

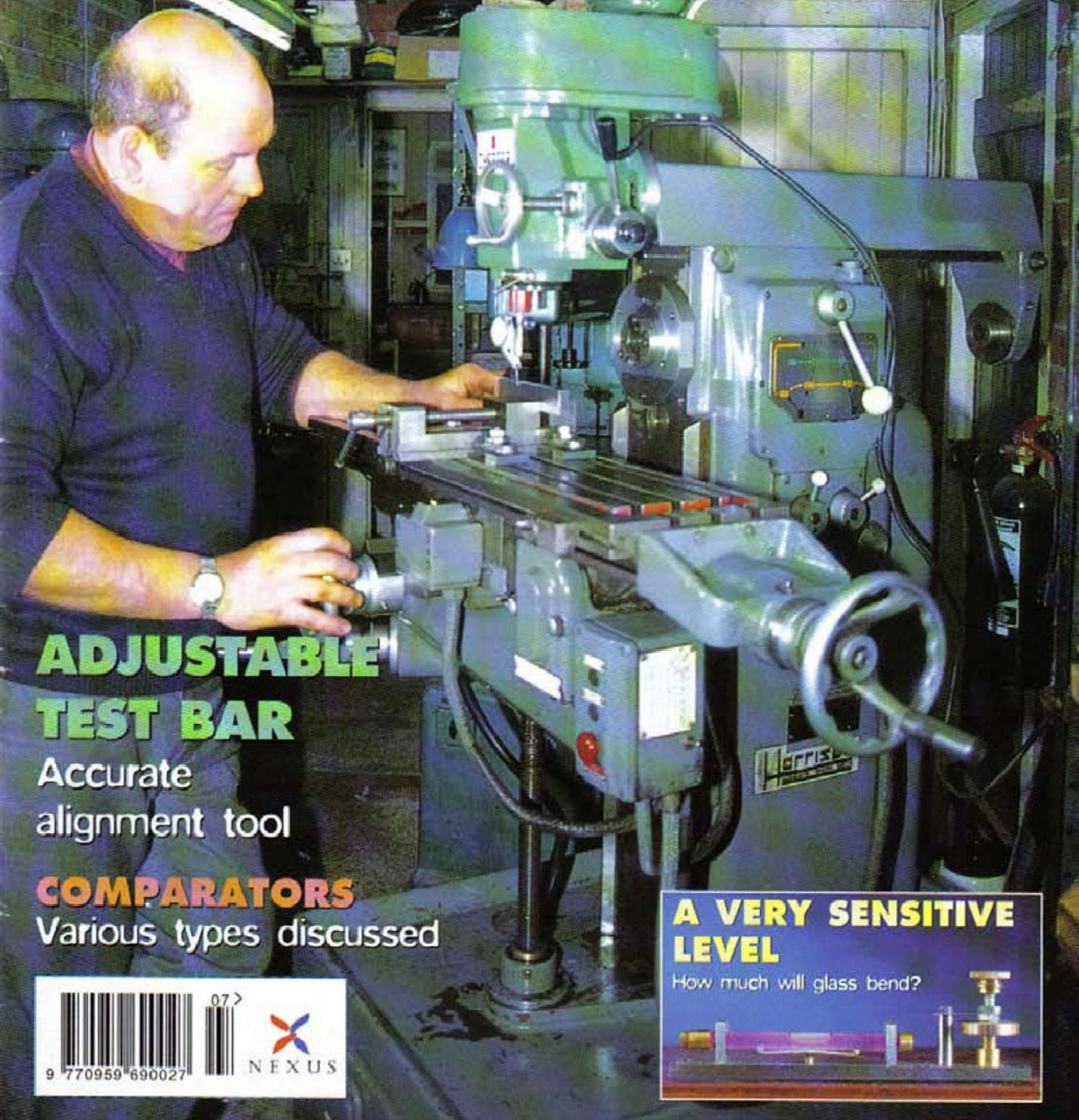
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JULY/AUGUST 1996 £2.95

MODEL ENGINEERS'

WORKSHOP

THE PRACTICAL HOBBY MAGAZINE



ADJUSTABLE TEST BAR

Accurate
alignment tool

COMPARATORS

Various types discussed

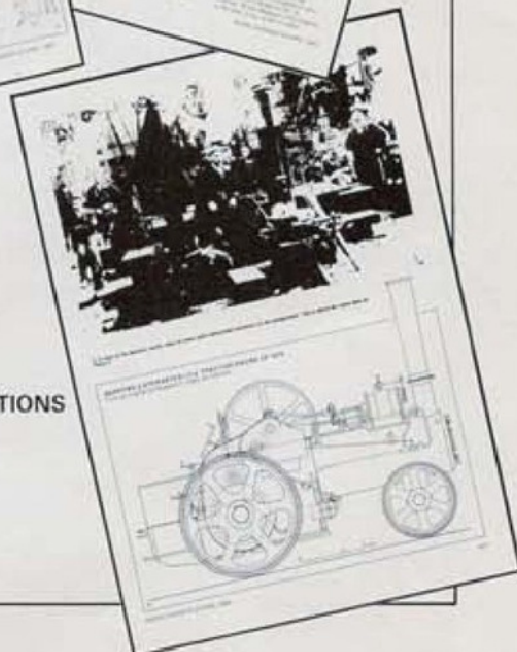
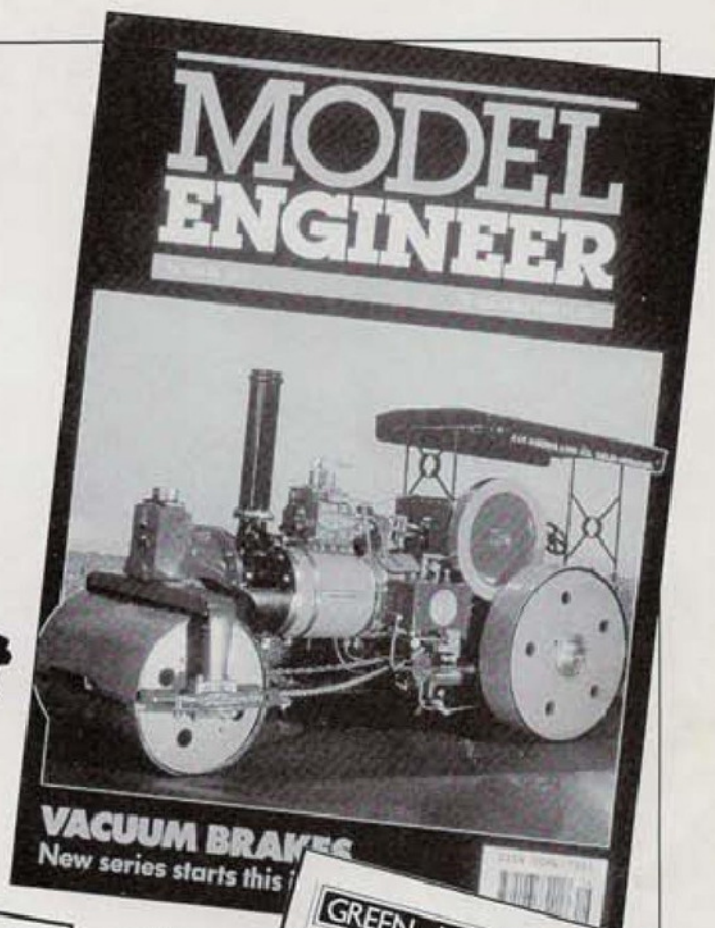
A VERY SENSITIVE LEVEL

How much will glass bend?



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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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Editor: Geoff Sheppard

Nexus Special Interests, Nexus House, Boundary Way, Hemel Hempstead, HP2 7ST, tel. 01442 66551

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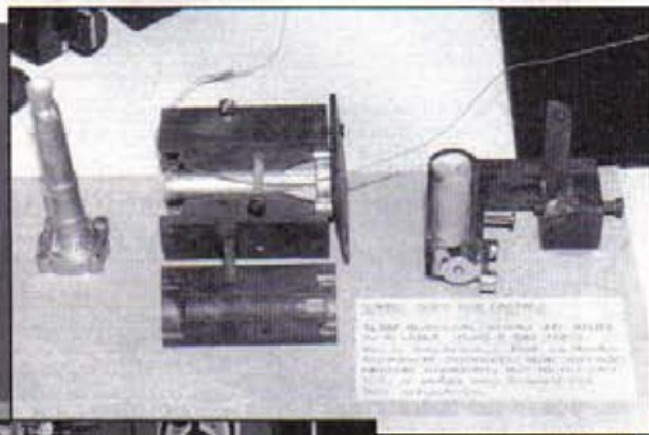
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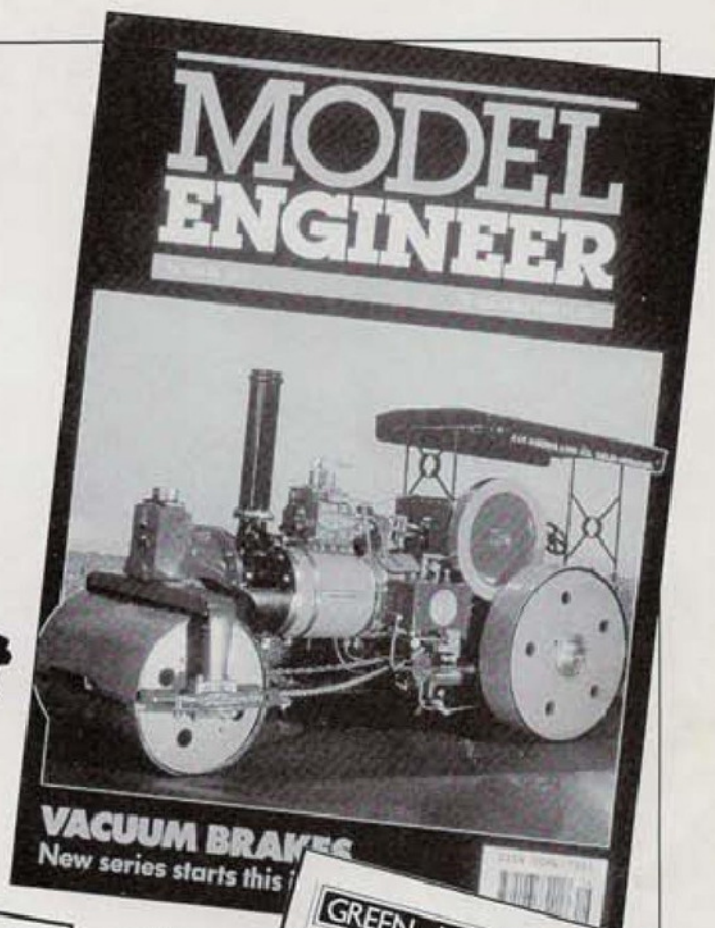
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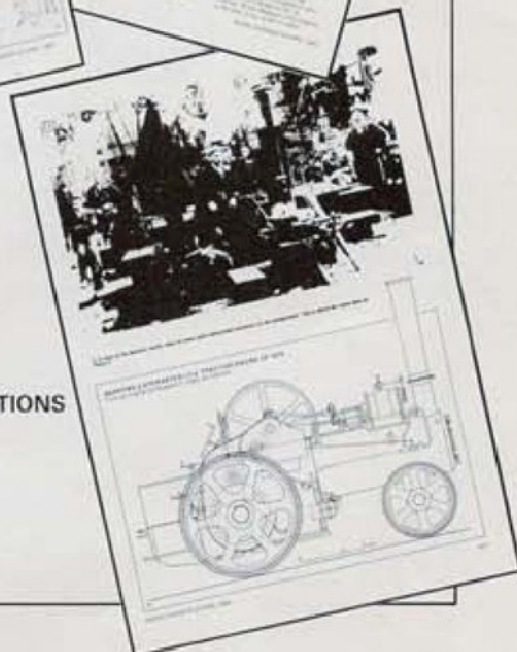
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ON THE EDITOR'S BENCH

Crofton was too valuable to lose. We joined forces, and with an energetic young accountant co-ordinating the fund raising, set about establishing a restoration project. British Waterways were willing to part with the site for a nominal sum, and enough money was raised to make a start. The Trust team took on the task of repairing the fabric of the building, while we engineers looked after the engines and pumps, and a third, suitably experienced group worked on the boilers.

Of the two engines in the house, the first to be tackled was the 1812 Boulton and Watt, known as 'No.1 Engine'. In this task, we were assisted by a group of apprentices from our company, young men who also thought that something of their engineering heritage was worth saving. So adept did they become, that at a later date, while we were steaming No.1 for the benefit of visitors, they took on the restoration of No.2 Engine, which had been built by Harvey of Hayle, Cornwall in 1845. We kept a watching brief while they set about the task with enthusiasm, and it was to our great satisfaction that one of their number, after qualifying, set up his own company to carry out such tasks on a professional basis. This company still flourishes and has established a world-wide reputation as leaders in the field.

Although we were dealing with units designed and manufactured early in the 19th Century, we decided that modern techniques were not to be rejected during the restoration. We were sure that, as Mark Figs states in his letter in *Scribe a Line*, that these pioneers of the engineering industry would have encompassed these methods with enthusiasm if they had had them to hand. One of the most frequently used devices was, of course, the 'putting-on' tool, as many parts were worn or wasted by corrosion, and manufacture of new replacements would have been expensive and time-consuming. A number of specialist firms gave valued assistance, doing jobs at cost price, or often at no cost at all, considering this to be their way of sponsoring the project. Electro plating and other metal deposition techniques proved to be our salvation on many occasions. I am aware that many readers of *M.E.W.* are engaged in similar restoration projects, so I would encourage them to become familiar with these new processes and not to be hide bound by the traditions of the past. These new methods are often developed by large manufacturing companies and are used initially to their own commercial advantage. Once this initial advantage has been exploited, the process

becomes more widely available, and small companies develop it for application to a wider scene, providing a service to industry in general. It is at this stage that we can take advantage of its availability.

A particularly good example is that of laser cutting. Only a few years ago, this process was at the leading edge of technology. Now, many smaller operators can make it available very cheaply. I know of a company which, because of the enormous capacity of the machine it has installed, has the data for many of the popular designs of small locomotive loaded into its memory. A set of accurate, finished main frame plates can be produced in minutes, at a price little more than that of the material if bought in small quantities. A fellow club member who asked for a pair of expansion links for a 7 1/4 in. gauge locomotive was presented with a dozen, at the same price 'because it was just as easy'. My point is that, although we don't have to use these facilities if we don't want to, we can take advantage of them if we wish. After all, how many of us set about making our own patterns and castings if these are available from one of our commercial suppliers?

An Appeal from Crofton

Returning to the letter I mentioned, this was from an old friend and colleague, Ian Broom, who is now Chief Engineer of the Crofton Branch of the Kennet and Avon Canal Trust. He reminds me that, during the restoration we had to install an electrically powered fan in the boiler flue system because by 1958, the chimney (which had been built in 1856) had developed a pronounced bend in its top half, and had to be drastically shortened. Plans are now in hand to rebuild the chimney to its full height of 82ft., to a design based on an original G.W.R. drawing (the Railway owned the canal for many years). Fund raising has started, supported by a foundation fund of £20,000 from the Manifold Trust. A total of £50,000 will be needed, so anyone wishing to make a contribution to the restoration of this piece of industrial archaeology is invited to purchase bricks for use in the chimney.

The names of all contributors will be entered in a 'Brick Holder's Register'. Bricks are priced at £1.00 each or six for £5.00.

Donations should be sent to: The Kennet and Avon Canal Trust, Canal Centre, Couch Lane, Devizes, Wiltshire SN10 1EB, and crossed 'Crofton Chimney Appeal'.

For anyone who has not seen them working, I can thoroughly recommend a visit to these, the oldest working engines 'in steam' in the world. Steaming dates can be obtained from the above address (Tel. 01380 721279).

A letter which arrived on my desk a couple of weeks ago revived pleasant memories of a project with which I was deeply involved many years ago. Before the preservation and restoration of mechanical artefacts became fashionable, a group of professional engineers at the company where I worked became concerned over the fate of the beam pumping engines situated at the summit of the Kennet and Avon canal at Crofton. Many similar historic installations had disappeared to the scrap man in the preceding years, including the mighty Severn tunnel engines from Sudbrook.

Fearful that the same fate would overtake the Crofton engines, we set out to research, document and record this product of the industrial revolution before it disappeared for ever. Many an interesting Saturday was spent measuring, drawing and photographing and also uncovering many facts which had either not been recognised, or which had been misinterpreted.

Before we could gain permission from British Waterways to visit the engine house, we would have to sign 'blood chits' to absolve them from any responsibility if an accident occurred (the wooden floors of the building were pretty rotten by then), and we would have to pay the overtime—in cash—to the old engineman who acted as caretaker of the site, before he would unlock the door. He would stand, resolute, on the bridge over the leat until the business was completed to his satisfaction, and only then would he produce the keys. In later years, when he had observed us closely and judged that we were fit and responsible persons to lay hands on his beloved former charges, he became a good friend. He would appear on steaming days to become a part of the attraction, and would regale visitors with tales of the days when the pumps were operational.

While we were engaged in this research, we encountered a group of enthusiasts from the Kennet and Avon Canal Trust, who also thought that

SCREW THREADS

John Robey looks at threads, ancient and modern, and provides those interested in restoration, or the history of machinery with useful data concerning what was, and possible modern alternatives in fastening practice

As clock restoration is one of my interests the need often arises to replace a damaged or missing screw or to re-tap a hole to take a new screw. It is common practice to drill the hole to a larger size and tap to the nearest size of BA thread. While acceptable for some work, it is certainly not how to treat valuable antique clocks by well-known makers. There is the story—doubtless apocryphal—of a faker who tried to pass off a reproduction clock reputed to have been made by Thomas Tompion in the late 17th century, until it was pointed out that all the threads were BA!

The original screws would have been made by hand using a screw plate—probably home made, with a home made hand tap for the tapped holes. As the tapped holes were usually in brass plates typically about $\frac{1}{8}$ in. thick an unsophisticated form of tap would have sufficed. Usually a deep tapped hole was not necessary, but where it was essential means were usually employed to get round the problem.

For instance early clocks with a verge escapement had an iron wire pendulum rod about $\frac{1}{16}$ in. diameter with a threaded end. A small pear shaped brass pendulum bob was screwed onto the rod, so turning the bob would alter the effective length of the pendulum and hence adjustments could be made to keep the clock to time. To avoid the deep threaded hole in the bob a wooden insert was fitted and the rod screwed into that, so forming its own threads.

