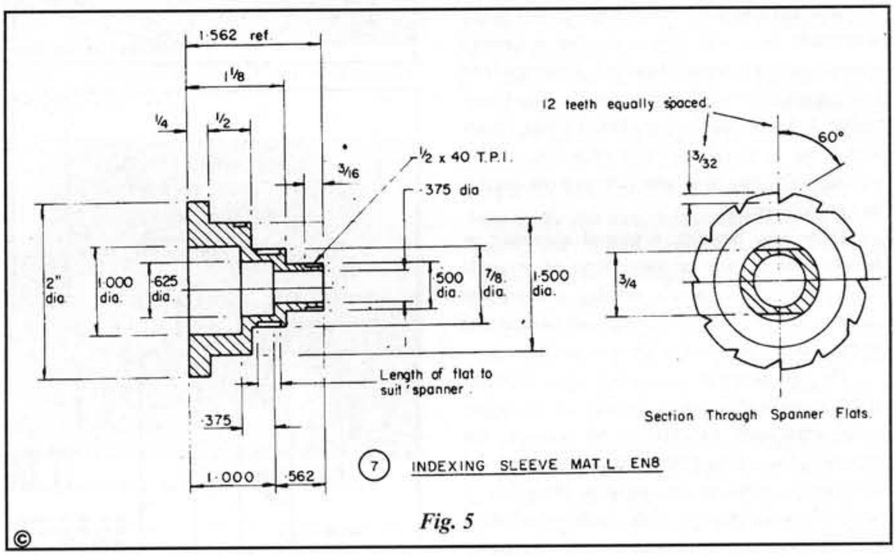


Fig. 5

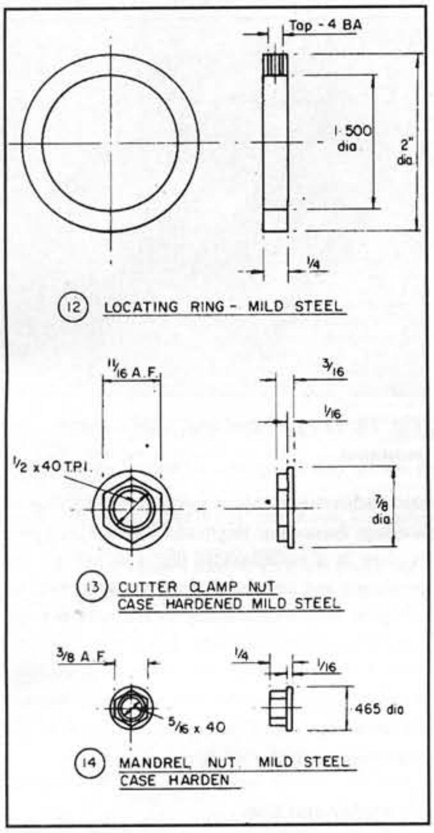
angular displacement.

It looked so promising on paper that Ivan Law said that if I would prepare dimensioned sketches he would make a prototype for practical test. We agreed, however, that an attachment the size of the one illustrated in the catalogue capable of relieving cutters up to 3 in. dia. by ¾ in. thick would be too large for the average amateur and that, since he would be making his own cutters, there was no need to cover such a wide range of tooth numbers. We decided, therefore, to reduce the size of the attachment to accept cutters with a ½ in. central hole ¼ in. wide and up to about 1¼ in. diameter—the same sizes in fact as those used by "Duplex" in his excellent series of articles in Model Engineer p.611, 16 June 1949 et seq. to which reference should be made for an excellent method of preparing the form tools for shaping cutters for gears of different numbers of teeth and diametrical pitch. We also decided that the construction, particularly in the smaller size, would be very much simplified if the variable adjustment of the throw of the eccentrics to suit different numbers of teeth were omitted. So one prototype as finally built has a tooth ratchet wheel and relieves cutters with this number of teeth—which seems entirely adequate for the size of cutter involved. The prototype machine was in fact completed and demonstrated on the SMEE workshop stand at the 1986 Model Engineer Exhibition where, running between centres at low speed in back gear, its repeated intermittent motion, like a hesitation waltz, was quite hypnotic to watch. Better than this, owing to its extreme rigidity it relieved 20 DP form cutters in silver steel without a trace of chatter. So successful was it in solving the perennial problem as to how to relieve form cutters in the home workshop, to which many solutions have been proposed but none entirely satisfactory, that Ivan Law has prepared working drawings of the machine as he actually made it. Fig. 3 shows the general arrangement and though it may look complicated the actual machining is relatively straightforward, the only departure from normal turning being the eccentric turning of the eccentrics on the Mandrel, Part 1.

