

No.47

MODEL ENGINEERS'

WORKSHOP

THE PRACTICAL HOBBY MAGAZINE

**MODELLING
MACHINE
TOOLS**

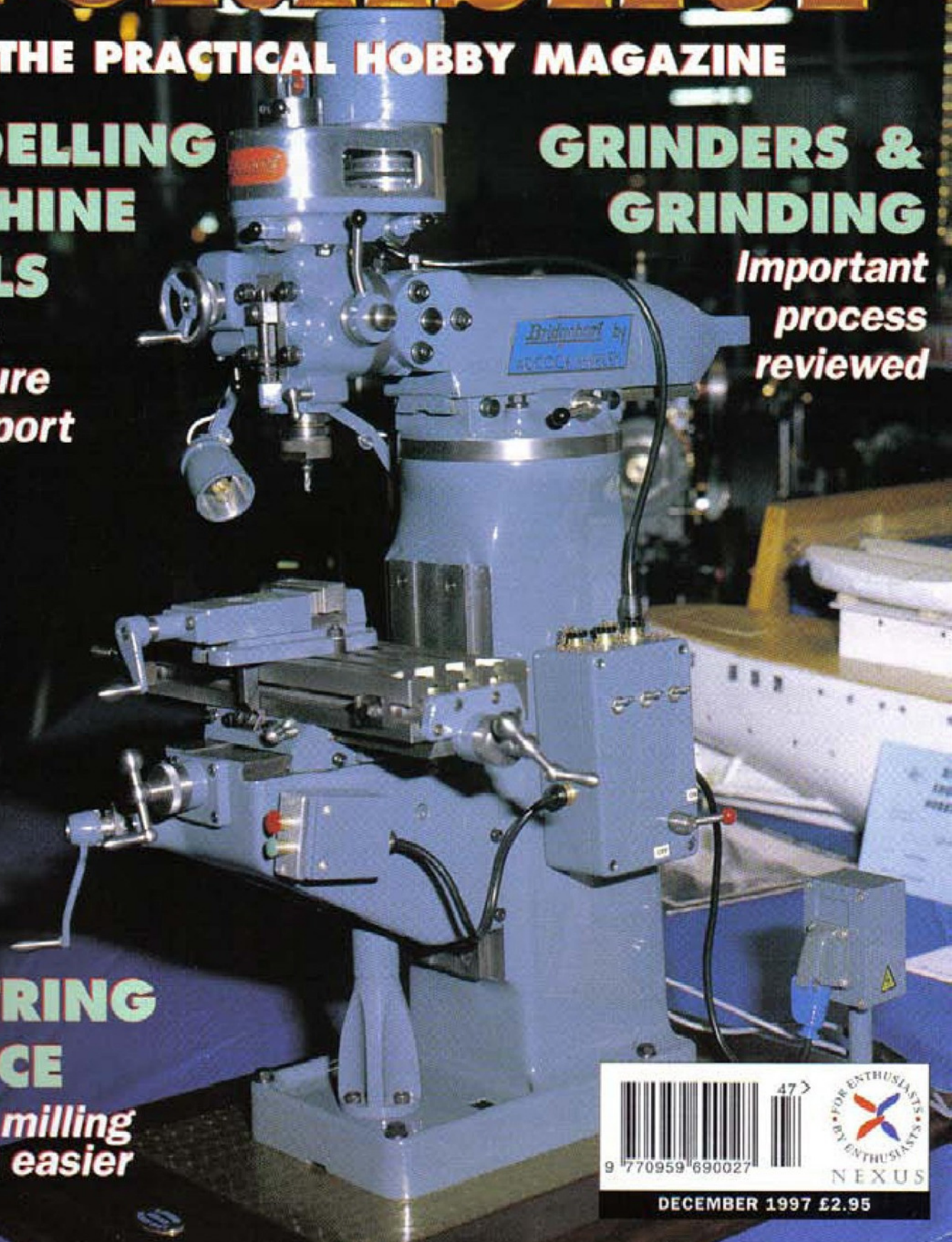
*Superb
miniature
Bridgeport*

**GRINDERS &
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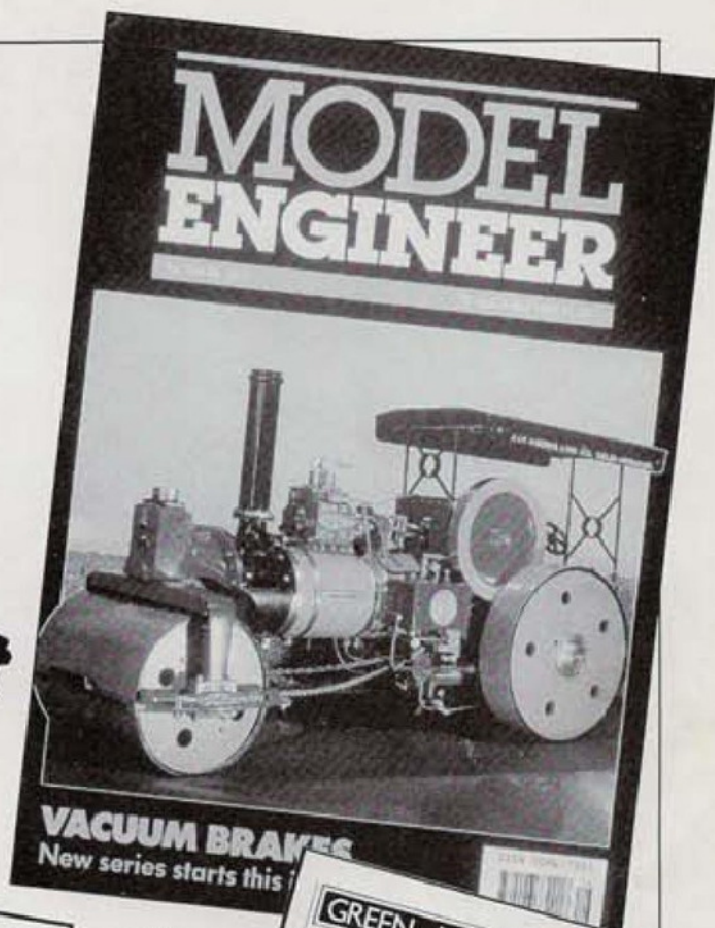
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FORWARD
TO...**
...every fortnight



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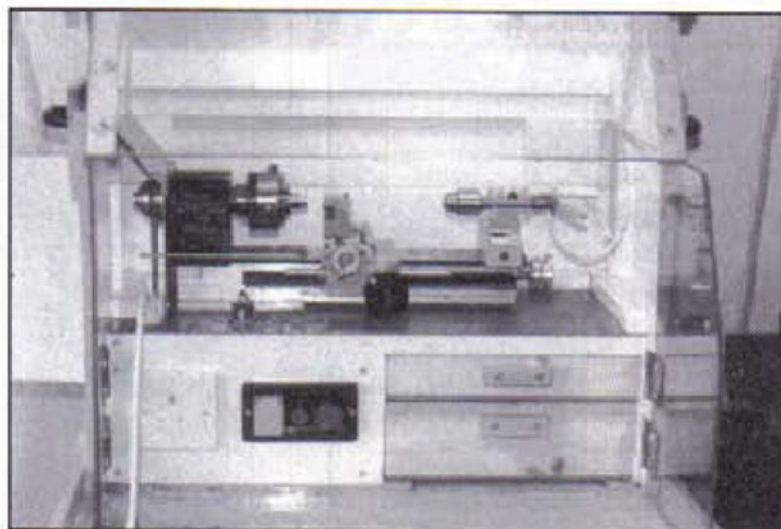
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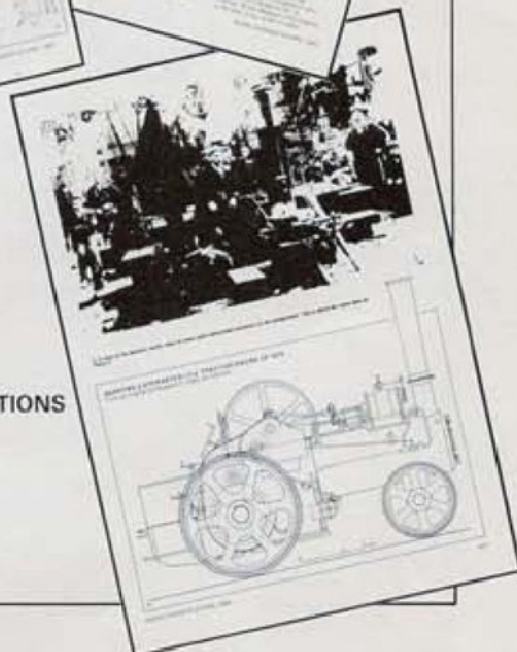
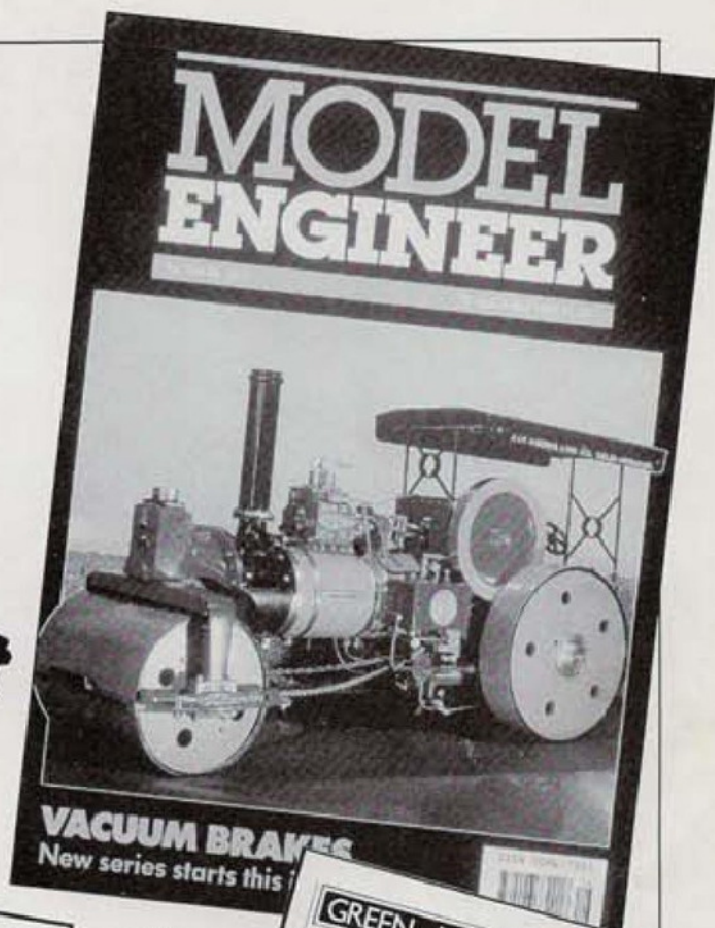
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Tooling puzzles to get you over the lethargy of the festive season.**On the cover**

First shown at the Bristol Exhibition this superb working model of a Bridgeport milling machine gained high awards at the recent Midlands Model Engineering Exhibition. Those who have not had the chance to examine this masterpiece will get their chance at the forthcoming Centennial Model Engineer Exhibition at Olympia. Builder, Barry Jordan tells a little of what was behind the project starting on page 45. (Photo: Ted Jolliffe).



The Peatol lathe comes as a basic machine tool but is capable of adaptation to many modes. This example is by David Hudson the aim being to provide a self contained mini-workshop for use indoors. In this issue Richard Bartlett describes how his version of the same machine, nicknamed Pete is used as a CNC machine to engrave nameplates.

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ON THE EDITOR'S BENCH

Over the past few weeks, we have been marvelling at a superb example of craftsmanship, in the form of Barry Jordan's outstanding miniature Bridgeport milling machine, which we show on the cover of this issue, and which Barry introduces within these pages. Following its appearance at the Bristol exhibition, it has recently been awarded major honours at the Midlands Model Engineering Exhibition which took place at Castle Donington.

Having spent a great deal of time at both exhibitions looking at this and the other models on display, and talking to many of the trade representatives, I have been pondering on the state of model engineering and the direction which it is taking. This is of interest to me because it may give some clue as to what model engineers will be seeking from their workshops in future years and perhaps give some guidance as to what to include within the magazine.

I am aware that a significant proportion of the readership operate home workshops in support of their involvement with the restoration and maintenance of full-size mechanical artefacts. Their workshops tend to be equipped with larger machinery, and their working practices lean more towards those used in industry, albeit perhaps those more familiar a few years back.

The true model engineer, however, working in a smaller scale, usually has somewhat different expectations of his equipment. Additionally, as has been pointed out to me quite frequently, many of our fraternity are working in confined spaces and are often operating on severely restricted budgets, and so their machinery is likely to be older, smaller and has to be more versatile. It is for this reason that designs for attachments and accessories continue to be so popular, even though examples of these have been described many times over. What then are the lessons to be learned from studying the items on view at these exhibitions?

The first is clearly that standards of fidelity and workmanship have risen

significantly over recent years. I am not referring just to those exhibits which are entered in the competitive sections at the major exhibitions, but more importantly, to those which are to be seen on the club and society stands. These displays are only made possible because those whom we consider to be among the ranks of the 'average' modeller are prepared to send their work to help put on a show. This gives us a far better insight into what is being produced in the majority of workshops. The higher standards are made more apparent when models made in an earlier age are brought out to put on a display of more historic material, and are on hand to provide a direct comparison.

The second is that the physical size range of models has increased. Not only are we seeing some very large models, such as half size steam driven road vehicles, but also working multi-cylinder internal combustion engines of small capacities that very few modellers would have dared to tackle only a few years back.

Are we seeing any changes in the subject matter of the models produced in the average home workshop, if there is such a thing? I believe that we are, but I must admit that it is all too easy to begin to come to a conclusion on this topic, only to go to another exhibition and have one's ideas turned completely upside down by a display of new work. Perhaps this is because the construction of a complex model of any size can take so long that we have little idea of what is 'in production', and suddenly we are confronted with a number of examples of the type of subject that we thought to be extinct. Only by careful observation over a protracted period shall we be able to draw any valid conclusions (and then we are still likely to be wide of the mark).

I do believe, though, that the steam powered road or agricultural vehicle is steadily supplanting the steam locomotive. Perhaps it is the freedom of operation allowed without the need for a fixed track which is encouraging this, or perhaps the popularity of the traction engine rally, where the working model exhibits sometimes appear to outnumber the full-size ones. As mentioned, it is in this branch of the hobby where the average size seems to have increased significantly, though it must be said that a similar trend can be seen in the railway locomotive field, where 5in. gauge seems to have supplanted 3 1/2in. gauge as the norm, and 7 1/4in. gauge models are much more frequently encountered, and models of large prototypes at that! One effect of this escalation of sizes in both

fields is that the professional boiler makers are inundated with work, as the majority of builders feel that they have neither the skills or equipment to tackle a pressure vessel in this sort of size.

At the other end of the scale, efforts seem to be concentrated on extracting more power from smaller prime movers, with better specific fuel consumptions. In previous editorials, I have mentioned the work going on in the development of miniature gas turbines and on Stirling cycle engines. Experimenters in these fields are working with more exotic materials than have been traditional in model engineering, and are seeking to produce complex shapes and work to very fine limits. These techniques have been perfected in industry, but usually only with capital investment at a level that few home workshop enthusiasts could justify.

Looking across this spectrum, there seems to be no alternative for those wishing to operate in the larger sizes than to accept that investment in suitably sized machinery is an inevitable consequence. We all tend to make our equipment handle jobs larger than that for which it was designed, but there are limits which cannot be exceeded, however much ingenuity we exercise. As far as the smaller experimental work is concerned, much depends on the inventiveness of our fraternity, and this is where magazines such as M.E.W. can help to spread the knowledge of such developments, provided, that is, that the innovators are prepared to share it. M.E.W. depends upon its contributing authors. Some are involved in engineering professionally, but many gain their experience only from their home workshops, and whatever their status, they are all amateur writers. The days when *Model Engineer* operated a workshop, manned by a team of staff technicians, are long gone, so we rely heavily on our 'volunteers'. If you feel that you may have a contribution to make, if it is only a letter to Scribe a Line, then your fellow readers will be indebted to you. What direction do you feel that we should be taking?

Incidentally, the hobby does appear to be in better health. One supplier of machinery recently described the market as 'buoyant', and several have noted an upturn in engineering at schools and colleges, with a measure of re-equipping of workshops taking place. Perhaps the British engineering industry isn't about to be consigned to the pages of history, after all.

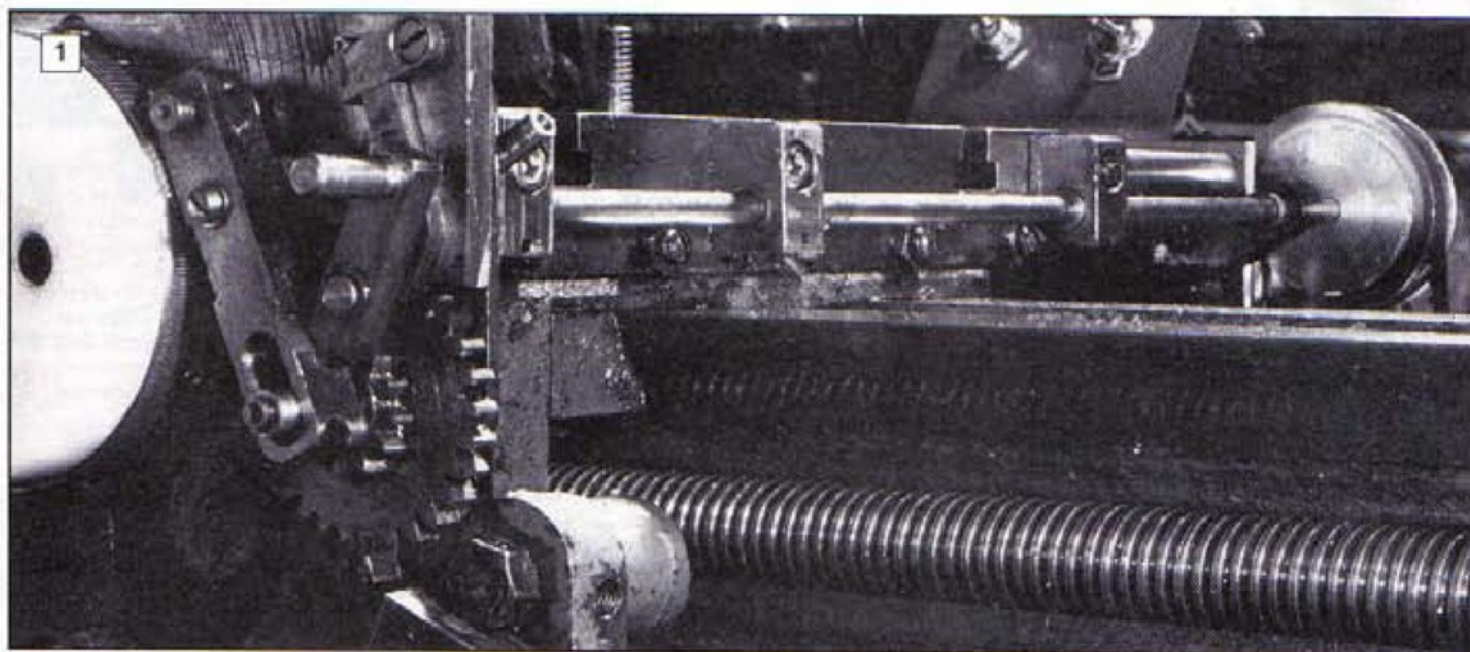
Seasonal Greetings

As this will be the last issue of M.E.W. to be published before Christmas, I would like to take the opportunity to wish readers, contributors and advertisers best wishes for the festive season, and a happy, peaceful and prosperous New Year to all.



LATHE UPGRADE ON A BUDGET

John Shrubsole describes a major modification which he made to his early Myford lathe. Similar principles could be used to enhance similar lathes of the period



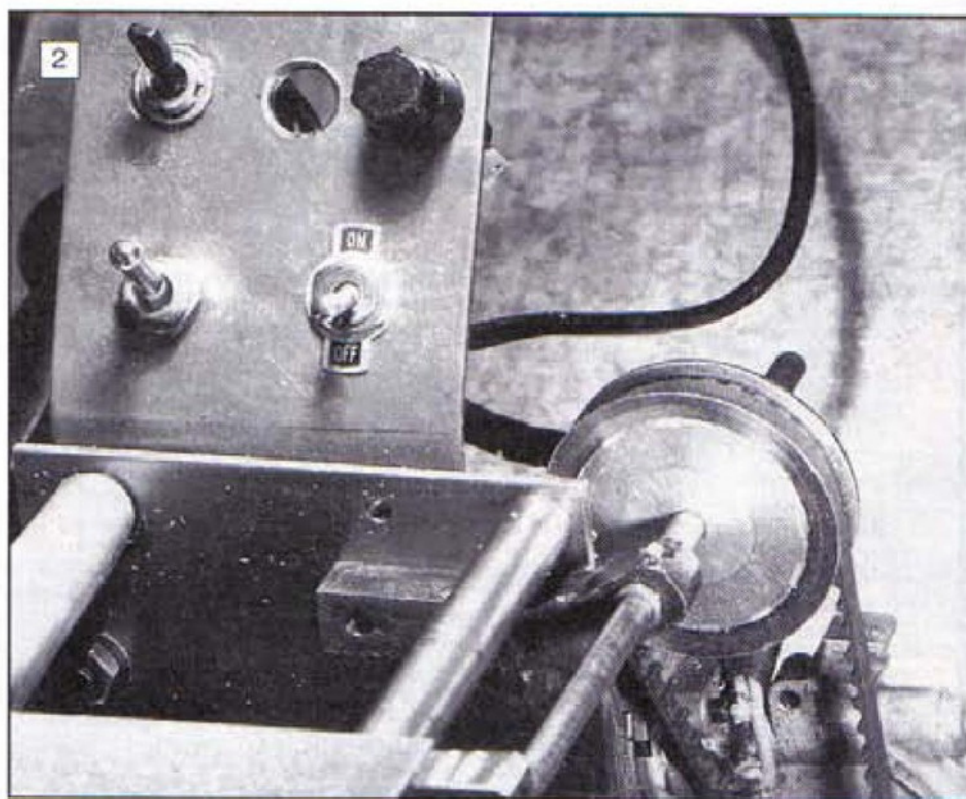
A general view of the power cross slide showing the transfer shaft bringing the drive from the rear mounted motor to the front of the slide.

The Powered Cross-slide

Having done much work on the lathe, improving its performance and productivity, the powered cross feed is one of the last major improvements that can be done. The approach to this venture was the same as that previously adopted, very much experimental, not knowing quite when or where it might end up, and if it didn't work I could easily revert to the original equipment.

My original concept was to have a very basic electrical powered drive to the cross-slide feed screw, being switched on and off as required, purely to gain a better result of the work being done. How one thing leads to another! The end product is a power feed, mechanically engaged and disengaged, with two mechanical speeds forward and reverse, with a further two speeds electrically forward.

Once again, 'costs' (or the lack of them) were at the forefront of my mind, and to this end I believe I have been reasonably successful. The power source came in the guise of a car electric window winder motor, so a visit to the local car scrap yard could prove worthwhile. If possible, get a passenger door one as it will have had a lot less use than the driver's. Obviously being a car electric motor it will be 12V DC,



A close-up of the tooth belt drive from the motor and the control panel.

therefore a small car battery and charger will be required, but most people I know in this activity already possess these items. The other purchases were a drive belt and pulley wheels, similar to a previous mod. relating to the lead screw feed speed reduction, and some gear wheels. Most other materials came from the bits box. (Photos 1-3 show the component parts in detail).

To demonstrate the effectiveness of this venture, I know that my cross-slide and its feed screw have some serious wear in them. However, having adjusted the cross-slide to its best possible situation, using the power feed I faced off a 4in. disc, which showed a dead flat surface with a consistent finish. This couldn't be achieved previously, so I felt adequately satisfied with the effort and its result.

Project overview

Before explaining how to go about manufacturing and installing this modification, it will probably be a good idea to start locating the materials we are unlikely to have at hand, and to have a brief overview of the project. General Arrangements are shown in Figs 1 & 2.

The motor, as previously stated, was used solely on the basis that it was available and about the right size in physical dimensions. I later found out that its output speeds are 60 and 120 rpm. Also consider the small size car wiper motors and the motors from electrically operated aerials, as these have worm reductions which bring the output drive speeds down dramatically and also produce plenty of power.

The belt and pulley wheels can be sourced from bearing retailers, and are usually readily available.

The sizes I used are:-

Belt:-	110XL025	1 off
Toothed pulley wheels:-	30XL037	1 off
	10XL037	1 off

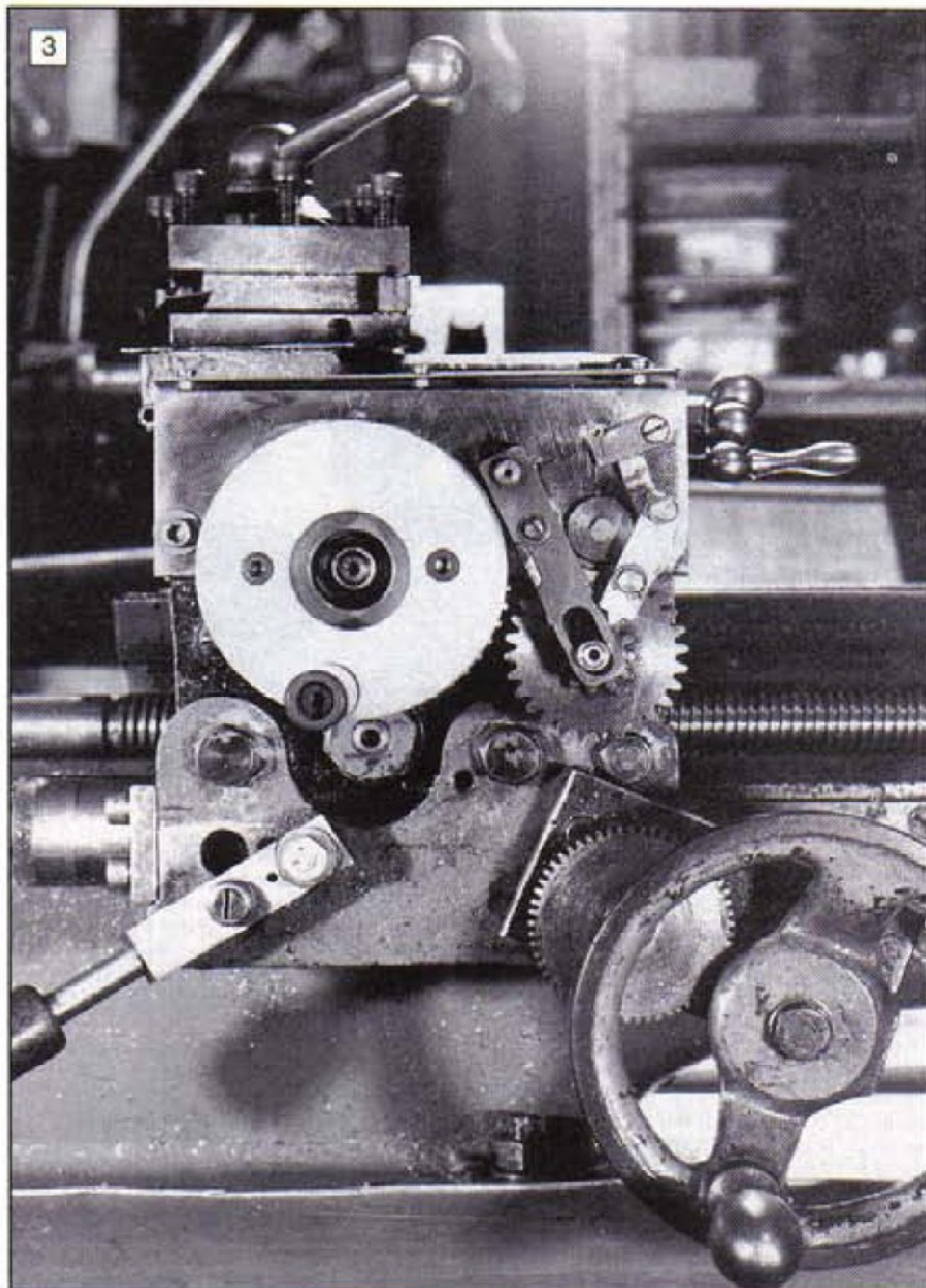
The four gear wheels:-

3.125in. dia. (48 Teeth)	1 off $\frac{3}{16}$ in. thick	PG16-48
1.875in. dia. (28 Teeth)	1 off $\frac{3}{16}$ in. thick	PG16-28
0.875in. dia. (12 Teeth)	1 off $\frac{3}{16}$ in. thick	PG16-12
0.875in. dia. (12 Teeth)	1 off $\frac{3}{8}$ in. thick	PG16-12

Suitable gears can be obtained from Hinchcliffe Precision Components Ltd., Chesterfield. Tel. 01246 209683. They supply exactly the same pitch gears and I quote their codes for these items.

The objective is to provide an electrically powered drive to the cross-slide feed screw, giving a final speed of 2 to 2 1/2 turns per minute, and which can be engaged and disengaged precisely with ease. This speed is about as fast as the graduated ring can be read and controlled satisfactorily, also it produces a good finish to the work. The speeds that I achieved are 2 1/2, 3 1/2, 5, and 7 rpm. However, there is scope for some adjustment of these by changing the ratio of the belt drive from the motor, or by altering the gear ratios.

The drive motor is suspended on an adjustable plate at the rear of the cross-slide, driving a transfer shaft along the length of the cross-slide via a toothed belt and reduction pulley wheels. Electrical protection of the equipment is by fuses; mechanical 'over-travel' protection is achieved by the feed screw disengaging



The front of the power cross slide showing some of the modifications made to this area of the machine.

from its nut when facing from the centre, and a micro switch electrical lock-out when facing towards the centre. Power to operate the motor is supplied by a battery, and is operated through fuses and switches which are mounted on a plate at the rear of the cross-slide. Mechanical engagement of the drive to the feed screw is by a small lever situated to the right-hand side of an additional front plate.

At the front of the cross-slide, a gear drive from the transfer shaft relays the motion to the cross-slide feed screw, this mechanism being further utilised as a clutch and speed change.

The cross-slide hand wheel has been completely re-worked, providing the asset of a larger, easy to use hand wheel, with the 0.001in. graduations now nearly 0.100in. apart, and therefore much easier to read. The whole of the front part of the modification projects less than did the original hand wheel from the front of cross-slide. The plunger blocks at the side of the cross-slide project about a

further 3/8in. This shouldn't create any operational problems unless the tail stock is used at extreme limits.

On with the work

To get a feel for the project, the best place to start is probably with the fittings that attach directly to the cross-slide itself. These are:-

- two mounting studs to the rear,
- two adapter studs to the front, and
- three plunger blocks to the side.

These parts are probably the most critical dimensionally, as they project the cross-slide datums, so care should be taken to ensure that threads and spigots are all concentric, and that the plunger blocks are as near identical as possible.

The plunger block bushes need to be a push/press fit into the blocks; location can be assisted by the use of a metal adhesive. The longest bush fits into the front



The cross slide handwheel stamping jig. Construction is self evident.

plummer block with 0.062in. projecting at the rear of it. The three remaining bushes fit the other two plummer blocks and one support bracket, all equally spaced within them.

Manufacture of the remaining parts is straightforward. Any comments pertinent to them will be made during assembly.

It will be necessary to remove the cross-slide from the lathe to drill and tap the various holes. When drilling, squareness is essential, so I clamped the cross-slide to an angle plate and in turn bolted that to the drill table. If you have a tilting drill table, ensure that it is square with the drill. From here onwards, I would suggest that all holes are lightly countersunk to remove any burrs and provide a good fitting surface. Dare I say it? If you don't have one, here the investment in an engineers countersink bit could well prove worthwhile. Although a larger drill will do the job, it will leave chatter marks, and consistency of good quality work will be difficult to maintain.

The two mounting studs are set into the rear of the cross-slide (Fig. 3) and in turn carry all the mounting plates and motor etc. The two adapter studs replace the original screws which hold the front plate to the cross-slide, and carry an additional front plate. (These can be fitted later when we tackle the front part of the modification, so keep them safe).

The three plummer blocks are bolted and pinned to the side of the cross-slide and carry the transfer shaft. As can be seen from the general arrangement drawing, they are sited away from the 'T' slots and gib strip adjusting screws if possible. Should they fall foul of these screw lock nuts, then the back corner of the block can be filed away sufficiently to allow the nut to rotate. Also note that the blocks are fitted to allow the transfer shaft to be at the same height as the two front plate mounting screws, and that the top of the blocks are below the upper surface of

the cross-slide. The front block is situated to be in line with the front of the cross-slide casting (not the front plate) providing the datum for gearing at the front of the cross-slide.

The transfer shaft is not in the detail drawings, but is a length of $\frac{1}{4}$ in. BMS, 16 - 17in. long.

When fitting the plummer blocks, drill and tap for the front one only at first. Install with the cap screw lightly nipped, and with the rear most block in its approximate position, slide the transfer shaft through both blocks and align the shaft, ensuring that it is parallel to the top of the cross-slide. Clamp the block in position and drill the next hole using the block as a guide. After tapping the thread, install the block with its cap screw and leave loose. Fit the shaft into the two plummer blocks and now lightly nip the second cap screw, which may cause the shaft to tighten up and not rotate freely. It may be necessary to release both screws and gradually re-tighten the screws while rotating the shaft. If there is gross misalignment, the shaft probably won't turn at all, but I'm sure that you will have achieved a reasonable result. To release any bite on the shaft, apply a small amount of fine carborundum grinding paste and a light lubricating oil to the shaft at the plummer block locations, rotate the shaft using a slow speed drill, moving the shaft back and forth. Care should be taken not to over do this process. When cleaned up and lubricated, the shaft should rotate freely. With these two blocks remaining in position, the centre one can be fitted in the same manner. With all three blocks securely in position and the shaft rotating freely, the roll-pin holes can be drilled in the cross-slide, again using the blocks as guides to ensure exact location, and the pins then inserted. I set my pins $\frac{1}{4}$ in. into the cross-slide, with $\frac{1}{8}$ in. into the blocks. The reason for the roll-pins is to create a positive location, and to provide a means

of easy alignment should it be necessary for the plummer blocks to be removed and refitted.

Both mounting studs can be fitted to the rear of the cross-slide and the fixed plate added.

The support bracket should be drilled but not tapped on initial manufacture, as yet once again the holes are used as guides. With the transfer shaft fitted, place the support bracket on it and clamp in position onto the front side of the fixed plate. Withdraw the shaft, remove the fixed plate complete with clamped support bracket and drill the holes in the plate. Tap the holes in the support bracket, bolt together and reassemble onto the cross-slide. Lap the shaft and bush as before if necessary. By now you may be thinking that this shaft must be best part worn out, so did I, and used another piece of material - there's no expense spared here!

Fitting the adjuster plate is no more than a Meccano exercise, and you have the drawings. The motor is shown in alternative positions (more about that later), and is best set up with the pulleys and belt in-situ. Once again, nothing difficult here, therefore no dimensions have been given, except to note that the mounting bolts were tapped into the adjuster plate. The motor mounting brackets have the centre hole slightly offset, this will give an additional amount of adjustment if required, by being fitted either way round. Note that the corresponding halves should have identification marks added.

The micro switch and static brackets, which are simply folded brass plate, can have the mounting holes elongated, as this will allow some adjustment when setting the operating rod (which should be parallel to the cross-slide) into position. The rod guide, which has not been drawn, is simply a nut silver soldered to the head of a micro switch mounting bolt, drilled out to the rod diameter and then dressed off with a file to look presentable.

Luckily, selecting a drive motor was easy for mine, my bits box threw one at me which proved to be ideal. Obviously, worm drive motors can be purchased new, and can also be mains supply driven, but before going down this road, give careful thought to the fact that a loose cable is necessary to supply its power. The motor I used had some switch gear and gears attached. Not being of any value in its new application, they were removed with part of the casing and the case sealed with a piece of simulated channel, with two screws tapped into its side and used as clamp screws.

Before mounting the motor, it will almost certainly need some modification. Firstly, the drive shaft will need extending or replacing. Replacing the shaft is not difficult and I'm sure that you can manage that without detailed guidance; just note that when removing the drive gear that carries the existing shaft, there are likely to be very small shims, stuck with grease to either the gear or casings. These should be looked after carefully, and replaced in the same locations when re-assembling the drive. The shaft I made was longer than required and made to extend in both directions from the gear.

Wiring to the motor is likely to be of various meaningless colours and quite

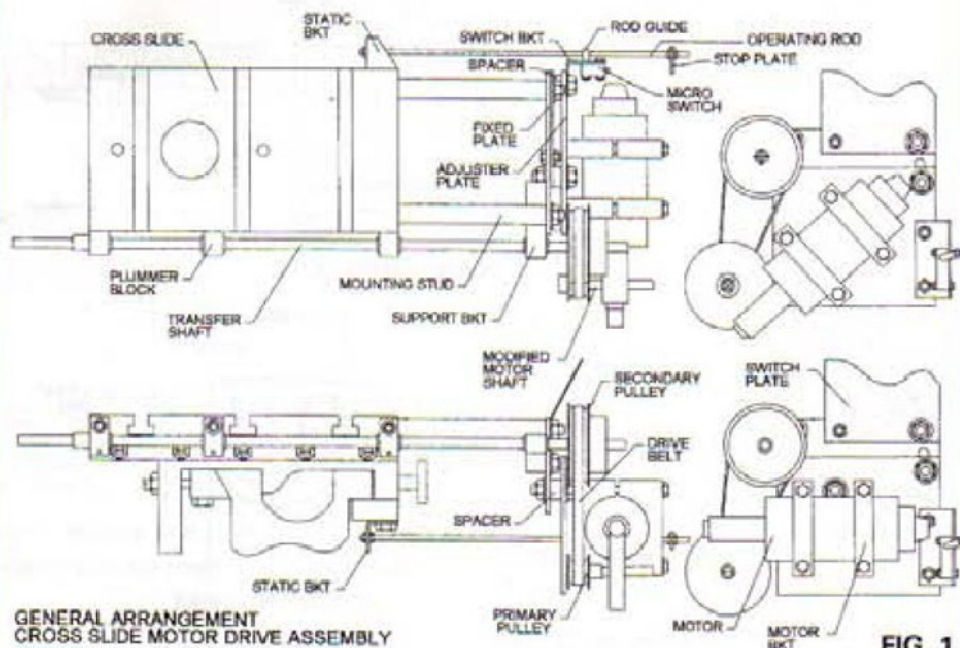


FIG. 1

all the components are made first, it is easier to fit them on with the cross-slide on the bench. In this case it will be necessary to remove the front plate and slide the cross-slide on to the saddle from the rear of the lathe. With the front plate and feed screw off, it will be easier to adjust the gib strip to obtain the best possible fit. When refitting the feed screw and front plate, the previously made front mounting studs can be used, but be aware that they will protrude and could become a knuckle trap. Temporarily fitting a piece of polythene tube or the like over the ends could be beneficial.

When fitting the transfer shaft, a thrust collar (not drawn) is required to be fitted behind the rear-most plummer block, to eliminate any end float in the shaft when final assembly takes place. This can be made from an additional adjuster plate spacer, and tapped to accept a suitable grub screw.

As this modification is mainly mechanical, I'm sure that, like myself, you would prefer to continue down that route to complete the mod. and to deal with the electrics later, so on to the front of the cross-slide.

The Front Half

Looking at the G.A. drawing, it may appear somewhat confusing, but as the various components, and sub-assemblies are made, all becomes clear.

The single most difficult part that I found to produce was the additional front plate. This I did in the lathe, on the face plate. Simplistically, it is best described as a piece of $\frac{3}{16}$ in. plate with holes cut in it, and then covered on one side with another plate ($\frac{1}{16}$ in.), again with holes cut in it. In reality it was made from $\frac{1}{4}$ in. plate, with the holes and recesses turned out of it. Ironically, this is the type of project that this very modification will make easier to accomplish. To make life a little easier, I have drawn and dimensioned this item from the rear of the view from which it will normally be seen, as the front is completely flat.

The gearwheels that I used started off being $\frac{3}{8}$ in. thick, it was necessary to reduce all but one (0.875in. dia.) to $\frac{3}{16}$ in. thick. The largest gear has the centre bored out to 0.875in., the remaining three are bored to 0.437 in.

Manufacturing the hand wheel assembly, which can be made from a variety of materials, is an interesting and rewarding turning exercise. In the drawings I have shown optional materials, the first that which I used, the second would have been my next choice, but any suitable material, can be used.

If the parts are made in drawing number order, the hub can be used as a plug gauge to ensure that the other parts fit correctly. On the hub drawing, you will notice a radial score line is called for. There are two reasons for this:-

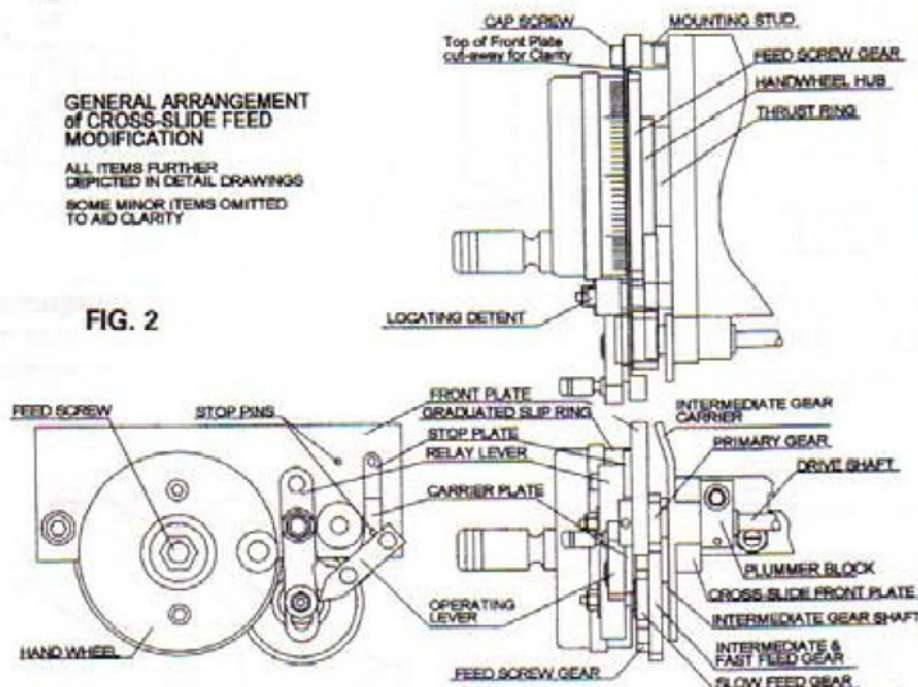
- i) It denotes the location of the grub screw, and
- ii) It lines up with a scored line on the handle.