In general screws were avoided wherever possible, and taper pins were used to hold many of the components in place. This principle also applied to many aspects of early engineering—one has only to look closely at the world's first cast-iron bridge, over the River Severn at Ironbridge in Shropshire, to see that it is held together with woodworking-type joints and iron wedges, not screws.

A modern engineer would be horrified at most of the old screw threads that can be seen in clock, locks or any other metal object from the 18th century or earlier. The threads are usually so shallow and the

threaded hole so worn that it is difficult to understand how they hold anything together at all!

For the highest quality work a restorer would cut a new thread by hand or with a screw-plate made to reproduce an authentic type of thread. For run-of-the-mill work where this is not justified, but where something closer to the original than the ubiquitous BA thread is wanted, then there is a wide range of modern alternatives that can be used.

Modern taps and dies are available in a wide range of sizes, pitches and thread forms, so that it is usually possible to find a close equivalent. This is particularly so for a tapped hole in a thin plate where a small difference in pitch is not going to make a great deal of difference anyway.

With this in mind tables have been prepared of all the screw threads currently available from approximately 1mm to $\frac{3}{8}$ in. diameter. As well as a table arranged by series, one has been arranged with the threads in order of TPI so that once a particular thread size is known then its nearest modern equivalent can be found and the hole re-tapped to that size and a new screw made to match.

The screw threads that have been included and their basic characteristics (full details of the thread forms are given in the standard engineering textbooks such as *Machinery's Handbook*)

Whitworth	W	
British Standard Fine	BSF	
Model Engineer	ME	55deg.—rounded crest and root
British Standard Brass	BSB	
Special Fine	Fin	
Unified Fine	UNF	60deg.—flat crest, rounded root
Unified Coarse	UNC	
ISO Metric	M	60deg.—flat crest, rounded root
British Standard Cycle	BSCycle	60deg.—rounded crest and root
British Association	BA	47 $\frac{1}{2}$ deg.—rounded crest and root

Some of the threads in the tables do not appear to be recommended standards, but taps and dies of these sizes are available from Tracy Tools Ltd, 2 Mayors Avenue, Dartmouth, South Devon TQ6 9NC (tel: 01803833134), who appear to be able to supply a wider range than most,

particularly of the non standard sizes—usual disclaimer. In particular some of the metric, BSB and Fine threads are not standard, but are available.

The tables also include the OD in inches and millimetres and the tapping drill size. Where the latter size is not readily available from published tables this has been calculated for 65% thread engagement as recommended in *Model Engineer's Handbook*. (Nexus Books)

An additional use of the tables will be to see where screws could be substituted for a specified thread, or to find the finest or coarsest thread for a particular diameter. For instance it is seen that 5-40UNC is the same pitch and OD as $\frac{1}{8}$ W and $\frac{1}{8}$ ME, 0BA is the same as 6 x 1M, while some of the BSCycle threads have BSF/BSBrass equivalents, differing only in thread form; similarly with some of the UNC and Whitworth threads. For the best work the thread form should be the same of course, but sometimes this is not so important.

During the recent restoration of a model beam engine it was found that the threads used were $\frac{1}{16}$ in. x 52TPI (7BA would have been the nearest substitute) and $\frac{1}{8}$ in. x 44TPI (equivalent to 5-44UNF), though the threads were very poorly formed and certainly not a modern standard.

To measure the OD and TPI pitch of a screw a micrometer or sliding calliper gauge, together with a screw pitch gauge (Imperial or metric system as appropriate) are needed. With a tapped hole this is a little more difficult, but one method is to prepare a piece of softwood of approximately the correct diameter and screw it into the hole without damaging the thread. On withdrawal it will be found to bear an impression of the thread which can then be measured as though it was a screw.

Even if only used to identify the correct threads for that tin of mixed screws which most model engineers seem to accumulate, it is hoped that these tables will prove useful, particularly as all the available threads are compiled together.



Threads Arranged by Series

Threads per inch	Diameter inch mm	Thread	Tapping drill mm	Threads per inch	Diameter inch mm	Thread	Tapping drill mm	Threads per inch	Diameter inch mm	Thread	Tapping drill mm
60	.062 1.6	1/16 W	1.2	80	.060 1.5	0-80 UNF	1.2	90.7	.051 1.3	12 BA	1.1
48	.094 2.4	3/32 W	1.95	72	.073 1.85	1-72 UNF	1.6	81.9	.059 1.5	11 BA	1.25
40	.125 3.2	1/8 W	2.65	64	.086 2.2	2-64 UNF	1.9	72.6	.067 1.7	10 BA	1.45
32	.156 4.0	5/32 W	3.3	56	.099 2.5	3-56 UNF	2.1	65.1	.075 1.9	9 BA	1.6
24	.187 4.75	3/16 W	3.9	48	.112 2.85	4-48 UNF	2.4	59.1	.087 2.2	8 BA	1.85
24	.219 5.55	7/32 W	4.7	44	.125 3.2	5-44 UNF	2.7	52.9	.098 2.5	7 BA	2.1
20	.250 6.35	1/4 W	5.3	40	.138 3.5	6-40 UNF	2.9	47.9	.110 2.8	6 BA	2.35
20	.281 7.15	9/32 W	6.1	36	.164 4.2	8-36 UNF	3.5	43.1	.126 3.2	5 BA	2.75
18	.312 7.95	5/16 W	6.7	32	.190 4.8	10-32 UNF	4.1	38.5	.142 3.6	4 BA	3.1
16	.375 9.5	3/8 W	8.2	26	.216 5.5	12-26 UNF	4.6	34.8	.161 4.1	3 BA	3.5
48	.125 3.2	1/8 BSF	2.7	28	.250 6.35	1/4 UNF	5.6	31.4	.185 4.7	2 BA	4.1
32	.187 4.75	3/16 BSF	4.1	24	.312 7.95	5/16 UNF	7.0	28.2	.209 5.3	1 BA	4.6
28	.219 5.55	7/32 BSF	4.8	24	.375 9.5	3/8 UNF	8.6	25.4	.236 6.0	0 BA	5.2
26	.250 6.35	1/4 BSF	5.5	64	.073 1.85	1-64 UNC	1.5	101.6	.040 1.0	1x.25 M	0.82
26	.281 7.15	9/32 BSF	6.3	56	.086 2.2	2-56 UNC	1.8	101.6	.047 1.2	1.2x.25 M	1.0
22	.312 7.95	5/16 BSF	7.0	48	.099 2.5	3-48 UNC	2.1	84.7	.055 1.4	1.4x.3 M	1.2
20	.375 9.5	3/8 BSF	8.4	40	.112 2.85	4-40 UNC	2.3	72.6	.063 1.6	1.6x.35 M	1.35
40	.156 4.0	5/32 ME	3.4	40	.125 3.2	5-40 UNC	2.6	72.6	.067 1.7	1.7x.35 M	1.45
40	.187 4.75	3/16 ME	4.2	32	.138 3.5	6-32 UNC	2.8	72.6	.071 1.8	1.8x.35 M	1.55
32	.187 4.75	3/16 ME	4.1	32	.164 4.2	8-32 UNC	3.5	63.5	.079 2.0	2x.4 M	1.7
40	.219 5.55	7/32 ME	5.0	24	.190 4.8	10-24 UNC	3.9	56.4	.087 2.2	2.2x.45 M	1.9
32	.219 5.55	7/32 ME	4.9	24	.216 5.5	12-24 UNC	4.5	63.5	.090 2.3	2.3x.4 M	2.0
40	.250 6.35	1/4 ME	5.8	20	.250 6.35	1/4 UNC	5.2	56.4	.098 2.5	2.5x.45 M	2.2
32	.250 6.35	1/4 ME	5.6	18	.312 7.95	5/16 UNC	6.6	56.4	.102 2.6	2.6x.45 M	2.3
40	.281 7.15	9/32 ME	6.1	16	.375 9.5	3/8 UNC	8.0	50.8	.118 3.0	3x.5 M	2.65
32	.281 7.15	9/32 ME	6.5	26	.125 3.2	1/8 BSB	2.4	42.3	.118 3.0	3x.6 M	2.6
32	.312 7.95	5/16 ME	7.2	26	.156 4.0	5/32 BSB	3.15	42.3	.138 3.5	3.5x.6 M	3.1
40	.312 7.95	5/16 ME	7.4	26	.187 4.75	3/16 BSB	3.9	50.8	.157 4.0	4x.5 M	3.65
32	.375 9.5	3/8 ME	8.8	24	.250 6.35	1/4 BSB*	5.5	33.9	.157 4.0	4x.75 M	3.5
40	.375 9.5	1/8 ME	9.0	25	.250 6.35	1/4 BSB*	5.5	36.3	.157 4.0	4x.7 M	3.5
60	.125 3.2	1/8 Fine	2.8	26	.250 6.35	1/4 BSB	5.4	33.9	.177 4.5	4.5x.75 M	4.0
60	.156 4.0	5/32 Fine	3.6	30	.250 6.35	1/4 BSB*	5.65	50.8	.196 5.0	5x.5 M	4.65
60	.187 4.75	3/16 Fine	4.4	36	.250 6.35	1/4 BSB*	5.75	33.9	.196 5.0	5x.75 M	4.5
				20	.281 7.15	9/32 BSB*	6.1	31.7	.196 5.0	5x.8 M	4.25
				24	.312 7.95	5/16 BSB*	7.0	28.2	.196 5.0	5x.9 M	4.4
				26	.312 7.95	5/16 BSB	7.1	25.4	.196 5.0	5x1 M	4.3
				30	.312 7.95	5/16 BSB*	7.2	50.8	.236 6.0	6x.5 M	5.65
				20	.312 7.95	5/16 BSB*	7.1	33.9	.236 6.0	6x.75 M	5.5
				24	.375 9.5	3/8 BSB*	8.65	25.4	.236 6.0	6x1 M	5.3
				26	.375 9.5	3/8 BSB	8.6	25.4	.275 7.0	7x1 M	6.0
				32	.187 4.75	3/16 BSC	4.2	33.9	.314 8.0	8x.75 M	7.5
				26	.219 5.55	7/32 BSC	4.9	25.4	.314 8.0	8x1 M	7.3
				26	.250 6.35	1/4 BSC	5.65	20.3	.314 8.0	8x1.25 M	7.1
				26	.281 7.15	9/32 BSC	6.45	16.9	.314 8.0	8x1.5 M	6.95
				26	.312 7.95	5/16 BSC	7.25	25.4	.354 9.0	9x1 M	8.3
				26	.375 9.5	3/8 BSC	8.85	20.3	.354 9.0	9x1.25 M	8.1

BSC — British Standard Cycle.

BSB — British Standard Brass

BSB* — although listed by Tracy Tools as British Standard Brass, these should be regarded as Whitworth Specials.

Fine — Whitworth Special Fine.

Tapping drills for 65% thread engagement.

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Threads per inch	Diameter inch mm	Thread	Tapping drill mm	Threads per inch	Diameter inch mm	Thread	Tapping drill mm	Threads per inch	Diameter inch mm	Thread	Tapping drill mm
60	.062 1.6	1/16 W	1.2	80	.060 1.5	0-80 UNF	1.2	90.7	.051 1.3	12 BA	1.1
48	.094 2.4	3/32 W	1.95	72	.073 1.85	1-72 UNF	1.6	81.9	.059 1.5	11 BA	1.25
40	.125 3.2	1/8 W	2.65	64	.086 2.2	2-64 UNF	1.9	72.6	.067 1.7	10 BA	1.45
32	.156 4.0	5/32 W	3.3	56	.099 2.5	3-56 UNF	2.1	65.1	.075 1.9	9 BA	1.6
24	.187 4.75	3/16 W	3.9	48	.112 2.85	4-48 UNF	2.4	59.1	.087 2.2	8 BA	1.85
24	.219 5.55	7/32 W	4.7	44	.125 3.2	5-44 UNF	2.7	52.9	.098 2.5	7 BA	2.1
20	.250 6.35	1/4 W	5.3	40	.138 3.5	6-40 UNF	2.9	47.9	.110 2.8	6 BA	2.35
20	.281 7.15	9/32 W	6.1	36	.164 4.2	8-36 UNF	3.5	43.1	.126 3.2	5 BA	2.75
18	.312 7.95	5/16 W	6.7	32	.190 4.8	10-32 UNF	4.1	38.5	.142 3.6	4 BA	3.1
16	.375 9.5	3/8 W	8.2	26	.216 5.5	12-26 UNF	4.6	34.8	.161 4.1	3 BA	3.5
48	.125 3.2	1/8 BSF	2.7	28	.250 6.35	1/4 UNF	5.6	31.4	.185 4.7	2 BA	4.1
32	.187 4.75	3/16 BSF	4.1	24	.312 7.95	5/16 UNF	7.0	28.2	.209 5.3	1 BA	4.6
28	.219 5.55	7/32 BSF	4.8	24	.375 9.5	3/8 UNF	8.6	25.4	.236 6.0	0 BA	5.2
26	.250 6.35	1/4 BSF	5.5	64	.073 1.85	1-64 UNC	1.5	101.6	.040 1.0	1x.25 M	0.82
26	.281 7.15	9/32 BSF	6.3	56	.086 2.2	2-56 UNC	1.8	101.6	.047 1.2	1.2x.25 M	1.0
22	.312 7.95	5/16 BSF	7.0	48	.099 2.5	3-48 UNC	2.1	84.7	.055 1.4	1.4x.3 M	1.2
20	.375 9.5	3/8 BSF	8.4	40	.112 2.85	4-40 UNC	2.3	72.6	.063 1.6	1.6x.35 M	1.35
40	.156 4.0	5/32 ME	3.4	40	.125 3.2	5-40 UNC	2.6	72.6	.067 1.7	1.7x.35 M	1.45
40	.187 4.75	3/16 ME	4.2	32	.138 3.5	6-32 UNC	2.8	72.6	.071 1.8	1.8x.35 M	1.55
32	.187 4.75	3/16 ME	4.1	32	.164 4.2	8-32 UNC	3.5	63.5	.079 2.0	2x.4 M	1.7
40	.219 5.55	7/32 ME	5.0	24	.190 4.8	10-24 UNC	3.9	56.4	.087 2.2	2.2x.45 M	1.9
32	.219 5.55	7/32 ME	4.9	24	.216 5.5	12-24 UNC	4.5	63.5	.090 2.3	2.3x.4 M	2.0
40	.250 6.35	1/4 ME	5.8	20	.250 6.35	1/4 UNC	5.2	56.4	.098 2.5	2.5x.45 M	2.2
32	.250 6.35	1/4 ME	5.6	18	.312 7.95	5/16 UNC	6.6	56.4	.102 2.6	2.6x.45 M	2.3
40	.281 7.15	9/32 ME	6.1	16	.375 9.5	3/8 UNC	8.0	50.8	.118 3.0	3x.5 M	2.65
32	.281 7.15	9/32 ME	6.5	26	.125 3.2	1/8 BSB	2.4	42.3	.118 3.0	3x.6 M	2.6
32	.312 7.95	5/16 ME	7.2	26	.156 4.0	5/32 BSB	3.15	42.3	.138 3.5	3.5x.6 M	3.1
40	.312 7.95	5/16 ME	7.4	26	.187 4.75	3/16 BSB	3.9	50.8	.157 4.0	4x.5 M	3.65
32	.375 9.5	3/8 ME	8.8	24	.250 6.35	1/4 BSB*	5.5	33.9	.157 4.0	4x.75 M	3.5
40	.375 9.5	3/8 ME	9.0	25	.250 6.35	1/4 BSB*	5.5	36.3	.157 4.0	4x.7 M	3.5
60	.125 3.2	1/8 Fine	2.8	26	.250 6.35	1/4 BSB	5.4	33.9	.177 4.5	4.5x.75 M	4.0
60	.156 4.0	5/32 Fine	3.6	30	.250 6.35	1/4 BSB*	5.65	50.8	.196 5.0	5x.5 M	4.65
60	.187 4.75	3/16 Fine	4.4	36	.250 6.35	1/4 BSB*	5.75	33.9	.196 5.0	5x.75 M	4.5
				20	.281 7.15	9/32 BSB*	6.1	31.7	.196 5.0	5x.8 M	4.25
				24	.312 7.95	5/16 BSB*	7.0	28.2	.196 5.0	5x.9 M	4.4
				26	.312 7.95	5/16 BSB	7.1	25.4	.196 5.0	5x1 M	4.3
				30	.312 7.95	5/16 BSB*	7.2	50.8	.236 6.0	6x.5 M	5.65
				20	.312 7.95	5/16 BSB*	7.1	33.9	.236 6.0	6x.75 M	5.5
				24	.375 9.5	3/8 BSB*	8.65	25.4	.236 6.0	6x1 M	5.3
				26	.375 9.5	3/8 BSB	8.6	25.4	.275 7.0	7x1 M	6.0
				32	.187 4.75	3/16 BSC	4.2	33.9	.314 8.0	8x.75 M	7.5
				26	.219 5.55	7/32 BSC	4.9	25.4	.314 8.0	8x1 M	7.3
				26	.250 6.35	1/4 BSC	5.65	20.3	.314 8.0	8x1.25 M	7.1
				26	.281 7.15	9/32 BSC	6.45	16.9	.314 8.0	8x1.5 M	6.95
				26	.312 7.95	5/16 BSC	7.25	25.4	.354 9.0	9x1 M	8.3
				26	.375 9.5	3/8 BSC	8.85	20.3	.354 9.0	9x1.25 M	8.1

BSC — British Standard Cycle.

BSB — British Standard Brass

BSB* — although listed by Tracy Tools as British Standard Brass, these should be regarded as Whitworth Specials.

Fine — Whitworth Special Fine.

Tapping drills for 65% thread engagement.