The Mandrel

The mandrel (Item 1, Fig. 3) is the heart of the machine and the most tricky to machine because it has been reduced in size to accept ½ in. bore cutters it is rather slender at the cutter end and yet has to withstand the full force of the form tools when relieving a cutter in tool or silver steel. It is recommended therefore that it be made in something tougher than free cutting mild steel. EN8 which is colloquially called "40 carbon steel" has an ultimate tensile strength of 35 tons/sq. in. and a yield strength of 18 tons/sq. in. and is not too difficult to machine, although the free-cutting grade EN8M, if it can be obtained, is easier. Of course, steels of even higher specification can be used and a professionally made machine would have the mandrel case-hardened and ground, but a "soft" mandrel lubricated with MoS2 grease before final assembly will have a very long life.

Because the mandrel must be turned about two eccentric centres, one of them only 0.030 throw, and have concentric centres at each end, it is not possible to adopt the usual method of marking-out, centre popping and centre drilling as the centres would intersect. It is therefore a job for the 4-jaw chuck with the blank set over for eccentric turning. So, with a dial test indicator (d.t.i.) first set the blank to run true. Then, with Nos. 1 and 3 jaws horizontal, move the blank over until the d.t.i. reads 0.168 in. It will become slightly slack between Nos. 2 and 4 so tighten them equally. As a further check, rotate the blank by hand and the difference between the highest and lowest reading should, of course, be 0.336 in. This can, of course, be read directly on a long travel d.t.i. but if one is not available a short travel one can be used by setting it at centre height behind the work on the cross slide and bringing it forwards to find the highest point. Set the d.t.i. and the cross slide index to zero and turn the work half a turn. Bring the cross slide forward 0.366 in. and at the lowest point the d.t.i. should again



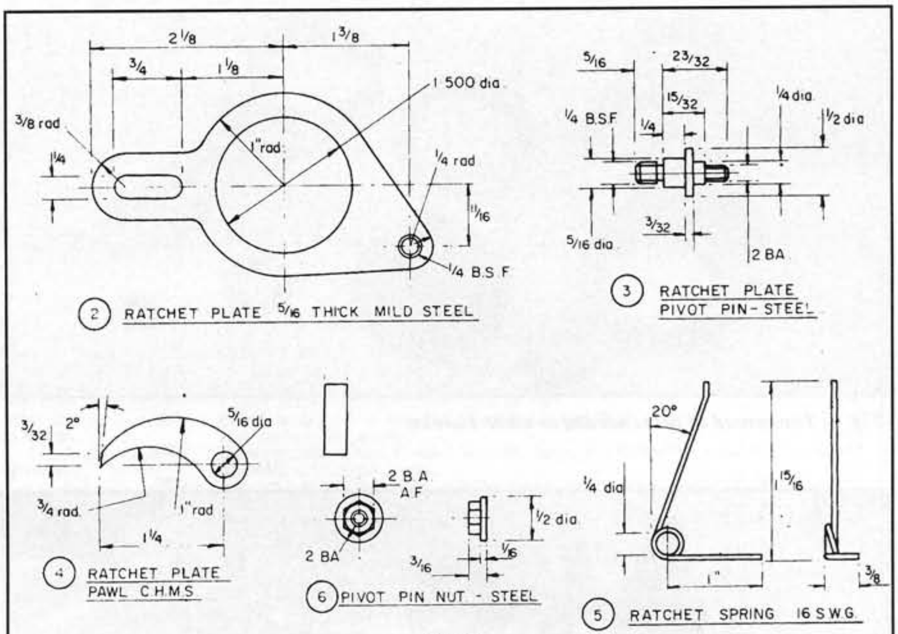


Fig. 7

read zero. The advantage of doing it this ways is that not only is the error in eccentricity doubled, and can be corrected, but working from the back of the cross slide feed screw which is rarely used there will be little or no wear on the threads.

