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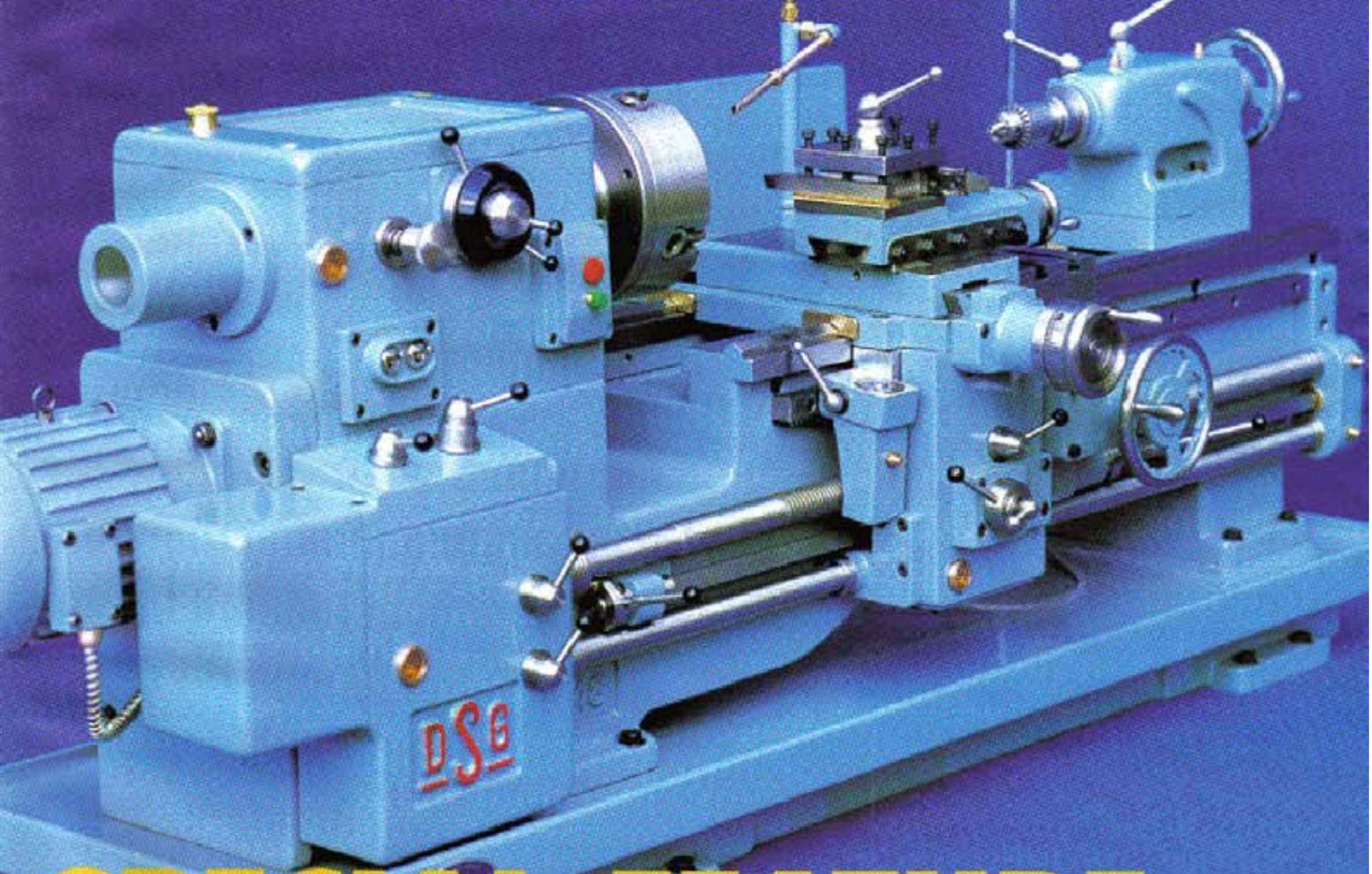
MODEL ENGINEERS' WORKSHOP

THE PRACTICAL HOBBY MAGAZINE



SPECIAL FEATURE

THE LATHE IN THE HOME WORKSHOP

- ★ THE HISTORY OF THE SMALLER LATHE
- ★ UNUSUAL HOME-BUILT MACHINES
- ★ MODIFICATIONS TO A DRUMMOND
- ★ A SCREWCUTTING AUTO-STOP

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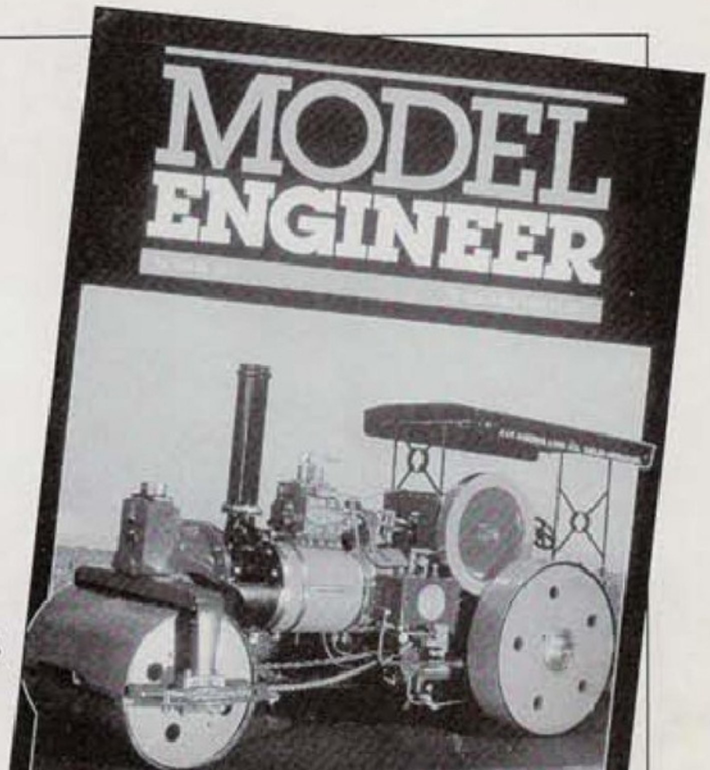
SOMETHING TO LOOK FORWARD TO...

...every fortnight



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

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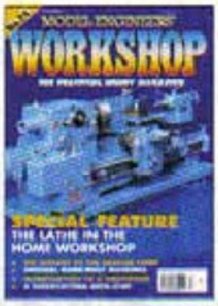

Front Cover

Not only is the lathe the main machine tool in most home workshops, it also makes an interesting subject to model. Barry Jordan, who specialises in creating miniature machine tools produced this 1/5th. scale version of a Dean, Smith & Grace Heavy Duty Gap Bed Lathe which won a Silver Medal at the Model Engineer Exhibition (Photo. Barry Jordan)

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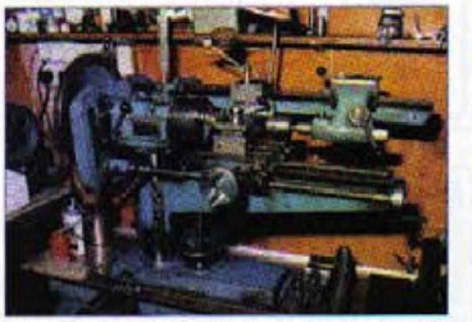

Inside

The late David Urwick devised this versatile machine which incorporated his patented triangular key. Known in later years as the MetalMaster, it is now the subject of a revival of interest, particularly in the USA. It was described in a number of articles in 'Model Engineer', two of which are reproduced, starting on page 23 (Photo. Mike Chrisp)

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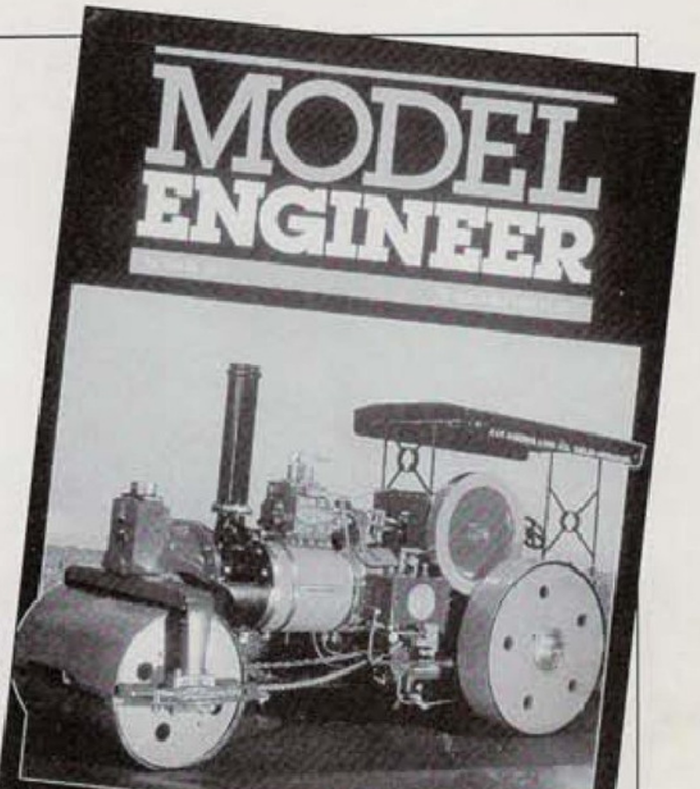

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Geoff Sheppard

ON THE EDITOR'S BENCH

As this is one of the 'intermediate' issues, scheduled in to make our eight in the year, I decided that it would make an opportunity to concentrate on a topic which is likely to be of interest to the majority of home workshop owners. The lathe has always been the centre piece of the amateur's metalworking workshop, often being referred to as 'the king of machine tools' because of its versatility. With the addition of a selection of accessories and attachments it becomes what is referred to in modern parlance as a 'machining centre'. Much of the content of *M.E.W.* and of our sister magazine *'Model Engineer'* has, over the years, been concerned with these additions and with the techniques associated with using them. I recall the Chairman of our local model engineering society, many years back, greeting each new member with the question "And do you have a lathe?", because the availability of such a machine was considered to be all that was needed to be able to participate fully in the hobby.

As it happens, the inspiration for this 'special' was not generated by a lathe at all, but by David Machin's article on fitting the patented 'Urwick' triangular key to the column of his milling machine. This prompted me to look up the original articles on the topic, in which David Urwick described what subsequently became known as the 'MetalMaster' lathe and to talk to Mick Collins, who is now in possession of the example of the machine which the designer kept for himself. He also has copies of much of the original documentation on the subject and has established a personal website, on which some of the MetalMaster material is portrayed .

Studying the design features of the MetalMaster led me to recall a variety of other machines which I have either seen or read about over the years, which incorporated the ability to vary the height between the bed ways and the mandrel centre. More often than not, this was intended to provide the capability of horizontal milling, so that a cutter arbor could be mounted between centres and the workpiece mounted on a table with 'X' and 'Y' axis sliding capability under the control of a conventional saddle leadscrew and cross-slide feed screw. Some of these were built by amateurs, but others were the products of recognised machine tool manufacturers who aimed them at both the home workshop and the industrial user.

Of the latter, I always thought that the Murad 'Bormilathe' would be one which gained a lasting foothold in the market. Murad was an established manufacturer of industrial machine tools, based at one time in the Watford area. During World War II the company made a major contribution to the production of armaments, supplying many machine tools and also advising the various Ministries when new and innovative processes were required to overcome manufacturing difficulties. Towards the end of the war, production of the 'Murad' car was planned and permission gained for the manufacture of two prototypes. This vehicle was reported to be of an advanced design and a great demand was anticipated, so the works would need to be extended significantly. The authorities refused to allow this on the grounds that it could result in traffic difficulties on the Watford By-pass, so a move to Aylesbury resulted. I have been able to find no further reference to the 'Murad' car, so whether manufacture was ever completed or not, I am unsure. Perhaps the design was acquired by one of the established car companies. It will make an interesting research project if I ever find the time!

Murad were approached by the Chief Engineer of the projected Trans-Antarctic Expedition, who was looking for a lathe to be the only machine tool for servicing their base workshop. A "tremendous number" of special accessories was designed and made, making the lathe which they supplied capable of carrying out any machining likely to prove necessary. It was this experience which prompted the subsequent design of the 'Bormilathe'. Despite this background and experience, both the Bormilathe and the company, which subsequently moved to Queenborough, Kent, have disappeared, probably victims of the great recession which hit the machine tool industry some years back. The article on page 48 depicts an example of the machine which is still in service in the workshop of a fellow model engineering society member, Ken Lansdown, who kindly allowed me to photograph it in a variety of configurations.

Another of the reprinted articles coincidentally also comes from another former club colleague. Les Redman developed the machine which he describes in the article which starts on page 34, again with milling capability, both horizontal and vertical in this instance. Les also designed machines which were produced in small numbers commercially by a local company. Sold under the 'Portmac' name these consisted of a bench vertical milling machine which incorporated some interesting features, and a very small horizontal mill known as the Redman Mini-Miller. The latter was advertised in the pages of 'Model Engineer' in the 1960s, and over the years I acquired an example of each.

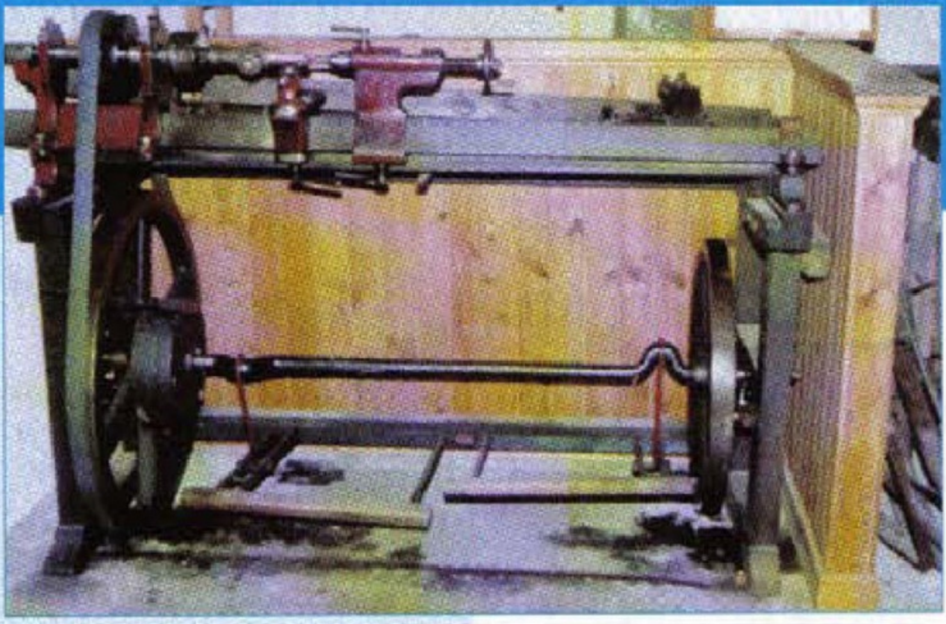
Also in this issue is an article from Don Unwin, a keen student of the history of machine tools who has made a number of contributions to these pages over the years. On this occasion, I asked Don if he would survey the development of the smaller lathe which proved to be suitable for use in the home workshop. As always, Don has produced some fascinating illustrations of machines which appear antiquated now, but which advanced the capabilities of the 'gentleman amateur' who was able to afford a workshop in the period which encompassed the late 19th. and early 20th. century.

Don's study really covers the era which preceded the arrival of the Myford ML7, a lathe which transformed the home workshop scene. When researching material for this issue, I came across the articles in which were described some of the entries in the 'Ideal Lathe' competition promoted by Percival Marshall. One or two of these incorporated a measure of forward thinking, but the majority seemed just to add minor embellishments to the established pattern. The advent of the ML7 swept all these away as immediately it became possible for the home workshop owner to acquire something which came close to meeting the 'ideal' definition at what was, even then, a relatively modest cost. We have recently seen the introduction of a new version of the Myford 7 Series, the 'Super 7 Plus', so I am considering using the occasion to look more deeply at the history of the Myford company and its products in a future issue.

The arrival of machine tools produced in Taiwan and mainland China has brought a whole new range of lathes and multi-purpose machines to the market. Although criticised by some on the grounds of quality, we have seen a steady improvement in much of that which is on offer, with the less than satisfactory examples falling by the wayside. Many of these machines are now being bought, their purchasers believing that they represent good value for money, with levels of accuracy quite adequate for the work they wish to carry out. The inventory of accessories and attachments, often provided as part of the basic package, make the acquisition of a well equipped workshop a much easier proposition than hitherto. A question which is not yet settled is how well they will maintain their value in the second-hand market, a factor which will affect 'trading up', something which many of us have done as we have steadily improved the capabilities of our facilities.

It is quite certain that the lathe will continue to be the mainstay of the home workshop and that the products on offer are still capable of being developed, although the rate of change is likely to be modest. I hope that readers will find this short review to be of interest.

A POT-POURRI OF SMALL LATHES



1. Triangular bed lathe, Camden Works. cl824/25

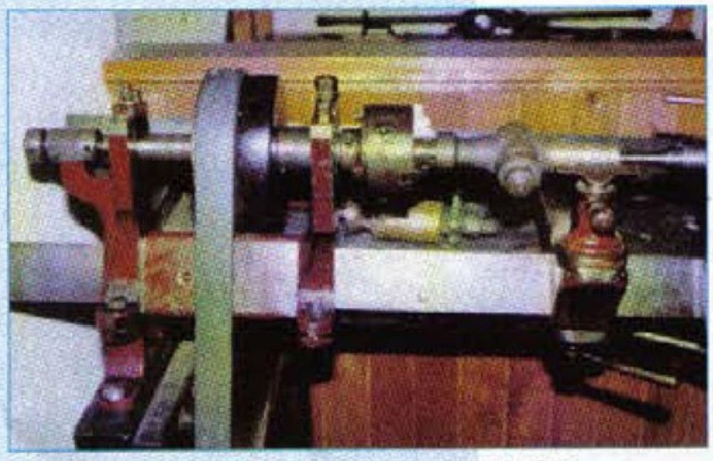
The small lathe has a fascinating history, some aspects of which are explored by Don Unwin

In my articles outlining the Evolution of the Lathe published in the M.E.W. Issues 15 and 16 (February and April 1993) I included machines of all sizes. In this article I am going to discuss relatively smaller machines of the types often used by the amateur.

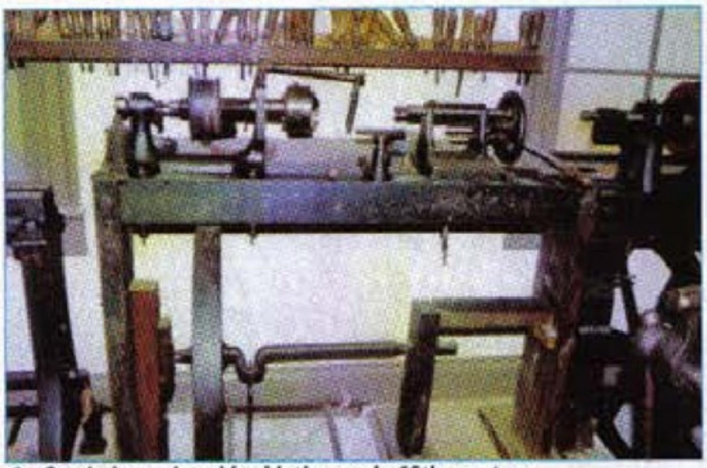
In the 19th. century it was generally the 'well to do' or 'gentleman amateurs' that could afford the time and money to use a lathe as a pastime. The main industrial users of the metal working lathe were clock and watchmakers, scientific instrument makers, brass finishers and small jobbing engineers. Henry Maudslay made the first accurate metal working lathe around 1798 and he rapidly developed it so that by 1810 he was producing his £200 lathe. Interestingly, at first he was uncertain at which end to put the headstock and one he made about 1800 had it on the right, instead of the left as is now the almost universal practice. A machine with a similar triangular bed and shown in **Figs 1 & 2** can be seen at the Bath Industrial Heritage Centre's Camden Works Museum. Unfortunately this lathe has no maker's nameplate but it is just possible that Maudslay may have made it as the design is similar and the workmanship is of Maudslay's very high standard. If not made by him or in his works, it is a very close copy. However, the 3-jaw self-centring chuck fitted, albeit old, is of later manufacture as, although invented in 1842 by James Dundas in Britain, they did not become widely available until made by Cushman in 1871. Another interesting feature is the provision of two treadles with the cranks at 90 deg. so enabling two people to treadle at once.

In addition to the triangular bed lathe, Camden Works Museum has, in its collection of engineering tools from the J B Bowler & Sons Bath engineering business, some other very interesting small lathes, all treadle driven and some locally made. It is interesting to note on these early machines how small in diameter the mandrels were, many without bores. One problem they were not sure how to deal with was end thrust. One type of adjustable thrust can be seen in **Fig. 2**. A very early machine **(Figs. 3 & 4)**, has a bed built up of iron plates on a wooden stand. The crude headstock seen in detail in Fig. 4 has no back bearing, but a cone that also takes the thrust. This machine has a small treadle for one operator. **Fig. 5** shows another crude machine, obviously built up of bits. Two cast iron plates bolted to cast iron spacing blocks (seen in **Fig. 6**) form the bed, whilst the stand is very similar to that of Fig 3 and probably made by the same person. It has yet another version of thrust bearing. The headstock illustrated in **Fig. 7** is that of another crude and apparently improvised machine. It has a very small diameter spindle with an internal nose thread and another different type of thrust. Again two cast iron plates, bolted together, form the bed.

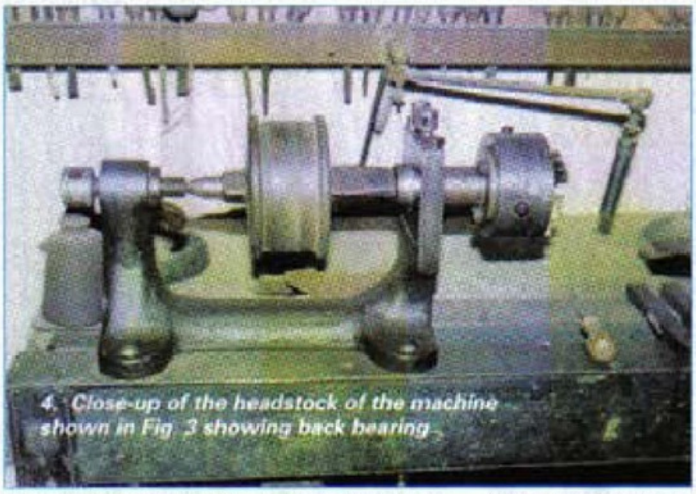
Fig. 8 is a puzzle. Whilst the bed looks very like that of a simple plain lathe shown in the 1894 catalogue of the Britannia Co. of Colchester, the headstock and tailstock are raised on packing blocks **(Fig. 9)** and do not appear to match the bed. However, the headstock includes features such as the 6-step pulley for round belt, the sliding back gear and the more sophisticated tail



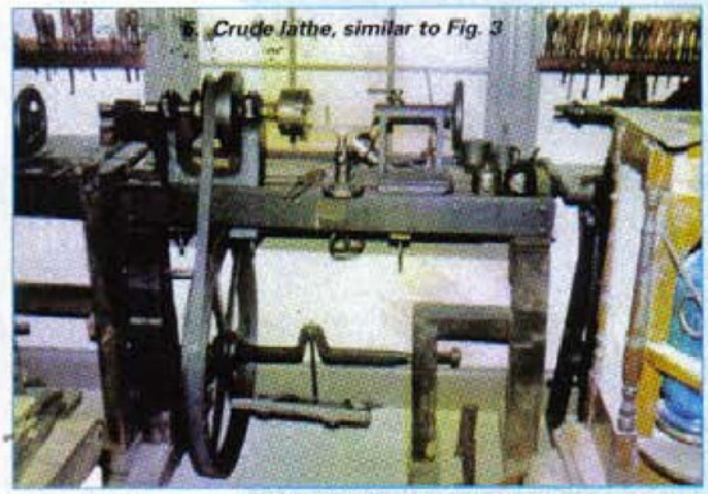
2. Close-up of the headstock of the lathe seen in Fig 1



3. Crude iron-plated bed lathe, early 19th. century



4. Close-up of the headstock of the machine shown in Fig. 3 showing back bearing



5. Crude lathe, similar to Fig. 3

thrust design illustrated on the 'improved' plain lathes in the Britannia 1894 catalogue. Similarly, the tailstock is also a Britannia design and both were almost certainly manufactured by them. The iron stand with wide treadle and two cranks is not exactly as those illustrated in the catalogue, but could well be of Britannia manufacture. Of interest is the tube steady, fitted after the centre height had been raised, probably by Bowler's as the machine was used in their brass finishing shop. One of the Britannia lathes was illustrated (Fig 24) in the April 1993 article.

A better quality plain lathe, 7in. centre height, not built up of various bits, is illustrated in **Fig. 10.** It has a cast iron bed with machined double V shears, mounted on a matching cast iron stand with correct three-step flywheel and long treadle. A robust compound slide rest with top slide adjustable for angle is clamped to the bed in the manner used on instrument maker's plain lathes. It has no index collars however. The front of the headstock pulley has brass division plate with six rows of holes, whilst the end thrust is taken on a ball thrust bearing acting against the back bearing housing **(Fig. 11).**

Screw cutting could be made easy on the 7in. centre lathe shown in **Fig. 12** as the cross-slide is fitted with quick withdrawal mechanism. The machine was already redundant when it came to the Museum and many parts are missing. Strangely, the headstock has only a single pulley on a slim spindle, but with thrust taken against the back bearing and is fitted with normal lever operated back gear. Probably the most interesting item is the early bell chuck, the predecessor of the screw and scroll chucks fitted to all the other machines in the collection. As mentioned, these machines and many others can be seen at the Bath Heritage Centre which is located in Julian Road, Bath.

Ornamental turning

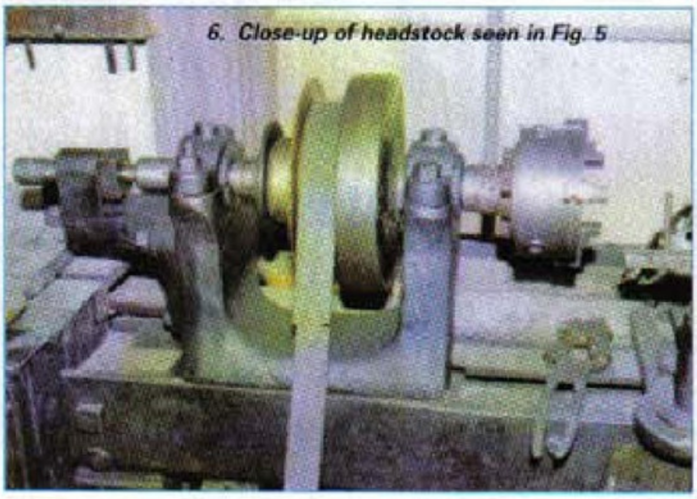
By the early 1800s, Charles and John Holtzapffel were making ornamental turning lathes which were very popular with the 'gentleman amateur', a later example of cl900 is shown in **Fig. 13** and two of the complicated slide rests in **Fig. 14.** Over the period 1843 to 1894 Holtzapffel published the five volumes of 'Turning and Mechanical Manipulation', a treatise written for the amateur craftsman.

As the 19th century progressed more people had disposable income available to spend on hobbies, so the demand for lathes for amateur use increased. By 1884 the Britannia Company of Colchester, in addition to their large range of industrial machines, were advertising many types particularly suitable for amateur use. For those who couldn't afford a complete lathe, machined castings were available as the 1878 advertisement reproduced in **Fig. 15** shows.

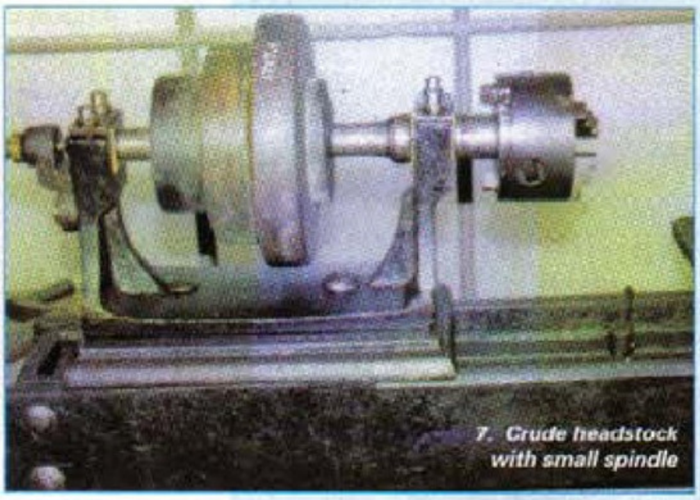
New publications widen interest

In 1865 *'The English Mechanic'* started publication covering a very wide range of practical and scientific subjects. However, it only catered to a small degree for the amateur mechanic. By 1898 Percival Marshall felt that there was sufficient interest for a journal specifically for the amateur mechanic and started the *'Model Engineer'*. This opened the floodgates for the small lathe and by the early 1900s many had appeared on the market. About the same time as Britannia, the Milnes lathes appeared followed in 1908 by the immensely popular Drummond 4in. centre round bed lathe, **Fig. 16**, and their $3^1/_2$in. centre screw cutting lathe. Others were Pittler, Relmac, Holmes, Star, W H Clarke and J Christopher, to name a few. Some were illustrated in my earlier article. At prices ranging from 17/6d ($87^1/_2$p) to around £8 the cost seems ridiculously low now, but a skilled man would probably be earning no more than £2 a week at that time. Some were very basic and crude, such as the 'Universal' lathe by E Gray at 21/6d (£1.$7^1/_2$p), **Fig. 17**.

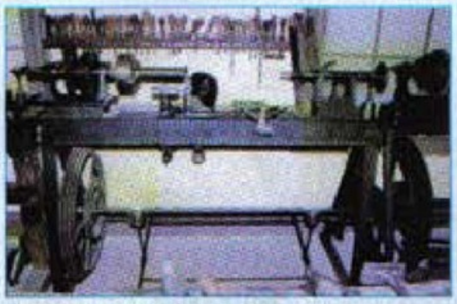
Even Drummond advertised a very basic tool in the *'M.E'.* called 'Little Goliath', **Fig. 18**. Many home workers made their own lathes, often under great difficulty due to limited facilities. In a copy of the *'Model Engineer'* published in 1905 one was illustrated in which the builder had used only few castings, **Fig. 19**. There were several attachments for lathes, designed to increase their versatility. **Fig. 20** from an 1894 catalogue, shows one version of many drilling machine attachments available. That in **Fig. 21**, also 1894, claims to combine lathe, drill, fretsaw, emery grinder and polisher. A more elaborate multi-purpose machine is shown in **Fig. 22**. However, multi-purpose or 'universal' machines were made for industrial users as well. They were used in places where space was limited, such as on board ship or in mobile workshops. A



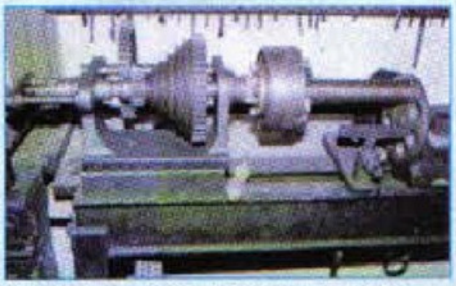
6. Close-up of headstock seen in Fig. 5



7. Crude headstock with small spindle



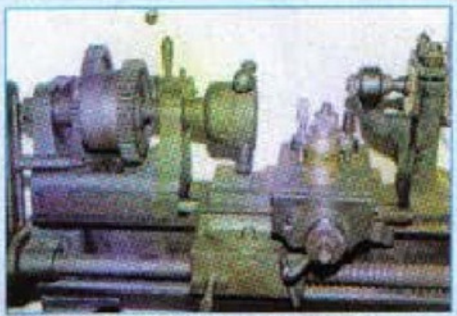
8. Lathe with raised headstock and tailstock of Britannia manufacture



9. Close-up of the Britannia headstock and tube steady

10. Plain lathe with compound slide rest

11. Headstock with division plate of lathe shown in Fig. 10



12. Headstock of 7in. centre height screw-cutting lathe

machine of this type made in 1888 by the London Lathe & Tool Co is shown in **Fig. 23**.

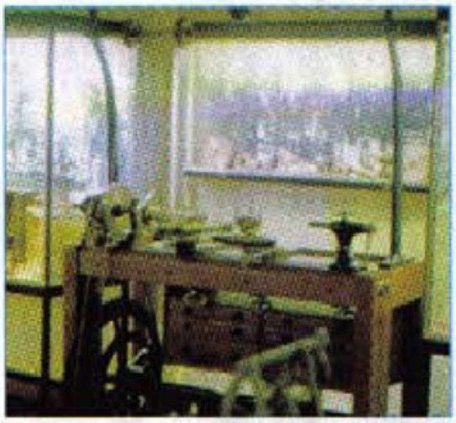
Many of the better machines were available with over-head gear, providing a drive to milling spindles mounted on the slide rest. J Lukin illustrated the example shown in **Fig. 24** in the 1894 edition of 'Turning Lathes'. A belt that is kept tensioned by the weighted jockey pulley wheel drives a small milling spindle mounted on the top slide.

There were some unusual arrangements on smaller industrial machines, **Fig. 25** illustrating a cross-slide which provided tool height adjustment on American lathes. The slide casting is pivoted on the carriage at the front and a jacking screw, fitted at the back, enables the slide to be adjusted up or down. To keep the whole thing rigid a weight is hung on the hook hinged to the upper sliding portion! Early American V-bed lathes often had a similar weight attached to the underside of the saddle to prevent it from lifting.

Not all lathes followed convention, and the small screw-cutting lathe of c1900 vintage **(Fig. 26)** that belonged to a friend of mine is an example. The headstock is located on the shears on the top of the bed whilst the saddle slides on separate slideways below, as seen in **Fig. 27**. It does not have the conventional tumbler reverse on a single lead screw, but has two screws rotating in opposite directions, **Fig. 28**. Engagement with the screws is by a double-sided half nut on the saddle. If the lever is turned upwards, the top screw is engaged and the lower if the lever pushed downwards. Although of somewhat quaint design, with a simple compound slide rest having no index collars, it is well made, heavily built and quite accurate. No maker's plate is fitted, so the origin is unknown.

Most small lathes for industrial use were extremely well made, two plain lathes as used in the scientific instrument trade being illustrated. A German Lorch with pump handle tailstock is seen in **Fig. 29** and, in **Fig. 30**, a Hjorth from USA. Both are fitted with draw collet chucks, as was usual on this type of machine. Amongst other manufacturers of similar high-quality lathes were the German companies Boley and Leinen, the Swiss Schaublin and the Sloane & Chase in USA.

Watch and clock makers' lathes were usually highly finished and often in polished boxes or cabinets such as **Fig. 31**. This cabinet contains two lathes or 'turns'. The upper one has a faceplate with



13. Holtzapffel ornamental lathe c1900

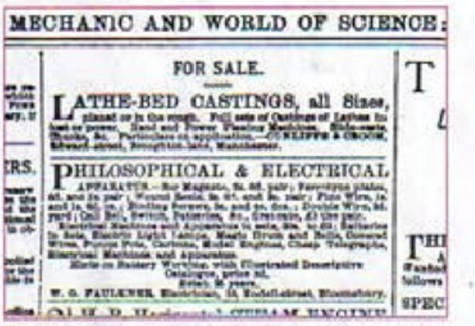
dogs for wheel work and the lower lathe has tee rest and tailstock. The slide rest can be fitted to either lathe. Note the comprehensive range of rod, cup and ring collet chucks. Instead of a threaded back plate, 3-jaw chucks had a shank which fitted into the mandrel and were held by the collet draw spindle.

Proliferation after 1918

The First World War put a stop to the manufacture of lathes for the amateur market but, after hostilities had ceased and things began to get back to normal, the number of small lathes proliferated! Some were just awful whilst others were extremely well made and good value for money. An interesting variant was the Hobbies Free-Wheel lathe of 1922, **Fig. 32**. The treadle was held up by a spring and, attached to it, was a cycle chain that passed over a bicycle free wheel fitted to a shaft with a heavy flywheel on it. A chain and gear wheels connected this, in turn, to the lathe mandrel. When the treadle was depressed it rotated the flywheel which continued to rotate during the return stroke of the treadle. As it was a plain lathe, provision of self-acting traverse to the slide required a special adaptation, shown in **Fig. 33**. Screw cutting was just as awkward, as **Fig. 34** shows, whilst **Fig. 35** reveals the woodworking ancestry!

Drummond's round bed lathe continued to be manufactured and others adopted a similar arrangement. One was the EXE $2^1/_2$in. centre bench lathe costing £7/19s (£7.95p) in 1936, which had a bed composed of two circular steel rods, **Fig. 36**. The EXE $3^1/_2$in. centre lathe had a more conventional cast iron bed, **Fig. 37**.