Threads Arranged by TPI

Threads per inch	Diameter inch mm	Thread	Tapping drill mm	Threads per inch	Diameter inch mm	Thread	Tapping drill mm	Threads per inch	Diameter inch mm	Thread	Tapping drill mm
101.6	.040 1.0	1x.25 M	0.82	40	.112 2.85	4-40 UNC	2.3	26	.125 3.2	1/8 BSB	2.4
101.6	.047 1.2	1.2x.25 M	1.0	40	.125 3.2	1/8 W	2.65	26	.156 4.0	5/32 BSB	3.15
90.7	.051 1.3	12 BA	1.1	40	.125 3.2	5-40 UNC	2.6	26	.187 4.75	3/16 BSB	3.9
84.7	.055 1.4	1.4x.3 M	1.2	40	.138 3.5	6-40 UNF	2.9	26	.216 5.5	12-26 UNF	4.6
81.9	.059 1.5	11 BA	1.25	40	.156 4.0	5/32 ME	3.4	26	.219 5.55	7/32 BSC	4.9
80	.060 1.5	0-80 UNF	1.2	40	.187 4.75	3/16 ME	4.2	26	.250 6.35	1/4 BSB	5.4
72.6	.063 1.6	1.6x.35 M	1.35	40	.219 5.55	7/32 ME	5.0	26	.250 6.35	1/4 BSC	5.65
72.6	.067 1.7	1.7x.35 M	1.45	40	.250 6.35	1/4 ME	5.8	26	.250 6.35	1/4 BSF	5.5
72.6	.067 1.7	10 BA	1.45	40	.281 7.15	9/32 ME	6.1	26	.281 7.15	9/32 BSC	6.45
72.6	.071 1.8	1.8x.35 M	1.55	40	.312 7.95	5/16 ME	7.4	26	.281 7.15	9/32 BSF	6.3
72	.073 1.85	1-72 UNF	1.6	40	.375 9.5	3/8 ME	9.0	26	.312 7.95	5/16 BSB	7.1
65.1	.075 1.9	9 BA	1.6	38.5	.142 3.6	4 BA	3.1	26	.312 7.95	5/16 BSC	7.25
64	.073 1.85	1-64 UNC	1.5	36.3	.157 4.0	4x.7 M	3.5	26	.375 9.5	3/8 BSB	8.6
64	.086 2.2	2-64 UNF	1.9	36	.164 4.2	8-36 UNF	3.5	26	.375 9.5	3/8 BSC	8.85
63.5	.079 2.0	2x.4 M	1.7	36	.250 6.35	1/4 BSB	5.75	25.4	.196 5.0	5x1 M	4.3
63.5	.090 2.3	2.3x.4 M	2.0	34.8	.161 4.1	3 BA	3.5	25.4	.236 6.0	0 BA	5.2
60	.062 1.6	1/16 W	1.2	33.9	.157 4.0	4x.75 M	3.5	25.4	.236 6.0	6x1 M	5.3
60	.125 3.2	1/8 Fine	2.8	33.9	.177 4.5	4.5x.75 M	4.0	25.4	.275 7.0	7x1 M	6.0
60	.156 4.0	5/32 Fine	3.6	33.9	.196 5.0	5x.75 M	4.5	25.4	.314 8.0	8x1 M	7.3
60	.187 4.75	3/16 Fine	4.4	33.9	.236 6.0	6x.75 M	5.5	25.4	.354 9.0	9x1 M	8.3
59.1	.087 2.2	8 BA	1.85	33.9	.314 8.0	8x.75 M	7.5	25	.250 6.35	1/4 BSB	5.5
56.4	.087 2.2	2.2x.45 M	1.9	32	.138 3.5	6-32 UNC	2.8	24	.187 4.75	3/16 W	3.9
56.4	.098 2.5	2.5x.45 M	2.2	32	.156 4.0	5/32 W	3.3	24	.190 4.8	10-24 UNC	3.9
56.4	.102 2.6	2.6x.45 M	2.3	32	.164 4.2	8-32 UNC	3.5	24	.216 5.5	12-24 UNC	4.5
56	.086 2.2	2-56 UNC	1.8	32	.187 4.75	3/16 BSC	4.2	24	.219 5.55	7/32 W	4.7
56	.099 2.5	3-56 UNF	2.1	32	.187 4.75	3/16 BSF	4.1	24	.250 6.35	1/4 BSB	5.5
52.9	.098 2.5	7 BA	2.1	32	.187 4.75	3/16 ME	4.1	24	.312 7.95	5/16 BSB	7.0
50.8	.118 3.0	3x.5 M	2.65	32	.190 4.8	10-32 UNF	4.1	24	.312 7.95	5/16 UNF	7.0
50.8	.157 4.0	4x.5 M	3.65	32	.219 5.55	7/32 ME	4.9	24	.375 9.5	3/8 BSB	8.65
50.8	.196 5.0	5x.5 M	4.65	32	.250 6.35	1/4 ME	5.6	24	.375 9.5	3/8 UNF	8.6
50.8	.236 6.0	6x.5 M	5.65	32	.281 7.15	9/32 ME	6.5	22	.312 7.95	5/16 BSF	7.0
48	.094 2.4	3/32 W	1.95	32	.312 7.95	5/16 ME	7.2	20.3	.314 8.0	8x1.25 M	7.1
48	.099 2.5	3-48 UNC	2.1	32	.375 9.5	3/8 ME	8.8	20.3	.354 9.0	9x1.25 M	8.1
48	.112 2.85	4-48 UNF	2.4	31.4	.185 4.7	2 BA	4.1	20	.250 6.35	1/4 W	5.3
48	.125 3.2	1/8 BSF	2.7	31.7	.196 5.0	5x.8 M	4.25	20	.250 6.35	1/4 UNC	5.2
47.9	.110 2.8	6 BA	2.35	30	.250 6.35	1/4 BSB	5.65	20	.281 7.15	5/32 W	6.1
44	.125 3.2	5-44 UNF	2.7	30	.312 7.95	5/16 BSB	7.2	20	.281 7.15	9/32 BSB	6.1
43.1	.126 3.2	5 BA	2.75	28.2	.196 5.0	5x.9 M	4.4	20	.312 7.95	5/16 BSB	7.1
42.3	.118 3.0	3x.6 M	2.6	28.2	.209 5.3	1 BA	4.6	20	.375 9.5	3/8 BSF	8.4
42.3	.138 3.5	3.5x.6 M	3.1	28	.219 5.55	7/32 BSF	4.8	18	.312 7.95	5/16 W	6.7
				28	.250 6.35	1/4 UNF	5.6	18	.312 7.95	5/16 UNC	6.6
								16.9	.314 8.0	8x1.5 M	6.95
								16	.375 9.5	3/8 W	8.2
								16	.375 9.5	3/8 UNC	8.0

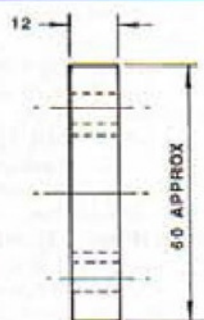
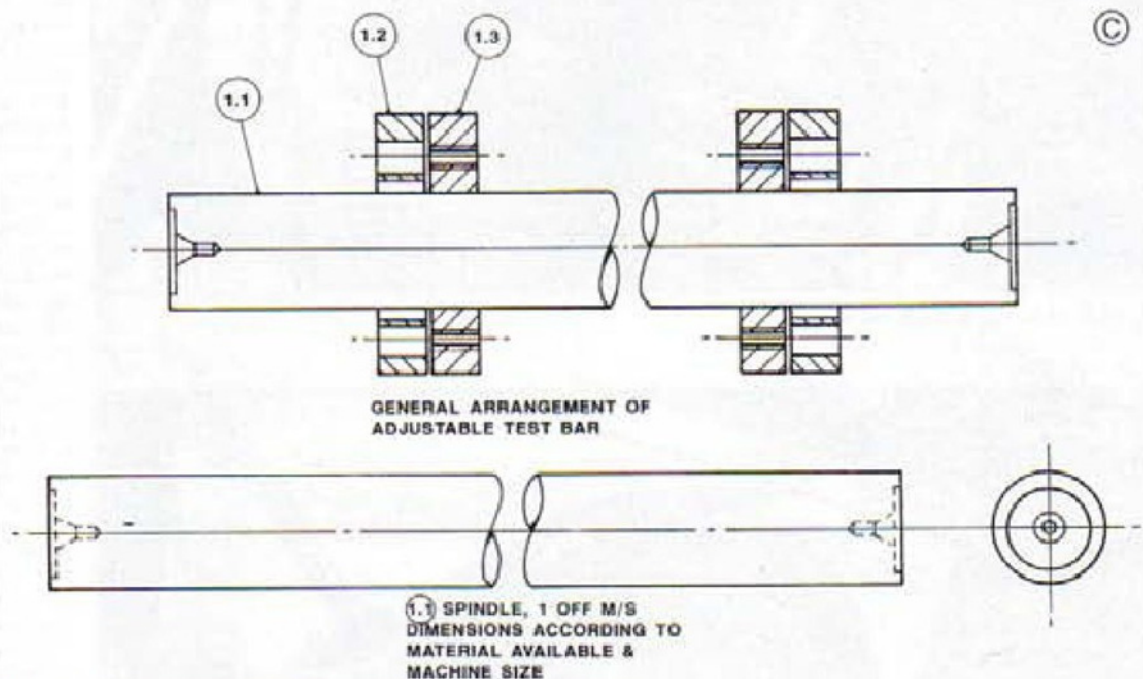
Threads Arranged by Outside Diameter

Threads per inch	Diameter inch mm	Thread	Tapping drill mm	Threads per inch	Diameter inch mm	Thread	Tapping drill mm	Threads per inch	Diameter inch mm	Thread	Tapping drill mm
101.6	.040 1.0	1x.25 M	0.82	40	.156 4.0	$\frac{5}{32}$ ME	3.4	40	.250 6.35	$\frac{1}{4}$ ME	5.8
101.6	.047 1.2	1.2x.25 M	1.0	60	.156 4.0	$\frac{5}{32}$ Fine	3.6	36	.250 6.35	$\frac{1}{4}$ BSB	5.75
90.7	.051 1.3	12 BA	1.1	50.8	.157 4.0	4x.5 M	3.65	32	.250 6.35	$\frac{1}{4}$ ME	5.6
84.7	.055 1.4	1.4x.3 M	1.2	36.3	.157 4.0	4x.7 M	3.5	30	.250 6.35	$\frac{1}{4}$ BSB	5.65
81.9	.059 1.5	11 BA	1.25	33.9	.157 4.0	4x.75 M	3.5	28	.250 6.35	$\frac{1}{4}$ UNF	5.6
80	.060 1.5	0-80 UNF	1.2	32	.156 4.0	$\frac{5}{32}$ W	3.3	26	.250 6.35	$\frac{1}{4}$ BSB	5.4
72.6	.063 1.6	1.6x.35 M	1.35	26	.156 4.0	$\frac{5}{32}$ BSB	3.15	26	.250 6.35	$\frac{1}{4}$ BSC	5.65
60	.062 1.6	$\frac{1}{16}$ W	1.2	34.8	.161 4.1	3 BA	3.5	26	.250 6.35	$\frac{1}{4}$ BSF	5.5
72.6	.067 1.7	1.7x.35 M	1.45	36	.164 4.2	8-36 UNF	3.5	25	.250 6.35	$\frac{1}{4}$ BSB	5.5
72.6	.067 1.7	10 BA	1.45	32	.164 4.2	8-32 UNC	3.5	24	.250 6.35	$\frac{1}{4}$ BSB	5.5
72.6	.071 1.8	1.8x.35 M	1.55	33.9	.177 4.5	4.5x.75 M	4.0	20	.250 6.35	$\frac{1}{4}$ W	5.3
72	.073 1.85	1-72 UNF	1.6	31.4	.185 4.7	2 BA	4.1	20	.250 6.35	$\frac{1}{4}$ UNC	5.2
64	.073 1.85	1-64 UNC	1.5	60	.187 4.75	$\frac{3}{16}$ Fine	4.4	25.4	.275 7.0	7x1 M	6.0
65.1	.075 1.9	9 BA	1.6	40	.187 4.75	$\frac{3}{16}$ ME	4.2	40	.281 7.15	$\frac{9}{32}$ ME	6.1
63.5	.079 2.0	2x.4 M	1.7	32	.187 4.75	$\frac{3}{16}$ BSC	4.2	32	.281 7.15	$\frac{9}{32}$ ME	6.5
64	.086 2.2	2-64 UNF	1.9	32	.187 4.75	$\frac{3}{16}$ BSF	4.1	26	.281 7.15	$\frac{9}{32}$ BSC	6.45
59.1	.087 2.2	8 BA	1.85	32	.187 4.75	$\frac{3}{16}$ ME	4.1	26	.281 7.15	$\frac{9}{32}$ BSF	6.3
56.4	.087 2.2	2.2x.45 M	1.9	26	.187 4.75	$\frac{3}{16}$ BSB	3.9	20	.281 7.15	$\frac{9}{32}$ W	6.1
56	.086 2.2	2-56 UNC	1.8	24	.187 4.75	$\frac{3}{16}$ W	3.9	20	.281 7.15	$\frac{9}{32}$ BSB	6.1
63.5	.090 2.3	2.3x.4 M	2.0	32	.190 4.8	10-32 UNF	4.1	40	.312 7.95	$\frac{5}{16}$ ME	7.4
48	.094 2.4	$\frac{3}{32}$ W	1.95	24	.190 4.8	10-24 UNC	3.9	32	.312 7.95	$\frac{5}{16}$ ME	7.2
56.4	.098 2.5	2.5x.45 M	2.2	50.8	.196 5.0	5x.5 M	4.65	30	.312 7.95	$\frac{5}{16}$ BSB	7.2
56	.099 2.5	3-56 UNF	2.1	33.9	.196 5.0	5x.75 M	4.5	26	.312 7.95	$\frac{5}{16}$ BSB	7.1
52.9	.098 2.5	7 BA	2.1	31.7	.196 5.0	5x.8 M	4.25	26	.312 7.95	$\frac{5}{16}$ BSC	7.25
48	.099 2.5	3-48 UNC	2.1	28.2	.196 5.0	5x.9 M	4.4	24	.312 7.95	$\frac{5}{16}$ BSB	7.0
56.4	.102 2.6	2.6x.45 M	2.3	25.4	.196 5.0	5x1 M	4.3	24	.312 7.95	$\frac{5}{16}$ UNF	7.0
47.9	.110 2.8	6 BA	2.35	28.2	.209 5.3	1 BA	4.6	22	.312 7.95	$\frac{5}{16}$ BSF	7.0
48	.112 2.85	4-48 UNF	2.4	26	.216 5.5	12-26 UNF	4.6	20	.312 7.95	$\frac{5}{16}$ BSB	7.1
40	.112 2.85	4-40 UNC	2.3	24	.216 5.5	12-24 UNC	4.5	18	.312 7.95	$\frac{5}{16}$ W	6.7
50.8	.118 3.0	3x.5 M	2.65	40	.219 5.55	$\frac{7}{32}$ ME	5.0	18	.312 7.95	$\frac{5}{16}$ UNC	6.6
42.3	.118 3.0	3x.6 M	2.6	32	.219 5.55	$\frac{7}{32}$ ME	4.9	33.9	.314 8.0	8x.75 M	7.5
60	.125 3.2	$\frac{1}{8}$ Fine	2.8	28	.219 5.55	$\frac{7}{32}$ BSF	4.8	25.4	.314 8.0	8x1 M	7.3
48	.125 3.2	$\frac{1}{8}$ BSF	2.7	26	.219 5.55	$\frac{7}{32}$ BSC	4.9	20.3	.314 8.0	8x1.25 M	7.1
44	.125 3.2	5-44 UNF	2.7	24	.219 5.55	$\frac{7}{32}$ W	4.7	16.9	.314 8.0	8x1.5 M	6.95
43.1	.126 3.2	5 BA	2.75	50.8	.236 6.0	6x.5 M	5.65	25.4	.354 9.0	9x1 M	8.3
40	.125 3.2	$\frac{1}{8}$ W	2.65	33.9	.236 6.0	6x.75 M	5.5	20.3	.354 9.0	9x1.25 M	8.1
40	.125 3.2	5-40 UNC	2.6	25.4	.236 6.0	0 BA	5.2	40	.375 9.5	$\frac{3}{8}$ ME	9.0
26	.125 3.2	$\frac{1}{8}$ BSB	2.4	25.4	.236 6.0	6x1 M	5.3	32	.375 9.5	$\frac{3}{8}$ ME	8.8
42.3	.138 3.5	3.5x.6 M	3.1					26	.375 9.5	$\frac{3}{8}$ BSB	8.6
40	.138 3.5	6-40 UNF	2.9					26	.375 9.5	$\frac{3}{8}$ BSC	8.85
32	.138 3.5	6-32 UNC	2.8					24	.375 9.5	$\frac{3}{8}$ BSB	8.65
38.5	.142 3.6	4 BA	3.1					24	.375 9.5	$\frac{3}{8}$ UNF	8.6
								20	.375 9.5	$\frac{3}{8}$ BSF	8.4
								16	.375 9.5	$\frac{3}{8}$ W	8.2
								16	.375 9.5	$\frac{3}{8}$ UNC	8.0

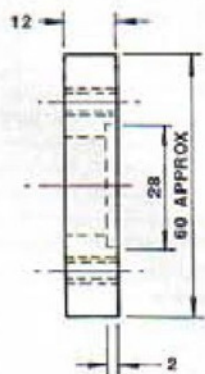
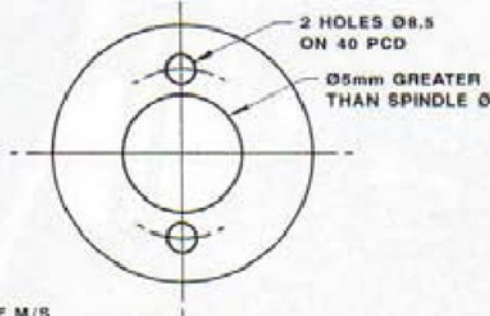
AN ADJUSTABLE TEST BAR

Another essential aid to accurate lathe alignment is described by Bill Morris, a contributor from New Zealand

When aligning a lathe, a test bar is almost indispensable, to form a virtual extension of the lathe spindle, in order to magnify errors of alignment between the spindle and the bed. Those who have to turn tapers by setting over the tailstock will, I am sure, agree with me that setting the tailstock back to its correct position for parallel turning is no easy matter without a test bar. A standard test bar is a substantial bar, ground all over between centres, with a Morse taper at one end. Even if



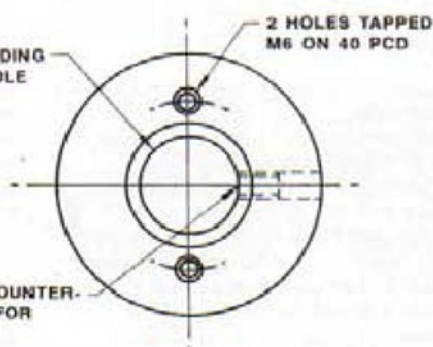
1.2 DISC, 2 OFF M/S



Ø CLOSE SLIDING FIT ON SPINDLE

TAP M6 & COUNTER-DRILL Ø6.5 FOR 10mm

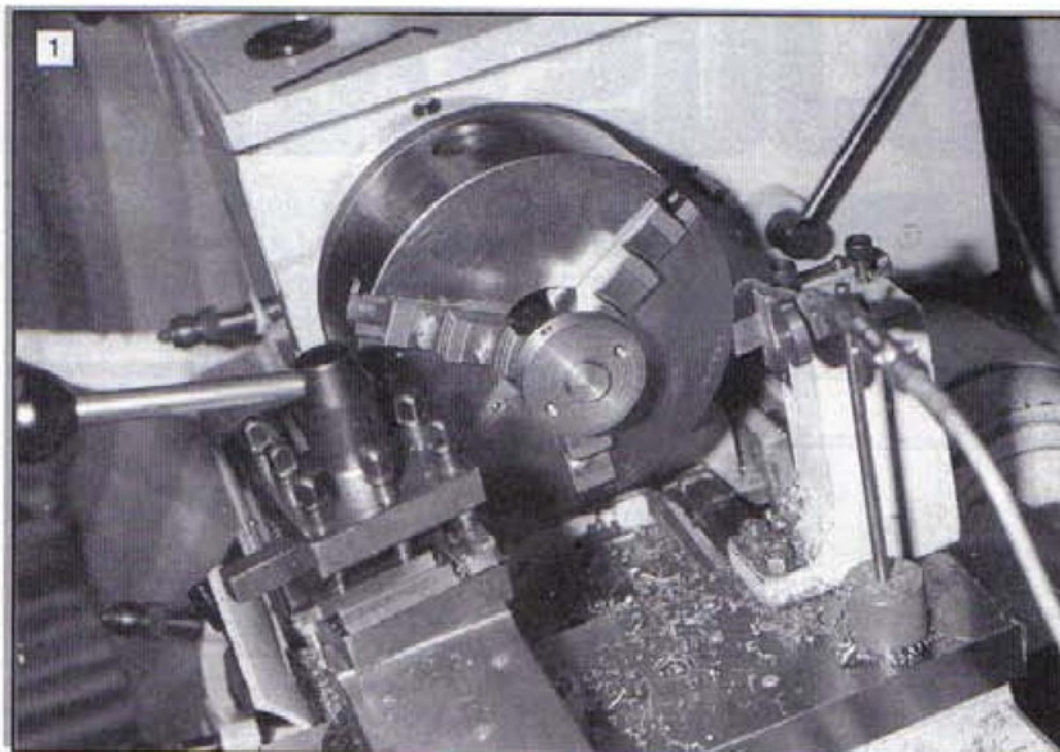
1.3 DISC CARRIER, 2 OFF M/S OR ALL.