At this stage a decision must be taken whether the turning can proceed with the work overhanging from the chuck or whether a back centre support must be used. If the lathe is in good condition this should be effective but if a back centre support is needed the blank must be at least ½ in. longer than that shown on the drawing at the small end so that a temporary centre can be put in it and machined away before the next setting. At this setting, however, the 1.500 in. and 1¾ in. diameters can be machined, the former being brought to a fine finish.

Using Nos. 1 and 3 jaws again, the work is brought back to run true—again with the d.t.i., of course. With care the work should not turn in the chuck but this can be checked by confirming that the high point of the already eccentrically turned portion is still opposite to No. 1 or No. 3 jaw and if necessary making any correction. Using Nos. 2 and 4 jaws, the work can now be offset 0.030in. as before and checked that the total throw is 0.060 in. but make very sure that it is in the right direction, i.e. it must lead the previously turned eccentric when viewed from the tailstock end as in Fig. 3. If necessary a small centre can be drilled for additional tailstock support and the remaining 1.000 in., 0.620 in., 0.375 in. diameters turned and the 5/16 in. x 40 tpi screw thread lathe cut. Now is the time to pay particular attention to the various lengths given on the drawing which are intended to give a clearance in certain positions and a close running fit without endshake in others. They are best achieved by using the leadscrew with micrometer index on the handwheel to regulate the length of cut and distance between shoulders to the dimensions given. The 0.620 in. dia. is a