14. Slide rests of the Holtzapffel lathe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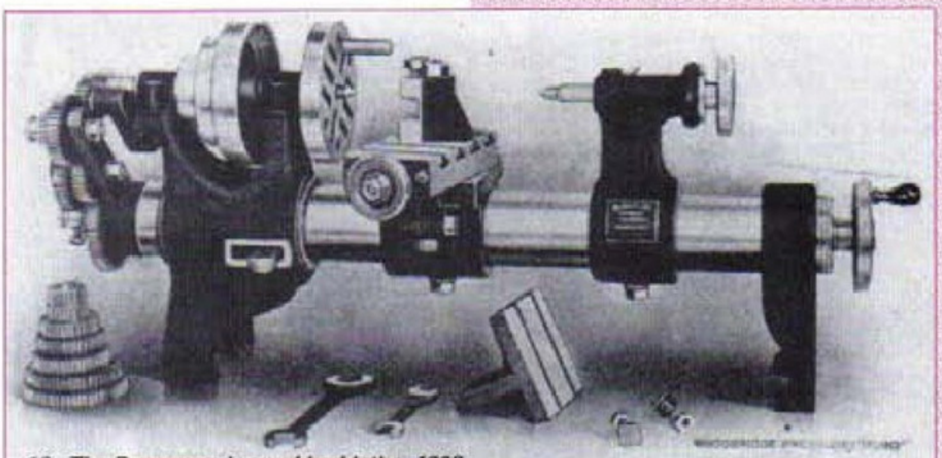
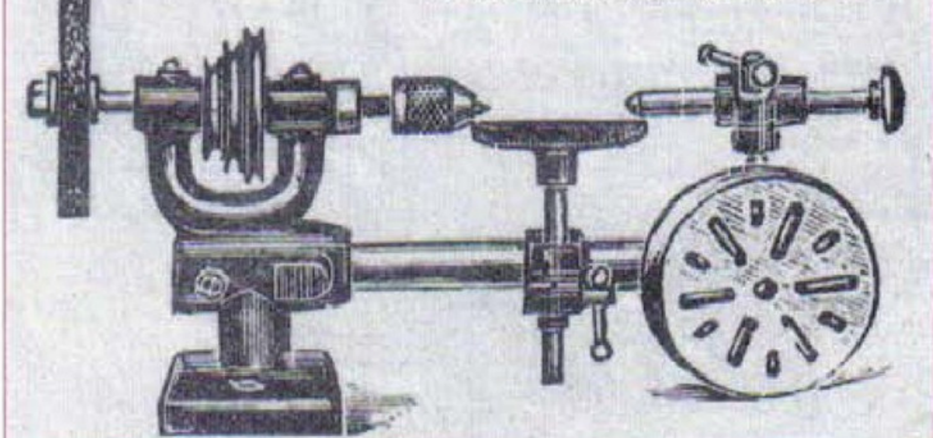
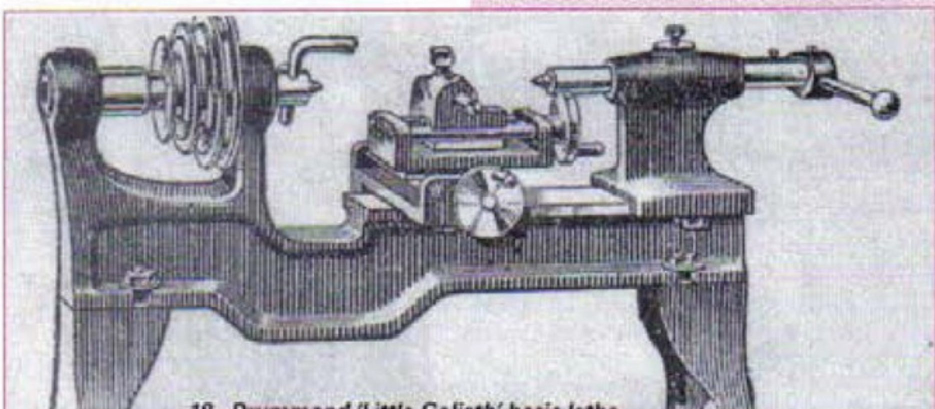
15. Advertisement for lathe castings, 'The English Mechanic' 1878


16. The Drummond round-bed lathe, 1908

17. The 'Universal' lathe by E Gray, cost 21/6d



18. Drummond 'Little Goliath' basic lathe

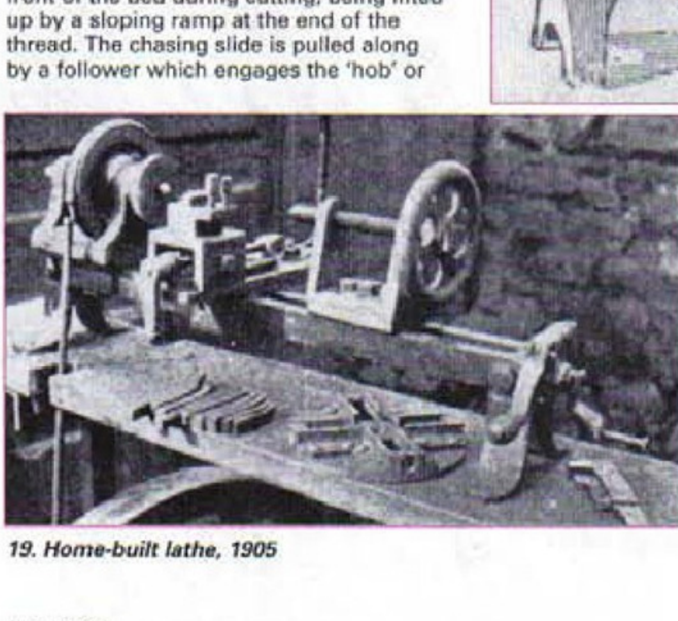
Both lathes had a large pulley on the back end of the mandrel, to provide the low speed normally achieved through the back gear. The cast iron stand was quite elegant although the treadle was rather small. Many manufacturers made simple basic plain and screw-cutting lathes, two examples of really basic machines are the 1⅝in. Adept **(Fig. 38)** and the 3in. Randa simple screw-cutting lathe, **Fig. 39**.

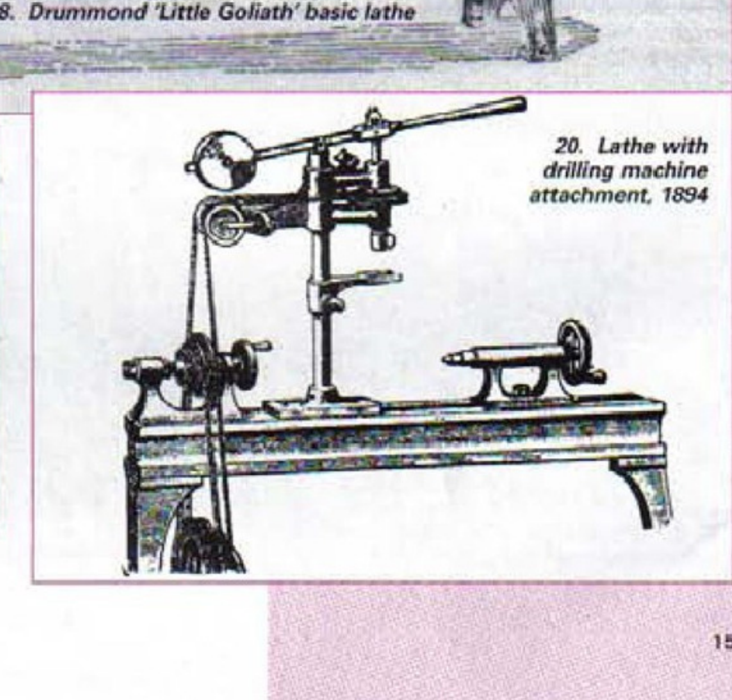
Trawling through old copies of *'Model Engineer'*, *'English Mechanics'* and old catalogues revealed a long list of manufacturers of lathes for the amateur user, some of which I have listed. Of these, of course, the names Drummond and later, Myford became synonymous with model engineering.

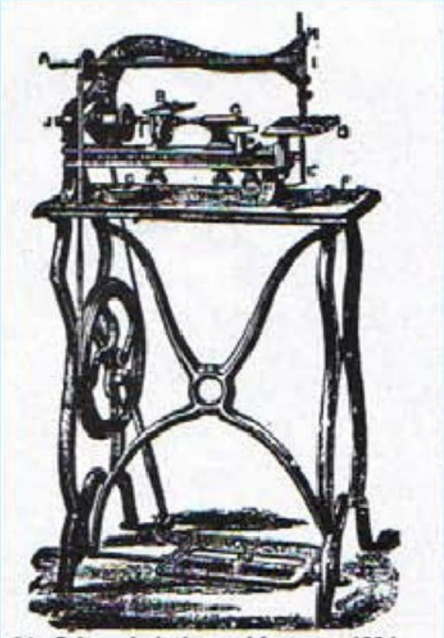
WWII caused another hiccup and many makers did not resume manufacture afterwards, whilst some new names including Boxford, Unimat, Chester, Warco and Cowell appeared.

A custom-built lathe

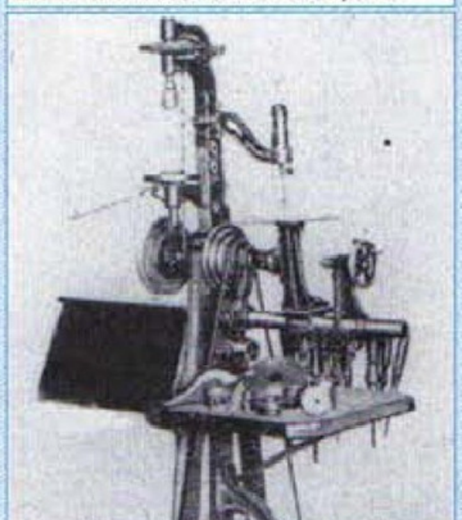
During the war period, instrument making lathes were in short supply and the company where I was working at the time decided to make their own. Some were plain lathes, but one batch consisted of 5in. centre, back-geared chasing lathes, one of which I now own and is shown in **Fig. 40**. They are fitted with heavy Timken taper roller bearings and bored through to take large draw collet chucks. The drive arrangement was a somewhat heavier copy of the countershaft fitted to the American 5in. Atlas lathes, giving a choice of 16 speeds with back gear. **Fig. 41** shows the slide that carries the chaser which is lowered onto the guide on the front of the bed during cutting, being lifted up by a sloping ramp at the end of the thread. The chasing slide is pulled along by a follower which engages the 'hob' or


19. Home-built lathe, 1905

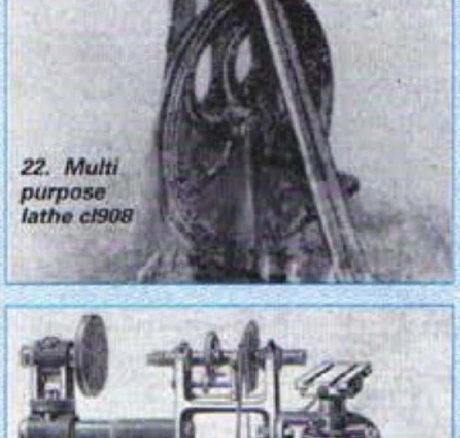

20. Lathe with drilling machine attachment, 1894



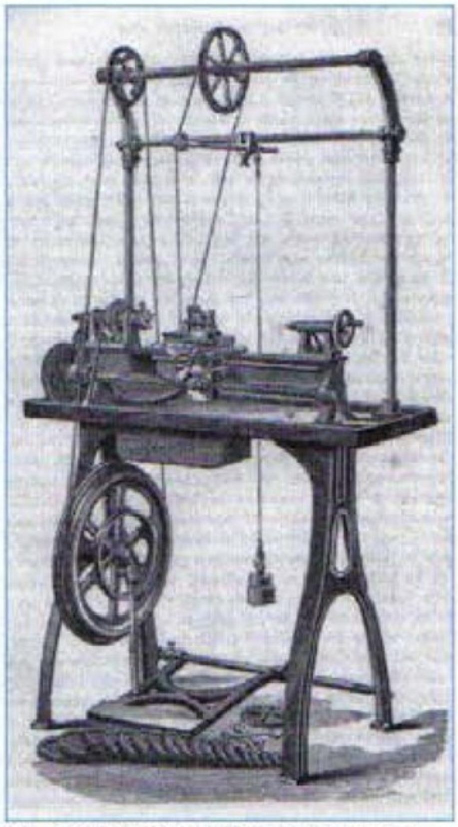
21. Britannia lathe and fretsaw, 1894



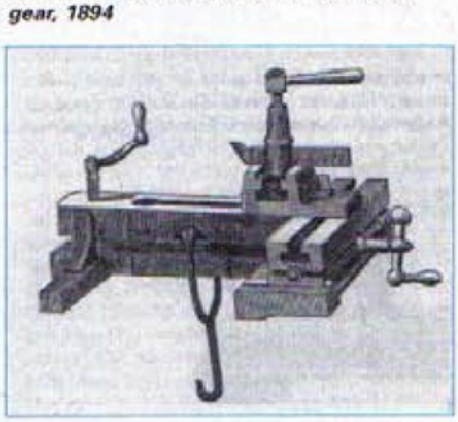
22. Multi purpose lathe c1908



23. A 'Universal' machine. London Lathe & Tool Co. Engineer, 1888



24. Screw-cutting lathe with overhead gear, 1894



25. Cross-slide with tool height adjustment, 1890

threaded sleeve on the back end of the machine, driven from the mandrel via a tumbler reversing gear train, **Fig. 42**. The follower is fixed to the rod upon which the chasing slide is clamped, so that when this is lowered, the follower comes into

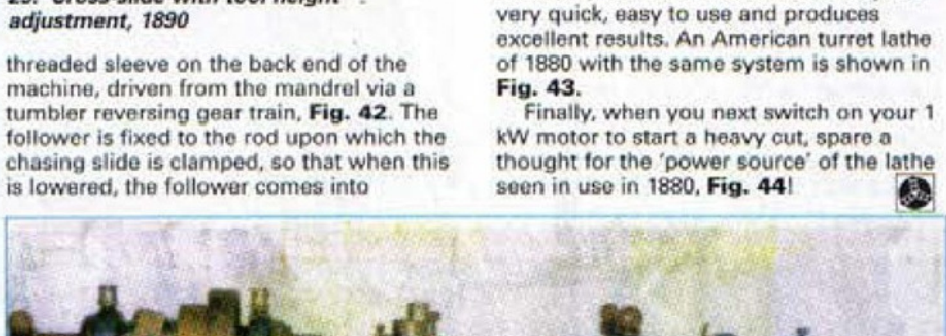
26. Unusual screw-cutting lathe, unknown make

27. Showing the two pairs of slideways of the lathe seen in Fig. 26

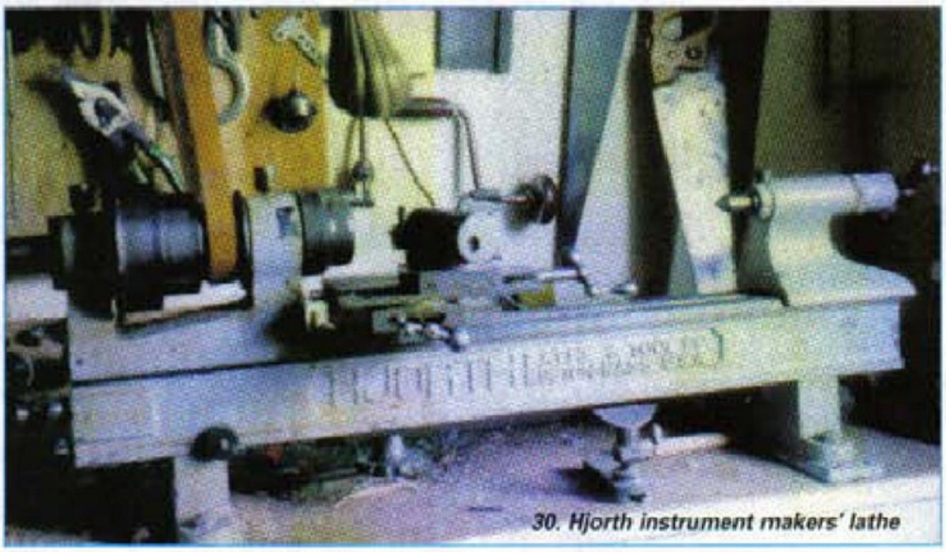
28. Showing the two leadscrews of the same lathe

engagement with the hob. Obviously there are limitations; for example, only threads for which hobs and followers are available can be cut and the maximum length that can be screw cut is limited to about 4in.. However, for instrument threads they are very quick, easy to use and produces excellent results. An American turret lathe of 1880 with the same system is shown in **Fig. 43.**

Finally, when you next switch on your 1 kW motor to start a heavy cut, spare a thought for the 'power source' of the lathe seen in use in 1880, **Fig. 44**!



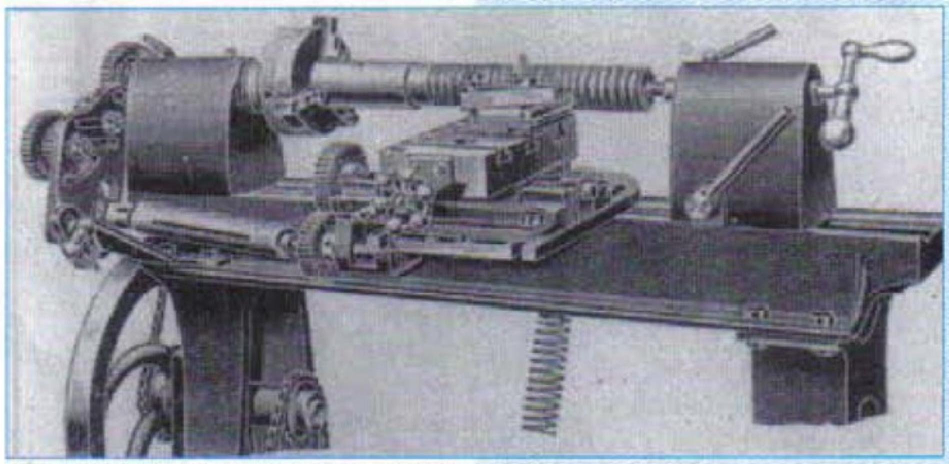
29. Lorch instrument makers' lathe



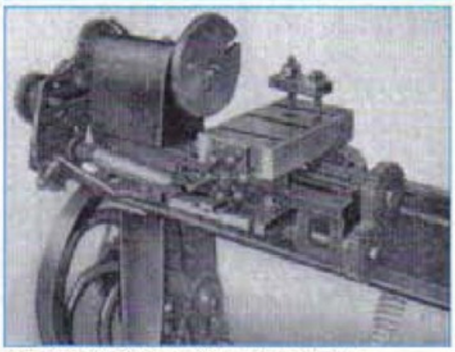
30. Hjorth instrument makers' lathe

31. Watch makers' combination cabinet

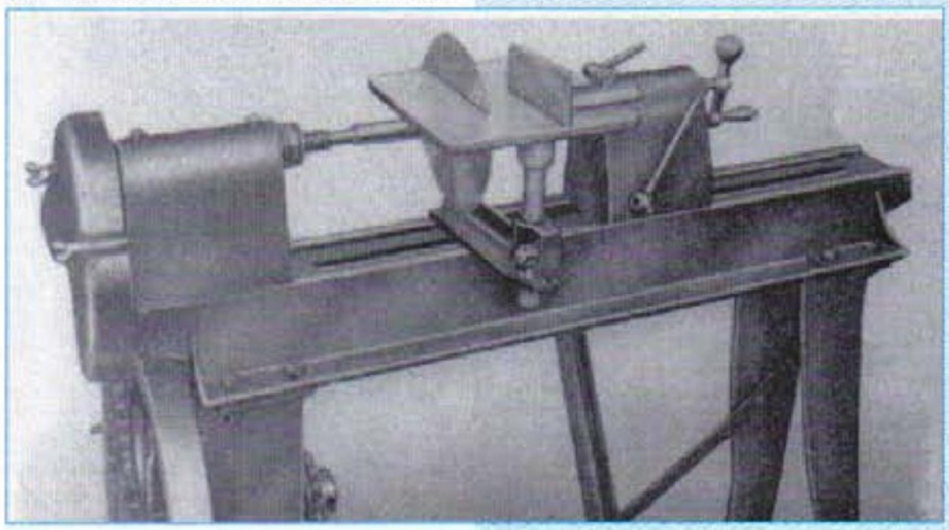
32. The Hobbies Free Wheel lathe, 1922



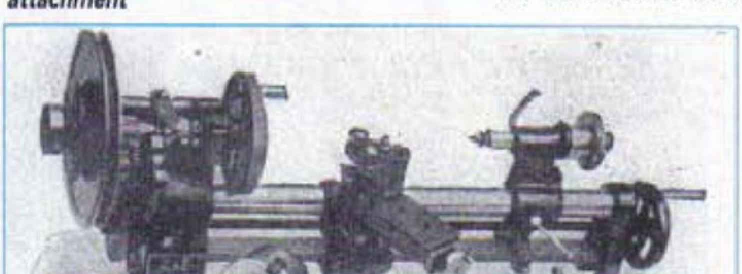
34. The Hobbies screw-cutting attachment



33. The Hobbies slide rest traverse attachment



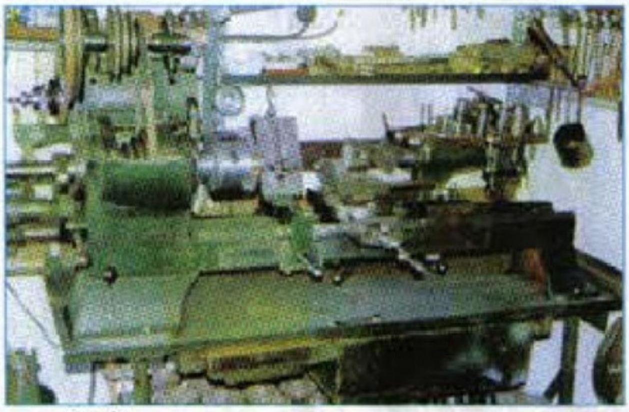
35. The Hobbies circular saw attachment



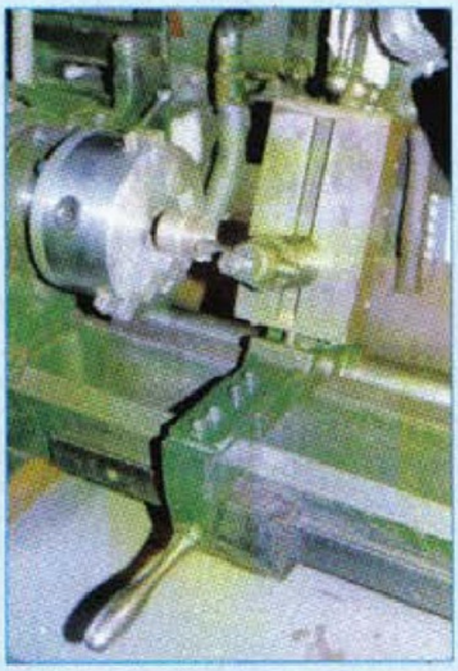
36. The EXE $2^1/_2$in. lathe with round bed, 1936

38. The Adept basic plain lathe

39. The Randa simple screw-cutting lathe



40. An instrument makers' chasing lathe, 1943



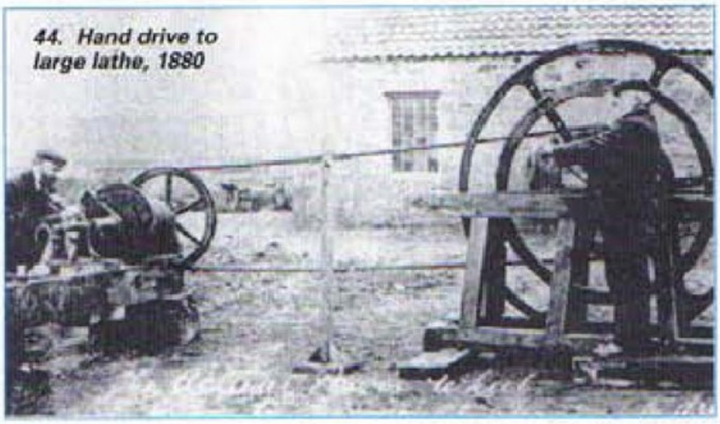
41. The chaser and slide of the machine seen in Fig. 40

42. The 'hob' and follower of the lathe shown in Fig. 40

Some makers of small lathes

George Adams
Aird & Co's 'Wade'
Portass
Buck & Ryan
W H Astbury
Atlas
Bonds
J Christopher
W H Clarke
Dignus Engineering
Drummond
Duck & Hutton
Eta Tool Co.
Gamages
Goodwin
E Gray & Sons 'Grayson'
S Harris
Heeley Motor Co.
W E Hughes
Hughes Fawcett & Co.
Humpage
Irwin & Jones
I.X.L.
F Leabrooks Engineering
Leyland & Barlow
F Marshall & Co.
R Melhuish
Milnes
Myford
Nicholl's
Mitchell & Co.
F Patrick
Pittler
Portass
South Bend
Stanhope Engineering
Star
Thompson & Hardy
T Thwaite & Co.
Tyzack's 'Zyto'
Union Tool Co.
Velox Tool Co.
J Willimot's 'Ideal'

43. American chasing turret lathe, 1880



44. Hand drive to large lathe, 1880

A SIMPLE DIVIDING HEAD FOR THE HOBBYMAT MD65

Peter Bowes of Victoria, Australia made good use of a wet weekend and ended up with a useful attachment for his Hobbymat lathe

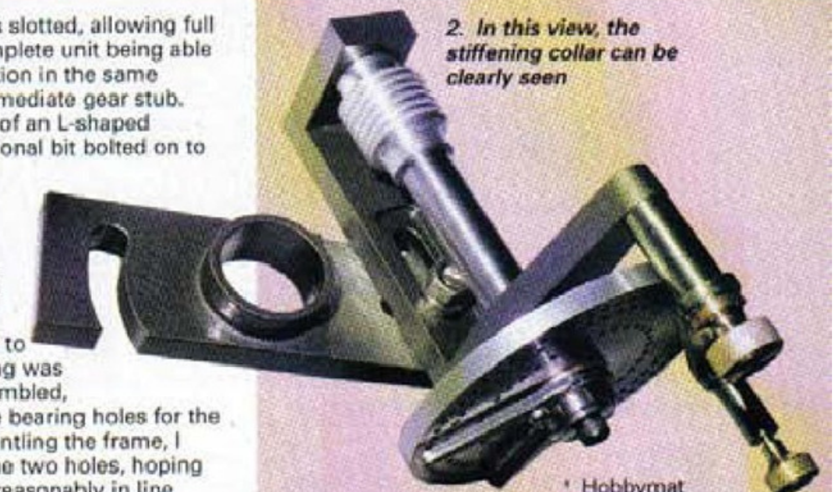
I'm sure you all know the story - making the tool, to make the tool, to make the tool...

The need for this attachment really made its presence felt when trying to engrave 360 degree marks on a disc, part of the tool and cutter grinder that I have been constructing in my spare time. I have, I might say, been gaining much guidance and inspiration from Derek Brooks' excellent article in M.E.W. Issues 16 & 17.

As in most of these things, the design is greatly influenced by materials at hand and ease of construction. The unit consists of a simple fabricated frame supporting a spindle with a worm on one end and a division plate at the other. The unit is attached to the Hobbymat **(Photo. 1)** by means of a bracket which is copied from the intermediate gear carrier, with the exception that the top section is bevelled at approximately 2.5 deg. to allow the worm to mesh with a standard Hobbymat change wheel. The slot and track for the locking bolt was machined square with the 2.5 degree angle. I added the collar around the bore which that pivots on the leadscrew bearing (seen in **Photo. 2**) in order to stiffen the bracket because the material to hand was a bit on the thin side. Whether or not this was absolutely necessary I am not sure.

The frame described next houses the worm spindle and is slotted, allowing full adjustment, the complete unit being able to be locked in position in the same manner as the intermediate gear stub. This frame consists of an L-shaped piece, with an additional bit bolted on to complete the U-shape. The 'L' was brazed, but could be silver-soldered, welded or the whole assembly joined by bolts.

1. The unit bolts to the rear of the Hobbymat headstock, pivoting around the leadscrew bearing



2. In this view, the stiffening collar can be clearly seen

I took great pains to make sure everything was a square when assembled, then marked out the bearing holes for the spindle. After dismantling the frame, I proceeded to drill the two holes, hoping that they would be reasonably in line when the frame was reassembled. After all, the spindle is not required to revolve at a million miles an hour.

The disc for the division plate was turned by drilling a hole in a piece of aluminium and mounting it on a bolt held in the chuck. Drilling the division holes was accomplished with the sixty tooth wheel on the lathe spindle, a very simple and temporary indent, and an electric pistol drill secured to the carriage. This was quite a fiddly exercise, making sure that all was secure to eliminate all possibility of movement. Of course, the old cord around the chuck and weight trick was used to take up backlash.

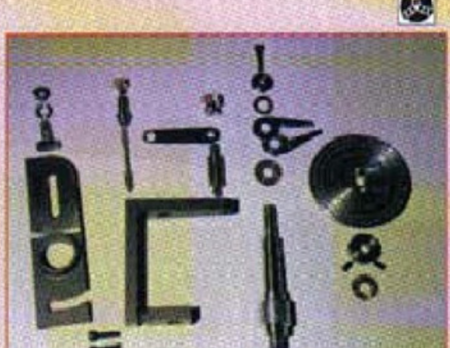
Measurements were taken from the completed frame to confirm the spindle dimensions. Jobs like this are what shim washers were invented for, so if things are not perfect, it is better to aim for a bit of endplay which can be adjusted out.

The worm was turned to 8 tpi and bored to be a light press fit on the spindle, with the provision for locking with a couple of grub screws. However, the fit turned out to be "very press" and when fitted it was obvious that the grub screws would not be necessary. Being of aluminium, I was reluctant to separate it, for fear of damage, so that's why **Photo. 3** shows the worm already mounted on the spindle.

I have incorporated two spring washers in the construction, these being made of hard phosphor bronze sheet about 0.3mm thick, cut out with a jeweller's piercing saw and bent to provide the spring.

All the turning can be done on the Hobbymat and the milling was done on my Taiwanese mill-drill using a $\frac{3}{8}$in. slot drill. The division fingers entailed a nice little exercise in hand filing, although they are not absolutely necessary. The holes for a particular division could be counted out and marked with a marker pen to achieve the same end.

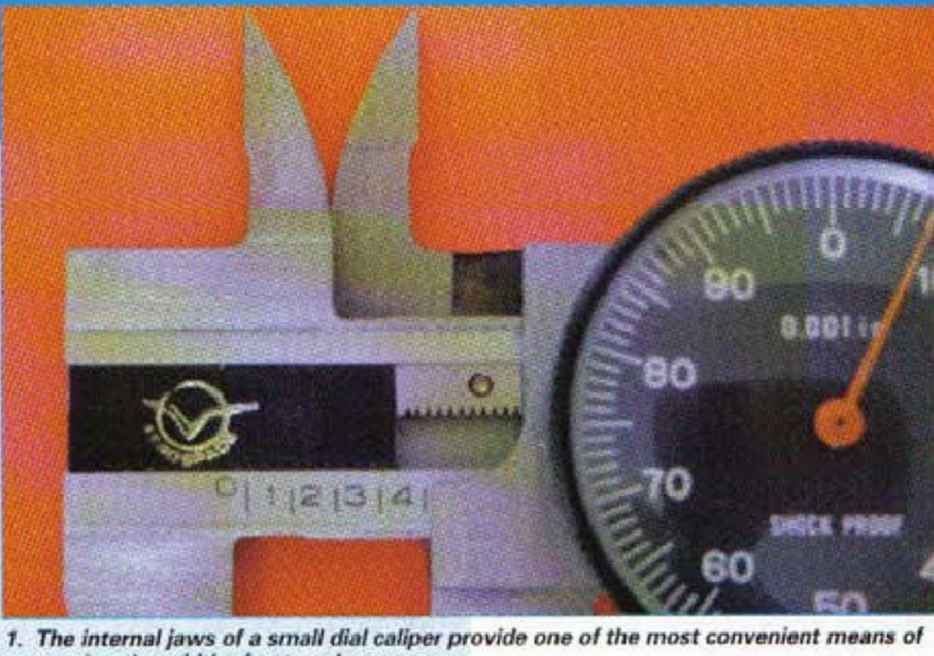
While I realise that a lot of dividing can be done using the standard change wheels, the 360 divisions proved a bit tricky, requiring two 20 tooth wheels and a lot of jiggling in the rather restricted space available on the Hobbymat. So, why not construct this simple unit that can be bolted straight on whenever the need arises, without any modifications to the lathe, and what better way to spend a long wet weekend?



3. The complete complement of components. The mounting bracket (extreme left) has the section above the stiffening collar machined at 2.5 degrees to allow for the helix angle of the worm

MEASURING GROOVES

Grooves, both internal and external are among the features created when turning. Philip Amos suggests some methods of determining their size



1. The internal jaws of a small dial caliper provide one of the most convenient means of measuring the width of external grooves

Because of the physical size of common measuring instruments, it is often difficult to accurately measure grooves and so indirect procedures must be used. Some of these are described below.

External Grooves

These are readily accessible, so do not usually present too much of a problem in the measurement of either width or depth

(a) Width

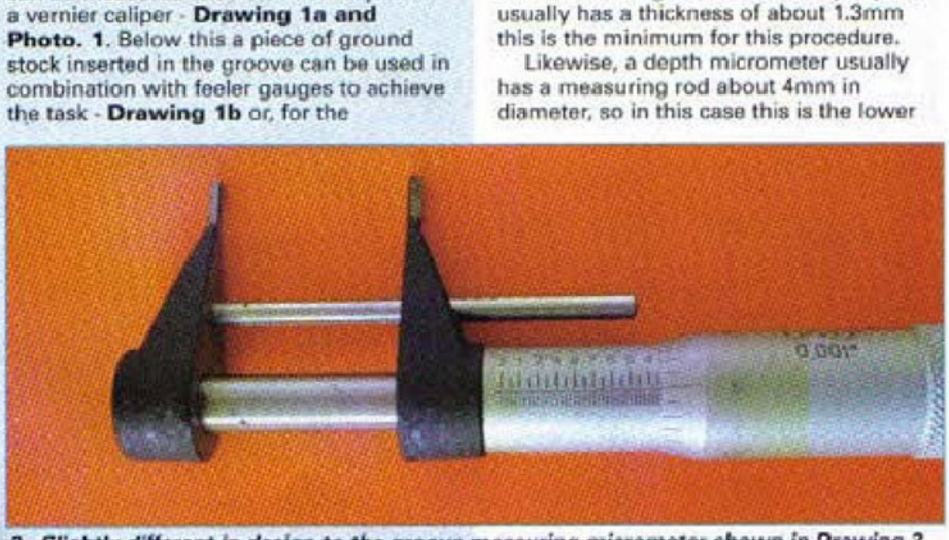
The width of a groove down to about 2mm can be measured with the internal jaws of a vernier caliper - **Drawing 1a and Photo. 1**. Below this a piece of ground stock inserted in the groove can be used in combination with feeler gauges to achieve the task - **Drawing 1b** or, for the narrowest grooves, the use of feeler gauges alone.

Some firms manufacture micrometers especially designed for this purpose - **Drawing 2** - which cover a range of 1.27 to 26.27mm. These are rarely found in commercial toolrooms and probably never in the home workshop. A similar instrument, capable of measuring the range 1.2in. to 2.2in. is shown in **Photo. 2**.

(b) Depth

The depth of the groove can be measured with the depth facility on a vernier caliper - **Drawing 3a and Photo. 3**- provided it will fit into the groove. As the depth piece usually has a thickness of about 1.3mm this is the minimum for this procedure.

Likewise, a depth micrometer usually has a measuring rod about 4mm in diameter, so in this case this is the lower limit **(Drawing 3b and Photo. 4)**. Where a narrower groove is encountered, the depth may be ascertained by inserting a very narrow piece of metal of known height 'x' into the groove and measuring the amount by which it protrudes ('y' on **Drawing 3c**) - so that the difference (x-y = z) represents the groove depth.



2. Slightly different in design to the groove measuring micrometer shown in Drawing 2, this instrument has a range of 1.2in. to 2.2in. It can also be used to measure the bore of holes or the inside diameter of tubes

Internal grooves

These are rather inaccessible and present more of a problem.

(a) Width

A groove micrometer can be used if available (which is unlikely). However a measuring hook can be made, as depicted in **Drawing 4a and Photo. 5**. Each such hook will have suitable dimensions for the particular job in hand, and are recorded after manufacture. If this hook is passed into the hole it can be engaged with each side of the groove in turn and its protrusion from the end of the hole measured in each case. The groove can then be calculated from these measurements.

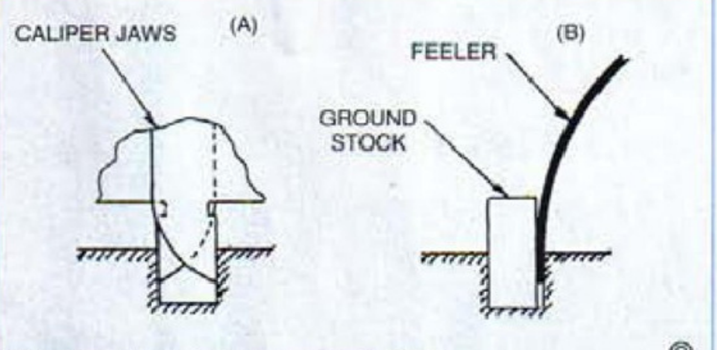
(b) Depth

Any device to contact the bottom of the groove must be small enough to pass down the bore for insertion and retraction. Unless the measurement can be taken while the device is in place this presents quite a problem. It may be possible to arrange some form of extension arm for a dial indicator. However, a simpler approach is to make a transfer caliper, as shown in **Drawing 4b and Photo. 5**.

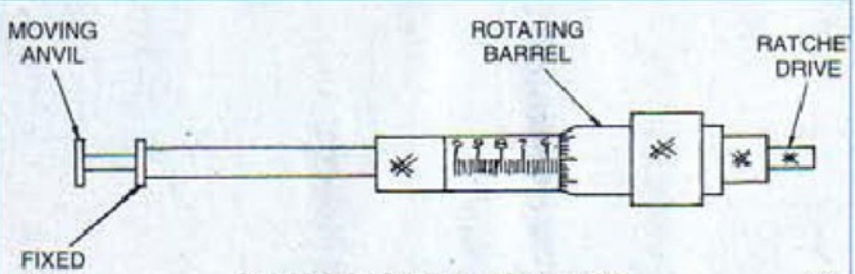
This device comprises two thin steel blades with points on opposite ends of each blade on opposite sides. There is a central pivot point which can be clamped. The procedure for use is outlined on the drawing. The item shown will fit down a hole 5mm in diameter and can expand to a usable size of about 20 or 25mm diameter. It is important that the pivot has no play or wobble. Mine uses a 1/16in. diameter silver steel pin in a reamed hole. The end of the pivot pin has a brass knurled head Loctited on (680) to one end, and a 1/16in. BSW brass knurled nut on the other for clamping.