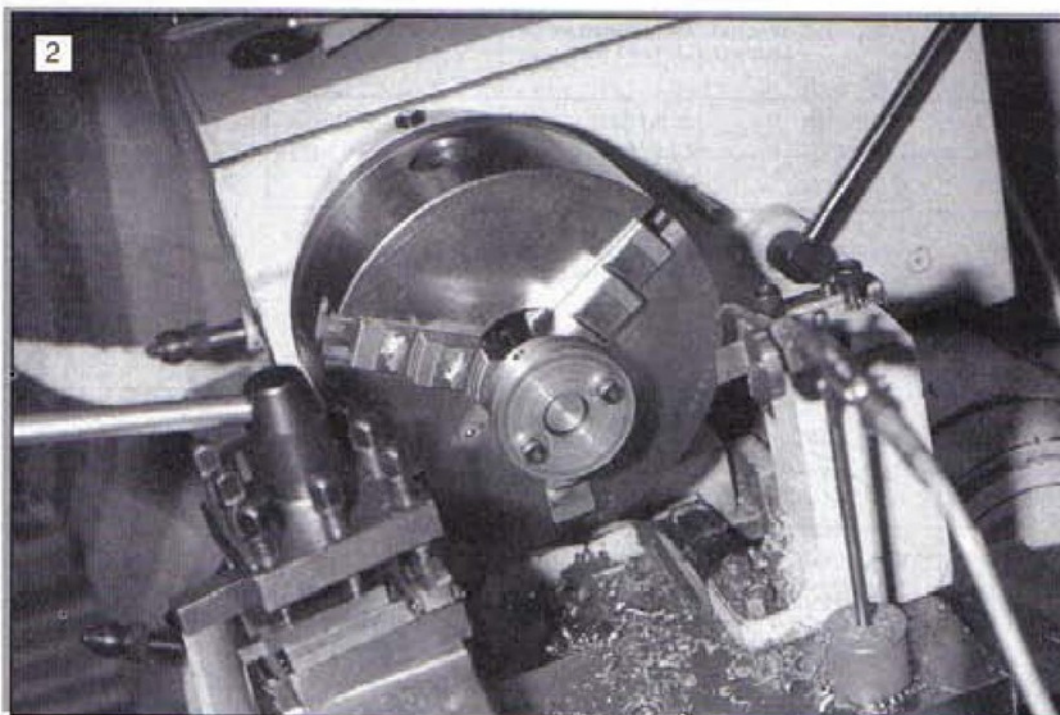
the amateur has access to a cylindrical grinding machine, getting the bar parallel and grinding a Morse taper is no easy matter. In fact, the Morse taper can be dispensed with, since it will only demonstrate that the axis of the lathe's spindle nose taper is aligned with the bed, though that is often taken to mean (usually correctly) that the lathe spindle as a whole is aligned with the bed.

General Arrangement

Unlike a standard ground bar, the adjustable test bar is well within the capabilities of a relative beginner. Figure 1 shows the general arrangement, in which a spindle, centred at both ends, carries two discs pressed, screwed or glued on to it with two further discs which can be attached to the fixed discs by screws and washers, and adjusted in a radial direction until they run true. Neither the spindle nor the fixed discs have to be true to the lathe centre line, nor does it matter whether they are truly circular. The only critical requirement is that the adjustable discs should be of exactly the same external diameter and truly round.



1: Stub of bar and carrier as a jig



2: Adjustable disc ready for turning

Spindle

So, start by selecting a suitable spindle. I give no dimensions for it in **Fig. 1**, but make it as robust as is possible, since even the $\frac{3}{4}$ in. dia. bar I used will droop measurably at one end under its own weight and that of the discs. Deflection of the free end of a beam held at one end is directly proportional to the cube of the length and inversely proportional to the fourth power of the diameter. In other words, if you double the length of the bar, it will droop eight times as much, but if

you double its diameter, it will droop only $\frac{1}{16}$ th as much.

Having chosen your bar, recess both ends to give some protection to the centre holes if it is accidentally dropped, and centre drill the ends (**drawing 1.1**). Ideally, you will have chosen a bar size that will pass through the spindle bore of your lathe and be able to do these operations with the bar held in the chuck. If you have not, you will have to use a fixed steady or even mark out and drill the centres by hand if your equipment is very limited.

Discs and carriers

A friend who was clearing out his scrap box gave me four discs of free cutting steel, about 60mm dia. and 12mm thick; I used these for the discs. Set yours up in a chuck in turn to face both sides, drill through and then bore to a close sliding fit on the chosen bar. Bore out the 2mm recess and cross drill one of the discs that are destined to be the disc carriers, and drill and tap for a cross screw (**drawing 1.3**). Mark out for the other holes, then mount a disc carrier and a disc on a stub of a bar to align them and drill through at tapping size. Tap the carriers and open out the holes in the adjustable discs to give a generous clearance on the fixing screws. Carefully remove all burrs.

When a roughing cut is made with the lathe, initial surface irregularities and out of roundness are reproduced on the cut surface to some extent, but can be reduced to immeasurably small values by one or more finishing cuts. The next sequence is designed to ensure that the adjustable discs finish up with as closely the same diameter and degree of roundness that it is possible to get by turning, since any errors here will affect the sensitivity of the bar to detect errors of alignment.

File a flat on a piece of the round bar that you used for the spindle and mount it in the chuck with about 20mm projecting. Mount the disc carrier which you cross drilled and tapped on to the bar and hold it in place with a screw bearing on the flat (**Photo 1**). The recess previously made in the face will allow a fine facing cut, then mount one of the adjustable discs (**Photo 2**) and take a roughing cut over the outside, just sufficient to clean up. Without changing the tool position, replace the disc with the other one, and take a roughing cut at the same setting. Replace the original disc and take a fine finishing cut, trying for the finest finish you can manage. Again,

without touching the tool setting, do the same to the other disc. The adjustable discs can then be mounted in the chuck with soft packing to avoid marking the surface that you have been so careful in making, and bored out to give a generous clearance on the spindle (**drawing 1.2**).

Assembly

Assembly is easiest by using Loctite or similar to attach the disc carriers to

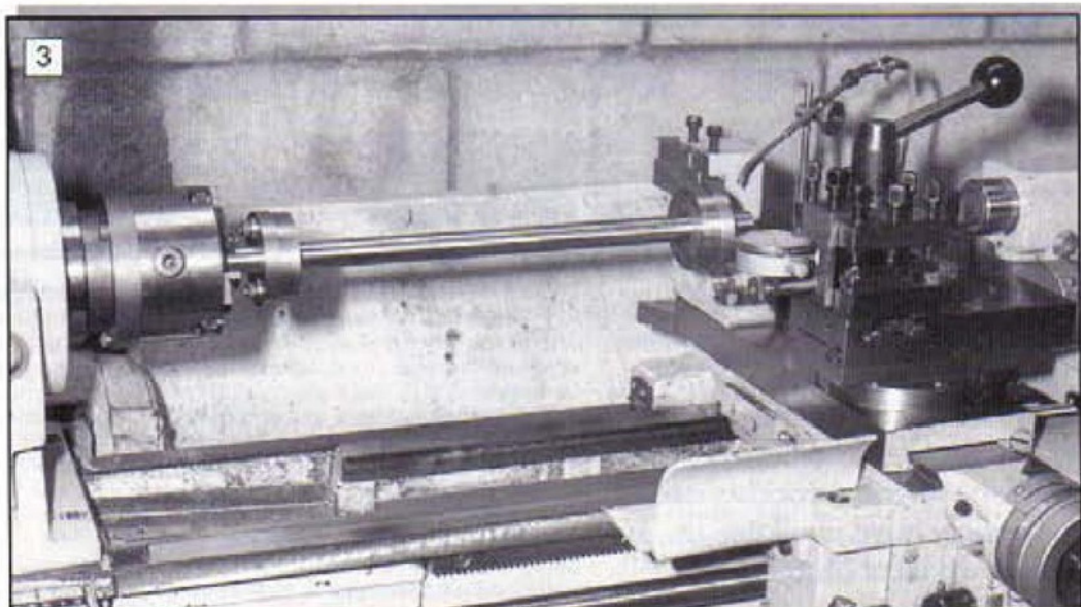
the spindle. Their exact position is unimportant as long as you allow room to get at the attachment screws (cap headed Allen screws or hex. headed). Leave a sufficient length of spindle projecting at one end to be gripped by the chuck, and leave enough at the other so that a dial test indicator (DTI) can be brought to bear on the disc.

Bed alignment

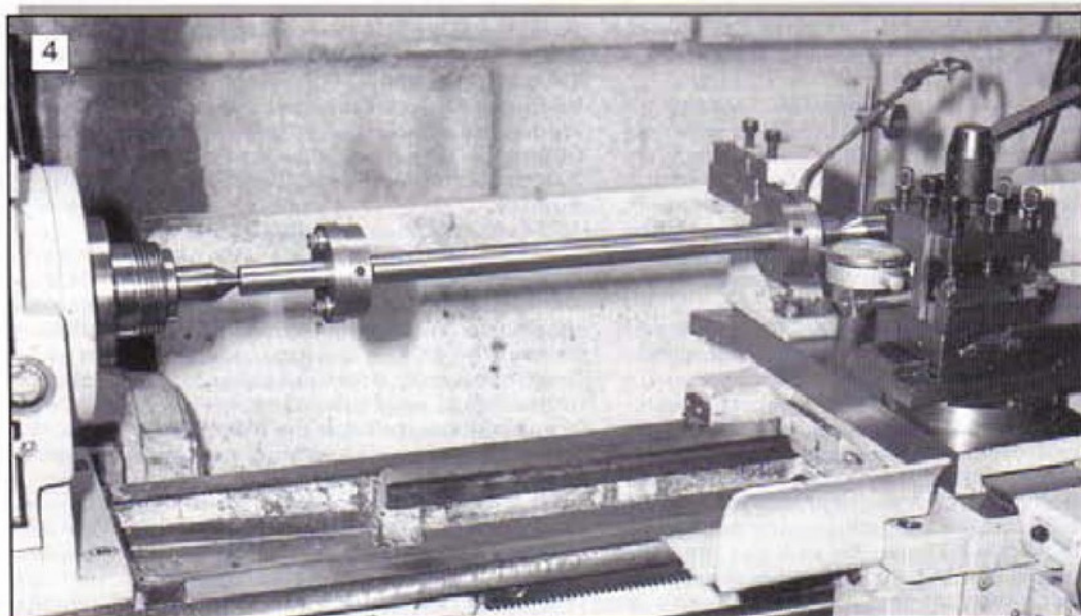
Photo 3 shows the test bar in use to check bed alignment. The screws are tightened finger tight, and each adjustable disc is centred in turn by gently tapping it into place until the DTI reading remains the same when the bar is rotated. This takes a little patience, and when correctly centred, each represents a virtual extension of the lathe spindle. If the lathe spindle is correctly aligned with the bed ways, then the DTI reading should remain the same when traversed from one disc to the other. Any inclination should be towards the tool post, so that there is no possibility of the lathe facing convex, and the error should not exceed 0.01mm in 300mm.

Centres alignment

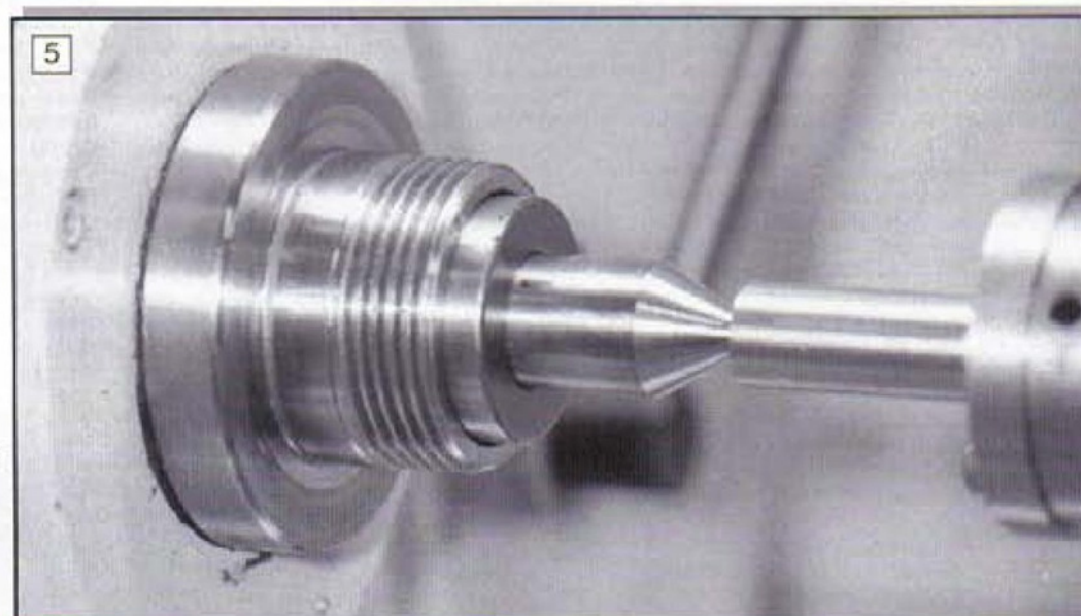
Photo 4 shows the bar mounted between centres. Again, both discs are carefully centred with the DTI, so that they will then be co-axial with the line joining the two centres. If this line is also parallel to the bed ways in the horizontal plane, then the DTI readings will be the same at both ends. If they are not, the bar offers an easy way to adjust the tailstock. The error should not exceed 0.01mm in 1000mm. Bear in mind that what is being checked is the alignment of the bed with the centres and if the centres themselves are eccentric, an error may occur if they are removed and re-inserted in a different radial position. I feel that it is wise to mark the centres as shown in **Photo 5**, so that they are always inserted in their sockets with the same orientation. A similar though shorter test bar can be made to check alignment of the quill of drilling and milling machines, using the same adjustable discs, though of course, a separate spindle and disc carriers will have to be made.



3: Testing bed alignment with that of lathe spindle



4: Testing alignment of centres



5: Head centre and spindle nose marked for repeatable orientation

TOOL AND MATERIALS SUPPLIERS - WESSEX

This article by Ted Hartwell lists some of the local suppliers who he has found helpful. We hope that this will be the first in an occasional series where readers describe stockists and what they have available in their own local area, so that eventually a complete directory can be built up.

One of the problems frequently encountered by model makers and those of similar ilk is the local purchase of specialised small tools and materials associated with their hobby. The DIY store groups, while providing popular lines, generally at attractive prices, do not cater for the enthusiast's requirements due to the lower demand, and hence turnover of such items. The majority of one's needs can be located and purchased via the advertisements in the Nexus Group Magazines, but with the disadvantages of not seeing the goods prior to purchase, carriage costs and waiting time. Over the past dozen or so years, the writer has sourced most of his 'bits and pieces' locally, both for personal use and the construction of sophisticated quality control equipment for specific applications in the motor industry. It is felt, therefore, that passing on such information, via Model Engineers' Workshop, may assist those living in the Wessex area, and that it may lead to readers in other areas making their own contribution. The suppliers listed in this survey are those with whom the writer has had direct contact. He has no other connection and cannot accept any responsibility in the unlikely event of problems arising, either due to the fault of the supplier or the purchaser. These companies, who deal mainly with the trade, do not normally include VAT in their prices but, to the writer's knowledge, the minimum charge likely to be imposed is £1.00 per transaction.

Allfix, 2 Leyland Road, Wallisdown, Poole, Dorset. BH12 5HB.
Tel. 01202 519066 (six lines) - Fax. 01202 518353.

Business hours—Monday/Friday 8.00am-5.00pm. Saturday 8.30am-12 noon.
Closed Sunday.

Suppliers of fasteners, fixings, tools and sealants.

Established some eight years ago in a

7000sq. ft. warehouse as an independent Company, Allfix are now one of the principal suppliers of screwed fasteners and associated tools and materials in the area.

The model maker is extremely well catered for with screws down to 10BA, metric screws down to 2.0 and an excellent stock of small rivets and washers.

The staff are most helpful—no order being too small. In addition a 30 mile radius delivery service is available for orders of £5.00 and above.

Alltools, 181 Alder Road, Parkstone, Poole, Dorset. BH12 4AN.

Tel. 01202 730376.

Business hours—Monday, Wednesday/Saturday 9.00am-1.00pm

2.00pm-5.00pm Closed Tuesday and Sunday.

Tool sales, trade and retail.