The reason for the latter is that, when drilling the opposing holes, it is very difficult to get them exactly opposite, and this line simply becomes an assembly mark.

GENERAL ARRANGEMENT of CROSS-SLIDE FEED MODIFICATION

ALL ITEMS FURTHER DEPICTED IN DETAIL DRAWINGS
SOME MINOR ITEMS OMITTED TO AID CLARITY

FIG. 2



short, and will thus need to be extended to reach the switch panel. I would suggest using soldered joints for this purpose, with shrink wrap insulation. Leave about 30in. of wire attached. There are likely to be at least three wires going to the motor; one will be common, one, slow speed, and the other fast speed. Some care is needed here as it will be almost impossible to know which is which.

The way the fast speed is obtained in these motors is by adding a third brush to the commutator, and please note that this speed is not reversible. With a fused link, experiment with the wires and a battery to identify what the wires do, and make a note. As you will find out, by reversing the

polarity of the slow speed, the motor will run in the opposite direction. By doing the same with the fast speed, there won't be a corresponding speed in the opposite direction, and an additional humming sound may persist. If allowed to continue, it will damage the motor. Using the information gained will determine which way the motor is fitted to the adjuster plate. With the motor in its position at the rear of the cross-slide, the fast speed drive rotation is clockwise, which will give two speeds when facing off towards the centre of the lathe.

It is possible to fit the cross-slide back onto the lathe immediately after fitting the plummer blocks and mounting studs, but if

©

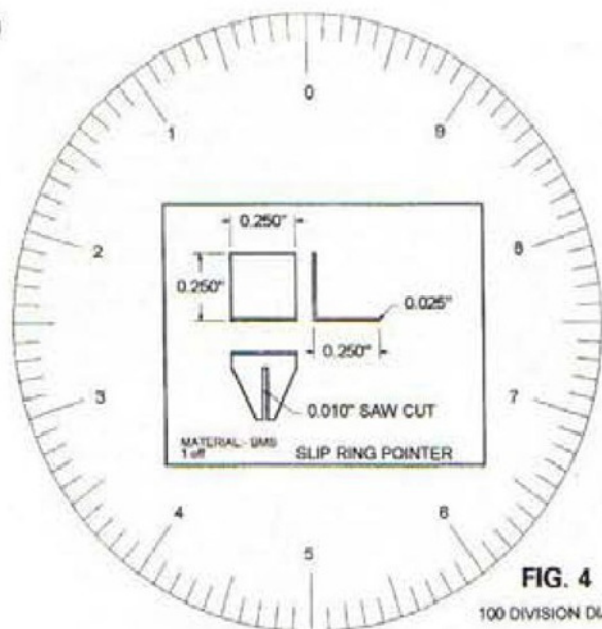
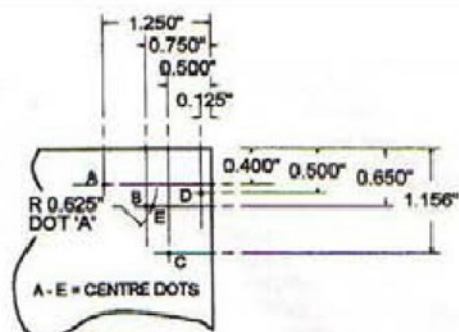


FIG. 4
100 DIVISION DIAL



STAGE 1
PLACE CENTRE DOTS

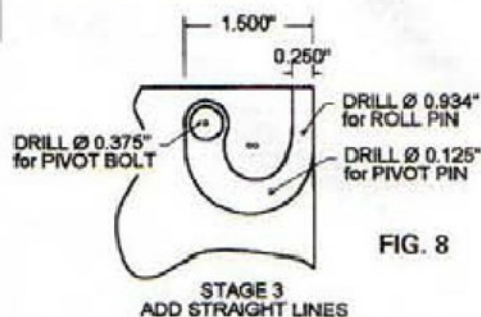


FIG. 8

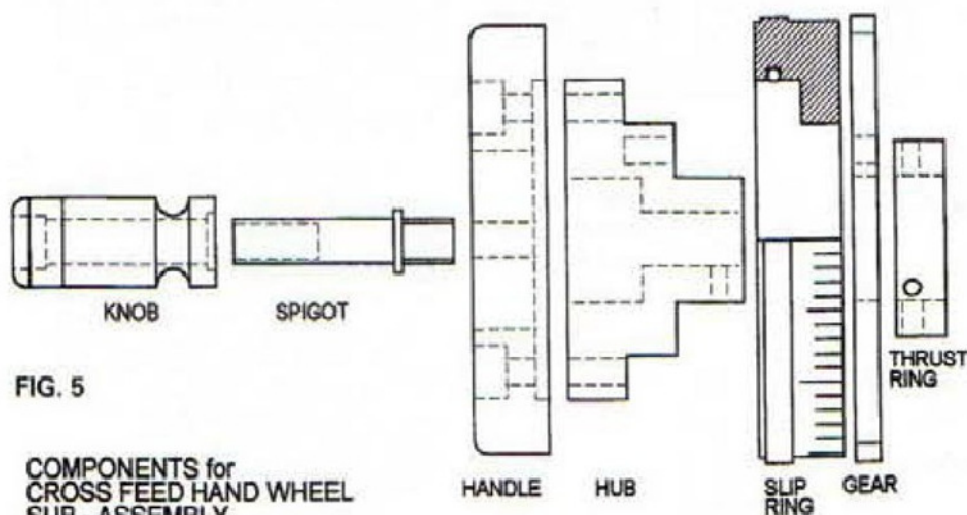
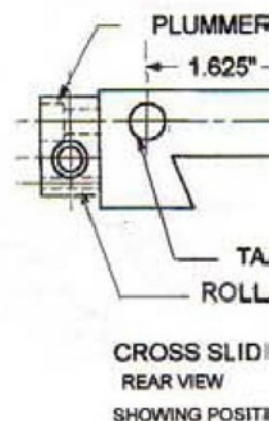
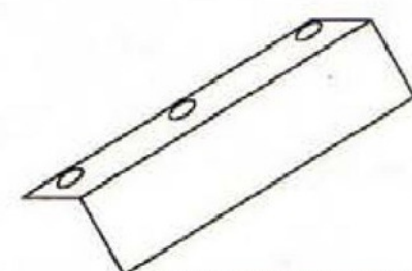


FIG. 5

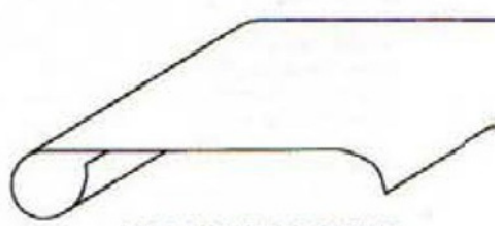
COMPONENTS for
CROSS FEED HAND WHEEL
SUB-ASSEMBLY



CROSS SLIDE
REAR VIEW
SHOWING POSITION



FOR FRONT OF CROSS SLIDE



FOR REAR OF CROSS SLIDE

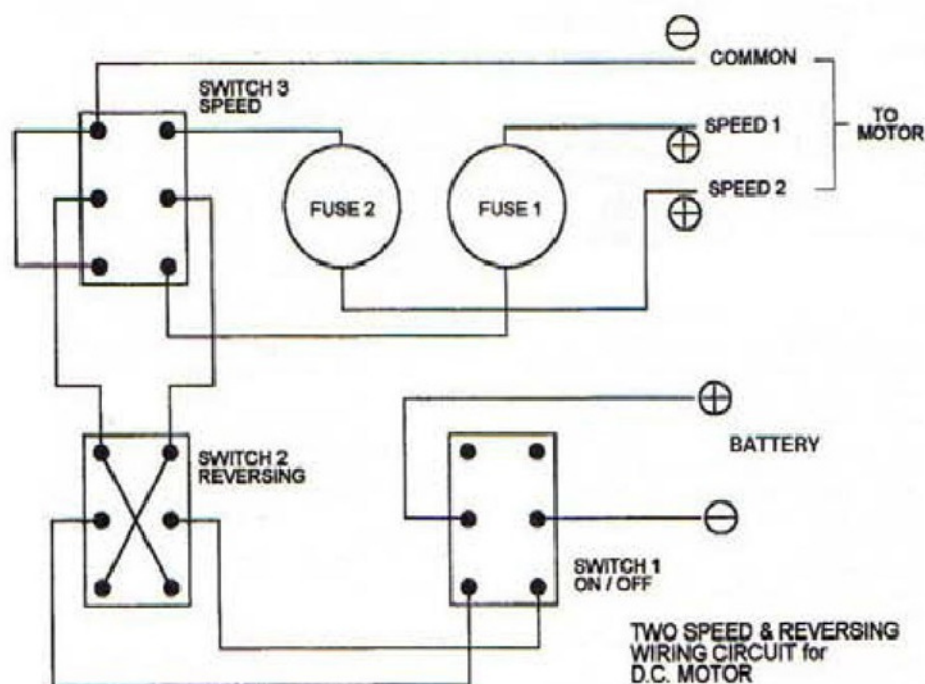
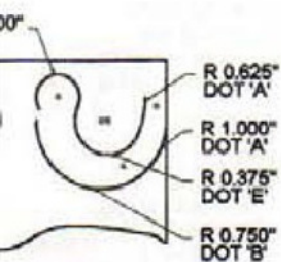


FIG. 10

TWO SPEED & REVERSING
WIRING CIRCUIT for
D.C. MOTOR



STAGE 2
ADD ARCS

CARRIER PLATE MARKING OUT PROCESS

Material - BMS 1/8" or 3mm PLATE
10ft
REMOVE ALL SHARP EDGES

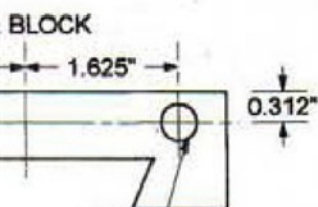


FIG. 3

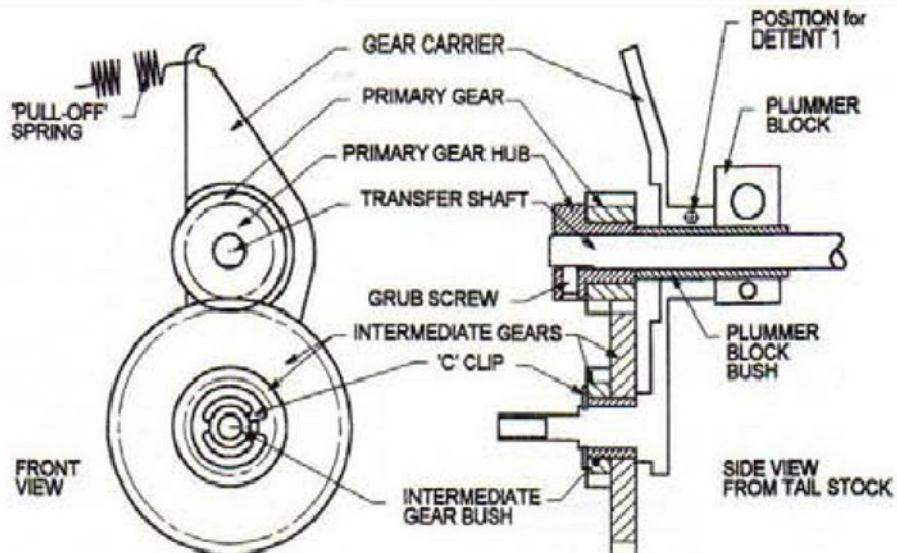
E with PLUMMER BLOCK

ONS OF MOUNTING STUDS



FIG. 11

COVERS FOR
THE MODIFICATIONS TO
THE MYFORD
'M' TYPE 3 1/2" LATHE



INTERMEDIATE GEAR CARRIER ASSEMBLY

FIG. 7

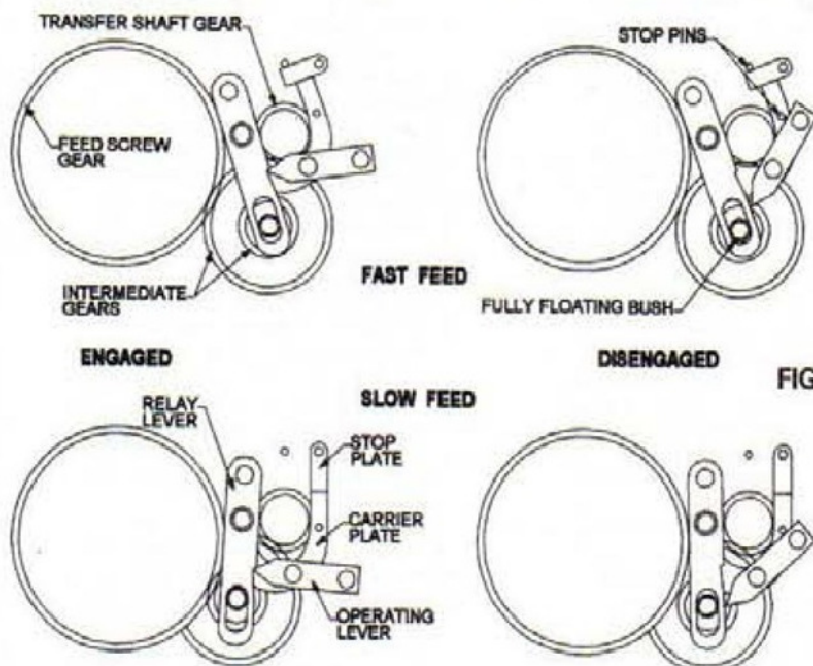


FIG. 9

OPERATING POSITIONS of GEARS and LEVERS For CROSS SLIDE POWER-FEED MODIFICATION

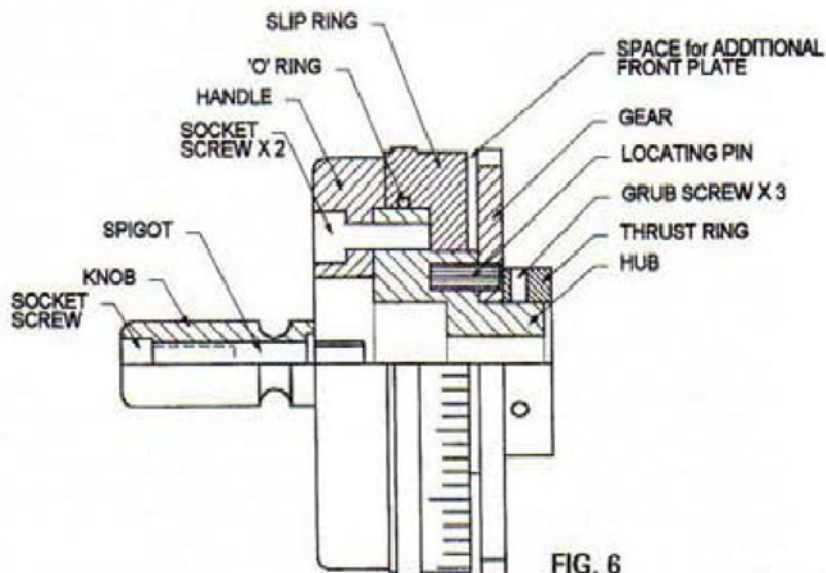


FIG. 6

CROSS FEED HAND WHEEL ASSEMBLY

©

The graduated slip ring has an 'O' ring fitted into it to act as an anti-rotation device. I used $\frac{1}{32}$ in. dia. material (not critical), which was cut to length from a larger diameter ring. Although this ring is not joined, it has a slight compression fit into its groove (slightly too long) and the groove was machined to allow the ring to protrude about 0.010in. so as to provide the grip.

Graduating rings

I had the slip ring graduations done professionally. However since then, a fellow model engineer and I have developed and tested a very simple method of graduating hand wheels and similar items. It employs a disk (the largest diameter which can be turned in the lathe), cut from Perspex/plastic, with the centre bored out to the diameter of the chuck mandrel. To this disk we glued a computer-drawn graduated circle (Fig. 4), and then fitted it on the mandrel behind the chuck. With the ring to be graduated centred up in the chuck, a pointer was used at the periphery of the circle to coincide with each graduation line. A pointed tool was set up to cut sideways at centre height, and the lathe set to its slowest speed without using the back gear. This puts some load on the headstock and helps to prevent the mandrel from turning freely. With the power turned off, the chuck can be rotated by turning the lay shaft large drive wheel to align the radial lines on the disk with the pointer. The length of the graduation lines on the slip ring can be determined by the use of the top slide or saddle stop. It is a simple job to score a line, then move on to the next and so on. To assist with the identification of the different length lines, use highlight pens of different colours to mark the five and ten thousand divisions on the disk. This operation does require some concentration, so take a break for a cuppa now and then.

For marking the numerals onto the slip ring, I made a jig, (Photo 4). This was of welded construction, the slot for the number punch being milled out on the lathe with the jig clamped to an angle plate, in turn bolted to the cross-slide. Before attempting to stamp the ring, clean the sides of the punches by rubbing on a sheet of fine emery cloth laid on a flat surface, ensuring that they have free movement in the milled slot. Also highlight the front of the stamps, as this will help to ensure that they are installed the correct way round. When stamping the numbers either side of the lines, judgement is required to be sure the marks are 'just' either side of the line. Too far apart and they will look a little odd and lose their impact. Remember, **any** mistake here can destroy a lot of work, or you be reminded of it every time you use your machine. We can coin a new motto here, **"Concentration = Have A Cuppa"**.

Hopefully you will have noticed that the scored line in the bore of the hand wheel handle, which should coincide with the line on the face of the hub. This leads on to say that when drilling these parts, it is probably best to drill the two parts together, to ensure adequate alignment.

The feed screw gear is driven by a locating pin (not drawn separately) $\frac{9}{16}$ in. long by $\frac{3}{16}$ in. dia., which is driven into

the No. 13 drilled hole of the hub.

Assembly of the hand wheel assembly (Figs. 5 & 6) is quite straightforward. Use a little lubricant on the 'O' ring and, when fitting the thrust ring, ensure that the plain drilled hole is located over the grub screw for the hub. On assembly, the thrust ring should be lightly clamped to the hub, with the feed screw gear sandwiched in between. The thrust ring has been designed to be the adjustment component in this assembly, it can be made narrower, or a shim cut and placed behind it, to suit the position of the additional front plate. The thrust ring, being a larger diameter than the original thrust area, sets up a new thrust and wear area on the front plate. This will give a smoother operation.

When manufacturing the gear carrier, bend the top over after machining and before soldering the centre boss and gear shaft in place. The reason for the bend is to carry the pull off spring from the far side of the additional front plate. When soldering the two components to the gear carrier, ensure that they are square with it. Note that the distance between the centre boss and the gear shaft may vary depending upon the size of gears used.

The primary gear, which is the $\frac{3}{8}$ in. thick gear, is a press fit onto the primary gear hub. The remaining two gears are a press fit on to the intermediate gear bush, which is then fitted to the gear carrier and located with a 'C' clip. This then becomes the gear carrier assembly (Fig. 7).

Detail drawings of the small components are shown, none of which requires much guidance, except for detent housing 1. As well as being a detent, it also doubles as a handle or knob, so you may well choose to shape it to look more like small handle.

Also shown is an item titled carrier plate, which has an awkward little shape. Please don't ask how I arrived at it, but it is basically a short curved slot. The way to deal with this is to paint a square corner of suitable material with car type aerosol primer paint which, when dry will provide a good marking out surface. When the centre dots have been placed (Fig. 8), it can be repainted and the next stage proceeded with, without the construction lines to create unnecessary confusion. Drill the holes before cutting out the shape of the plate, while there is something to get hold of. The operating lever fits onto the pivot pin (which is to be silver soldered into the carrier plate), and is located with a 'C' clip. The relay lever is straightforward apart from the indent recess in the side, which has not been dimensioned fully. At this stage, mark and start the detent, cut to a depth of about 0.030in., then leave until a little later in the assembly procedure.

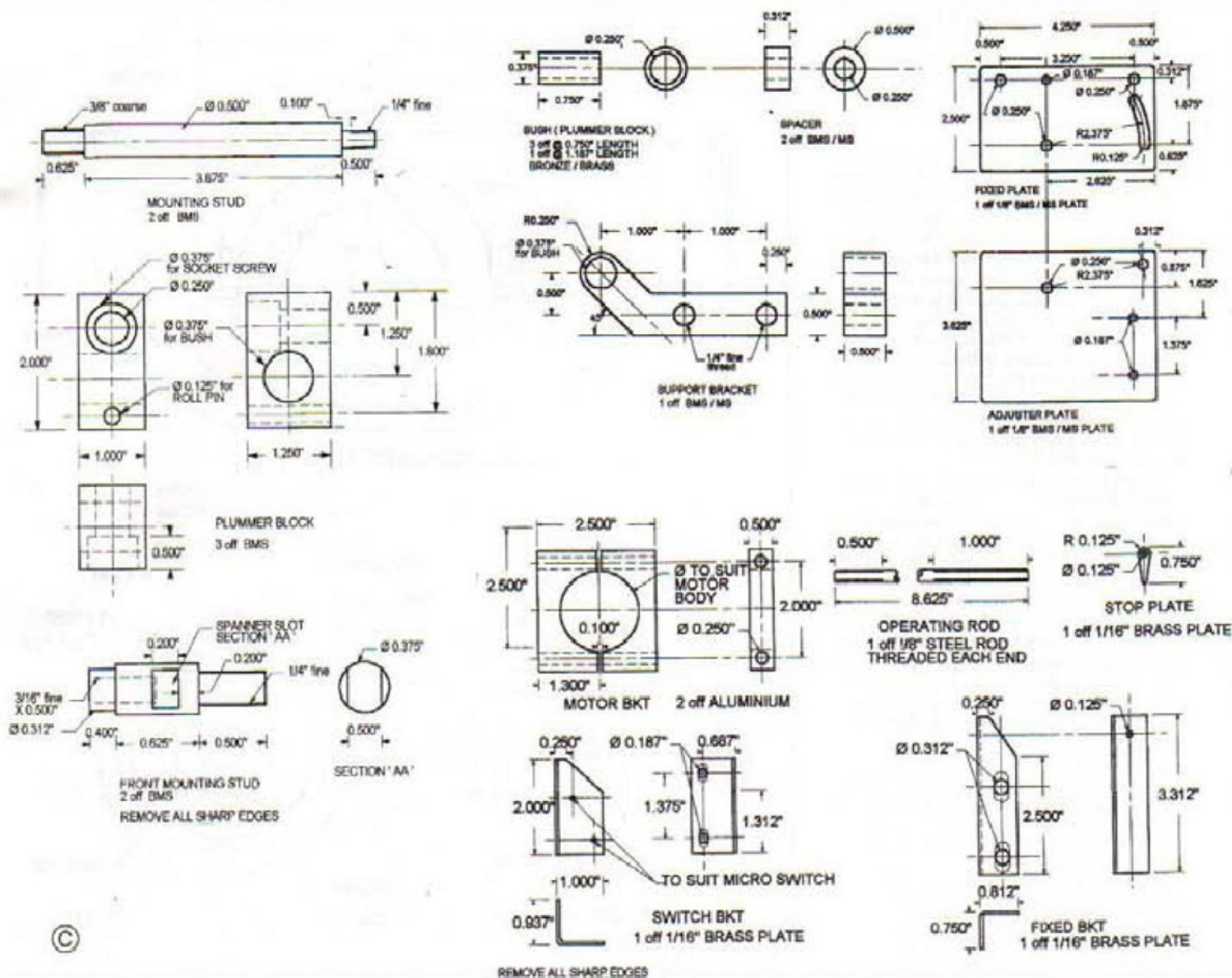
Assembly and Operation

These processes involve a degree of assembly and disassembly to achieve optimum results. Once having made the parts and sub-assemblies, study the photographs and Operation Positions drawing (Fig. 9), I'm sure that things are becoming clearer.

First fit the new hand wheel assembly. To be able to make use of the lathe, a temporary pointer can be made up and clamped under the top slide nut. Next,

install the gear carrier assembly on the front plunger block, followed by the primary gear on to the front of the transfer shaft, eliminating any end float by setting up the thrust collar previously fitted to the shaft. Now the gear train is in place, check its operation by moving the gear carrier assembly backwards and forwards, rotating it to engage with the hand wheel gear; to ensure gear engagement is possible in both speeds. When this is satisfactory the position for detent housing 1 can be determined. This is at the right hand side of the gear carrier boss, in such a position that it will not rise above the top surface of the cross-slide. With the gear carrier in its operating position, mark the top of the boss for the oilway drilling, which also goes through the plunger block bush. Remove the primary gear assembly and then the gear carrier assembly. When doing the necessary drilling, endeavour to position the holes longitudinally apart. This may allow a small clip to be placed over the oilway drilling, to prevent the ingress of debris. I used a small centre drill for the oilway, as this gives a neat cone to receive the oil. Unfortunately it necessary to remove the transfer shaft from the front plunger block to drill through the bush and then dress the bore. With the oilway drilled and the detent location drilled and tapped in the gear carrier, place it back on to the plunger block in a working position. Using a scriber, mark the position of the oil way on to the bush, and also mark the two operating positions of the detent through its tapping. With the gear carrier removed, the oilway through the bush can be completed, and with the use of a round needle file, the two indents can be made at the marked locations. The depth of the indents relates directly to the size of steel ball used. A suitable compression spring is required to load the steel ball. I used a coarse, rather heavy duty type of spring, cut to the length of the detent housing bore. When compressed, with the ball in place, this gave a satisfactory operation. The reason for this detent is to prevent the gear carrier from drifting out of drive and to provide a feel of location when changing the drive speed. There are no mechanical forces at work to force the gear carrier to move along the bush, so this detent need not be too tight, but I'm sure that vibration may have an unpredictable effect if it were not located. When you are happy with the detent and oilway, leave in place and refit the transfer shaft and primary gear, this time permanently.

Fitting the additional front plate requires the hand wheel assembly to be released from the cross-slide lead screw and withdrawn sufficiently to allow the additional front plate to be located in the space between the slip ring and the hand wheel drive gear, then together moved back onto the lead screw, also locating the plate onto the two studs. When in place, a socket screw can be put into the left hand stud and the relay lever pivot bolt into the right hand stud. The flats on this bolt are for a spanner to tighten it, and the remains of the circular flange are for the carrier plate to register on. At this time we need to consider making a pointer for the slip ring, and here you can fashion one to your own preference. I got a bit carried away



here in terms of necessity and milled the additional front plate and soldered one in. Rather than using a scribed line as a pointer, I used 0.010in. saw cut (see drawing). This gives one the advantage of looking down on to horizontal lines. Also, when a graduation line is in the saw cut, it is as accurate as can be reasonably be expected.

Press the relay lever bush into the centre hole of the relay lever and place this unit on to the pivot bolt, with the gear shaft spigot of the gear carrier in the elongated slot. Place the fully floating bush on to the spigot inside the slot. Move the relay lever to engage and disengage the drive in both speeds. This should be able to be done freely without excessive free movement. It may be necessary to lengthen the slot to obtain full movement.

Fitting and setting up the carrier plate and stop plate is a bit of a balancing act which I think requires a little explanation of the theory behind it which will, I'm sure, make the following procedure fairly straightforward.

The depth of the indent in the relay lever is obviously directly related to the size of the gear teeth, but as the indent is nearer the axis point of the lever than the

intermediate gears, the dimensions reduce proportionately. A second feature on this front is that using two gear sizes, the amount of movement required for both size of gears will not be exactly the same, so here a compromise occurs. What this means in practice is that one speed gear will disengage slightly more than the other. Another and probably more important feature, is that the operating lever passes through the 90 degree mark in relation to the relay lever when fully engaged, and locks the relay lever into the deeper end of the indent. I'm sure that you will now see the importance of the safety devices built into the system earlier, because there is no way that this will disengage by itself.

To start the setting up process remove the relay lever, fit the carrier plate, with its pivot and stop pins in place, over the flanged part of the relay lever pivot bolt. Clamp into position for slow speed drive using a small plate. Add the relay and operating levers in the disengaged position. Carefully engage the drive using the relay lever, then bring the operating lever into the indent. Any excess pressure applied here will probably move the carrier plate. At this stage it will most likely be

necessary to deepen the indent in the relay lever until the operating lever has room to fully engage the top of the indent. With finer toothed gears, it may be necessary to reduce the effective length of the operating lever. Temporarily place an elastic band from the top of the gear carrier to the far side of the additional front plate, which will apply a light tension to the system and assist with engagement / disengagement. When a suitable arrangement has been achieved the stop plate can be added. This is done with the drive engaged and the carrier plate being pushed to engage the gears tightly. Place the stop plate in position above the carrier plate and mark the screw centre. Drill and tap for a suitable thread and fit the stop plate into position. If this last operation leaves the gears too tightly enmeshed, file the foot of the stop plate until a suitable mesh is achieved.

To set the drive for fast speed, bear down on carrier plate with the operating lever and flip the stop plate to the left and release the carrier plate. With the relay lever in drive engaged position, push the carrier plate etc. to mesh the fast speed gear with the hand wheel gear. In this position, allow the stop plate to rest on the

top of the carrier plate and scribe a short line on to the additional front plate in the location of the second stop pin. Drill and fit the stop pin on the line. Check the engagement / disengagement and adjust as necessary by filing away the stop plate at the stop pin location using a round needle file.

Select a suitable spring to stretch from the top of the gear carrier to the far side of the additional front plate. Ideally it will be close coiled, with a long stretch ability (mine is about 2in. long by $\frac{5}{16}$ in. dia.). Drill and tap the additional front plate in a suitable location and fit a screw and lock nut from the rear as the spring anchor. Check the operation of both drive speeds. As you will see, it is this spring that keeps all the components in operational mode. It may be noted that the fast speed drive may be reluctant to disengage, in which case increase the tension of the spring. This may be easier to achieve by fitting a second anchor point.

Invert the detent housing 2 into the top hole of the relay lever and mark the additional front plate with its various locations through the small hole. These locations can be slightly drilled for a detent ball to locate in. Unhook the pull-off spring, remove the relay lever and fit the detent housing 2 from the rear and add a suitable spring and steel ball. Replace this assembly and secure with a suitable screw and washer in the relay lever pivot bolt to retain the relay lever, ensuring that free movement of the lever persists. Refit the spring.

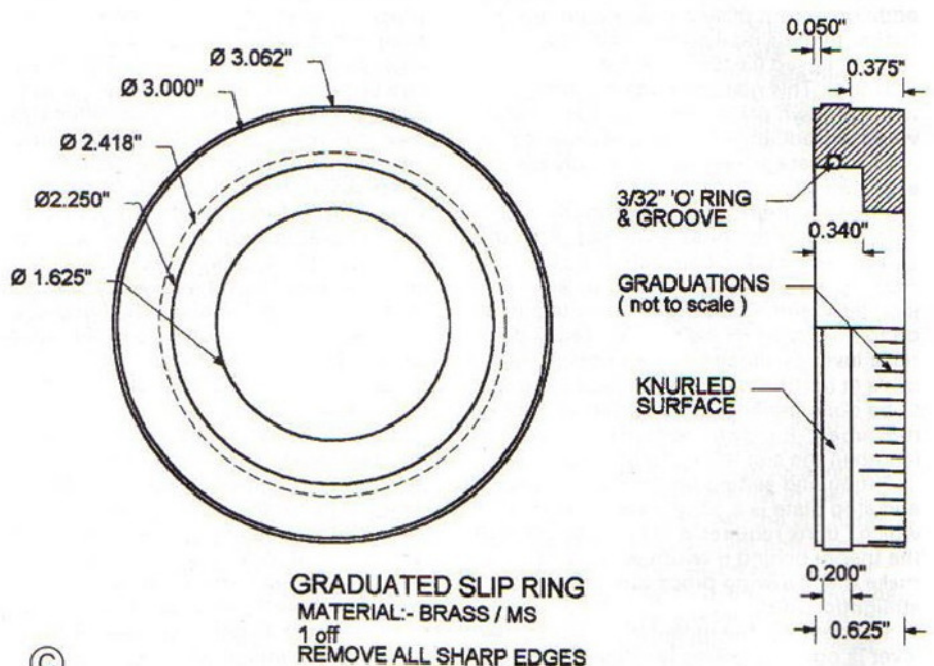
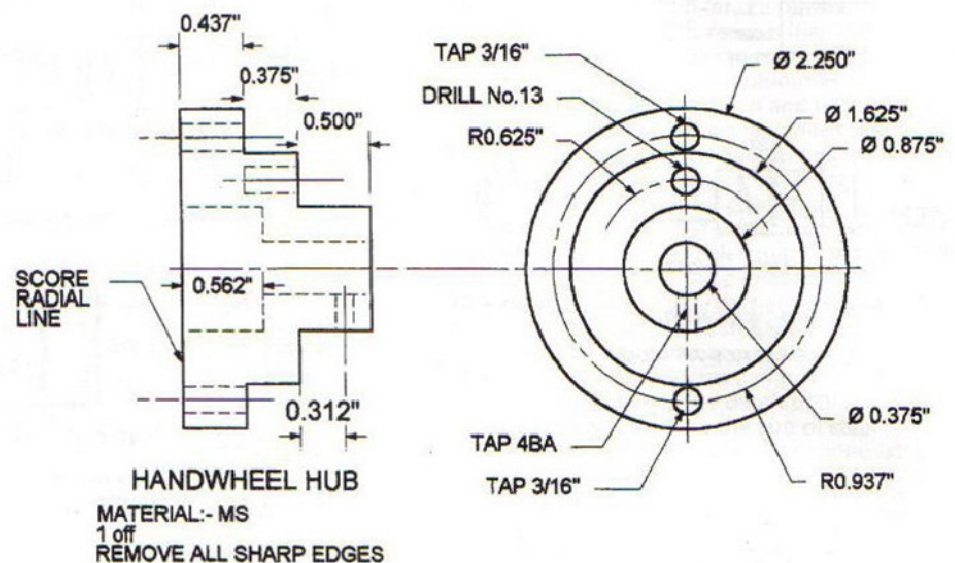
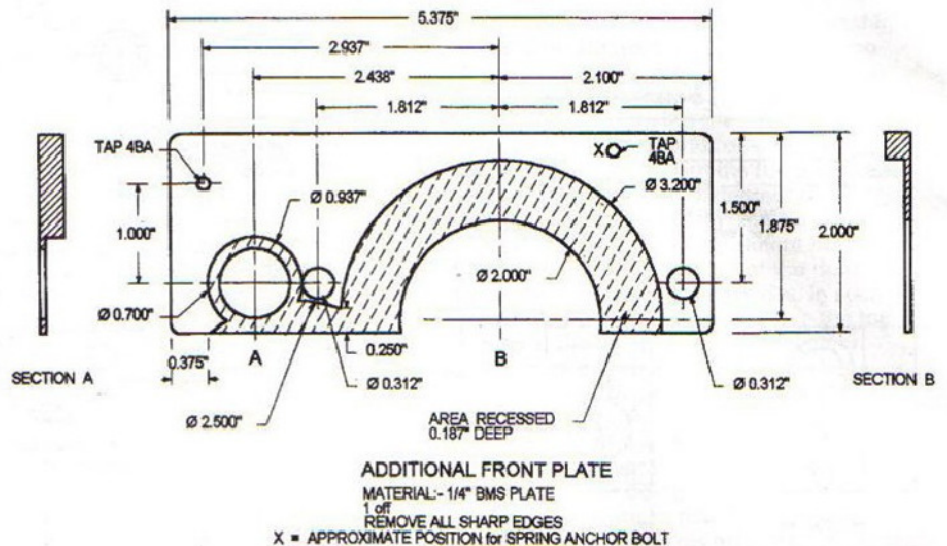
The spigot of the gear shaft which protrudes through the bottom of the relay lever needs to be trimmed back and a suitable screw and washer fitted to retain the fully floating bush, maintaining its freedom of rotation.

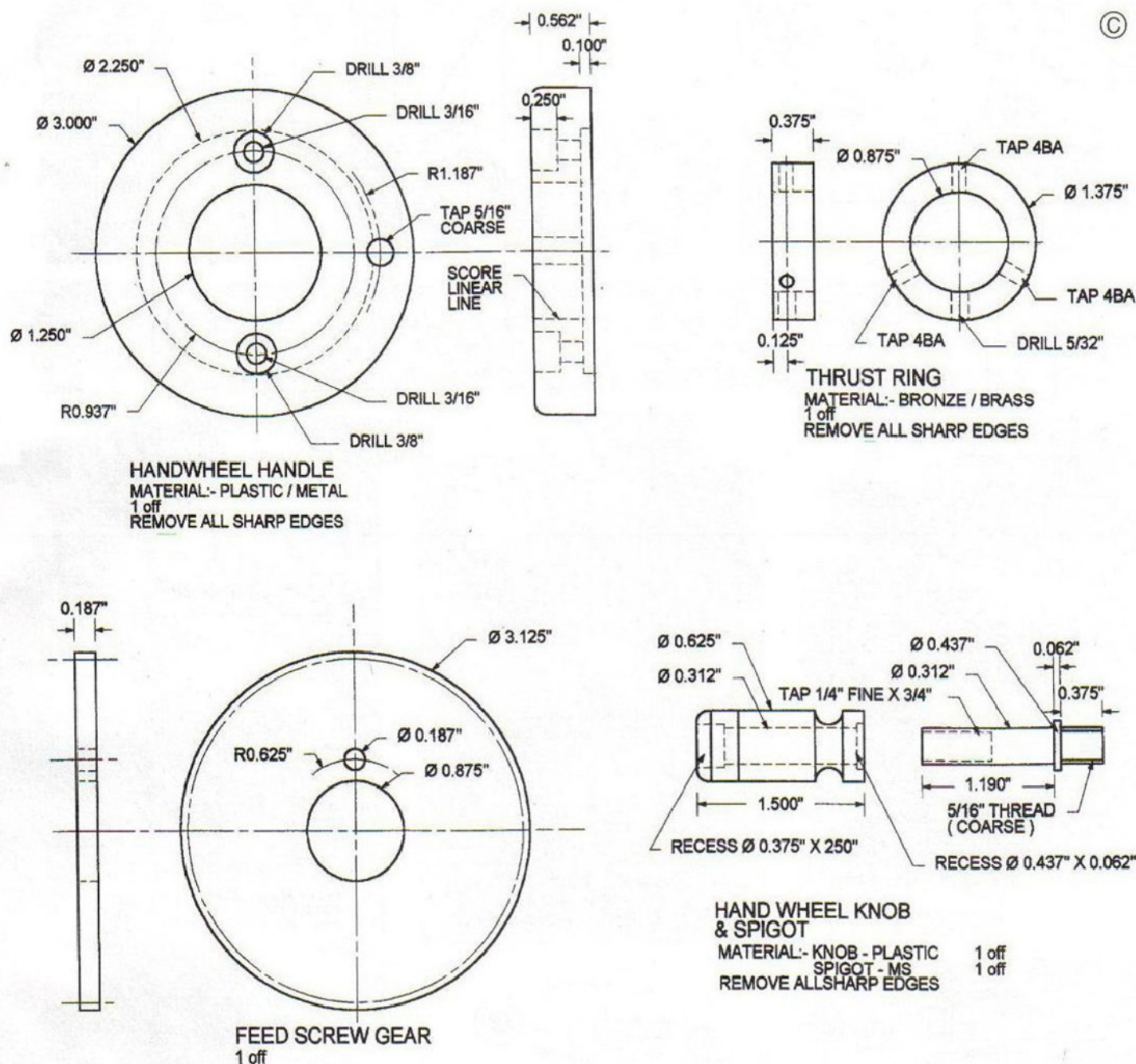
With the main mechanical work completed, recheck the engagement and disengagement and take a good look around the work generally for any foreseeable errors. Lubricate all new working parts and place the cross-slide in a mid way position and ensure the power drive is in the disengaged position. Connect the slow speed electrical wires to the battery using a fused link. This should get the motor driving the relay shaft and the intermediate gears rotating. Check the operation of the engagement and disengagement. Before changing mechanical speeds, disconnect the power. Check the operation of the micro switch cut-out, and that the cross-slide lead screw disengages in the opposite direction.

The Electrical System

This consists of a mounting plate attached to the top of the fixed plate at the rear of the cross-slide. On this plate are mounted three 6 pole 2 position toggle switches and two fuse holders. Details of the mounting plate have not been given, builders can glean enough information from the photograph already shown, along with this short description and circuit diagram (Fig. 10).

Switch One is the ON / OFF switch. Switch Two is the reversing switch. Switch Three is for the two electrical speeds. The two fuses are for the fast and slow speeds. It is in this order that wiring circuit has





been constructed. **Remember Fast Speed is obtainable in one direction only!!**

Determining what size fuses to use can only be assessed by experimenting and possibly with the use of an ammeter connected into the circuit at the battery while the various speeds are tried. Note the readings, and obtaining fuses as close to these figures as possible. I found that the loading of the drives had very little influence on the ammeter readings. Therefore, the lowest possible rated fuse that will allow the system to operate should be used. Finally mark the switches with their functions.