Other shapes

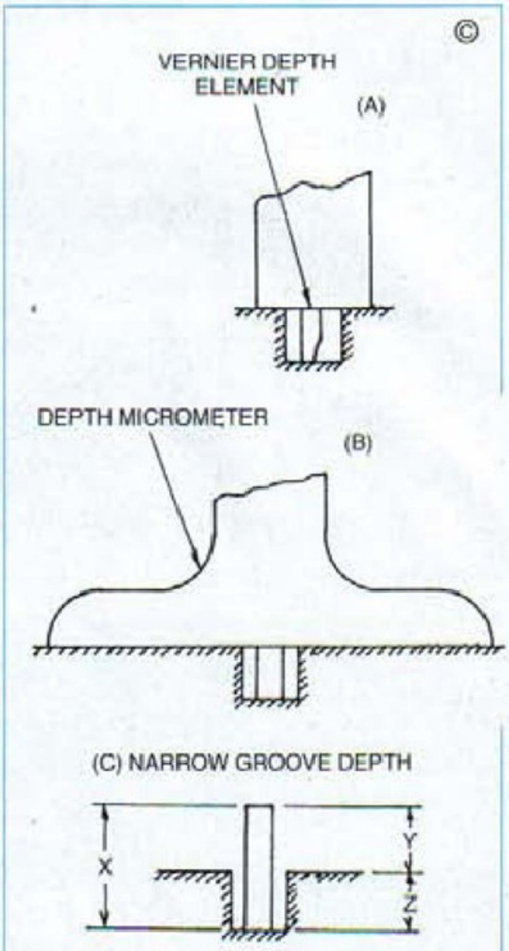
Although most grooves encountered have a rectangular cross-section other shapes may be found, a few examples being



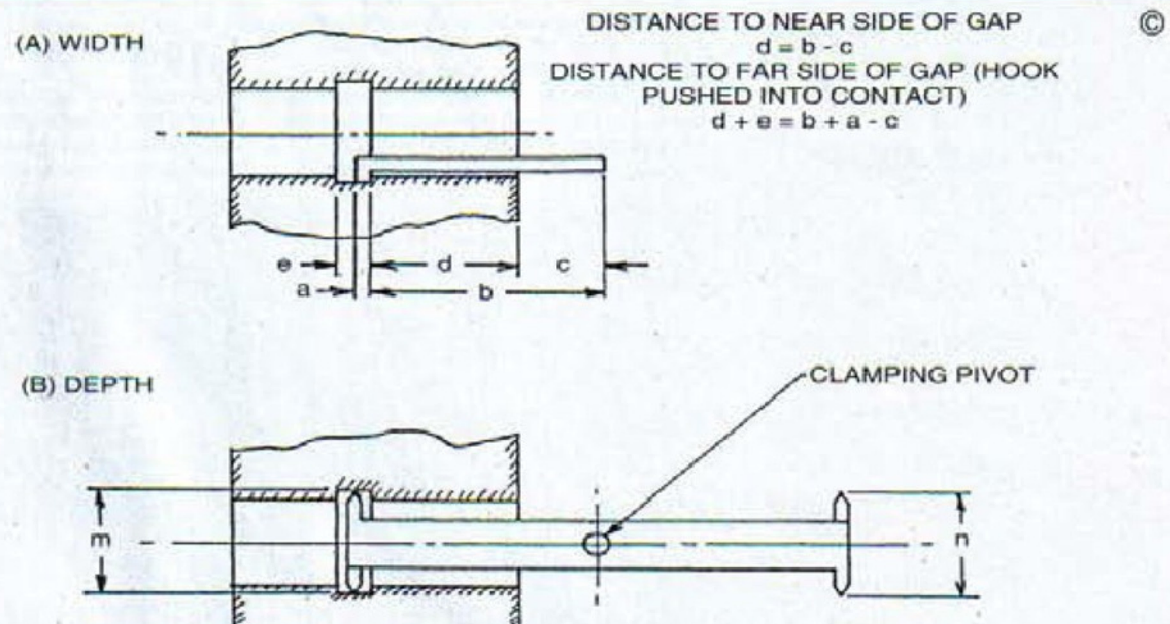
Drawing 1 External groove widths



Drawing 2 Groove micrometer

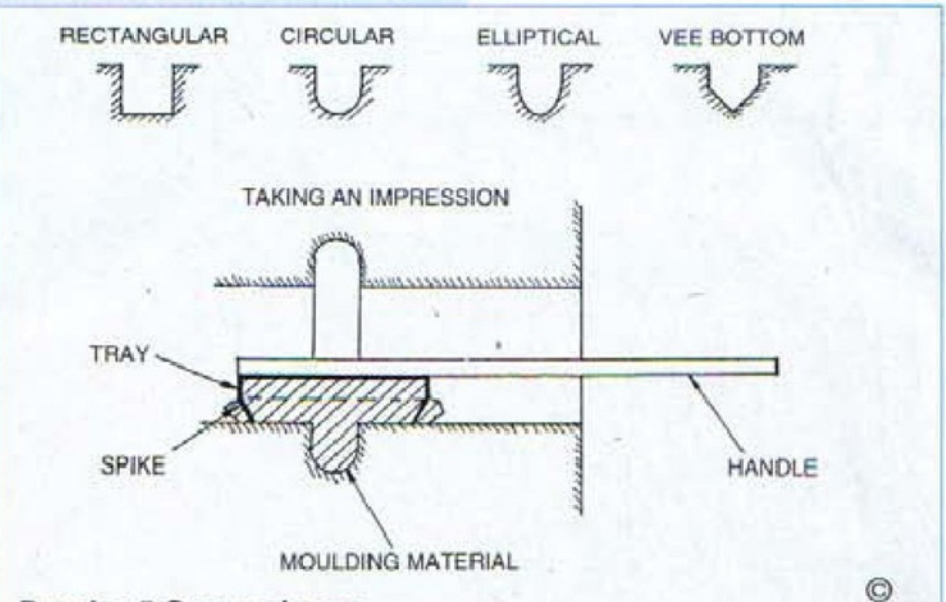


Drawing 3 External groove depths



SEQUENCE: UNCLAMP PIVOT, PUSH LEFT POINTS TOGETHER & ENTER INTO HOLE, EXPAND UNTIL IN CONTACT WITH BOTTOM OF GROOVE. CLAMP PIVOT, MEASURE n, UNCLAMP PIVOT. CONTRACT LEFT POINTS, WITHDRAW, SET RIGHT POINTS TO LENGTH n, CLAMP PIVOT, MEASURE m.

Drawing 4 Gap measurement (internal)



Drawing 5 Groove shapes

4. A depth micrometer

shown in **Drawing 5**. If these are external grooves it may be possible to measure their size and shape by methods similar to those outlined above, or by optical projection in some cases. However, internal grooves are a challenge. Since about 1900, military artificers have used gutta percha to take impressions of the bores of guns to check possible defects in the rifling. Whilst satisfactory for inspection purposes this material is probably not sufficiently rigid for accurate measurement. Thus recourse may be made to materials used in dental practice to take impressions of teeth. These include gutta percha, various types of wax and also two-part silicone rubbers of various hardnesses. The latter may be the most appropriate for our purposes. Suggested procedure is to make a small tray of width about $^1/_8$ the circumference of the hole, this tray being attached to one end of a rod for operation and having some spikes to assist retention of the moulding material. These spikes can also act as limiters when pressing the material into the groove. The tray should be coated with proprietary adhesive to hold on to the moulding material, and the workpiece coated with a film of release agent. The moulding material is mixed and applied to the tray, which is then inserted in the hole and pressed against the wall so that the moulding material engages the groove and adopts its shape. After curing (about 10 minutes) the tray is withdrawn radially and then axially. At this stage it should have an accurate impression of the groove which can then be measured.

It is unlikely that this rather elaborate procedure will be required very often, but it may be useful in particular cases.

Conclusion

Grooves, either external or internal can be measured accurately with equipment usually found in the home workshop or easily made therein.

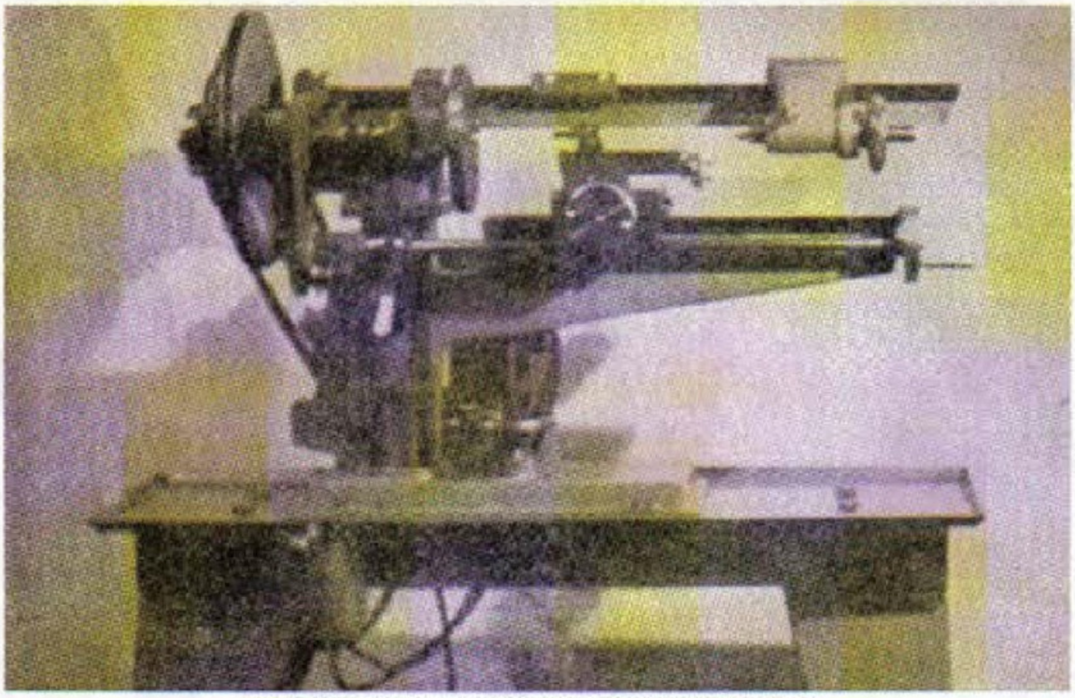
3. The depth measuring facility on the end of the dial caliper shown in Photo. 1. The constraints imposed by the size of the blade are obvious

5. Centre - transfer caliper and to the right, a measuring hook

A Free-Lance Lathe

By W. D. Urwick

(Reprinted from *'Model Engineer'* Vol.104 No.2597 March 1 1951)



The machine in its normal condition for general lathe work

MANY years ago, to my great regret, I was obliged to part with a $4^1/_4$in. Super-Relm lathe, on leaving home for an engineering career, and it was only recently that I felt its replacement to be a practical possibility. Meanwhile, experience has convinced me that the small lathe has become standardised in design and that the requirements of the amateur's workshop are not necessarily met by a large lathe in miniature.

Some months were spent considering all the information that could be collected on small lathe design, particularly those most interesting articles to be found in the early volumes of THE MODEL ENGINEER. The lathe in the home workshop is an overworked tool and its basic shortcoming, in point of versatility, is lack of vertical movement. The vertical slide and all the weird and ingenious milling attachments that one sees are all designed to contend with this weakness. I decided I would be rash enough to try and build a machine having a cantilevered bed carried on a vertical slide of some sort, so that, if successful, it would at least have a wider application than the traditional machine, and, in fact, be as much a milling machine as a lathe.

Having reached this decision, the final design was conditioned by the following arguments:-

(a) A rise and fall bed demanded some separate means of support for the tailstock.

(b) For this purpose, an auxiliary fixed bed of T-section seemed to present the simplest machining operations and fewest problems in lining-up on assembly.

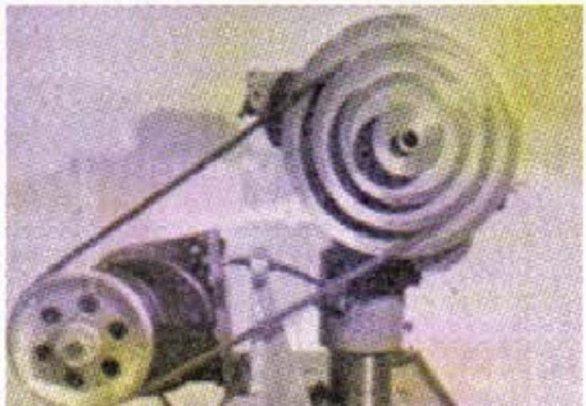
(c) The only practical position for this T-bed would be to the rear and slightly above the centre-line of the lathe. Here it would not foul the cross-slide with the bed fully raised nor would it cast too much shadow on the workpiece

(d) Suitable brackets to carry the T-section bed would have to be behind the headstock, and would, therefore, rule out normal back gear and belt drive.

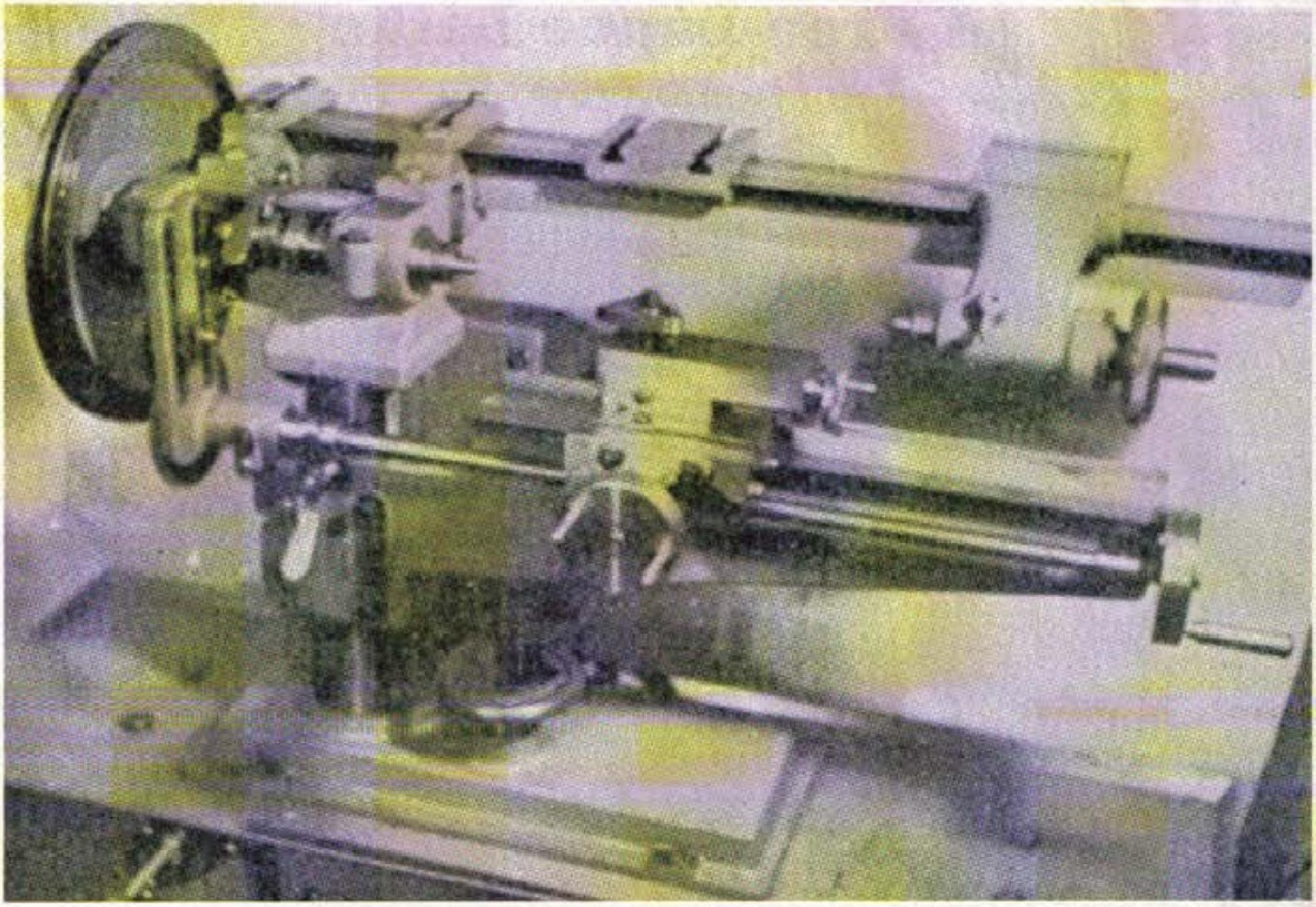
(e) At this point the design of the $3^1/_2$in. Exe lathe provided the answer, and as I had access to an example in the possession of my friend Mr. F. H. Harmsworth, of Maidenhead, many of this excellent little machine's good points were frankly and enthusiastically adopted. The large out-board pulley and the dog-clutch on the mandrel between the headstock bearings for engaging the changewheels, were obviously the right thing.

The ease with which one can change belts and the satisfaction of being unable to pick up the wrong thread in screwcutting make it surprising that this arrangement does not seem to have been widely used.

It was decided that a ground steel column $3^1/_2$in. diameter x 12in. high



End view, showing the driving arrangement from the $^1/_3$ h.p. Higgs geared motor which is used

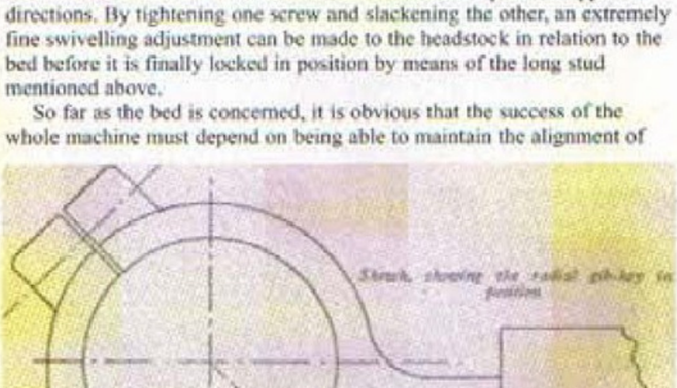


Close-up of the lathe proper, to show details

should form the backbone of the machine, as this seemed the simplest way of ensuring that the top surface of the rising and falling bed was kept parallel with the centre-line of the mandrel in the vertical plane. This steel column was faced truly and bored right through to take a long $^5/_8$in. diameter stud, which was screwed into the underside of the headstock, the latter being also recessed some $^3/_8$in. to fit over the top of the column. The stud passes down through the column and baseplate, also recessed, and a nut tightened by box-spanner from beneath the machine draws the three parts together. The column is prevented rotating in its recess in the baseplate by an Allen grub-screw and provision for some slight swivelling of the headstock for alignment purposes is obtained in the following manner.

The base of the headstock carries two $^3/_8$in. B.S.F. Allen screws, each with a 60 deg. point entering corresponding recesses in the column. These recesses are drilled $^1/_{16}$in. out of true in the horizontal plane in opposite directions. By tightening one screw and slackening the other, an extremely fine swivelling adjustment can be made to the headstock in relation to the bed before it is finally locked in position by means of the long stud mentioned above.

So far as the bed is concerned, it is obvious that the success of the whole machine must depend on being able to maintain the alignment of



Sketch, showing the radial gib-key in position

this part as it is raised and lowered, and to be able to lock it strictly parallel to the centre-line at any desired height. This has been achieved with considerable success by means of the radial Gib-key shown in the sketch reproduced herewith (Provisional Pat. No. 29873/50). As the locking screws are tightened at any required setting of the bed the two radial faces of the key-ways in bed and column are forced into alignment by the triangular key. In tests with an indicator at the extreme end of the bed variations of the order of 0.002in. to 0.003in. were found to be caused by unequal tightening of the two locking screws, and it might be better practice to employ one only at the mid point of the key. Otherwise the device seems to be accurate and to give the desired rigidity.

The tailstock has its alignment in the vertical plane assured, since the tops of the two brackets are ground after assembly to the headstock casting and the top face of the T-bed is forced upwards by two screws against the straps bearing on these ground surfaces. Horizontally, the T-section bed can be adjusted by means of small Allen screws bearing obliquely on the V sides of the two brackets.

These various adjustments present very little difficulty and with the aid of a "Unique" indicator in the toolpost and test bar between centres, the settings can be checked over in a matter of minutes. In any case, this little bit of extra trouble is far more than compensated by the great increase in scope of action with the machine, which is provided by the movement in the third direction.

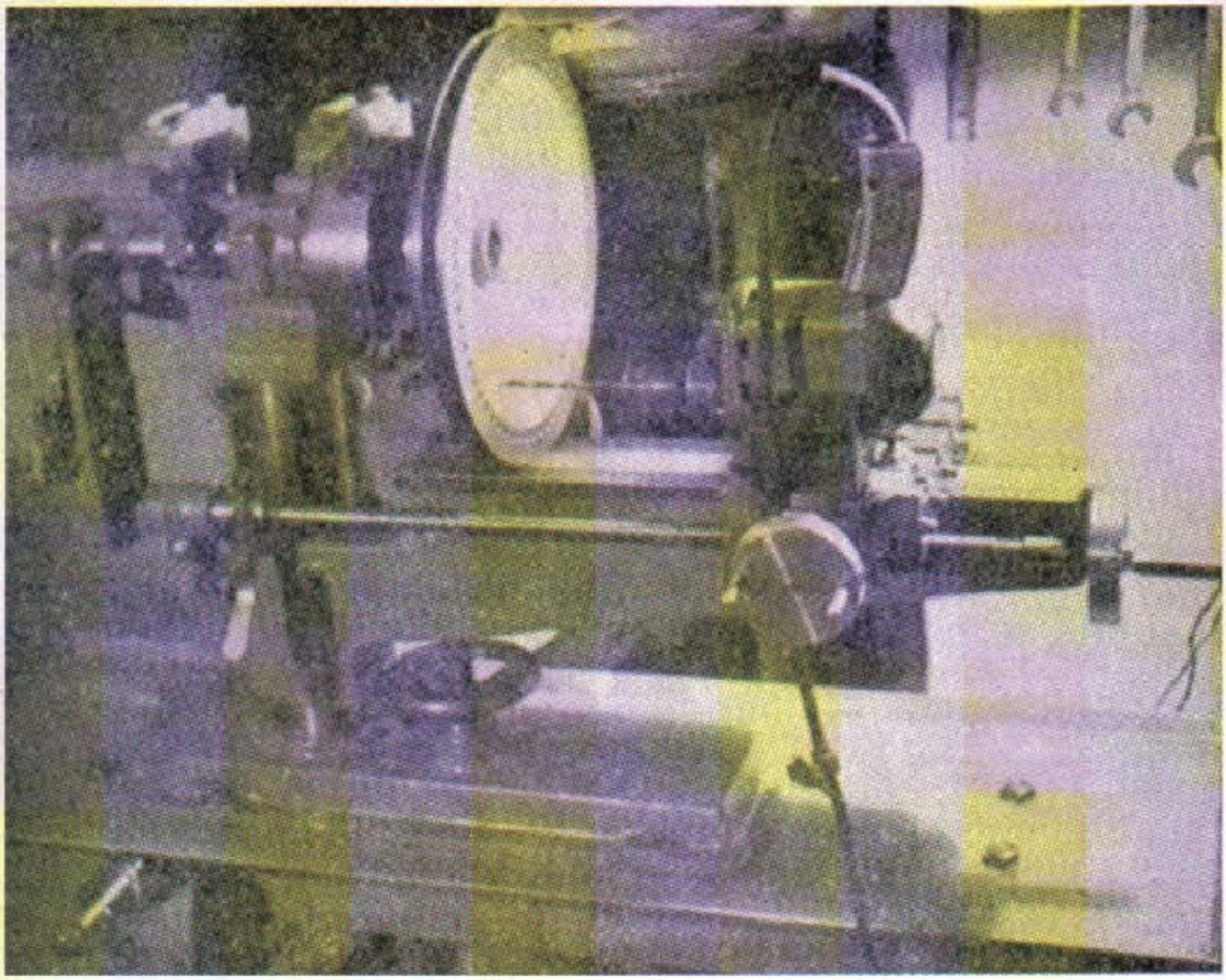
The following differences from orthodox lathe practice can at once be appreciated:

(a) No packing is needed in the toolpost, and any size of tool can be used.

(b) The tailstock can pass right over the saddle.

(c) The machine can be used like a normal milling machine.

(d) By temporarily removing the T-section bed, an awkward job of considerable size can be tackled either in the chuck or on the faceplate. In fact, when the top-slide had been suitably built up to centre height, the boss in the lower corner of the banjo plate was turned, bored and recessed without difficulty. This meant a 14in diameter swing over the bed. One of the photographs shows a similar set-up used for marking off and drilling the 60 holes provided in the rim of the driving pulley, which in conjunction with a link-piece, make the pulley into a useful dividing head as on the Exe lathe.



The machine set-up with the bed lowered to the full extent, and T-section bed removed

The tailstock casting was bored without difficulty on the machine itself. It was first drilled and roughed out by mounting it upside down on the cross-slide table and a final cut was taken by adjusting it to slide stiffly along its own bed and then advancing it, by pushing it along with the saddle, towards a heavy boring bar rotating in the three-jaw chuck. Finishing to size was done with an expanding reamer.

The banjo plate and changewheels rise and fall with the main bed, and the former is long enough to allow the wheels to mesh with the driving pinion on the mandrel over the vertical range and to provide auto-feed to the saddle.

It would be quite possible to turn a long piece of work to a considerable taper by removing the Gib-key and slewing the whole bed to the required angle, since the part of the bed casting surrounding the column is split and provided with a locking bolt. Normally, this bolt is adjusted to make the bed a nice sliding fit on the column.

All patterns were home made and I was fortunate in having my own foundry available for the production of the castings. Essential grinding and milling operations were carried out by local firms, but much other work was done in spare time on machines, the use of which could be had from friends, and once the lathe spindle was running with a mock-up drive, the remaining parts were finished on the lathe itself.

Until this point I have not mentioned the major criticism of the design of this lathe, and that is the obvious and inevitable spring which must exist between the two cantilevered beds. It is indeed possible, by exerting some pressure, to force the ends of the two beds apart by 0.005in. or more. For all chuck and faceplate work and for turning between centres up to, say, 4in. length, this spring is unimportant. For long turning, however, between centres an adjustable tie-rod, not shown in the photograph, has been provided to lock the ends of the two beds at any setting. After careful adjustment of the tailstock centre, a trial piece of $^3/_4$in. diameter mild-steel was turned to a high finish for a length of 10in. and showed an error in diameter over this length of 0.001in. only.

A small T-slotted table slides on the T-section bed, and it is intended that this should carry a small vertical drill which could be brought to bear on work mounted on the cross-slide. If the Editor can spare the space, it is hoped to give a further report on this accessory in use a little later on.

Although not long completed, and it has taken just twelve months to build, the lathe has, up to the present, proved, if anything, more satisfactory than I had anticipated and has stood up well to everything it has been asked to do.

The following general specification may be of interest; it will be appreciated that a number of features have been adopted from the $3^1/_2$in. Exe lathe already mentioned.

1. Vertical centre height over bed variable between 2in. and 7in.
2. Distance between centres, 16in.
3. No back gear, no countershaft, no rack traverse.
4. Eight speeds, 55 r.p.m. to 800 r.p.m., by belt change only.
5. Micrometers on cross-slide and leadscrew 3in. and $3^1/_2$in. diameter respectively.
6. $^3/_4$in. clearance hole through hollow mandrel.
7. No. 3 Morse taper to headstock with reducing sleeve to No. 1 Morse. Tailstock barrel No. 1 Morse.
8. Dog clutch on mandrel for screwcutting.
9. Dog clutch on leadscrew for self-act.
10. Change wheels 18 d.p. Number of teeth all divisible by three in place of usual five. One 38-tooth wheel converts for a large range of metric threads.
11. Cross-slide table 8 in. x $4^1/_2$in.
12. Face of main driving pulley provided with 60 holes which can be used as a dividing head.

METALMASTER
A Zero Taper Machine Tool

By David Urwick

(Reprinted from *'Model Engineer'* Vol. 149 No. 3684 2 July 1982)

DURING THE EARLY 1950's I designed and built for my personal use an unorthodox machine tool and this was described in an article in *Model Engineer (No.* 3480 4-17 January 1974) under the title "A Revolutionary Lathe". I have recently returned to this country after eleven years in Malta, during which time I built numerous model experimental Stirling engines that have been described too in these pages. All of them and many other things besides have been made exclusively on this machine and a $^3/_8$ in. bench drill. There has been a recent revival of interest in my machine with its wide capabilities over and above those of the ordinary lathe and I feel that some of the details from my previous article could bear repetition and would be of greater interest accompanied by general arrangement drawings of the complete machine, which I did not have at that time. With hindsight it seems likely that descriptive matter and photographs alone made the machine appear to be more complicated than it actually is (Figs. 1, 2 & 3). In the plan view, Fig. 2, the cover of the headstock casting has been removed to show the mandrel with its sliding dog clutch and pinion for initiating the gear train.

During my career as an engineer I have had no association with the machine tool business and so, when it came to designing my machine, I was perhaps in a better position to take a good look at the traditional lathe with an open mind and especially from the user's point of view. It seemed to me that the normal small lathe fell far short of what the amateur really needed in his workshop. He was, after all, trying to simulate full scale practice in a room or shed a few square feet in area and he wanted something more comprehensive than a lathe, designed, as it is, primarily for turning between centres. Vertical slides and tortuous expedients like blocking up the head and tailstock are not very good practice and even mounting work for boring on the faceplate always struck me as a tedious exercise. So the novelty of my machine was going to be that the entire bed and saddle would be given a vertical feed, so that work on the cross slide could be moved in three directions, something like a horizontal boring machine in miniature. The problem with this concept is how to maintain the various elements in a sufficiently accurate alignment.

At this point, early one morning my unconscious coughed up the triangular gib key idea that I described in *Model Engineer, 15* August 1980 and the machine started to take form in my mind. I had no hesitation in adopting whatever I fancied to be useful features in small lathes of the past and present, whilst designing my machine round this basic idea of a radially precise keyway device, Fig. 4.

The fundamental principle in which my design differs, I think, from all others, is that, when looked down on from above, the headstock, tailstock and the bed can all be rotated, within limits, about a central column. It is only when all these three lie exactly on the same radius from the centre of the column that a bar, turned between centres, will be parallel. This condition of ZERO-TAPER is ensured by adjustment under control of the operator. The main bed, cantilevered out from the column, can be raised and lowered by a screwjack, and is maintained in its movement on this vital radius by the triangular gib key with a degree of precision, I think, not otherwise obtainable. The headstock and the tailstock can then each be lined up with the bed by means of fine setting adjustment screws, Figs. 5 & 6. The truth of everything in the vertical plane is taken care of in the design of the machine, but the operator must familiarise himself with the by no means difficult task of adjusting the alignment of the mandrel and the tailstock in the horizontal plane, to this zero-taper condition.

A ground test bar and a Dial Test Indicator (d.t.i.) are therefore essential accessories to this machine. If the d.t.i. is kept mounted on a universal arm, see Fig. 7, carried on a slide fitted to the auxiliary bed, it is always available to check and test work in the machine, whether round or flat. In fact, the top surface of the tee auxiliary bed becomes a kind of fixed datum in space, to which everything else is referred. This is an unlooked for bonus and is of the greatest value.

Without in any way disturbing the setting of the head and tailstock, the triangular key can be removed altogether from the machine and this allows the bed to be swung round the column to any desired angle of taper. For such things as Morse tapers, where the angle is small, the self-act can still be used for the full traverse of the saddle, with the workpiece, if required,

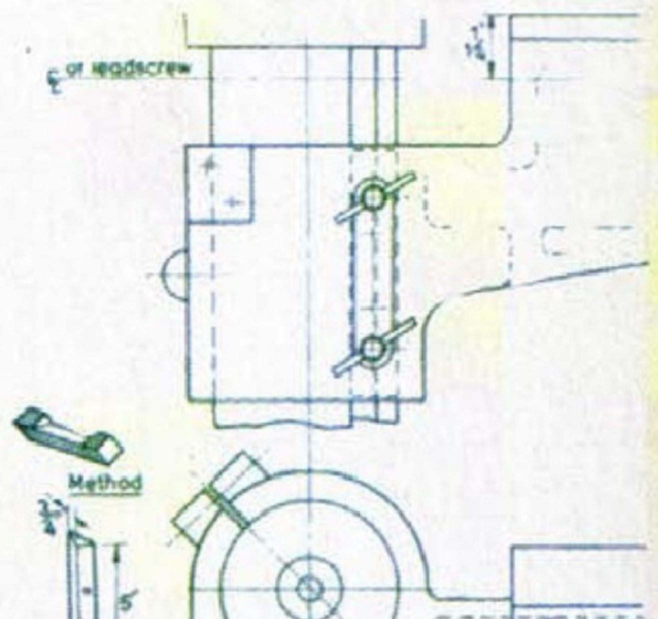


Fig 4
© ARRANGEMENT OF TRIANGULAR GIB KEY

between centres. The replacement of the key restores the original alignment for parallel turning. A normal lathe is machined by the manufacturer so that the mandrel centre-line and the tailstock are in alignment, to close limits, with the bed, and the user must rely on the precision with which this has been done. On the Metalmaster, the truth of alignment for parallel turning is in the hands of the operator. Once set up, the accuracy will be maintained indefinitely, but the adjustment is there, if the machine has been dismantled or there is some particularly important job in hand, when it is reassuring to be able to check things before starting.

Undoubtedly, I was much in debt for some good and unusual design ideas to that beautiful little Exe $3^1/_2$in. lathe of the 1930s. I have an original sales leaflet for this machine, quoting a price of £21 for the bench model, complete with 13 steel changewheels and two fitted chucks. Machining limits in its manufacture were quoted to the order of 0.0005in. in a 12in. length. A friend of mine at the time possessed one of these lathes, to which he was absolutely devoted, and so I was able to examine it in detail and to include a number of its special features in my own design. I was particularly attracted by the use of a large (11in. dia.) pulley flywheel mounted on the outboard end of the mandrel.

This four-stepped pulley dispensed with the use of backgear for slow speeds and therefore left the back of my headstock clear for the two brackets to carry my auxiliary tee bed. I was seeking the simplest possible drive for my machine and decided to make use of a Higgs $^1/_2$ h.p. geared motor. This motor has a final shaft speed of about 300 r.p.m. and so two pulleys, one large and one small, enabled me to have eight mandrel speeds, using a single throw-off vee belt. This motor is bolted to a hinged plate and bracket fixed at the back of the machine, belt tension being taken care of by means of a length of $^3/_8$in. BSF screwed rod, bent to a suitable radius, attached to the plate and passing through a slot in the bracket. A large diameter knurled nut on the screwed rod is sufficiently slack to ignore the curvature and this rather primitive arrangement has served me faithfully since the day it was set up.

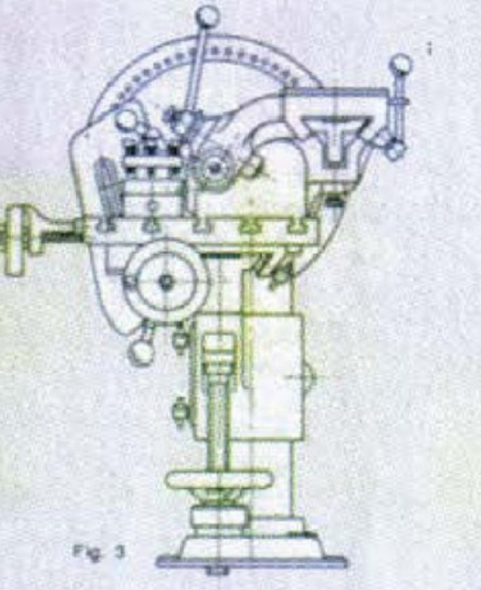


Fig. 3

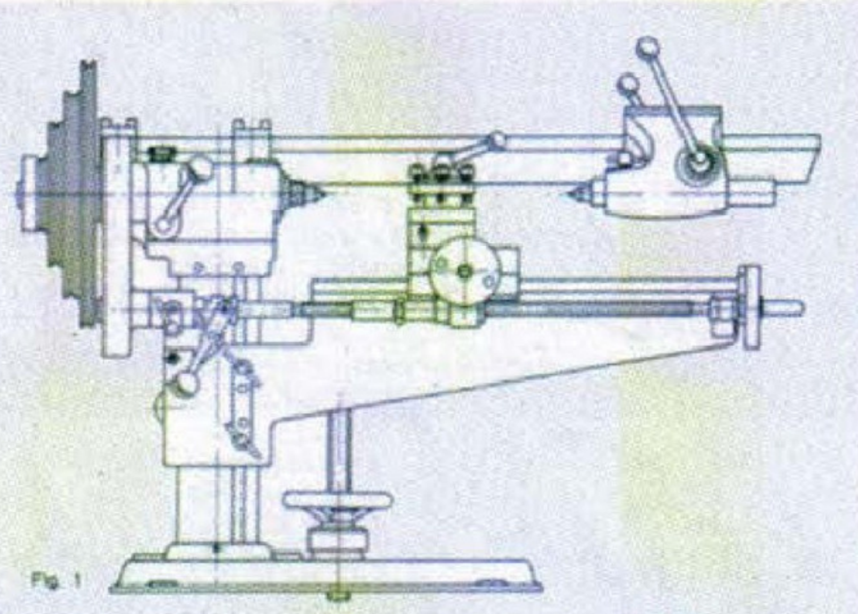


Fig. 1

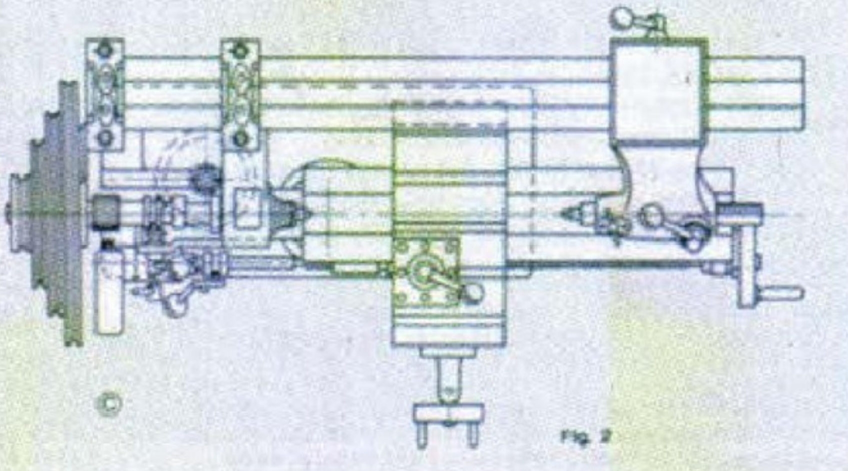


Fig. 2

The pulley flywheel which weighs about 12 lb., serves a number of valuable purposes:

(a) The rim carries 60 equally spaced holes to be used as a dividing head,with a device for subdivision into 360 degrees.
(b) It is silent and takes the place of backgear.
(c) The momentum stored in it greatly helps to eliminate chatter, particularly when parting off and when making intermittent cuts with a flycutter.
(d) It is very convenient when using taps and dies in the tailstock, the weight giving a sensitive control as the thread is cut by hand, especially when running up to a shoulder. The rackfeed to the tailstock and its ability to pass right over the saddle also help with this kind of work.
(e) It can be used freely as a brake to stop rotation after switching off the motor and generally as a handwheel when turning chucks etc. mounted on the mandrel.