Alltools commenced trading in 1979 and have recently moved to a more spacious corner premises in a local parade. The shop is a virtual 'Aladdin's Cave', frequently with unusual or 'hard to find' items on display. Recent 'goddies' have included the following:

Diamond hardness tester, Tachometer, Optical measuring heads, Compound and vertical slides, Precision slip gauges, Small Lorch centre lathe.

Stocks held range from new and secondhand machines, power tools and an impressive display of small tools, many of which are very competitively priced. Mainly catering for the Engineering Industry, woodworking machinery and hand tools also feature in the stock.

Secondhand tools and machines are purchased for cash or taken in part exchange, thereby assisting those who wish to change or upgrade their workshop facilities.

Ashley Bearing Company, 580/586 Ashley Road, Parkstone, Poole, Dorset. BH14 0AQ Tel. 01202 746031 - Fax. 01202 741108

Business hours - Monday/Friday 8.00am-5.30pm, Saturday 8.30am-1.00pm. Closed Sunday.

Independent bearing and transmission specialists.

Established in 1972, Ashley Bearing Company have progressed to being one of the principal distributors of bearings and transmission products in the local area.

In addition to supplying a complete range of rolling bearings down to 3mm

OD together with seals and transmission components (also in small sizes) many other associated products form an impressive 'behind the counter' display. This includes a selection of electric motors, bronze and plastic rod, linear bearings, circlips, shim material and jointing.

Unusual items such as tungsten carbide ball bearings and combined rotary and linear bearings have been obtained for the writer at short notice and at a competitive cost.

Barlow Fastener Centres Limited, 27/31, Nuffield Road, Nuffield Industrial Estate, Poole, Dorset. BH17 02U. Tel. 01202 685881. Fax. 01202 666168.

Business hours - Monday/Friday 8.00am-5.00pm, Saturday 8.00am-12.30pm. Closed Sunday.

Specialist suppliers of screwed and other fasteners.

Barlow Fasteners Centres Limited hold extensive stocks of interest to the home workshop enthusiast down to 6BA and 2.5 in metric threads together with the more commonly required associated taps and dies.

Job lots of mixed bolts, screws etc., are available from time to time at attractive prices.

Facilities are also on hand for the identification of most known threads although those related to the Imperial system are gradually being phased out in order to provide a more comprehensive stock of metric fasteners.

B.R.T. Balena Close, Creekmoor Trading Estate, Poole, Dorset. BH17 7DX. Tel. 01202 697631. Fax. 01202 603320.

Business hours - Monday/Thursday 8.30am-5.30pm, Friday 8.30am-5.00pm, Saturday 9.00am-12 noon. Closed Sunday.

Distributors of rolling bearings and power transmission components.

A local branch of a Nation-wide network, B.R.T. are recognised distributors for all the principal bearing and transmission companies within the U.K. (and several outside the U.K.).

Items of interest to the home workshop enthusiast include miniature ball races (down to 1mm bore) to special order and small oil seals, some with widths down to 2mm. While most bearings are of normal (NC) internal clearance, other grades are available or can be sourced within a few days.

Associated items stocked include a full range of BA taps and dies, cutting oils, lubricants and plain bearings.

Engineers Supplies (Dorset) Limited, Haymoor Road, Poole, Dorset. BH15 3NT. Tel. 01202 741115. Fax. 01202 749199. Business hours - Monday/Friday 8.00am-5.00pm. Closed Saturday & Sunday.
Stockists of engineering tools, abrasives and instruments.

Established some thirty years ago Engineers Supplies (Dorset) Limited are a major supplier of small tools and equipment to the engineering companies in the area.

The opportunity has been taken to use the extensive showroom to display representative items of most of the stock covering virtually all the requirements of local industry.

Catering mainly for the trade, the majority of tools and measuring instruments likely to be required by the home workshop enthusiast are held in stock. Of particular interest are drills from 0.2mm upwards with increments, in the smaller sizes, by 0.05 mm together with small reamers in similar steps. The stock of silver steel is unique in the writer's experience in covering not only Imperial and metric in 13in. and 2 metre lengths but also letter and number drill sizes. The range of gauge plate/ground flat stock includes both metric and Imperial sizes in a comprehensive range of widths and thickness.

A detailed catalogue (costing £2.50) is available, this also forms a useful reference and contains an invaluable guide on safety and the maintenance of small tools.

K.E.S.Tools 262, Ashley Road, Parkstone, Poole, Dorset, BH14 9BZ. Tel. 01202 742393. Fax. 01202 722042. Business hours - Monday, Tuesday, Thursday & Friday 9.00am-1.00pm. 2.00pm-5.30pm. Wednesday & Saturday 9.00am-1.00pm. Closed Sunday.
Retailers of power and hand tools for craftsmen.

K.E.S.Tools, established some ten years ago, have an extensive range of professional power and hand tools together with facilities for the repair/overhaul of most makes of electrical equipment used in the workshop.

Items on display include miniature power tools and accessories and other tools of interest to the amateur not seen in local DIY outlets.

M.J.Engineering, Manor Hatch, 63b, Southampton Road, Ringwood, Hants. BH24 1HE. Tel. 01425 476234. Business hours - Wednesday/Friday 9.00am-12.45pm, 2.00pm-4.30pm Saturday 9.00am-12 noon. Closed Sunday, Monday & Tuesday.
Scale model traction engine specialists.

M.J. Engineering, located in what was at one time the stables to the Manor House, should be familiar to the majority of those interested in model road locomotives.

The current mail order catalogue lists five types of traction engine for which comprehensive drawings and all castings and materials are available. In addition, most miscellaneous items the model maker may require are included - the writer, as a home workshop enthusiast, finds it hard to visualise 12 BA hexagon bolts or even 6 BA socket head cap screws!

Additionally to the materials for models, the writer was impressed by the range of associated books on display (and listed in the catalogue) as well as volume upon volume of earlier copies of *Model Engineer*.

Items not included in the brochure are secondhand machines and small tools which naturally vary from week to week and warrant an occasional visit.

M.J. Engineering are professional model makers with facilities to produce the range of gears necessary for model traction engines. These facilities are also currently in demand by veteran, vintage and classic car restorers when replacement gears are unavailable.

Walter Shaw & Son Limited, 78/86, Nuffield Road, Nuffield Industrial Estate, Poole, Dorset. BH17 0RS. Tel.01202 673539. Fax. 01202 669509. Business hours - Monday/Thursday 8.30am-5.30pm. Friday 8.30am-4.30pm. Saturday 8.30am-12 noon. Closed Sunday.
Scrap metal merchants.

The writer makes no excuse for including the above Company who have traded since 1925.

The principal interest to the model maker is in the stock of secondhand non-ferrous metals both in bar and tube form, frequently in short ends. Whilst the precise size may not always be available, the prices are very competitive with staff normally available to advise on the identification of the metal selected.

The writer finds the variety of various brasses, bronzes and aluminium particularly useful in maintaining an 'under the bench stock' for that urgent odd job.

F.E. Slater (Poole) Limited, Units 5 & 16 Manor Park, Willis Way, Fleets Industrial Estate, Poole, Dorset. BH15 3SZ. Tel./Fax. 01202 674300. Mobile 0831 529721. Business hours - Monday/Friday 9.00am-5.30pm. Saturday 9.00am-12 noon. Closed Sunday.
New and used machinery and equipment.

While F.E.Slater (Poole) Limited carry an extensive stock of small and medium machine tools - mainly secondhand, the interest to the home

workshop enthusiast is probably in the stock of used cutting tools, measuring equipment and accessories. These range from butt welded and carbide tipped lathe tools to 'bargain packs' of assorted used lathe tools of small section, slitting saws and milling cutters.

The shelves also contain many other odd items in the form of lathe chucks, angle plates and milling cutter holders.

The stock is continually changing and thus warrants the occasional visit or a specific search for that special item, prior to which a telephone call would be appreciated.

Smith Metal Centres, Unit 9, Cedar Trade Park, Cobham Road, Ferndown Industrial Estate, Wimborne, Dorset. BH21 7PE. Tel. 01202 893755. Fax. 01202 893712.

Business hours - Monday/Thursday 8.30am-5.00pm. Friday 8.30am-4.30pm. Closed Saturday & Sunday.
Non ferrous metal stockists (local branch of nation-wide organisation).

Smith Metal Centres are specialised stockists of non ferrous metals and alloys in a wide range of sections. Whilst normally sold in stock lengths they are prepared to cut the lengths and quantities typically required by the model maker.

An established local supplier to home workshop enthusiasts in both Hampshire and Dorset for solid sections and particularly copper tube for model boiler fabrication.

Wessex Metal Stock Limited, Unit 29, Uddens Trading Estate, Wimborne, Dorset BH21 7NL. Tel. 01202 861337. Fax. 01202 861338.

Business hours - Monday/Friday 8.30am-5.00pm Closed Saturday & Sunday.

Independent suppliers of stainless, Carbide and alloy steels, Aluminium and non ferrous metals.

Wessex Metal Stock Limited commenced trading in 1988 and specialise in the supply of machine shop and engineering materials.

While prepared to cut short lengths of the larger sections on request, the stock of bar ends can frequently satisfy the casual purchaser. Where these have lost their colour code the storeman will normally be able to advise on the actual specification. When the need to purchase a cut length is anticipated, a prior telephone call can confirm the availability of the sawing facilities, frequently in use on contract work.

The stocks held are principally bright (cold finished) sections in Imperial and metric dimensions covering a wide range of grades including stainless steel and which are listed in their brochure.

In common with most steel stockholders, the would be purchaser is advised to wear stout boots and old clothes!



A LATE DEVELOPMENT

THE STORY OF THE GRINDSTONE AND THE GRINDING MACHINE

part 2

Don Unwin continues with the story of the development of the grinding machine, looks at it as an early industrial tool and some of the ramifications of the equipment as it came in general use in 20th century production workshops. Last time we had reached the point where Norton, one of the famous names in this process had made a start on production machinery.

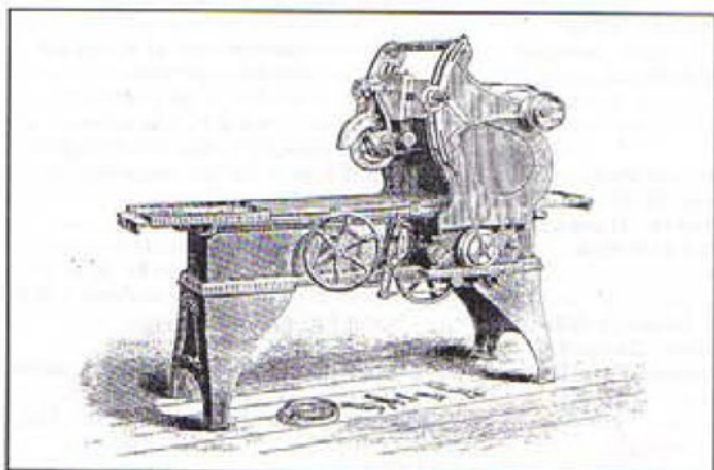


Fig. 13: B & S Plano surface grinder of 1877. (Brown and Sharpe catalogue).

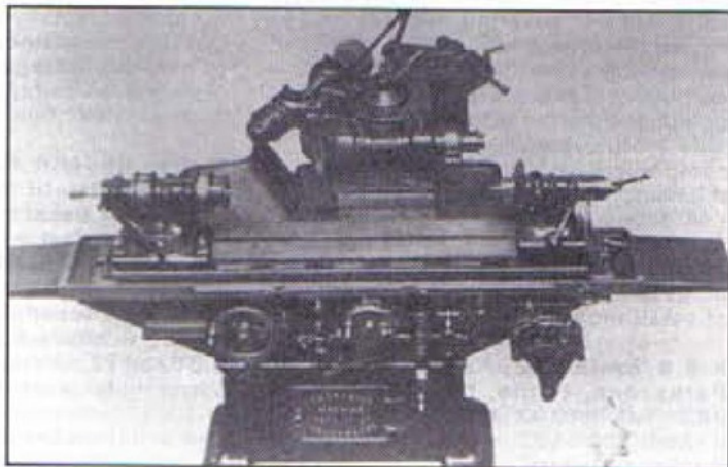


Fig. 14: Churchill 3 turret grinder, c.1930

By November 1900 Norton had sold the first two heavy production machines. They were plain cylindrical machines of unprecedented proportions using large diameter 2in. wide wheels and a table traverse which moved the wheel width each revolution of the work piece. To prevent distortion the work was flooded by a continuous and copious suds supply instead of holding a wet rag in contact as was the earlier practice.

These high production rate heavy duty precision cylindrical grinding machines became a valuable tool for the fledgling automobile and locomotive building industry. Ford for his mass produced automobile needed precision ground surfaces, only available at great cost before 1900 due to the skill content. Norton had provided the answer.

Norton's grinder together with Maudslay's lathe and Joseph R. Brown's universal milling machine were the main developments in machine tools up to this time.

The Landis Brothers Company, Philadelphia USA, builders of portable

engines and agricultural machinery acquired a small B & S grinder and one of the brothers, A. B. Landis, became very interested in grinding machine design to suit their type of work. This interest led him to founding the Landis Tool Co. and in 1883 they produced a machine of advanced design and rigidity. Longitudinal motion was given to the wheel head with the work table fixed but with a small angle swing for grinding tapers.

While we have so far been talking primarily about external cylindrical grinders, the development of internal grinding was also taking place. We have mentioned the P & W grinder lathe with a belt driven spindle carrying a small wheel mounted on

the carriage, the work being held in a chuck while Brown & Sharpe made a successful internal grinding attachment of a similar type for their universal grinding machine in 1880. These machines, which were adaptations to external machines, had problems with spindle stiffness, wheel wear, overhang of spindle and obtaining

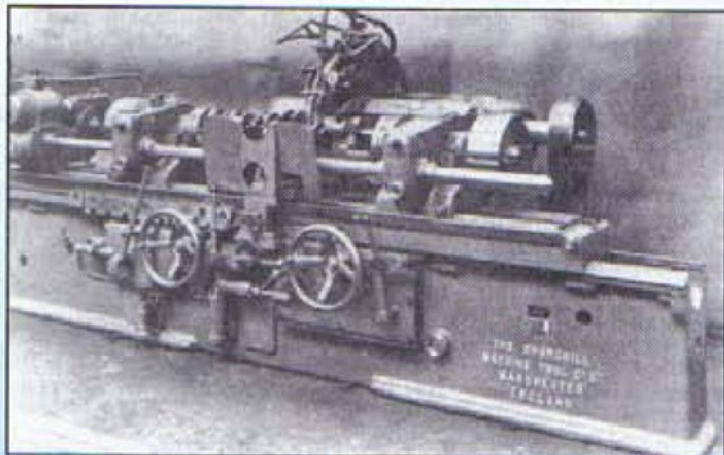


Fig. 15: Churchill crankpin grinding machine c. 1930.

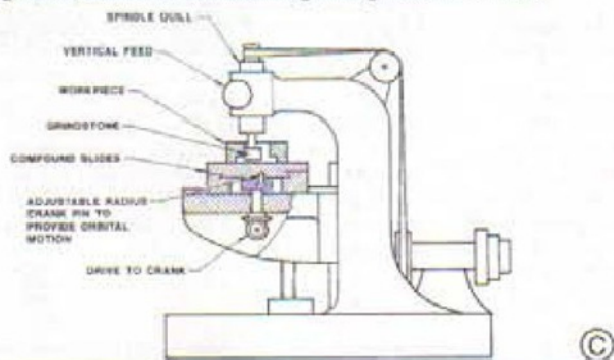


Fig. 16: The Myford 12ME cylindrical grinding machine of 1990. (Photo: Myford Ltd).



Fig. 17: Assembly of the Heald internal sliding spindle grinding machines, c.1920.

Fig. 18: Reid and Neilson internal grinding machine of 1896.



Nasmyth's grinder of 1838 was the forerunner of the other important type of machine, the surface grinder. In the same way that early designs of cylindrical grinders were based on the lathe, the planing machine provided the basis for the early surface grinders with the grinding head fitted in place of the tool. Brown & Sharpe made such a machine in 1877 and sold it for many years, called a plano type surface grinder (Fig. 13). However with the success of their milling machines the planer type was superseded by a knee type, basically a small horizontal miller with a high speed spindle. These were all peripheral type grinders in which the circumference of the wheel was in contact with the work surface.

Bursting of the generally poor quality wheels was a serious problem and the job of a grinder was considered a hazardous occupation.

Attention to the ways of mounting wheels started from 1863 onwards. B & S were recommending elastic washers between clamp discs and wheels in 1891 and were also fitting adequately strong guards on their machines in the same year but simple sheet metal guards were more normal and were still being fitted in 1951.

As we have seen, in the last decade of the 19th century

silicon carbide was synthesised and the value of artificial aluminium oxide discovered which revolutionised the grinding process, resulting in a period of great machine development activity. This included greatly increased rigidity, better wheel drives, heads and bearings, hence overhung wheels and higher speeds became possible. Feed gears, copious coolant supply, dust exclusion and steady rests were all improved while the use of dead centres became the standard practice. Most important of all was the advent of greatly improved grinding wheels.

Soon afterwards in 1902 the Landis Tool Co. built a machine although not universal with a work head which could swivel through 90deg. and no countershaft. It was the first machine in which the wheel head traversed along the work instead of the work reciprocating. At the same time Wm. Muir provided in-feed by traversing a saddle that carried the work table instead of the wheel head.

Meanwhile Reinecher in Germany entered the grinding machine field in 1907 by making a saddle carrying the wheel head type with ways on the back similar to the Landis and another with wheel heads front and back to balance the cutting forces which could grind work 33ft. long x 3ft. diameter.

Then, in 1907 C. H. Norton introduced automatic loading and a year later Pratt & Whitney developed auto-sizing which eventually became standard practice on all types of production grinders.

Special cylindrical grinders for grinding automobile engine cam shafts were developed in 1908. On one type the camshaft was mounted between centres on a rocking cradle which was operated by a single master cam. The disadvantage was that only one cam surface could be ground at a time. Later this was overcome by mounting all the master cams on one master shaft. The other type introduced by J Holroyd in 1909 moved the grinding head back and forth by the master cams instead of the work.

Charles Churchill, an American machine tool maker visited England in 1861, stayed here and founded Charles Churchill & Co. to import machines then started the Churchill Machine tool Co. in 1865 to make them here at Manchester. One of their interesting products was a multi-purpose grinder of 1910. It had three spindles with a vertical axis turret to bring each spindle

Fig. 19: Bryant hole and face grinder, 1908.