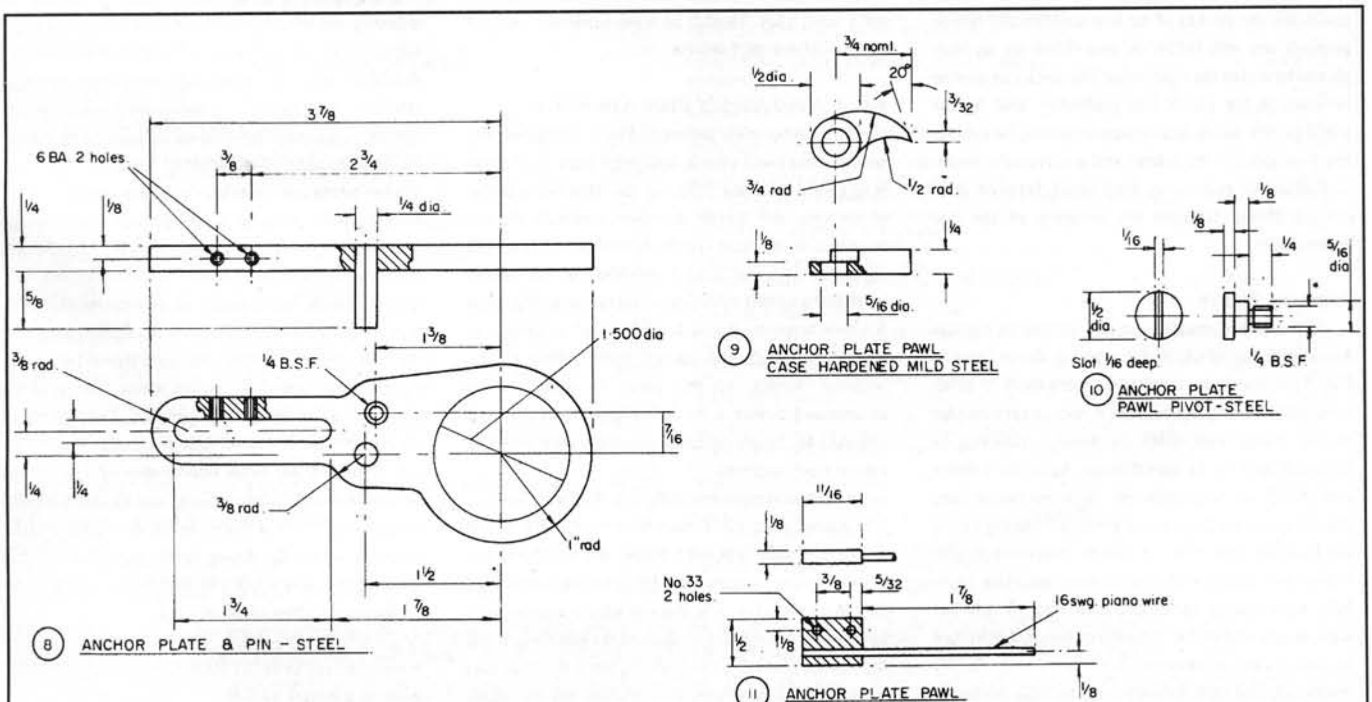


Fig. 8

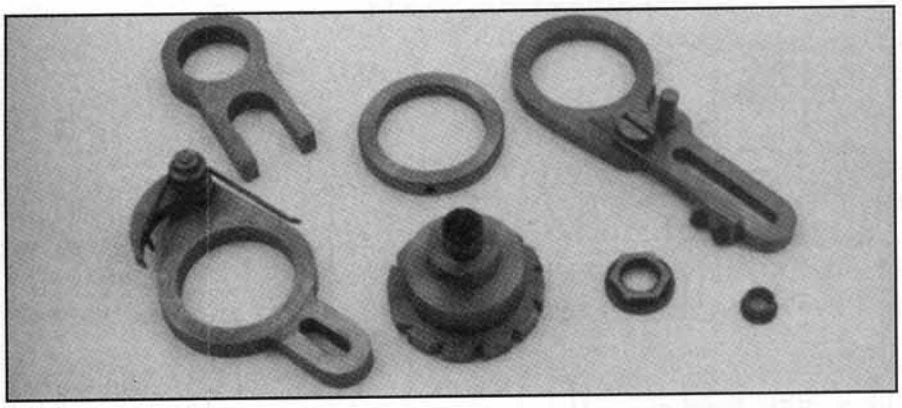


Fig. 9: The spread of parts needed to make Eureka.

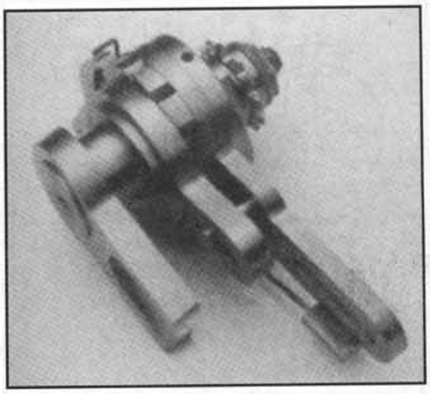


Fig. 10: The finished tool, with a cutter mounted.

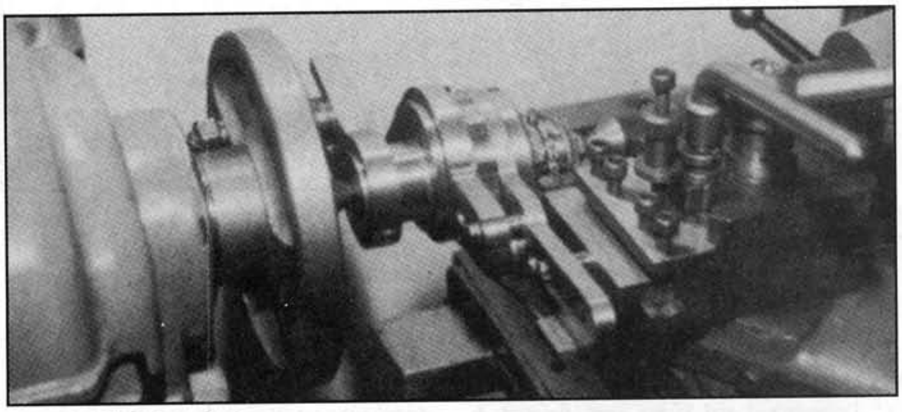


Fig. 11: This is Eureka in use.

clearance but the 0.375 in. dia. is for a close running fit and should be brought to the best possible finish. The final operation after the temporary centre, if one has been used, is machined away and the 7/8 in. dimension brought to length is to re-centre to run true and drill the final centre about which the mandrel will rotate. But before doing so it would be well to check that the strokes of the two eccentrically turned portions are still 0.336 in. and 0.060 in. as they should be and in the right order. The work can now be reversed in the chuck and preferably held by the 0.620 in. dia. which is a clearance centred for turning the 1 in. dia. for the carrier and a permanent centre drilled in this end too. A final check between dead centres should confirm the accuracy of the two eccentrics.