The use of a large pulley flywheel of this description is clearly a subject for interesting debate but, in my personal experience, with this small sized machine, it has proved to be an unqualified blessing. It is possible that exception might be taken to the use of a free unguarded belt in these safety-conscious days. A guard would largely defeat the use of the pulley as a convenient handwheel and maybe the best answer would be to have a suitable motor with thyristor variable speed control, when the pulley could be suitably modified to allow for a belt guard whilst retaining its other benefits.

Another excellent idea that I adopted from the Exe lathe was the unusual screwcutting arrangement. It may not be familiar. A sleeve, permanently fitted on the mandrel, carries a 24 tooth gearwheel, which initiates the change-wheel train, and also a single-dog clutch, by which it takes its drive from the mandrel. In screwcutting, this clutch is used to engage the change-wheel train, with the satisfying result that it is impossible to pick up the wrong thread. The change-wheels can spin quite easily as the saddle is traversed back to the start of the thread.

With one exception, the numbers of teeth on the change-wheels are all multiples of the number 3, instead of the usual 5. These, together with the 24 tooth wheel on the mandrel and an 8 t.p.i. leadscrew, provide a comprehensive range of threads with simple trains. The formula could hardly be simpler:

$$\frac{\text{No. of driven teeth}}{\text{No. of driving teeth}} = 3 \times \text{t.p.i.}$$

Numerous metric threads can be cut, to a tolerable degree of accuracy, by the introduction of a 38 tooth wheel. It will be appreciated that this wheel fitted to the leadscrew, with two suitable idlers, gives a 2mm pitch (to an error of only 0.0026in. per inch). Other metric threads can be readily calculated as multiples up and down from this basis. The 38 tooth wheel also enables 19 t.p.i. (i.e. 1/4in. and 3/8in. gas (BSP) thread) to be cut with a simple train.

There is only one critical dimension to be taken care of in building this machine and this is the vertical distance down from the top surface of the auxiliary tee bed to the centres of the headstock and tailstock. As the tops of the brackets at the back of the headstock are ground true with the axis of the mandrel, this should not present much difficulty and limits of the order of ±0.0000 in. should be used if possible. The prototype tailstock was bored in the machine itself. The two straps holding the tee bed seat on the ground tops of the brackets and the ground top face of the tee bed is forced upwards against the straps by the two vertical locking screws. This ensures alignment with the axis of the headstock in the vertical plane but allows adjustment horizontally by means of the socket grubscrews. Although my machine has been dismantled and reassembled many times, a d.t.i. mounted on the cross slide and traversed along the top surface of the auxiliary tee bed shows no appreciable movement over its full length.

The auxiliary bed links the head and tailstock and by so doing limits to 8in. dia. the size of work that can be accepted between centres. It is not often that one would want to turn work above this size but there may well be occasions when one needs to bore work larger than 8 in. overall. The auxiliary bed, complete with the tailstock, can be easily removed and the main bed lowered to accept a maximum swing of 14in. This dimension depends only on the length of the column. Quite frequently some large object requires an operation well within the capacity of the machine and it is a most satisfying feeling to be able to do the job without recourse to outside help. At the same time great discretion must be exercised in not overloading the machine, which is able to accept workpieces much larger than those usually associated with one of this size. We all have to learn by experience just what any machine is capable of tolerating in its various operations. On my workshop wall hangs this quotation from Chaucer:

"The lyf so short,
The craft so long to lerne,
The assay so hard,
So sharp the conquering."

The best practice for general turning work with this machine is to make use of the great rigidity of a four-way toolpost fixed direct on the cross slide slotted table and it is only rarely that the topslide will be needed, for short tapers or feeding a screwcutting tool in at the thread angle, if this method is adopted. As the tailstock is mounted on its own bed, the main bed is shorter

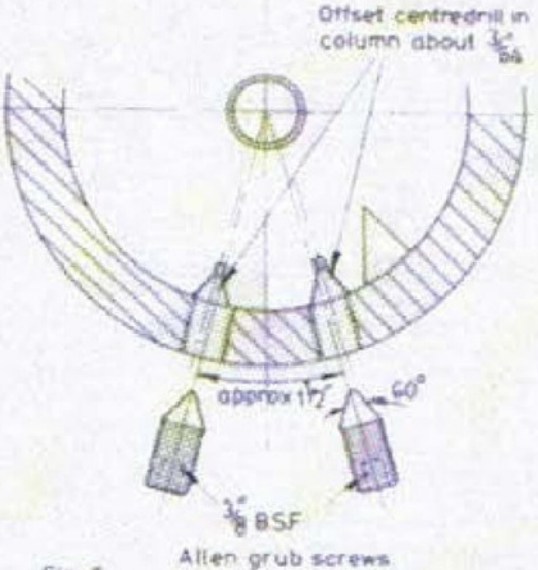


Fig. 5
ARRANGEMENT OF ADJUSTING SCREWS FOR HEADSTOCK ALIGNMENT

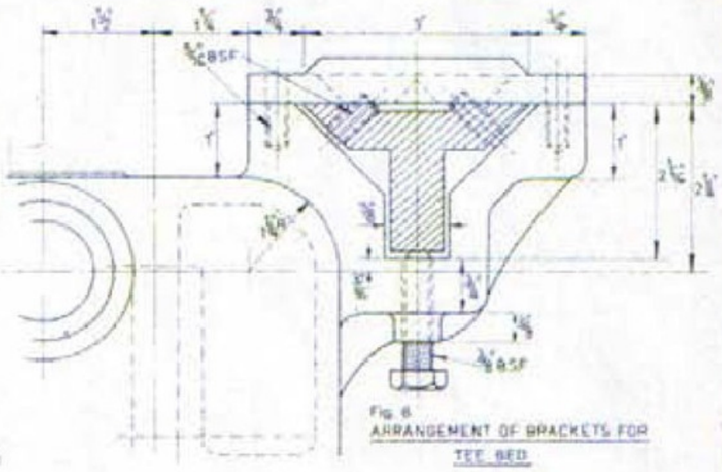


Fig. 6
ARRANGEMENT OF BRACKETS FOR TEE BED

than usual and, the large feedscrew handwheels being graduated on their full diameters of 3in. and 3½in., they can be read easily whilst one is standing upright in front of the machine. It is, of course, unnecessary to pack tools to centre height and all four tools in the turret can be at different heights with no inconvenience. A parting tool can often be raised or lowered whilst actually making a cut, in order to determine the best position. Tools generally can be set by reference to the tailstock centre or by adjustment to face off the pip on the end of a bar.

An obvious criticism of the machine design is that there may be a lack of rigidity between the two cantilevered beds leading to chatter, when long slender work is turned between centres. This worried me a lot before I built the machine and nearly discouraged me altogether. The simple answer is to realise that it is only the actual elasticity in the metal with which one has to contend and that a light tie rod between the two outer ends of the beds is all that is required. I have long since lost the tie rod that I originally fitted, so seldom was it used, and when such work is unavoidable now I fit a plate clamped across the flats of the main bed and connect this plate to the barrel of the tailstock by means of a pair of dog leg links. This outfit was made from material in the scrapbox and with it in position the machine is as rigid as anyone could wish. The dog leg links allow some movement of the main bed for toolsetting before clamping everything up tight.

The boring head, described in *Model Engineer* No. 3676 5-18 March 1982, is really a "must" with the machine and to go with it, a good deep machine vice, Fig. 8, is desirable. I find that these two, together with end mills, slitting saws and facing tools, are quite as much in use as the toolpost and turning tools.

It is quite possible that some details of the Metalmaster could be improved upon in the light of present day design ideas. At the same time, before starting to build my machine, I considered it very carefully from all aspects, simplicity, versatility, portability and cost. Most of the original patterns I made myself but, alas, they have not survived. I can say that I have felt no desire to change anything. I built a dividing head on the machine and I would like to add a rotary table and perhaps a light drilling and milling head which could be mounted on the auxiliary bed, but these are extras and involve no change.

The basic zero-taper principle seems to meet successfully the special needs of the model engineer and perhaps those of small scale light industry. The machine is portable, in that it can be taken down easily into handleable pieces, put in the back of an estate car and reassembled in about an hour, in a new place, ready for work.

At least, I have had many years of enjoyment from this original tool and am pleased that some of its more interesting features should be placed on record.

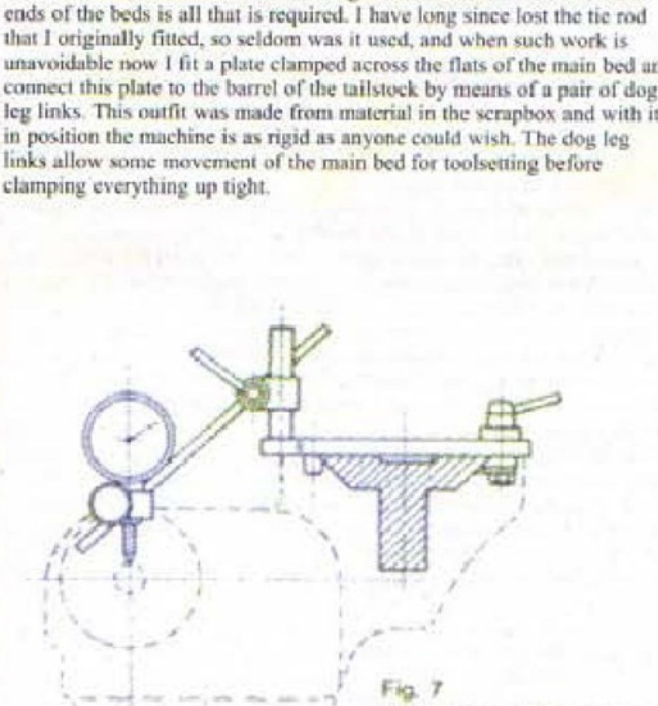


Fig. 7
DIAL TEST INDICATOR ATTACHMENT FOR AUXILIARY BED

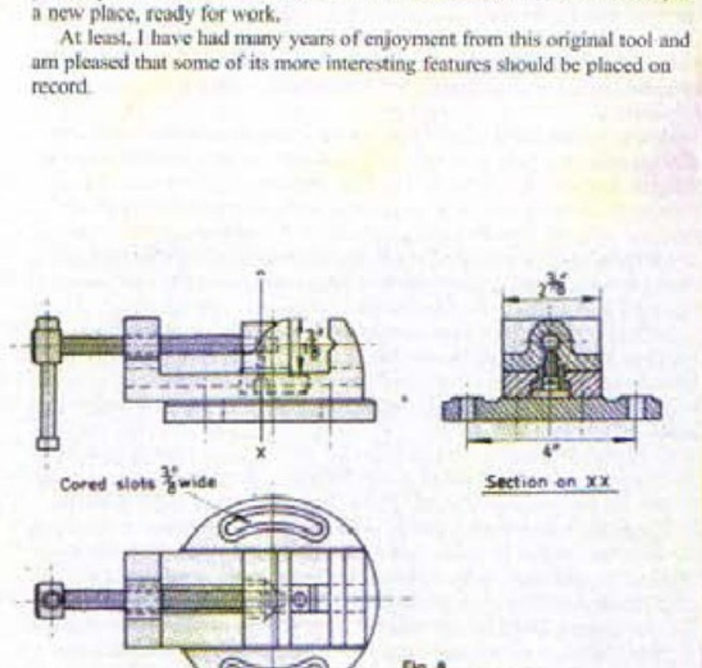
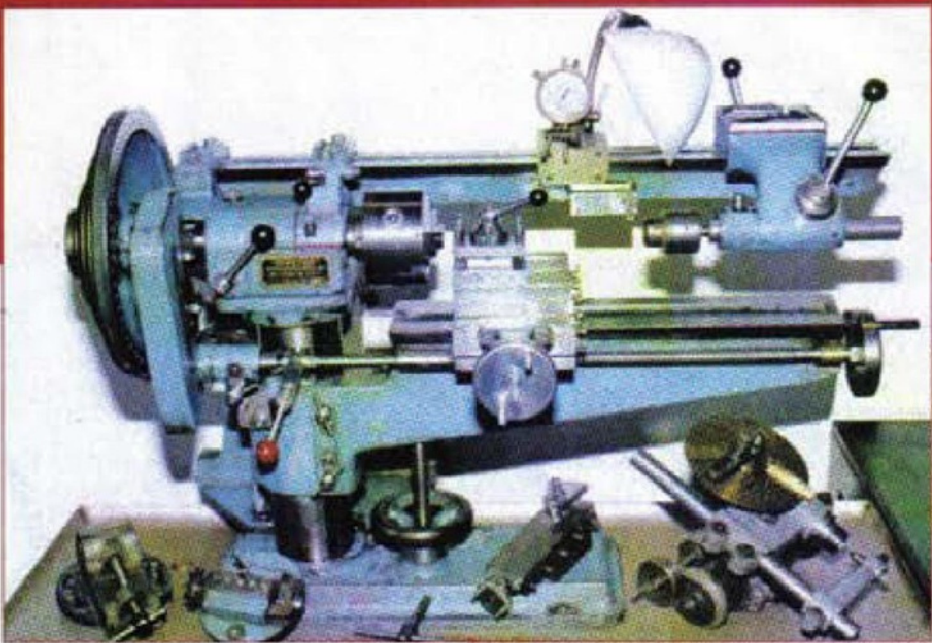


Fig. 8
MACHINE VICE

THE 'METALMASTER' UP TO DATE

Mick Collins relates the later history of this intriguing machine, further details of which can be found on his website at www.sylvestris@btinternet.com



David Urwick's lathe was introduced to model engineers as the 'Impetus' in the early nineteen fifties but for some reason, probably the combination of cost, conservatism and the shortage of disposable income in those post-war years, the machine never sold and only about a dozen were ever made. The photograph shows machine No 5, the example David kept for his own, model engineering, purposes.

At some stage, David became interested in model Stirling engines and it was as a result of an article that he wrote on his moving regenerator type in *'Model Engineer'* that I first wrote to him.

A long correspondence and friendship followed, and when David returned to England from his retirement home in Malta I was able to visit him at his new home in Somerset. Naturally we gravitated to his newly built workshop, where I saw not only his collection of Stirling engines but also his Metalmaster, a machine that had fascinated me ever since reading about it in the *'Model Engineer'* back in the fifties.

Unfortunately it wasn't working as, during the journey back from Malta, the cross-slide feed-screw nut had been lost. However, within a couple of days I had made and posted a replacement to him and the next time I visited I was able to play with the machine.

Sadly, a few years later, poor David became a victim of Parkinson's Disease and, anxious that his machine should go to an appreciative owner, he offered it to me. A fair price was agreed and I became its proud owner.

Seen here with the machine are some of the accessories including the boring head mentioned in the *'Model Engineer'* article, the topslide, the vice designed to fit the cross-slide and a matching dividing head. The saddle fitted on the auxiliary bed is my own addition and can be slid along by hand before locking in position. It was originally made to hold a fixed steady but, in addition, proves very useful for holding the lamp, the D.T.I. and the home-made tool height setter, a device similar to the old 'Unique' indicator, which can be swung out from under the saddle to sit on the tool tip.

There is little I can add to David's articles re the versatility of the machine. It is certainly all that he claimed for it and can be converted to any of its functions within a couple of minutes. Its accuracy was all that he claimed for it although now, after nearly fifty years of 'amateur' use, slightly impaired by wear at the headstock end of the bed. In retrospect, David thought that, since the tailstock was no obstacle, the saddle could have been made rather longer with some advantage. I can't really comment on the machine's rigidity since I normally use it for building small model Stirling engines and handle it like cut glass - nevertheless recent jobs have included, skimming the brake drums of my wife's Morris Minor and re-machining the base of an Indian cylinder barrel, requiring the full 14in. swing to accommodate the finning around the valve seats. Sumitomo tips are very satisfactory for all these straightforward turning and boring jobs.

David's geared motor drive was becoming very noisy and has been replaced with a Sinclair C5 motor with infinitely variable speed control since when parting off $1^1/_4$in. steel has become a real pleasure - albeit a slow one!

Finally, I must agree with his remarks regarding the usefulness of the vertical feed - handling a conventional lathe now feels like working with one hand tied behind my back, and the sheer versatility of the machine has given me a new hobby - that of finding new jobs for it to do. Mitring picture frames took longer than expected though, due to the need for spotless cleanliness.

A revival of interest

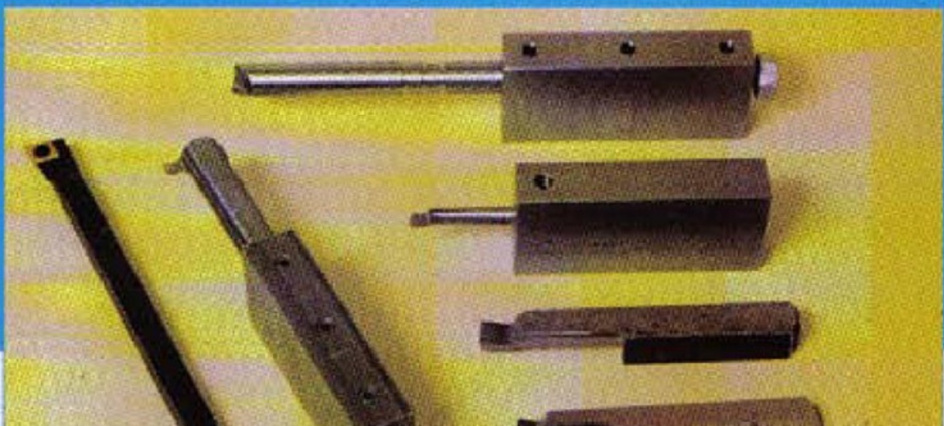
DuWayne Schmidlkofer of Riverdale, near Atlanta, Georgia has sent news of a group of about 50 people who have shown an interest in making new versions of the Metalmaster. They communicate by means of an Internet news group at http://groups.yahoo.com/group/Urwick_MetalMaster and several people have indicated that they are starting pattern making. This has been made possible because David Urwick's widow has made the original drawings available and these can be obtained as Shareware. One of the group has a set of the original castings, so efforts are being made to obtain photographs. Mick Collins has also provided a copy of David Urwick's original notes on construction.

DuWayne has started design work on a smaller version (about the size of a Taig) as he feels that at this size it could be a more practical project for most home workshop owners. He is also considering scheming out dedicated accessories for gear cutting, vertical milling and grinding.

Duwayne can be contacted at duwayne@netzero.com.

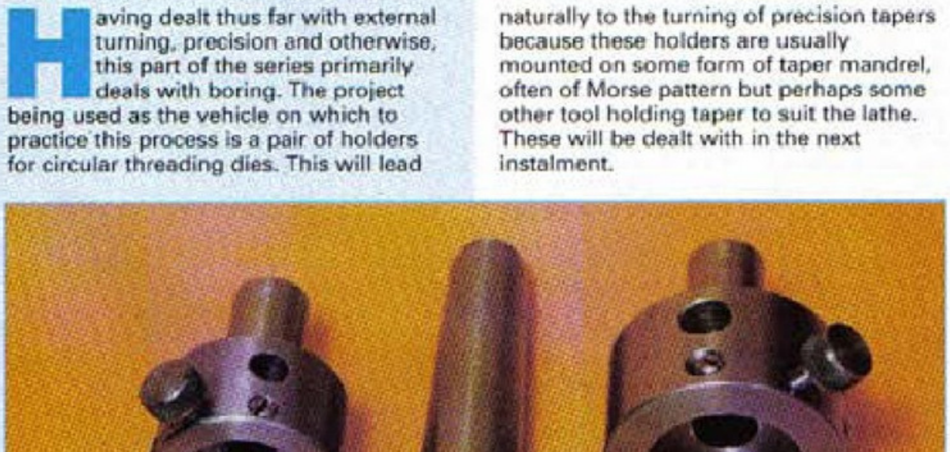
LATHE PROJECTS FOR BEGINNERS (8) Boring

Creating bores to precise diameter, length and finish requires a systematic approach and practice. Harold Hall describes some useful items of tooling which will allow the novice to gain useful experience while making them



1. Even for basic boring, tool requirements vary depending on diameter, depth and material. This results in far more tools being required than for simple external turning

Having dealt thus far with external turning, precision and otherwise, this part of the series primarily deals with boring. The project being used as the vehicle on which to practice this process is a pair of holders for circular threading dies. This will lead naturally to the turning of precision tapers because these holders are usually mounted on some form of taper mandrel, often of Morse pattern but perhaps some other tool holding taper to suit the lathe. These will be dealt with in the next instalment.



2. 1in. and 13/16in. die holders for use in the lathe tailstock

Boring - the problems

The task of boring is more fraught with problems than most other turning operations, not least because it is difficult to see what is happening. The main problem though is the shape of the tool, this because the internal curvature of the bored hole reduces the clearance between tool and workpiece while in the case of external turning, the curvature adds clearance to that of the tool being used. The result is that boring tools are critical to the size of the hole, something which is particularly a problem with smaller diameters.

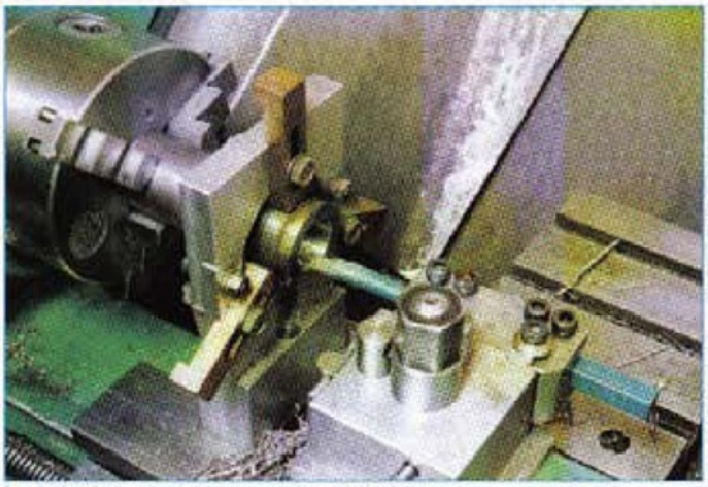
Boring small diameters, Why?

You may ask why will it be necessary to bore smaller holes (say less than 10mm diameter), if you already have a drills up to that size and in 0.1mm increments? The reasons are, typically;-

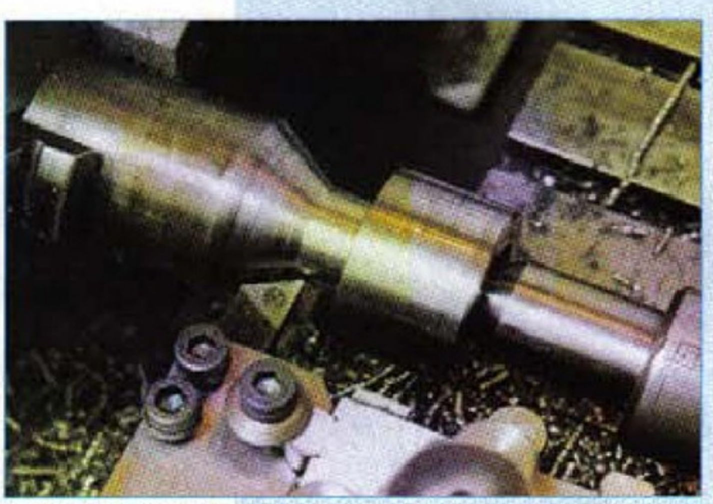
1. You may need to create a hole of a precise diameter for which you have no other suitable tooling. Perhaps you have a set of metric drills but want to make a close-fitting hole for an Imperial spindle. Considering a 3/8 in. spindle (0.375in.), the nearest larger size drill will be 9.6mm, (0.378 in.), not really a close fit. Boring before reaming may also be a requirement.

2. If a part needs inside and outside diameters to be accurately concentric, you may need to bore the inside diameter because drills cannot be guaranteed to start and/or continue on axis.

3. A bored hole may be preferable to achieve a better finish.



3. Producing the bore for the smaller holder



4. The first stage of creating the shank of the smaller holder using a left-hand knife tool. Note the support of the tailstock centre

4. Considering larger holes, you may have only a limited range of drills above 10mm, so holes will have to be drilled and opened up by boring.

The tools

If, therefore, we start on the basis that holes may need to be bored from 6mm up (and smaller is not unknown), then a tool that can cope with that diameter will be required. This is close to the smallest available commercially, one catalogue listing diamond insert tools which will get down to 4.57mm but, as is to be expected, these are very expensive. Solid carbide tools can be obtained which will even deal with holes of 0.020in., but strength considerations mean that they can be used only for very short bores, 1/16in. being the maximum depth in this case.

For most of us, small boring tools will need to be ground by the user, from high speed steel tool bits. This is not the easiest of tasks and needs tackling with considerable caution, due to potential dangers and wasted tool bits if the tool is a failure. The method used to form the cutter will depend on many factors, one's skill and the type of grinder available being just two.

Assuming a simple off-hand grinder and only limited experience, the sequence shown in **Sk. 1** will make a good starting point, but before expanding on the subject of forming a cutter we will return to our 6mm boring tool. At this size, the tool will be fragile and only light cuts possible, though at 6mm diameter this should not be a problem. Also, being fragile, the depth which the tool can cope with will be limited, say 20mm maximum, but at 6mm diameter, deeper bored holes will not often be a requirement. The tool will, though, cope with ease with larger diameters because the problem of clearance reduces as the hole size increases. However, only being able to take light cuts will make it a frustrating operation, and the 20mm depth limit is likely to be insufficient in many cases. The golden rule when boring is always to use the biggest, strongest boring tool the hole will accommodate, even changing tools as the hole gets bigger. Because of this, larger tools will have to be made, a minimum of three, but ideally more.

A tool made entirely from high speed tool steel will consist of three main features, the portion which is clamped in the tool holder, a reduced size shank providing clearance in the hole being bored and the actual cutting head. The critical area is the shape of the head and how this relates to the inside of the bore it is attempting to make. **Sk. 2** illustrates this more easily than trying to express it in words.

Earlier in the series (Issue 72 page 29), the question of tool height was discussed and Sk. 1 of that article demonstrated how making a cut would be impossible if the tool were too high. The reverse situation applies to boring tools as here, if a tool is too low, the cutter may fail to cut properly. With experience you will find that, at the limiting conditions, only a small increase in height will change the cutter from a non starter to one that performs with perfection. This feature can be used to advantage where a tool, too large for the hole size, can be pressed into service by mounting it above centre **(see Sk. 3)**.

Whilst tools made entirely from high speed steel are the only types practical at smaller diameters, the deeper holes likely to be required at larger sizes will demand tools that have a deeper reach than can be achieved with this material which is too fragile for deep holes. To overcome this, tools with separate cutter tips mounted in more robust holders will be needed. These may take the form of home-made holders to which are fitted small pieces of high speed steel, tools with brazed-on tips of tungsten carbide or the more elaborate type which can accommodate replaceable tips. **Photo. 1** shows a range of boring tools, includes some tooling of each type but the scope of this series does not permit further elaboration, so do read other articles on the subject (Ref. 1). To summarize, to be able to carry out what is basically the same operation, a much wider range of tooling will be required than most will anticipate.

Tailstock die holders

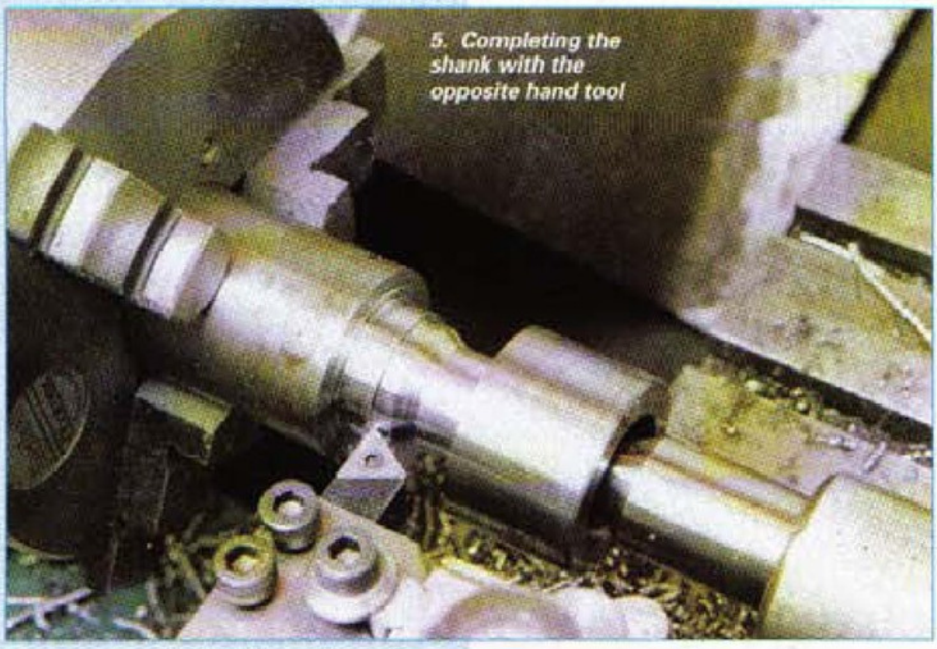
These die holders have been chosen as the vehicle to provide the need for practising boring operations. Whilst not unique, the design **(Fig. 1)** differs from the widely available double-ended type in which the body incorporates a housing for each of the two commonly encountered die sizes (13/16in. and 1in., dies being made to Imperial dimensions), as seen in Photo 18 on page 29 of M.E.W. Issue 69. The type described here can be observed in **Photo. 2**, the essential differences being the use of separate holders for each size of die and the substitution of a tommy bar in place of the fixed handle. The advantages of these differences are, in my opinion, the fact that the separate holders allow dies for two sizes of thread to remain set up, often useful when parts being made require more than one thread to be formed, and that the use of a tommy bar can avoid the problem of the handle fouling the top slide or cross-slide. Taking things a stage further, the holders are so simple to make that it would be worth making one for each commonly used thread size, leaving the die adjusted to perfection. These days there appear to be some seven different diameters of circular dies available, so this design allows a holder to be created for any one of them, something not possible with just one of the conventional double-ended pattern.

Two methods

Whilst both holders are essentially the same, I have used a different sequence of operations for each. You may chose to use one or other method for both holders, though if its experience you are after try the two.

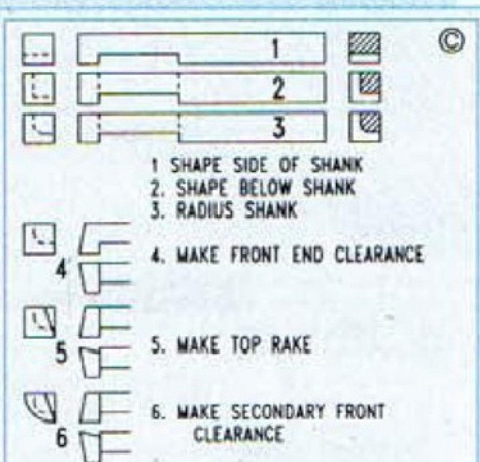
Like many workshop owners I went through a stage where lack of available money and, crucially, time to make items of tooling, frequently resulted in the use of less than satisfactory methods. One example was my way of making external threads. Not having a tailstock die holder I used my normal die stock, pressing this against the front end of the tailstock barrel to keep the die true to the axis of the lathe. The tailstock, left loose on the bed, was fed forward using my right hand whilst I rotated the die stock with my left. The problem was that sometimes it worked perfectly and sometimes the thread went off course.

Not using the workshop very frequently at that time, it was some while before I realised that the problem occurred only with one die stock. On examination, I found that the rear external face of the die stock was not parallel to the internal mounting for the die itself. With a stub mandrel turned to fit into the die stock, and the latter held in position with its own

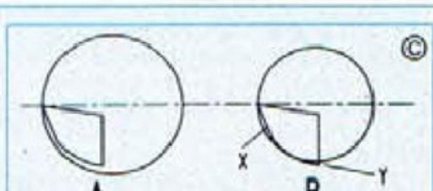


5. Completing the shank with the opposite hand tool

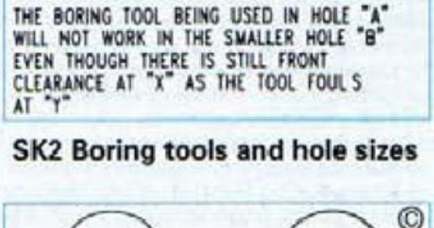
three screws, the rear face was machined correct it. After this the problem was eliminated, though the experience did make me realise that this is really not the way to produce threads and highlighted the importance of the accurate alignment of the die. For this reason I have particularly paid attention to this requirement in the two manufacturing methods.



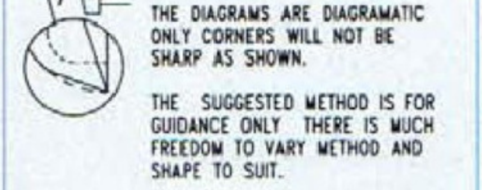
SK1 Shaping boring tools



SK2 Boring tools and hole sizes



SK3 Boring tools and tool height



SK4 Boring tool shapes

Method one

Method one is used for the smaller holder. Chuck a length of 32mm diameter steel, about 80mm long, and check that the outer end is running true, say within 0.02mm total indicator reading. If this is not achieved in the 3-jaw chuck, use the 4-jaw. With a short piece of steel of relatively large diameter, it should be possible to set up the fixed steady on the outer end without additional support for the workpiece.

The problem with longer and or slimmer workpieces is that the application of the first arm of the steady can deflect the part off axis. Apologies for repeating advice given previously, but with the series being aimed at the novice, some points may bear repetition for them to stick in the mind, particularly the problem of attempting to support a part that is not running true at the position at which the steady is being used. The rotating part will attempt to follow its natural path but the steady arms will exert a considerable restraining force, causing the part to work out of the chuck. The closer the steady is to the chuck, the greater the effect, and it is particularly crucial if the part is large in diameter requiring the use of the reverse jaws. Every effort should be made the workpiece running true and the steady set accurately.

Face the end of the bar to remove saw cut marks then drill with the largest drill you have, to a depth just short of that of the bore to be made. You may need to use one or more smaller drills first to avoid overloading the lathe motor. Choose a boring tool that will work at the diameter of this pilot hole and which is capable of facing the end of the bore. Boring tools come in two basic forms, as illustrated in **Sk. 4**, though of course there are many variations, essentially for blind hole and through-hole boring. Personally, whilst I have tools of both types, those I grind from high speed steel tool bits are invariably to suit blind holes and, as the bore in this case is shallow, I would normally use a high speed steel tool, such as that shown third from the top right in Photo. 1. However, you will see from **Photo. 3**, that I chose to use a tungsten carbide tipped tool, of a type that is very commonly available both for blind and through-hole boring.

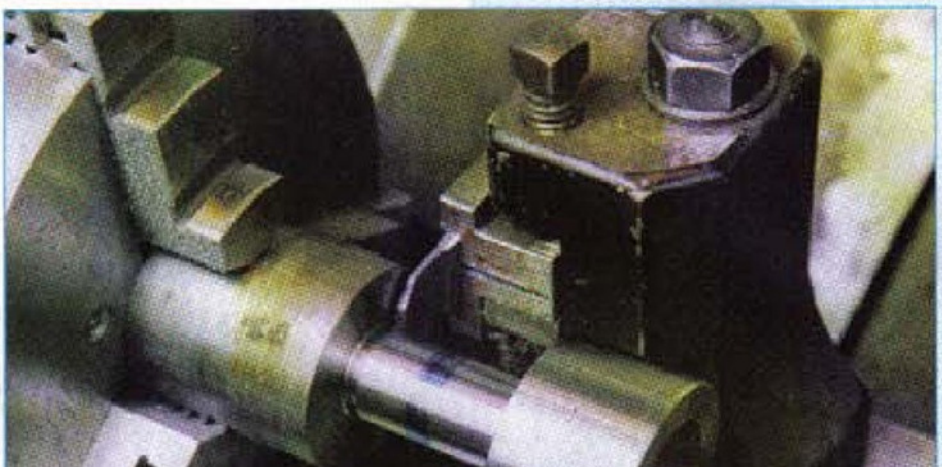
Start by increasing the diameter and boring to a depth of 6.5mm. If you own a 'saddle stop', then set this to control the depth using the saddle to feed the tool rather than the top slide. Having managed without a saddle stop for many years, once I had equipped myself with one I soon learnt its considerable advantages, and would therefore urge you to make one. It need not be complex (Ref. 2), and the time spent will be repaid many times over. Setting the stop is a job for the distance gauges made in the last issue. Select gauges to the width of 6.5mm (5 + 1 + 1/2) and, using the saddle hand advance wheel, grip them between the end of the stop adjusting screw and the saddle. Keeping them in position and with the lathe mandrel stationary, advance the top slide until the tool just touches the face of the part being bored. Remove the distance gauges and the depth of bore will be exactly 6.5mm, using the saddle to advance the tool and being careful not to move the top slide.