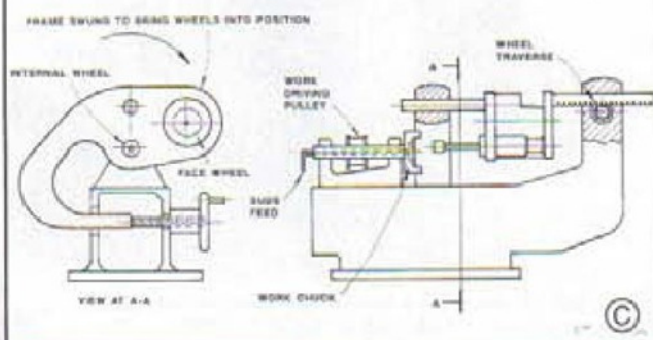
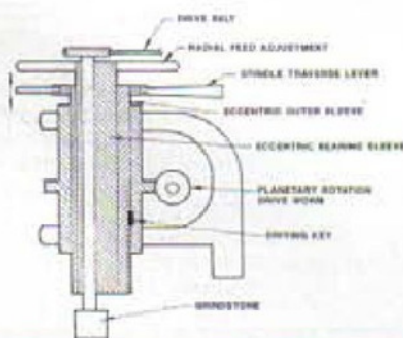


Fig. 20: R. Peacock Planetary spindle of 1888.



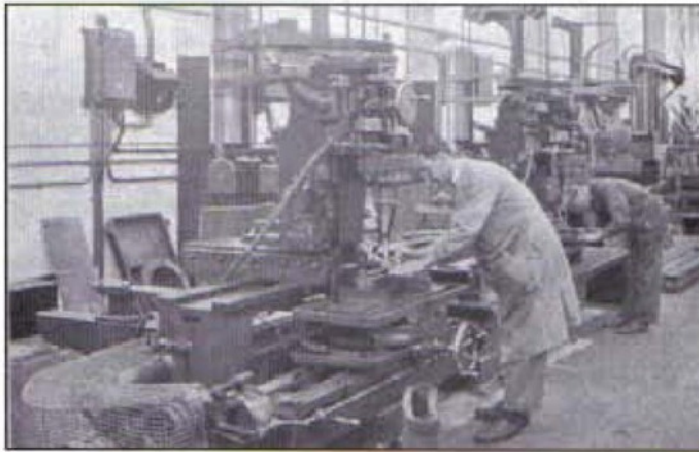


Fig. 21: Curved expansion link grinders as used at the L.M.S. Railway Works, Crewe in 1931. (Photo: Railway Gazette).



Fig. 22: Churchill pendulum grinder working on curved expansion links, c. 1930.

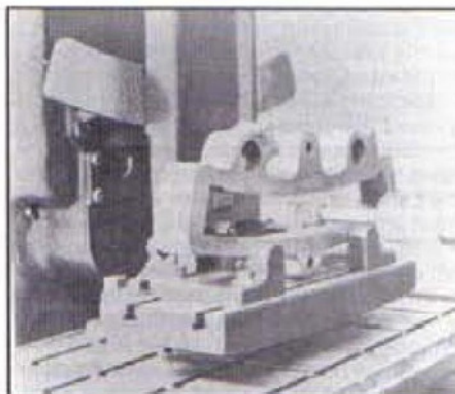


Fig. 23: The link in position on the machine table.

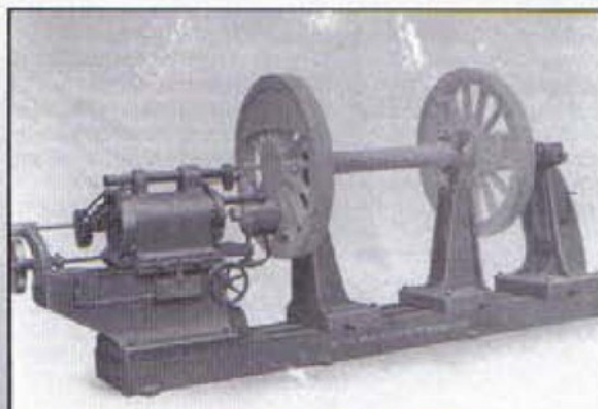


Fig. 24: Beyer Peacock locomotive axle assembly crankpin circumference grinding using planetary spindle, c. 1908.

into position, one for internal grinding, one for cylindrical work and one for facing work (Fig. 14).

Another was the crank pin grinder, Fig. 15 showing an example from the 1930s.

To come right up to date Fig. 16 illustrates the excellent, relatively small Myford cylindrical grinding machine.

Grinding machines specifically for internal work rather than attachments fitted to external

machines began to be developed towards the end of the 19th century.

The work was held in a rotating headstock and one type had the wheel head on a fixed cross slide with the work head traversed whilst the other type had wheel head on a cross slide which traversed along the bedways. Figure 17 illustrates this type being assembled in the US factory at Worcester.

In 1896 Reid and Nielson patented an entirely different method of internal grinding, Fig. 18. The spindle rotated about a fixed vertical axis and reciprocated up and down. The work was on a freely sliding compound slide which was driven orbitally by a crank with an adjustable radius pin from underneath. This radius had to be quite small so that the out of balance forces were minimal although the hole being ground was a considerable distance from the centre of mass. Pratt & Whitney used the same principle for grinding ball tracks of cup and cone bearings in 1899. Their design had the compound slide carrying the wheel head and two cams oscillating the slides. This enabled non-circular shapes to be ground. Internal and external versions were made. To grind the circular tracks of large 40in. diameter gun mountings in 1906 P & W adapted the principle on a machine in the form of a facing lathe.

Another special purpose production machine was made in 1908 by The Bryant Chucking Grinder Co. USA for dealing with large quantities of work requiring hole and face grinding. Fig. 19.

The other form of internal grinding was the planetary spindle in which the work is stationary and the

wheel axis rotates and is provided with means whereby the radius can be adjusted to set the diameter and cut. This type was particularly suitable for work too large or irregular to be rotated.

In 1893 the locomotive builders Beyer Peacock developed their planetary grinding spindle originally patented by R. Peacock in 1888, Fig. 20. They were fitted to machines for large work and special purposes such as locomotive curved valve gear links. These had a vertical wheel spindle which was given axial reciprocating motion up and down the slot which was mounted on a radius arm mounted on the table, Fig. 21, while some other makers of similar machines moved the table up and down. They had also patented a planetary feed adjustment and it was extensively used by many other makers.

The pendulum grinder, Figs. 22 and 23, is another type of machine for grinding the curved links which used the planetary spindle.

Beyer Peacock also used their planetary spindle for grinding the outside crankpins of locomotive wheel and axle assemblies which were too large to rotate, Fig. 24. A later example of this machine grinding the bores to accept the crank pins is shown installed in the L.M.S. Crewe locomotive works in the 1920s, Fig. 25.

An alternative method of radial adjustment on a planetary spindle was used by Mayer Schmidt and F Schmidt of Germany in 1902 as depicted in Fig. 26.

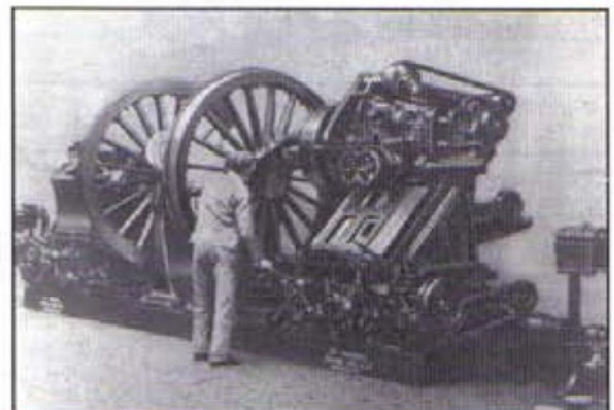


Fig. 25: Churchill planetary grinder for crankpin holes on locomotive driving wheel assemblies, c. 1927.

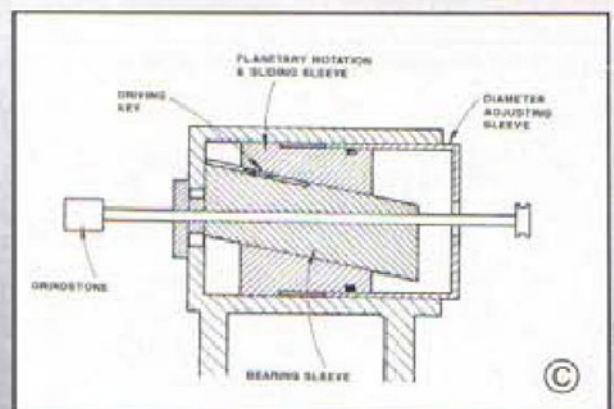


Fig. 26: Diagram of Mayer and Schmidt planetary grinding spindle.



We visit PAT TWIST

We continue with our look around the workshop of a very accomplished amateur engineer, seeing how he manages to adapt various items to help in his day-to-day activities. This time we concentrate on Pat's Myford lathe and its ancillaries.

Part 2

Continuing our look around this splendid workshop we start by looking at a novel measuring device.

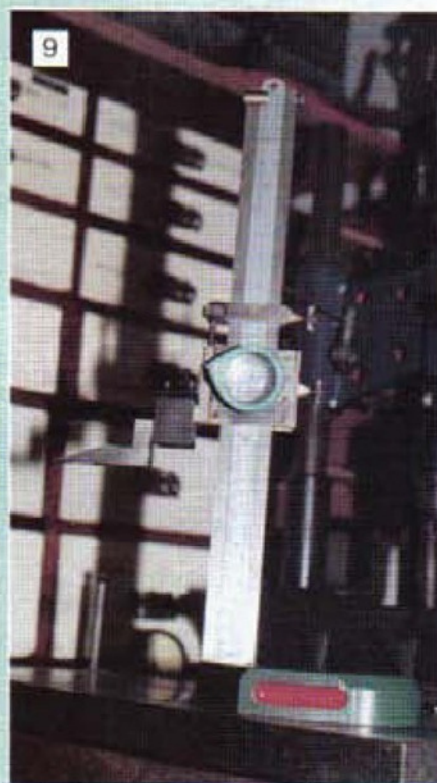
Comparatively rare in home workshops are height gauges, largely on the grounds of cost and frequency of use. Pat has come up with a very workable alternative where the measuring is done from a very accurate narrow rule rigidly supported and the division and fiducial line magnified for ease of use. Pat reckons that this is repeatable and accurate to within 0.003in., adequate he feels for the typical work carried out in the home shop. Construction is seen in **photo 9**.

Many people have made a split threaded bar for supporting threaded items for shortening. Pat has a couple,

interesting was the one in the foreground of **photo 10**, this is made from BMS and the outwards bow is caused by the release of locked in stress when the sawcut was put down the centre.

Moving to the drilling machine, the base of one of these would be an ideal place for storage if it were not for all the swarf from drilling operations that collects there. Pat solved this problem in typical style a sheet metal tray is mounted under the main drilling table two bent up ears projecting over the side of the table secure it in position, and it is easily lowered for cleaning. **Photo 11** shows the idea. The machine boasts a built in spotlight clipped to the pillar, certainly the intense local light is useful.

The lathe is the most used machine in the shop, Pat's is a well equipped Myford Super 7 bench mounted. Unusual in that the bench is carried on substantial brick pillars to reduce any vibration. The set-up is extremely rigid (**photo 12**). The lathe carries masses of extra equipment, in the





drawers below and on the shelving at the rear, that lying in the path of flying swarf and oil is protected by a hanging plastic sheet, hence the slight blur at the rear of the photo. Pat uses an air line to blow down the lathe, the compressor is sited to the rear of the brick built workshop, the air tubing can be seen across the brick pillar under the headstock. General cleaning of machines and floor is taken care of by an industrial vacuum cleaner housed in the space below the lathe.

Photo 13 shows a close-up of the headstock and the very useful tool tray mounted over the belt guard. The drive to the overhead gear is taken from the lathe countershaft and run up by belting as required, **Photo 14** shows the overhead gear, simple yet effective.

Photo 15 shows the very convenient coolant holder for the lathe, note also in this picture the use of Tee handles on the lathe.

Although he has a very well equipped milling machine some milling and boring jobs are undertaken on the lathe. Part mounted in **photo 16** is Pat's boring sub table, a steel fabrication securely fixed with Tee nuts and with a series of threaded rotation holes in the top; more convenient than slots for holding irregularly shaped work. Incidentally when this was welded the welder jacked the two angles outwards after tacking to minimise distortion to the finished job. Note also in this picture the use of the Lammars three way toolpost instead of the more conventional four way type. Staying with the lathe, **photos 17 & 18** show two views of a special 4 jaw fixed steady, with reversible jaws fabricated from oddments. Alternative bolt holes allow the use of the tool as a conventional 3 jaw steady if required.

Remaining with the lathe for the moment, Pat's nobby little box for holding all his tool and other packings for the lathe is shown in **photo 19**, simple, and obvious once it has been thought through, yet we have never seen another



in any workshop visited. This comes in very handy in conjunction with the very simple tool shown in **photos 20 & 21**, a pre-setting device for getting lathe tools to exact centre height.

Photo 22 shows the answer to internal threading, ex diehead chasers brazed to a mild steel shank make this an easy job; die head chasers are often available in a range of TPI's through many tooling suppliers.

Final tool selected from the mass for the lathe is that shown in **photo 23**, a false mandrel matching the nose thread on the Myford mounted in a ball bearing shaft; and lockable against rotation. A lug at the bottom allows this to be held horizontally or vertically in the bench vice, it is a simple matter to position work on the faceplate flat on, it lays there while being clamped. Once positioned, turn through 90 deg. as in the photo, release the spindle lock and spin the job up to check balance.

Next issue we conclude this report by looking at the milling machine and storage facilities.

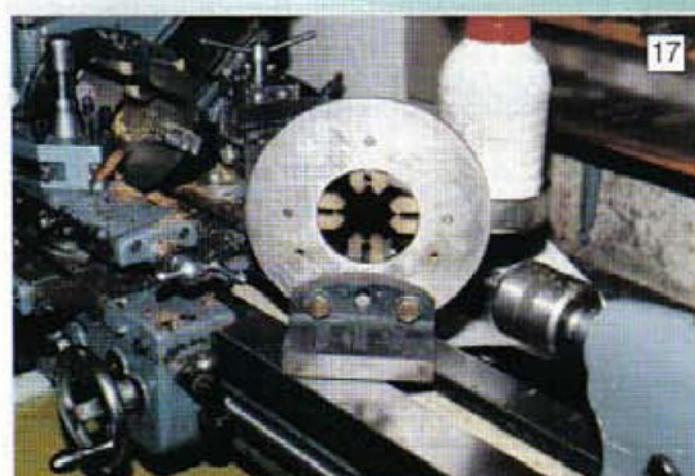




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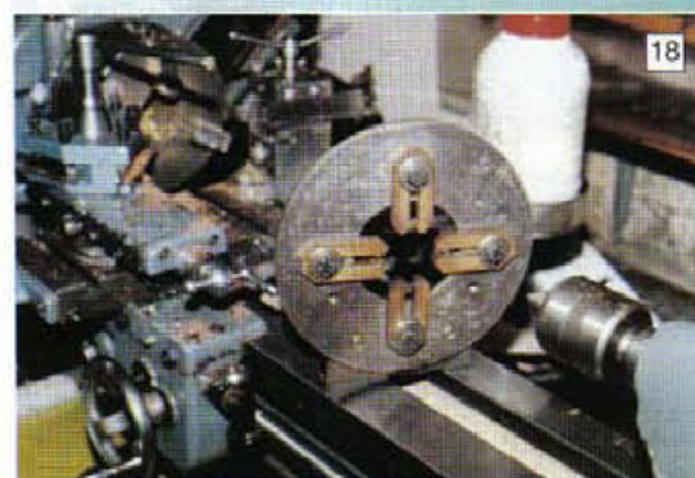
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23

SCREWCUTTING ON THE UNIMAT 3

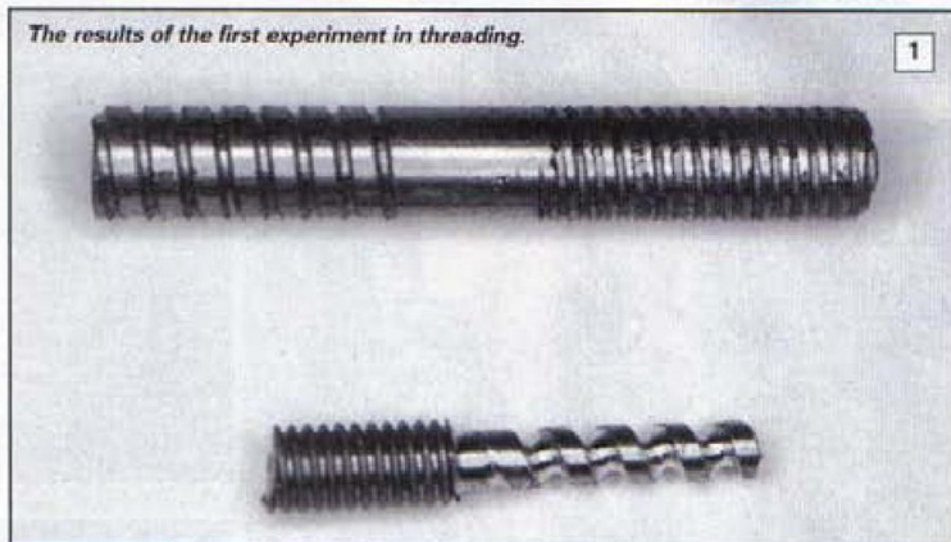
In this article Bob Loader recounts the trials and tribulations of making parts for a telescope, requiring various threads using his Unimat 3 which he had to specially adapt for the purpose.

A long time ago I made screwcutting attachment for my Unimat 3 lathe. I had a few gears, accumulated over the years, including a 60, 40 and four 24 teeth ones. I'd made two 20 tooth ones and I bought a 30t at the last Model Engineer Exhibition. I cut the samples in **Photo. 1**, to see how it went. **Photo. 2**, shows the gearing I used to cut the coarse pitch brass item and **Photo. 3**, depicts the cutting under way. The idea worked after a fashion but would need more work to be a going concern. My normal threading requirement is of a sort which I can do with a tap and die, so there the experiment stopped.

The parts would still be gathering dust, if I hadn't had an enquiry from my son-in-law. He has a telescope, no ordinary one but one of those short fat ones which are full of extremely accurate mirrors, lenses and other components. It is a Maksutov Cassegrain type and as the name implies, Russian made. A similar telescope made by American manufacturers is more expensive, so the enthusiasts tend to use the Russian telescope with American accessories.