Covers

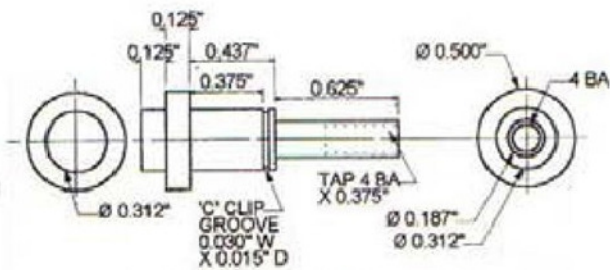
The manufacture of covers for equipment is usually done reluctantly as a necessary evil, as they don't usually have any tangible productive benefit.

Apart from protecting our digits and things from becoming a mangled mess, they also protect the machinery from our abuses like piling swarf and debris into working parts. I have made three covers for the modifications so far (Fig. 11), using 0.030in. thick material. All are made with steel sheet. The easiest way to make covers is to make card templates first, as it is far easier to throw away a piece of card rather than a piece of hard worked metal, which we for ever try to get perfected.

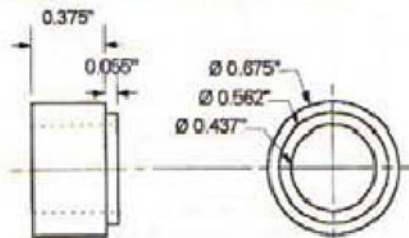
The cover for the front of the cross-slide is simply a piece of material the length of the additional front plate with a single bend in it to reach out and down to the top of the cross-slide. It is located by having three nuts and bolts set in the holes in the plate itself. The bolts then locate in three holes drilled in the top of the additional front plate. If the two outside bolts are slightly bent towards each other, they will create a firm rattle free fixing.

The cover for the rear of the cross-slide needs to be able to be instantly opened and closed, to gain access to the saddle lock screw. This is achieved by having a length of material whose width is equal to the length of the rear mounting studs, wrapped around one of the mounting studs which then partly wrapped around the opposite stud. This again forms a rattle free fixing and works quite well at keeping debris out of the rear belt drive.

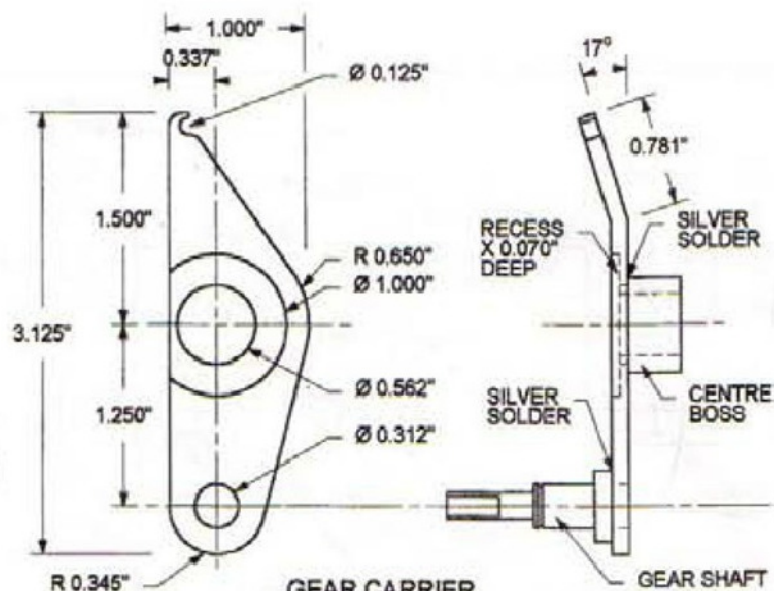
Finally, the third cover is for the gearing of the saddle hand wheel. This is a little more difficult to make, but by no means impossible. Again made of sheet steel, it is like four sides of a box, made to fit the hand wheel extension plate and taking into account the thickness of the gears used, with a scallop cut out for the hand wheel centre. It is located with a single screw tapped into the top of the saddle hand wheel extension plate.



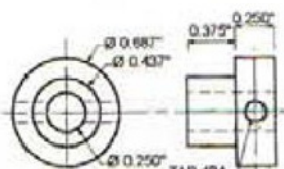
INTERMEDIATE GEAR SHAFT
MATERIAL - STEEL
1 off



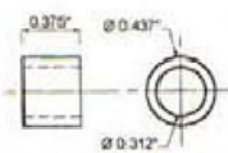
CENTRE BOSS
MATERIAL - STEEL
1 off
BOTH ITEMS for GEAR CARRIER
REMOVE ALL SHARP EDGES



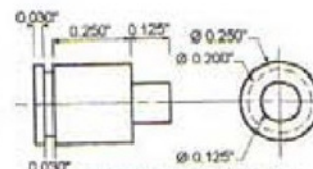
GEAR CARRIER
MATERIAL - 1/8" BMS PLATE
1 off
REMOVE ALL SHARP EDGES



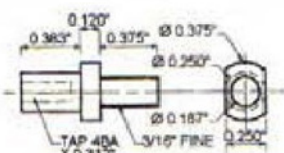
PRIMARY GEAR HUB
MATERIAL - STEEL



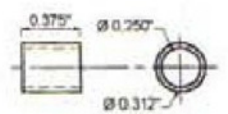
INTERMEDIATE GEAR BUSH
MATERIAL - BRONZE / BRASS



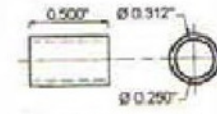
CARRIER PLATE PIVOT PIN
MATERIAL - STEEL



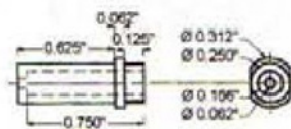
RELAY LEVER PIVOT BOLT
MATERIAL - STEEL



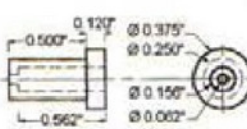
RELAY LEVER BUSH
MATERIAL - BRONZE / BRASS



RELAY LEVER FULLY FLOATING BUSH
MATERIAL - BRONZE / BRASS

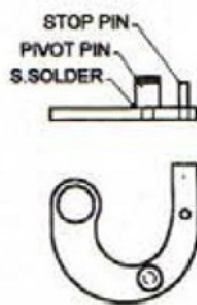


DETENT HOUSING 1
MATERIAL - STEEL



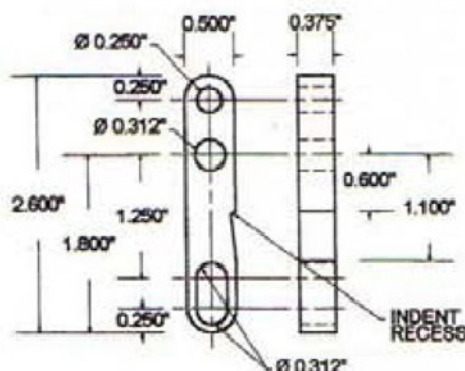
DETENT HOUSING 2
MATERIAL - STEEL

SMALL COMPONENTS
1 off each
REMOVE ALL SHARP EDGES



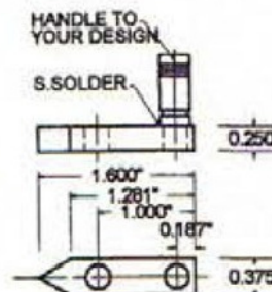
CARRIER PLATE

SEE SEPARATE DRAWING
for MARKING OUT DETAILS



RELAY LEVER

MATERIAL - BMS
1 off
REMOVE ALL SHARP EDGES



OPERATING LEVER

MATERIAL - BRASS / BMS
1 off
REMOVE ALL SHARP EDGES

GRINDERS & GRINDING

More and more home workshop owners are seeking higher dimensional accuracy and better surface finish in their work. Having described how to construct an inexpensive surface grinder, Alan Jeeves reviews the grinding process and looks at some of the types of machine available

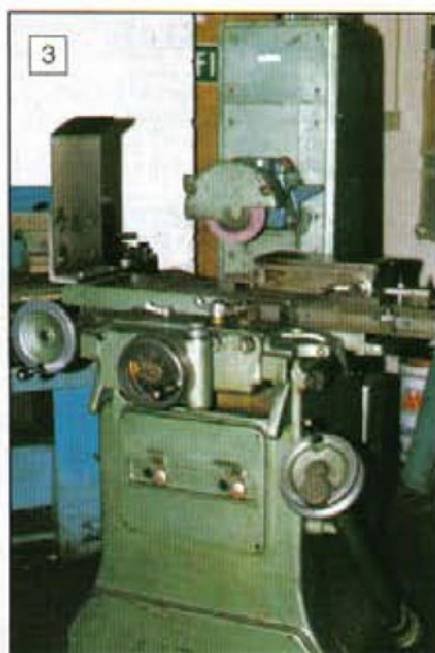


Basic surface grinder - very compact (hand traverse)

With the continued expansion of the engineering home workshop, which has, I believe, been brought about chiefly because of the considerable interest in the restoration of old motor vehicles and the increasing need to work with larger components than the traditional model engineer was concerned with, the use of grinding machines by amateurs is now becoming more widespread. The term 'grinding machine' will be used, for the purpose of this article,



Small surface grinder with mechanical traverse. Note dust extraction.



Small hydraulic surface grinder. A good machine for the home workshop



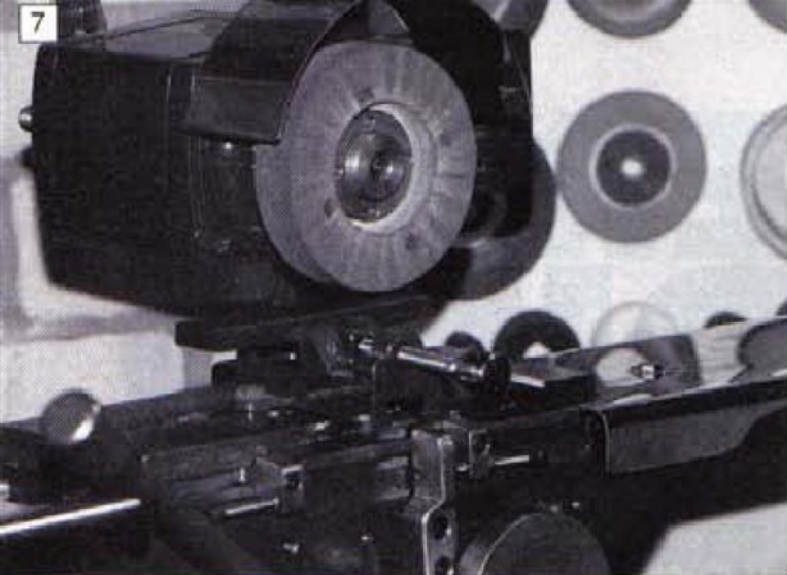
Sophisticated surface grinder with coolant/filter system.



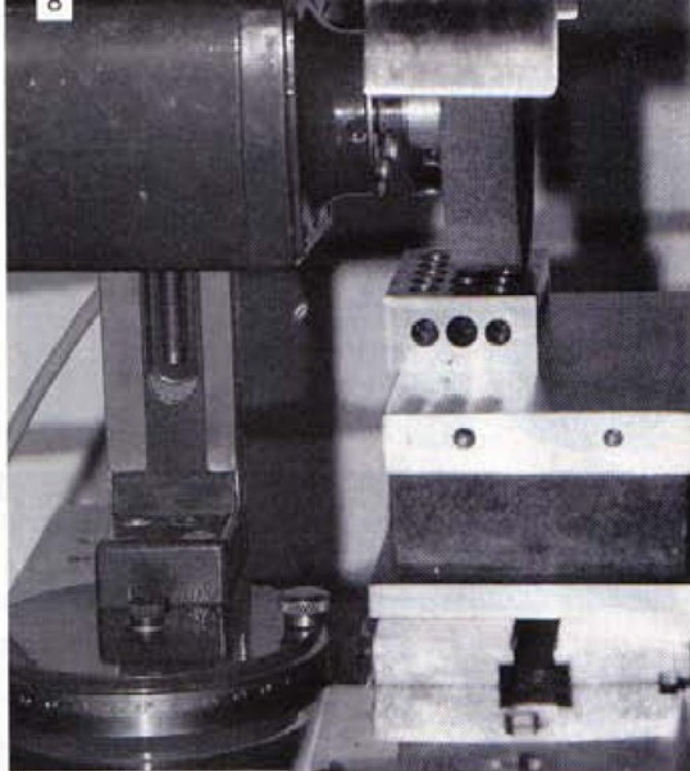
Rack & pinion traverse



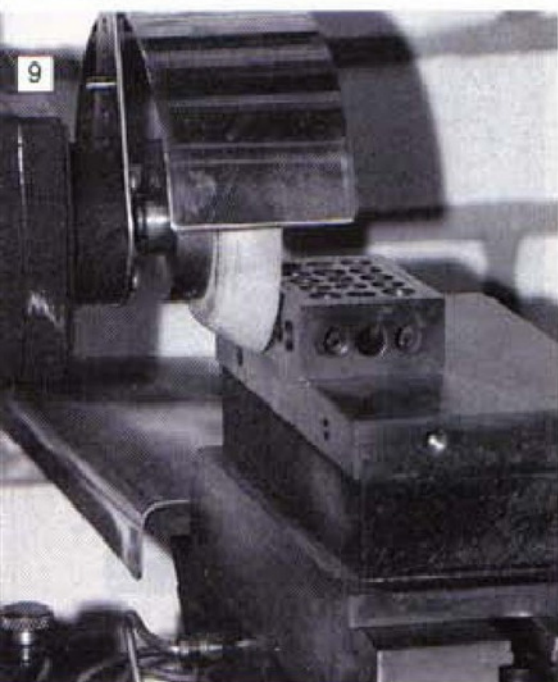
Small swing grinder (hand traverse)



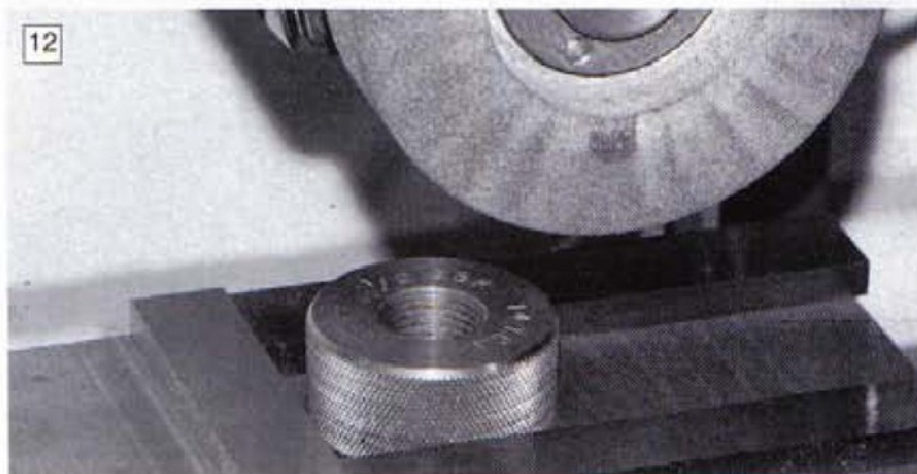
Surface grinding from the vice



Surface grinding off the magnetic chuck



'Side swiping' square to first face



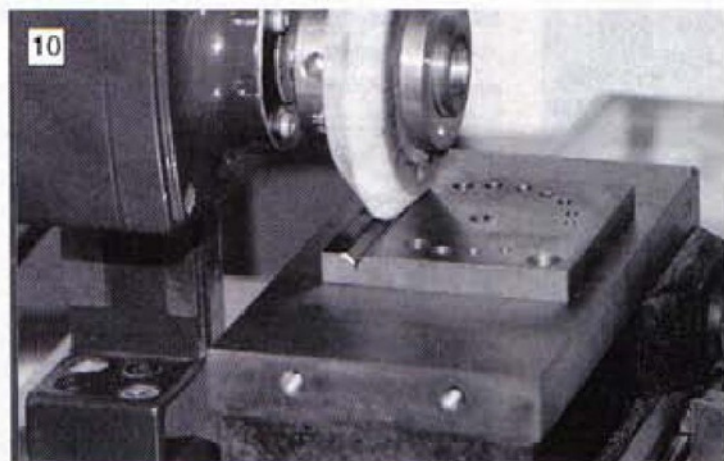
Small job on magnetic chuck, supported by parallels

to describe any machine which removes metal by means of a revolving abrasive wheel - other than the standard offhand tool grinder, which has been an indispensable part of the home workshop for countless years.

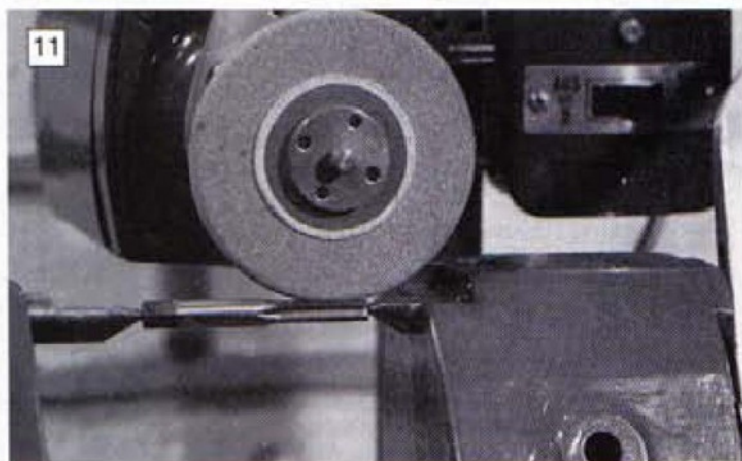
Surface grinding machines

Of the grinding machines which are suitable for home users, probably the most frequently encountered is the tool and cutter grinder (such as the Quorn), but

as the use of these machines is covered extensively by other contributors, I do not intend to deal with them in this article. Turning to machines, the primary use of which is the finish machining of manufactured components, the most



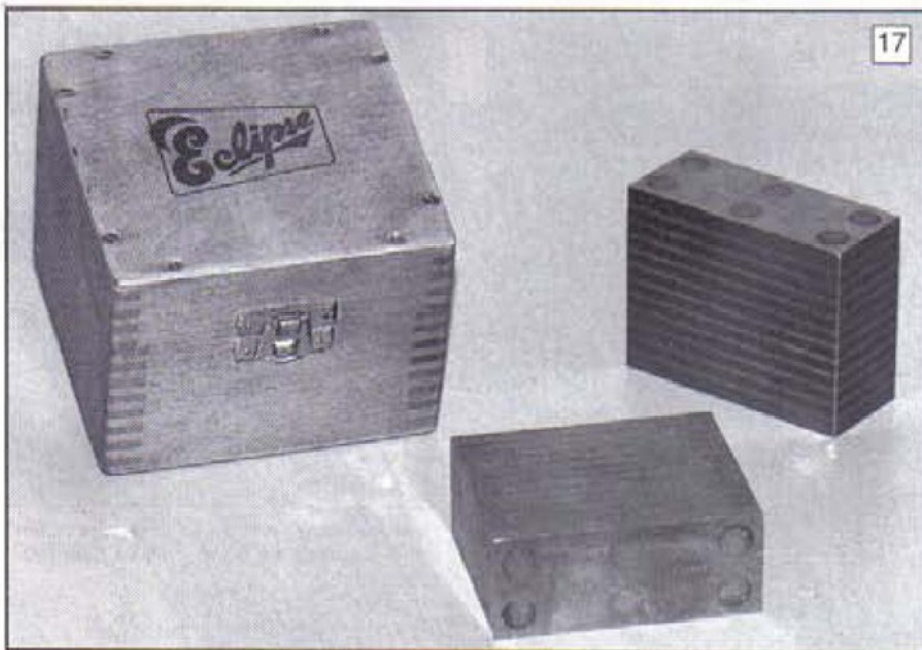
Form grinding



Form grinding (tap fluting)



13
Wheel well guarded



17
Laminated blocks can be used as a setting-up aid

popular must be the surface grinder.

As the name suggests, these machines are used primarily for the grinding of flat surfaces, although other operations can be carried out on them. Their main concern is the grinding of hardened steel, but they can also be used for the grinding of soft materials. This type of grinder is well renowned for its ability to machine two opposite faces of a component parallel to a high degree of accuracy.

The surface grinder usually consists of an abrasive wheel which is mounted vertically on to a horizontal spindle fixed to a column which is so designed as to allow the wheel to be raised or lowered above the work - the 'horizontal spindle disc type grinding machine'. The work is placed on to a table which reciprocates back and forth in a plane which is parallel to the axis of the grinding wheel, and which can also be cross traversed at 90 degrees to this axis (Fig. 1). Some grinding machines have a powered feed (usually hydraulic) to the work table, others do not. These small non-powered traverse machines (hand operated) are less complex, and therefore represent a more practical proposition for the majority of home workshop owners.

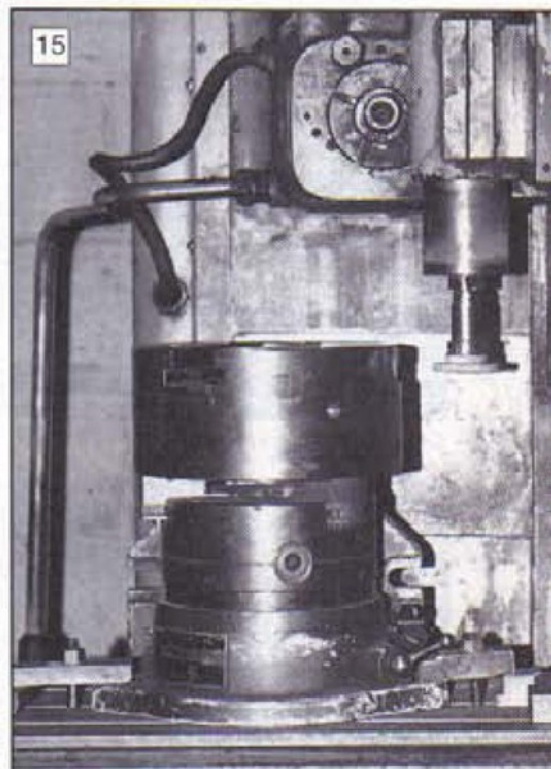
On some smaller machines, the wheelhead does not rise and fall, but is a fixed casting. The bed on these particular machines is arranged to form a 'knee' which is able to rise and fall on slideways, cuts being put on by raising the knee a small amount.

The means of transmitting energy from the linear traversing handle to the work table during manual operation is almost invariably by way of a rack and pinion arrangement in preference to a leadscrew. The reason for this is that a brisk rate of traverse is essential for surface grinding, and the rack and pinion system permits this. A leadscrew may, however, be used for the cross feeding of the table.

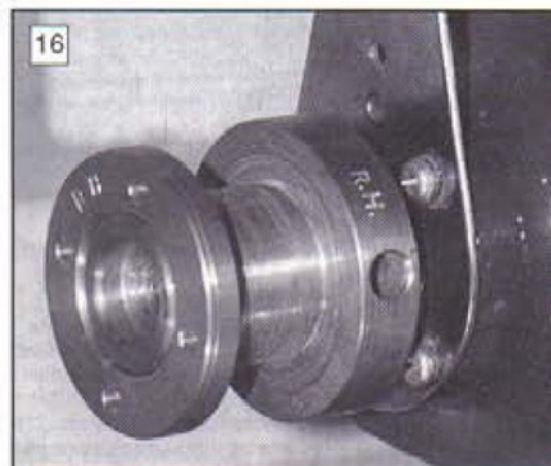
Another type of surface grinder which may be encountered is a simpler version frequently referred to as a 'swing' grinder, a constructional series for which featured in *M.E.W.*, Issues 45 and 46. This machine uses a cup-shaped abrasive wheel which is mounted horizontally on to a vertical spindle attached to a radial arm above the work. The arm is, in turn, attached to a column which is free to rotate, and this arm, carrying the wheelhead, is swung back and forth in an arc encompassing the



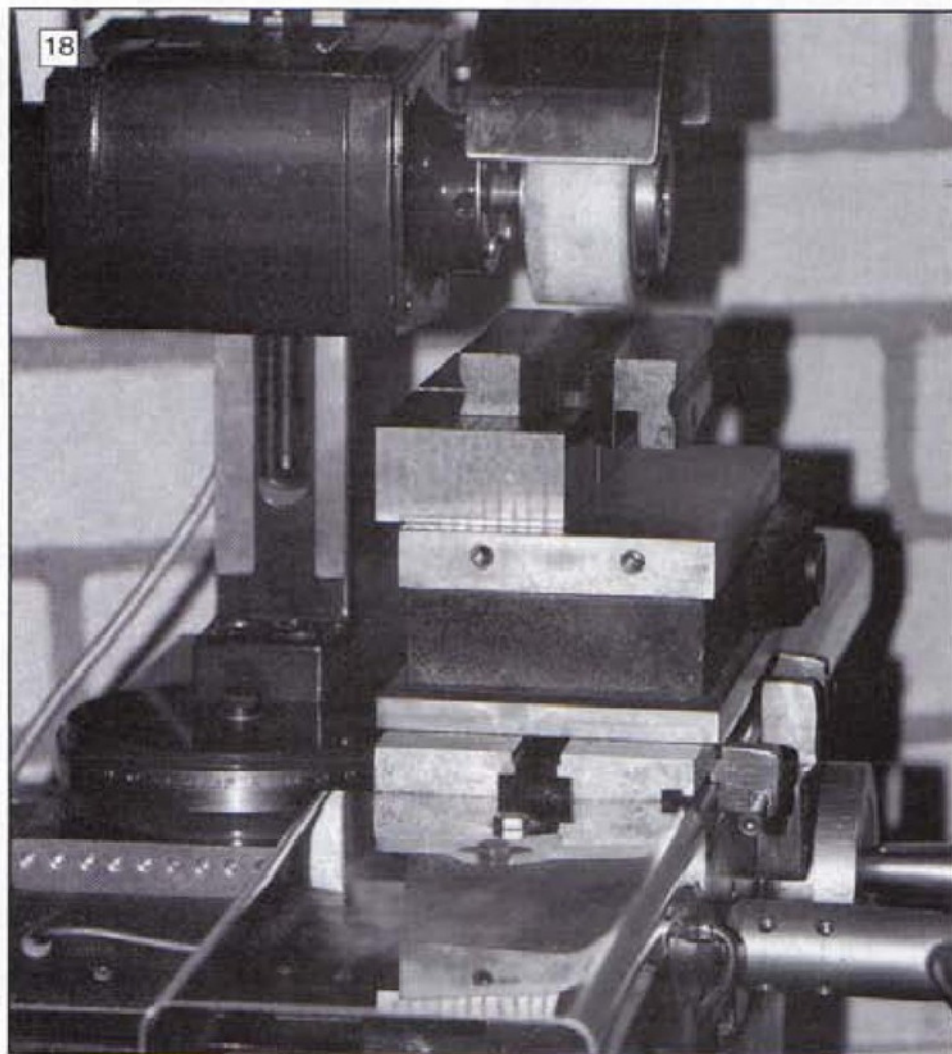
14
Spot grinding



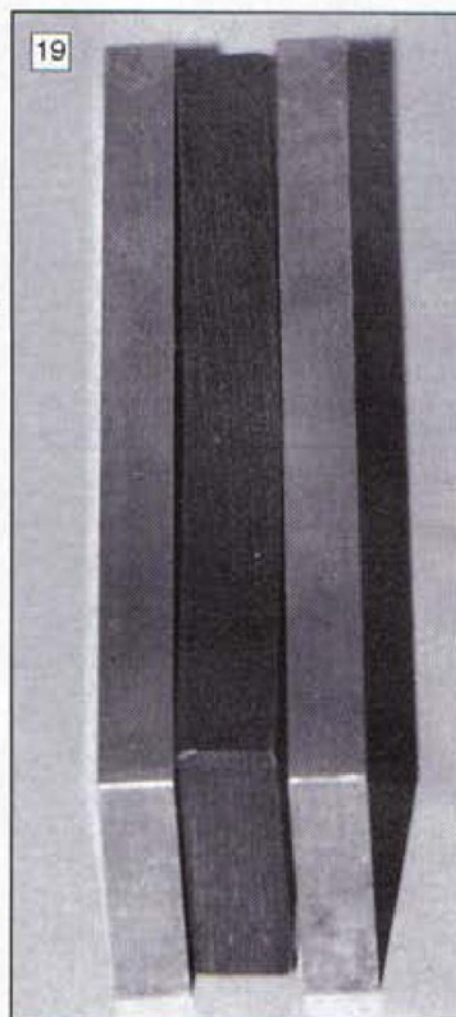
15
Vertical grinding machine



16
Wheel arbor



18 Laminated block in use on a 'stepped' job



19 Heat treatment can cause distortion. This job is sandwiched between two parallels to show this



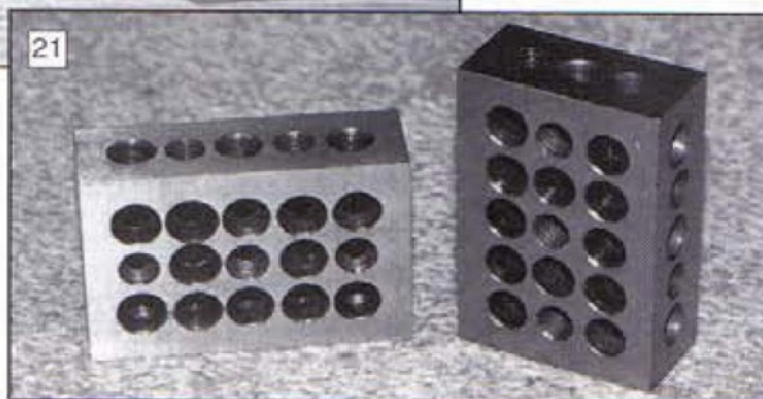
20 Magnetic sine table for grinding angles

work area. A 'cut' is applied by lowering the radial arm towards the work (Fig. 2). The table area on to which the workpiece is mounted remains stationary at all times, there being no traversing facility in any direction. The swing grinder is a useful addition to the workshop, but is by no means as versatile as a horizontal spindle disc type surface grinding machine.

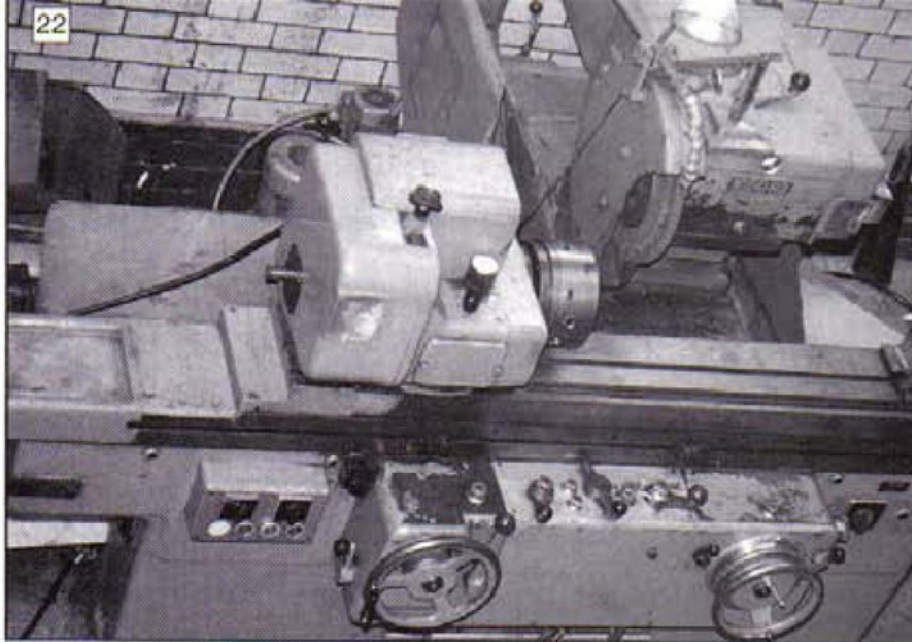
Surface grinding techniques

Why surface grinding? In industry, such benefits as lower cost of tooling and ease of set-ups are relevant assets of surface grinding, alongside improved production rates, but such matters will seldom concern the amateur, who will most likely be more interested in 'one off' jobs. For him, the real advantages of owning a surface grinding machine may be one or all of the following:-

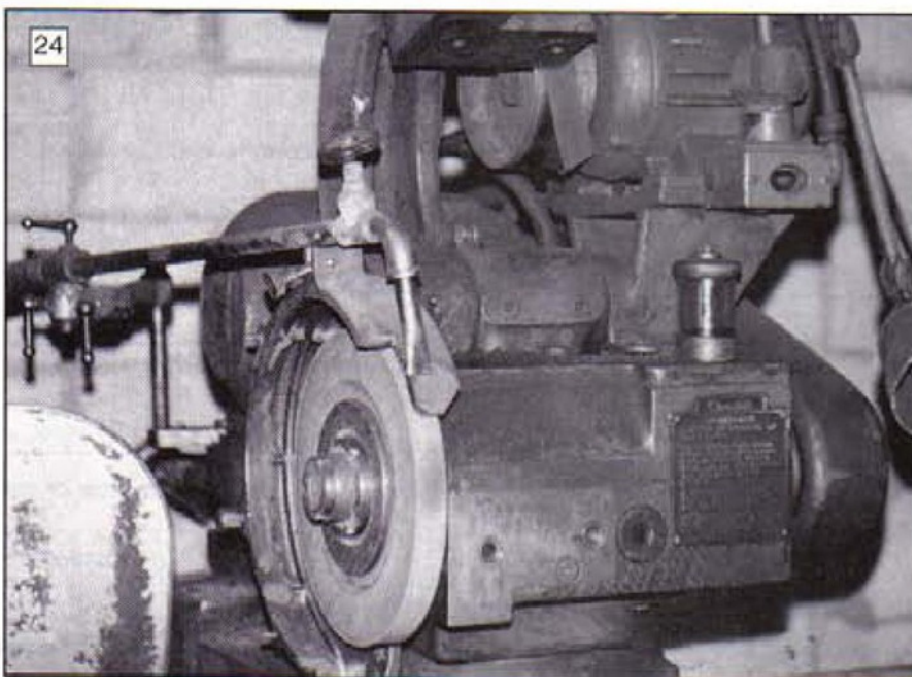
- 1) An effective means of removing hardened (heat treated) steel.
- 2) Excellent dimensional accuracy.
- 3) Attainment of a high degree of parallelism of opposite faces.
- 4) High quality surface finish.



21 Home made 1-2-3 blocks. A typical surface grinding job



Layout of a cylindrical grinding machine



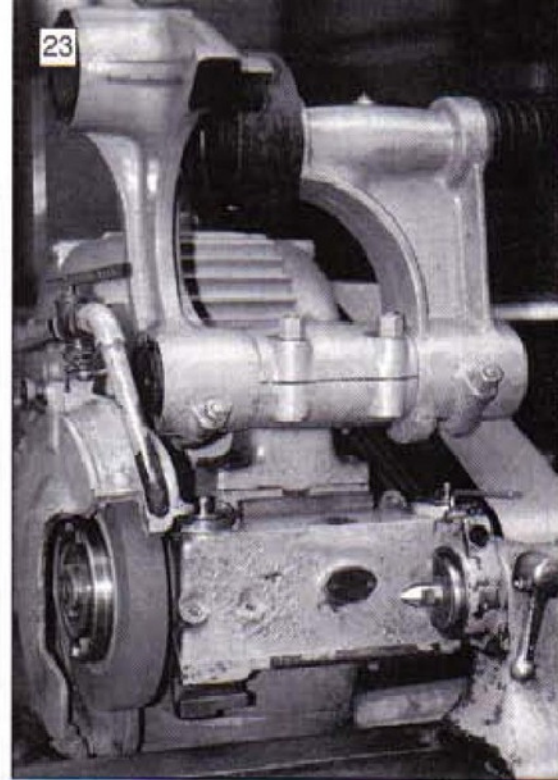
The universal workhead with the bore grinding spindle raised clear

Workholding

When surface grinding a component, it must be securely mounted on to the work table. The most common method of doing so is by the use of a magnetic chuck which is, alas, an expensive item for occasional home use. The work can, alternatively, be clamped directly to the machine table or held in a vice. Whichever method is adopted for holding the work, no distortion must take place when the job is tightened down because the ground surface will deform when the clamping force is released. This is one reason why the magnetic chuck is such a great asset when light gauge jobs are being ground.

Only small amounts of metal will be removed per pass on light duty surface grinders, and cuts will certainly be kept below 0.025mm (0.001in.). Depths of cut which actually stall or significantly slow down the grinding wheel must be avoided. Once the work is suitably mounted on to the work table (and the table stops set if powered traverse is fitted), it must be

determined where the high area of the surface is. This can be ascertained by trial and error, as the wheelhead is slowly lowered towards the job while the table is simultaneously traversed back and forth, and from front to back by the cross feed, below it. If the machine is of a type where a fine feed control is fitted to the wheelhead feed handle, this can be used to advantage. This control advances the wheel, by means of a ratchet, in increments of (usually) 0.0025mm (0.0001in.). When the first sparks appear, the grinding process actually begins, and the ground area will increase as more material is slowly removed. The work is passed completely under the wheel and out at the opposite end. Under no circumstances should the work be stopped and allowed to 'dwell' under the wheel while it is still cutting. This will almost certainly burn the job, leave an indentation in the surface, and in extreme cases cause the wheel to burst. If the machine is equipped with a coolant system, a copious flow of liquid should be



Tailstock is adjustable on machine table

supplied to the wheel. Successful surface grinding can, however, be carried out without the aid of coolant, although care must be taken as the temperature of the work increases. If the work is measured when still warm, the effect of contraction as it cools may end up with it being undersize.

Faults

One of the most common faults of surface grinding is to generate 'chatter'. This condition is made apparent by the disappointing 'hammered' finish to the work. Chatter will be quite common on the smaller grinding machines and is caused by several factors. If there is any play in the spindle bearings, then the wheel will bounce as it progresses along the surface of the work. The same condition arises if the wheel is not sufficiently secure on the arbor. It may be though, that the wheel only requires re-dressing in order that it may cut cleanly and produce a good finish. The wheel must, of course, be of the correct specification and be well balanced to achieve good results. Another cause of poor finish is incorrect cutting speed. Usually, the spindle will have only one or two speeds, and the rate of travel of the table may or may not be adjustable. The best finish will be obtained by experimenting with the machine, which must be standing securely to avoid rock or vibration.