Without a saddle stop it will be necessary to use the top slide to advance the tool, controlling the depth by observing the top slide feed dial. Lock the saddle and bring the tip of the boring tool up to the face of the workpiece and zero the micrometer dial. Set the depth of cut using the cross-slide, being careful to note the setting of the cross-slide micrometer dial, and bore to a depth of 6.5mm. Continue increasing the diameter until the bore arrives at 13/16in.

Before retracting the tool from the bore, advance the cross-slide to disengage the cut. If you just wind the tool back out of the bore, you will almost certainly find that it will cut more deeply on the return movement. This is due to slight clearances in the lathe saddle assembly being taken up in the opposite direction with the reversal of saddle movement. This may not appear to be a disadvantage when there is still plenty of metal left to remove, but has been the cause of many an over-size bore when close to finished dimension. Get into the habit of disengaging the tool then re-setting the next deeper cut with the cross-slide dial, being sure, of course, to make the necessary allowances for any backlash in the cross-slide leadscrew.

An alternative method, which avoids the need to move the tool setting, is to stop the lathe mandrel before winding the tool out from the bore. This is likely to result in there being a very fine straight groove being cut in the internal surface, but avoids a more serious problem.

An additional factor, which must be taken into account when doing any turning, but particularly when boring, is the phenomenon of 'spring' in the tool. Reaction to cutting forces will result in the tool attempting to move away from the workpiece. External turning tools are usually so stiff that this should be a relatively minor problem, but boring tools are likely to be much more flimsy so, as mentioned above, always use the stoutest tool which will enter the bore, even changing tools to ones with larger section as the bore diameter increases. The final procedure is to 'work out the spring' by taking repeated cuts with the same tool setting until no further cutting action is observed. Using the technique of stopping the mandrel before withdrawing the tool can be an advantage here, as no alteration



6. Parting off the almost finished holder

of cross-slide setting is necessary - indeed, the cross-slide can be locked while these cuts are in progress.

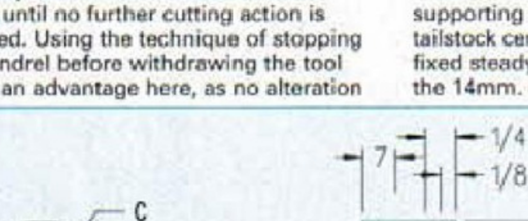
On the final cut, feed the boring bar deeper by 0.05 mm., adjusting the saddle stop as necessary, and wind the boring bar to the centre, by so doing facing the base of the bore. If this does not result in a clean finish place a further cut of 0.05 mm. and face the base again, repeat as required. With a right hand knife tool, machine the outer end face until the depth of the bore measures 1/4in.

Next, centre drill the base of the bore, supporting the component with the tailstock centre after having removed the fixed steady. This will allow you to create the 14mm. diameter spigot at the rear, first with a left hand knife tool (**Photo. 4**), also establishing the 20 mm. dimension, then with a right hand tool (**Photo. 5**). Make the spigot 34mm. long, sufficient to enable parting off to take place at this reduced diameter. Also leave the 14mm. portion 0.3mm. over-size for eventual finishing to diameter.

Now fit a finishing tool and use this to skim the 32mm. diameter to give a good finish, and also reduce the spigot to 14mm., making it within +0.0/-0.02mm. With a chamfering tool now fitted, chamfer both front and rear edges of the major diameter. Finally, part off at 28.5mm. long (**Photo. 6**), after first drilling 7mm. diameter through to this depth.

With the material now shortened, the part can safely be held on the 32mm. diameter, suitably protected, and the end of the spigot faced to a 28mm. length and finally chamfered.

There remaining tasks are to create the holes for the tommy bars and the die adjusting screws. These are simple exercises and I will not comment other than to say if you have a dividing head, using this will help to position the holes regularly, though this is not that important, especially those for the tommy bars. The screws we will come to later.



The larger holder

In design, the holder for the 1in. die is only a larger version of the smaller and could therefore use the same manufacturing procedures. However, to gain more experience a different approach is to be described. This, together with some ideas on turning tapers, will continue in the next issue.

References

1. Deep Boring Tool. M.E.W. Issue 8 page 14

2. A Bed Stop for the Unimat 3. M.E.W. Issue 44 page 39
An adjustable lathe stop. M.E.W. Issue 37 page 55

A Universal Machine Tool for the Model Engineer's Workshop

By L. F. REDMAN

(Reprinted from '*Model Engineer*' Vol. 78 No. 1923 March 17 1938)

THE machine about to be described is the result of several years' experience and experiments in developing a machine and accessories which would cover a wide range of utility for both experimental and model-making requirements. As will be realised, a machine of this description can only be the outcome of development extended over a period of time, working a great deal by rule of thumb and benefiting from the knowledge acquired from previous try-outs.

I started model engineering when about sixteen years of age and had about four shots at making a vertical marine engine, one inch bore and stroke, before I succeeded in making a successful working model. Having got so far by the aid of a lathe I had contrived from angle iron and various oddments, I decided, before continuing model work, to make myself something more presentable in the way of a lathe. To purchase one at this time was out of the question, as my age and finance was very limited.

I, therefore, began building another lathe using the existing one to make the bits and pieces. This machine took me about three months to build and was a decided improvement on the last. The bed was constructed of seven-eighths square B.M.S. bar, two lengths forming the bed, and separated by two pieces of the same section at either end. I made some simple wood patterns for the headstock and tailstock, whilst a slide-rest was constructed of M.S. flat bar. This brought the job to the end of the three months' programme. Another start was made on a model but I soon realised that some kind of screw-cutting gear was a necessity, so I once more plunged into machinery improvements ; and so the merry round has gone on.

Looking at photo (Fig. 1) it will be noticed that the machine follows closely the orthodox lines of a centre lathe, the headstock being the main centre of difference. The only parts purchased were the bed, rack, lead screw, change wheels and an old top slide from a large centre lathe, which forms the slide upon which the headstock is raised and lowered. The rest of the job, was machined from castings. The patterns I had to make were for the box-form headstock and the standard to which the top slide referred to was bolted. When the machine is used as a centre lathe, the drive is direct on to the tail end of the mandrel from the countershaft at the rear ; but when used as a miller, the chain is transferred to the tailstock end. It then drives the shaft below the lead-screw, which transmits the motion through bevel gears (from a sewing machine), to the vertical splined shaft over which the sliding keyed sleeve rotates. This in turn, through the medium of the spiral gears, drives the mandrel. The spiral gears are from a motor-car over-head camshaft picked up at a car-breaking depot.

The drive, to be seen at the tail end of the leadscrew is to give an independent feed to the leadscrew. A small countershaft is driven from the threestep pulley, seen on the extreme right, and this, in turn, drives the pulley facing the camera. The lever to the left of the pulley lifts the worm into mesh with the gear attached to the end of the lead-screw, a small spring-loaded latch keeping it in mesh. The small ball-headed lever above, when pressed down, releases the worm spindle which drops quickly out of mesh, due to the tensional pull of the round belt. The feeds obtained are 0.002", 0.004" and 0.006" per revolution of mandrel (approx.). The milling-mandrel steady is exceedingly useful for supporting short ends in the chuck when the tailstock is not convenient ; also, for supporting work between centres (that is a centre in the milling-arbor steady) for taper turning. When the headstock is raised to the top of the slide, it is possible to bore out the boss of a wheel twenty inches in diameter in the gap. The vertical bar, to the right of the vertical drive shaft,

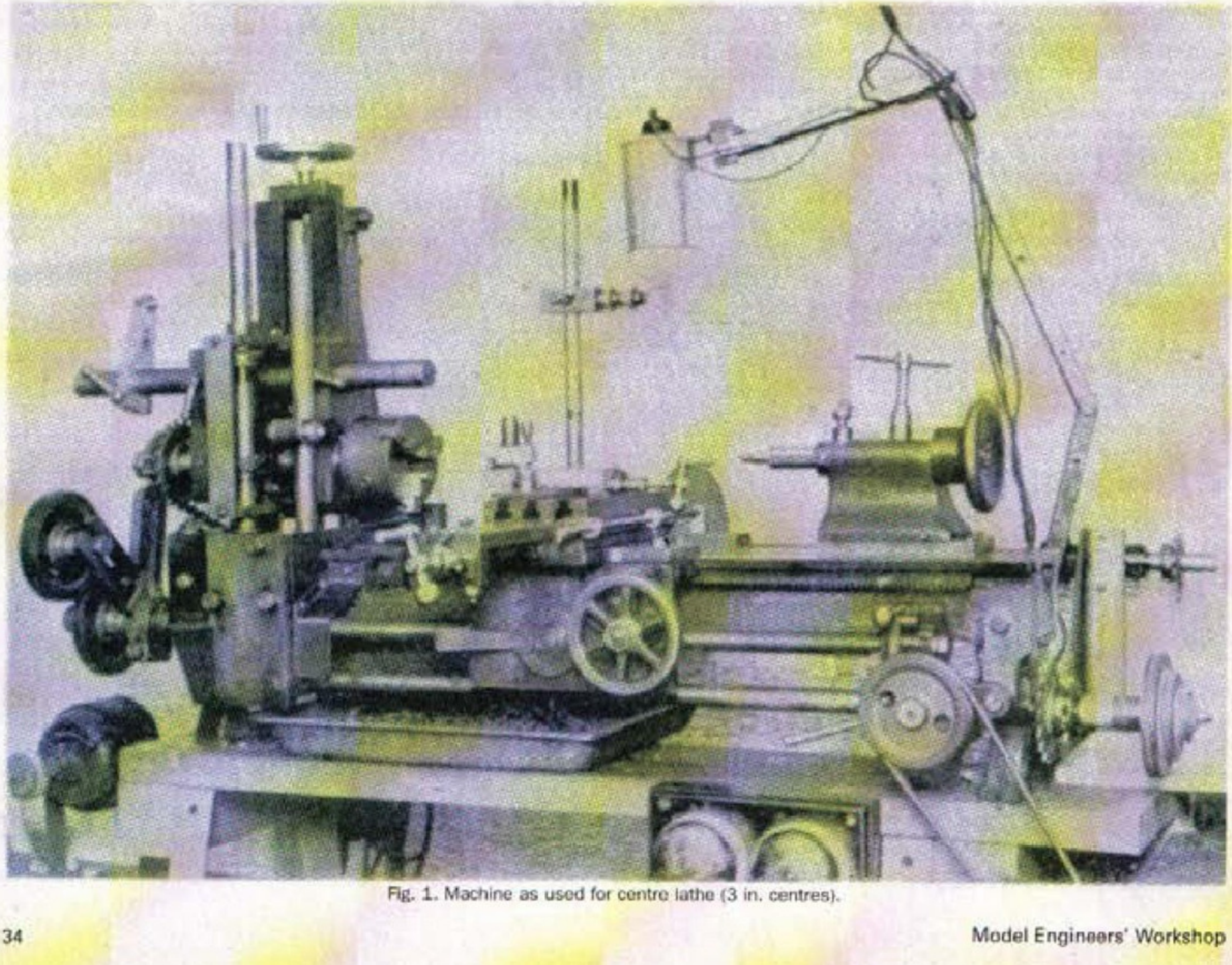


Fig. 1. Machine as used for centre lathe (3 in. centres).

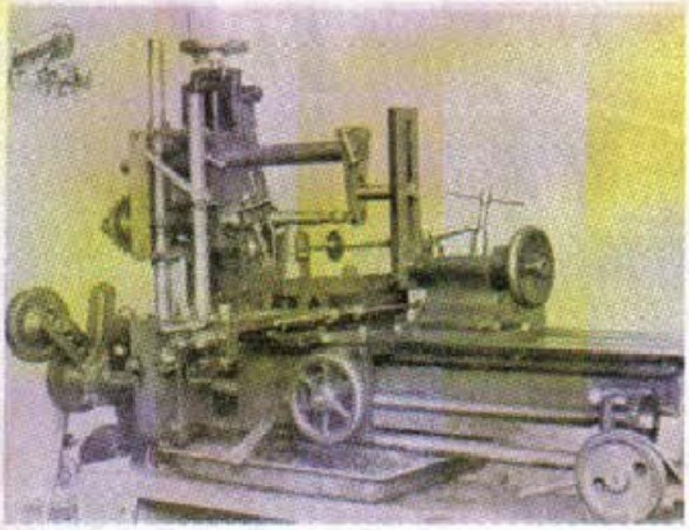


Fig. 2. Machine as horizontal miller.

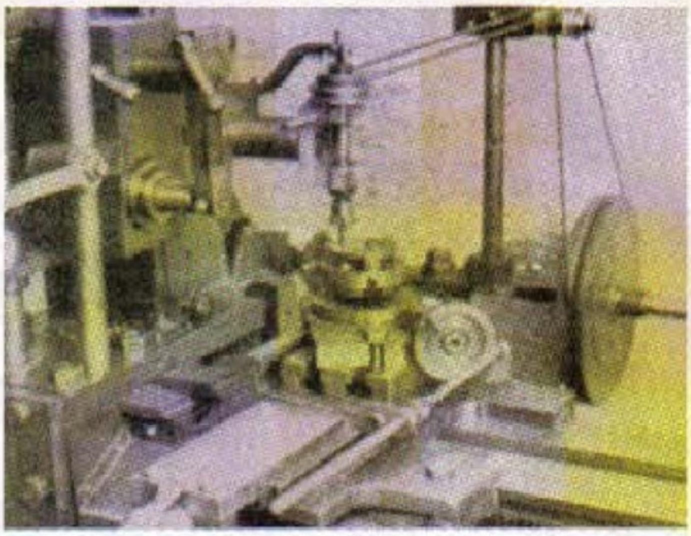


Fig. 3. Machine as vertical mill

forms a steady for the headstock, a split clamp locks the head when set for height, and makes it very rigid under cutting strains.

Turning to Fig. 2, it will be seen that the machine is set up as a horizontal miller. The arbor-steady gains extra support for "heavy milling" from the slotted steady attached to the tailstock. The dividing-head has been slung around in the photo, to give a better view. The dividing-head gives a useful range of divisions up to eight hundred with the existing plate.

To the right of the cross slide will be noticed a round rod of silver steel, which is secured at the rear end of the saddle, and is a sliding fit through the small plate attached to the tee-slotted table. The collars are locked with set-screws at determined positions, and form useful stops to prevent over-running when milling slots, etc.

Another set-up for vertical milling operations is that shown in Fig. 3. The drive is obtained by utilising the change wheels, which gives a varying range of speeds. The bar-steady used on the horizontal arrangement is slipped out of the headstock, and the tubular one, to which the vertical head is fixed, is slipped through in its place. This tube is bushed at either end, to form the bearings of the horizontal shaft, which runs through the centre and drives the vertical cutter spindle by means of the bevel gears seen. These gears, before modification saw service on a printing machine. The cutter-spindle is bored throughout its length, and is reamed 0.375" to take cutters, which are locked by means of a 1/4" Whitworth Allen grub-screw. The outstanding feature of this arrangement is that the head can be set at any angle through 360 deg., enabling one to tackle a wide range of milling operations.

After using this arrangement for some time, experience proved that the equipment left much to be desired - mainly, that spindle speeds were too low for using small-diameter fly-cutters and end-mills. Fig. 4 shows yet another experimental try - out which has proved very efficient. As will be seen, the vertical spindle-head is fixed by means of a stud and nut to the steady, as used for horizontal milling. This head, when removed from the steady, fits on the lathe bed, and is located by means of a tenon, and converts the machine into a high-speed lathe for fine work. The centre-height (3") corresponds with that of the lathe centres, actually, the drive being obtained from the pulley, seen on the countershaft at the rear. The belt is of 1/8" diameter gut, and drives in a very positive manner, the slip being almost nil., The bores in the circular table, dividing-head and vertical spindle, in Fig. 3, are all reamed to 0.375" diameter, as, also, are the other chucks and fixtures used in conjunction with the set-ups, so as to be interchangeable. For example, a job can be turned in a chuck, or on a screwed adapter, with 0.375" diameter shank, and then transferred to the circular table, or other apparatus, without disturbing its setting. This enables either drilled holes or milled faces to be in correct relation to each other. This machine has turned out a great many parts, of an intricate nature, for a friend, who has been experimenting for some time on carburettors, and I hope, at some future date, to send along some photos of the components produced.

In conclusion, I would like to say that the photos were taken by Mr. Porter, of the Bristol Model Power Boat Club, and I think you will agree that he has made an excellent job of them.

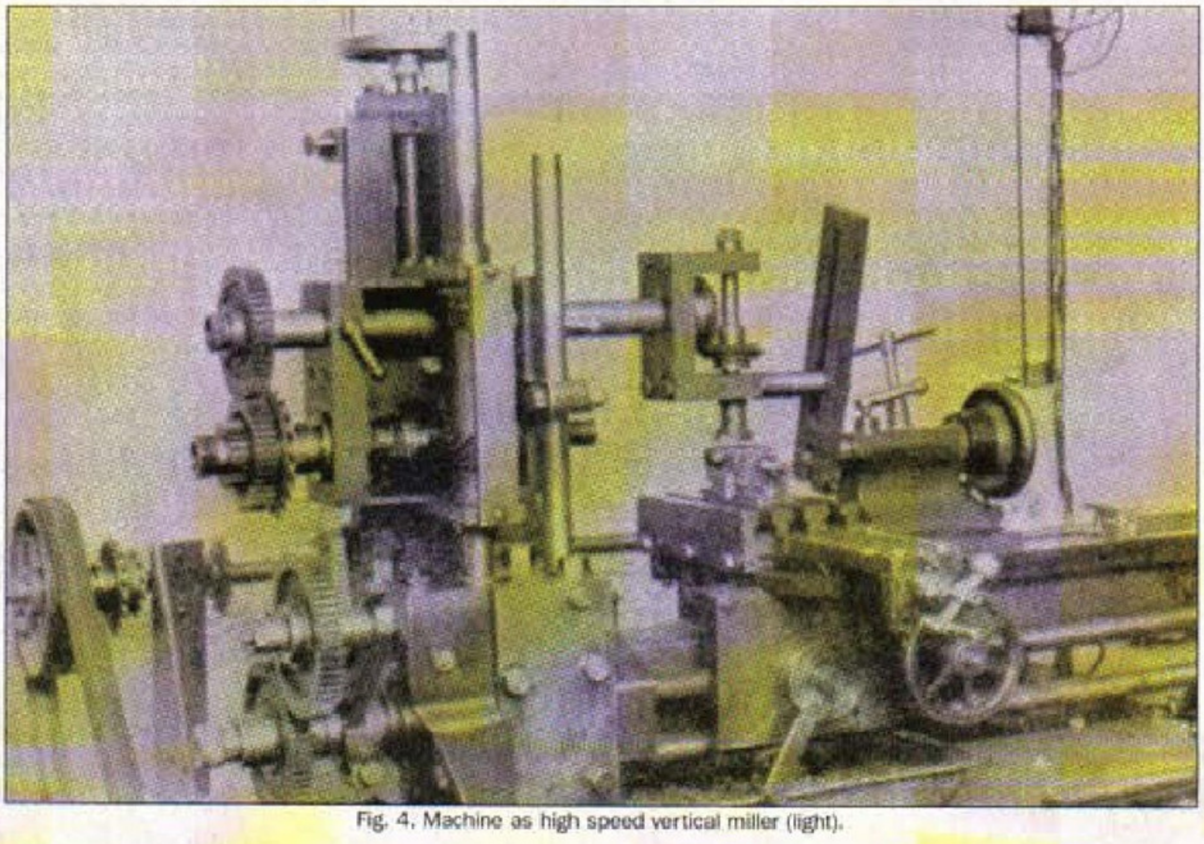
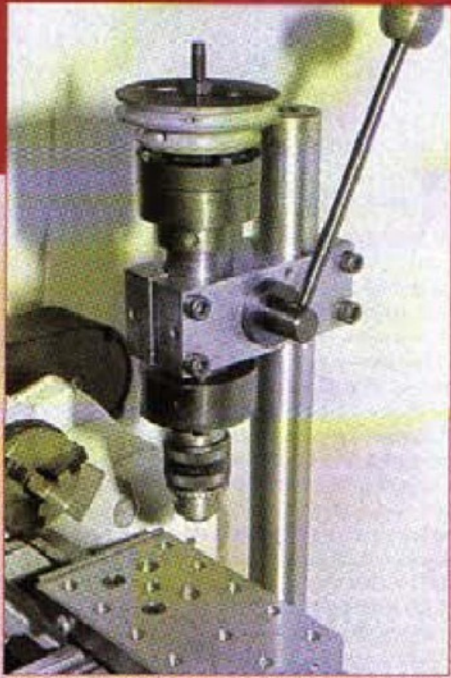


Fig. 4. Machine as high speed vertical miller (light).

DRILLING IN THE SMALL LATHE



1. *The primitive vertical head*

Smaller workshops often do not have the space to house a multiplicity of machines. Bob Loader demonstrates that it is possible to press the lathe into service for other duties

When my wife bought me a Unimat 3 I soon realised what a great machine it was. The only problem was how I was going to do the drilling. The catalogue of accessories showed a very nice looking milling/ drilling head and a table and other interesting things, at the time a bit too pricey.

A primitive vertical head

I did three terms at a model engineering course offered by my local college, where I designed and made the vertical head seen in **Photo. 1** with guards and belts removed. With a tapered roller bearing in the chuck end and a rack and pinion movement, it should have been very useful. I also made a pillar to fit the vee in the lathe bed. It wasn't much good, took too long to set up, didn't run very smoothly and had various other faults, all of my own making. There was though, a useful spin-off.

A milling table

I made the milling table shown with the head as a standby job, for when I was waiting for a machine or for other reasons. It was something which could be made fairly easily without too much machinery. Most of it was marking out and drilling the holes shown in **Fig. 1**. I tried making a table with tee slots first, by fabricating it, with a solid base and strips riveted to it. It didn't work, so I had another think and decided to use tapped holes instead of slots, a lot easier to make and in the small size of the table, just as effective. It was ground accurately all over and the top surface scraped. I made a couple of fences for setting. It has been well used and is an excellent item for the owners of all small lathes to make.

Early drilling methods

I used the home-made drilling head a few times, **Photo. 2** showing one such operation. The vice used was the milling table with fabricated parts bolted to it to convert it into a vice. Once again it was tiresome to get set up and I thought it would be better to leave the lathe as it was and do what drilling I had to with what I had. It turned out to be quite all right for most things using the face plate supplied with the lathe as a table, with the drill chuck held in the lathe headstock. Larger drills were held in the 3-jaw chuck. Being a useful size, a $^3/_8$in. drill with a turned down shank was used a lot. Turning down a drill shank is quite easy because they are left soft; how else would they get so horribly scarred?

I also made an adapter, **Fig. 2**, to hold a

2. *Drilling with the vertical head and fabricated vice*

$^1/_2$in. capacity Jacobs chuck, which can be bought as an accessory for Black and Decker drilling machines. The adapter is an easy job, needing just an M14 x I thread to fit the lathe spindle and a $^3/_8$ UNF one to screw the chuck into. Both threads must, of course, be concentric.

Using the face plate

The Unimat face plate is all right to support some work; if the work is small enough it can be hand held, or held with a parallel clamp used as a hand vice, like the tap wrench being drilled in **Photo. 3**. It can also be useful to use a piece of scrap wood as a broad seating to stop the work from tilting.

Problems start when the work needs clamping. A simple shape like that seen in **Photo. 4** is easy, but for other work the three clamping slots and the rim on the periphery of the face plate make it a bit awkward.

An improved face plate

There was an obvious need for a larger and better shaped face plate, so I made one. It was a fabrication to avoid complicated machining and was described in M.E.W. Issue No. 25. It is larger than the one which comes with the machine and has four slots **(Photo. 5)** which makes clamping much easier. The back surface is flat, so that clamps will lie flat when parallel clamps are used, a favourite clamping method of mine for small work **(Photo. 6)**.

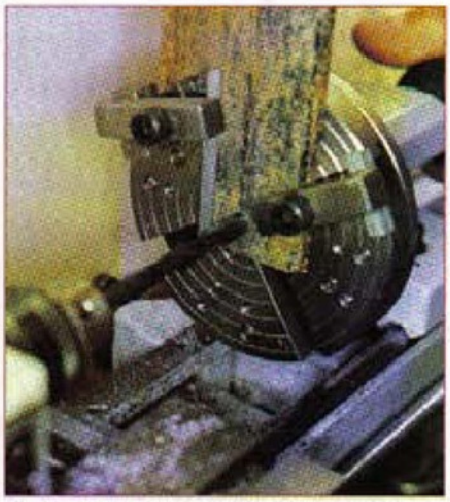
A larger face plate is useful for some turning operations, the only small snag being that the larger size won't pass over the cross-slide, so sometimes a long series drill is needed to reach the work, **Photo. 7** showing an example.

Lining up drilling work

A centre drilled hole or centre punched mark is usually good enough, but it is a good idea to have a setting point like the one shown in **Photo. 8**. This can be run into the centre hole or punched mark with just enough pressure to hold the position, allowing the work to be clamped and checked again. It can also be used to pick up the junction of two scribed lines with a surprising degree of accuracy, I used it.

3. Drilling using a parallel clamp as a hand vice

4. Simple shape - simple clamping

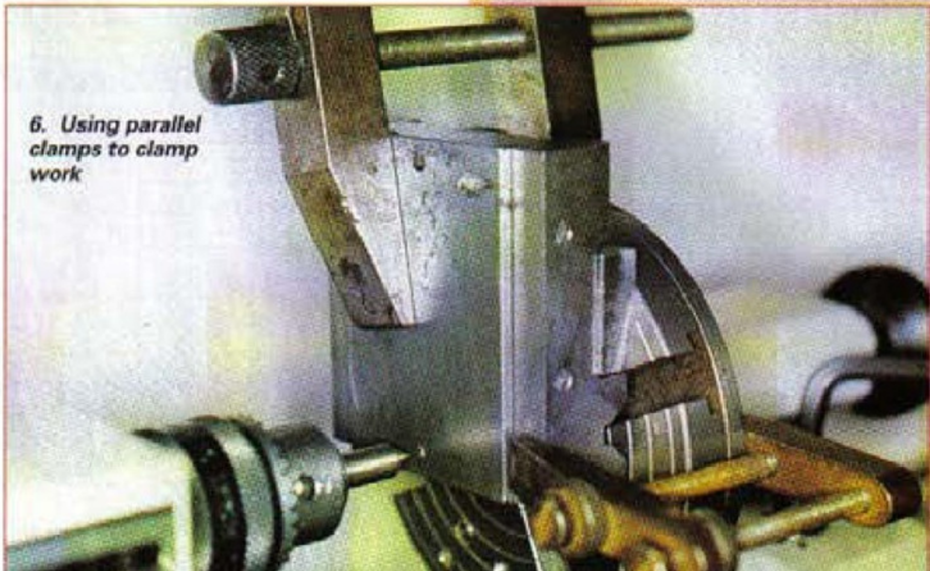


5. Easy clamping with the improved face plate

many times when I did such things for a living. The one shown was made from a broken end mill, ground to a 60 deg. point on a cylindrical grinder, but a serviceable version can be easily made by setting a piece of silver steel running true, turning the point and hardening the first 1/8in. or so. If done carefully, work set up in this way will rarely be far out. The point can also be used to set work precisely along the lathe axis, as shown in **Photo. 9**.

The drilling process

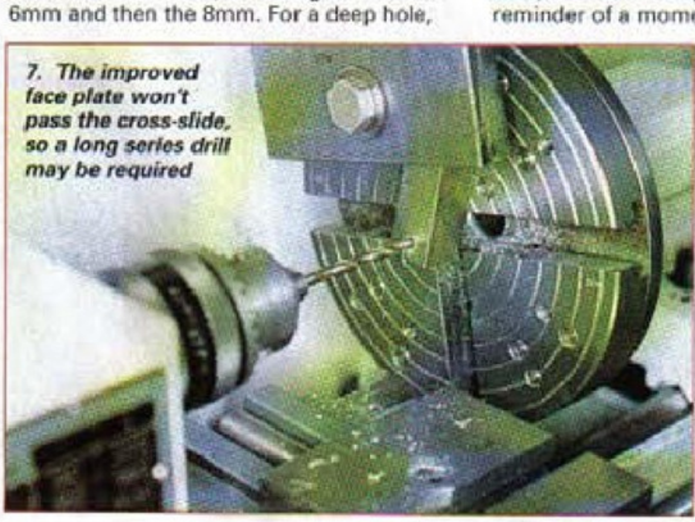
On any lathe with limited power, drilling is better done in stages, especially when the hole is large or deep. For instance, to drill a hole of 8mm diameter, I'd start with a 3mm drill or smaller, following with one of 6mm and then the 8mm. For a deep hole, the 'Woodpecker' technique of drill a bit, take the drill out, drill a bit more and so on, clearing swarf as the drill gets deeper is a good idea.



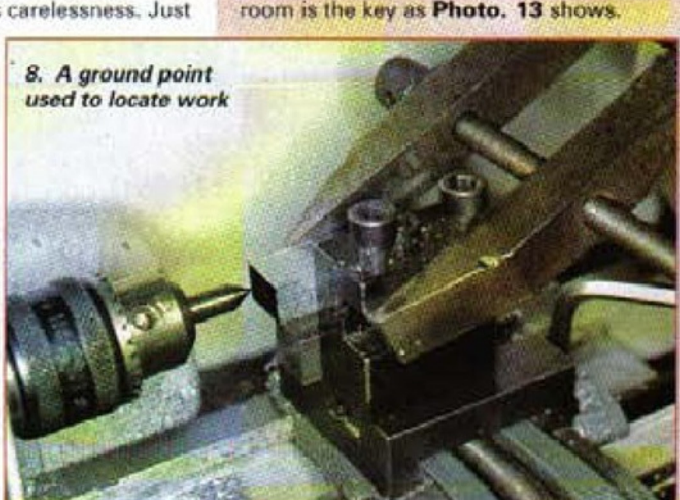
6. Using parallel clamps to clamp work

Clamping

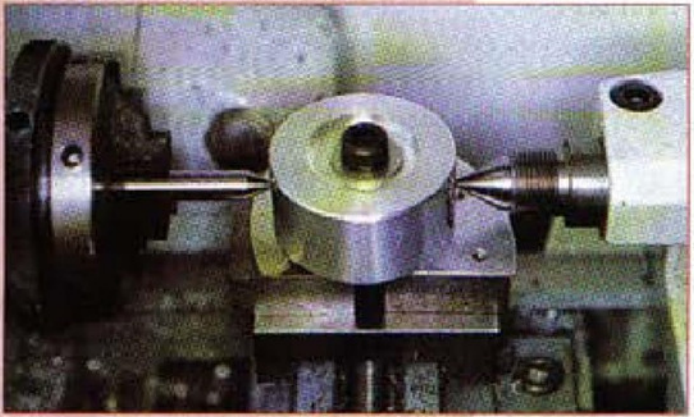
Only quite small work can be hand held or held with a parallel clamp for a hand vice as mentioned earlier. Even this could catch and spin, so never take chances. Imagine a job like the one in **Photo. 10** spinning. I have scars from similar misadventures, some dating from the 1950's. They may fade, but never disappear, a constant reminder of a moment's carelessness. Just one clamp, if it is big enough and well positioned, will hold most work, the one shown in **Photo. 11** was good enough to use when counterboring, something which always needs rigid clamping. I use parallel clamps a lot and, where they aren't suitable, strap or bridge clamps. Another very useful clamp is the custom made one seen in **Photo. 12**. The others in the photo are:- a bridge clamp, a small strap clamp and the pick of the lot, the staircase clamp which has a slotted body and a support block with machined steps to fit the steps in the body. If there is room to use it, this clamp is ideal. Having sufficient room is the key as **Photo. 13** shows.



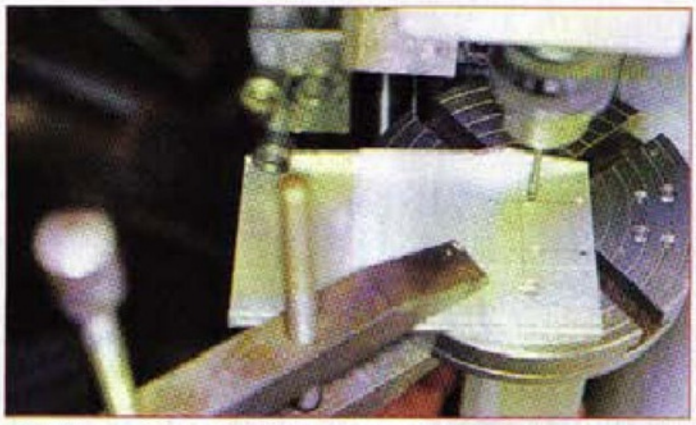
7. The improved face plate won't pass the cross-slide, so a long series drill may be required



8. A ground point used to locate work



9. The ground point and tailstock centre lining up work on the lathe centre line



10. Thin work must be clamped to avoid spinning

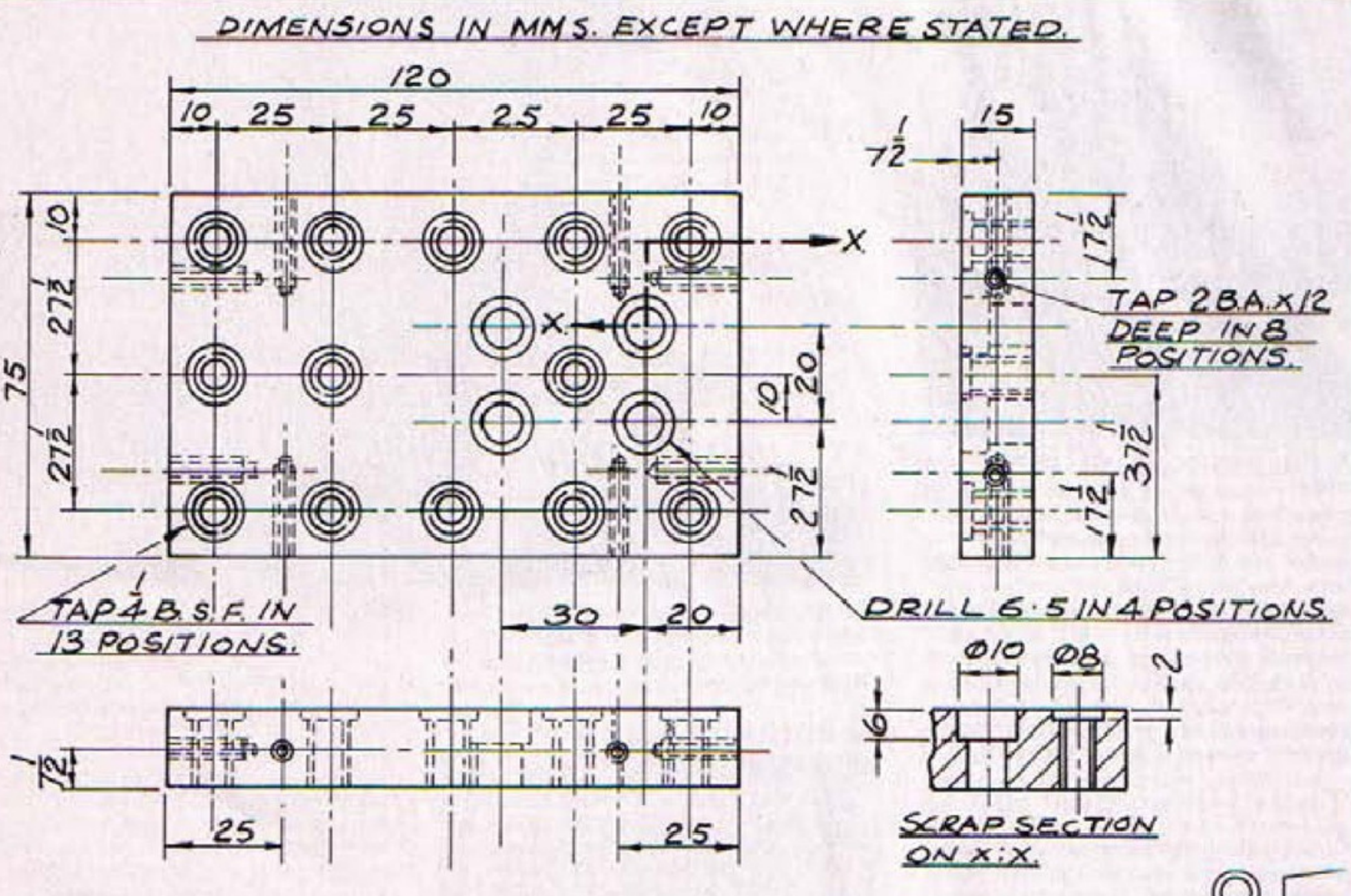
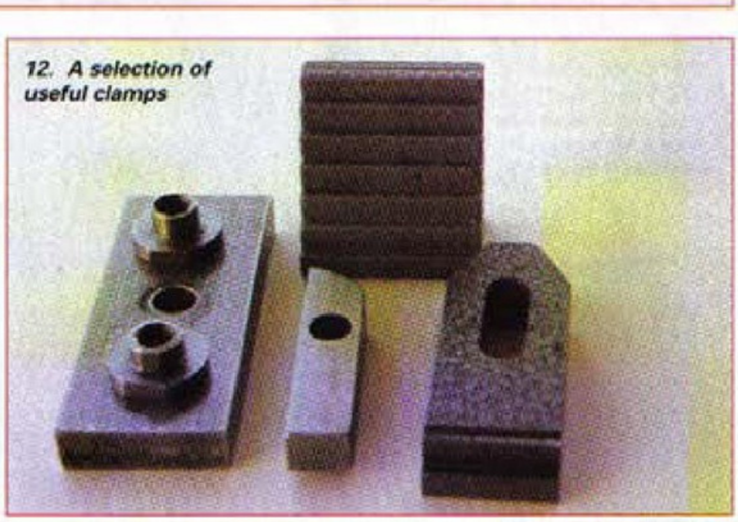


Fig. 1 Milling table - B.M.S.