I expect some readers will have spotted the snags already, the difference in the threads. It is possible to get adapter rings, but once an American accessory has been

The results of the first experiment in threading.



The gearing for the coarse pitch thread in photo 1.

fitted, it is not possible to fit a further Russian one on to that. So Martin, my son-in-law, asked if I could make the adapter shown in **Fig. 2**. It would connect an American male thread to a Russian female one. The thread would have to be as short as possible, with concentric threads and made from non-reflective material, so that it didn't mess up the optics.

I agreed to have a go, wondering if I'd had a sudden attack of *Migbin* (mouth in gear, brain in neutral).

The problem would be the threading, cutting the American thread on the Unimat, which is all metric,

Another minor problem would be that all the business had to be conducted by letter and telephone as Martin lives near Boston, USA. He did send an adapter with the American male thread and the Russian female one, for me to use as a gauge.

The American thread was 2in. x 24TPI; I thought I

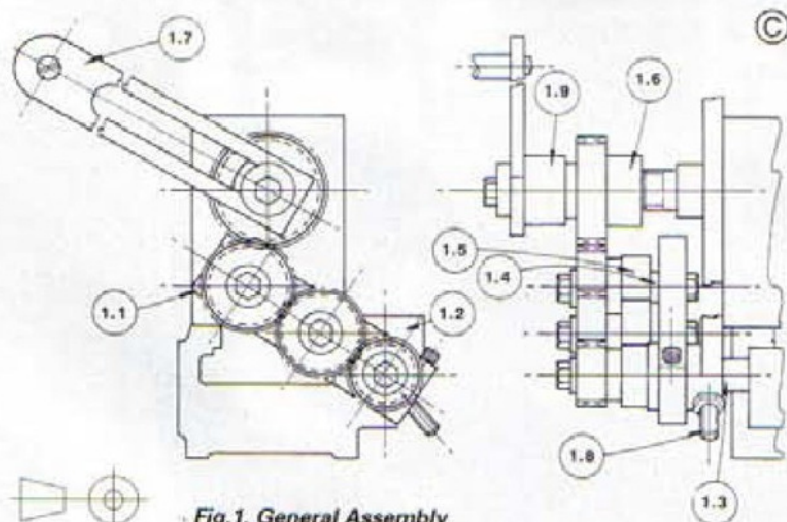
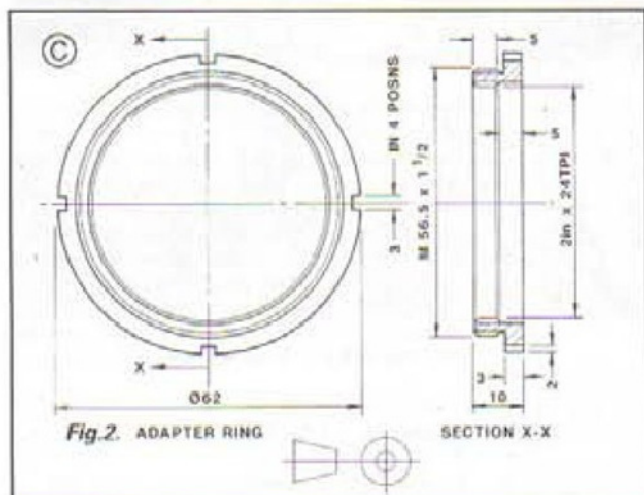
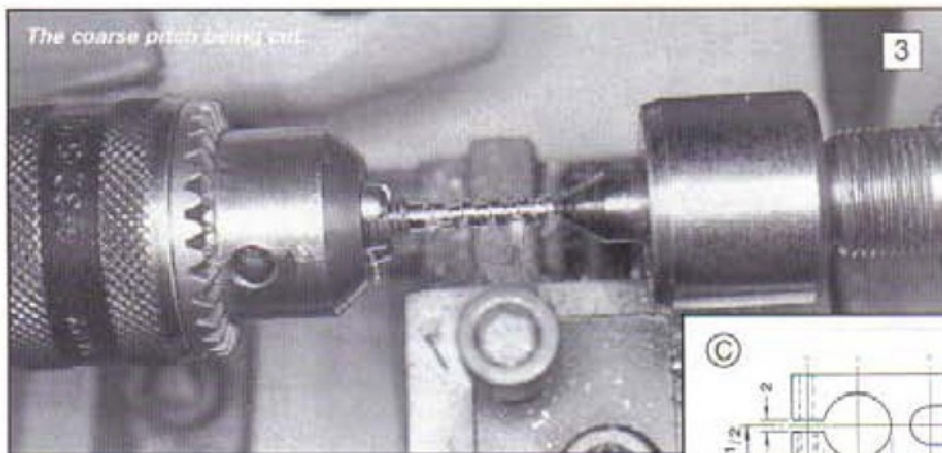


Fig. 1. General Assembly



might get away with it if I cut a 1mm thread. The 24TPI pitch is 0.0416in. which converts to 1.058mm. The pitch error would be 0.058mm, or 0.002 inch. As there were only about 4 or 5 threads engaged, I could probably make it fit. The Russian thread would pose no problem, as it was 1.25mm pitch.

The fun really started when I dusted off the parts of the threading tackle and roughly assembled them to see what I had to do. For starters, the bolt clamping the bracket to the lathe headstock would foul the swinging arm in some positions.

Photo 2, shown this quite clearly. The bolt is just above the Tufnol gear. It needed the bracket counterbored, and the bolt replacing with a cap-head type.

Have any of you out there counterbored a component on the wrong side? You can perhaps imagine how I felt when I did. I said, 'my word, how unfortunate', several times, because I'd have to make another bracket and there is quite a critical dimension between the centre of the bolt and the centre of the shaft which drives the lead screw.

The first replacement was well out and couldn't be put right. The second was all right but made from 7mm material and needed shims and washers in places to make it fit. I had run out of suitable 8mm steel. The other small but important part to make was a means of retaining the drive shaft in the bracket. A set screw with a spigot on the end was the solution.

Making the parts

Notice that the parts drawings have no

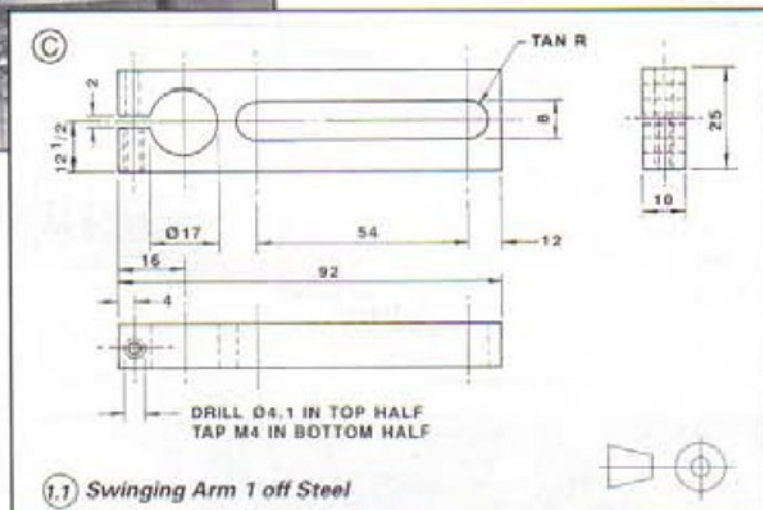
tolerances and the dimensions are nominal. **Fig. 1.** gives the arrangement of the parts. The important fits are the swinging arm on the drive shaft in the bracket and the winding spindle in the lathe spindle. Common sense will dictate where other lengths and diameters need to be carefully made.

Swinging arm, (1.1)

This carries the idler gears and clamps round the 17mm spigot on the bracket. It is easy to make except for the 17mm hole which cannot be swung on a face plate or in a 4 jaw chuck on the Unimat. It was saddle bored and *must* fit well on the bracket. The 8mm slot was drilled at each end, hacksawed out roughly, then filed. The drilling was done from the lathe headstock using the faceplate in the tailstock as a drilling table. The 2mm slot was hacksawed, its only function is to provide a clamping action.

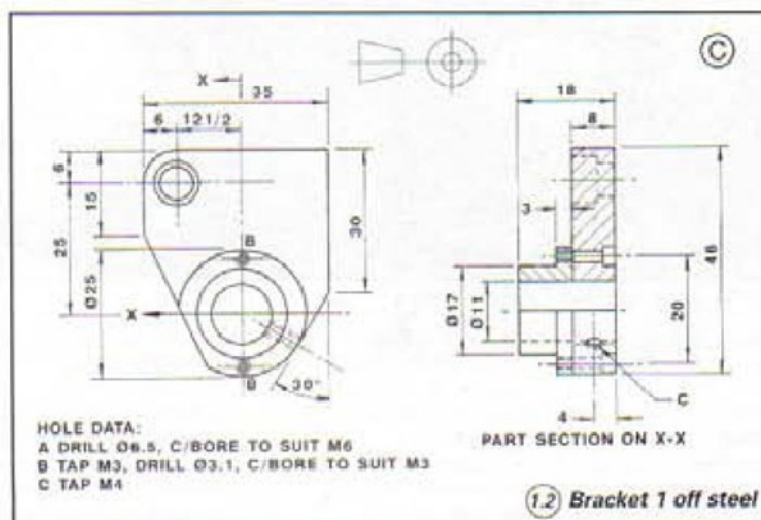
Bracket, (1.2)

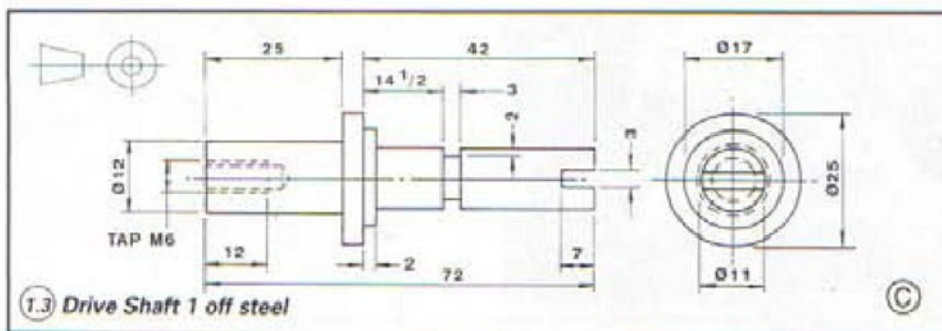
This was made in two parts, the 25mm flange and the 17mm spigot are three jaw chuck job, with reversed



jaws where necessary. If the swinging arm has been made first, it will be easier to fit the spigot to it. It is always easier to fit a diameter to a bore than the other way round. The 11mm hole should be as nearly as possible the same size in the bracket and the boss, so that a piece of scrap bar can be machined to 11mm dia. and left in place while the holes 'B' in **Fig. 3.** are drilled, tapped and counterbored.

Photo 5. shows the setting up for the 11mm hole in the bracket. I used the four jaw chuck I made a long time ago, not the first time I've been glad to use it. The strips of aluminium alloy between jaws and work are there to avoid marking the job. The dial indicator (DTI) is resting on an accurately ground point made from a broken end mill. The threaded end, which has an accurately made centre hole, locates in the tailstock centre and the other end is ground to a 60deg. included angle. I made this setting aid when I had the use of a Churchill cylindrical grinder, so I know it is accurate. When the work is rotated by





centres, so that everything is concentric. The 11mm diameter will probably need to be a touch undersize to fit in the leadscrew housing.

The 3mm undercut in the 11mm dia. is where the retaining screw locates in the bracket and stops the shaft pulling out. It needs cutting little by little with a thin parting tool. For jobs like this on small lathes it is a lot easier and breaks fewer tools.

With all the turning finished, the 3mm slot can be sawn and filed till it fits, I used a junior hacksaw and a 4in. smooth hand file. The last job is to hold on the 11mm dia. using some protection between chuck jaws and work, then drill the tapping size hole in the other end. Do the tapping in a vice, the chuck won't hold it tight enough.

Gear spindle. (1.4)

There are two of these which carry the idler gears. They *must* be a running fit on the 12mm diameters which are best turned with a tailstock centre supporting them, the centre hole will be a good start for the tapping drill. The tapping drill can go right through. The other end is flattened and fits in the 8mm slot in the swinging arm. The 8mm dimension from the end to the shoulder can be 1/4mm or so under, so that the bolt will clamp it securely.

Spacers. (1.5, 1.6)

Possibly the simplest components of the lot, they don't have to be Duralumin, I just happened to have some pieces which needed hardly any work to make them the size shown. All they have to do is space the gears and allow them to rotate freely. The long one which fits on the winding spindle and one of the short ones have a slot in them to allow a round pin to go through. This is because of my way of keying the gears, more about that later. The slot in the one on the drive shaft can be seen in **Photo. 12**.

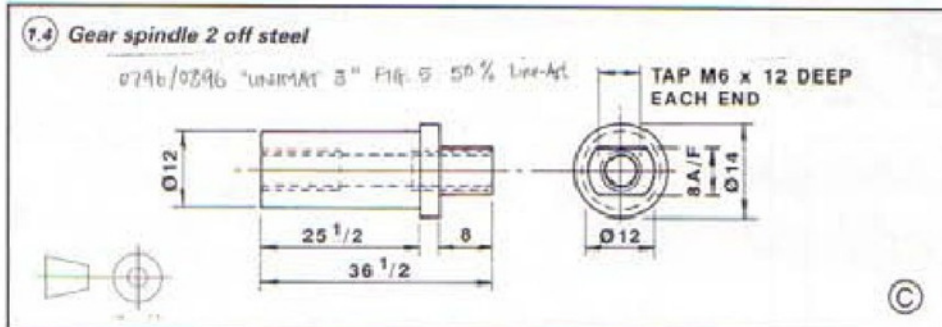
Locating screw. (1.8)

A length of 4mm steel studding or a cap head or other screw with the head cut off will be quite good enough for this. In use it is locked with a nut, once the right degree of tightness has been found.

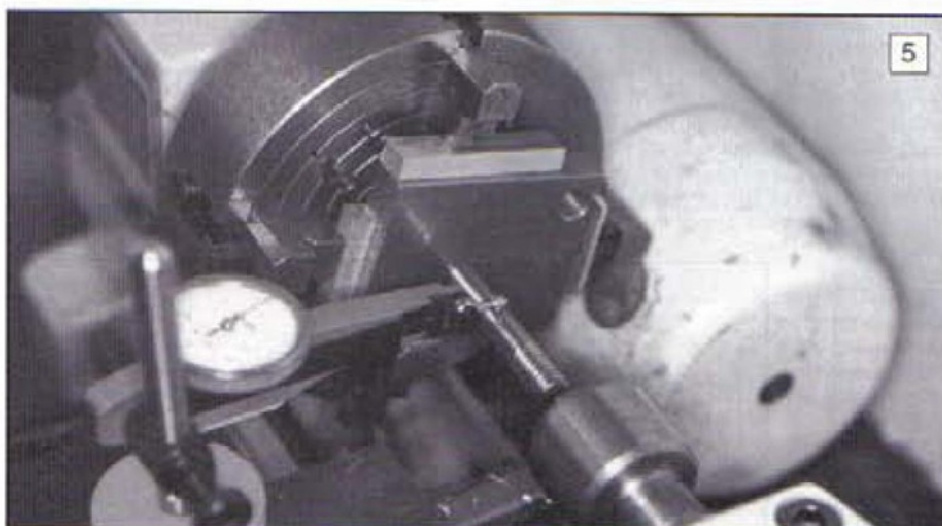
Winding spindle. (1.9)

In common with the drive shaft this needs to have concentric diameters so it is as well to turn the 10mm dia. first, using tailstock centre support. The 10mm is *nominal* and will probably be a bit over, so turn it to 10.15mm and use emery cloth to get the diameter to just slip nicely through the lathe spindle. Drill, tap, and cut the slots when it fits *and not before*.

It will be tedious, rubbing the spindle down to fit inside the lathe spindle, but it must be done so that when a socket screw is tightened in the tapped hole it will expand and lock it. To make the locking effect, only the taper tap is used. Once the spindle fits, it can be passed up the lathe spindle, locked with the socket screw and



Undercutting the drive shaft.

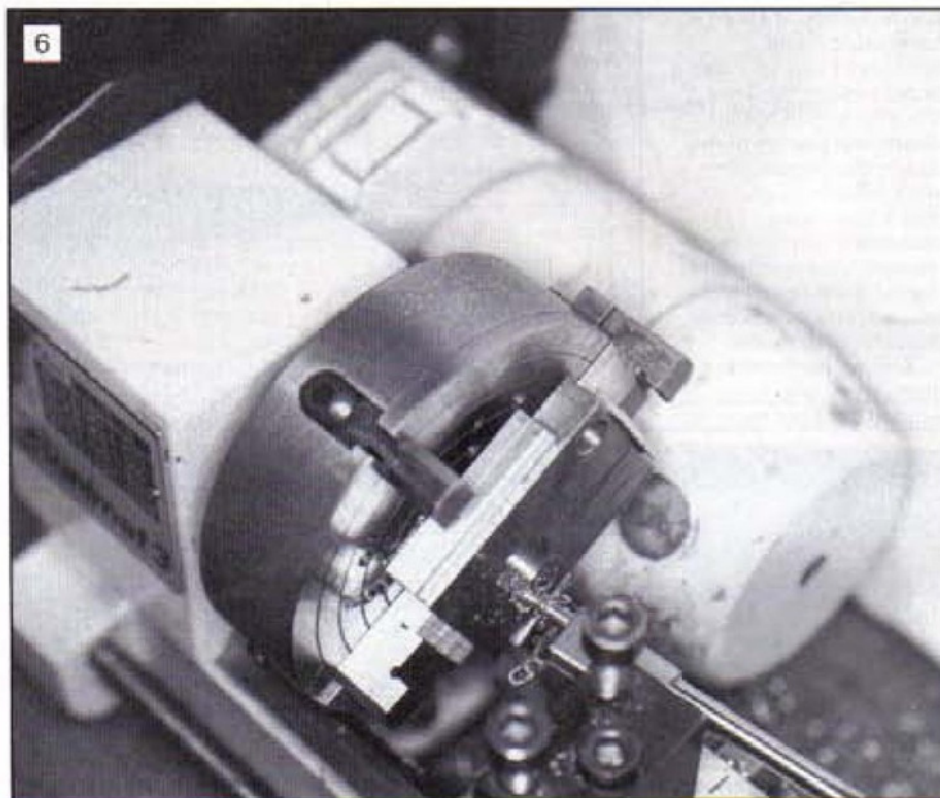


Setting the position for the 11mm dia. hole in the bracket.

hand, and the indicator doesn't wobble, you have won and can drill and bore the hole. The other hole, 'A' in **Fig. 3**, can be drilled against the faceplate, like the one in the swinging arm. Remember to countersink on the right side! Once the drilling has been done, the rest of the shaping can be sawn and filed.