Indexing Sleeve

The finished mandrel can now be used as a gauge for other parts, of which the indexing sleeve (item 7, Fig. 5) is the most important. Fortunately it is all concentric turning but because it, too, is very slender at the cutter end, EN8 or similar material is recommended for its manufacture. Again the 1.000in and 0.375 in. diameters are most important and should be bored the closest possible running fit on the mandrel. The 0.562 in. length dimension is also important because when the mandrel nut, item 14, is fully tightened up the sleeve must rotate freely but without any end shake. It would be prudent therefore to leave this dimension oversize in the initial machining and trim it down prior to final assembly. Cutting the 12 ratchet teeth and the spanner flats is a straightforward milling operation with a dividing head.

The other items to complete the indexing sleeve assembly are the locking ring, item 12, and the cutter clamp and mandrel nuts, items 13 and 14, shown in Fig. 6. Because the last two are, of necessity, relatively slim it is recommended that even if made of mild steel they should be case-hardened and, of course, all threads lathe cut.

Ratchet and Anchor Plate Assemblies

The ratchet plate assembly, Fig. 7, comprises the ratchet plate itself, item 2, machined from 5/16 in. thick bright mild steel, the 1.500 in. dia. hole being bored to fit over the larger diameter eccentric on the mandrel. At the outer end the ratchet pawl, item 4, is supported on a pin, item 3, screwed into the ratchet plate and a nutted extension to carry the spring, item 5 which bears on the back of the pawl to keep it in engagement with the ratchet teeth. Although the nominal length of the pawl is given, it is recommended that it be left slightly oversize and adjusted for length on final assembly, after which it can be case-hardened.

The anchor plate assembly, Fig. 8, is very similar. The anchor plate itself, item 8, of 1/4 in. thick bright drawn mild steel is bored 1.500 in. dia. to fit over the corresponding diameter of the indexing sleeve and carries a pressed-in 1/4 in. dia. pin which engages with the corresponding slot in the ratchet plate. To avoid interference between the working parts the backstop pawl, item 9 is counterbored 1/2 in. dia. and carried on a headed pivot, item 10. It is held in engagement with the ratchet wheel by a spring, item 11. Again, although the nominal length of the anchor plate pawl is given, it is recommended that it be left soft and overlength and adjusted on final assembly with the complete attachment running in the lathe between centres until both pawls drop cleanly into the ratchet teeth without over-run or excessive backlash. Note, too that in final assembly the backstop pawl is below the indexing sleeve and invisible in either the engraving or the photographs.

Assembly and Use

A spread of parts is shown in Fig. 9, the assembled appliance in Fig. 10 and in use in Fig. 11. No. details for the drive carrier are given but since the cutting motion is intermittent it must be positively driven from the catch plate either by a peg in. the latter engaging a slot in. the former or vice versa. Equally, no details of the form tools—although their general shape can be inferred from the sketch in Fig. 3 and the photographs. The cutting edge must, of course, be at centre height and each must carry a 1/4 in. dia. peg to engage the anchor plate to keeping the indexing and relieving in phase with the cutting edge. For the shape of the form tools themselves reference should be made to the already mentioned series of articles by "Duplex" which, using circular arc cutters, is an excellent method of generating cutters for involute teeth of any number and DP.

In preparing blanks for gear cutters it is recommended that, in addition to turning in the ordinary way to save excessive work on the relieving attachment, the blank should be first profiled with the form tools but without, of course, relief. It can then be gashed with twelve teeth but in mounting it in the relieving attachment make sure that at the end of the gathering phase and before the beginning of the indexing phase the gash is centrally disposed about the edge of the form tool. Also remember that once a cut is put on, the lathe must make 12 revolutions before all the teeth are relieved and the next cut can be applied. However, thanks to the slow drive and the eccentric action, the device is very powerful and will quite happily take a 0.001 in. to 0.002 in. depth of cut in annealed carbon or silver steel.

Finally, my thanks to all who have taken part in solving the riddle of "EUREKA" and producing what must be a unique tool. ●

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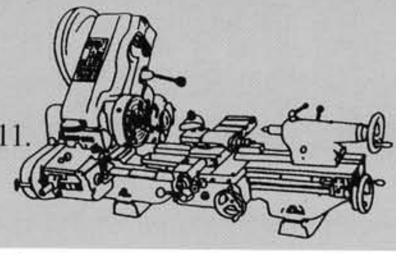

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