11. One clamp used correctly will hold work for counterboring



12. A selection of useful clamps

Both bridge and strap clamps are very effective and the important thing to remember is to keep the packing the right height, so that the clamp is parallel. The same applies to using parallel clamps. They are called parallel for a good reason; they will only function correctly when they are.

Clamping round material

Most drilling will be of flat or rectangular pieces. Round shapes will need different techniques and there is an attachment which will make it easy. It is something which can be made quite quickly and is called a crutch centre. **Fig. 3** shows the assembly and **Fig. 4** the parts, just two of them. The dimensions are nominal and can be changed to suit an individual requirement. **Photo. 14** shows the parts and **Photo. 15** the whole thing. I won't dwell on the making, the only awkward bit being milling the vee and **Photo. 16** shows this being done. It is best to saw the vee to shape first and use a 90 deg. countersink to just clean up. The photo is of a different component, but the process is identical. Remember to cut a slot at the base of the vee as it makes the machining easier and forms a channel for drills to run out into. A crutch centre is invaluable for the type of job shown in **Photos. 17 and 18** and also very good for cross drilling.

Using separate drilling machines

Sometimes it is useful to have other drilling machines or spindles and I am lucky to have a miniature low-voltage drilling machine. I don't use it a lot, but it was very good for drilling a series of small holes in the disc shown in **Photo. 19**. It looks a bit of a lash-up, but it did the job.

Other ways and means

Some jobs need a lot of head scratching to work out how to get a drill to where it is wanted. **Photo. 20** took a lot of thought. A vee shaped part had to have a couple of holes in the flat face. A small vee block clamped to the face plate made the location and the vee piece was hand held. Luckily the holes were small enough to drill without a clamp.

Other work can sometimes be held in

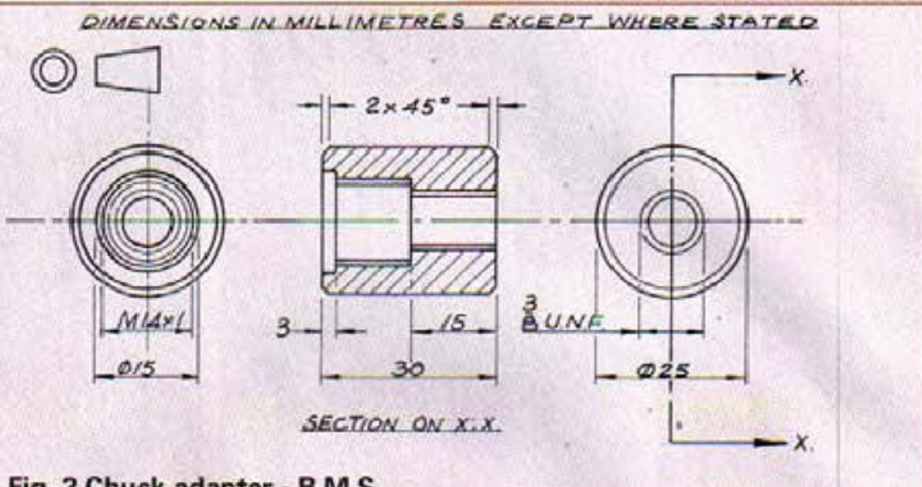
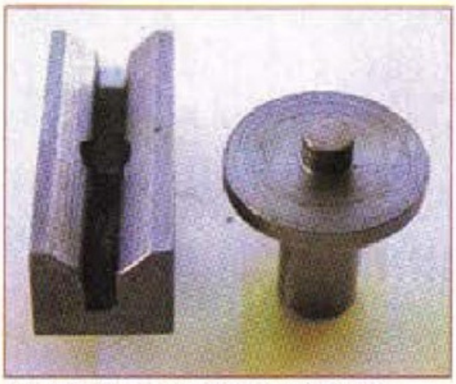


Fig. 2 Chuck adapter - B.M.S.

13. The 'staircase' clamps, ideal for work like this

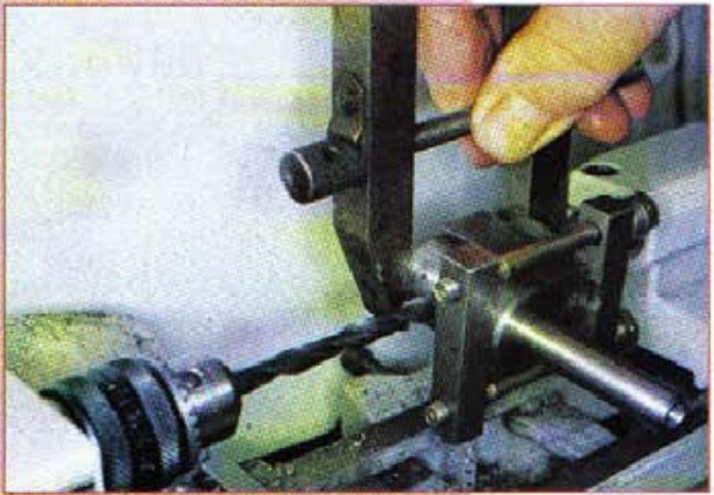


14. The two parts of a crutch centre

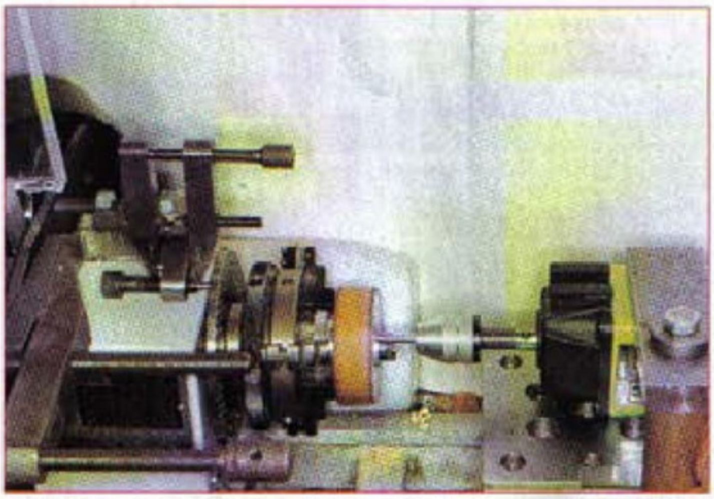
15. The assembled crutch centre

16. Milling a 90deg. vee

17. Using the crutch centre



18. Another job for the crutch centre



19. An improvised set-up using a low voltage drilling machine clamped to the drill table

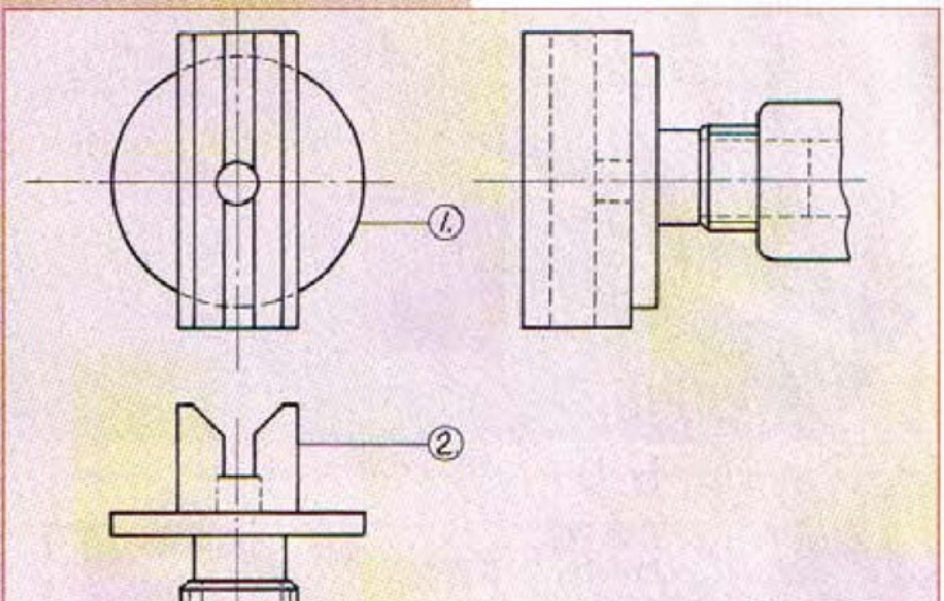


Fig. 3 Crutch centre assembly

screwing the face plate to the lathe spindle, leaving the bolts holding the angle plate to the cross-slide half tight, and offering it up to the face plate. When there is no daylight, gently do up the bolts, keeping a cheek on the alignment. It will be accurate enough for most work. The angle plate is ground on faces and edges and available in more than one size from Millhill Supplies, a company with which I have no connection, apart from being a satisfied customer.

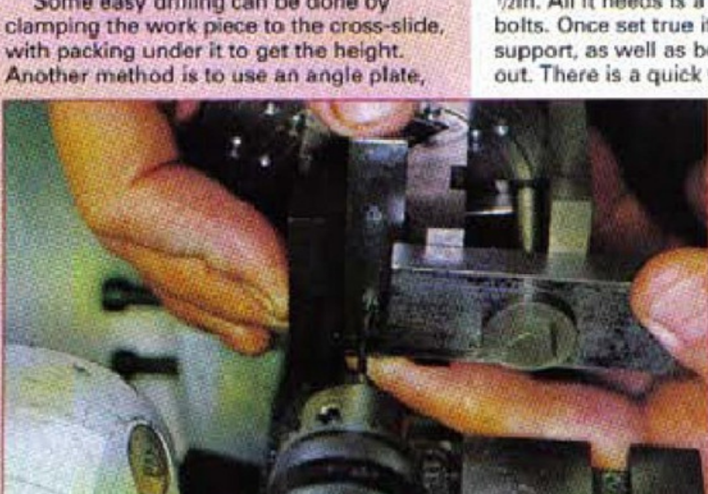
The milling table, with suitable packing, is another support, useful when holes have to be drilled on accurate pitches, using the cross-slide as an accurate indexing device **(Photo. 23)**. When the work has an awkward shape, it is sometimes easier to use the 4-jaw chuck, or to clamp work to the face plate **(Photo. 24)** or, if the work is still too difficult to hold, it may be an idea to saddle bore it **(Photo. 25)**.

My starting point was wondering how to drill effectively with just the lathe. By buying and making one or two odds and ends, I've got to the stage where it is no problem. It may take a bit longer and sometimes be a bit of a fiddle, but there is usually a way round even the most awkward jobs. It also reinforces my opinion that the Unimat is a great machine for it's size.

the lathe toolpost. **Photo. 21** shows the machining of a holder for a boring bar, with a D-bit doing the finishing.

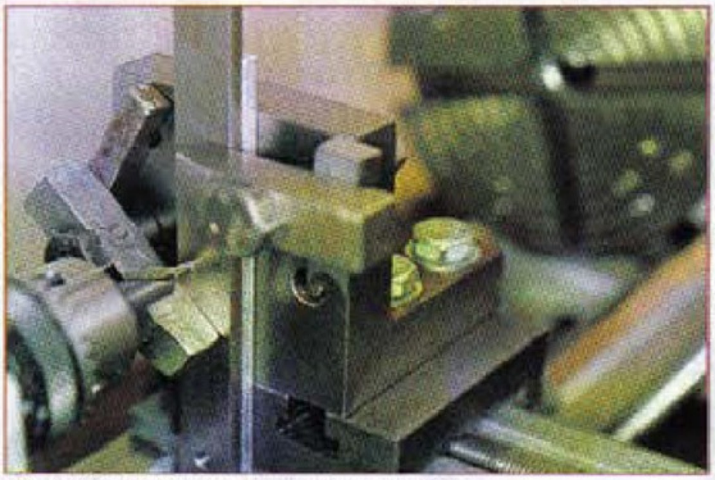
Some easy drilling can be done by clamping the work piece to the cross-slide, with packing under it to get the height. Another method is to use an angle plate, **Photo. 22** and clamp the work to it vertically. The angle plate is 3in. x 3in. made from cast iron, the thickness being 1/2in. All it needs is a few holes drilled for bolts. Once set true it makes a very good support, as well as being used for marking out. There is a quick way of setting true by

Supplier - Millhill Supplies, 66 The Street, Crowmarsh Gifford, Wallingford, Oxon OX10 8ES Tel. 01491 838653 Fax. 01491 825510 E-mail: sales@millhillsupplies.co.uk



20. An example of awkward clamping

21. Holding work in the toolpost



22. Work clamped to the small angle plate

23. Larger work can be done better by drilling clamped to the face plate

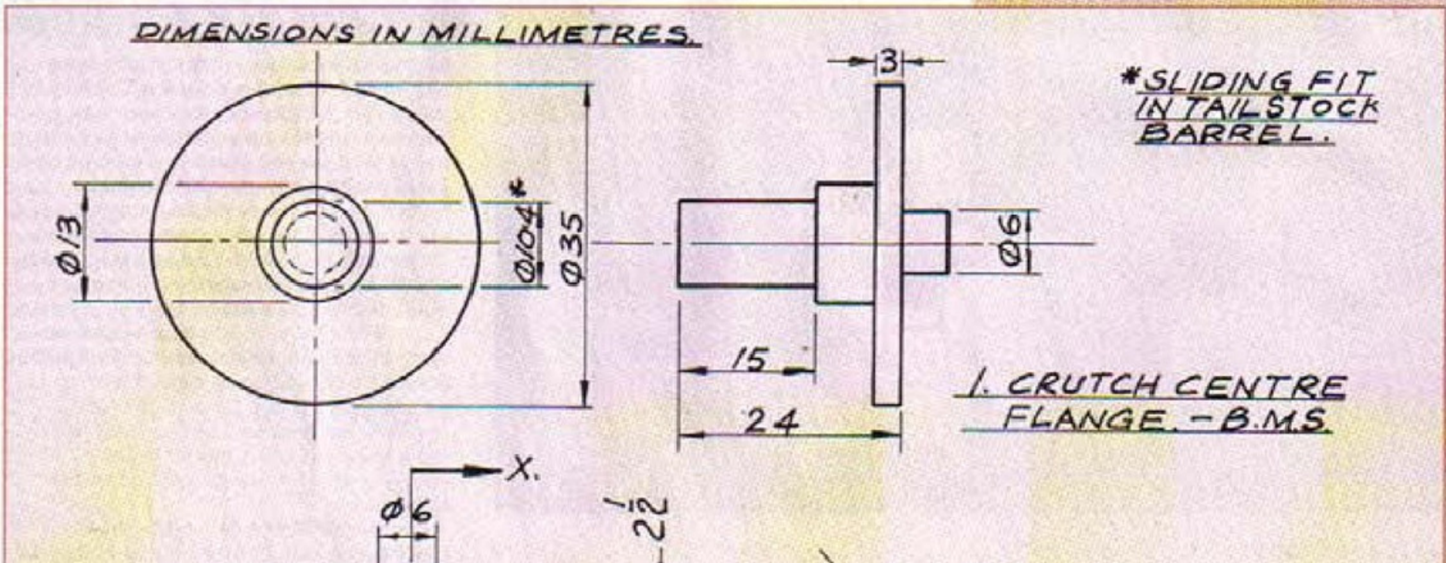
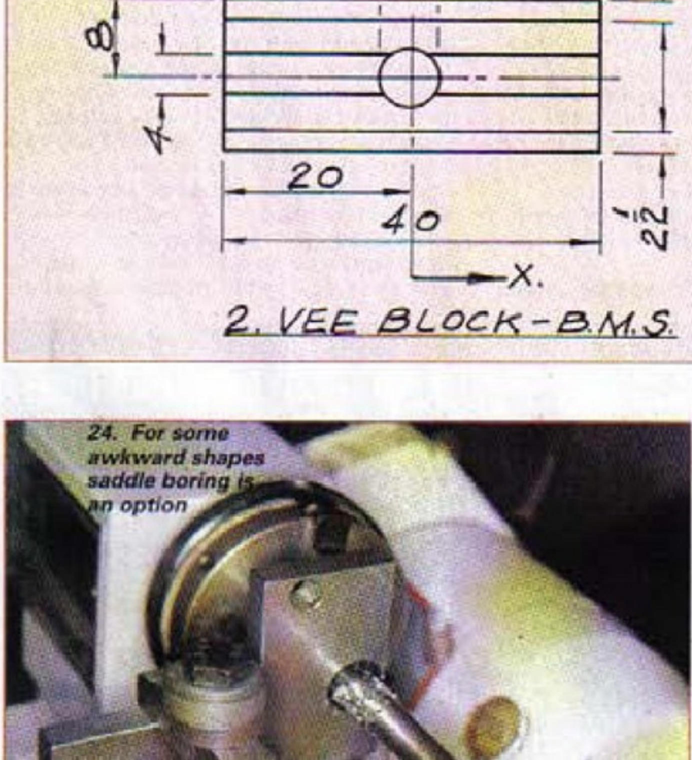
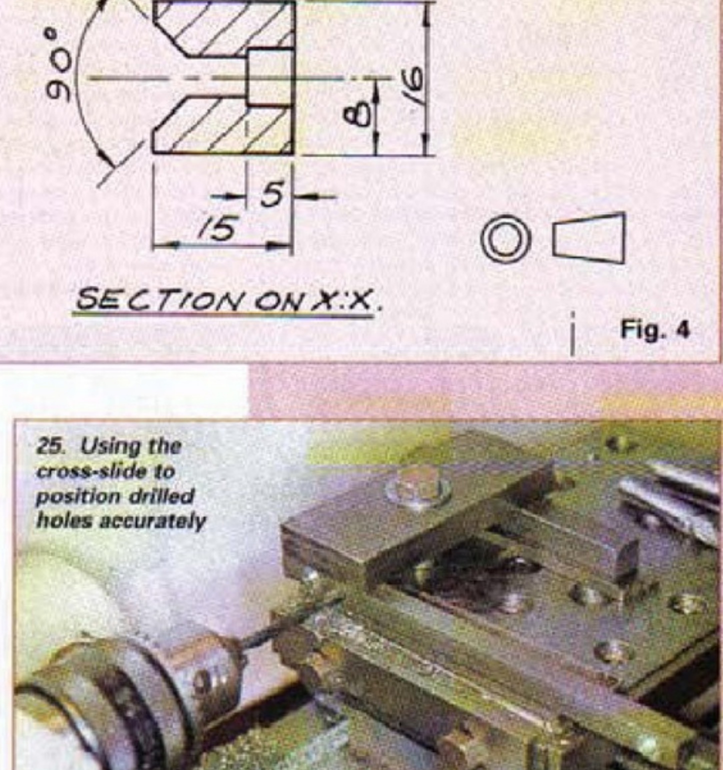


Fig. 4



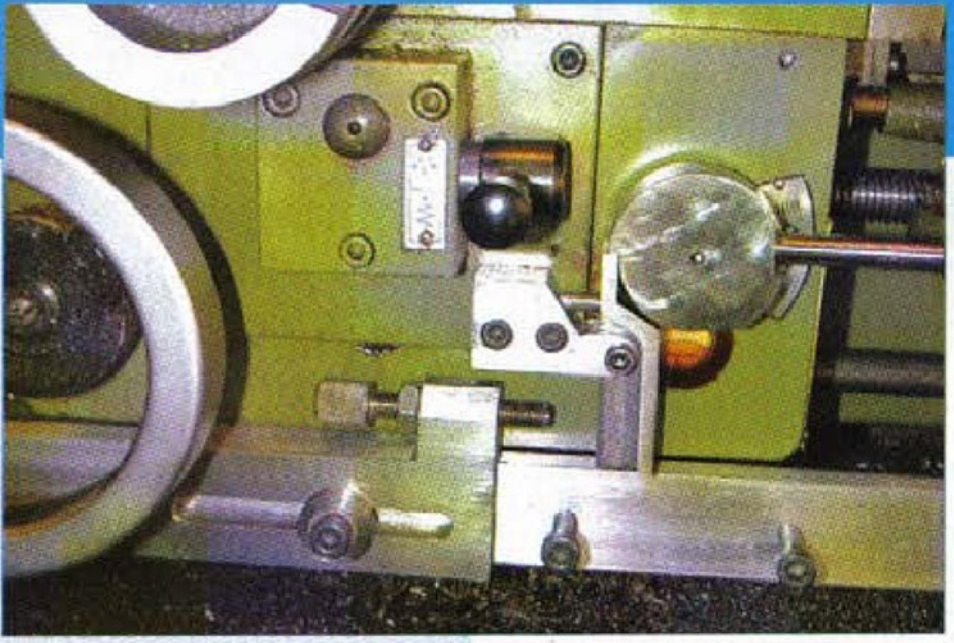
24. For some awkward shapes saddle boring is an option



25. Using the cross-slide to position drilled holes accurately

AN AUTOMATIC SCREWCUTTING STOP

Peter Rawlinson describes a modification suitable for a $6^1/2$in. centre Taiwanese lathe



1. The new set-up, screwcutting engaged

This unit came into being because of an article first published in the *'Model Engineer'* 20 - 25 years ago, the mechanism described at that time being designed for the Myford lathe.

I had recently acquired a new standard ML7 lathe and was minded of the better finish which could be achieved during screw cutting or, indeed, any operation which involved the sliding action of the saddle, by machining at a higher speed. However, this meant that ones reflexes had to be on the top line when machining up to a shoulder, and I therefore decided to add the auto cut-out to the leadscrew as my reactions are not that good. As the Myford employs a single leadscrew, the device can be used both when screwcutting and operating with a fine feed, and the service that it was to give in subsequent years proved its value over and over again.

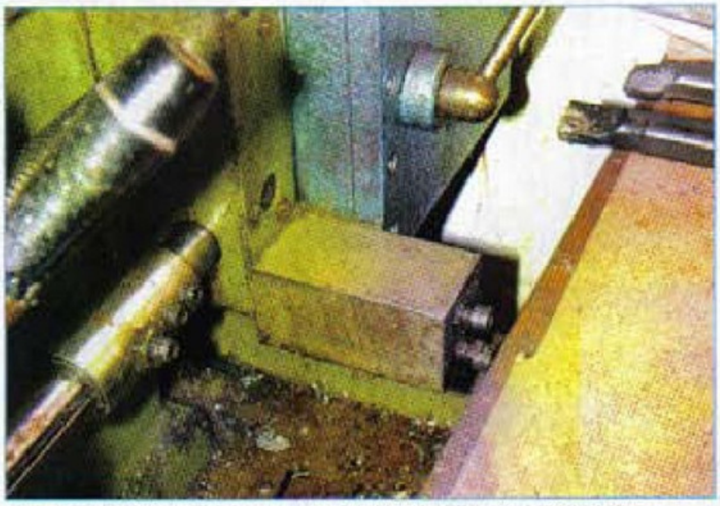
However, in the end all good thing have to go, and I decided a larger lathe was required. I would have liked a Colchester, but the pocket was not deep enough, so a Taiwanese machine was purchased and it has served me very well ever since. I have fitted it with a variety of modifications to tailor it to suit my requirements, for example a DC variable speed main drive motor and a similar variable speed saddle traversing mechanism. I have also equipped it with a digital read-out system, but the first thing to be made was a new version of the auto screwcutting stop. This had to be of a different design to that fitted to the Myford for a variety of reasons, as described below, but the extra work involved was thought to be warranted due to the greater potential advantages.

On this particular lathe, the drive mechanism is built more like an industrial unit, with a separate leadscrew for screwcutting and a splined shaft for sliding and facing cuts. The device therefore only works on the screwcutting aspect of the sliding action, but if a very fine thread is selected it will, of course, work when traversing. However it must be born in mind that if this is used continually, extra wear on the leadscrew is likely to take place.

Depending on the configuration of your lathe, it may be possible to modify the system to incorporate the mechanism into

2. Screwcutting released

3. The left-hand mounting block for the trigger bar. This will have to be designed to suit the lathe to which the unit is to be attached



4. The right-hand mounting block will have to be tailored in a similar manner

5. The adjustable trigger stop

the sliding and facing system, and even to work in an adjustable stop system for the cross-slide to take care of facing cuts.

Like all modifications of this type, the parts have to be designed to fit the individual lathe and may, in some cases, need significant alteration, so please make sure that the new components will fit before cutting metal. The principle of operation is shown in **Fig. 1** and the positions of the components just before and at the trigger release point illustrated in **Photos. 1 and 2**.

The control handle which engages half-nut with the leadscrew on my lathe is, unfortunately, on the right-hand side of the apron, as against being on the left-hand side on the Myford (i.e. nearest the chuck) and therefore a different design and layout was required. It became necessary to fit a trigger bar (Item 1) which runs from the headstock to the tailstock end of the bed, situated on the underside of the apron. This bar is tapped at 80mm centres for an M10 bolt which clamps the adjustable trigger stop in the desired place.

The only problem is that this trigger bar does make the cleaning of the lathe under-tray a little difficult, but this was overcome by fitting a 15in. handle onto a car windscreen scraper!

All the parts are straightforward and simple to make and, if the auto stop is to be used frequently then I would recommend that the appropriate items should be case hardened.

Blocks to space the trigger bar **(Photos 3 and 4)** off the lathe bed are not detailed as they will need to be suitable for the machine in question, and the length of the bar will need to be adjusted to suit the lathe length.

Item 2, the adjustable trigger block **(Photo. 5)**, which is again quite straightforward, is clamped to the bar in the appropriate position, then fine adjustment of the trigger point set with the screw (Item 3) and locknut **(Photo. 6)**. The block does need a lot of material to be removed if it is machined from solid, but it could be fabricated.

The pivot block (Item 4) is secured to the saddle apron in the appropriate position, and the detail design may need to be changed to make it fit your lathe **(Photos. 7 and 8)**. It is fitted with a spring-loaded plunger which pushes the latch bar into contact with the handle in the latch position. The pin (Item 5) is made of silver steel and hardened.

Item 6, the latch bar **(Photo. 9)** which pivots in the block is milled from mild steel and hardened as required. By all means try the unit before heat treatment, but do harden before the edges get worn. It is pivoted on a 6mm cap head screw which is secured with a lock nut. The fork into which the pivot fits is tapped on the inner side.

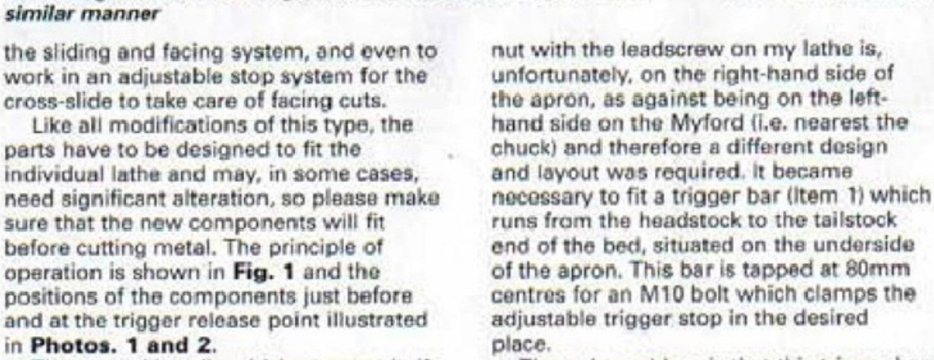


Fig. 1 Operation of screwcutting auto-stop

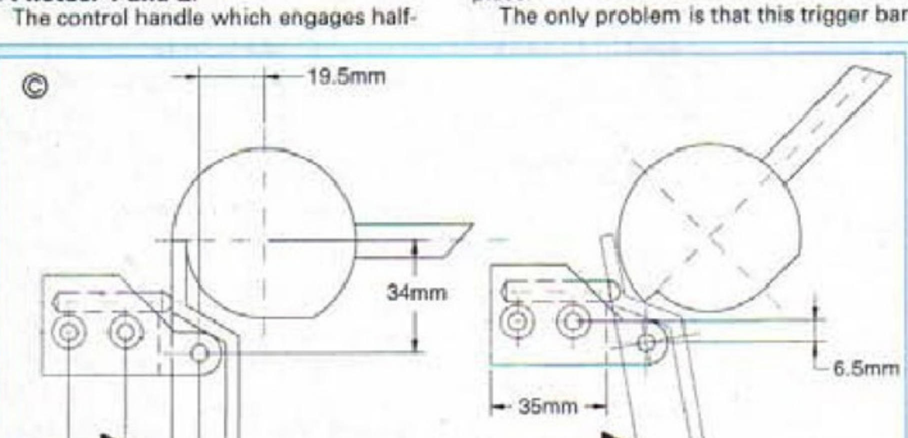
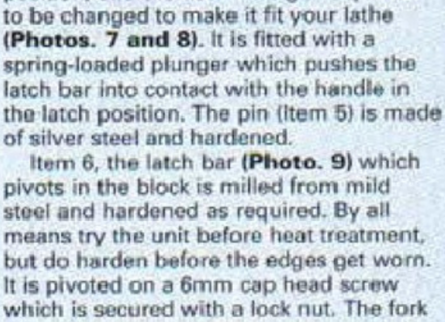
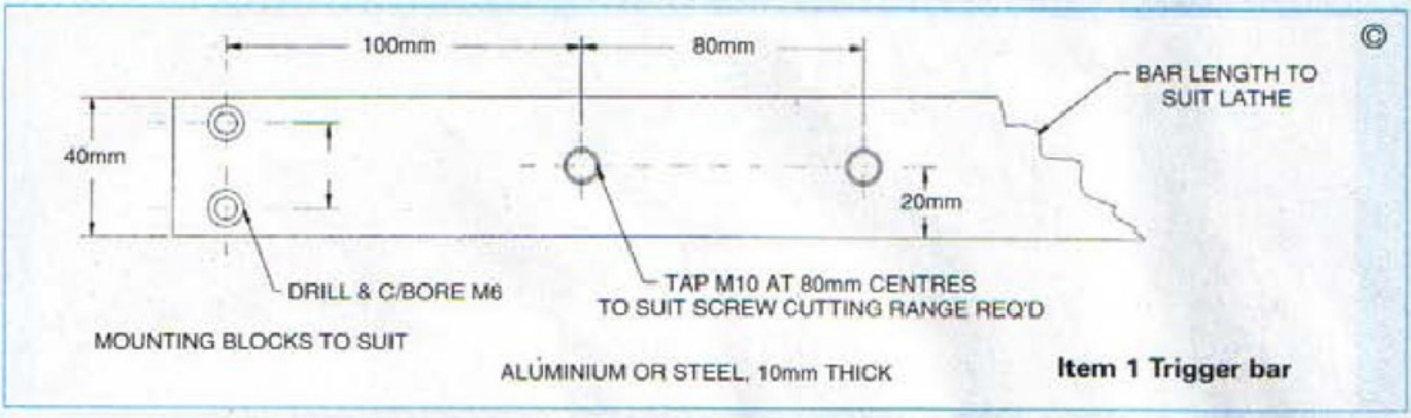


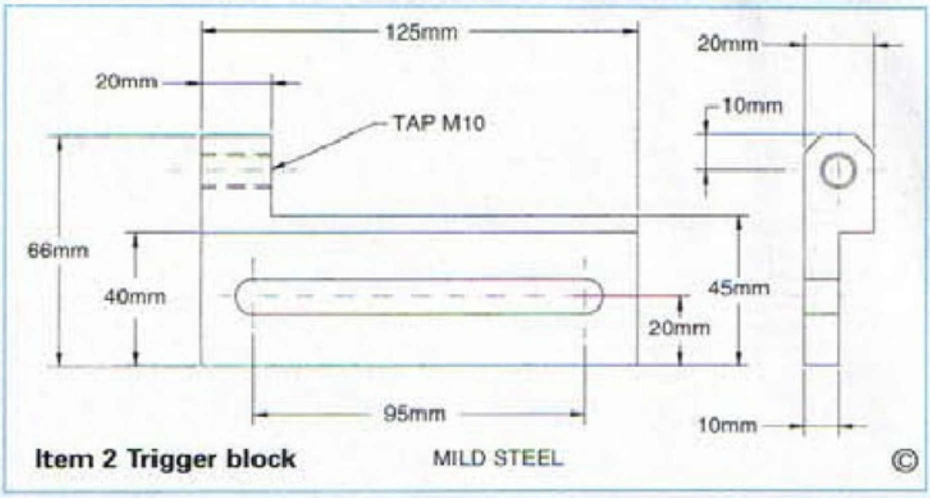
Fig. 2 Handle assembly



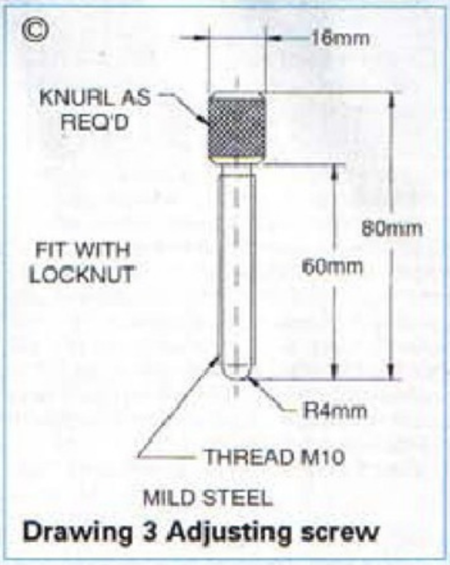
6. The trigger stop on the mounting bar. The clamp bolt hole positions may need to be adjusted to suit requirements



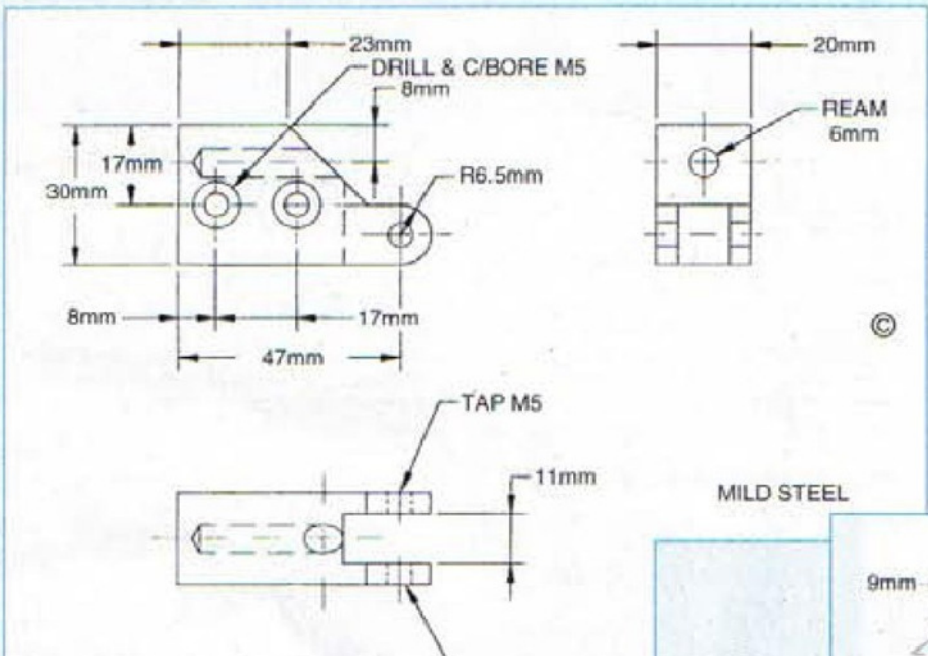
Item 1 Trigger bar



Item 2 Trigger block

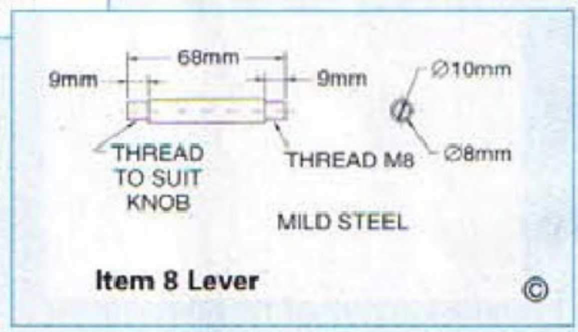


Drawing 3 Adjusting screw



Item 4 Pivot block

Item 5 Pin

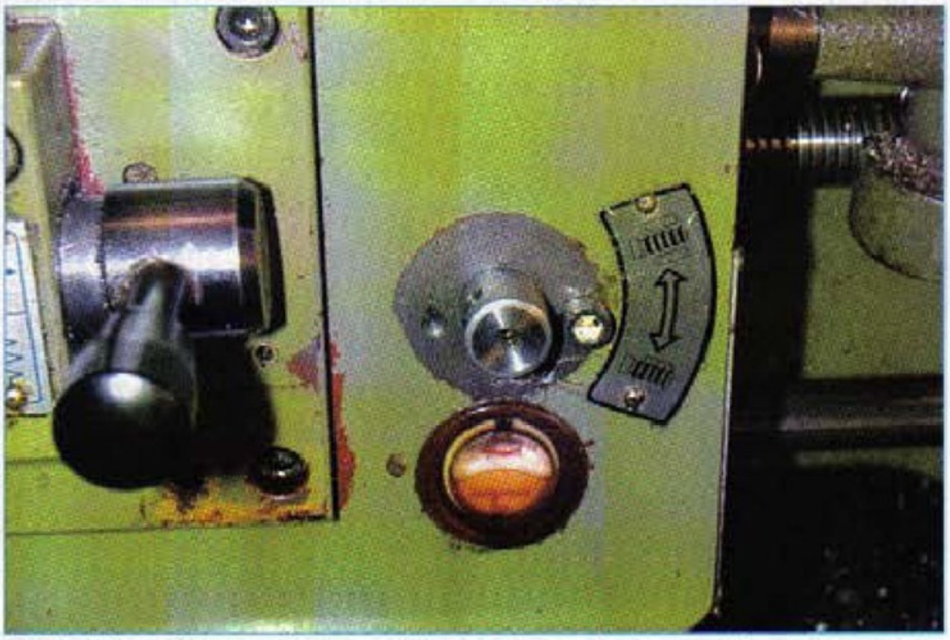


Item 8 Lever

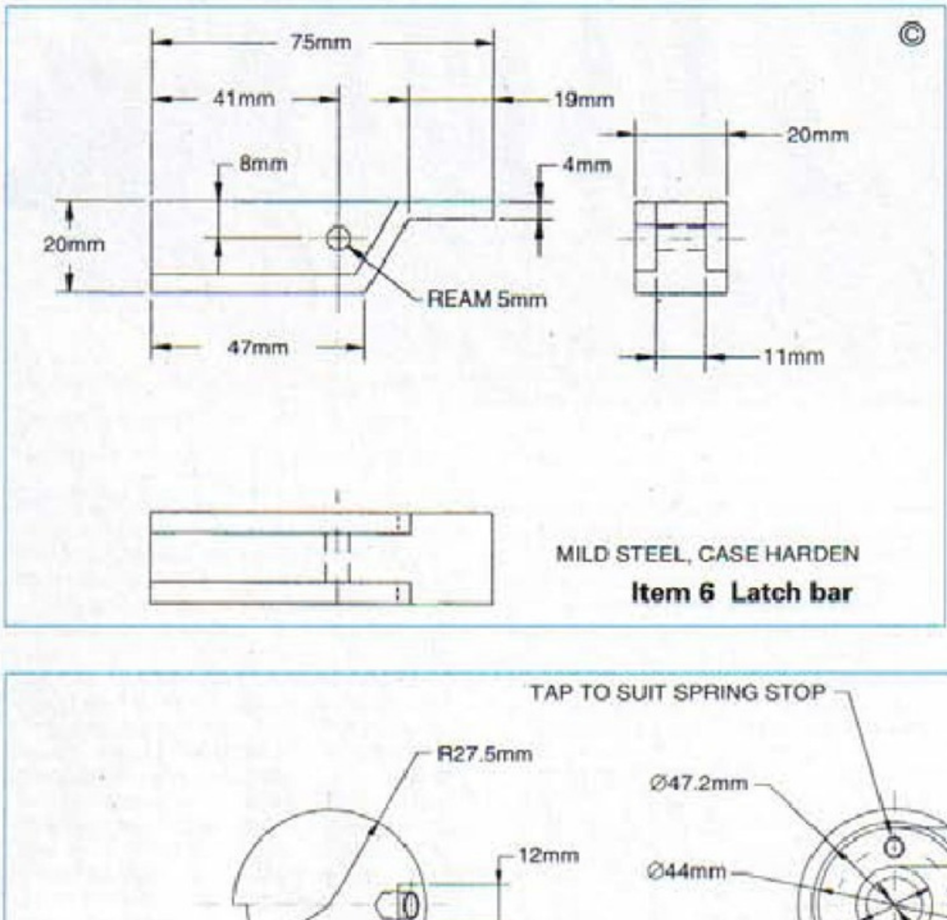
Fig. 2 shows the arrangement of the handle assembly **(Photo. 10)** which is made to fit onto the existing handle shaft and to be clamped into place using a 6mm grub screw.