Other uses for the surface grinder

Grinding on the periphery of the abrasive wheel is the most common method of using the surface grinding machine. Other methods of removing metal are also occasionally used however, and one such practice is 'side swiping'. Say a rectangular block is to be ground to achieve exact squareness. To facilitate this, two adjacent faces can be surface ground

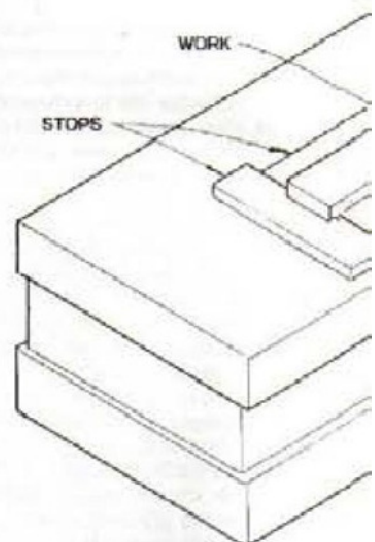
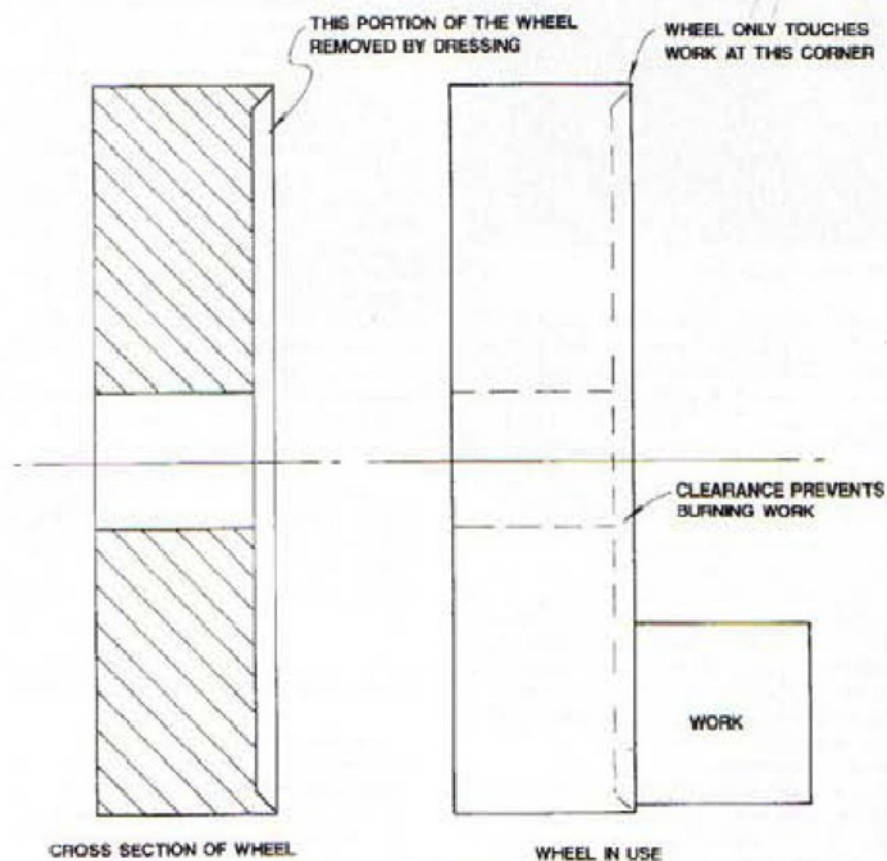
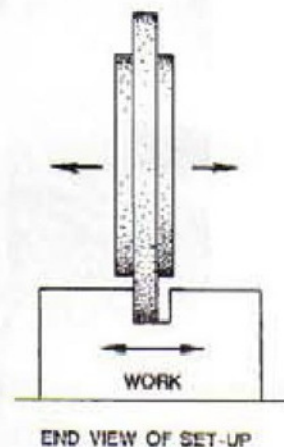
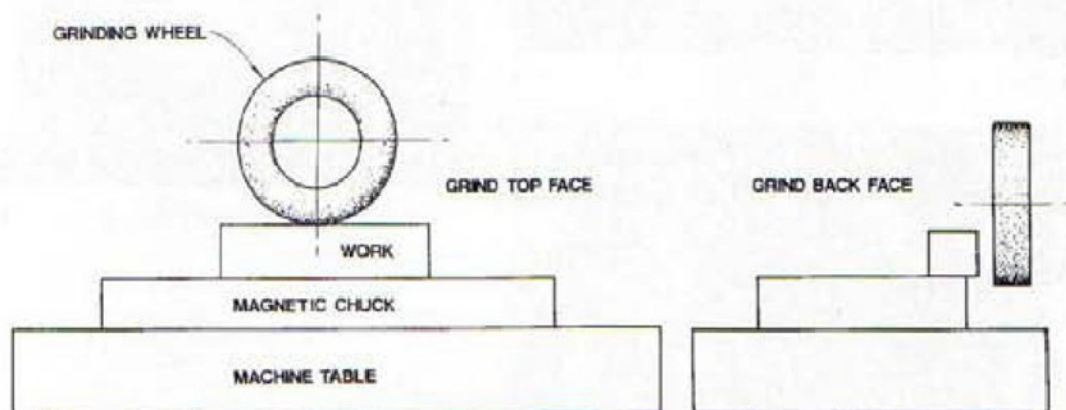
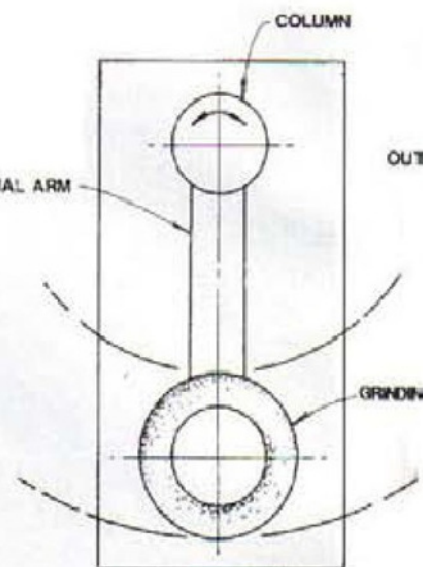
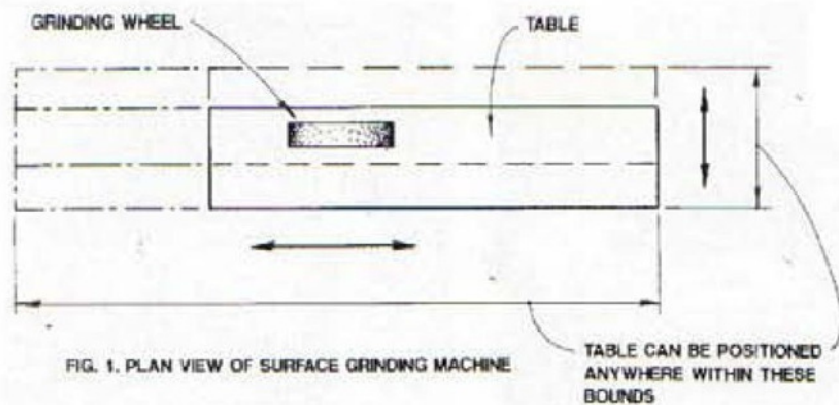


FIG. 6

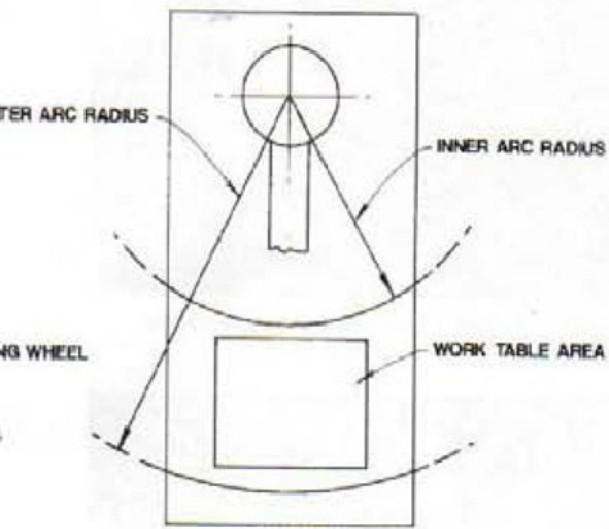
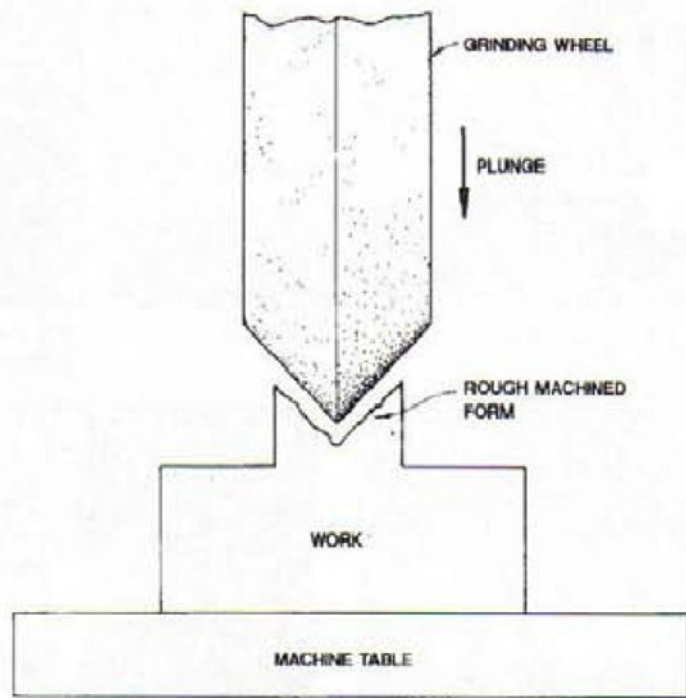
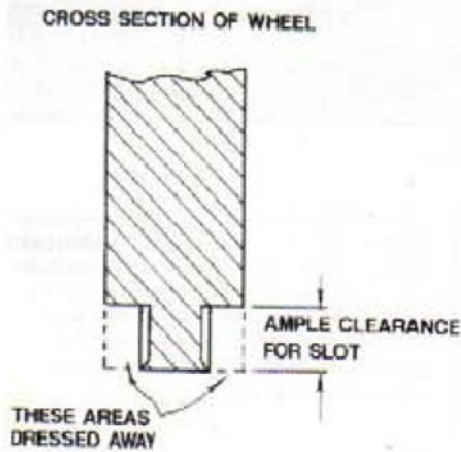


FIG. 4. SWING GRINDING MACHINE



END VIEW OF SET-UP

FIG. 5. FORM GRINDING



SLOT GRINDING

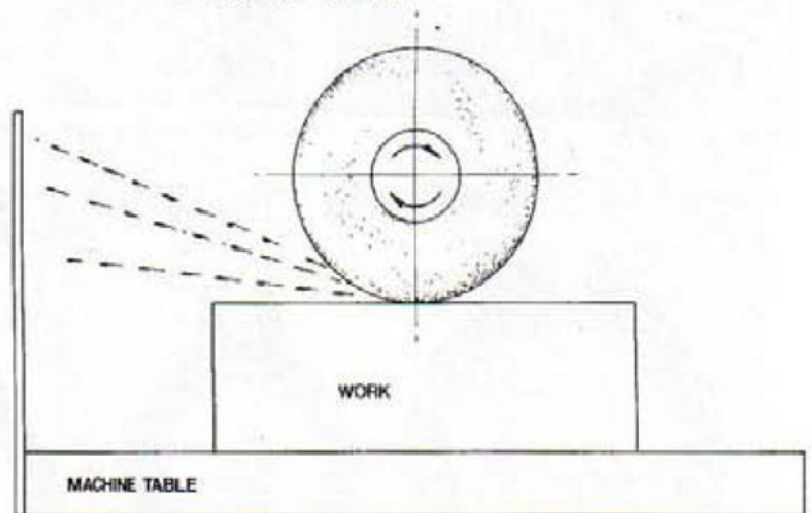


FIG. 7. END GUARD

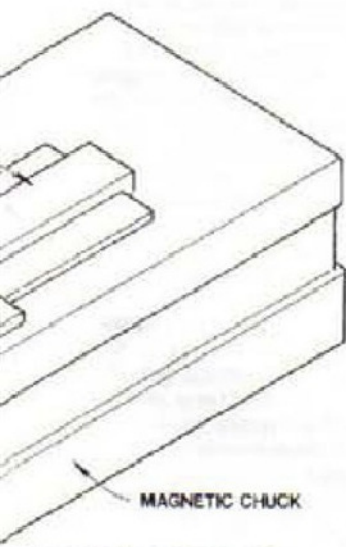


FIG. 8. HOLDING A SMALL JOB

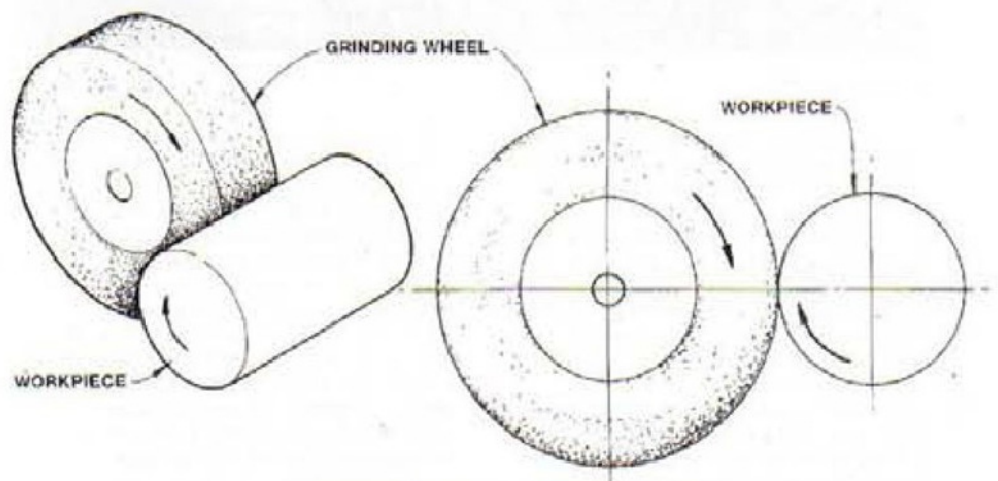
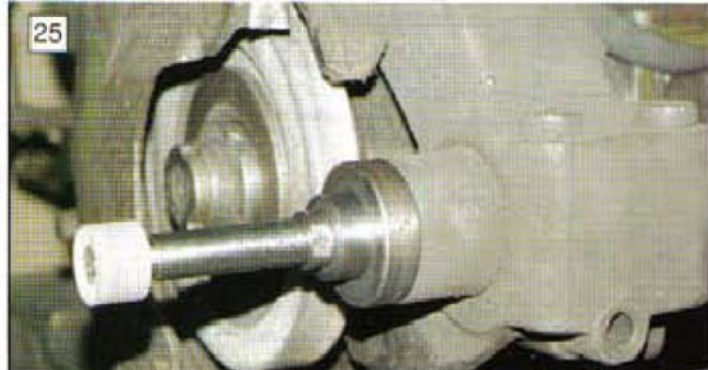
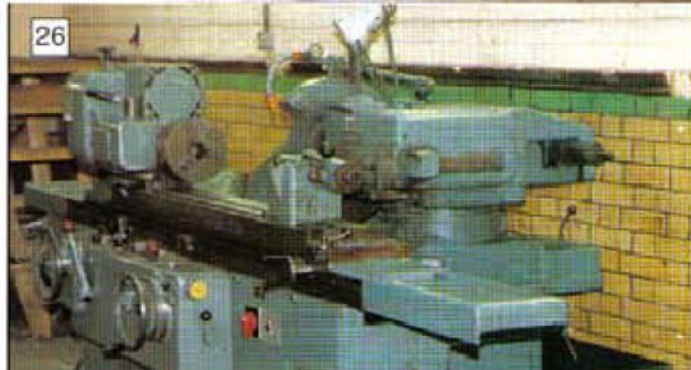


FIG. 9. ROTATION OF WHEEL & WORK FOR CYLINDRICAL GRINDING



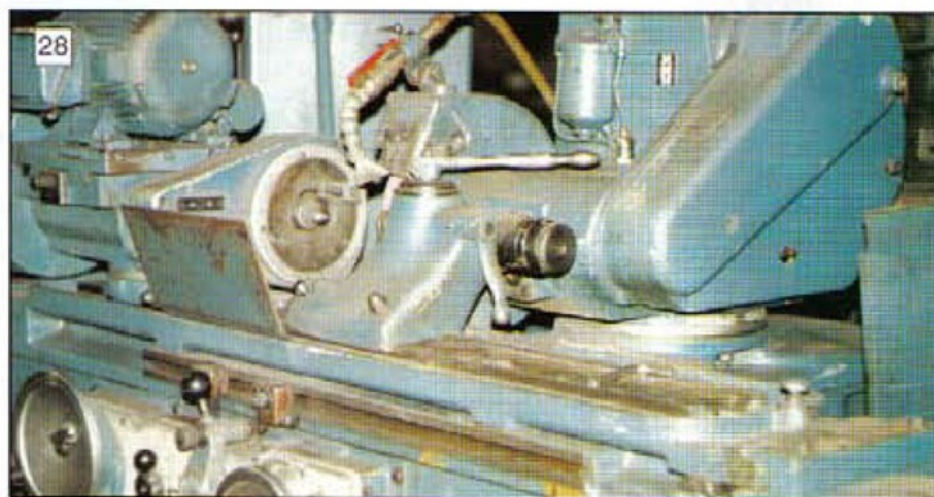
Bore grinding spindle lowered



This universal wheelhead spins through 180 deg. to use the bore grinding spindle at rear



Magnetic chuck for cylindrical grinder



Set-up for grinding between centres with catch pin



A set of carriers

in one chucking. The procedure is to clean up one face by grinding it in the conventional manner and then use this face (knowing it to be flat) for the magnetic chuck to adhere to. The work is now placed on the chuck, slightly overhanging the front edge (**Fig. 3**) and tapped parallel to the linear axis of the table (using a DTI). The opposite (to the first) face can now be ground, and then the wheel, which has been especially dressed on its side (**Fig. 4**), can be flicked across the overhanging face, thus making it square to the other two ground faces. A slow table feed should be used, in conjunction with very light cuts. The block can now be placed with this face down on the magnetic chuck, and the remaining face ground - all four faces square.

Form grinding can also be carried out on the surface grinder, but the wheel must be dressed to the required shape (usually with the aid of attachments), as this process is executed by the 'plunge grinding' technique. This is where the wheel is brought straight down into the work and very light cuts taken until the whole form has been completed (**Fig. 5**). The plunge method can also be made use of for the flat grinding of work which is narrower than the actual wheel width. An example of form grinding is where a small Vee block is hardened and requires grinding to finish.

Precise slots can also be ground in order to produce good finish, accuracy and parallelism, three of our four main reasons for surface grinding. A special wheel may be needed for a slot, having been

narrowed down deep enough to reach the bottom of the slot, and perhaps made two thirds as wide as the slot is designed to be. By a combination of conventional surface grinding (on the periphery of the wheel) and side swiping (on both sides of the wheel) a slot can be ground to its final dimensions (**Fig. 6**).

Surface grinding safety

Surface grinding can be very dangerous if care is not taken, and eye protection should always be worn. It should be determined in which direction the wheel rotates, and a guard placed at the appropriate end of the bed, to arrest the workpiece should it be thrown off the table (**Fig. 7**). This is particularly important when using a magnetic chuck. If this type of chuck is used, it is a good idea to provide pieces of steel to act as stops for small workpieces which do not have a great deal of surface area for adhesion (**Fig. 8**). The wheel itself should be provided with a guard, and this should be regularly cleaned of grinding refuse. Particles of dust become lodged under the wheel guard, and soon form large pieces of debris which can then dislodge and fall onto the work, thus jamming the wheel or being thrown about the workshop. The wheel itself should never be touched by hand when running.

Spot Grinding

A hit-and-miss method of surface grinding used frequently in the past in modest workshops having no surface grinding facilities, is 'spot grinding'. It

must be pointed out that this form of grinding can be quite dangerous if extreme care is not taken, but it is worthy of mention as some experienced home workshop owners may see the process as a practical proposition.

Here is how it works:- a small cup shaped or recessed grinding wheel is mounted on to a vertical spindle (say a sensitive drill) and this wheel is run at as fast a speed as it is possible to attain. The work is then moved about on the flat drill table by hand and with a downward pressure, while the wheel just skims its surface. This movement is continued until the sparks abate. A very light cut is applied by advancing the machine spindle, and the process repeated until the surface has been 'cleaned up'. The job can then be turned over and ground on the opposite side. The obvious drawback to this method of grinding is that it can be unsympathetic to the fingers. I have used this method myself successfully in the past for grinding home made circular screwing dies and the like, and it is certainly useful for dealing with hardened steel parts. I recall spot grinding one day when I was visited by a friend. As the work has a tendency to overheat rapidly during grinding I had a small trough of cold water handy on the bench. My friend thought the trough was there for me to plunge my fingers in! The danger to life, limb and digits makes spot grinding a process not to be undertaken lightly.

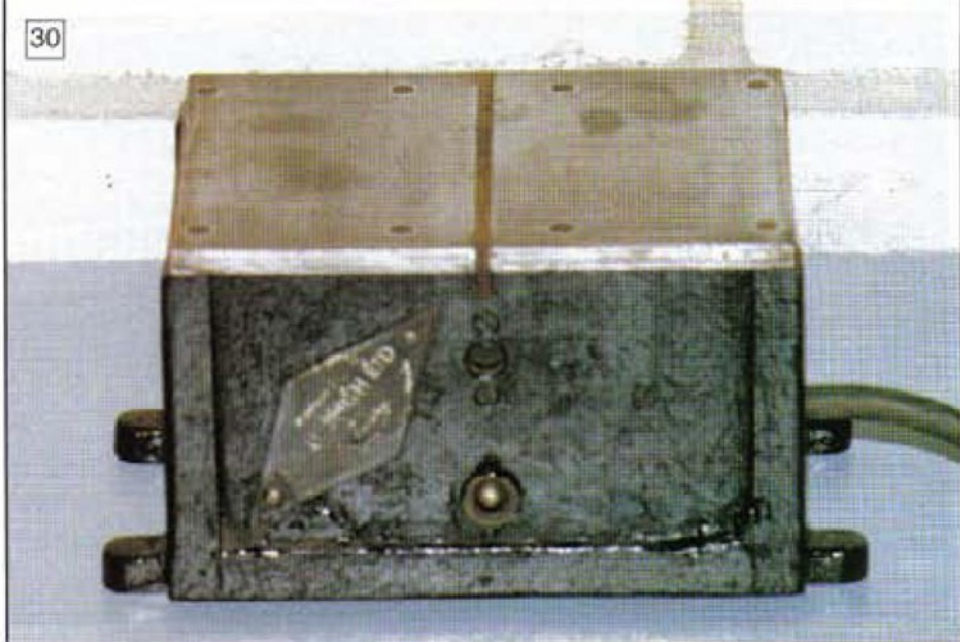
Specialist surface grinding machines

Occasionally, certain used grinding machines come onto the market, perhaps through auctions, being machines which have been built for special purposes. These machines would only be a sensible addition to the home workshop if they are readily adaptable for the new purpose. An example of one such machine is a small bench or pedestal mounted grinder for grinding Coventry type die box dies. This particular machine can be put to good use as a standard surface grinder though, if it is in serviceable condition. It takes up a floor area of just 800mm x 800mm.

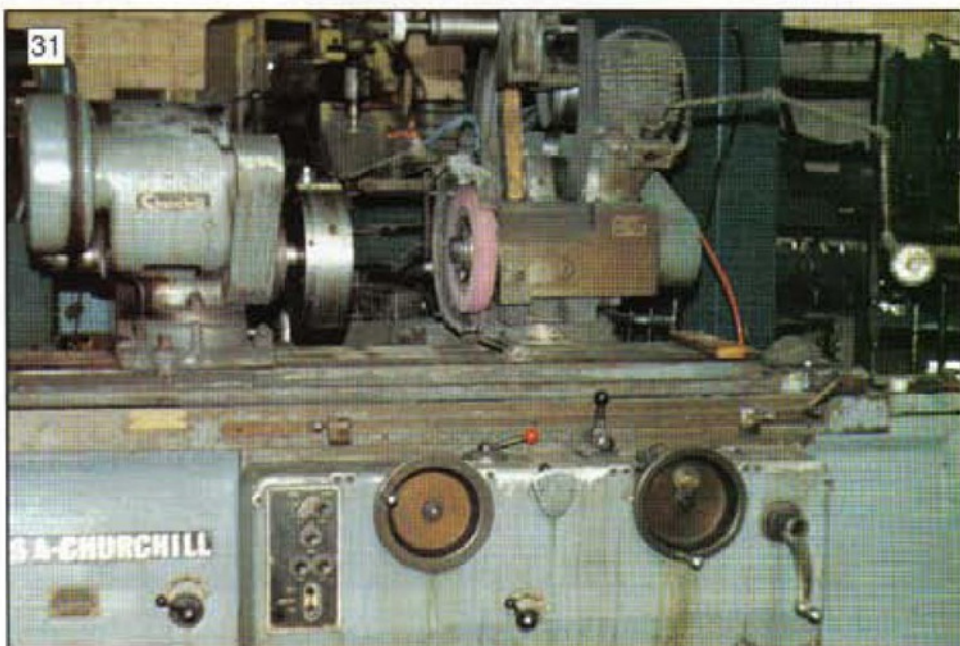
Another specialist machine is the vertical spindle grinding machine (**Photo 15**). These generally tend to be large, heavy machines and are quite tall due to the amount of vertical movement of the workhead. They should be avoided unless a specific use for them is anticipated.

Cylindrical grinding

Rather less likely to be encountered in the home workshop are cylindrical grinding machines. Nevertheless, small grinders and (especially) grinding attachments which are fitted to lathes are frequently seen. As surface grinders deal with flat work, so (as the name implies), cylindrical grinding machines handle round (cylindrical) work - either on the outside diameter (external grinding) or on the inside diameter (internal or bore grinding). As with surface grinders, cylindrical grinders are especially effective on hardened steel, and can generate close parallelism along with a good surface



A demagnetiser



Stops set for table traverse

finish and dimensional accuracy. The main difference between the utility of the surface grinder and that of the cylindrical grinder is that (as we have already seen) the surface grinder can be quite a light and compact machine, but cylindrical grinders are invariably heavy and cumbersome, and can be difficult to transport and accommodate. This is one reason why the option of the grinding attachment or the adaptation of the tool and cutter grinder (as described by Philip Amos) is so attractive in the small workshop.

External grinding

The external grinding machine consists of two units, the first being a powered headstock or 'workhead', which holds and rotates the work, and the second being a grinding wheel mounted on a sliding stock - the 'wheelhead'. The grinding wheel runs in a clockwise direction and the workhead rotates in a counter-clockwise direction (**Fig. 9**).

Because the wheel is running so fast, perhaps 2000/3000 rpm, the workhead does not have to rotate that quickly (possibly up to 100 rpm) to generate a very high cutting speed. The headstock spindle speed is variable on most cylindrical grinders (**Photo 34**).

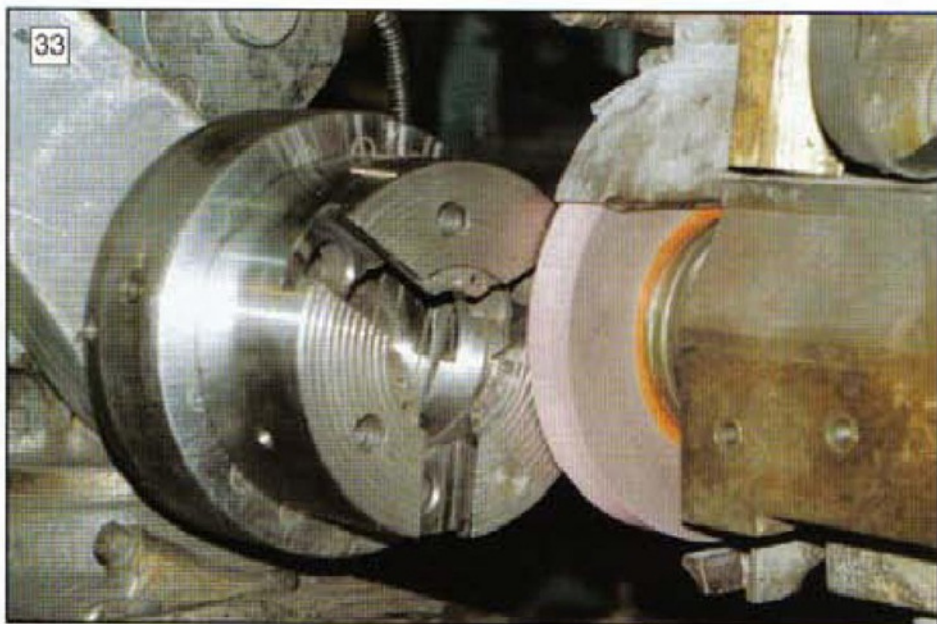
The machine table, upon which is mounted the workhead and the tailstock, slides from side to side in a similar manner to the surface grinder table. The wheelhead slides from front to rear at 90deg. to the table axis. Cylindrical work is mounted in the machine, and the grinding wheel is advanced towards it until metal is removed from the outside diameter.

Internal grinding

When grinding the internal diameter of a workpiece, a modified version of the cylindrical grinding machine is used. Instead of having a wheelhead with a disc type grinding wheel mounted on it, a small scale wheelhead has a spindle on to which can be mounted much smaller grinding



As well as moving on a rack, these stops have a fine adjustment screw



Side swiping a chuck face

wheels. This wheelhead must be arranged in such a manner that its spindle centre line is in line with the centre line between workhead and tailstock, much like a conventional centre lathe (Fig. 10). The grinding wheel runs in a counter-clockwise direction (Fig. 11). Cylindrical work to be bore ground is mounted in the machine and the grinding wheel is positioned inside the bore, clear of any metal. The wheelhead is then retracted until metal is removed from the inside diameter, the more the wheel is retracted, the more metal is removed.

Workholding

The difference between holding work on the surface grinder and holding work in the cylindrical grinder is the fact that in the latter case the job must rotate as the grinding wheel cuts. This makes workholding slightly more difficult.

There are three main methods of cylindrical work holding - in the conventional jawed chuck (either 3 or 4 jaw), on a magnetic chuck, or between two centres mounted in headstock and

tailstock respectively. Providing the work is solid and has centre holes in each end, mounting between centres is an ideal method. A 'carrier' (or driving dog) is secured to the workpiece which is driven by a catch pin mounted on the spindle nose. As much grinding as possible is carried out before the carrier is repositioned at the other end of the work and the job turned round between centres. Even if the job has a bore and cannot be provided with centres (say a bush) it can be pressed onto a mandrel which has a slight taper and a centre hole at each end.

If the job is to be ground internally, then a simple method of holding the work is in a 4-jaw or 3-jaw self centring chuck - much the same way as in the lathe. Care has to be taken not to over tighten the chuck and compress the work, which would then spring open when the chuck is released.

The magnetic chuck works in the same way as the surface grinding chuck, but it is circular instead of rectangular. It is a good way of holding short, large diameter jobs, such as disc type milling cutters which require the bore to be finished.

Special workholding methods

Sometimes, the three main workholding systems are not suitable for a particular application and it is then up to the engineer to devise a successful alternative method for himself. Fixtures are quite easily designed and constructed, but must be accurate or the advantage of the machine accuracy may be lost. If a simple bush is being ground and a standard mandrel is not available because the bore is 'undersize' due to grinding allowance, then a simple arbor can be made, onto which the bush can be attached before

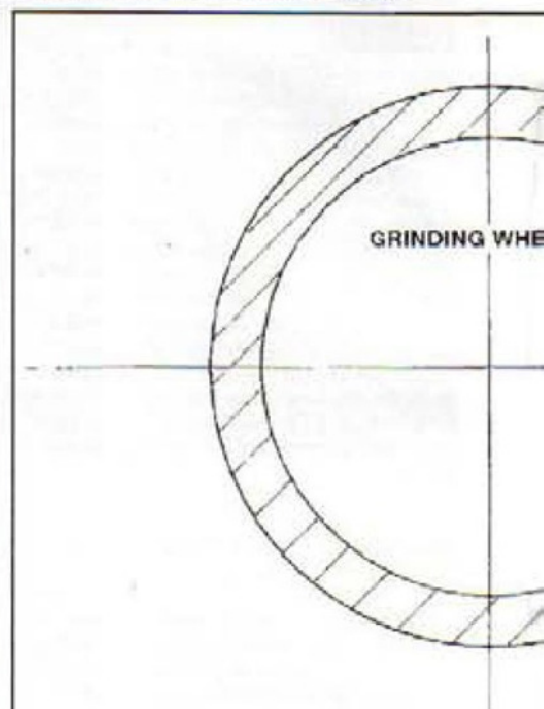
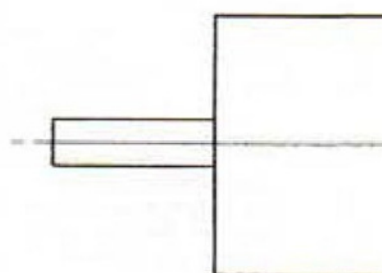
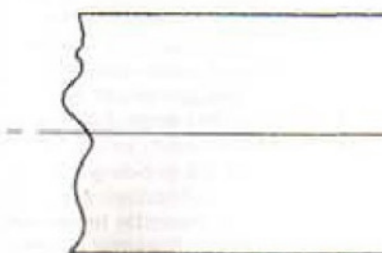


FIG. 11. INTERNAL GRINDING, VIEW



CENTRE LAP CHUCK



PROTECTED CENTRE CHUCK

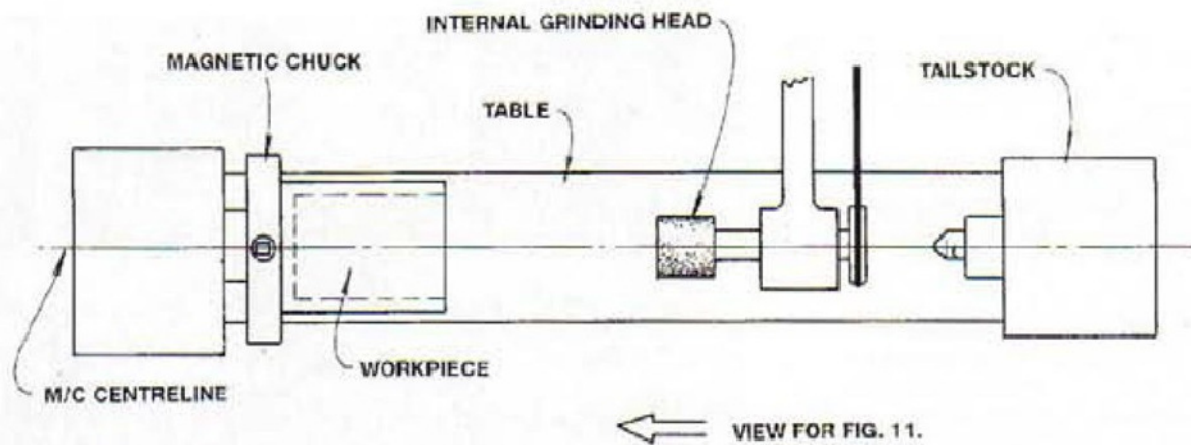
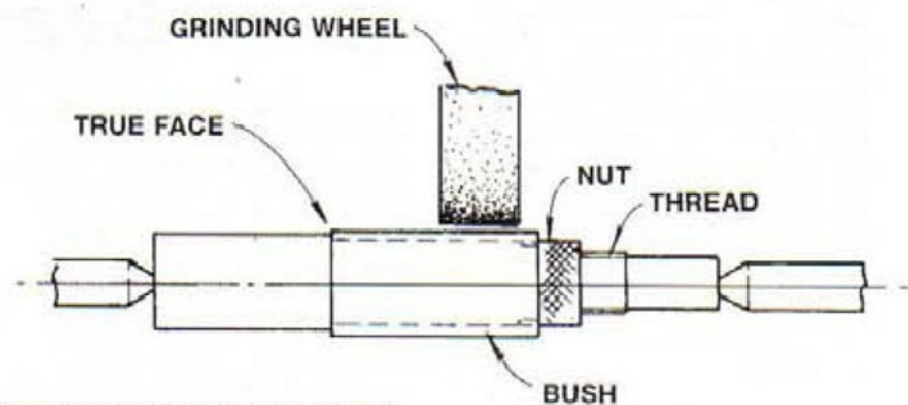


FIG. 10. PLAN VIEW OF INTERNAL GRINDING SET-UP



GRINDING O/D ON STEPPED MANDREL

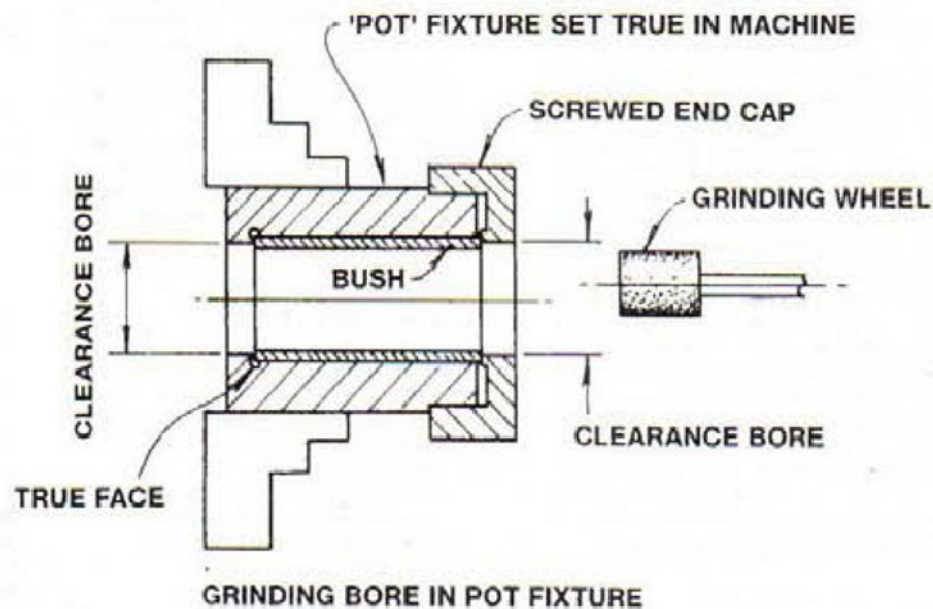
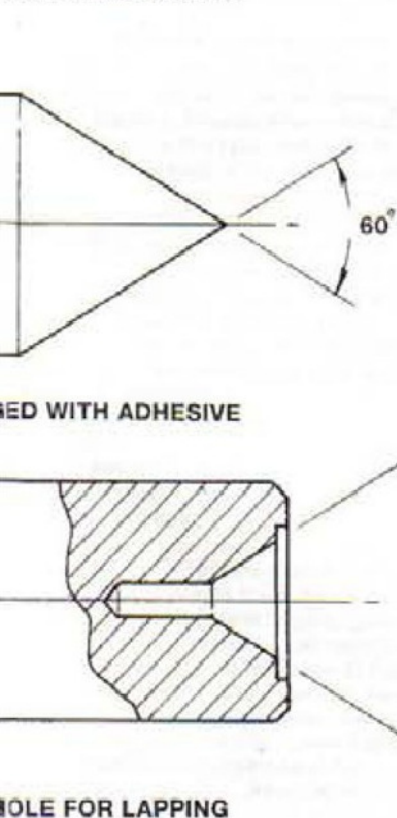


FIG. 12. SPECIAL WORKHOLDING FIXTURE

mounting by one of the three conventional techniques. Once the outside diameter has been ground, the bush can be transferred to a 'pot' fixture, where the bore can be ground (Fig. 12).

The universal grinding machine

Having two separate cylindrical grinding machines, one for internal work and a second machine for external work, can be something of an extravagance for the small workshop, and so the 'universal' grinding machine has evolved, capable of coping with both types of grinding. This machine is essentially an external cylindrical grinding machine, being provided with a secondary wheelhead which can be brought into play when internal grinding is to be undertaken. The same workhead will hold work for both external and internal grinding.

Originally, a completely separate wheelhead was fitted to the machine for bore grinding, but this constant swapping from wheelhead to wheelhead was a time consuming operation. Soon, alternative methods were devised for changing from head to head. The two main methods in use today are a completely reversible wheelhead, which pivots through 180deg. - external grinding wheel at one end and internal wheel at the other - or a bore grinding head which swings down from above the external wheel and is secured in place. To be able to grind bores and outside diameters on the same machine is a great asset.

Grinding attachments

Many attachments have been introduced over the years which can be fitted to lathes and which will successfully perform grinding work while utilising the lathe spindle as the workhead. Many engineers deplore the use of such contrivances, as the abrasive dust gets into the slide ways and bearings of the lathe and causes rapid wear. This may be so, but these attachments have long been extremely popular in small workshops where grinding operations have been essential, but the acquisition of a grinding machine has not been possible. If a grinding attachment is used, then great care should be taken to clean down the lathe after use. Again, two types of attachment are generally available. A small wheelhead which mounts on to the lathe cross-slide and is controlled by the cross-slide leadscrew will grind external diameters, while a small, fast running toolpost mounted head can be used for bore grinding. A modified pneumatic die grinder is ideal for this application.

Grinding work between centres

A job which is to be ground between centres will have been turned in the lathe, and centre holes will have been provided at the turning stage. An allowance has to be made by machining oversize those external dimensions which are to be brought to final size by grinding. The amount of this allowance will depend upon several factors. If the work has been



Workhead speed control lever on a Churchill grinder. This company was once the world's largest manufacturer of precision grinding machines.

heat-treated after turning, it may be found that distortion has taken place. More allowance will have to be made for a long slender job than will have to be made for a short chunky job. It may also be that several dimensions are involved, and these may not be concentric with each other. When the work is placed in the grinding machine, therefore, some features may be running out of true by a considerable amount. The grinding allowance will have to be sufficient to deal with this.

If the job is such that the centres are to be used for purposes other than the actual grinding, say a mandrel which will be used between centres many times, then the centre holes may be 'lapped'. A simple lapping device (Fig. 13) may be made from soft material such as brass, cast iron, copper or aluminium and charged with abrasive paste. The lap then becomes a hard abrasive cone which can be rotated by hand or used in a drilling machine to clean up the centre holes. A job dealt with in this way can be placed between centres time and time again and be exactly true every time.

The magnetic chuck

Much cylindrical grinding work is produced off the magnetic chuck. The magnet is powerful enough to hold the work secure for the light grinding cuts which are taken.

In order for a job to be able to adhere to this type of chuck, enough surface area must be available, and this is a primary consideration. It is essential that the job does not move on the chuck during grinding. However, when setting up work on the magnet it can be set at half power to allow the job to be easily tapped true to the DTI. Naturally, when perfect truth has been achieved the magnet can be advanced to full power.

The typical holding power of a good quality magnetic chuck is somewhere in the region of 12 Kg/cm² (170 lbf/sq.in.) It must, though, be said that some of the cheaper models of Far Eastern

manufacture which are available now have a significantly less holding power. These chucks are, nevertheless quite serviceable and are (due to their lower cost) very popular.

Parts which have been held on a magnetic chuck will, inevitably, become magnetised themselves to a certain degree. This may not be desirable, and a simple method of destroying unwanted magnetism is by the use of a demagnetiser. Two types are generally available—the platen type and the tunnel (or hollow coil) type. Passing the magnetised parts over or through the demagnetiser completely destroys any residual magnetism.

The conventional chuck

Both 4-jaw independent and 3-jaw self centring chucks are used for cylindrical grinding, especially internal grinding. Many specialists favour the use of the 'Griptru' chuck manufactured by Pratt-Burner. This particular chuck can be finely adjusted to run extremely concentric, while also being able to be operated by a chuck key in the normal manner. Chucks are used mainly for the thick walled jobs such as bore grinding small gears. There are occasions though, when 6-jaw self centring chucks are used to distribute the gripping forces more evenly.

Summary

Grinding, then, is a realistic option for the modern home workshop where a higher standard of workmanship is required. Using the simplest of grinding machines opens up a whole new realm to the model engineer, especially where hardened work is encountered. Grinding not only allows extreme accuracy to be achieved, but also offers a 'professional finish' to components which are intended to be the focal points of a particular model or piece of equipment which is under construction.



A SMALL INSTRUMENT VICE

Perhaps one of the simplest toolmaking exercises in the book, but a useful piece of equipment for all that. Len Walker describes a neat little vice designed to be held in the larger bench vice



The finished vice. A plain jawed version with a file handle in place of the vice tail would please any fisherman who ties his own flies.

This is a simple, easy to make version of the traditional instrument maker's vice. It is invaluable for securely holding small parts while carrying out accurate filing or similar operations. With the shank gripped (between soft jaws) in a bench vice, it brings small work up to a more convenient working height, with improved visibility. The shank can be quickly set at any angle, to suit the job in hand. A few construction notes may help.

Detail 1. The fixed jaw

Made from $\frac{1}{2}$ in. square BMS, cut and filed to length. Mark off and mill or file the 'vee', which must be at 90 deg. to the sides. Drill and tap the $\frac{1}{4}$ in. BSF tapping hole, accurately square in both planes. This can be achieved if the work is clamped to the drilling machine table, then drilled and tapped at one setting, using a taper tap held in the drill chuck to ensure a true start. Aim for a good 'standard' thread - use a cap screw as a gauge. Chamfer both ends of the thread to ensure that there are no sharp edges left which, when case hardened, might damage Detail 6, the clamping screw. File $\frac{1}{4}$ in. and $\frac{1}{16}$ in. chamfers and set aside.