On the inside of the central boss (Item 7) there is a groove to accommodate the spring which returns the handle to the disengaged position. This groove has a 6mm tapped hole to take a cap head screw which acts as a stop for the return spring. However, proper blocks may be machined and fitted if desired. The latter will give a better job, but does entail considerable extra work for little extra gain. There is also the equivalent block required to be mounted on the apron of the saddle for take the reaction of the spring. This will require to be placed accurately.

This has proved to be a useful addition to the lathe and well worth the time taken over its construction. As always, I can be contacted on 01233 712158 (Charing, Kent, UK), but telephone queries only please.



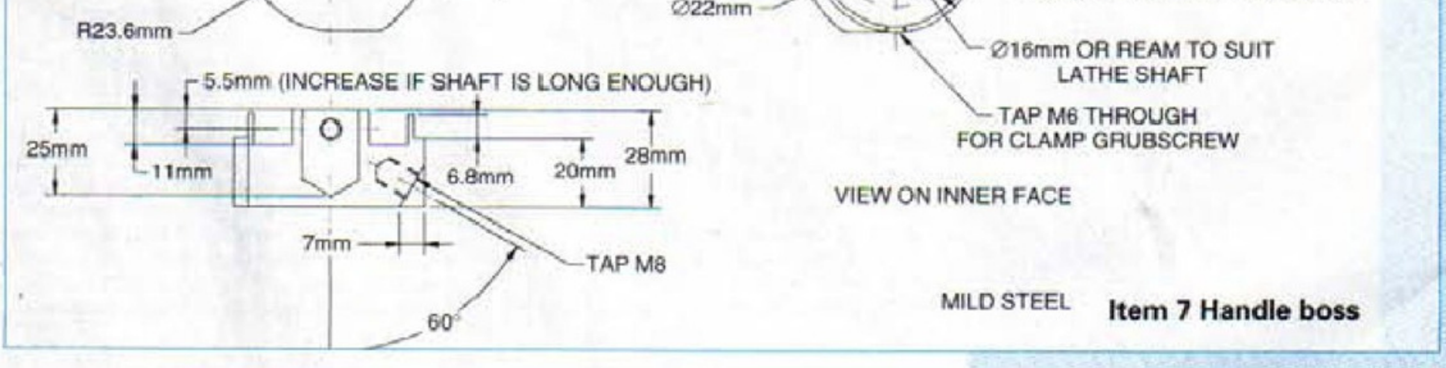
7. The lathe saddle apron before modification, the standard screwcutting engagement lever having been removed



8. The pivot block which is secured to the apron. Again this may need to be tailored to suit

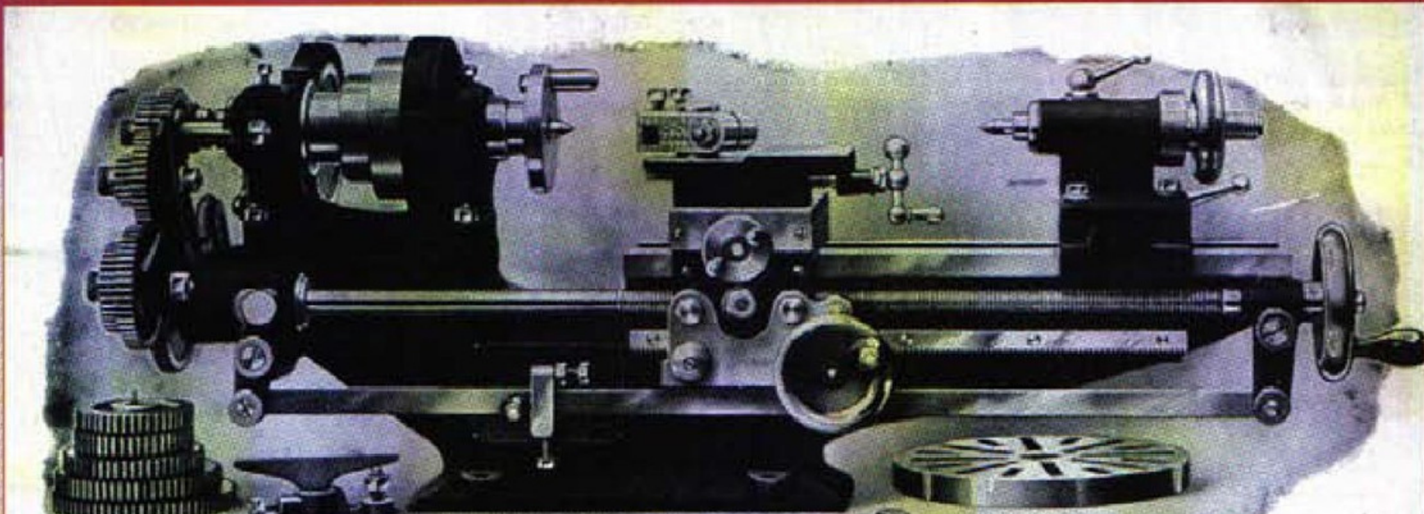
9. The latch bar which pivots in the block

10. The new handle showing the spring groove



TOM'S TIPS - Modifying a Drummond Lathe

Tom Bartlett, former Workshop Superintendent of the Society of Model and Experimental Engineers, recalls some improvements he made to a classic lathe



The Drummond 'M' type lathe

Obtaining a Drummond treadle-operated flatbed lathe was the starting point of my model engineering. This early type was provided with a headstock that could be swivelled a little either side of centre, enabling one to do taper turning.

Later, I was able to obtain the latest model, a $3\frac{1}{2}$in 'M' Type **(Fig. 1)**. This was an excellent lathe; in fact all Drummonds were considered to be very good, so much so that all British Navy battleships had one on board.

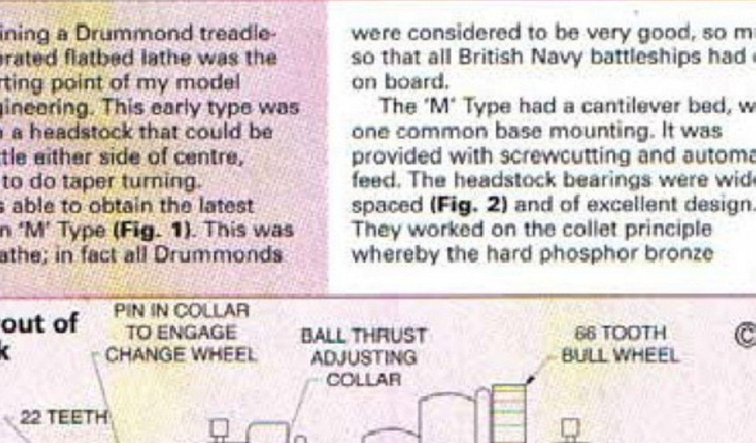
The 'M' Type had a cantilever bed, with one common base mounting. It was provided with screwcutting and automatic feed. The headstock bearings were widely spaced **(Fig. 2)** and of excellent design. They worked on the collet principle whereby the hard phosphor bronze bushes were tapered externally and housed in coned seatings in the headstock casting. The bushes were split and threaded and fitted with a screwed adjusting collar which could be used to take up wear, but everything remained concentric.

It was while studying this feature that I came up with the idea of fitting a larger mandrel which would accommodate a bigger bore. The original was only bored $\frac{3}{8}$in. and equipped with a No. 1 Morse taper. I thought it was well worth the alteration to obtain a $\frac{5}{8}$in. clear bore with a No. 2 Morse taper.

On dismantling, it became clear that the headstock bushes were tapered far more than was really necessary and, by reducing the taper, it would allow a thinner bush to be used and hence, a larger diameter mandrel.

The first thing was to obtain the material for this from the local scrap-yard, and I got a piece of drive-shaft from a lorry, about $1\frac{1}{2}$in. diameter with a splined end. This end was hardened and had to be cut off, but the remainder was machinable, so I started by cutting a 13in. long piece from it and boring a $\frac{3}{16}$in. hole right through. This was done on the large 'Holford' lathe in the S. M. & E. E. workshops. I extended a high-speed drill

Fig. 1 Layout of headstock



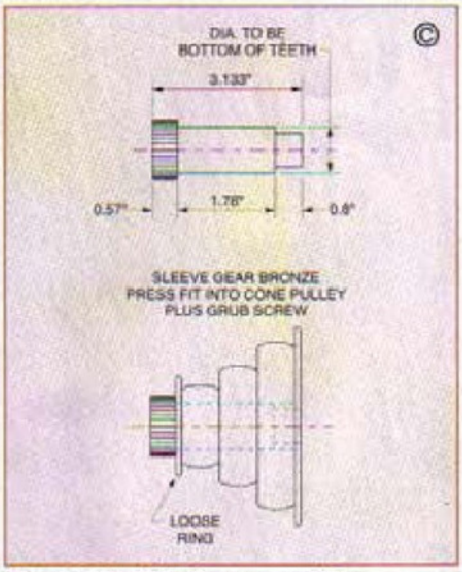


Fig. 2 Modified cone pulley

by silver soldering it onto a piece of silver steel, and was thus able to drill right through. Frequent withdrawals of the drill were necessary to clear away the swarf and to lubricate the drill. When it broke through it was about 1/8in. out of centre, so I then put it up between centres and turned it concentric.

My idea was to do the whole of the rest of the conversion and to open up the bore at home on my own lathe.

I cannot remember accurately the various dimensions, but I am sure that on removing the front bearing, which was 1in. bore, I was able to use this to replace the rear bearing, unaltered.

The amount by which I could increase the size of the mandrel was governed by the size of the boss on the bull-wheel which was carefully bored out and a new keyway cut for a Woodruff key. It was also necessary to bore out the cone pulley **(Fig. 3)** and provide a new sleeve gear which was pressed into position. I had to have this gear 'made out', not having the facilities for gear cutting at the time.

The next important job was to open up the front bearing housing and reduce the taper. This was done with a long boring bar which had a slot cut in it to take a floating cutter which could cut on both sides. The bar was turned by hand using a handle something like a carpenter's brace which allowed me to push as well as turn. I found it necessary to fit a screw at the end of the tailstock to limit the feed and provide a scraping action instead of a cutting action. This worked out very satisfactorily. I was assisted by my wife who undid the screw fractionally on my instructions.

A new front bearing bush was made up, with a threaded collar, as the original, but I did incorporate one improvement. Instead of relying on the pointed lubricating screw to expand the bush, eliminating any clearance, I milled a slightly tapered slot to take a small wedge **(Fig. 4)**.

When all was re-assembled, the bore

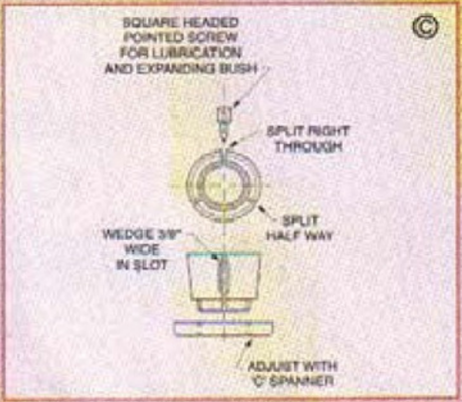


Fig. 3 New front bearing arrangement

was successfully opened up with successively larger drills and finished off with a 5/8in. reamer. The mandrel nose was screwed 1 1/8in. x 8 tpi. with a 1 3/16in. register, and bored No. 2 Morse taper. I didn't find it necessary to change the 22 tooth wheel at the rear of the mandrel.

The 5/8in. diameter bore enabled me to fit a hand wheel mounted on a 5/8in. expanding bolt - a very useful accessory when screwcutting, tapping and reaming in the lathe.

A further modification I carried out was to drill a hole through the tailstock barrel to provide an easier method of removing drill chucks. This was solid when new.

FIRESIDE READING

A former Unimat lathe owner gives his thoughts on a new book from one of our regular contributors

UNIMAT III LATHE ACCESSORIES by BOB LOADER

If any machine has its own guru then, for the Unimat, it must be Bob Loader. Bob has probably produced more articles and projects around the Unimat machines than any other contributor to MEW.

This new book has a range of topics designed for and produced on the Unimat. My own first venture into the world of Unimat was back in 1962 with the somewhat basic Unimat 1. How I wish there had been a book like this to help me through the near vertical learning curve of operating my first lathe.

The book comprises 14 chapters, each one a project in its own right. Ranging from the basic Milling Table (avoiding the machining of tee slots) to some more challenging exercises such as a headstock raising block to increase the diameter that can be swung. No matter what the complexity of the project, Bob has treated them all with his down to earth, common sense approach. Laced throughout the projects are hints and tips which could easily be adapted to all types of machining, not just applicable to the Unimat, such as the use of blue shoe cleaner instead of traditional engineers marking blue. Of course if you are not in the habit of wearing blue shoes this may be of limited interest. Although the projects are designed around the Unimat there is no reason why they could not be adapted to any type of small (and not so small) lathe.

Engineering is, by and large, a problem solving activity and this book sets out to resolve a lot of the limitations of working on a very small machine. The author is always conscious of the limitation of low horsepower and the small mass of the Unimat, therefore the watchword is many and small cuts.

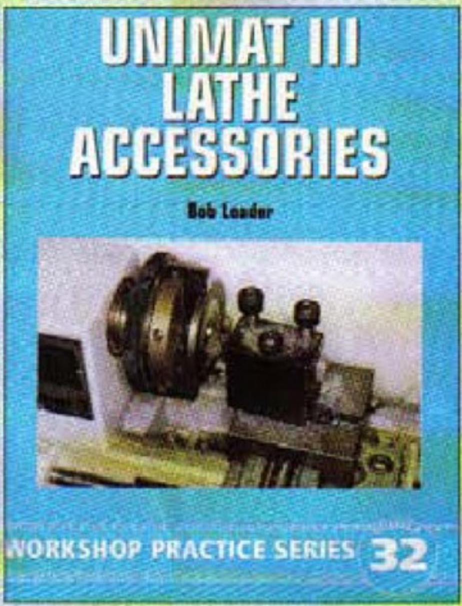
Each project is accompanied with fully dimensioned drawings and the photographs are a delight; they are well lit, clear and relevant.

Small asides, such the fact that his hacksaw that always cuts concave makes you realise that these are the workings of someone dealing with real day to day problems - I guess we all have some tool or other that we make those 'special' allowances for.

Although Bob is an obvious fan of the Unimat he is not above recognising that it has some shortcomings. These shortcomings are usually the reason to get a new project on the go. The machining of a 90mm face plate shows what a bit of lateral thinking can do, especially when confronted with a task that would clearly stretch the limits of the Unimat if approached from a conventional viewpoint. And just to show that the projects are not just space fillers you can see that some of the early projects are in use in the later chapters.

I could go on to detail more of the chapters, but as space here is at a premium, suffice it to say that this book is must for everyone who owns a Unimat and an essential buy for everyone who does not own a Unimat. G.G.

UNIMAT III LATHE ACCESSORIES by Bob Loader is No. 32 in the Workshop Practice Series and is available from Nexus Books at £6.95 plus £1.15 p&p. ISBN 1-85486-213-8



THE MURAD BORMILATHE

The Bormilathe was developed by Murad Developments Limited, then of Aylesbury, Buckinghamshire as a result of their experience of supplying machinery to the 1955 Trans-Antarctica expedition led by Dr. Vivian Fuchs (later Sir Vivian). Launched in the autumn of 1959 with advertisements in 'Model Engineer', the machine was aimed initially at the amateur market, but interest from industry soon showed that it had a wider appeal. One of the first customers was UKAERE at Harwell who followed up their first order with a repeat for a batch of eleven. The armed forces, public corporations and many industrial concerns soon followed their example. Production was later established at a new factory at Queenborough, Kent.

The Bormilathe featured a short but wide cast iron bed, the left-hand end of which carried a vertical slide on which the headstock was mounted. This could be raised or lowered under the control of a leadscrew, to provide a centre height which could be varied between $3\frac{1}{2}$in. and 7in. The spindle was through-bored $\frac{25}{32}$in. (later $\frac{13}{16}$in.) and housed a No. 3 Morse taper socket. It was carried in pre-loaded angular contact bearings and threaded $1\frac{3}{8}$in. x 8 tpi Whitworth form, though later catalogues quote $1\frac{7}{8}$in x 8 tpi.

Final drive to the spindle was by 'V' belt and stepped pulley, but a special motor designed by British Bronson, the electrical company in the Murad group, allowed up to twelve speeds to be obtained. This was achieved by fitting the motor with a gearbox containing pick-off gears which provided the ratios 1:1, 2:1 and 3:1. By arranging this gearbox to pivot about the motor axis, the varying centre distance associated with the elevating headstock could be accommodated.

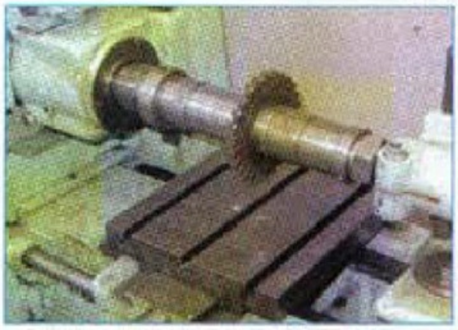
The tailstock was mounted on a similar vertical slide, the position of which could be set along the bed to accept 10in. between centres. A later long bed version stretched this to 18inches. This vertical slide could also be set over to facilitate taper turning. The tailstock barrel could be removed easily, allowing a bronze bush to be fitted in its place so that a milling arbor could be supported. This Morse taper arbor was provided with a positive drive from the headstock spindle.

A substantial saddle could be traversed by hand wheel or leadscrew, full screwcutting facilities being provided. A conventional cross-slide and top slide ran on dovetail ways, but the cross-slide could be quickly removed, allowing a 'T' slotted milling table to be substituted.

A full range of accessories was listed and the motor could be obtained in single- and three-phase versions.

The initial advertisements quoted a price of £39.10.0 (£39.50), but careful reading indicates that this was without a motor. At the time, the basic Myford ML7 was some £20 more expensive. By the early 1960s the price had risen to £91.17.6d (91. $87\frac{1}{2}$p), but the $\frac{1}{2}$hp. single-phase motor cost an additional £19. 10. 0 with just one set of pick-off gears, the other sets being an extra £1.12.0 each.

Although apparently being the manufacturers of a wide range of machine tools, the Murad company no longer appears to exist. If any reader has information on the later history of Murad or this interesting machine, we would be pleased to hear. The photographs are of an example still in use in a model engineer's workshop. Somewhat modified and a trifle travel stained, it is still capable of accurate work and should provide valiant service for many years yet.



A KEYWAY SLOTTING TOOL

John Payne describes a simply made special-purpose tool

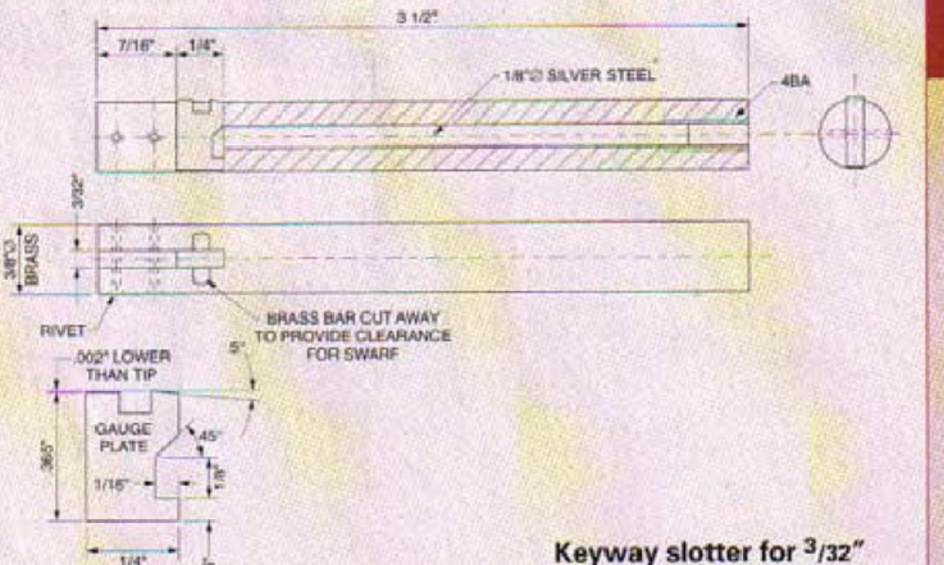
In 1937, when I was 14 years old, my father took me to the M.E. Exhibition and among many things we looked at Stuart's stand (I still have the catalogue). Father was attracted to the No. 9 engine, and said that we should get the kit and build one between us. It never happened.

Some years ago an old friend acquired a No. 9 set, part machined, at a boot sale, and later passed it on to me when his sight went. Six months ago, I decided to build it in memory of my father, but this was difficult as all the work was very badly done and all had to be done again, including making a new crankshaft.

In an effort to make the engine a bit more refined than some, I decided to key the flywheel and eccentric to the crank with $^3/_{32}$in. wide gib head keys, so made for the purpose a keyway slotter, the drawing of which is shown.

It can only be used, as drawn, for $^3/_8$in. dia. bores and I racked it through very easily with the lathe saddle, having held one end in a block in the toolpost. The block was drilled $^3/_8$in. with a drill held in the lathe chuck. The 0.002in. step controls the depth of cut and the groove catches the swarf, which must be cleared at every pass. Finger pressure on a 4BA cap screw was enough to advance the cutter which was retracted before withdrawal. The cutter and $^1/_8$in. pin were tempered dark straw.

I tried to make a leather flat belt to drive the governor, but without success. An 'O'-ring was fine, but didn't look the business, so I turned a wood disc to hold the 'O'-ring whilst I sanded it flat with a sanding drum. The section was fine, the tension was good, so I painted it brown with some 20 year old paint that would not dry. I then thought that it would be more realistic if dusted with snuff, but not having any, I used cocoa!



Keyway slotter for $^3/_{32}$" keyway in $^3/_8$"ø bore

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- Back numbers of M.E.W. Issues 2 and 4 to 10, 13, and 16 to 18. Good price paid.
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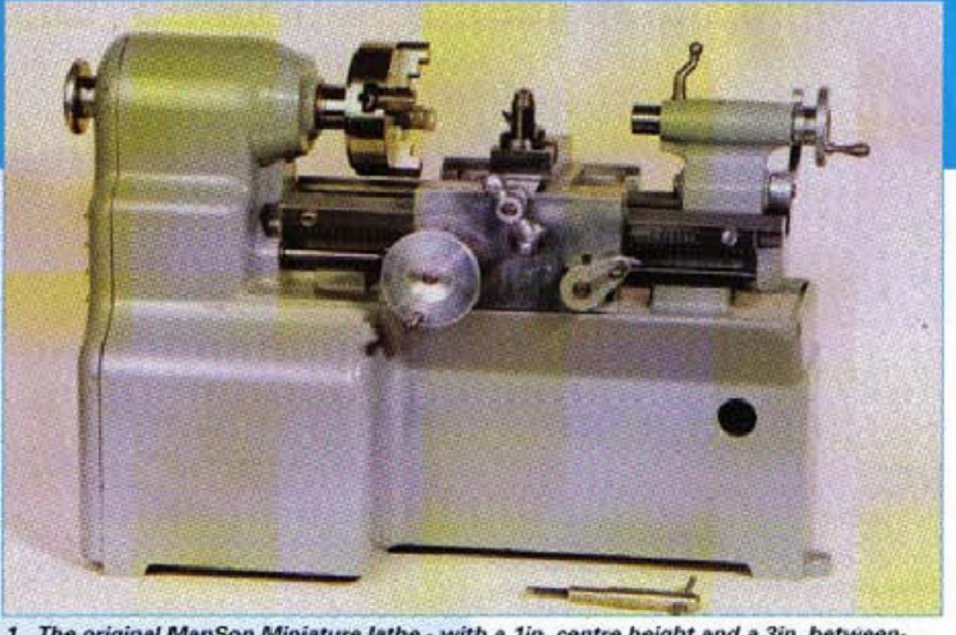
- Does anyone have a user manual, service manual or circuit diagram for a Newall Electronics DRO type DIGIPAC 5 HP2 001A (S/No. 31796) as originally fitted to a Harrison M300 lathe or any other useful information? Costs of copying and postage etc. gratefully reimbursed. Tel. 01481 257253 evenings (Guernsey) or contact pchumphry@hotmail.com

THE MANSON LATHES OF SMALL MACHINES INC.



1. The original ManSon Miniature lathe - with a 1in. centre height and a 3in. between-centre capacity it was just over 9in. long

Tony Griffiths of Buxton, Derbyshire describes some interesting small American lathes of the post-WWII era

Given that, at the time, only a tiny percentage of Americas machine tools were made away from the Eastern states, Los Angeles, California, immediately after World War II might not immediately come to mind as a place where a new manufacturer of miniature lathes might emerge. However, as an important metal-working centre on the West Coast, that is where Small Machines Inc. choose to make the tiny and very unusual ManSon machine.

The company, which began trading in October, 1946 and was located at 2010 South Sepulveda Boulevard in West Los Angeles, California, USA. They boldly advertised their first machine as, *"The World's Smallest Lathe"*.

In mid 1948 they introduced the watchmakers' DuoLathe (their best model, which could be had with collet holding and/or micrometer tailstock), followed shortly afterwards by the less expensive MonoLathe.

The first ManSon

The original ManSon lathe **(Photos. 1 and 2)** was really very tiny; just $9^3/_{16}$in. long, $3^{11}/_{16}$in. wide and $6^3/_4$in. high (223mm x 94mm x 171mm). It had a swing of 2in. (51mm) and a between-centres capacity of 3in. (76mm) - whilst the collet capacity was limited to $^1/_8$in. (3mm). Whilst physically small, the remarkable thing about the ManSon is its appearance, which closely resembles a scaled-down toolroom lathe of the era, along the lines of the American Monarch EE or English Smart & Brown Model A.

So difficult is it to categorise the lathe, that the words "working model" might be considered a fair description. Certainly, when worn out, they make a wonderful mantlepiece decoration - at least, for those lucky enough to have an understanding better half.................

The stand and headstock were in die-cast aluminium whilst the V-bed, of cast iron, was screwed to two bosses on the top of the cast aluminium stand. The headstock spindle **(Photo. 3)**, running in self-oiling porous bronze bearings, was bored through $^3/_{16}$in. and carried a nose thread of $^7/_{16}$in. x 20 American National Fine.

The base of the lathe contained a 110 volt motor **(Photo. 4)** which drove upwards, via a neoprene '0'-ring belt, to a wheel with an inboard gear attached, positioned just below the headstock spindle. The inboard gear then drove a gear attached to the end of the spindle whilst a small gear (on the spindle) drove back down through a 'compounded' set of slender, clock-like gears **(Photo. 5)**, to the 32 tpi leadscrew. Unfortunately, because the leadscrew drive gears were fixed in place, and could not be changed, the lathe was not capable of screwcutting. Even so, this was almost certainly the world's smallest production lathe ever to have been made with a power sliding facility.

There was no backgear on the early model and the number of spindle speeds, from the fan-cooled motor, was limited to two.

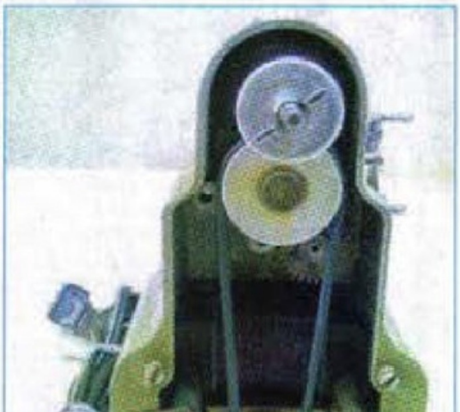
The carriage assembly **(Photo. 6)**, which featured relatively enormous saddle wings, could be moved along the bed by either a hand-operated rack feed or under power from the 'leadscrew'.

The apron had gearing which gave a "correct" movement of the saddle as the handwheel was moved. The clasp nut was one-sided - and without a compensating thrust pad, but, for the forces involved, probably quite adequate **(Photo. 7)**.

The cross-slide and the saddle on which it ran were both of aluminium, the latter being cast

2. The base and the headstock were a one-piece casting to which the cast iron bed was attached by screws

3. The headstock spindle, complete with the leadscrew drive gear cluster, shown with a 4-jaw independent chuck



4. The drive system showing the built-in two-speed motor

integral with the apron **(Photo. 8)**. The cross-slide gib was interesting as it consisted of a corrugated strip of spring steel, designed to be self adjusting. With the small forces involved, it seems to have proved to be quite successful. It was retained by simply being bent over at the ends **(Photo. 9)**, and examination of this area suggests that it was touched on a grinder to ensure flatness.

There being no swivelling top slide, tool movement was constrained at 90 deg. to the bed. The toolpost was a miniature of the quick-setting 'American' type.

Although it would have been much cheaper and easier to have fitted plain parallel ones, every handwheel on the lathe, including the proper, but miniature, ball-ended 'balanced' wheel on the cross-feed screw, was fitted with shaped handles.

Looking as though it was carefully scaled from a very much larger lathe, the tailstock carried a very positive eccentric lock which ran through the length of its base **(Photo. 10)**. The barrel was clamped by closing up a simple slit in the casting.

The machine was finished in grey - and weighed just 10 or 12 lb, according to which publicity catalogue you believe. Without a motor the weight is, however, only 41b 4oz.

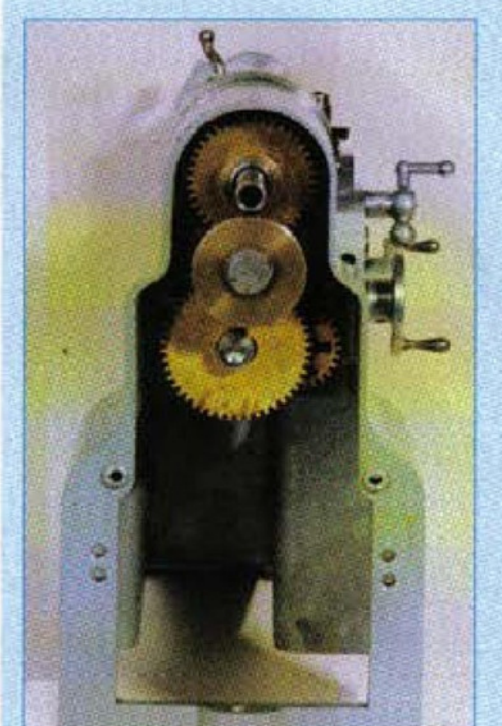
The lathe was supplied, as standard, with a $1\frac{1}{4}$in. faceplate, two centres, a toolpost, motor and switch at a cost of $58.50. For an extra $2.25, a single drive dog was supplied, together with a tool bit and test rod. In comparison, in 1948 the 'Craftsman 80' 6in. swing by 12 in. between centres, backgeared, screwcutting lathe cost $42 without a motor and $55.50 with.

A British lathe of the same era was the 'Flexispeed' which demonstrated a completely different - if not to say a diametrically opposed - approach to building a miniature lathe. Of much cruder appearance, the 3in. longer Flexispeed is an entirely useable lathe, with a $1\frac{1}{2}$in. centre height and admitting 6in. between centres. It has adjustable, gibbed slideways, a swivelling top-slide, all-cast iron construction, a set-over tailstock and carries standard No. 1 Morse taper centres. The carriage can only be moved along the bed by hand-feed via the bronze full nut on the leadscrew - and a separate motor is required to drive the 3 speed spindle pulley. Without a motor, the Flexispeed weighs 8lb 5oz, close on double that of the ManSon and in 1946 it was available at £6 16 6d (£6 $82\frac{1}{2}$p). For 'serious' work, which would you have chosen in 1946?

Some idea of the actual size of the Manson can be gauged from **Photos. 11 and 12**.

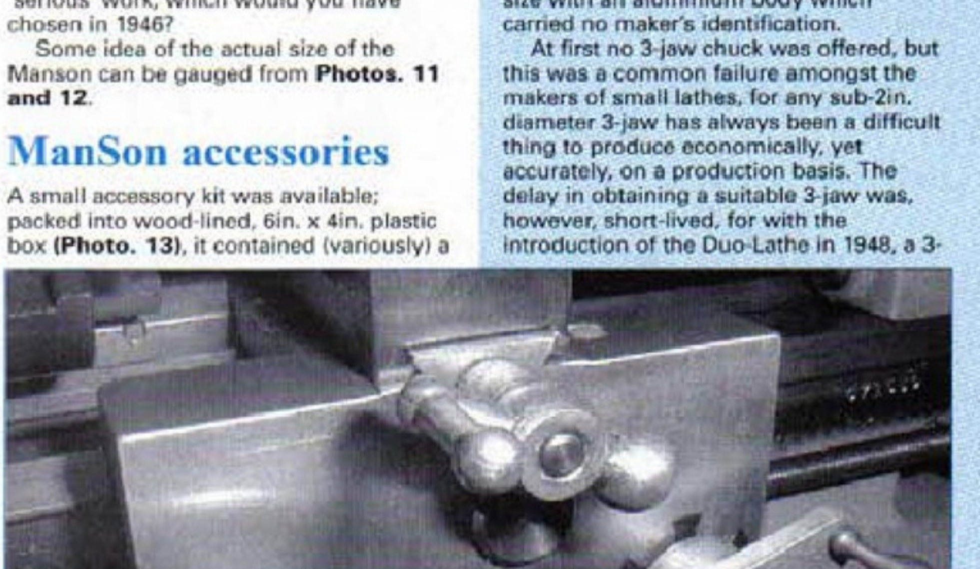
ManSon accessories

A small accessory kit was available; packed into wood-lined, 6in. x 4in. plastic box **(Photo. 13)**, it contained (variously) a 4-jaw independent chuck (stamped with the ManSon name and address) **(Photo. 14)**, a collet chuck and four collets of $\frac{1}{32}$in., $\frac{1}{16}$in., $\frac{3}{32}$in. and $\frac{1}{8}$in., a $1\frac{3}{4}$in. diameter faceplate with eight tapped holes, a tailstock drill-chuck, one centre drill, two lathe dogs, several lathe tools and an Allen-wrench. Similar kits, but with different ranges of accessories, were also produced. Depending on the date of manufacture, the 4-jaw chuck was also known to have been supplied in a larger size with an aluminium body which carried no maker's identification.