Detail 2. The moving jaw

This is also made from $\frac{1}{2}$ in. square BMS. Leave over length (say $2\frac{1}{4}$ in. long) to make it easier to hold while drilling. Drill, then ream the 0.265in. dia. hole. Drill at the $\frac{1}{4}$ in. dia. reamed hole position - but only $\frac{7}{32}$ in. dia. Also drill and tap the 6 BA hole, at the 0.250in. dimension shown. Cut to final length and square up the ends. File the $\frac{1}{4}$ in. and $\frac{1}{16}$ in. chamfers, and set this aside.

Detail 3. Locking screw

Make this from a 6 BA grub screw, the end 'pip' being polished.

Details 4 & 5. The handle

This can be made as an assembly, with one end solid and with the other as a loose cap, riveted on. Alternatively, the centre portion can be made from $\frac{5}{32}$ in. dia. silver steel and fitted with a loose cap at each end (which, on reflection, is probably easier). *Most important* - remember to assemble the handle through Detail 6 before riveting!

Detail 6. The clamping screw

Turn this from $\frac{1}{2}$ in. dia. EN8 (for toughness). Chuck a $3\frac{3}{4}$ in. length, face the end and centre. Pull $2\frac{3}{4}$ in. out of the chuck and grip securely. With support from the tailstock centre, turn the 0.265in. dia. to a running fit in the fixed jaw. Turn the retaining groove as shown, then undercut and screwcut the $\frac{1}{4}$ in. BSF thread, a close fit in that in the fixed jaw. Turn the $\frac{7}{16}$ in. dia. and part off. Reverse and, holding on the 0.265in. dia., form the $\frac{5}{8}$ in. spherical radius and polish.

Mark off, then drill and ream the 0.156in. dia. hole. Toughen, then polish the 0.265in. dia. and the shoulder.

Reaming Details 1 and 2 together

Assemble the clamping screw through the moving jaw and screw into the fixed jaw. Line up both jaws and firmly grip together. With the assembly raised on a 1in. parallel, the $\frac{7}{32}$ in. dia. hole in moving jaw can be lined up, and the assembly securely clamped to the drilling machine table.

Now drill and ream $\frac{1}{4}$ in. dia. through both jaws—this ensures a correct 'line up'. Lightly chamfer both holes.

Both jaws can now be casehardened, protecting the threads during this process. Clean out the threads and other holes, ensuring that the finished bores are smooth.

The guide pin. (Detail 7)

A part which can be made from silver steel, a drive fit in the moving jaw and a slide fit in the fixed jaw. Harden, temper and polish. Alternatively, it can be made from a $\frac{1}{4}$ in. dia. x 2in. long commercial dowel. Any required adjustment of diameters can be made by using a medium oilstone (well oiled) while the dowel is rotating in the lathe. Polish finally using 600 grit wet or dry paper, with a few drops of light oil.

To ensure the accuracy of line-up on assembly, the fixed jaw can be used as a guide for assembling the guide pin. Using the clamping screw to hold the two jaws together, insert the pin through the hole in the fixed jaw to line up with the hole in the moving jaw and press it into the latter. This should ensure that the moving jaw and pin moves smoothly in and out when the clamping screw is turned. Ease slightly if required; smooth operation is essential.

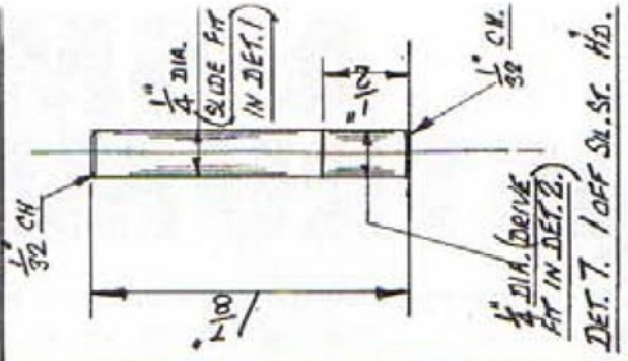
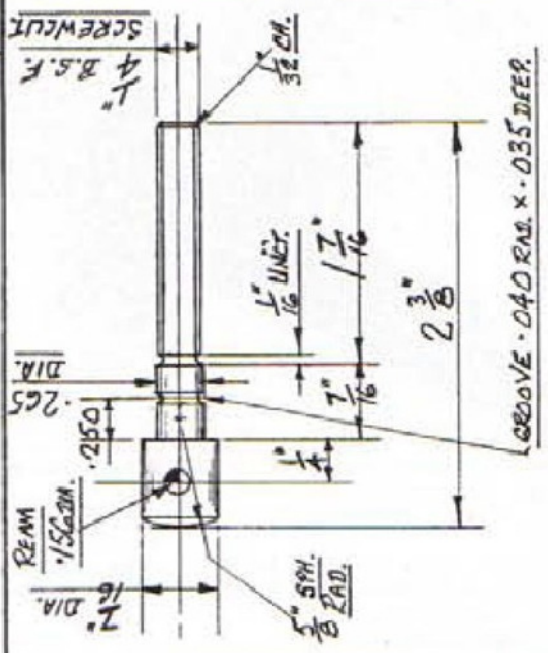
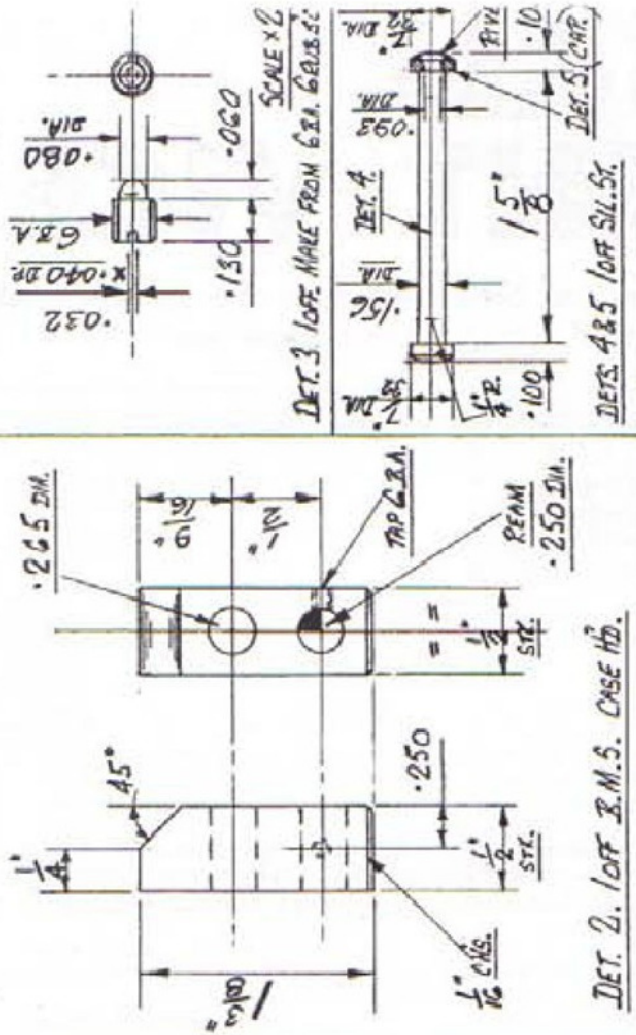
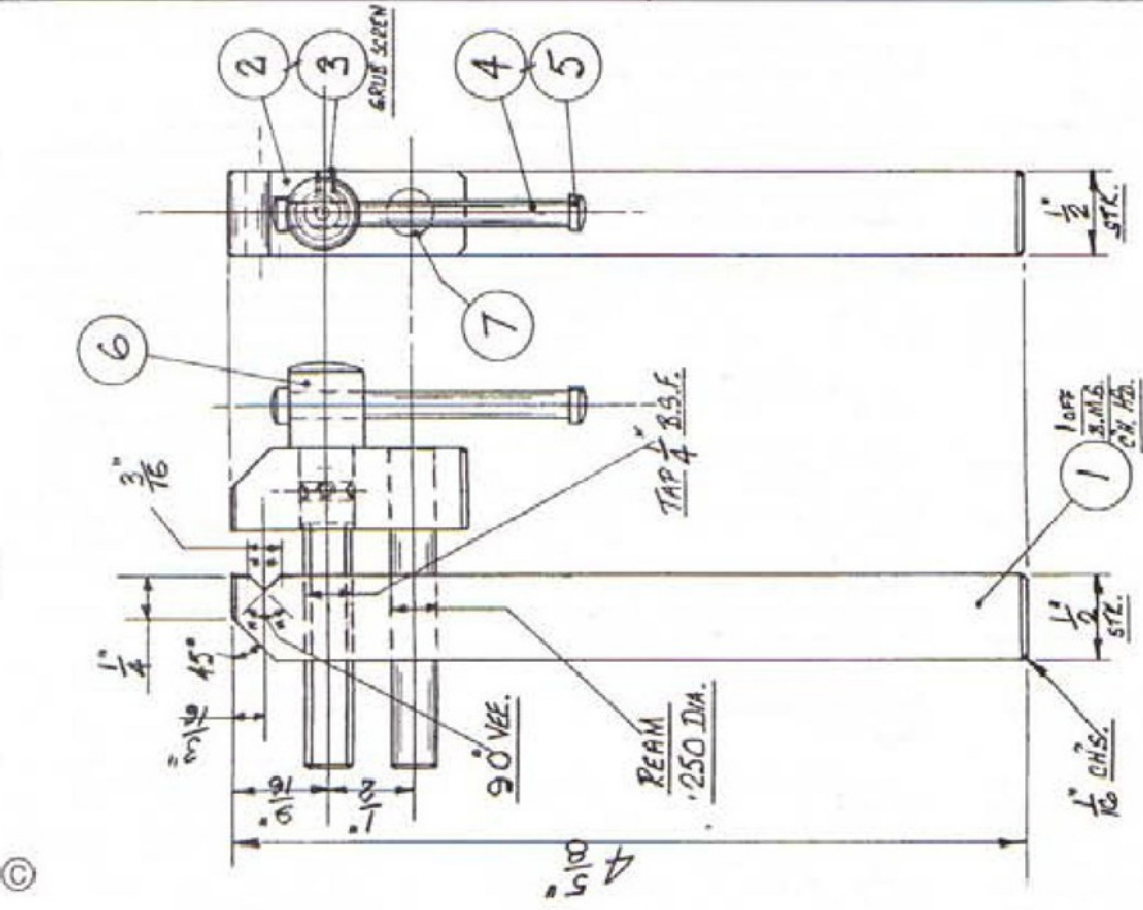
Thoroughly clean everything, getting rid of any grit or swarf and assemble. A drop of Nutlok or similar will secure Detail 3, the retaining screw. Lubricate with a light oil.

Finally, a passing thought from just pre-war toolmaking apprenticeship days. I remember one of the 'old boys', every inch a master craftsman, saying to me "Lad, the only one you really hurt by doing bad work is yourself". Nearly sixty years on, I can't improve on his comment!

Go to it—work well, and work safely.



INSTRUMENT VICE.





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- Our displays will feature lots of background information on the exhibits, including some little known facts.
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- Many started with Meccano, so a display featuring the history of that product will feature in our village.
- Wonder at what you see, as the Society of Ornamental Turners demonstrate the capabilities of a Holtzapffel lathe.
- Study and produce a private lightning blast from one of the interactive replica electrical machines on parade.

Please note, whilst every effort is made to ensure that the above details are correct, some features may be subject to change or cancellation.

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SEE YOU THERE...

RESTORING AN AUTOMATIC CENTRE PUNCH

We have all come across good quality tools that have seen better days. A little tender loving care can work wonders, and revive an expensive item with little or no outlay. Dick Marks of Newton Abbot gave the treatment to this eclipse marking out tool

Whilst reading through some back numbers of *Model Engineers' Workshop*, I came across a letter in the Nov./Dec. 1993 issue from Mr Jerrard of Exeter seeking information on Automatic Centre Punches. Having repaired my own, I decided to write this article.

Some time ago, I was given a box of old tools, and amongst them was an early Eclipse 171 Automatic Centre Punch, covered in rust and muck, but working. Some time last year it decided to play up and to work only intermittently. Being one of life's inquisitive souls and also short of money (like many model engineers), I decided to strip it down and see what was wrong, and also find out how it worked. I first removed the screwed piece at the bottom, and out dropped the Punch Shaft and a spring. Inside the Main Body was a brass screwed bush with two small holes drilled in it for removal purposes. As I did not have a tool that would fit, I opened these holes out with a slightly larger drill held in a pin vice, then by mounting two pieces of piano wire in the vice at the correct distance apart, the brass bush was unscrewed and removed. The rest of the punch was then dismantled as far as possible, and each piece was inspected for faults.

What makes it tick?

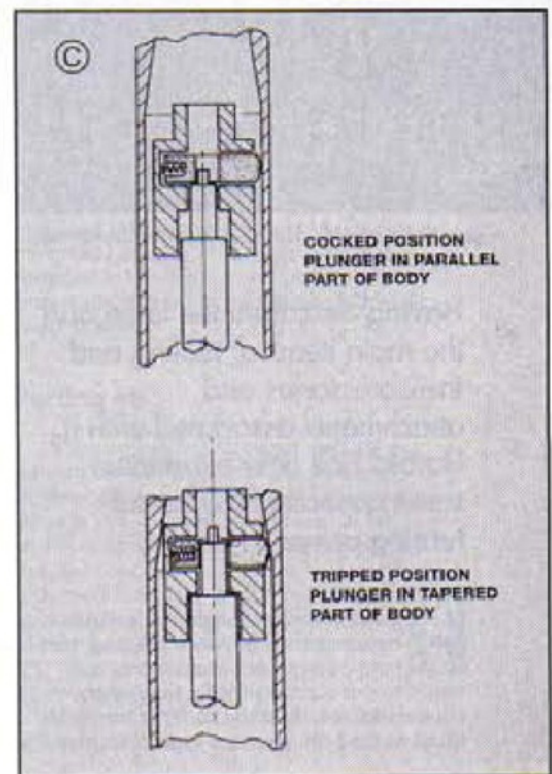
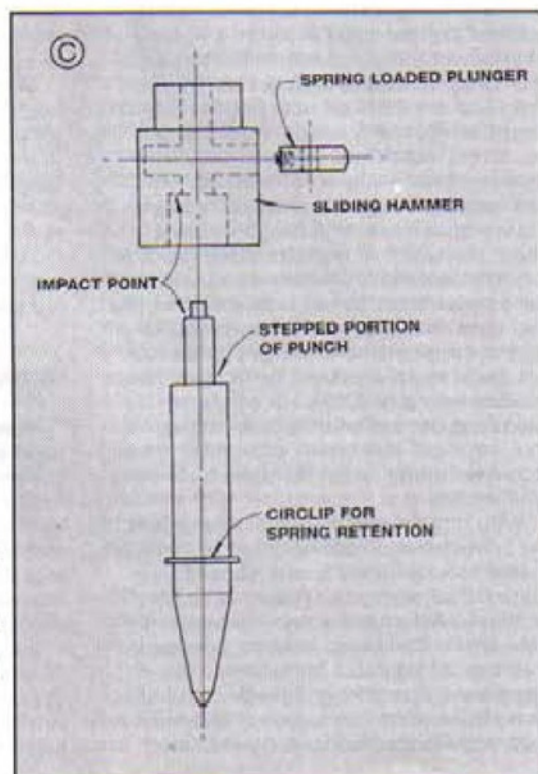
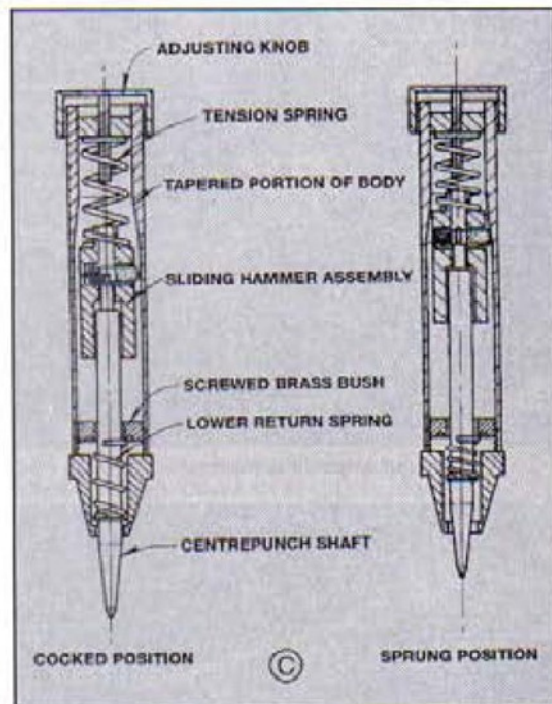
If I first explain how the Automatic Centre Punch works, it will be easier to see what was at fault with mine. If you refer to the drawings, you will see that inside the Main Body is a circular piece I have called the Sliding Hammer Assembly. Inside this, there is a small, transversely mounted spring loaded plunger. While in the parallel part of the Centre Punch Body, the hole in the centre of the plunger is not displaced enough to be fully opened, and only allows the smaller part of the stepped portion of the Punch Shaft to enter. When pressure is applied to the Punch Tip, the Sliding Hammer Assembly rises and enters the tapered part of the

Centre Punch Body. This pushes the Spring Loaded Plunger further across the Sliding Hammer Assembly and fully opens the hole in the Plunger, thus allowing the middle part of the stepped portion of the Punch Shaft to enter the hole. This allows the shoulder on the widest part of the Punch Shaft to impact with the lower part of the Sliding Hammer Assembly and subsequently to make an indent in the material being punched.

The adjusting knob screws a keyed bush up and down, to vary the tension on the large spring (there is another, smaller spring inside the large spring). The lower return spring resets the mechanism after each operation.

The problem solved

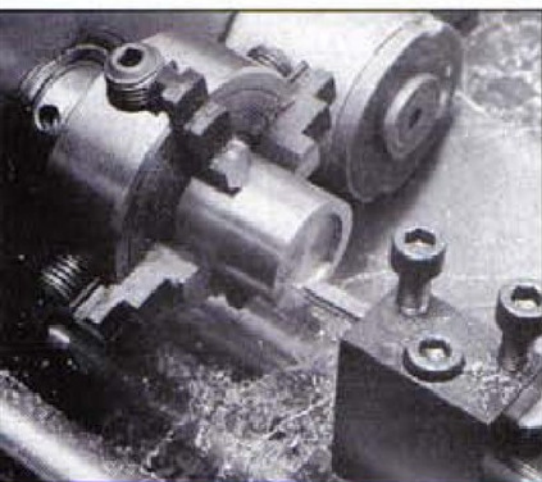
And what was at fault with my punch? The tiny spring behind the plunger had lost some of its tension. A light stretch, and after a light oiling and reassembly it is back in service.



A BEGINNER'S GUIDE TO THE LATHE

THE TURNING PROCESS

Part 12



A facing cut across a workpiece.

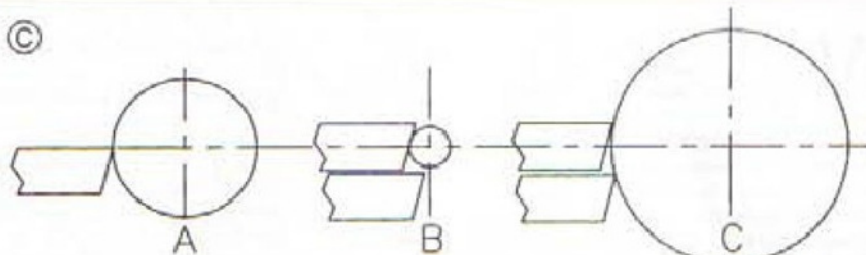


A good test of skill, turning a slender workpiece to a shoulder.

Having described the lathe and the main items of tooling and the accessories and attachments associated with it, Harold Hall now examines some aspects of the actual turning process

Having previously established the requirements for work holding, tool holding and tool shapes, we are ready to get started. With a task ready, choose the tool for the job. This has to be fitted to the lathe and the type of holder

©



- A. TOOL HEIGHT CORRECT WILL CUT AT ALL DIAMETERS.
B. TOOL HIGH, OR LOW, SMALL DIAMETER, WILL NOT CUT.
C. TOOL HIGH, OR LOW, LARGE DIAMETER, WILL CUT.

EFFECT OF TOOL HEIGHT AND WORKPIECE DIAMETER.

SK 1

will determine how easy this is, but whatever method, the requirements are the same.

Tool positioning

The first requirement is for the cutting edge of the tool to be at centre height. I have seen articles recommending that the tool to be off-centre, high in some cases, low in others, but I do not consider this to be good practice. It is true, that in some situations tool height is less important than in others. An off-centre facing tool will certainly cause a problem if facing to the workpiece centre. If low, it leaves a sharp projection, if high, it ceases to cut as it nears the centre, creating a smooth raised area. **Sk.1** shows how a high or low tool may not cut at small diameters, but may at larger diameters. This comment is not given as an excuse to be lax, but does indicate why a tool may cut on some occasions but not on others. A parting off tool, set high, may create difficulties when it ceases cutting as the diameter becomes smaller.

With no other method available to judge the correctness of tool height, it is a simple matter to very lightly face a piece of material, adjusting tool height until there is neither a sharp nor a smooth projection. This can be done with most tools, even if they are not intended for facing operations. A tool height gauge could be an early project to undertake (References 1 & 2). A quick method used by old time

turners was to pinch a steel rule between tool tip and workpiece, if the highest point of the rule swings towards the turner the tool is too low, if it is upright the tool is on centre height, top of rule away from the operator means tool set too high. However it would be foolish to try this with one of the modern inserted tip carbide tools, where there could be a danger of chipping or cracking the tool tip.

While setting the tool to the correct height, it also requires positioning to ensure relief angles are correct in relation to the workpiece. With some toolholders there is plenty of scope to get this wrong, as they have no method of locating the tool square to the lathe's axis. It is also desirable to keep the overhang of the tool from its mounting to a minimum, to help to avoid vibration which leads to chatter.

Rotational speed

There can be no precise recommendation for spindle speeds. What is acceptable on a large robust lathe will not be so on a lighter one. Anyone who has operated a larger lathe will have experience of how easy vast amounts of metal can be removed, compared to the average machine encountered in the home workshop.

Let us consider some of the factors. Obviously, the faster the machine is run, the quicker material can be removed - worthwhile, even in the home workshop. If the work has an acceptable finish, and the

lathe shows no signs of being over stressed, all would appear well. Higher speeds mean, for a given feed rate and width of cut, more work done at the cutting edge, with a greater chance of the tool overheating, causing early failure of the cutting edge. A copious supply of coolant will help, but if things are taken to extremes, even this will not prevent the problem.

We are not however so concerned about rotational speed (rpm) of the work, but linear speed (metres or feet per minute) at the cutting edge. Rotational speed is therefore diameter dependant. An acceptable speed at one diameter can be doubled at half the diameter.

Running at much too low a speed creates a quite different problem. In this case it is difficult to feed the tool slowly enough to prevent the feed rate becoming too high, thus perhaps creating a poor finish. This will also increase the load on the workpiece, and for small diameters, cause it to deflect.

Fortunately, between the two extremes, there is a wide range of acceptable speeds for a given material and diameter. This should be obvious, as most lathes have only a few speeds. One well respected small lathe has speeds of 250, 500, 1000 and 2000 rpm. If such wide gaps were unacceptable the lathe would be unpopular. Obviously, finish must be acceptable, and this will be visually apparent. Deflection of the workpiece will be detectable by measuring after completion of a cut, but heat at the tool and load on the lathe will be less easy to detect. These factors are also dependant on the material being machined; the tougher it is, the slower the speed and/or feed rate must be.

Another situation that will require a lower speed is the machining of irregular shapes, say square materials, or more of a problem, an odd shaped casting. Especially with castings, the speed should be held low. Screw cutting is another operation that demands a lower speed, but for quite different reasons.

The following gives a starting point for choosing rotational speeds. For light lathes, lower speeds may be required; for robust machines, higher speeds will certainly be possible. In the end it is for the lathe user to establish suitable speeds for his or her situation. This can be recorded in the workshop note book.

Dia. (mm)	MATERIAL					
	A	B	C	D	E	F
	Speed in rpm					
3	3300	2330	1650	2000	5000	10000
5	2000	1400	1000	1200	3000	6000
10	1000	700	500	600	1500	3000
15	660	470	330	400	1000	2000
25	400	280	200	240	600	1200
32 (i)	310	220	155	190	470	940
50	200	140	100	120	300	600
100 (i)	100	70	50	60	150	300

Material

A= Free cutting mild steel (loaded)
 B= Mild steel
 C= Stainless, Silver steel
 D= Cast iron
 E= Brass, Copper
 F= Aluminium

Notes

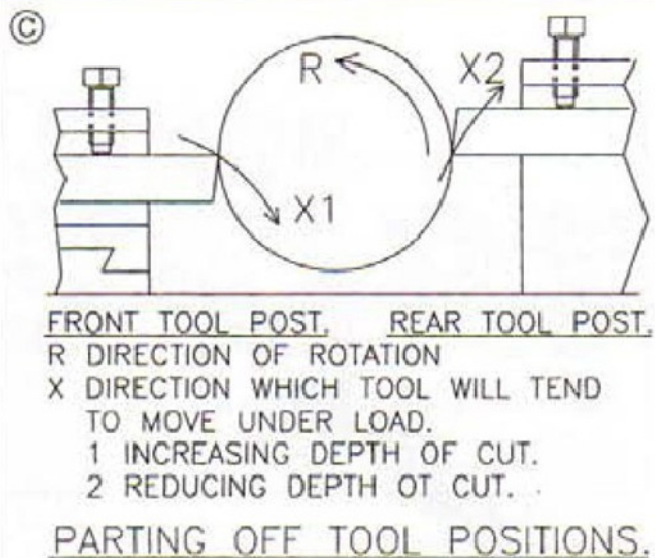
- The list gives suggested rotational speeds for light finishing cuts using HSS cutting tools.
- For roughing cuts, reduce speeds by 25%.
- If using Carbide tipped tools speeds can be increased appreciably, to double the figures given, maybe more.
- For parting off, reduce values by 50%, but for larger diameters, increase the speed in steps as the diameter reduces.
- For intermittent cuts on larger items, reduce the values by at least 50%.
- If in doubt, aim for a lower speed, but not so low as to make machining difficult.
- Few lathes have speeds as high as those quoted for the smaller diameters, use the highest available and take light cuts only.
- With a continuous flow of coolant higher speeds should be possible, say + 25%.
- If requiring linear speed, as given in most other published lists, the following gives sufficiently accurate values. The value given for 100mm diameter can be taken as feet per minute, and one tenth of the value for 32mm as metres per minute.

Feed and width of cut

Having chosen the tool and machine speed, we still have two closely related factors to establish, namely width of cut (length of cutting edge in use) and feed rate (tool travel per workpiece revolution). Our concern is the load that these place on the workpiece and on the lathe itself, and the effect this has on finish and heating of the cutting tool.

It would be easy to consider that feed had little effect on the load as, if a width of cut of 4mm has been set, then this will remain constant whether the feed is 0.1mm or 0.2mm. Why then the difference when taking the same width cut? The reason is that the material being removed is also being bent as it leaves the part. The force needed to bend the strip being removed will depend on its thickness, which will be greater for a greater feed rate. The additional force then creates more friction with the cutting tool, and collectively these factors increase the load appreciably as the feed rate is increased. Also, increasing the width of the cut will increase the load, nominally in proportion. It is therefore established that feed and width of cut together account for the load placed on the workpiece. It is therefore impossible to separate these when considering heat developed at the tool.

Normally the aim is to remove as much metal as is possible in the shortest time, all other considerations being met. To double the removal rate, one can double the feed, or double the width of cut. Increasing the feed rate will have a greater adverse effect on finish than will increasing the width of cut. However at the extreme, that is a very



SK 2

large width of cut and a very fine feed, tool wear may become a problem. Consider a workpiece, 25mm diameter being reduced in diameter over a length of 50mm. If the feed rate is 0.1mm then the tool will have cut through a length of $\pi \times 25 \times 50 / 0.1$ which equals 39.27 metres. If now the feed rate is halved then the distance would double to 78.54 metres, obviously having an adverse effect on tool life.

Unfortunately I have not been able to come up with any firm values, but I hope the reader is now in a better position to understand the situation, which is a far from a simple one. I would therefore suggest the following:- feed should be as high as is possible whilst still achieving an adequate finish; the width of cut can then be increased to a point where the system is still not over-stressed.

Feed rate is the least definable parameter. Many lathes have only a change wheel driven feed mechanism, and it is often a laborious task to alter it. As it has only a limited range of feed rates, it is unlikely that any attempt will be made to adjust this to suit perfectly the job in hand. A feed rate of 0.1mm per rev. would probably be a good value to start with.

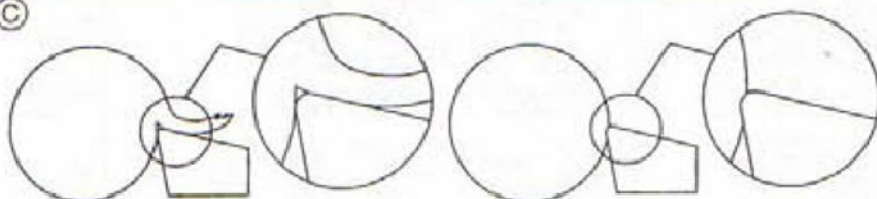
More often than not, feed will be applied by hand, giving rise to a number of considerations. Is the finish adequate? Is the accuracy adequate? Is the lathe untroubled and are you happy with the progress of the task regarding time taken? If yes to all the questions, then width of cut and feed rate are about right. Accuracy is included because, if the rate of metal removal is too high, then the workpiece may deflect causing tapered or barrel shaped work.

Parting off

While appearing straightforward, parting off will almost certainly pose problems for most beginners. Unless the lathe is very robust, it will have to be carried out with great care. Sk.2 illustrates that the tool will tend to dig in if in a front mounted tool post, as the rotation tends to cause the tool to deflect downwards and further into the workpiece, as per arrow X1. This is not just the tool being bent, but its mounting can also move.

While the feed rate is below a critical level, all will be well. However, a slight

©



SHOWING, MUCH EXAGGERATED, HOW A BLUNT TOOL WILL BE ABLE TO TAKE A HEAVY CUT, WHILST BEING UNABLE EFFECTIVELY TO TAKE A VERY FINE CUT.

EFFECT OF A BLUNT TOOL.

SK 3

increase will cause additional deflection, that in turn will cause increased depth of cut, increasing tool deflection, and so on. This causing it to dig rapidly in with potentially disastrous results. If the lathe is belt driven and they are not too tight, hopefully the worst will be that the belts will slip, otherwise more serious results will occur, maybe a broken tool or damaged workpiece.

The problem is not so severe if the tool is mounted in the rear toolpost, as the tool tends to move as per arrow X2. In this case, if the operator applies too much feed, the deflection will tend to reduce the cut rather than increase it. Even so, the workpiece, if not robust, can tend to deflect and roll under the tool, again with potentially disastrous results. This can also happen with a front mounted tool, in this case tending to roll over the top of the tool.

A further advantage of the rear mounted tool is that the forces exerted on the toolpost and slideway system is downwards, into the bed of the lathe. This means that working clearances (or wear) in the slides do not result in movement of the tool, as is more likely to be the case if the forces are upwards, as they are with the front mounted tool.

In either case, although the rear mounted tool will make life much easier, the following must be observed:-

- 7). Keep machine speed on the low side, say 50% of normal.
- 2). If parting off a large diameter, raise the speed in one or two steps to compensate for the reducing diameter.
- 3). Keep the tool sharp, but with a top rake on the low side for the material being machined.
- 4). Use the narrowest cutting edge possible, having considered the depth of cut and the strength of the tool.
- 5). Keep the projection of the tool to a minimum. Use a purpose designed mounting method if possible.
- 6). If the workpiece is held in the chuck, part off as close to the chuck jaws as possible (no further away than the diameter of the workpiece). If the chuck jaws are in very good condition, especially if a four jaw chuck, then $1\frac{1}{2}$ times may just about be acceptable. This is also dependant on the size and condition of the lathe mandrel and bearings.
- 7). The comments in (6) above assume that the part is being held using the full depth of the jaws. If this is not so, then the part must be supported using the tailstock centre. A fixed steady just may suffice, but this lacks control on the part working out

of the chuck, in fact can under some circumstances encourage it. (See article on steadies)

- 8). Use a cutting lubricant.
- 9). Apply feed at a slow and even rate to keep the tool cutting, except when changing speed as in (2) above.

Achieving accuracy

If one is faced with turning a diameter to a tolerance of say $\pm 0.005\text{mm}$ (0.0002in.) ± 0.0 , it would be a brave turner who, finding the workpiece 0.25mm oversize, would then put on a depth of cut of 0.125mm attempting to bring it to size in one go. Caution would demand that the diameter was further reduced before making that final finishing cut to achieve size.

This may demand a very shallow final cut, in which case, there are two factors that make this far from easy. First, how does one reliably move the tool in by a very small amount, even if the cross slide dial is calibrated in 0.02mm divisions? The answer is to use the top slide. If the top slide is set over to 6deg. , it will found that to move the tool in by an amount of 0.01mm the top slide will require feeding by about 0.1mm , a magnification factor of 10 times. An angle of 0.6deg. approximates to a magnification of 100 times. The 6deg. angle is not precise (5 deg. 44m being more exact), so the top slide angular calibration would not give an accurate result. The simplest solution is to set the topslide as accurately as possible using the calibrations, then to measure the job regularly and adjust the rate of tool movement accordingly. To achieve a very accurate setting, then a dial test indicator locating on to a parallel test piece in the chuck could be used. Adjust until the indicator deflects by 0.1mm for 1mm , or 10mm travel.

Having now established a means of reliably advancing the tool, there still is a potential problem. For such fine cuts to be taken, the cutting edge must be very sharp and well finished. It should be honed with a suitable stone. The reason should be obvious from the illustrations in SK.3. The honing operation should be carried out specially for the task in hand; a tool that has had more than a few minutes use may not be adequate.

Finishing to a precise dimension should always be done with multiple light cuts, for if the penultimate cut is on the heavy side, the workpiece may spring a little, especially at small diameters. The part

would then reduce further on a subsequent cut, even if the tool were not advanced at all. It is easy in such a situation to arrive at an undersize part. Remember also the temperature of the workpiece as, it is easy to get a false reading from a piece that is hot and therefore expanded. The final cut should be taken with the job as near to ambient temperature as possible.

Achieving a fine finish

The need for a part having a very precise diameter is usually coupled with a need for a fine finish, though the need for a fine finish may exist on its own, purely for appearance sake.

Some turners advocate a very fine (say 0.1mm) feed using a knife tool with a small radius at its tip. However, a greater feed rate (say 0.2mm) coupled with a tool having a longer edge in contact with the workpiece will almost certainly make the job easier and produce better results, especially if fed by hand. Referring for a moment back to the article and sketches on lathe tools published in Issue 45, a round nose tool (SK.11) will work well, and is the method I normally use, but will not work up to a shoulder. The preferred tool is shown in SK.9. The cutting edge X is slightly convex and about 2mm wide, it is shown wider in the sketch for clarity. A chamfer (say 1mm) on the leading corner assists in taking deeper cuts than that taken to finally bring the part to size. Deeper cuts taken without the chamfer, would not be ideal as there is no side rake. The chamfer enables the cut to make use of the top rake present. The tool in SK.10 works similarly for face finishing.

Final comment

Much, much more could be written on the subject of basic turning, but the more I wrote the more difficult it would be to assimilate and the less basic it would become. There is no substitute for practical experience. Put a piece of bar in the chuck and experiment with a variety of tools, using different speeds, depths of cut and rates of feed. Always observe closely the results of your labours and the experience gained will soon accumulate. Being a beginner will then be a thing of the past. While experimenting try the effect of tailstock support on the workpiece, using a centre in the tailstock. Note how the job tends to tighten up as the workpiece warms up.

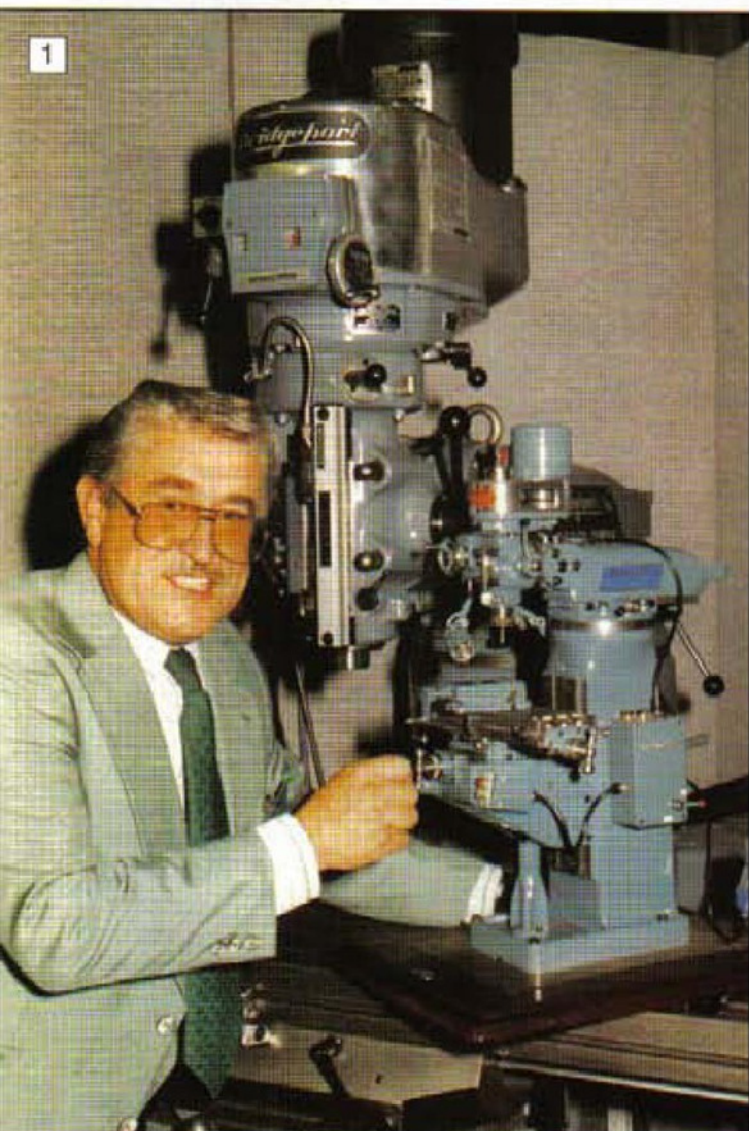


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1. Lathe tool height gauge. M.E.W. Issue 5 page 28
2. A clock stand for setting lathe tool height. M.E.W. Issue 42 page 26

THE MINIATURE BRIDGEPORT MILLING MACHINE

The recent Bristol Exhibition saw the first public appearance of a remarkable miniature machine tool, which fascinated all who studied it. Its builder, Barry Jordan of Derby tells how the project started, and promises us a fuller description



Barry Jordan poses with his machine sat on the table of a full size machine, at the recent Midlands Model Engineering Exhibition at Donington (Photo: Mike Chrisp).



The miniature rotary table that started it all. In itself it is a small masterpiece.

In January 1997, a friend showed me his latest acquisition; a Sharp four inch rotary table. This little table was very nice and well finished, a handy addition to any workshop. A few days after seeing this I stood in my workshop scratching my head wondering what to make next? "I know, A smaller rotary table than Arthur's. A good deal smaller!". So I set to and carved and hacked at several pieces of redundant cast iron. The end result was a two inch diameter miniature rotary table. Several comments were passed by the friends who saw it, and I came to the same conclusion as them - I must make a miniature milling machine to use this little table on. What machine to model though? A Raglan, like the one

I own? A Tom Senior? I went through a list, Astra, Centec, Myford VMC, Elliot, Cincinnati. Then it clicked, The Bridgeport! Yes. With great enthusiasm I dashed off to see my good friend, Des Gratton, who owns a small engineering company in Derby. He has a real Bridgeport. I just stood and looked at it for fifteen to twenty minutes. My initial thoughts were "There must be other machines easier to base a model on than this, but what a challenge!"

I went home brooding on the many problems. Where do I start? What part do I tackle first? The table, the body, the knee or the head? Can this model be made without castings? What do I use to power it with? Will the



The completed model of the machine, viewed from both sides.

lawns get cut if I start it? Will my marriage survive? After several weeks of thought, a plan of action was arrived at. I would fabricate the main body and knee from aluminium plate, with cast iron for the slide-ways, all bolted together.

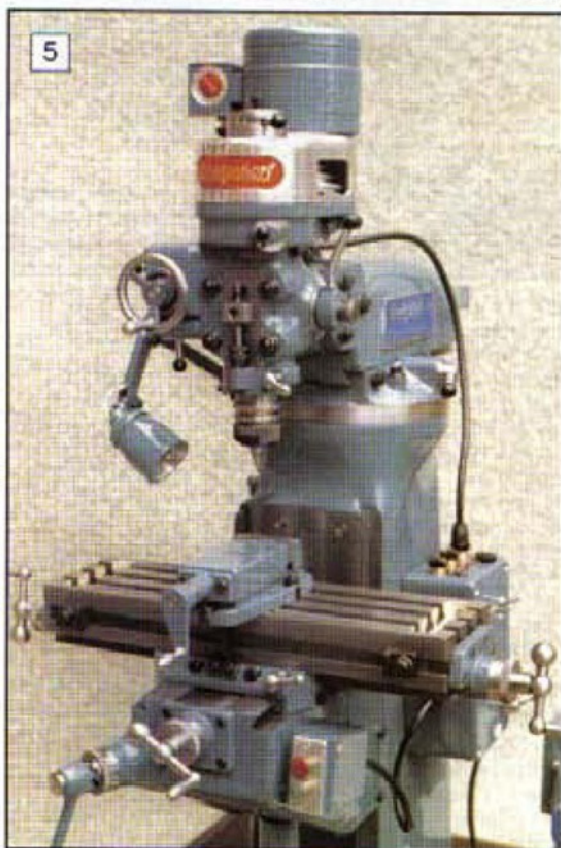
The table, head and over arm or ram would be manufactured from solid cast iron billets, commercially available. The top pulley cover made from Dural (giving a nice polished finish). That was it, ready to start.

It was at this point that I started to do a little research on the background of the Bridgeport. I soon discovered that Bridgeport production started in USA in 1938. Sixtieth Anniversary in 1998. What started as a fun project finally took on a

new significance - in honour of this famous company and equally famous machine.

The machine is now finished, and on 20 September last, I took the first trial cut on a small block of mild steel, and all worked fine. I can mill on it, with or without the rotary table. Although the original concept was that of a model, the result has been a machine tool in miniature, the building of which I believe will interest readers of *M.E.W.*, so in future issues I will be describing how I built the machine and its equipment.

As we went to press we learnt that the model was awarded 1st Prize in Class 7 at the Midlands Model Engineering Exhibition at Donington.



Close-ups of the working head of the miniature machine, we have to define the pictures as being of the miniature, it is indistinguishable from the real thing.



INTERNAL GRINDING WITH THE QUORN

Philip Amos addresses two modes of internal grinding - die sharpening on the Quorn itself and the use of the wheelhead on the lathe toolpost



DIY Set of Grinding Points (Grey material).

Introduction

There are two distinct internal grinding activities that can be undertaken with a Quorn Universal Tool and Cutter Grinder, and both are addressed by Professor Chaddock in Ref.1. In essence, they are the sharpening of threading dies on the machine itself, and, when the Quorn

wheelhead is used on the toolpost, grinding of internal diameters in the lathe.

In either case, the size of the grinding wheels or points is much smaller than the size used in its normal tool and cutter grinding role—perhaps 3 to 25mm diameter instead of 100mm diameter—and so the rotational speed should be much greater for satisfactory grinding results.

This matter is addressed in Ref.1 and in more detail in Ref. 2.

The quality of finish can be adversely affected by vibration stemming, in part, from out of balance of the large diameter drive pulley, and from the belt join, so the most careful attention to these two matters can provide worthwhile improvement.

Sharpening Threading Dies

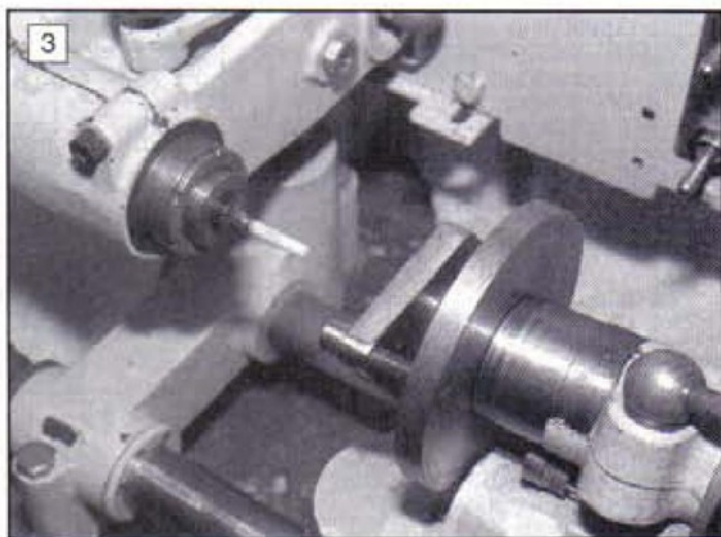
On page 120 of Ref.1, Professor Chaddock shows, in Fig. 95, the essentials of a die carrier to suitably position a threading die for sharpening. His design will accept dies to 15/16in. diameter. However, as I have a number of 2in. diameter button dies, this design seemed to need modification. Drawing 1 shows the result. This covers my range of dies of 13/16, 1, 1 1/2, and 2in. diameter and 1in. AF hex. These vary in thickness from 6 to 17mm, with three, four, five, six or eight clearance holes of diameters 2 to 13mm.

The Chaddock design will fit over the top of the rotating base, and this allows sufficient axial room for the grinding point. The revised design will not so fit, and a spacer was made to position the carrier shank so as to locate the flange to the left of the boss on the rotating base.

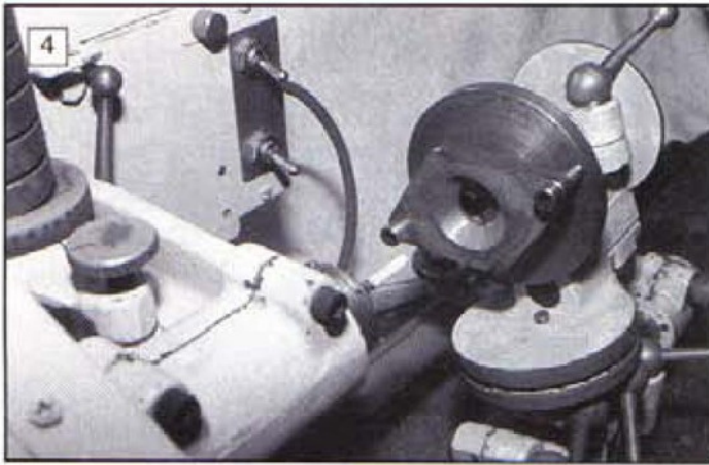
The die carrier comprises six items. Item 1, the pump centre is made by appropriate lathe work on the ends of a piece of 5/8in. dia. silver steel. Item 2 is a



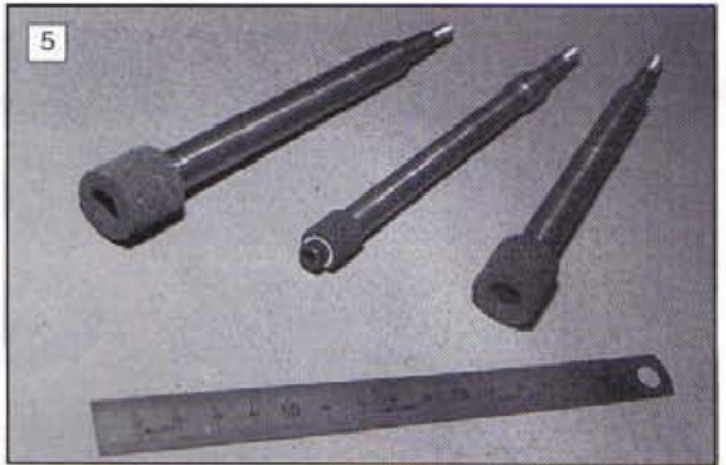
Chainsaw Grinding Points (Cylindrical).



Die sharpening.



Die holder.



Internal grinding arbors.



Grinding bore of ring.

clamping collar already in the kit of Quorn accessories for use with any of the $1\frac{1}{8}$ in. dia. arbors and mandrels. Its bore is nominal $1\frac{1}{8}$ in., but is arranged to be a

was then held in the 3 jaw chuck with brass shims on the jaws to protect its outer surface, and drilled, bored and reamed $\frac{5}{8}$ in. dia. to provide a sliding fit

H7/g6 fit (Limits as defined by BS4500: Limits and Fits for Engineering, tables are available in any good engineering reference book - Ed.) as suggested in Ref.3. Item 3, the main barrel, was turned between centres to be an easy running fit in the toolholder when the latter was unclamped, and firmly held when clamped. Its OD is, therefore, $1\frac{1}{8}$ in. nominal but also H7/g6 fit. This part

for the pump centre.

Items 4 and 6 were sawn out of pieces of 8mm mild steel plate and drilled and tapped M6 and $\frac{1}{2}$ in. diameter. Item 4 was mounted on a mandrel and its OD brought to size. Next, it was held in the 3 jaw chuck and its inside diameter bored to fit Item 3, to which it was joined with Loctite 680. When this had hardened, the assembly was mounted with Item 3 in the 3 jaw chuck (again with brass shims) and both sides of Item 4 were skimmed to ensure that they were flat and perpendicular to the axis of Item 3.

The profile of Item 6 was filed to shape and it was then bolted to the assembly with spacer washers, so as to provide clearance for both the internal diameter and conical depression to be turned to size.

Item 5 was turned from $1\frac{1}{2}$ in. dia. mild steel bar and bored to be a loose fit on Item 3. Care was taken that its ends were machined perpendicular to its axis. Because of the variety of die thicknesses,

two lengths of clamping screws are used, so that these do not project behind the flange, Item 4.

When mounting the die in the carrier, it is positioned by sliding the pump centre into the appropriate die clearance hole. It is best if the die body is arranged, as far as possible, to be equally between the two screws holding down the bridge, rather than in the transverse mode, as a more even clamping action results.

Mounted grinding points of various shapes seem to be freely available with $\frac{1}{8}$ and $\frac{1}{4}$ in. dia. shanks, and these can be readily accommodated with matching size collets (see Drawing 2)

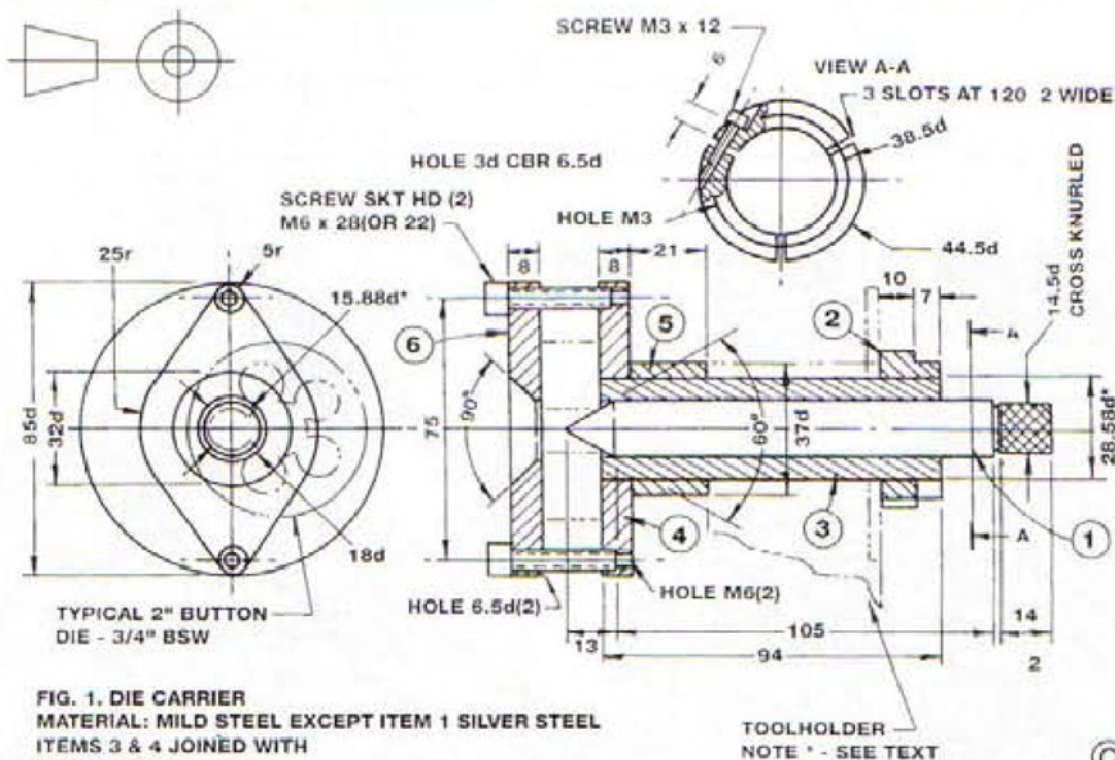


FIG. 1. DIE CARRIER
MATERIAL: MILD STEEL EXCEPT ITEM 1 SILVER STEEL
ITEMS 3 & 4 JOINED WITH
LOCTITE 680

TOOLHOLDER
NOTE * - SEE TEXT

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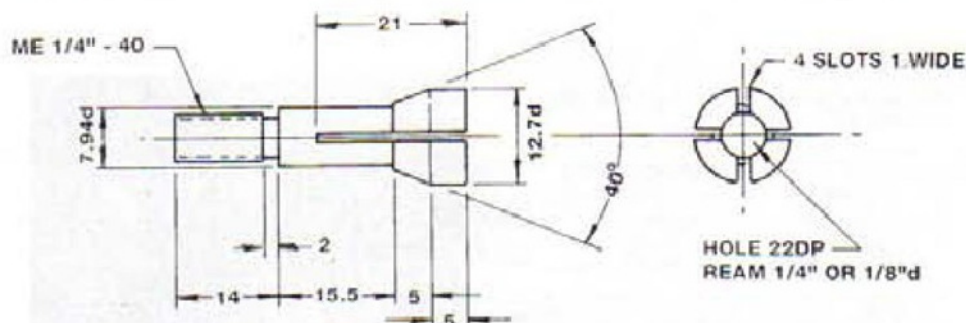


FIG. 2. COLLETS
MATERIAL: MILD STEEL

Internal Grinding in the Lathe

Small grinding wheels are commercially available for toolroom applications, and in this country, Norton and others offer several sizes of which the three smallest seem to be the most useful;

Diameter	Length	Hole	Recess (mm)
13	13	4.76	Nil
20	20	6.35	10 d. x 10 long
25	20	6.35	13 d. x 10 long

made for the wheelhead. The $\frac{1}{4}$ in. dia. one already existed for use with the $\frac{3}{32}$ in. dia. slot drill used to cut the spiral groove on the Quorn vertical pillar. These collets are closed on the point shafts by use of the normal Quorn draw spindle. Sets of grinding points of various shapes and sizes are often available at DIY stores—those shown in **Photo 1** came from Sears & Roebuck in USA. Most are too large to be of use in the die sharpening activity however. Another source of useful grinding points is to be found amongst suppliers of small battery powered grinders for sharpening chain saws. Those shown in **Photo 2** are Oregon brand from Omark Industries USA. As shown in Drawing 3, their size is appropriate to most dies, and they can be shaped to slightly smaller diameter with a diamond. Finally, for the very smallest die holes, very small cylindrical grinding points are available from several sources some of which are listed on Drawing 3. Brownells are located at 200 South Front Street, Montezuma, Iowa 50171, USA. Tilgear are at 69 Station Road, Cuffley, Herts EN8 4TG, UK.

Having positioned the die in the carrier, the grinding point is introduced by sliding the workhead base along the machine bars. The cut is set by use of the rocking lever, and taken by rotating the carrier in the toolholder. This procedure is effected in turn in each die clearance hole until all have been ground. **Photos 3 and 4** show the arrangement.



TABLE FOR DRAWING 3

SOURCE	STYLE	SHAFT LENGTH A	POINT LENGTH B	POINT DIA. C
OREGON	7	20	20	6
BROWNELL	080-697-002	38	6.4	3.2
DREMEL	83702	38	6.4	3.2
TILGEAR	E127	?	6.4	2.4
	E129	?	9.5	3.2
	E130	?	13.5	3.2
	ECP1	?	11.1	2.4
	ECP2	?	14.3	3.2

FIG. 3. GRINDING POINTS
MATERIAL: SHAFT - MILD STEEL
POINT - ALUMINIUM OXIDE
(EXCEPT * SILICON CARBIDE)

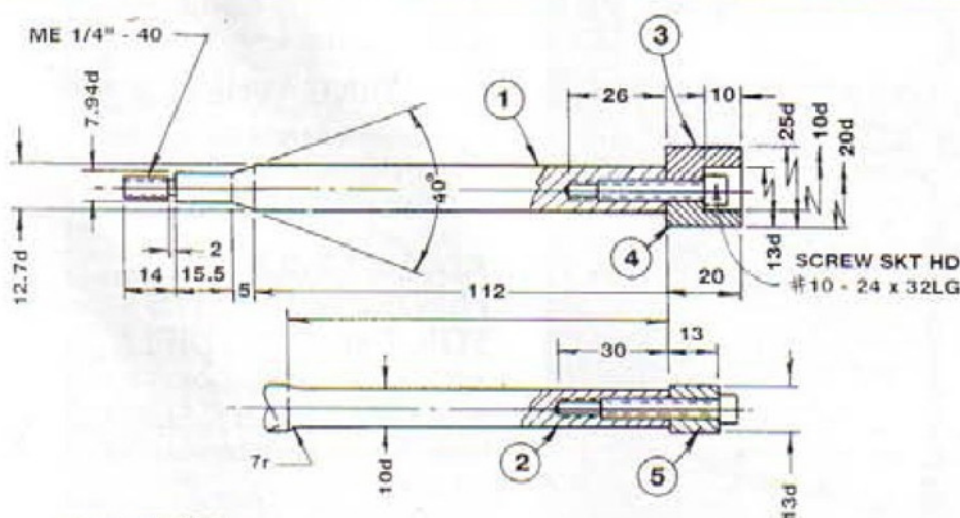


FIG. 4. ARBORS
MATERIAL: ITEMS 1 & 2 MILD STEEL
ITEMS 3, 4 & 5 ALUMINIUM OXIDE

Scaling photos in References 1, 4 and 5 led to a view that about 100mm projection for the wheel arbor from the Quorn spindle face would be appropriate, and so three such arbors were produced, as shown in Drawing 4 and **Photo 5**.

For the two larger diameter wheels, items 3 and 4, the arbors, item 1, were made from $\frac{1}{2}$ in. dia. BMS and secured with socket head screws, $\frac{1}{4}$ in. NF, with blotting paper washers each side of the wheel. For the smallest diameter wheel, item 5, the arbor item 2 is reduced to a diameter of 10mm for most of its length. The wheel is secured with a socket head screw No. 10-24 (as my stockist did not have 2 BA) again with blotting paper washers. The arbors are held into the Quorn wheelhead using its normal draw spindle.

This is where your sins will find you out, as a very slight error in angle of the axis of the bore and taper in the wheelhead spindle will produce a significant runout at the grinding wheel. If

the error is 1 minute of arc, its tangent is 0.00029, so that at 100mm the offset will be 0.029 (say 0.03), which is easily detectable with a dial indicator. In the practical case, where the error is likely to be significantly greater than this, so too will be the runout. This error can of course be corrected with a diamond shaping operation, and the arbor and spindle marked so it can be removed and replaced in the same orientation—but it is very sensitive to position and may need a touch up with the diamond each time it is moved.

In use, these internal grinding wheels are applied in a similar fashion to the operation of cylindrical (external) grinding as described in Ref.6, with the topslide at an angle of 6 deg. and used to set the cut. The cut is taken using the saddle traverse.

Photo 6 shows a typical job—grinding the inside of a ring.

For some jobs, a simple grinding point will suffice in lieu of using a grinding wheel on an arbor. As in boring practice, the shortest projection that is practicable is the way to go.

In selecting the size of grinding wheel for a particular job, two considerations apply. It is undesirable to have too great an arc of contact between wheel and work, but on the other hand too small a wheel will have a lower peripheral speed for the same spindle rpm and will have to be replaced more often. Ref.1 suggests a compromise of maximum grinding wheel diameter three quarters of the work hole diameter; while Ref.5 suggests two thirds when it is less than 25mm.

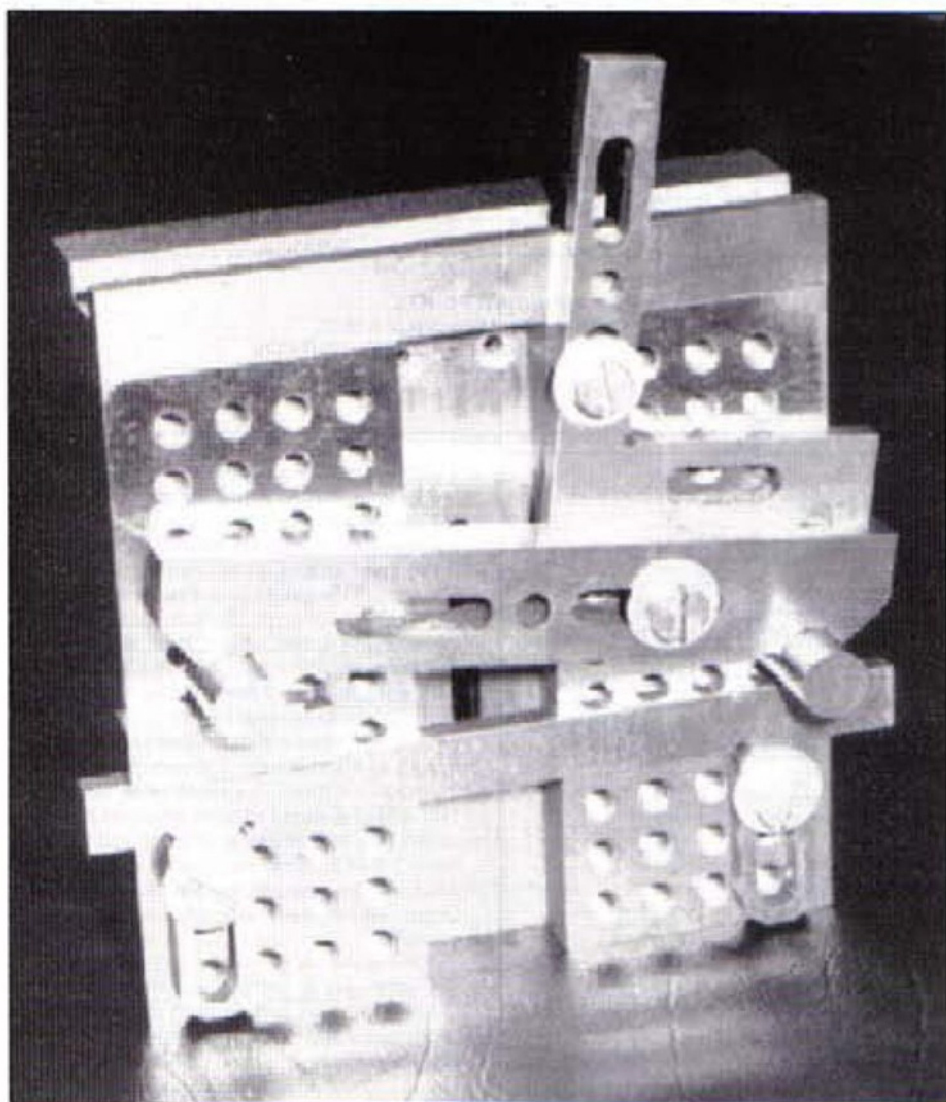


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IN OUR NEXT ISSUE

Coming up in Issue No. 48, will be



**ISSUE ON
SALE 23
JANUARY
1998**

A UNIVERSAL PARALLEL CLAMP

Bill Morris gained inspiration for this useful fixture from a Russian textbook.

GRINDING WHEELS

Alan Jeeves continues his series on grinding with a look at abrasive wheels.

ADJUSTABLE FEEDSCREW NUTS FOR THE MILL/DRILL

Although designed for the Warco Minor unit, P. S. Smith's basic design could be adapted for other machines.

(Contents may be changed)

where

THERE'S A WILL, THERE'S A WAY

Vintage vehicle restoration always generates new problems. Things are either too big, or too small, or they are difficult to handle. Peter Gerrish recalls a few instances where ingenuity was required

A few years ago, at the funeral of a very highly respected engineer, it was said that he was never known to refuse to do a job because of the lack of the correct equipment, and that invariably by the end of a couple of working days, he had adapted some existing device to do the job. I had the privilege to work with him, and I like to think that some of his philosophy rubbed off on me.

I have always had welding equipment of some kind in my workshop, and would like to suggest three welding based ideas for your perusal.

I have had one of Mr Warco's excellent universal bandsaws for some years, and realised long ago that more or less un-clampable compound angles (in steel items) could be set up by tack welding the component to a bit of odd stock which could more easily be held in the standard saw vice. Try it out some time.

My MIG welder came in handy recently while reconditioning my vintage Lancia front suspension and the only currently available thrust bearing needed 0.008in. grinding off the inner race diameter. I had no lathe toolpost grinder, but an hour's work and the use of a standard 1/4in. air drill produced a workmanlike device which did the job perfectly (See Fig. 1).

A piece of thin wall steel tubing with about the right ID to suit the body of my air drill was set up in the three jaw, and the sawn ends cleaned up. Then, the piece of 1/2 x 5/8in. mild steel that I used as the toolpost holder was set up in the toolpost and tack welded to the tube (a piece of damp rag was spread over vulnerable parts of the lathe to avoid damage from welding spatter). This sorted out any alignment problems, as I knew the drill holder was at the correct height and at right angles to the work face. The tube was then cut down the centre by hacksaw, filed up and then the air drill held on to the holder with two Jubilee clips. Voila, one toolpost grinder.

The third 'hackit and weld' method was when recutting a damaged thread on a drive shaft (another vintage car job - Fig. 2). The shaft was 3in. longer than the lathe bed, and while I could fit one end in the four jaw and support the other end in a fixed steady at a ground bearing location collar, the thread cutting tool held in the toolpost could not get within 9in. of the thread, which overhung the lathe bed. I first tried turning the top slide through 180deg., which gave me 5in. more reach,

but eventually I resorted to welding up a strong MS. beam section into a tool holder, with the single point turning tool at the end. With all the overhang and the tough material, I could only take 0.001in.

cuts, but eventually it did the job. Some of the vibration was cut down by altering the frequency of the long tool holder by sticking a great lump of Plasticine part way along the holder.

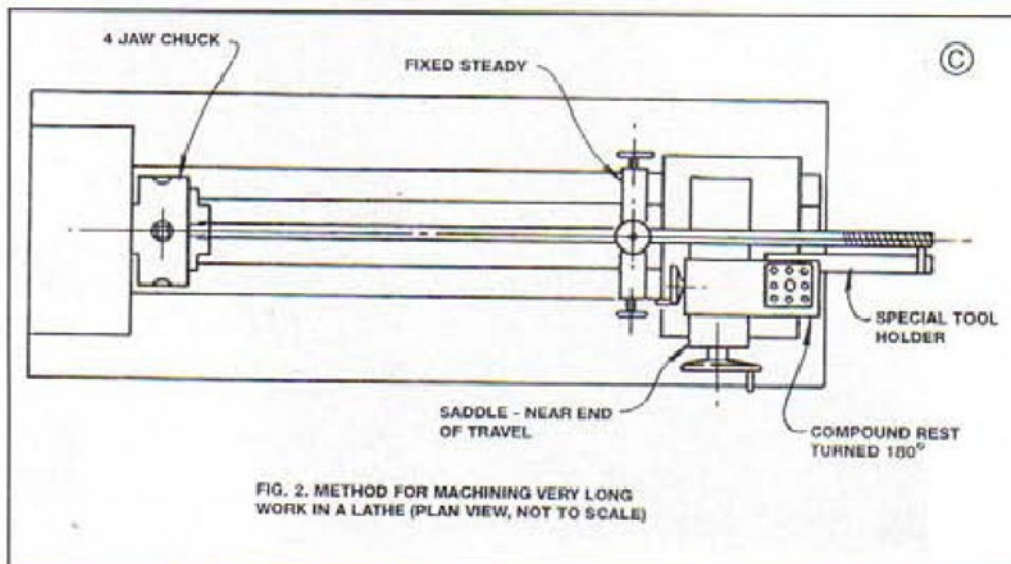
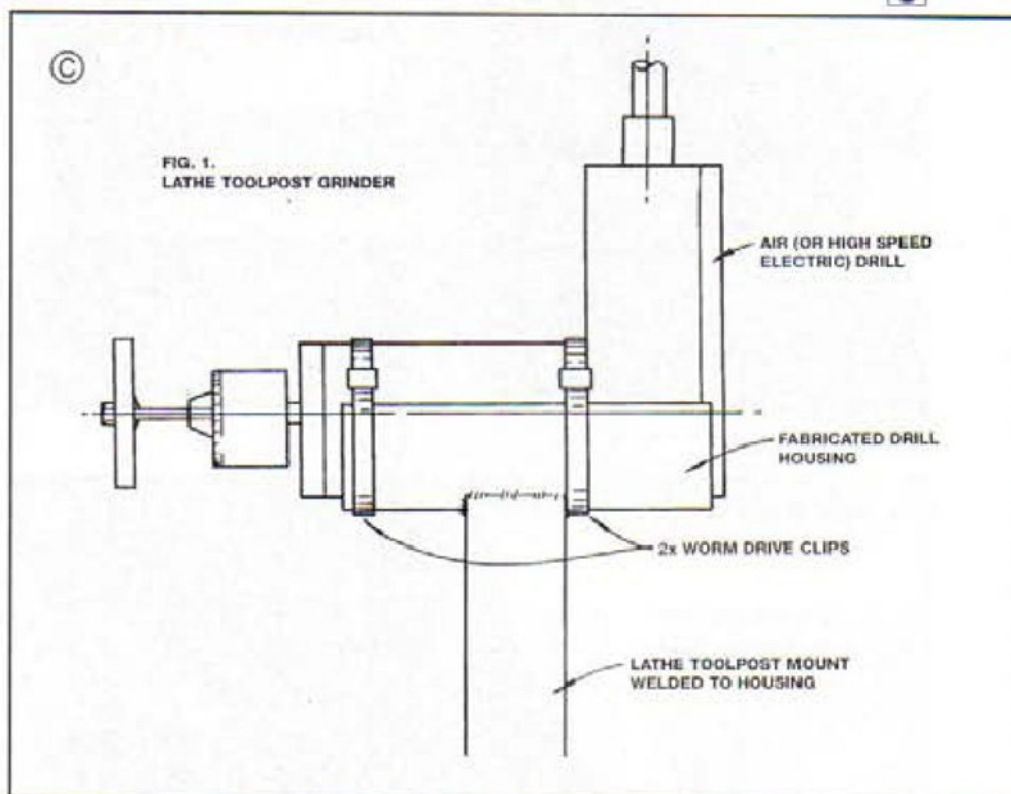
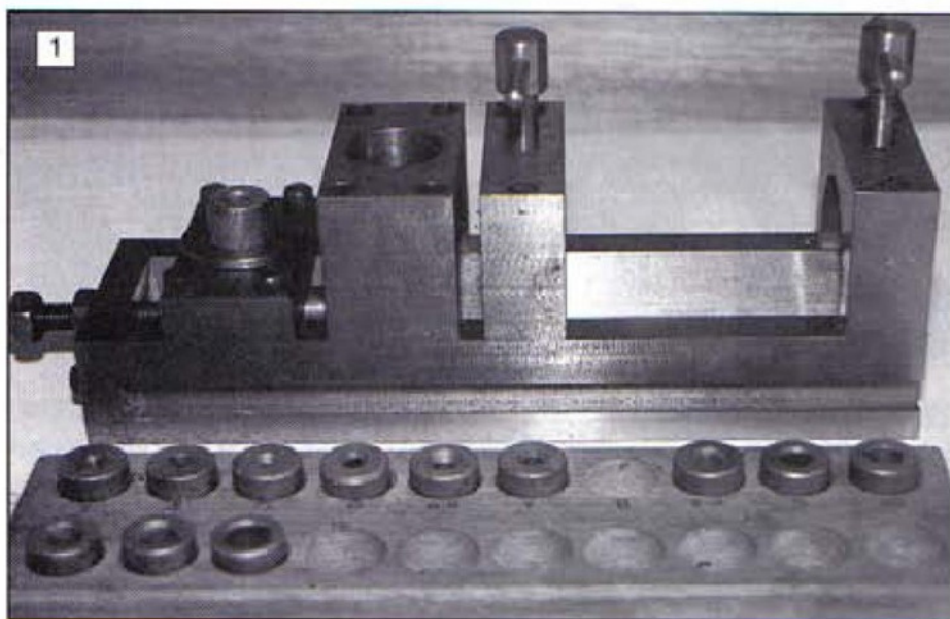


FIG. 2. METHOD FOR MACHINING VERY LONG WORK IN A LATHE (PLAN VIEW, NOT TO SCALE)

MILL/DRILL CENTRING DEVICE

When setting up a component for machining, a frequent requirement is to locate the cutter in the centre of the item. Peter Rawlinson describes an ingenious but simple device which will assist in the majority of cases.



V block and drill sleeve system.



Wobbler type of centring device.

Over the years, both as a professional and amateur engineer, I have always been perplexed by the process of drilling cross holes through the centre of round bars. Now, I know that there are many ways of carrying out this operation, and many have been discussed in the various magazines, from the most simple to the most complex. A couple of examples are shown in **Photos 1 & 2**. For many jobs, time-consuming setting up procedures are not warranted, but whatever the dimensional accuracy requirements, we should always aim for a workmanlike job—that is a job that looks right.

Initially, I started off making a long 'V' block with an inbuilt adjustable drill guide. This worked, but was not a 'pleasing' way of solving the problem. I then came across a small tool on the market, and made one for myself, but it was necessary to fit this into the chuck, centre the bar and then replace it with a drill, so neither was this 'pleasing'. I therefore decided to see if something else was possible, and the outcome is the device covered in this article.

Originally, the device was for use on a pedestal drill only, but subsequent development has increased its usefulness five fold, and it can now be used very accurately indeed in a number of situations. Before I proceed, I would like to point out that I have taken out a Patent on this device, but I am happy for any individual to make one for himself. However, the author should be contacted, via the editor, for any other requirements.

The following traces the history of its development, and also describes how to make a set in the simplest way.

To give some idea of its evolution, **Photos 3 - 6** cover the various stages of the unit from its simple beginnings to the final design. May I point out however that the simplest is the most difficult to make and the final design is the easiest to make.

The Mk. 1 unit (**Photo 3**) is the simplest unit and is for lining up drills only. A slight variation on this, the Mk. 2, is capable of lining up both drills and saws. **Photo 4** shows the next stage, when accessories were added to make the Mk. 3 which can now, in addition, align small end mills.

The Mk. 4 unit is a bit of a monster (**Photo 5**), and it does the same job, but in a different way. The final design (Mk. 5), which is shown in **Photo 6**, solves the problems and simplifies the manufacturing.

In the following description, I shall refer to the unit (to save space and typing) as the 'M. D.'



Mk. 1 Centring Device (Drill only). The Mk. 2 was similar, and would assist in the setting of saws.



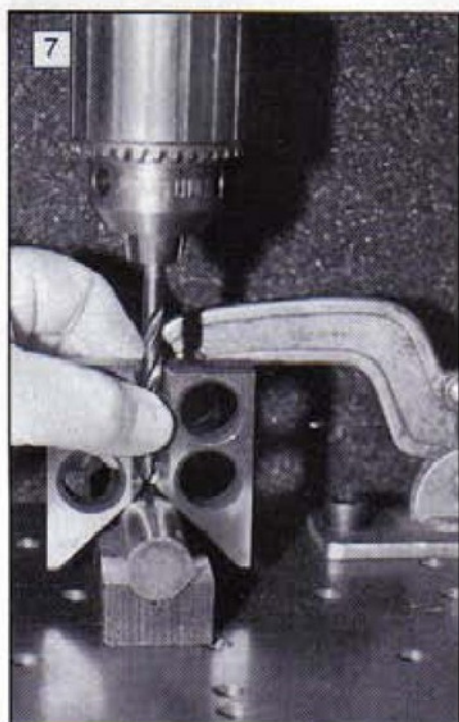
The Mk. 3 Centring Device, showing the accessories added to enable the setting of small end mills to be achieved.



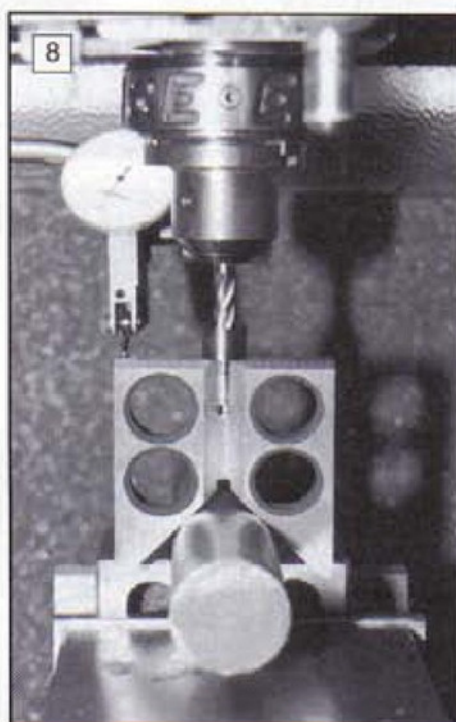
Mk. 4. The Monster.



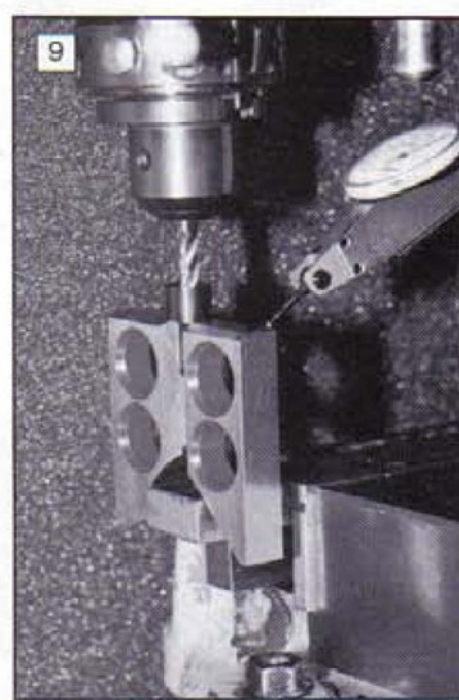
Mk. 5. The final design.



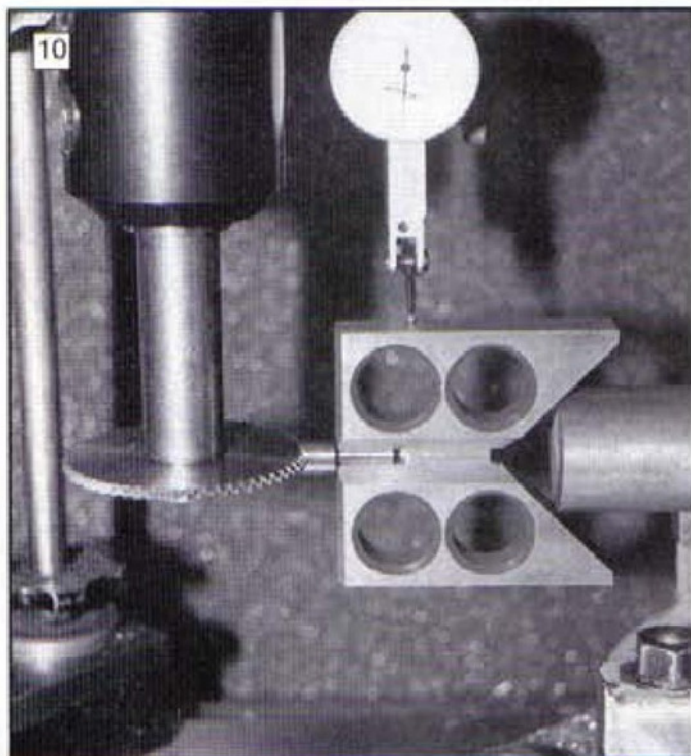
The M.D. in use, centring a drill.



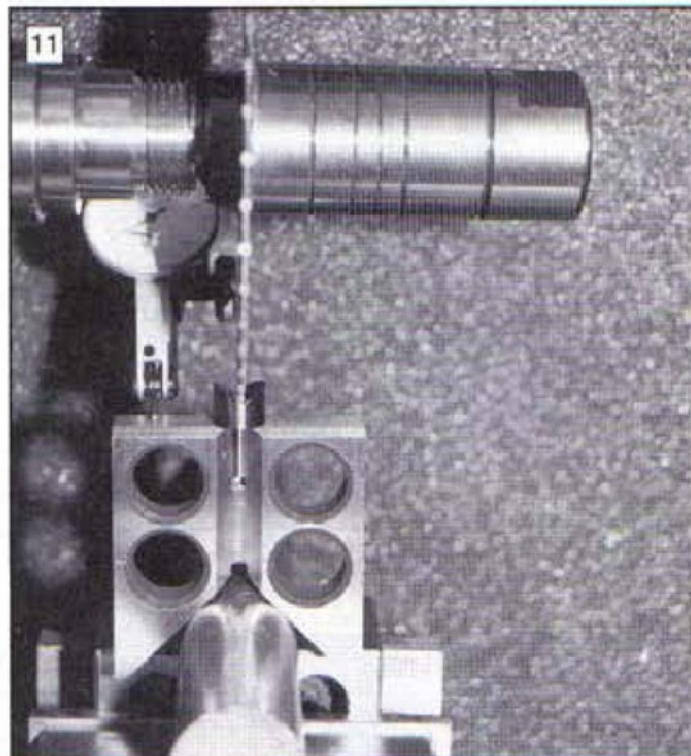
Centring a small end mill.



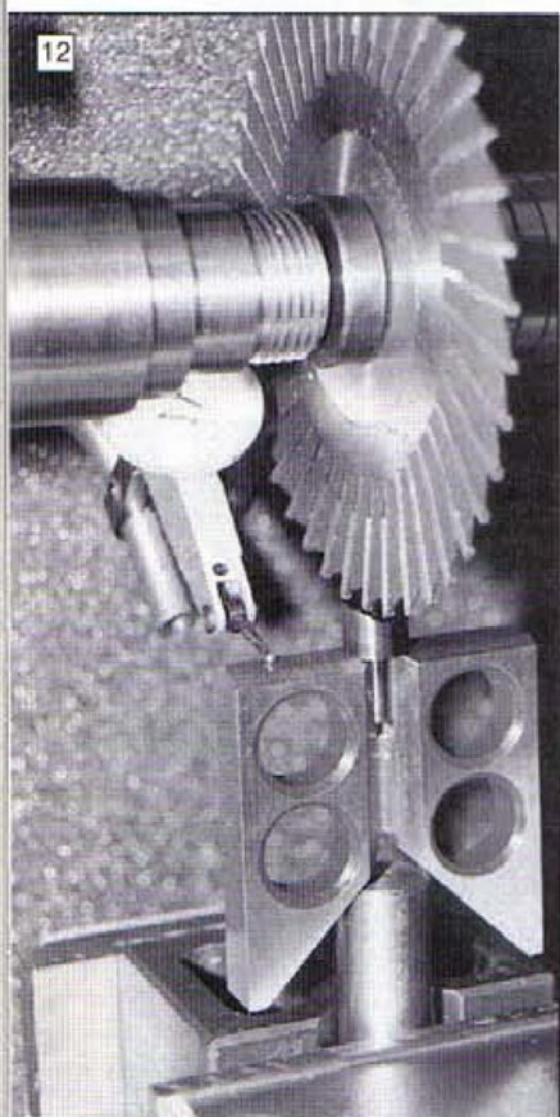
A similar principle is used when centring a rectangular bar.