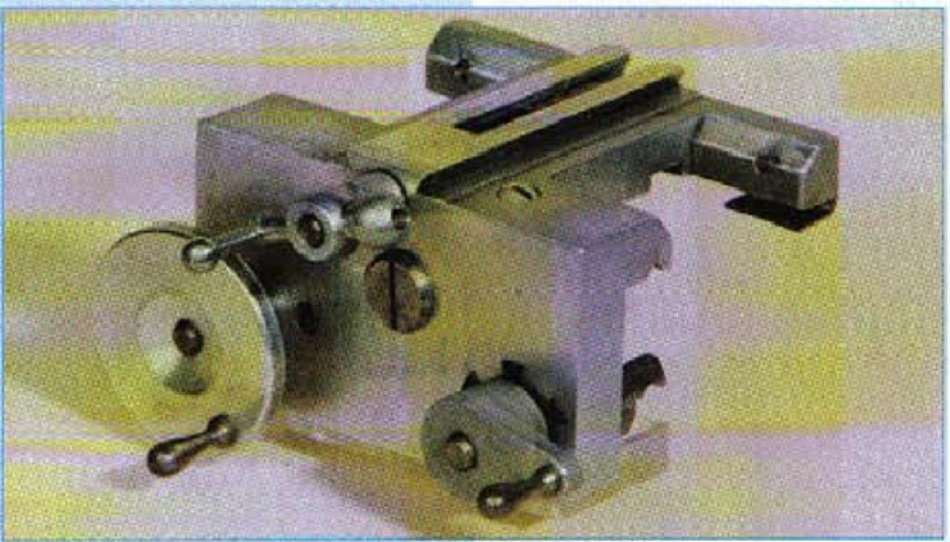


5. The gear train to the leadscrew

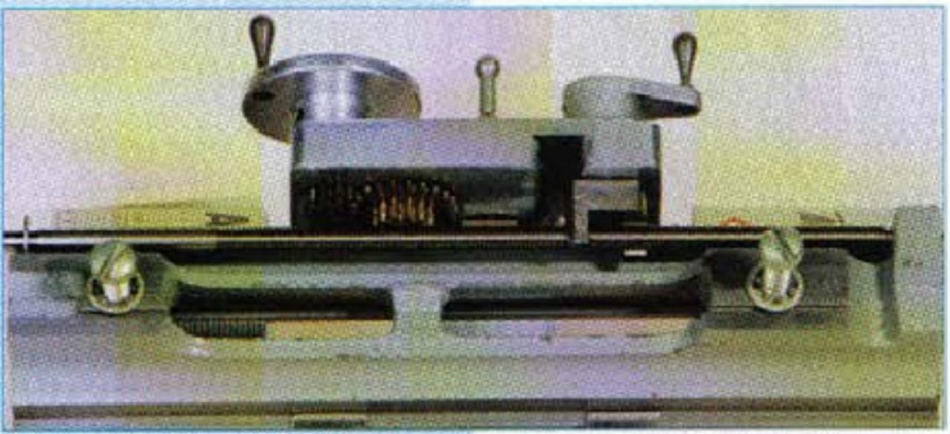
At first no 3-jaw chuck was offered, but this was a common failure amongst the makers of small lathes, for any sub-2in. diameter 3-jaw has always been a difficult thing to produce economically, yet accurately, on a production basis. The delay in obtaining a suitable 3-jaw was, however, short-lived, for with the introduction of the Duo-Lathe in 1948, a 3-



6. The carriage assembly. The left-hand wheel traverses the unit by means of the rack while the left-hand lever engages the single-sided half nut



7. The substantial integral saddle and apron casting. note the elegantly shaped handles



8. A view from under the bed. The gear train provides 'correct' movement of the traversing hand wheel

9. The cross-slide and toolpost components. The method of locating the corrugated stainless steel gib strip is evident

10. Tailstock components. The eccentric lock gives a firm grip on the bed

jaw self-centring chuck was offered as an optional extra for only a few more dollars than the independent 4-jaw. Today, many enthusiasts for tiny lathes fit a suitably-mounted Jacobs 'tailstock' chuck; they are very accurate and, whilst hardly as versatile as the real thing, can be surprisingly useful. Unfortunately, the ManSon lathe is so minute that even a smaller Jacobs chuck might prove too large.

The ManSon DuoLathe, circa 1948

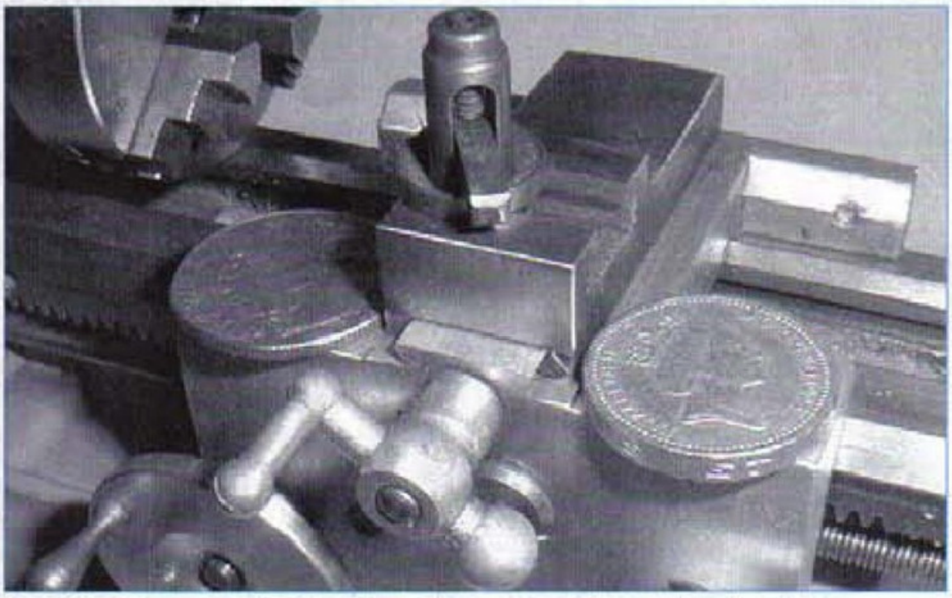
The second product of Small Machines Inc. was the DuoLathe, resplendent in its highly-polished aluminium finish **(Photo. 15)** and designed to appeal to watchmakers, jewellers, instrument repairers and laboratory and other specialist technicians who needed a small but accurate lathe capable of mounting a screw-feed tool slide as well as a more traditional 'tip-over' hand-tool rest.

At 10½in. long, 3¾in. deep and 7¼in. high, it was slightly larger than the ManSon and allowed the swing to be increased by 1in. to 3in., the between-centres capacity lengthened by 1¼in. to 4¼in. and the weight to rise by 21b.

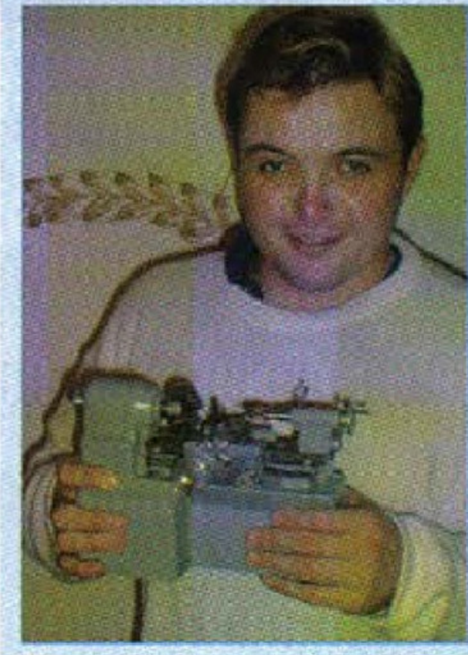
The spindle, now hardened, ground and mounted on ball races, was enlarged to allow the mounting of standard WW type collets and chucks - and to increase the bore to 5/16in.. The ability to take WW (Webster Whitcomb) 8mm collets (or 'chucks' as they are sometimes called in the watch trade) would have made the lathe much more attractive to those owners who already had a collection of expensive collets used on their other watch-repair equipment. Incredibly, a backgear **(Photo. 16)** was also provided which, combined with the foot-controlled, variable-speed (rheostat) motor gave speeds from 100 to 3000 rpm. These modifications made the lathe a much more practical proposition for serious work.

The tailstock was supplied, as standard, with a simple 'push' barrel capable of taking WW jeweller's collets, chucks and attachments - although an optional self-eject, screw-feed barrel unit (as illustrated) was available as no-cost alternative. The body of the tailstock could, as on many larger lathes, be set over for taper turning and, offered as a further option, was an unusual accessory which the makers called a "micrometer-adjustable tailstock". An examination of the illustration below should make its method of operation clear.

Supplied with the early lathes were a motor with foot-operated rheostat controller, two centres and a headstock-spindle drive plate. However, shortly after the lathe's introduction, the 'tip-over' tool rest became part of the standard equipment. Accessories available included the two special 'micrometer' collet-holding and screw-operated tailstocks, a self-centring 3-jaw chuck, an independent 4-jaw chuck, a tailstock drill chuck and centre drill, a small standard Morris tap and die set (the Morris Company is still in business and sells the same set), various types of tool bits, lathe dogs, spare belts and wrenches.



11. A US 'Quarter' on the left of the saddle - and a British Pound on the right.



12. ....and to human scale, this is how small a ManSon really is

A new Company

On August 4, 1949 a new company was incorporated, MasterSon Engineering Co. of 1416 Westwood Boulevard, Los Angeles and by the mid-1950s they had introduced a line of three new Master Lathes:-

Model S (for 'Standard') had bronze bearings,

Model BS for 'Ball Bearing Standard' and

Model BWW for the 'Ball Bearing Large Spindle' for 8mm WW type collets.

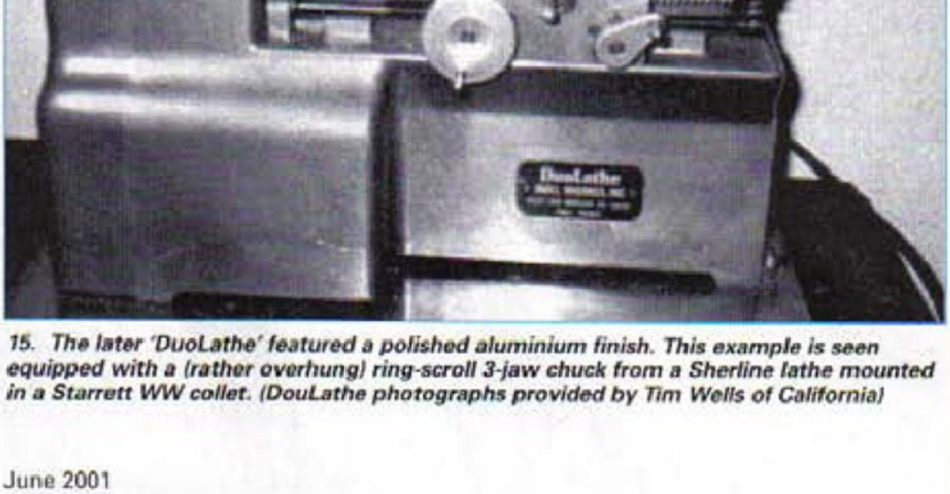
This latter machine could be specified with change gears for screwcutting, a dial thread indicator, built on countershaft unit and various factory installed accessories - a remarkable achievement in a lathe only 10in. in overall length.

If any reader can provide high-quality pictures of the later Model S, Model BS and Model BWW lathes, the author would be very grateful.

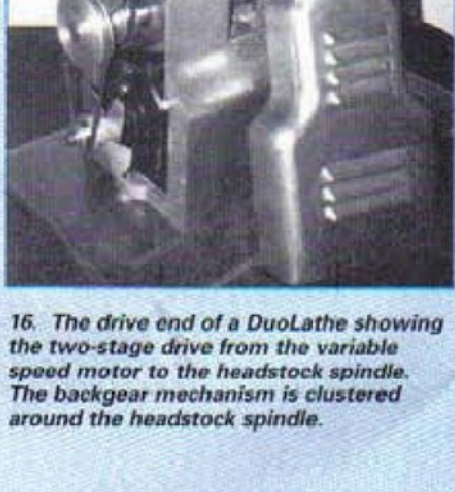
Tony's website www.lathes.co.uk contains further details of these and other interesting items of workshop machinery.

13. An accessory kit as supplied in a fitted case

14. An early ManSon independent 4-jaw chuck

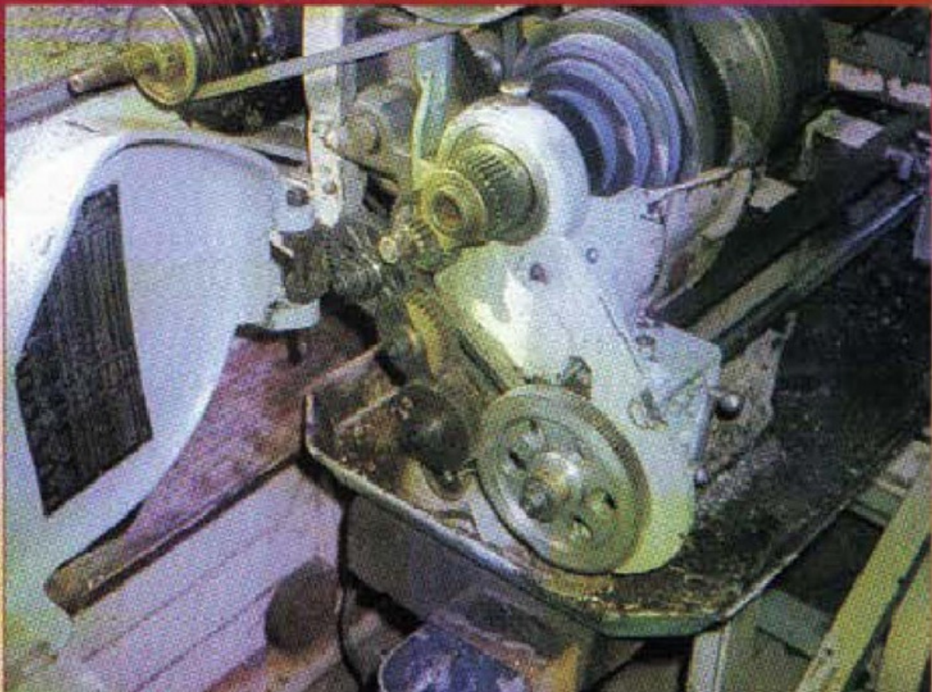


15. The later 'DuoLathe' featured a polished aluminium finish. This example is seen equipped with a (rather overhung) ring-scroll 3-jaw chuck from a Sherline lathe mounted in a Starrett WW collet. (DouLathe photographs provided by Tim Wells of California)



16. The drive end of a DuoLathe showing the two-stage drive from the variable speed motor to the headstock spindle. The backgear mechanism is clustered around the headstock spindle.

CUTTING METRIC THREADS ON AN ATLAS LATHE



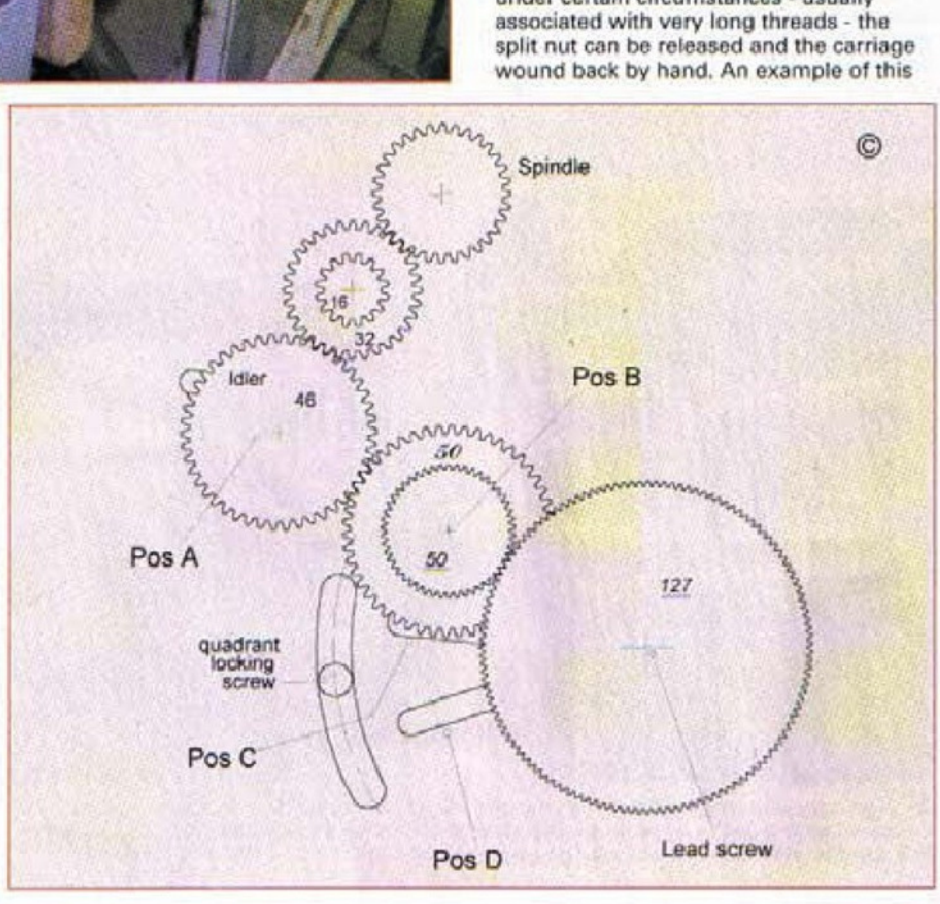
Norman Hust suggests a solution to a problem encountered by many lathe owners

I have noticed that, over the years, requests have appeared in Scribe a Line for details of Atlas lathes. It would therefore appear that there are still plenty of these around, along with their copy, Acorntool. I believe that Sphere and Halifax lathes were also copies, but I have not come across these myself. The maker - Atlas Press Company of Kalamazoo, Michigan - first produced these back in the 1930's, and many were brought into the UK during and just after WW2. Atlas made different types and sizes, but most lathes (and copies) which are still around, appear to be the 5in. (10in. in North America) change-gear type, with a compound gear of 16 and 32 teeth, driven from the spindle.

As with many other Imperial lathes, the threading chart gives change wheel set-ups for cutting metric threads with the standard gear set. Because these standard sets do not include a 127 tooth gear, the resulting thread is an approximation only - albeit usually very close and good enough for most purposes. However, in order to obtain a true metric thread on an Imperial lathe, a set of extra gears is necessary; these are sometimes called transposing gears and they include the 127 tooth wheel.

When cutting metric threads, I always found that setting up an 'approximate' gear train was complicated and tedious, and I decided that using a set of transposing gears would be preferable. I don't know whether it is possible to obtain commercially made Atlas transposing gears, but because of the age of these lathes, I feel that it would be unlikely. I know that some lathe manufacturers supply these gears, but - in my opinion - the systems are sometimes more complicated than they need to be. I know of one manufacturer who supplies a set consisting of 10 gears (Ref. 1).

I have found that gear trains for mathematically correct threads are more straightforward to set up; fewer wheels usually being required than with the 'approximate' gear train methods. Also, under certain circumstances - usually associated with very long threads - the split nut can be released and the carriage wound back by hand. An example of this



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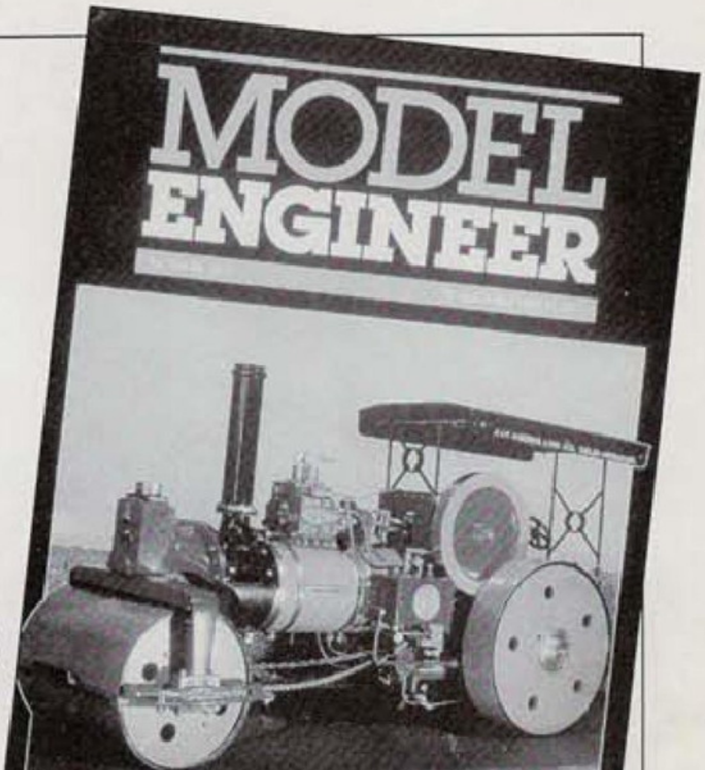

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is cutting a 0.8mm pitch thread of 4in. length. The distance of 4in. equals two complete turns of the threading dial and is exactly 127 threads long.

For my Atlas lathe, I have solved the problem with only two transposing gears; a 50 tooth and a 127 tooth. Whilst I can't claim that these will cut all metric threads, they are suitable for most of the sizes from M3 (0.5mm pitch) to M20 (2.5mm pitch) as well as 1BA (0.9mm pitch). For some of the metric threads an additional 'standard' (16DP) gear with 50 teeth was necessary, so perhaps it would have been more correct to say that three transposing gears were used. This 50 tooth gear is over and above the standard Atlas gear set, and serves the purpose of a transposing gear for the sets-ups as shown in the chart, although other size wheels could have been used with different gear trains. This 50 tooth wheel can, of course, be combined with the standard set and would be suitable for many other operations, e.g. making up special gear trains for worm cutting, indexing or feeds.

Gear tooth form

This is not an article on gear design or cutting, but it is necessary to mention that in order to keep my 50 and 127 tooth transposing gears to an acceptable diameter, the gear teeth were cut to a Module 1 form. This corresponds to wheels of 52mm and 129mm outside diameter respectively. For the thread pitches mentioned above, the large wheel is always mounted on the leadscrew spindle, but it still gives ample clearance for the standard gear case in its shut position. It also fits in well with the various gear trains (see photo and Diagram 1). In my system, these two wheels only mesh with each other, so there is no need to make them compatible with the standard Atlas gear teeth. Indeed, if the large wheel were to be cut to the 16DP form, the outside diameter would $8^1/_{16}$in. - i.e. 129 x $^1/_{16}$in. - and this would be far too large for the existing gear case, or to fit into a gear train. Other small tooth sizes could also be used for the transposing gears, e.g. 26DP or Mod 0.8, but the only cutters available to me (borrowed), were of the Module 1 sort.

New threading chart

I have made up a metric threading chart similar to the style used in the standard Atlas chart , an example of which can be seen inside the gear case cover in the photo. The standard Atlas Imperial chart gives diagrams of gear trains up to Fig 9, but with the metric chart I have extended this to Fig 15.

The sizes of the idler gears that I have shown are optional in most cases. Both in the case of the standard and the metric charts, if the specified idler gear is not available, a different size can usually be fitted. However, if the idler is too small, the gears won't mesh, or the 'T' gear in position 'B' will foul the 32 tooth compound gear. If the idler is too large, the quadrant locking screw may be obscured. Fig 15 shows an example where the idler size is at the maximum.

Diagram 1 shows the set-up for cutting a 0.8mm pitch thread (Fig 13 in Diagram 2). In my view, this indicates the simplicity of the system compared to the 'approximate' method. It also shows the difference in size between a standard 50 tooth wheel and a Mod 1, 'transpose' 50 tooth wheel. The gear train in the photo is for cutting a 1.5mm pitch thread (Fig 15 in Diagram 2).

Although this system and the charts are designed for an Atlas lathe, the principle is applicable to all change-gear lathes. With lathes having metric lead screws, the method to 'transpose' - i.e. obtain true Imperial pitches - still applies, but with these lathes, the 127 and 50 tooth gears would be reversed, so that the 50 tooth transpose gear would be positioned on the leadscrew. Unfortunately, this spreads out the gear train and would make setting up more difficult. With any lathe not having the Atlas type 16 and 32 compound gear, many more calculations would be necessary.

Reference

1. MEW No 44, Scribe a Line, page 64

IN OUR NEXT ISSUE

Coming up in Issue No. 75 will be

A QUICK-CHANGE SCREWCUTTING AND BORING TOOLPOST

John Chambers extends the toolholding principle described by John Brittain in Issue No. 65

PERMANENT MECHANICAL FASTENINGS

Methods of joining components which are not required to be subsequently dismantled are reviewed by Philip Amos

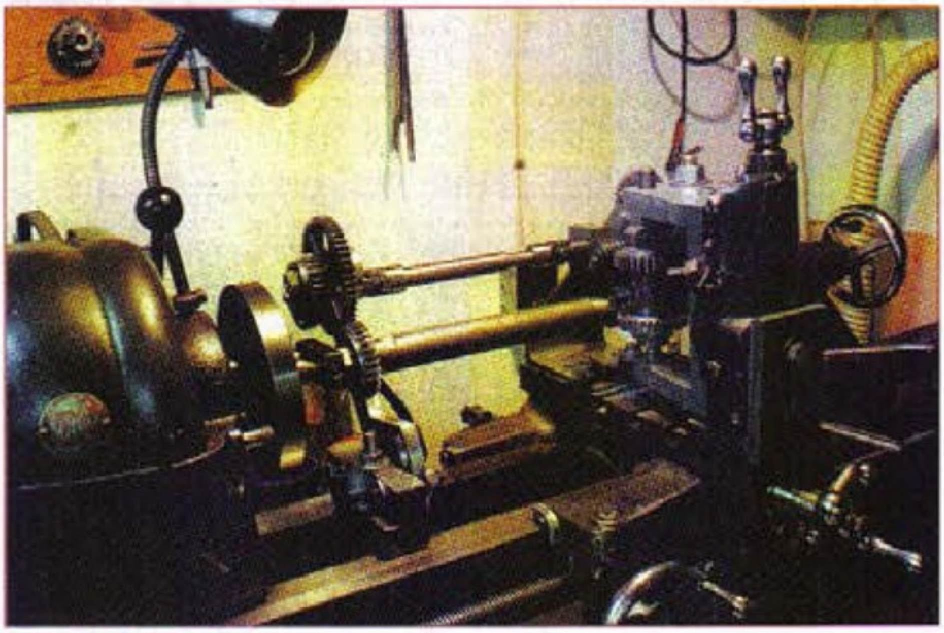
ADDING A CROSS FEED SELF-ACT TO AN ADEPT HAND SHAPER

John Crammond adds a facility to a once popular small machine

Issue on sale 8th June 2001

(Contents may be changed)

SCRIBE A LINE



Gear hobbing

From John Whalley, King City, Ontario, Canada

With apologies to Dr. Giles Parkes, as I am probably making larger gears than he did (mine are 16 and 18 DP, 14½ deg. PA), as I made the device for making gear cutting hobs described in Issue No. 57, but experienced difficulty getting it to relieve the whole length of the teeth, even though I made them as short as I felt practical, at about 0.175in. The situation became worse as full thread depth was reached. It certainly was possible to make a hob, but they were not as free cutting as one would expect them to be.

After much experimenting I found that a single lobe cam running at 9:1 ratio with the spindle, and with a travel of about 0.035in. and having an in-feed of about 80% and retraction of 20% gave excellent results, enabling the teeth to be longer as opposed to the gashes, and therefore much easier to form with a slitting saw. My decision to use a single lobe cam was influenced by the desire to treat every tooth exactly the same, and to be able to change the ratio if I want to use a different number of teeth, such as the relief of a home-made tap.

The hobs produced are 1.375in. dia. and 1.125 in. long, with a 0.625in. bore. They cut very smoothly in the lathe, and will stand a fairly aggressive feed.

I enclose a photo of my gear cutting attachment, the design of which I found years ago in an American publication, and modified to suit my purpose. It will cut worm gears, spur gears and helical gears and will relieve taps with absolutely no problems, and could be easily scaled to fit any lathe. It has proved to be an immense improvement on cutting gears one tooth at a time, as well as being easy to set up and remove from the lathe when it is not needed.

If there is any interest in this method, please let me know and I would be pleased to offer any information required.

Gear shaping

From Anthony Rhodes, Berkeley, California

A long awaited article on Gear Shaping was finally published in Issue No. 72, March/April 2001, authored by George Dimelow. The matter of offsetting the single tooth cutter by the pitch distance, on either side of the initial cuts and tangent to the pitch circle, was rather clever. This does bring the teeth closer to the correct form. A couple of points should be made. Firstly, if the machinist were to make a rack-form cutter including three teeth, the need to offset above and below for the semi-involute form would be eliminated. It would require additional care in making the cutter and additional power to make the cuts, but these shouldn't be significant issues. Secondly, the cutter needs to be a modified version of the rack, whether of single or multi-tooth form. It must have an extended addendum, usually $^{1.157}/_{DP}$, or equal to the dedendum-to-be-cut, and a reduced dedendum, usually $^{1}/_{DP}$, or equal to the addendum-to-be-cut. Without these adjustments it will cut a gear WITHOUT CLEARANCE when meshed with a normal gear.

Now, on to a couple of disappointments. The simpler issue is that, while mentioning the method could be applied to cutting internal gears and illustrating the point with a photo of such a gear, nothing was said about how to adjust the method for this purpose. It may be apparent that the method as described for external gears will not work on internal gears. Can we get some clarification on this point?

More importantly, I've been hoping for an article describing a method that would produce a gear which would not require hand fettling. I will admit that the method described works, in rough terms, but it's quite minimalistic and results in gears which would be unsatisfactory for use in, let's say, lathes, mills, dividing heads, etc.

Aside from purchasing expensive, ready-made equipment, has anybody produced a home-made mechanism or process by which gear shaping or gear planing can be used to generate external and internal spur and helical involute gears, possibly even bevel gears? I'd include hobbing or any other generating methods in the question, but an interest in internal gears, and possibly even bevels, pretty much rules that out.

Varnishing brass

From Peter Shepherd, Malvern, Victoria, Australia

I have read the various letter which have appeared over recent issues of M.E.W. regarding the colouring and varnishing of brass. If this subject is still open, I would like to add the following which may be of interest.

Some time ago I acquired a lovely old Oertling analytical beam balance which had been discarded - into a rubbish bin (!) - by my company's laboratory, in favour of one of those direct reading electronic units.

Whilst the brass fittings on the balance itself were in good order, the case fittings were in poor condition. After cleaning and polishing to the appropriate lustre, I treated the parts by the following method which is outlined in Machinery's Handbook (p.1215 Fifth Edition, 1919):-

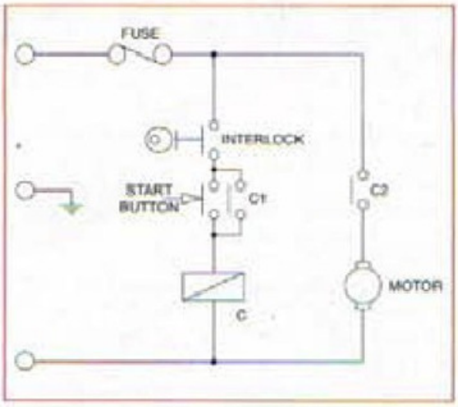
"Polished brass pieces can be given various shades from golden yellow to orange by immersing them for a certain length of time in a solution composed of 5 parts by weight of caustic soda, 50 parts water and 10 parts copper carbonate. When the desired colour is reached, the work must be well washed in water and dried in sawdust."

By making some trial runs with pieces of scrap, I was able to time the immersion to obtain a very close match to the rich golden colour of the original finish. The parts were then coated with a product called 'Incralac' from an aerosol can. This product is made in Australia by the Wattyl Company for finishing polished brass and copper.

An excellent finish was obtained. Incralac has good durability, but if higher levels are required, one of the more sophisticated resin systems should be considered.

Warco mill safety interlock - a warning

From Alan Bendall, Weston Super Mare, North Somerset



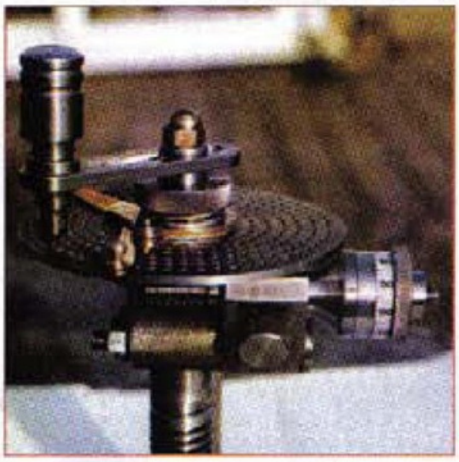
I refer to the article in M.E.W. Issue 72 by Dr. David Hall of Ipswich, 'A Safety Interlock For A Warco Mill'. There are two errors in the application of this device which makes it a very unsafe interlock indeed.

1. The first rule of safety interlocking is NEVER switch in the neutral conductor. Consider what would happen if a fault to earth were to occur in the cable feeding the switch or in the switch itself The circuit path would now be a line feed to the motor, but the return circuit would not be via the neutral, but through the fault connection to earth. The switch is now totally ineffective. The motor will start and run, via the earth return path, quite happily regardless of whether the safety switch is in operation or not!

2. Consider the situation when the clamping arm screw is being used and the switch is in the off position. If the machine on/off switch is inadvertently turned on, the clamp arm safety switch now acts as the machine on/off switch. As soon as the clamp arm is tightened the machine will start.

This switch needs to be wired into a circuit with a 'No-Volt coil' or a simple contactor circuit. This has the effect of stopping the machine in the event of the clamp arm not being tightened, but it will not restart unless the clamp arm is in the correct running position and the start button is pressed.

Harnessing the technology



From Peter Turner, Keyworth, Nottinghamshire

I have recently made a dividing head, with micro adjustment, for my ML10 lathe according to the drawings of G. H. Thomas. All went reasonably well; I even managed to engrave the 100 divisions on the micro drum at the second attempt, having lost concentration on the first whilst I had a cup of tea! The last operation involved the numbering of these divisions using a set of number stamps.

Without a jig it was impossible to achieve anything like respectability and even when I set up a lash-up jig, the variability of the impression gave a poor result, and I had to skim off the offending set of numbers. I next tried a bit of art and skill as I used my hand-held engraver. This resulted in a passable scale of numbers but it sat awkwardly alongside the engineering of the rest of the device.

So, next I measured the diameter of the drum, and attempted to find a scale of numbers arrayed vertically that would match the length required to match exactly the circumference of the drum, using the typing facility afforded by Microsoft Works on my computer. I found different fonts gave different vertical separations and, by combining this variability with the spacing and the size of font, found what I wanted. It happened to be a font called Bangle which, at size 12 with double spacing, gave a perfect length of scale (by eye that is, which is all that was required). I should say at this stage, if I had failed to get a perfect match, I would have chosen the nearest smaller scale and turned the drum to suit

I stuck the scale on with contact adhesive, all but the last half inch, which I then cut precisely to length before sticking down. I then applied three coats of two-part resin in successive applications, to make the scale durable

During all my previous efforts which had been skimmed off, I had finished with a nice groove on the drum and I cut the paper scale to this width exactly, which gave a pleasing result. I should finish by saying that the finished result is extremely clear and a joy to use, even if it does lack the polish of the professional instrument maker.

I attach a photograph of the result.

A problem solved

From Josef Schaller, Puyallup, Wa., USA

Having become thoroughly frustrated with the rocker style toolpost system which came with my South Bend lathe, I decided the time had arrived to find a solution to the problem.

The problem is rigidity or, more precisely, the lack thereof. It is most troubling when using a parting tool as, no matter how much I torqued the tightening bolt, the rocker would shift, throwing the cutting end below centre. Also, while turning a piece to a specific diameter, the turning tool would rotate horizontally. Neither of these scenarios is conducive to enjoyable machining and a t times can prove disastrous.

Needless to say, I jumped with joy when Issue no. 65 of M.E.W. arrived containing the article "Avoiding the Use of Packing" by Mr. John Brittain. Having recently purchased a small milling machine or, to be more accurate, having recently received a small milling machine from - to borrow a term - 'estates manager', I was now able to solve the problem.

I immediately set about the tasks involved and ended up with a top slide tool holder and a front parting tool holder, as per diagrams 1 and 5 in the aforementioned article.

Needless to say, my life at the lathe has improved dramatically and my frustration level has dropped to zero. I now spend most of my time machining and none worrying about tool height or rigidity. What a relief!

Thank you, M.E.W. and Mr. John Brittain.

No courses for novice turners

From K. W. Lindsay, Prenton, Merseyside

I have been a wood-turner for years and want to learn something about metal turning. Your series on "Lathe Projects for Beginners", which started in Issue 67 is gripping stuff for a novice.

What surprises me about your publication (and I take similar magazines on woodturning) is that there is no "Education Courses" section. All the wood worker's publications are crammed full of "Learn-to-Turn" courses offered at every corner of the country. One, three or five-day courses make a very respectable living for some skilled craftsmen who are patient with beginner, men and women, who want to acquire a new skill. The best of them offer advanced and bespoke courses to high levels of creative craft. The clever ones go on to offer adjacent courses in "Tool sharpening", "Turning and carving" etc., etc., for second-sale customers. It is not uncommon for the family to offer B&B as part of the package.

Looking at the marvellous projects that your readers have made, you have many very talented people with skills that could enthuse others to learn. It is thus sad to hear, in the opening section of your article for beginner turners, that there are few courses in engineering techniques. This is reinforced by a glance down the titles of Nexus books, which has no basic text on the metal lathe, although you mention a series that was written by Harold Hall some years ago. Is this a gap in your publications list, or is it so 'old hat' to most engineers that they have forgotten they ever learned it?

I would like to know if model engineers welcome beginners of any age. It is always best to learn-by-doing, as your new series suggests. If I have no access to a lathe, how can I benefit from Harold Hall's wisdom?