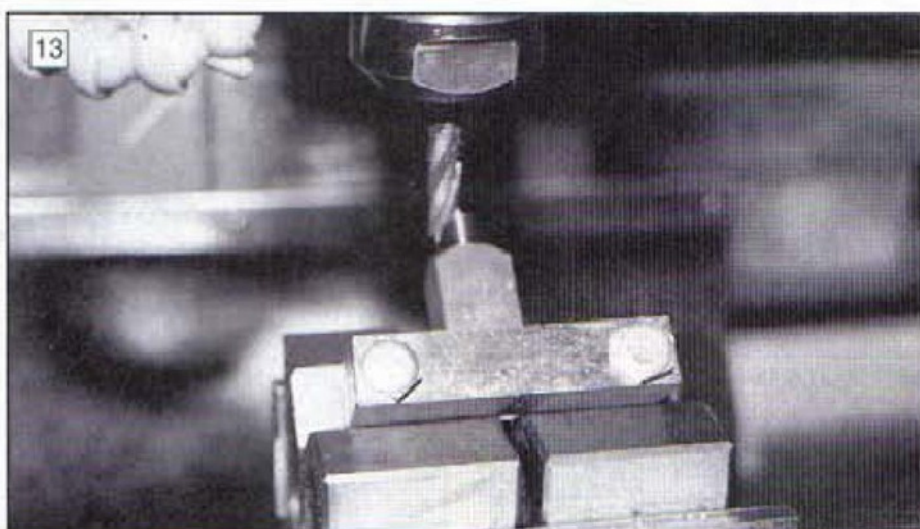
The M.D. in use, centring a saw.



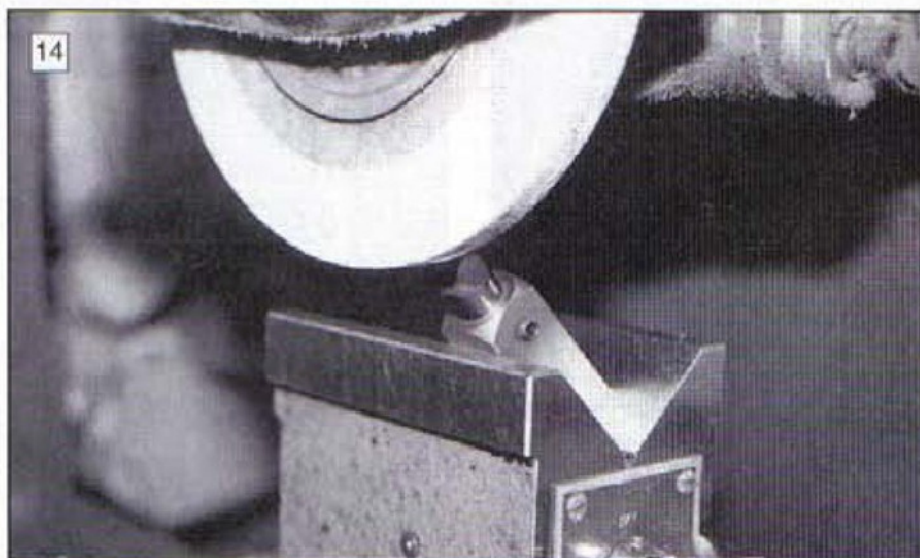
The M.D. can be used equally effectively on a horizontal mill.



Again on a horizontal machine, the M.D. in use for a vertical cut.



The accessory jig mounted on a 'V' block in the milling machine vice.



The magnetic 'V' block will hold the jig in a similar manner when finish grinding the accessory.

Application

The next series of photographs shows how the M.D. is used for a variety of setting tasks.

Task 1 (Photo 7)

Here, the M.D. is used to centre a drill over a piece of round bar. The clamp in the background is to clamp the workpiece in place once it is set up. It is, of course, necessary to align lengthways at the same time. The set-up can also be used to centre drill square or rectangular material.

Task 2 (Photos 8 & 9)

Using the smaller conical accessory, the M.D. is seen being used to centre a small end mill or slot drill (of the three tooth variety) for keywaying a round shaft. Note the dial gauge in the background, which is used to accurately align the top edge of the M.D. with the bed of the mill. When it is level, the cone accessory at the top is vertically over the round bar, and the end mill is accurately over the centre line of the workpiece. The dial gauge is held on a heavy based stand (see *M.E.W.* No.44, pages 36-38). It can be slid along the mill bed in order to check the alignment.

The large cone accessory will take 25mm dia end mills (**Photo 8**), and the method also works with rectangular bars, as can be seen in **Photo 9**.

Task 3 (Photo 10)

Ever had the problem of lining a saw blade up to cut a slot into the end of a round bar? **Photo 10** shows the M.D. solving this problem, using the 'V' accessory. Again, the dial gauge is used in a similar manner to check the final setting. This requirement was the reason for the design of the Type 2 unit.

One point to watch is that the saw teeth must not be offset, otherwise at least three teeth should be used when setting. If you have any difficulty with this, then make some discs, the same thickness as your saws, and substitute these when aligning.

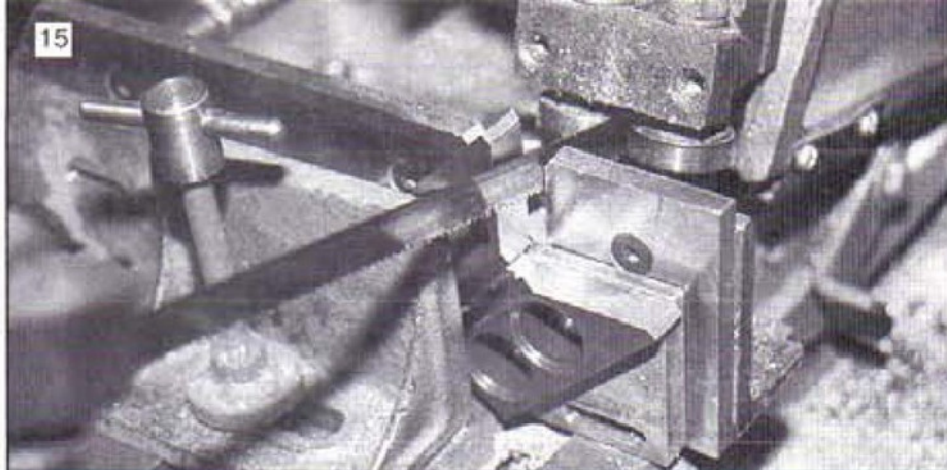
Task 4 (Photos 11 & 12)

If you have a horizontal mill (or a vertical with a right angle gear box), the saw can be lined up in a similar manner.

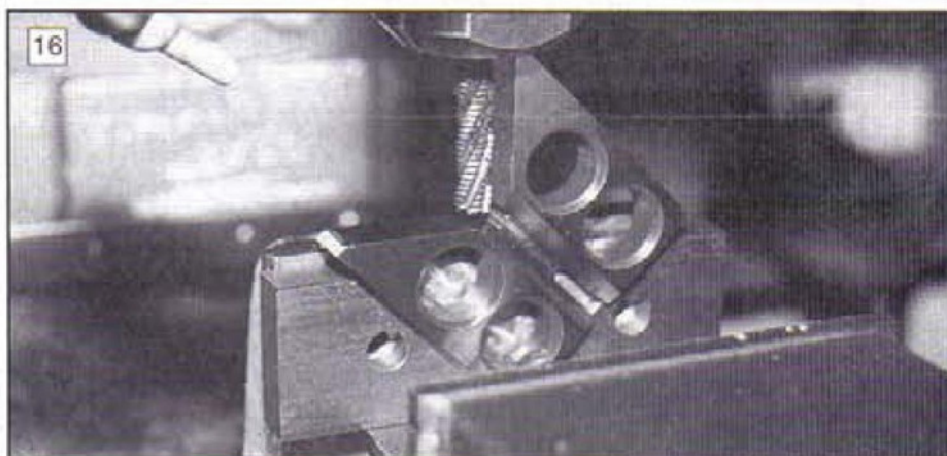
The above shows just some of the applications for which the M.D. can be used, but I am sure that others will be found. It is a simple piece of equipment and, as has been seen, requires only a dial gauge mounted on a heavy based stand to achieve an accuracy acceptable for the majority of jobs. If you are using the unit on the end of a bar, remember to machine the end off square before setting up, or it will not be accurate.

Manufacture

Manufacture of the M.D. is straightforward, especially if a surface



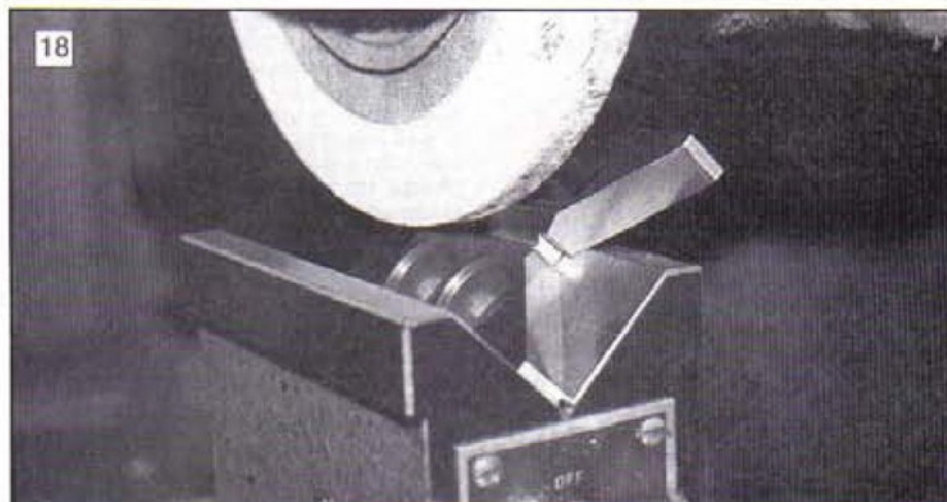
A second jig locates the main block in the band saw for cutting the 'V'.



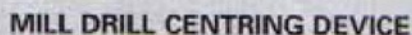
The next operation is to mill the 'V' close to size, using a further jig in the mill vice.



After drilling the central hole, the face 'V' is milled.



Grinding the face 'V' using a magnetic 'V' block.



Accurate Finish to suit

MILL DRILL CENTER

The "V" s, and the 6 mm.
Reamed hole

MUST

Be Symmetrical with the CENTRE
line, also all EDGES Must be
PARALLEL or Perpendicular to the
CENTRE LINE.

Main block

Having completed the accessories, we come to the main block. The holes and chamfers in the block are purely for lightening and aesthetics, and can be forgotten if you wish, but if you are anything like me you will put them in.

Obtain, if you can, a piece of $2\frac{1}{2} \times \frac{1}{2}$ in. gauge plate, some $2\frac{5}{8}$ in. long. This is hard enough without heat treatment for amateur purposes. Mild steel left unhardened could be acceptable for infrequent use, but if grinding is possible, case hardening after initial machining would be preferable. Gauge Plate is accurately ground, and only needs finishing on the machined edges. The ends must, however be accurately machined. They *must* be perfectly square with the other edges and faces.

You should now have a block of perfectly squared steel, with all sides and edges at 90 deg. and parallel. Mark out and machine the holes, and then accurately set up in the mill or lathe and bore and ream the 6mm dia. hole for the accessories. Mark out the two 'V's, and cut the excess away in the saw. (I made a simple jig, as can be seen in **Photo 15**).

I then made a second jig to fit the mill vice (**Photo 16**). By machining one side of the 'V' and then turning the block over and machining the other at the same setting, the 'V' will be symmetrical about the centre

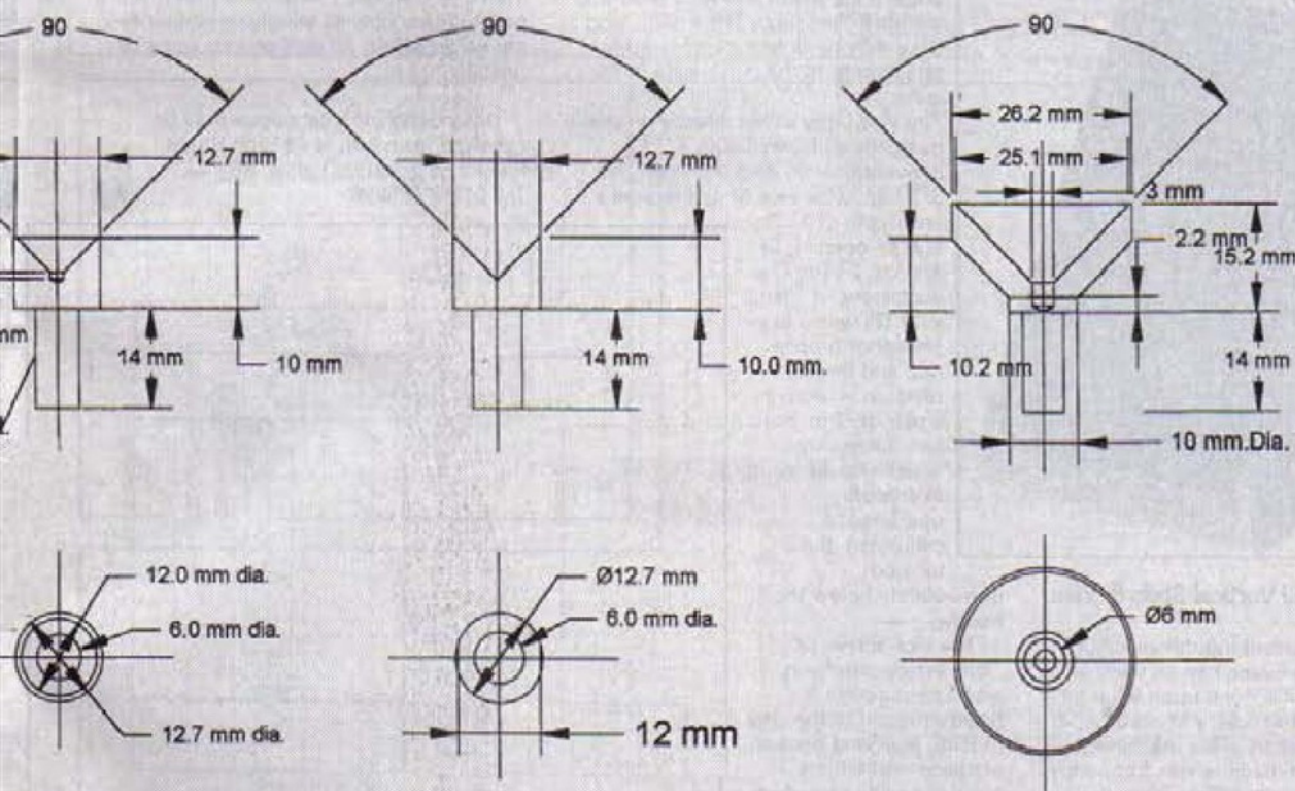
line. If you are not going to finish grind, lock all adjustments and take a fine cut to give a good finish. If you can grind, use a magnetic 'V' block and a fence.

Next, machine the 3mm wide relief slots to full depth. These are not critical, but will show up like the proverbial pimple if not right. The lead angles can now be machined on the top edges. These help the dial gauge stylus to slide onto the block and makes use easier.

The face 'V' is again machined in the same manner, using a jig which consists of a 'V' block with tapped holes, so that the work piece can be bolted to it (**Photo 17**), turning it over for the second side. The grinding is done using a similar procedure (**Photo 18**). Always make sure that your jig is clean and the workpiece is seated properly or the accuracy will be impaired. Other than this, as said before, the angle of the 'V' does not matter.

Finally finish off by polishing on a sheet of wet & dry, by laying the abrasive paper on a surface table or such. Start off with a coarse grade and finish with fine to give a good surface.

Make or obtain a wooden box. It will not only keep all the parts together and protected, but it will give additional pride of a job well done, and make the time you have spent seem more worthwhile. I hope that you will find the 'M.D.' as useful as I have.



Hardened and Tempered.

Spigot must be a good sliding

reamed hole in the block

INTRING DEVICE. ACCESSORIES



FROM THE PLANS SERVICE

Martin Evans is best known for his designs for miniature locomotives, having written on the subject in *Model Engineer* for many years. From time to time he has, however, described items of workshop equipment which he has made to assist in locomotive building. This is one such item.



This three-quarter view of the tool shows the massive construction of the base, a good way to damp out vibration and chatter.

The description

The unit was described in two issues of *Model Engineer*, that of 7 June 1985 (Vol. 154 No. 3754) and 5 July 1985 (Vol. 155 No. 3756), and the drawings added to the Plans Service.

The attachment was constructed from four castings, two of iron and two of phosphor bronze, with other components machined from both ferrous and non-ferrous sections. The castings for the prototype were supplied by Dave Goodwin of Blackburn, Lancashire, who lists them in his current catalogue. The basis of the unit is a heavily webbed angle plate which is $4\frac{1}{2}$ in. wide and stands $6\frac{1}{8}$ in. high. The $4\frac{1}{8}$ in. long base may be drilled as required for attachment to the cross-slide of the lathe.

The vice body slides directly on this base, the slideway being a conventional 60 deg. dovetail. The 3¹⁵/₁₆in. wide vice body features a jaw depth of 1¹/₈in., and an opening of approx. 2³/₄in. The leadscrew, of 3⁷/₈in. x 10 TPI works in a phosphor bronze nut, and thrust reaction is taken by a pair of 3⁷/₈in. bore ball thrust races, which should result in smooth operation. A calibrated dial is located

immediately below the handle.

The vice screw, of 1/2-in. Whitworth form, also acts through a bronze nut on to the steel moving jaw, and because of space restrictions, is provided with a knurled handle which is drilled for a tommy-bar hole.

For those requiring a compact, sturdy unit which is larger than that normally available, this combined vertical slide and vice is worthy of serious consideration. Dave Goodwin has also added to its versatility by

offering an additional casting, for a plain sliding table, which may be tee slotted or drilled and tapped as preferred, thus turning the unit into a conventional vertical slide.

Availability

A reduced version of WE 34, which shows the combined unit is reproduced here. the full size drawing may be obtained from Plans Department, Nexus Special Interests Ltd., Nexus House, Boundary Way, Hemel Hempstead HP2 7ST at a cost of £4.75 plus £1.50 p & p.

Photocopies of the original articles can be ordered from the Photocopy Service at the same address. Please note that this is a part-time service, so telephone enquiries are not possible, all applications must be postal.

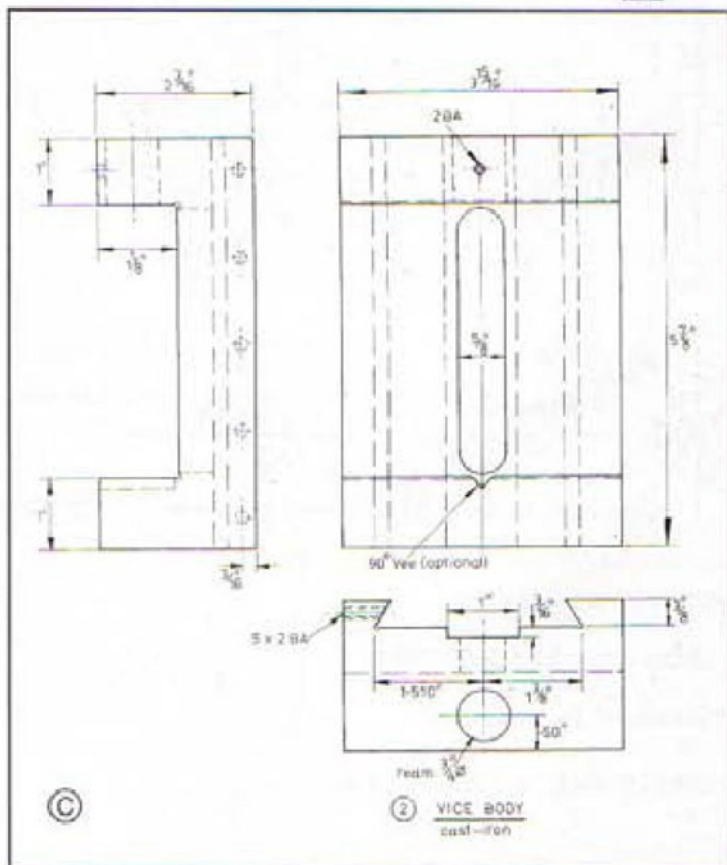
Dave Goodwin's catalogue may be obtained from him at 43 High Street, Rishton, Blackburn, Lancs. BB1 4JZ. Tel. 01254 885836.



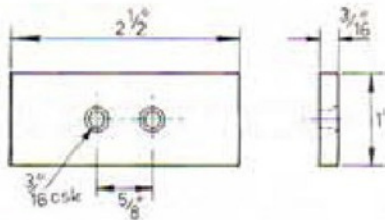
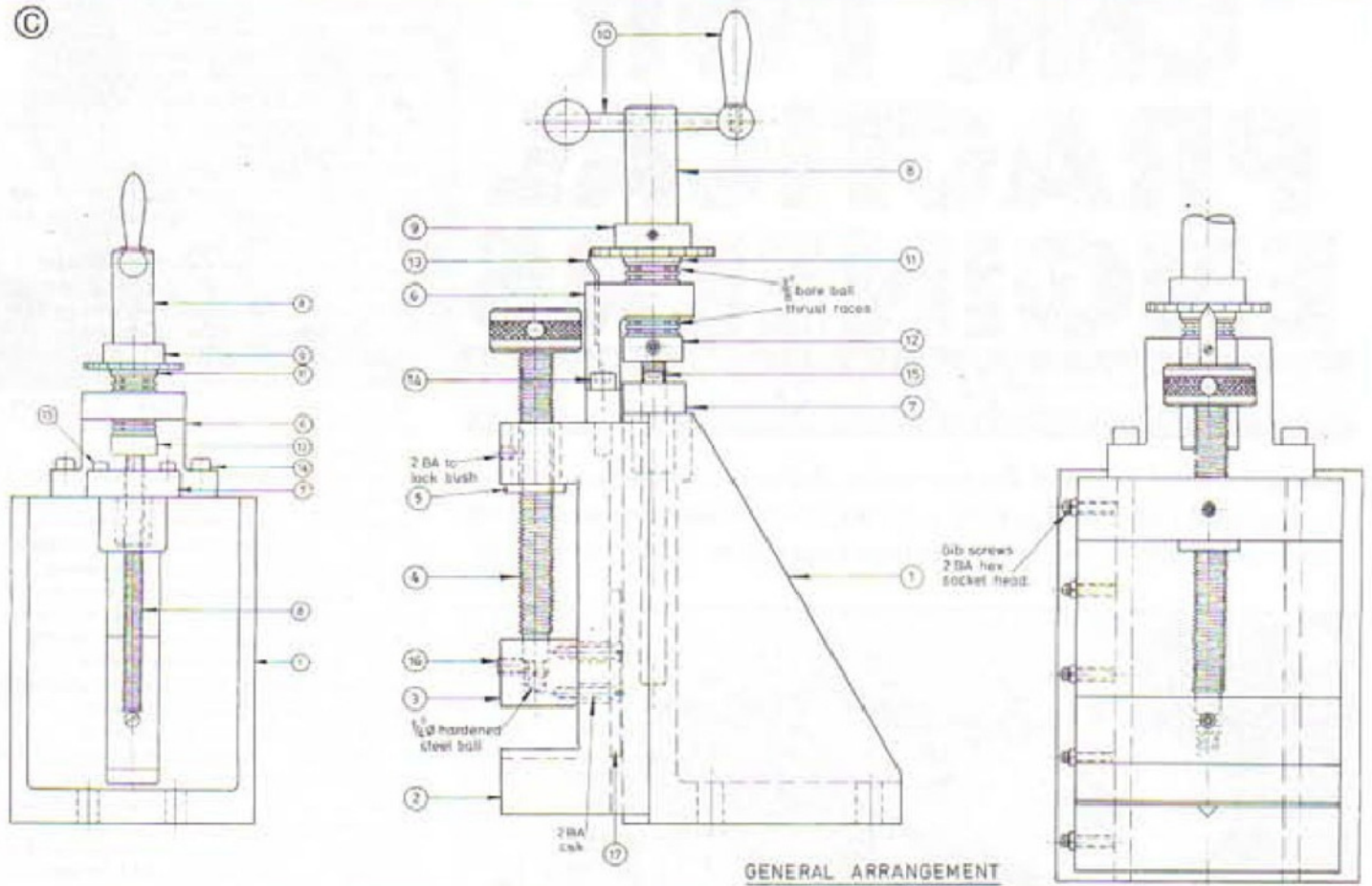
WE 32 Combined Vertical Slide & Vice

At the time of describing this piece of equipment, Martin Evans had no vertical milling machine, and relied upon what he described as a rather elderly Myford Super 7 lathe for the majority of his machining. Consequently, this machine was frequently set up in milling mode, which made the use of a vertical slide essential.

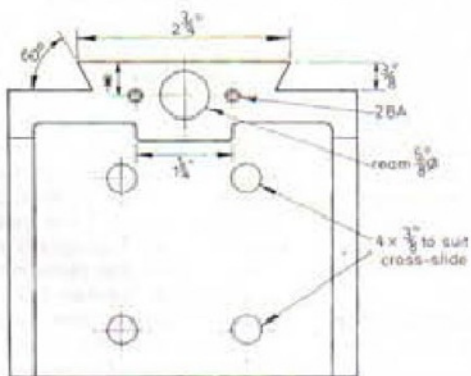
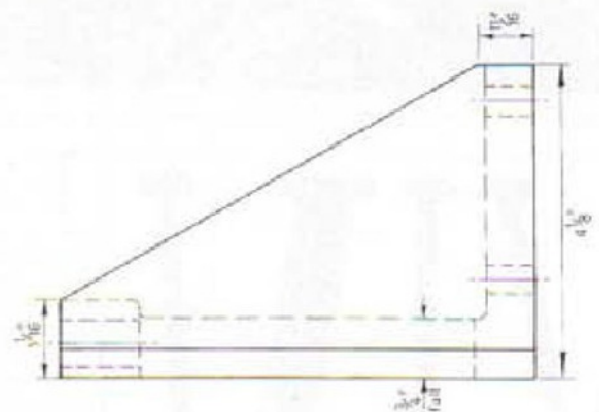
The vertical slide employed was the standard Myford unit, fitted with a machine vice, which although somewhat larger than that offered by Myfords, still proved to be on the small side for the heavier milling operations. Excessive overhang of the assembly also resulted in a lack of rigidity, so an improved attachment was devised, as depicted on Drawing WE 32.



(C)

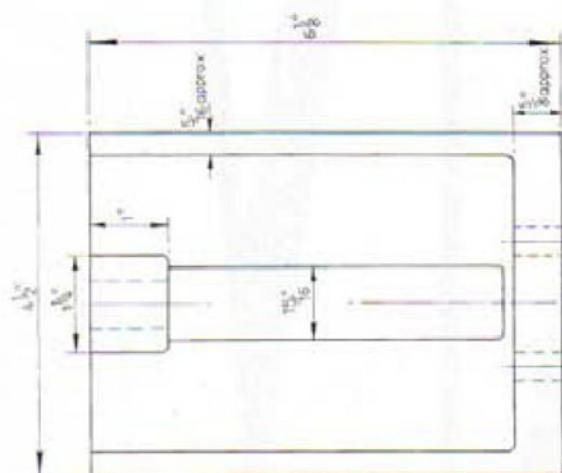


(C)



1 SLIDE BODY: cast-iron
Mark off from item (7)

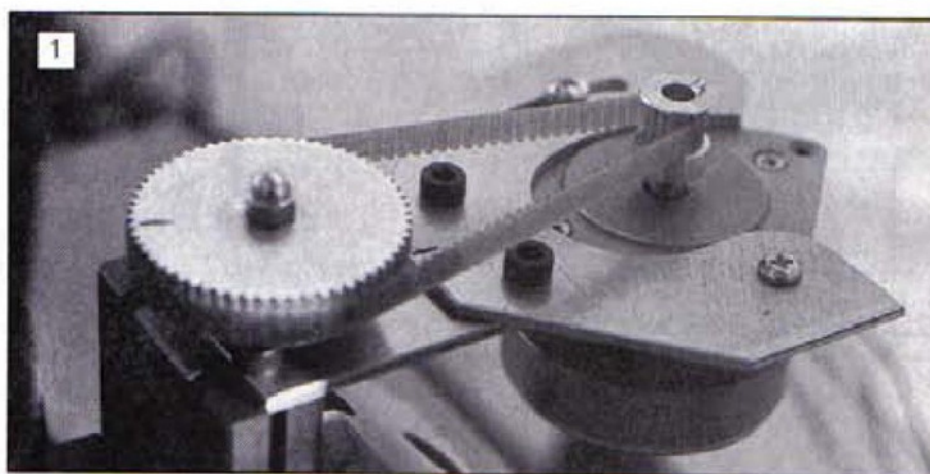
(C)



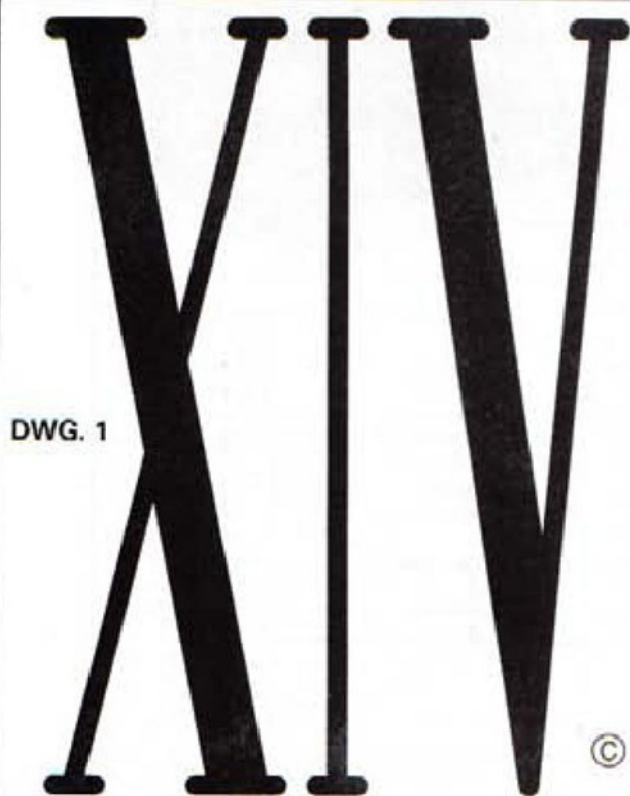
CNC FOR PRACTICAL ENGINEERS

PART 6

In this, the final article of the first series, Richard Bartlett expands on the engraving of characters for such applications as nameplates and clock dials, with his adapted machine now under full 3-axis control



The stepper motor connected to Pete's vertical slide, providing control of the 3rd axis



The limitations of using CAD to generate the characters for our engravings were discussed last time, together with the possibility of designing our own alpha-numeric characters and custom symbols. This article addresses both of these points.

Pete has now been uprated to full 3-axis control, the vertical slide being driven by a small size 23 motor from Magenta (Photo 1). The torque is increased by gearing through a toothed belt using a 14 tooth pulley on the stepper and a 60 tooth pulley on the 20 TPI leadscrew, which was the nearest readily available to 4:1 ratio. This gives 857 motor steps per rev of the leadscrew, rather than the 200 steps of the X and Y axes. This arrangement requires SCALE = 80 and SCALZ = 343 for full size characters with thou steps. (Remember, SCALE is the scale ratio times 20)

The following examples of the design process for custom 'virtual type' will show that you can design any font of characters or any special symbol by simply drawing the design to scale on graph paper, then by counting the

squares, the magnitude of each line segment can be estimated and typed straight into the control file via the text editor. This technique owes little to the computer; you dictate the accuracy and resolution of each and every part of your design, including the checking and making the dreaded corrections. Not unlike a reversal of Caxton's printing press, it is a simple but time consuming task to ensure that what you draw on the paper is carved out in the wooden type.

For those who may wish to delegate these 'simple but time consuming' jobs to the computer, the second example gives pointers to two areas that benefit from a simple 'BASIC' program. DOS 5 onwards comes with QBasic, which shares its editing environment with EDIT, so you are already familiar with QBasic's editor. The speed restrictions of this simple interpreted computing language are no limitation here, as the programs are not being run in real (machining) time. I feel that these examples make ideal 'first base' programming applications for anyone wishing to apply computers to their own workshop applications. To this end I have described what the programs are doing and what inputs may be necessary. Remember, you do NOT have to use these supplemental programs if you are prepared to scale your drawing.

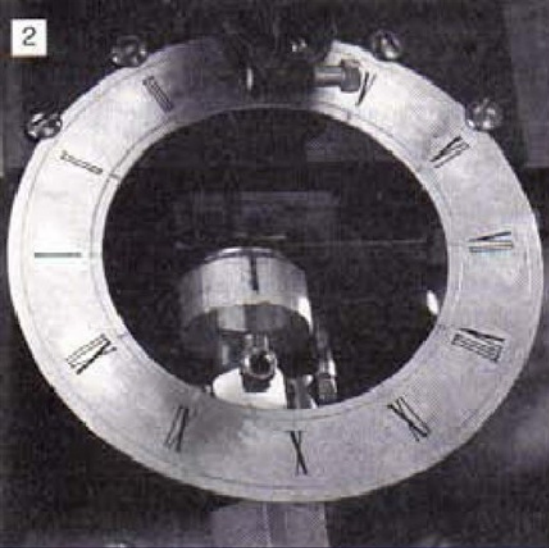
(You could go all the way down the computer aided road and design the character in CAD and digitise it by saving to an HP plot file, as we have done previously. If the character contains circular data however, you will be back to depending on the CAD program to set the resolution of the arcs, and this is the situation which we are trying to improve upon. The manual drawing plus programmable calculating should be the best compromise.)

Simple engraving using custom characters or 'virtual type'

A useful little application for our CNC machine might be the custom engraving of clock dials. To keep this demo as straightforward as possible, we will use Roman numerals, which means that all twelve numbers can be made up of the characters I, V and X.

The three characters can be drawn manually on graph paper to a vertical scale of 10in, which is 10 times full-size (see Drawing 1). The proportions of the characters are a matter of personal preference, and my design rules were:

Cutter width for 1 inch tall character = 25 thou. Thin strokes are 1 width, thick strokes are 3 widths. Characters are separated by 1 width, and serifs extend 1 width. The control file for each number starts by assuming that the cutter is located at the BOTTOM CENTRE of the number and is UP. The control file leaves the cutter at this position on completion of cutting. Note that these sizes are scaleable using the SCALE factor in your PARAM file, but remember to alter the size of the cutter in proportion to the change in scale factor. For example, a character 1/2in. tall would need a SCALE factor of 40 and a cutter diameter of 13 thou. When the outer profile of the characters has been designed, the cutter centre paths can be



The set-up for clock dial engraving

drawn in. It is these cutter centre paths that are measured to produce the data for machining, making this another example of 'simple' engraving.

As an example, the control file for the character 'X' is shown below; units are thous.

```
REM RNUM X; PR135,0; REM; CD60; PR100,0; CU60;
PR25,0; CD60; PR175,975; CU60; PR25,0; CD60; PR100,0;
CU60; PR50,0; CD60; PR175,975; CU60; PR25,0; CD60; PR
175,975; CU60; PR150,0; CD60; PR50,0; CU60; PR25,0; CD60;
PR225,975; CU60; PR25,0; CD60; PR50,0; CU60; REM;
PR185,0; SP0;
```

The PR135,0 move is made cutter UP and travels from the centre line datum to the edge of the lower serif. The following REM statement simply acts as a marker for the beginning of the engraving proper. Similarly, the REM at the end marks the end of the cutting process, the following move being made to return the UP cutter to the centre line datum.

Because the start and finish positions are the same point, a simple check can be made on the coding by calculating the algebraic sum of the X and Y movements. These should both be zero. Alternatively, the control file in Compucut format can be converted to an HPGL file and the result plotted out on a plotter or viewed on the screen via an HPGL emulator such as 'PRINTGL', which is available as shareware from PDSL.

To use PRINTGL or a plotter and, assuming you have written RNUMX.CON in EDIT, then to produce the HPGL 2-D equivalent file, key ALT F then select A from the file menu to 'save as', and then delete the extension .CON and type .PLT then enter. Key ALT S, and from the search menu select 'change'. The screen will prompt for 'what to search for'; you type CD60 then key TAB to enter the next prompt box, which is 'change to'. You type PD and TAB four times to take you to the 'change all' option. Enter to do this, and enter again at the 'changes complete' prompt.

Repeat this to change all CU60 statements to PU statements, now ALT F for the file menu and S to save RNUMX.PLT.

If you have a copy of PRINTGL in your COMPUCUT directory, then type PRINTGLD and enter. The screen will show a cursor on the 'plot file' option. Enter to accept this, and the cursor will

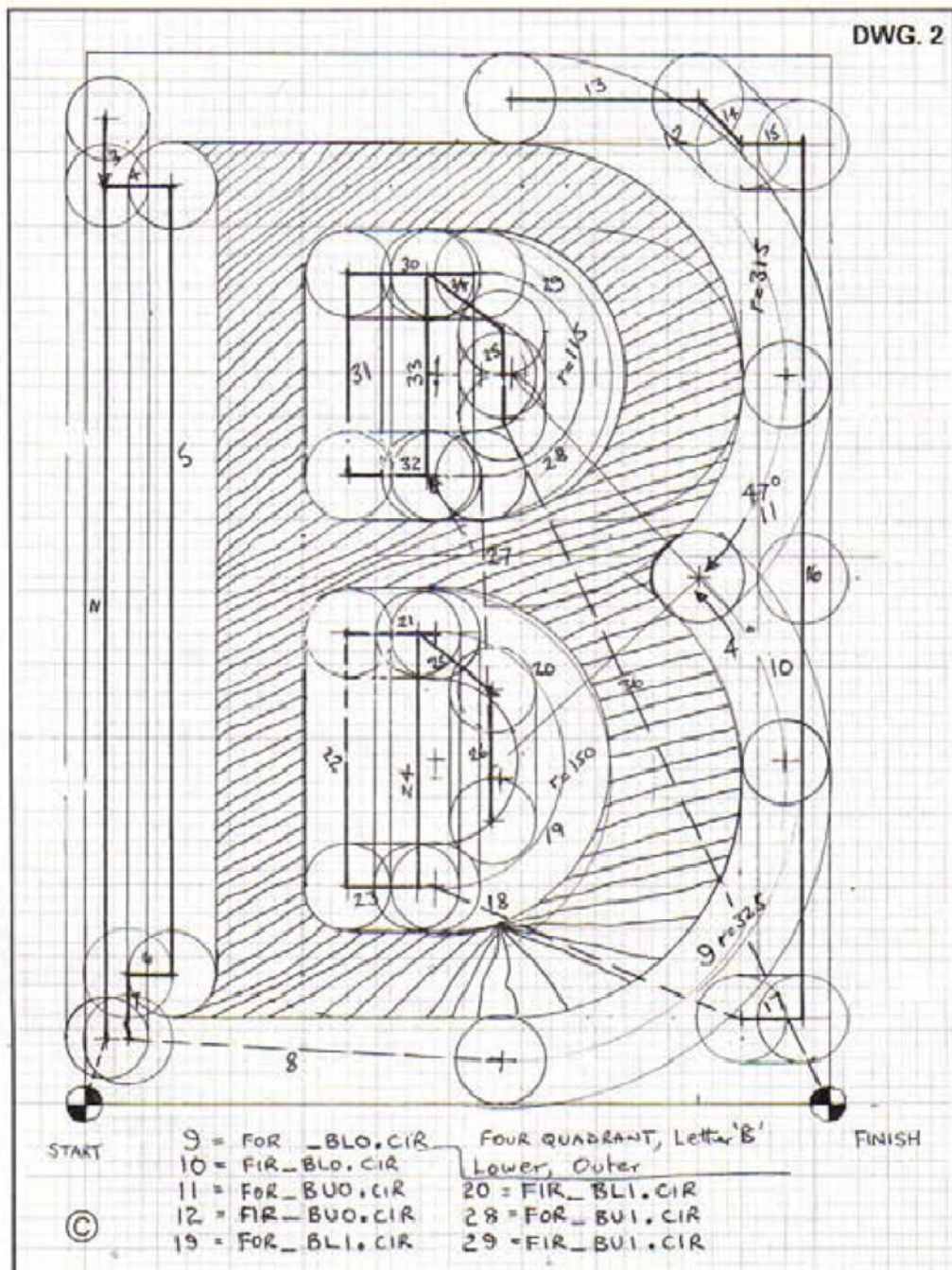
move to the file name column. Type in RNUMX.PLT and enter. If you have a SVGA screen then cursor down to 'output format' and cursor down to whatever SVGA standard your system supports. Enter this. Cursor to the left to select 'run printgl' and enter. The program will then display on the screen the cutter centre paths for the Roman numeral X. If all is well, quit the emulator, otherwise note the shortcomings of the paths and quit to edit your .CON file. There is a documentation file with the PRINTGL emulator to help you through its many other functions.

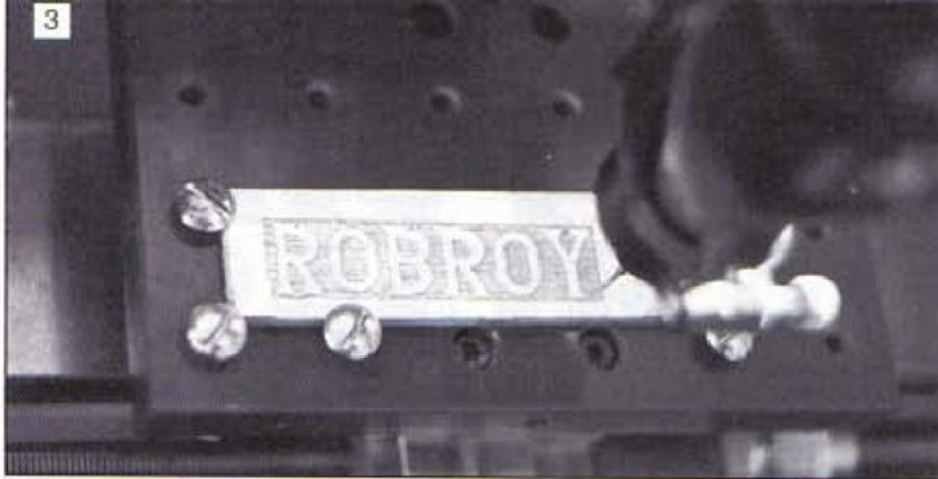
Although the supplemental table on Pete is small, its 1.5in. Y movement will support a character height of 1.5in., which would not look out of place on a chapter ring of 12in. diameter. To use this set-up, decide on the character height for your project clock, then set the SCALE value to achieve this, bearing in mind that full scale (SCALE = 20) is 1in. tall if the machine is made to give 1 thou per step. 'Normal' Compucut designs using 200

steps per rev motors and 50 thou pitch screws come out at $\frac{1}{4}$ thou per step, so SCALE = 80 would give 1in. character height on these machines. For a try-out we can go with $\frac{1}{2}$ in. height, so set SCALE = 40 and SCALZ = 343 in the PARAM file.

Cutter profile

The cutter will be a conventional engraving cutter, as used on pantograph machines, rather than the Dremel version, which is more of a burr. The cutting diameter will be 13 thou at the tip, which will increase with the depth of cut, due to the 40 deg. included angle of the cutter. High speed steel from an ex-centre drill is quite adequate for brass or aluminium alloy dials. First mount the tool bit in the cutting head (Dremel or whatever) and grind the tool bit to a 40 deg. point, with both tool and wheel revolving. Next, grind a flat on the bit to make what would have been a D-bit. Grind the flat to a depth of one radius plus 3 to 5 thou, to ensure that,





A first try-out of the Rob Roy nameplate, using plywood

even with some run-out in the cutter head, the cutting edge does not rub. Now back-off the conical section behind the cutting edge to give radial clearance. Finally, at an angle of 10 deg. for both side and front clearance, stone the tip to give a 13 thou flat.

Machining set-up

A hole is drilled in the table to accept a small dowel which will provide radial location for the inner edge of the chapter ring or outer edge of a dial, and will also act as the angular datum for the numerals. Mark out the 30deg. points on the inner edge of the chapter ring. Locate the chapter ring on the dowel at a 30deg. mark and turn the dial until the diameter from the point of contact on the dowel to the opposite mark is square to the X axis. Clamp the dial here, and set the cutter to give the appropriate radial distance from inner edge of dial to base of numeral, the cutter being located on the base of the numeral.

The control files are all called RNUMxxx.CON where xxx is the Roman numeral, for example RNUMVIII.CON for the numeral eight. In these control files the vertical feed movements are always 60 thou. If you decide that a cutting depth of 15 thou is right, then set the cutter 60 minus 15 thou = 45 thou above the workpiece. If you are not sure of the depth for a particular size, and it will vary slightly to give the optimum width, then set the cutter to 55 thou above the work, run Compucut and give RNUMI.CON as the file. Give the PARAM file, enter 0 for the Offsets, switch on the interface, switch on the cutter head (assuming it is manual) and run the program. Observe the depth/width then make any Z axis adjustments and re-run the program until the cutting depth is correct. Locate the chapter ring on the next mark, line up and this time give RNUMII.CON as the control file. Repeat until all twelve numerals are engraved.

Photo 2 shows the first result of this procedure which, with hindsight, shows the characters of each numeral slightly too close together, this font being perhaps more suited to a watch than a clock.

Reverse engraving using custom 'virtual type'

CNC engraving really comes into its own with 'reverse' engraving, that is the

machining away of the surrounding background of a character to leave it standing proud, as though produced by casting.

The design rules for the reverse characters ROB ROY were:

Full size character is ONE inch tall, (this is scaleable up or down using SCALE in PARAM)

Tile width (at full size) is 0.85in.

No part of a character is within ONE cutter diameter of the edge of its tile.

All machining is done with a 2.5mm end mill (scaled for the one inch character height)

First cut for all labels is centred around the outer edge of all the tiles in label.

Cutter is assumed to be UP at the start of a character and located at lower left corner of the tile.

Cutter is left UP and located at lower right corner of the tile on completion of a character.

Serifs and small internal radii are formed by cutter.

Large radii are generated from data produced by 'counting squares' or by the program 'CIRCDATA' which allows resolutions down to a half degree per step. This removes the visible polygonising of the curves seen last time on 'SIMPLEX' whose data was taken from a CAD font.

As before, you choose to draw on graph paper at TEN times full scale or use CAD to design the characters R, O, B and Y. My design for 'B' is shown drawn on graph paper, and I will use the character 'B' as the example.

The design rules are as previously, but with a 2.5mm cutter as standard for the 1in. character height. I consider this the best size compromise between good character definition offered by small internal radii, and few cuts to reduce the background. Locally available cheap graph paper was A4 ruled with 2mm squares. For convenience I adopted a scale of 1 line represented 10 thou. Remember that the first cut was all around the label centred on the edge of the tile, and that the cutter is now UP and in the lower left corner of the first tile.

Draw in the destination of each cut, I do this by drawing a circle equal to the scaled cutter diameter, drawing the cutter centre path as a dotted line for a 'move with cutter UP' and a solid line for a 'move with cutter DOWN'. Each centre path is numbered in the sequence in which it is cut, to enable the drawing to be related to the control file. The tangential lines representing the sides of the slot can be

drawn in to check that adjacent cuts overlap by at least 10 thou, to clear the background area cleanly. As can be seen from the drawing, the character 'B' consists of many plain cuts, with four radial cuts. Each radial cut is designated as UPPER or LOWER and within these categories as INNER and OUTER.

If you are set on 'counting squares' move on to end of diversion 1

Your 'QBasic' program 1.

Because the best DraftChoice font gave the SIMPLEX label shown in the previous article a rather 'low resolution' look, I have written a program to generate high resolution circular data, called CIRCDATA. The program prompts for angular positions of start and finish of the arc measured in degrees, the radius of the arc measured in steps, the angular movement per cut in increments of 1/2 deg. and the name under which the data file is to be saved. I use the file extension .CIR for circular data generated this way (FILENAME.CIR).

It is a characteristic of my CIRCDATA program that zero degrees is at 3-o'clock and angles increment anti-clockwise. Also, an arc cannot be specified to pass thro' zero in one cut; it has to be calculated in 2 cuts one ending and the other beginning at zero. The arcs of the character 'B' are examples of these, the arc file being named after its quadrant. Angle 0-90 being the FIRst quadrant, 90-180 the SECond quadrant and so on, using FOR for fourth, 270-360.

The high resolution arc files created by the CIRCDATA program are:

FOR_BLO.CIR FIR_BLO.CIR FOR_BUO.CIR FIR_BUO.CIR
FOR_BLC.CIR FIR_BLC.CIR FOR_BUL.CIR FIR_BUL.CIR

For example, FOR_BLO.CIR is read as 'a fourth quadrant circular data file for letter B, lower, outer radius'.

The CIRCDATA file assumes that the cutter is on the centre of the radius, so the data starts with a move of one radius to reach the first angular datum. If this is not the case, and you have left the cutter at the start of the radial cut then delete the first data statement.

The last data statement is a correction, which may be 0,0 to bring the cutter to the final datum position. If 0,0 is reported, the algebraic addition of all the Plot Relative moves from the first to the second datum is the same as the single Plot Relative from first to second datums. Sometimes, because the program has to round off to the nearest motor step for each move, a small discrepancy can arise after a lot of moves. The program simply advises you of any error and unless you reject it, the correction is added in as valid data.

Do remember that a resolution of 1/2 deg. gives very small increments, and in consequence generates a lot of data. List the .CIR file and if you see data statements with repeated zeros for one axis, as in 3,0; 3,0; 3,0; these lines would be amalgamated into one move of 9,0; if you used a lower resolution. The advantage of using the lowest acceptable resolution is that there is less computing to be carried out around a given arc, so the cut has improved

continuity, with less chance of rubbing and burning on wooden models. This is the only advantage of a fast PC for dedicated CNC. It carries out the computation at the end of each line segment more quickly, improving the cutting continuity and reducing rubbing.

End of QBasic programming diversion 1

The accuracy with which users will be able to extract the linear cutting data from the drawing will depend on their circumstances. I suspect a 'best' of $\pm 1/4$ square is possible, but I settled for $\pm 1/2$ square, this being ± 5 thou on a 1in. character, which I feel is very adequate. (Note also, that CIRCDATA beats this easily, so we should expect well rounded characters with no visible polygonising).

Go into EDIT and open a control file for the letter B. Remember that the cutter is ready at the lower left corner and UP. My drawing digitised into:

```
REM LETTER 'B';
PR 25,75;
CD60; PR 0,1050; PR 0,-75; PR 75,0; PR 0,900; PR 50,0; PR 0,-75;
CU60; PR 125,-25;
CD60;
REM FOR_BLO.CIR; PR 2,1; PR 2,4; PR 2,6; PR 27,9; PR 26,11; PR
25,13; PR 24,15; PR 22,17; PR 21,19; PR 19,21; PR 17,22; PR
15,24; PR 13,25; PR 11,26; PR 9,27; PR 6,28; PR 4,28; PR 1,2;
PR 1,1;
```

```
REM FIR_BLO.CIR; PR -1,28; PR -4,28; PR -6,28; PR -9,27; PR -
11,26; PR -13,25; PR -15,24; PR -17,22; PR -19,21; PR -5,1;
```

```
REM FOR_BJO.CIR; PR 19,20; PR 17,21; PR 16,23; PR 14,24;
PR 11,25; PR 9,26; PR 7,27; PR 5,27; PR 2,27; PR 0,10;
```

```
REM FIR_BJO.CIR; PR -1,27; PR -4,27; PR -6,27; PR -8,26; PR -
11,25; PR -13,24; PR -15,23; PR -17,22; PR -19,20; PR -20,19; PR -
22,17; PR -23,15; PR -24,13; PR -25,11; PR -26,8; PR -27,6; PR -27,4;
PR -27,1; PR -215,0; PR 50,50; PR 70,0; PR 0,-1000; PR 70,0;
```

```
CU60; PR 370,150;
CD60; PR 20,0;
```

```
REM FOR_BLI.CIR; PR 13,1; PR 13,2; PR 13,3; PR 12,4; PR 12,5;
PR 12,6; PR 11,7; PR 10,8; PR 10,9; PR 9,10; PR 8,10; PR 7,11;
PR 6,12; PR 5,12; PR 4,12; PR 3,13; PR 2,13; PR 1,13; PR -1,-1;
```

```
REM FIR_BLI.CIR; PR -1,13; PR -2,13; PR -3,13; PR -4,12; PR -5,12;
PR -6,12; PR -7,11; PR -8,10; PR -9,10; PR -10,9; PR -10,8; PR -11,7;
PR -12,6; PR -12,5; PR -12,4; PR -13,3; PR -13,2; PR -13,1; PR -1,-1;
PR -100,0;
PR 0,-290; PR 80,0; PR 0,290; PR 85,-75; PR 0,-150;
```

```
CU60; PR 75,395;
CD60; PR 60,0;
```

```
REM FOR_BUL.CIR; PR 10,0; PR 10,1; PR 10,2; PR 10,3; PR 9,4;
PR 9,5; PR 8,5; PR 8,6; PR 7,7; PR 7,7; PR 6,8; PR 5,8; PR 5,9;
PR 4,9; PR 3,10; PR 2,10; PR 1,10; PR 0,10; PR 1,1;
```

```
REM FIR_BUL.CIR; PR 0,10; PR -1,10; PR -2,10; PR -3,10; PR -4,9;
PR -5,9; PR -5,8; PR -6,8; PR -7,7; PR -7,7; PR -8,6; PR -8,5; PR -9,5;
PR -9,4; PR -10,3; PR -10,2; PR -10,1; PR -10,0; PR -1,1;
```

```
PR -150,0; PR 0,-230; PR 90,0; PR 0,230; PR 85,-65; PR 0,-100;
```

```
CU60; PR 375,-785;
SP0;
```

The data is now complete. I stress again, it does not matter whether the circular data is generated by your program or by you carefully counting squares and parts of squares. If you have counted squares then save the file as B.CON. If you have used CIRCDATA the format needs to be edited to remove the quotes around the circular data calculated by the program. Do this using the

SEARCH and CHANGE menus in EDIT.

This is then saved as B.CON as the cutting data for this character. Digitise the other characters in the same way, and save the data as R.CON, O.CON and Y.CON.

Because each character starts at lower left and finishes at lower right, then the algebraic sum of the Y axis moves must be zero. The algebraic sum of the X axis moves will be the width of the 'tile'. Checking this through each time requires a fairly high level of concentration because a result of anything other than X=850, Y=0 will flag an error, and cause a re-run through the digitising process. My mental arithmetic led to a couple of 'hiccups' where it eventually panned out that the digitising was right but the checking was flawed. At this point I decided to give the little chore of checking the final position to the computer.

If you are adding the moves mentally or by a calculator, then go on to end of diversion 2

Your QBasic program 2

The program that does this is called CHEKSTEP. To use it, you edit your control file, for example LETTER_B.CON, by using the SEARCH and CHANGE menus to put quotes around the PR, CU, CD and SP statements, as in "PR-35,65;", then save the file as LETTER_B.CHK. Run the CHEKSTEP program and give LETTER_B.CHK as the file to be checked, and LETTER_B.HPV as the file to pass to your HP emulator program to allow the viewing of your cutter centre paths. My first attempt at 'B' included a large error which was detected by the HP emulator, as can be seen from the two emulations (Drawings 3a & 3b). The first shows how the fourth quadrant lower inner radius was misplaced; the second shows the correction. When the CHEKSTEP program flags an error, the axis, polarity and size are known, but not which line segment is wrong. However, there are clues to be seen. If the error is -240 and it is the only error, then the possibilities are that a). You have missed out a 240 move, b). that you have put in an extra -240 move, or c). that you have got wrong polarity on a 120 move. If the error is compounded of several mistakes, you will just have to re-digitise the drawing from scratch.

End of QBasic programming diversion 2

Open the EDIT editor and start a file called ROBROY.CON. The first cut to make is the cut all around the label, starting and finishing from the lower left corner of the label. We now need to merge in the letters ROBROY in order. EDIT with DOS 5 has no single key MERGE facility and only a single level clipboard, so you can do it like this:

Save the current file, which is the border only, as ROBROY.CON and then EDIT and CUT it to the 'clipboard' by placing the cursor at the top left of the program and, whilst holding the SHIFT key down, use the cursor down key to

SELECT the required lines of text, which is all of it for this example. Now press ALT E and use the CUT sub-menu to place the border in memory.

Use ALT F then select OPEN, and give LETTER_B.CON as the file to load. Having loaded the data for the first letter, place the cursor at the top left corner, and with ALT E and PASTE, the contents of the clipboard will be merged in above the 'B' data. Save this as ROBROY.CON, just in case something goes awry and you lose a file. Now SELECT the text, then EDIT and CUT the file to the clipboard. Next, OPEN the control file for the next letter and merge with the previous data by placing the cursor at top left and PASTING the clipboard in. There is an 'ON-LINE' help system initiated by F1 to help you through the EDIT functions. Do not worry if things get lost whilst you are getting used to cutting and pasting to and from the clipboard.

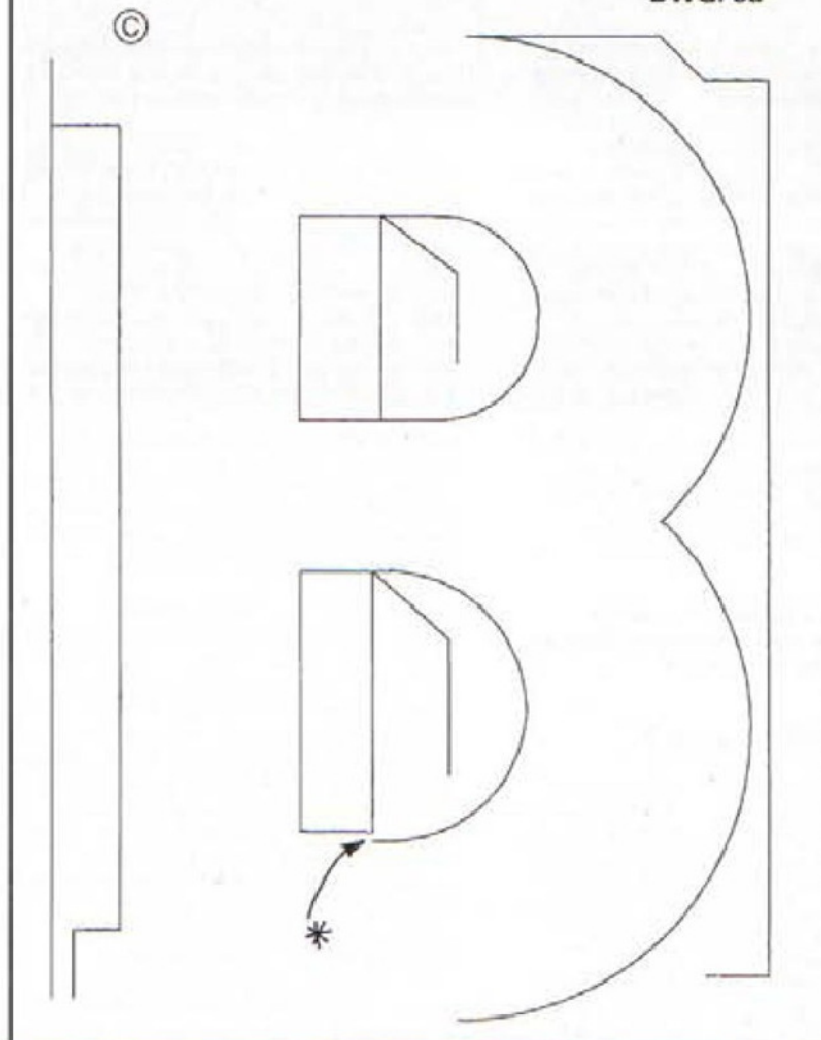
Finally, save the complete file as ROBROY.CON and you are ready to reverse engrave your label. I think it is prudent to try out a new symbol on hardboard before wasting metal and blunting cutters on designs which may need to be altered once you see them 'in the flesh' as it were. Photo 3 shows the first attempt at an embossed ROBROY. The slightly woolly edge to the characters is due to the try-out being cut in plywood. There is clearly a mis-match between the height of the 'O' and the other characters, and the upper outer first quadrant curve on 'R' has been stopped short of a true blend with the first 'border' cut. It is worth noting that the same error appears on 'R' and 'B' because this section of the data for 'B' was borrowed from the 'R'. It is quite useful to recognise similarities between characters, as the relevant block of data can be CUT from one and PASTED to the other.

I have not had time to complete the alpha + numeric set of virtual type to complete the ROBROY style reverse font, but if some reader were to offer this or other fonts, or indeed any interesting symbols, they might be of interest to other Compucutters.

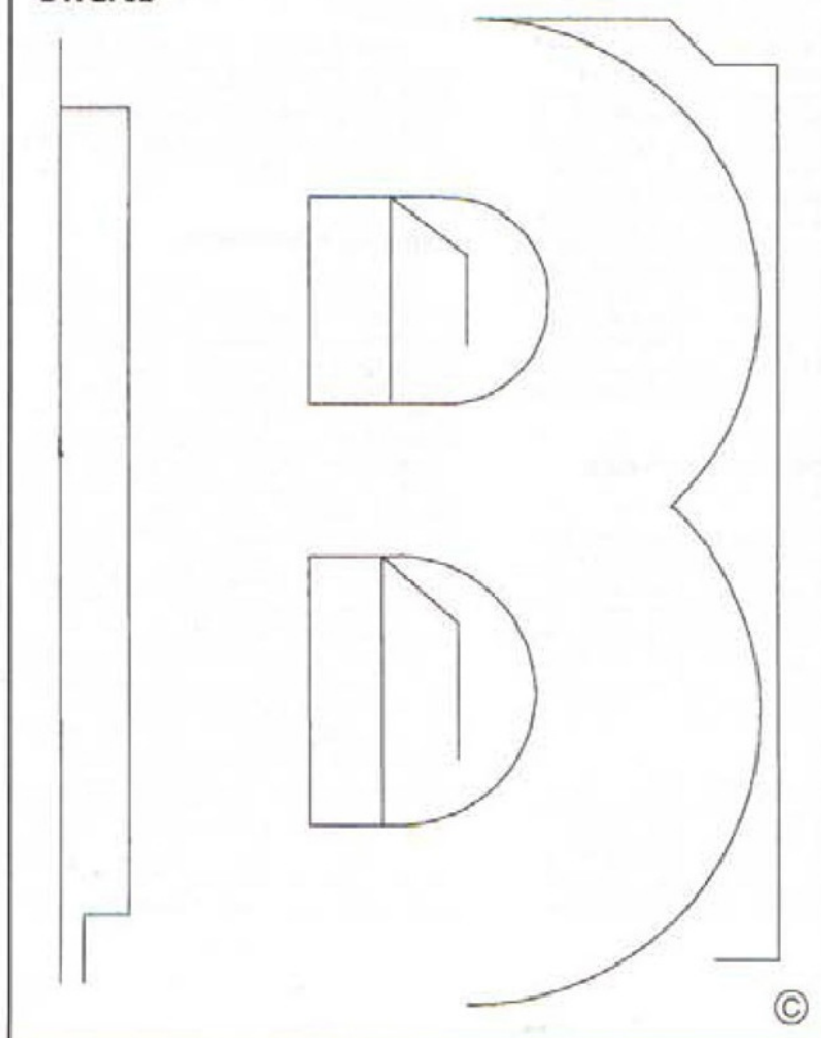
Reducing interference

Some Compucutters using larger motors have reported considerable cross axis interference. One reason for this is the temptation to only spend £2.50 on a skimpy printer cable. A full specification cable has each data line and its associated ground conductor twisted together. These 'twisted pairs', together with an earth drain conductor are contained within a screened sheath of braided copper or mylar foil. The assembly is then covered with PVC for protection. The metal housings at the terminations ensure that the cable is fully shielded from both radio frequency interference and electro magnetic interference. It is the latter that can cause reduced performance when working with stepper motors, unless some thought is given to cable selection and routing. Do not allow stepper wiring to lie close to the printer cable. Similarly, keep the mains wiring away from the printer cable. Suitable printer cables are Farnell 648-346, costing £12.57 for a 3 metre lead. RS offer their 202-600 for £16.61 for 3 metres. Most importantly, use screened cables to run to

DWG. 3a



DWG. 3b



the limit switches, and do not run the limit switch wiring in a harness with the stepper wiring. Ideally the limit switches should be within a steel enclosure, allowing the screening to be bonded (electrically continuous, NOT glued) to the enclosure. Remember to ground all associated metal work, such as machine and motors, to system 0v, at one substantial connector. It is my experience that the prototype is quickly tuned to work well with the above points catered for, when all wiring runs are segregated by being well spaced out. Then, when the job is 'tidied up', one can be back with the jitters or reduced torque, due to the rapidly switching high currents in the large steppers creating intense magnetic fields around their conductors. These rapidly building and collapsing fields induce voltages in any closely neighbouring conductors in a conduit, which can in turn conduct these voltages back to the interface, where they can corrupt the low voltage TTL signals.

If these troubles persist the solution is to screen the stepper cables. If you follow this option, only ground the screening at the motor end of the 6-core cable.

System developments

This concludes the introductory suggestions based on a small adapted machine. The accent has been on a 'let's get on with it' style of construction which, if you are engraving, routing, hot wire cutting, electro discharge machining, plasma arc / flame cutting, clock gear cutting etc. can be quite adequate. I will make available the SCREWCUT, CHECKSTEP, and CIRCDATA programs, together with the ROMAN NUMERALS (I to XII) font, drop me a line if you are interested.

I would like to thank those readers who have given their valuable and much appreciated feedback in response to

these articles. The wide range of applications and machine sizes has prompted two revisions of the software. The Ver 1.0 had a capacity of 3000 commands which I thought was fairly enormous. This, at the request of several users, was soon extended to 7000 commands. Users importing clipart into their CAD designs applied pressure (by regular phone calls, nothing too physical!) for unlimited file size, which is only limited by the amount of RAM in one's PC. Recently there have been two requests to increase the maximum number of steps per cut to something reasonable (it is already 32,000 !!). Maximum steps per single cut can now be 2,147,483,647. From these interesting contacts, I can only assume that shipbuilding in Britain is on its way back in.

What next ?

On that list of 'tricky' jobs, is blading for small turbines. Milling precise profiles in Nimonic and similar alloys is the very antithesis of the demonstrations looked at so far. Metals which 'work harden' when rubbed rather than cut, require rigid work/cutter location and relatively substantial feed forces. Such tools are usually large and relatively expensive.

I am working on an 'alternative' design for a small, portable vertical mill, with 4-axis Compucut CNC to tackle these jobs. It will feature adaptations of readily available 'modern' components and a modest tool kit, and will be described in modular form, as soon as each is perfected. The first of these will be a compound table constructed from the castings of one of the inexpensive cross-vides now so readily available.

In the meantime, good luck to the many experimenters who have taken their first steps in to CNC machining.



SCRIBE A LINE

Modern industrial methods and the home workshop

From Harold Hall, Berkhamstead, Herts

For some time I have felt inclined to share some thoughts with readers of M.E.W., but have kept them to myself, being sure that some other writer would come up with similar comments. However, an item in *On The Editor's Bench*, Issue 45, under the title *An elusive IC*, has prompted me to put fingers to keyboard. My thoughts relate to two subjects which are having major effects on our industrial counterparts, and to a lesser extent the home workshop.

Younger readers, reading early copies of *Model Engineer*, would no doubt be surprised at the limited equipment in the workshops of the day. A lathe, possibly a small drilling machine and an off hand grinder, some of which was probably home made. Today's more affordable machines make present day workshops far better equipped.

To date, machines have been simple, and therefore reliable. Many present day workshops are still using machines made in the early years of the century. Failure of these machines is virtually unheard of, and except for wear affecting accuracy, they are as reliable today as the day they were made.

Electronic aids

Many readers are unenthusiastic about the use of electronics in the home workshop, fearing that computer control would take the skill out of their activities. During my time in industry, entirely in the variable speed drive market, I saw many changes. Initially, control was by multi-stud regulators (200 plus steps) on the field of a dc generator. Thermionic valves and then power transistors replaced the regulator, and eventually thyristors eliminated the generator. Sequence controls were extensive, and on many jobs I engineered, there were in excess of 1000 relays. Progress meant that large relays were replaced by small relays, and then, in part, by logic circuits using transistors, followed by logic IC's and onwards to electronic programmable controllers.

This happened over a period of around 30 years, and illustrates the speed of change. This had extreme effects on industry. Take a paper making machine costing some tens of millions of pounds, the variable speed drives and their sequence controls accounting for a million or two of this. The installation could be brought to a halt if a failed integrated circuit had ceased to be available and superseded by something which was not totally compatible; far from an uncommon situation.

The effect was that the machine user was forced to carry large stocks of spares, particularly for the electronics. If a component failed, followed by eventual failure of the available spares, the complete machine would be useless. The component makers would not, for any money, make a few tens of a part, having originally made it by the tens of thousands. This caused us, the manufacturer of the control equipment, to cobble together pieces of circuitry, frequently untidily, just to keep the machine going. This was acceptable only because of the impracticability (time and cost) of a complete control system being

replaced.

Bringing this to a domestic level, who has a television, say 25 years old which is not now technically out of date, and if it becomes faulty, probably to be informed that it is beyond economic repair? Of even greater significance, the very latest computer purchased some five years ago would already be out of date, and in another five years, probably not worth repairing.

So, what would the effect of these wonderful electronic gadgets be if they crept into our home workshops? Firstly, reliability will have been lost and costly repairs necessary. Even the knowledgeable electronic engineers rarely attempt to service the domestic TV these days, so the home workshop owner is unlikely to attempt this in the way he or she may replace a worn bearing. The longevity of the equipment will be much reduced, no computer controls still running after say 30 years even if the machine itself is still functional. Even simpler items, such as digital verniers, will have a limited life, whereas the well cared-for mechanical vernier will last almost indefinitely.

All this adds up to a much more expensive workshop to run, and a down-grading of the equipment available in most workshops due to the cost of acquisition and servicing, once again becoming rather like the workshops of the 30's and 40's.

Now if this seems a gloomy story, stop worrying, for it is an hypothetical case. I have not the slightest doubt that the workshops as we know them today, and the methods used, will be with us for very many years to come, as I feel the above adequately illustrates the impracticability of bringing computer control into the average home workshop. Those who manufacture smaller machines for the home workshop and the small business will continue to make the basic machines for a long time yet.

However, this is not a case for the exclusion of electronics from the workshop, or even M.E.W., for those who see it as an extension to their workshop activities. I am sure Richard Bartlett would indicate, regarding his CNC for Practical Engineers, that a major reason for building the set-up was the satisfaction of creating the equipment, together with the problem solving that this type of project requires. Its ability, when complete, to assist in the manufacture of a few parts is probably a secondary consideration. This was certainly so for me when I developed the digital readout that featured in early issues of M.E.W.. Incidentally, a tree in my garden was struck by lightning, and this somehow found its way into the workshop, causing a failure to a number of the components in the readout electronics, which have still to be repaired. A light switch was damaged internally, otherwise the non-electronic equipment withstood the effect. So much for the reliability of electronics.

Metritication

Metritication is a totally different situation. Unlike our machine tools, which are almost entirely made for the home workshop market and very small businesses, our materials and small tools are, without doubt, made for industry as a whole, and we are but a fraction of one percent when it comes to

sales. In view of this, we will be controlled by the rate of change to metritication in industry. Already, letter and number series drills are non-preferred and metric drills are intended to replace them. How long will it be before these and fractional drills disappear altogether, in favour of the more logical metric series of drills. Bright steel angles are now only available in metric dimensions, and other materials will surely follow.

Reference to any industrial catalogue will show that metric fasteners are, in most cases, the only ones being supplied. Taps and dies in Imperial sizes, whilst being required for repair work for years to come, will become progressively more expensive, as will other Imperial tooling, typically micrometers.

To sum up therefore, the use of electronics in the average home workshop will be very limited, and developments in this direction very slow. Metritication, on the other hand, will be a continuous process and unstoppable, and will be much in evidence in a matter of ten to twenty years. The model engineer will, of course, continue to see Imperial dimensions for many years, in kits of materials for locomotives and the like.

But more on the I.C. in question

From Jim Cox, Grantham, Lincs

With regard to Mr Avery's very helpful letter, the TDA2086A is not too easy to obtain, but a very similar integrated circuit is the TDA1085.

I enclose a photocopy of one page of the data, which shows the essential connections (unfortunately not suitable for reproduction here - Ed.). The full set of data sheets can be downloaded from the Internet at www.mot-sps.com/cgi-bin/dlsrch.

TDA1085 is currently stocked by Grandata Ltd., Tel. 0181 900 2329

Link-Up answers shared

From Anthony Walton, Tulse Hill, London

May I take this opportunity of warmly thanking all your readers who were kind enough to assist in my inquiries?

As you may remember, I wanted to know:

a) the lightest and cheapest oil with which to fill jam jars, in which to immerse rust-prone items in order to protect them, and

b) what was the smallest lathe with 4 MT headstock?

A good answer to a) was W.D.40 in liquid form, about £25 a gallon, but a better one was hydraulic oil HM32 - containing a rust protector - at about the same price for five gallons.

As to b), I was grateful for the gen on the Littlejohn and/or Raglan lathe, but the smallest lathe appears to be some versions (and some only) of the Nu-Tool combination lathe. EMC0 originally, I believe, had a Compact 10 with 4 MT, but now have a Super 11 with this taper. Graham Engineering at one time produced a lathe, stock number 1L-540-011, 18in. between

centres, with a 4 MT spindle, and it is possible that some of the smaller Smart and Brown lathes have such a taper. As of now, however, the smallest 4 MT headstock lathe appears to be the Nu-Tool in some of its versions.

Magnets and hacksaw blades

From A. Denton, Kempston, Beds.

I just had to write about the 'Handy magnetic base for dial gauge' in Issue No. 45, from James Lait. He says that there is no way in which the magnets to which he refers can be switched off. I solved a similar problem when I was sorting out some ferrous from non ferrous cuttings some time ago. A piece of thin plastic sheet (the sleeve that M.E.W. is mailed in is ideal) is required. Slit the sleeve open to one thickness, in two pieces. Place the magnet central on one of the pieces, fold the loose material around the magnet stem and tie it up like a 'dolly bag'. The magnet will obviously attract only ferrous materials, but non-required material is easily released by untying the 'dolly bag' and shaking, before re-attaching, leaving a clean base for further use.

Replying to Jonas Beausang in the same issue, it is possible to make a suitable hole in HSS saw blades, not by punching, but by drilling. Use a suitable size Durium (Carbide) tipped drill, at a slow speed and a fair amount of pressure. Be ultra careful at the break-through of the point. My problem in the past was obtaining 12in. blades, so 14in. had to be broken and end ground to 12in. size, then drilled. Once upon a time, I used to scour the scrap yards for broken blades that had enough length to cut 12in. blades. There were plenty to be had at that time. I suppose there still are if you have the time and places to look.

Also, end mills can be re-drilled on the end by placing them in the lathe and using the tipped drill in the tailstock chuck.

'Sable' lathe information

From A.R. Eden, Petersfield, Hants.

In the current issue of M.E.W., your correspondent B. C. Spick asks for advice on the refurbishing of his Smart & Brown 'Sable' lathe.

May suggest that he gets in touch, directly, with Bracehand Ltd, which is the name of the company that carries on the business of Smart & Brown. I had a note from them concerning their change of address in November 1995. Their Mr. Fred Matthews will, I am sure, give Mr. Spick all the information he requires. The new address is:- Bracehand Ltd., 6 Tithe Farm Close, Langford, Biggleswade, Bedfordshire, SG18 9NE. Tel: 01-462-817039. Fax: 01-462-816325

I enjoyed enormous help and support from Mr. Matthews some years ago, when I was refurbishing an old Smart & Brown lathe, and am confident that Mr. Spick will receive the same treatment.

...and a request regarding a Zyto lathe

From Martin Harvey, Hayle, Cornwall

I always keenly await the next issue of M.E.W., and have been following the series 'Lathe Upgrade on a Budget' with particular interest. My concern is upgrading a Zyto '202' 3 $\frac{3}{8}$ in. screwcutting lathe which my grandfather bought just before the last war, and which I now have in my clock-making workshop.

The lathe was made by S. Tyzack Ltd. until, I understand, the early '60s, but the company

have no information other than that. The lathe is very similar in construction to the Myford ML10, with the two notable exceptions:

- i) On the 'Zyto', the mandrel runs in bronze-bushed headstock bearings, as opposed to plain cast iron
- ii) My handwheels do not have calibrated dials fitted.

I propose tackling the matter of fitting calibrated dials by adapting some of the published designs, even though they are intended for use on other lathes. I see no great problems providing, of course, I graduate them for the correct screw pitch of 0.082in.

I am, however, completely in the dark when it comes to adjustment and lubrication of the headstock bearings. Because of the general similarities to the ML10, I am applying the information I have on that model, and all seems to be well. I regard maximum mandrel speed as being 1200, but never actually exceed 960, which is more than fast enough for any of my work.

I should like to add a vertical slide to the lathe, to enable me to undertake light milling operations. At first sight, attachments intended for a Myford would seem to be appropriate, but I hesitate because I have no experience of the use of vertical slides on small lathes. Mistakes, after all, promise to be quite expensive.

Although I have studied engineering on OND, and subsequently studied clock restoration, my experience on lathes has been confined to production work on large industrial machines and, more recently, to clockmaking with the ML7, and Super 7 - rather a different world from that now encountered.

I hope some of your readers will have had first-hand experience of my type of lathe, and might be able to cast some light upon my problems. I shall gladly reimburse all reasonable expenses, and thank you in anticipation.

LINK UP

- Reader to reader service
- queries
- wants
- Help
- small sales
- & its all free!

WANTED

● Model engineer wishes to purchase a mill (v/h) in reasonable condition. Good home offered to much loved equipment, but not a large size please. Single or three phase. Full details and price in writing (private purchase only, no dealers) K.A. Willson, Pinedale, Broomrigg Rd, Fleet, Hampshire GU13 8LS Tel. 01635 511011 (weekdays a.m.) Fax: 01635 33647

● Starting up. Need the following, plus any other useful bits for white metal bearing type ML7:- face plate, catch plate, Myford vertical slide, 3in. angle plate; Keats angle plate, tailstock handwheel, taps, dies, tools etc. Les Savage, 3 Shaftdowns Lane, Gwinear, Hayle, Cornwall TR27 5LE Tel. 01209-831766

● Change gear, 40t needed for Drummond 'M' type lathe (late model). Also vertical slide to suit the same lathe. John Faulkner Tel/Fax 01304 361341 (Deal)

Small surface grinder, any condition - hand operated. Tel. 0121 4776985 (Birmingham)

● The Myford Manual by Ian Bradley and early issues of M.E.W. Magazine - your price paid. Also gearbox for Myford ML7. Must be in excellent condition. A. Jackson 78 Fairway Drive, Edmonton, Alberta, Canada T6J 2C4 Tel (403) 435-4425, Fax (403) 1135-1627 Email 102421.247@compuserve.com.

● Back numbers of M.E.W.; Nos. 1 to 12, 14 to 23 and 27 inclusive. Fair price paid. Also required any unused/unmachined castings for 1 $\frac{1}{2}$ in. Allchin that are spare to requirements. Anything considered. Joe Lloyd, 3 Leafield Avenue, Longwood, Huddersfield HD3 4TW. Tel. 01484 654557

● Hand operated shaper required, preferably in reasonable condition. Collection can be arranged. Tel. 01428 713594 or Geoff at 13 Kay Crescent, Headley Down, Hampshire GU35 8AH

● For a Pultra 90mm CH lathe:- details of the internally threaded collet closing tube, also a handbook would be useful. M. Silvester, 'Freshfield', Wood Lane, Fishlake, Doncaster, S. Yorkshire DN7 5JZ

FOR SALE

● Mitutoyo 12in. Vernier Gauge. Thumb lock adjustment. Inside, outside, depth and step measurement. Unusually Imperial calibration only. New condition. Complete with plastic pouch. £30.00 Tel. 01442 863026 (Hertfordshire)

● Whitecote (Taiwan) 12 speed bench drill, 230-2430 RPM, 240V single phase motor, $\frac{1}{2}$ in. capacity, complete and working £30. Tel 01892 530544 (Tunbridge Wells)

● Various Myford lathe bits. 3 and 4 jaw chucks, also catch plate £15 Tel. 01253 354478 (Blackpool)

TEASERS

With the Festive season upon us there are bound to be periods when workshop activity is taboo. In order to while away the time we have display a couple of examples of old and unusual tooling to stir the grey matter and see how many readers can identify them. No prizes for correct solutions, but it could be fun to find the original purposes of these tools. They need not necessarily have any engineering connotation!

1



3



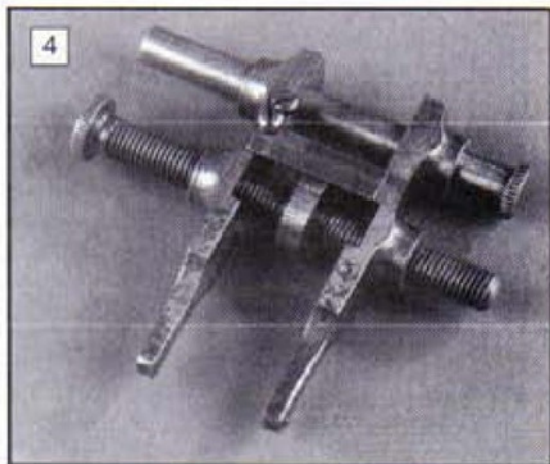
Spike?

First item is a spring loaded steel bodied spike. Made from a forging it is about 6in. long and has a hole in the end probably for mounting on a belt. The body looks a little like a spike when extended (photo 1), but is able to fold under the influence of the spring in photo 2. The only identification marks are U.S. Patent on the serrated beak, a letter S stamped in, and an arrow at the top of the handle. It belongs to Mike Radford who has no idea as to its original function.

2



4

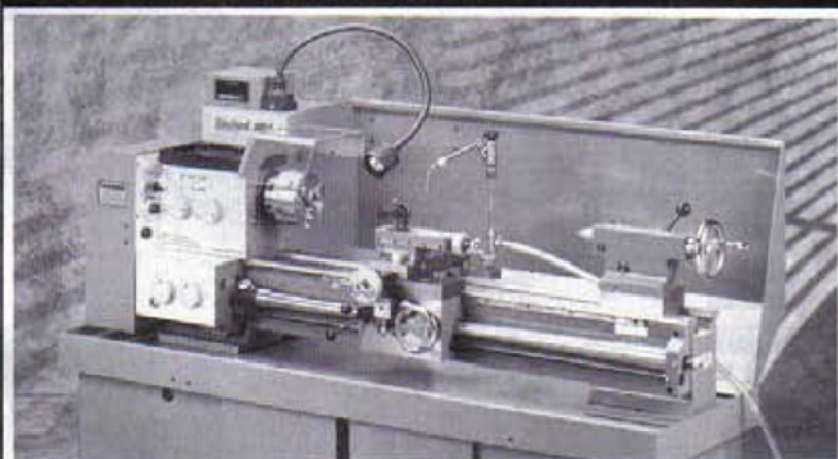


Clamp?

Next comes the object in photos 3 & 4. All steel construction, it was found in the effects of a former engineer. The thread is 20TPI and the central nut has 0.001in. graduations to run against the scale in photo 4. At first sight this was some form of clamp, but it is too light to exert much force. Mr. R. Redbond, who loaned us the tool is very curious as to the original purpose of the tool.

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