Drive shaft. (1.3)

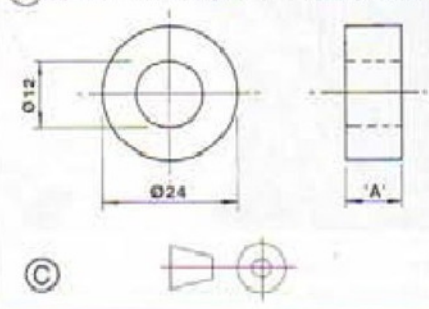
This is the final link and connects to the leadscrew by the slot which fits the tongue on the end of the leadscrew. It is best made by rough turning to about 1mm oversize all over, then putting between



Boring the hole in the bracket.

1.5 Spacer 3 off length A.. 10 Duralumin

1.6 Spacer 1 off length A.. 15 Duralumin



the 12mm diameter turned, drilled and tapped. The last job is to file the flats to fit the slot in the winding handle.

Winding handle. (1.7)

Once again there was some Duralumin of a suitable size to hand, but it could have been made from any available material of suitable strength. It rotates the winding spindle and is slotted to allow for different arcs of movement. I haven't included the handgrip, mine was a shoulder bolt which allowed a piece of tube to rotate freely. Material which is comfortable will do, remember that to cut a thread it will have to be wound to and fro a lot.

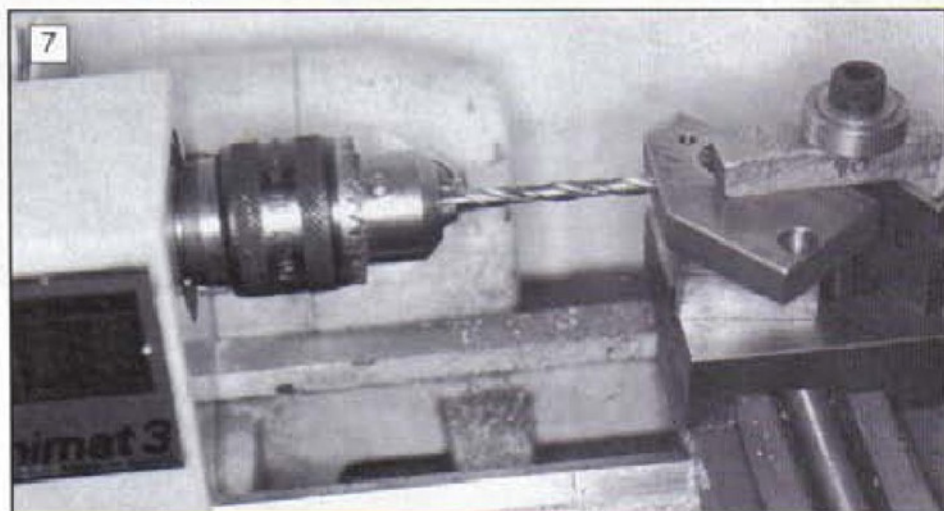
With all the components made, the only thing to consider is the method of driving the gears. All mine have 12mm holes in

them, for different bores the drawings of most of my parts would be different, to accommodate other sizes. The other difference would probably be my method of keying the gears. I use round pins to drive the gears rather than the conventional square keys. For gears of the size I use, 20DP, the round pin is quite sufficient and a lot easier to make and fit. Those gears which have different sizes of bore I bush down to my common size of 12mm.

Making the adapter

The first thing was to find some material. The ebonite I had was too small, Duralumin would machine beautifully but would need anodising or some process to get rid of the reflective surface. That left that good old standby, mild steel. The only piece I had was some 10 x 75mm; at least I could oil black it to get rid of

the shine. I anointed the formidable lump with a large spirit marker, marked it out and looked out all my hacksaw blades, tension files, coping saw and junior hacksaw. I sorted out some CDs for the accompaniment and made a start. It was a two CD job and **Photo. 8.** shows it well under way, a new hacksaw blade was due by the look of it. The lugs were left for later clamping to the faceplate. It looks a right mess, but the hacksaw is one of the finest roughing out tools in the box and reduced the work the Unimat had to do later. Without this roughing out first the job would have taken ages. I cut the centre hole out first. This I would normally do with a coping saw, just one hole to get the blade in first, then a coping saw, used carefully, does the same sort of job as a fretsaw in wood. I drilled the hole, threaded the coping saw blade through and started. It didn't feel right and a look at the blade showed why. The teeth were worn flat. I took out a new blade and tried it with a file. It took the teeth straight off. The last lot of blades I bought were counterfeit and the only way it showed was the colour of the blades, they were steel colour. The moral is, don't buy at a market and *never* touch any with a natural steel colour, they should be blue-black. Don't take too much notice of what it says on the packet, mine were allegedly Eclipse.



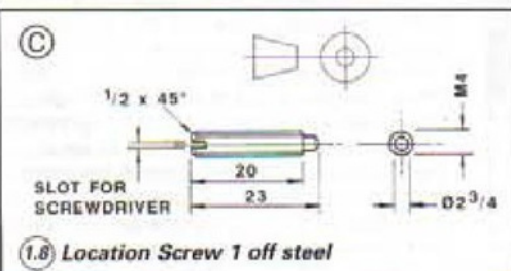
Drilling the tapping size hole for the locating screw in the bracket.

Cutting out the rough shape of the adapter.



Try one with a file if possible.

That little episode made the job take a little longer, but as soon as I could get a hacksaw in the hole it went fairly well. When the shape was reasonably accurate, I made special tee nuts and washers and



1.8 Location Screw 1 off steel

turned the heads off the cap head I'd use down as far as I dared. **Photo. 9.** shows why this was necessary; my home made face-plate only just clears the lathe bed and motor. The fastening lugs I'd left were filed down as far as possible, leaving about 2mm thickness for clamping. I got it running truly, as far as I could, to the marked line of the bore and clamped down firmly. On that setting I could machine both diameters on the same centre. **Photo. 9.** shows the start of the machining. Machining the bore was a slow job, but because of the size, larger tools than boring bars could be used. I put in an undercut as close to the surface of the faceplate as I could, so that there was a

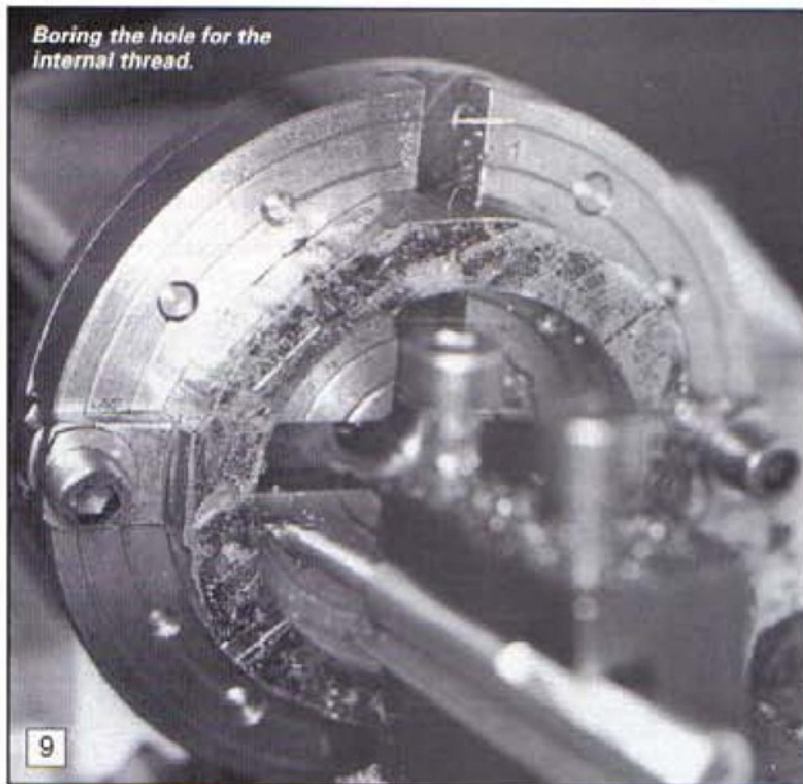
gap to turn to, it saved a lot of chatter and vibration. Even so it was a nerve racking business. Once I'd turned out the lumps and bumps of the rough sawing and filing, it went fairly well, give or take a broken belt. I replaced it with the usual vacuum cleaner one and dusted it with talcum powder, I do that to stop the belt going grotty. Turning the outside diameter was as long-winded but I got there in

Threading the internal thread, note the tight clearance between faceplate and motor.

10



Boring the hole for the internal thread.



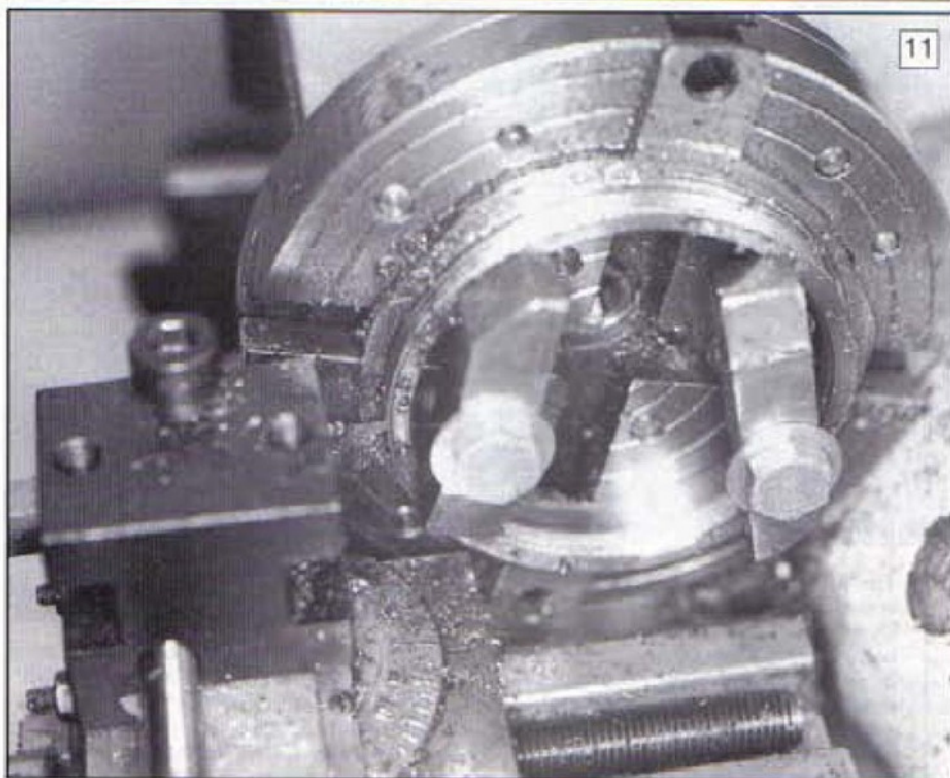
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the end. So much for the preliminaries, I sorted out all the gears, bracket and swinging arm, fixed the winding handle, connected to the lead screw and found a suitable threading tool. The tool was one I've had a long time, forged from some K.E.10 tool steel by my old friend Steamboat, the blacksmith. It is small enough to run out nicely into an undercut. At this stage I put on the compound slide, so that I could re-position the tool if there was a mishap.

The gearing was easy, the leadscrew has a 1mm pitch, it needed equal gearing. the 20t gears I made were suitable. For the gear train to mesh there had to be an idler. One idler reverses the direction, so by putting another in it came back to the rotation I wanted.

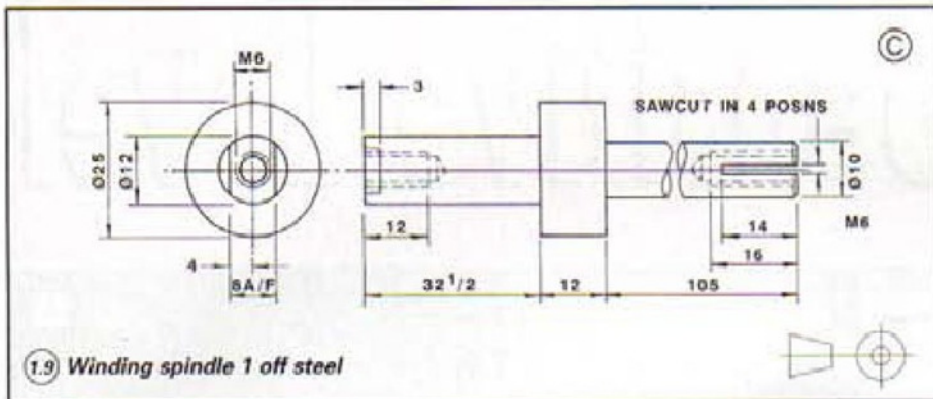
I was glad I'd put the compound slide on, because shortly after I started cutting the internal thread, the spindle gear threw out of engagement. I re-meshed the gears and tried again with the same result.

When I looked for the reason, the leadscrew was jammed solid. I stripped everything down and freed it. Luckily it was nothing drastic, a rubbing where the drive shaft went into the leadscrew had got worse with a few cuts. As the cutting was done by hand winding it was soon corrected, under power it could have been much worse. I oiled and cleaned all the parts and made sure that the drive shaft rotated freely in the leadscrew housing



11

The external thread about half cut, note the different clamping method.



when the bracket was tightened down.

It was an easy matter to re-position the tool in the thread when all was in order again, thanks to the compound slide. The slide also allowed for flanking the thread, by shaving a bit off front and back flanks of the thread without changing the depth setting. This takes some of the strain off the tool, which when it is cutting near full depth, can be considerable. It is an alternative method to the method of setting the compound slide at half the thread angle and cutting down one flank. I couldn't use this method because of the restricted room available on the Unimat.

It took quite a while to cut the internal thread, but hand cutting had several advantages. The progress of the tool can be felt and it is much more sensitive, especially when coming to the end of the travel. There is no chance of blundering into the back of the undercut, because it can be felt. With little machine noise, tapes or CD's can be heard better than usual, there is no splash from whatever cutting fluid is used, in my case it was light machine oil.

When the sample Martin had supplied went in about five threads, I stopped. I hoped that when I'd machined out all but the five, it would fit. **Photo. 10.** shows the internal thread well on towards finishing. With the internal thread cut, I had to re-clamp. The clamps had to be specially shaped and I used the ones in **Photo. 11.**

I left the original ones done up till the new ones were tight, to prevent the job from moving off centre. Cutting the $1\frac{1}{2}$ mm pitch just meant changing the gear on the winding spindle from a 20t to a 30t, so that the ratio became 3:2 or $1\frac{1}{2}$:1. This thread was a bit more troublesome because the diameter I turned it to was a bit of a guesstimate. It is never very easy to measure a thread over its core diameter and deduce the outside diameter from that. I did plenty of flanking and

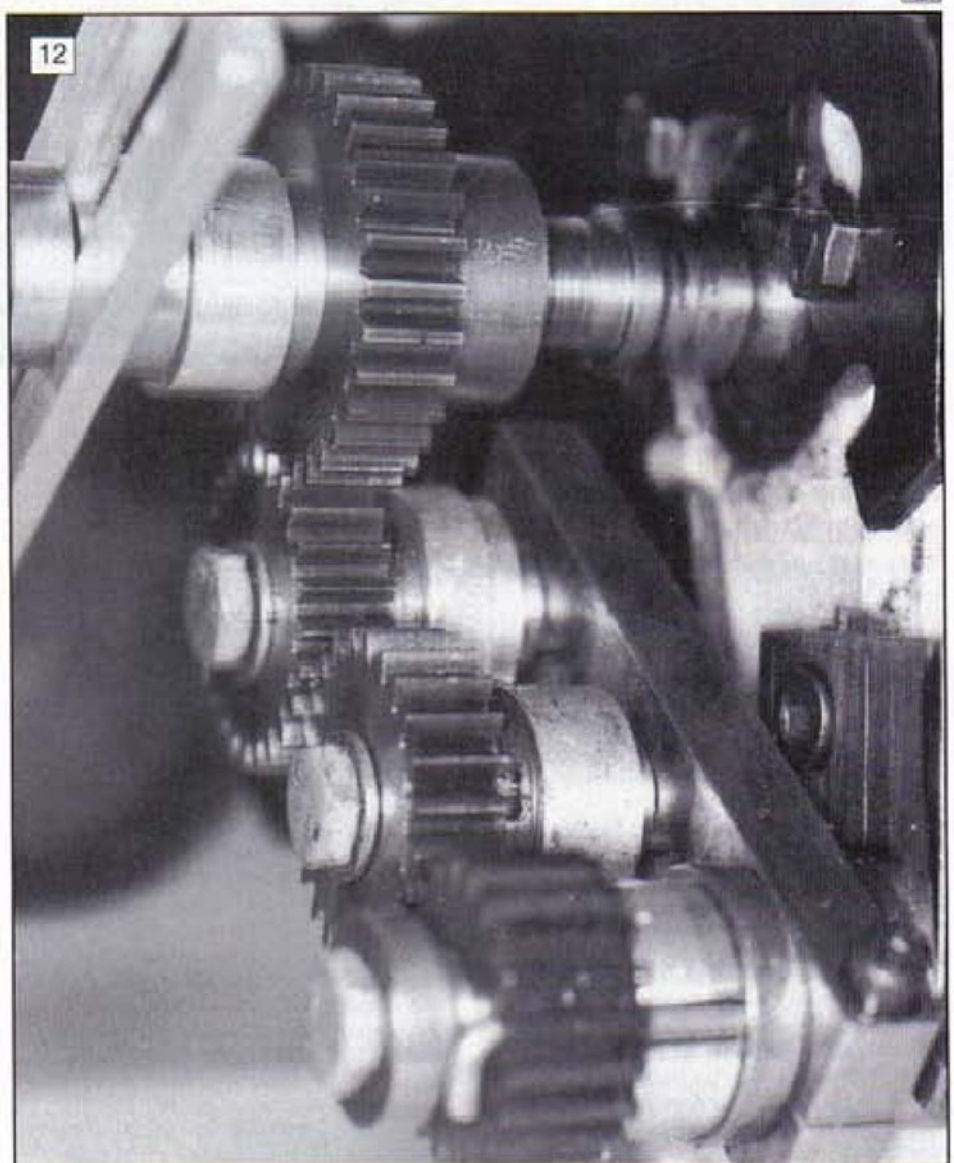
eventually it fitted, it is easier to fiddle about with an external thread, you can see what you are doing for one thing. **Photo. 12.** is the gearing for the $1\frac{1}{2}$ mm pitch thread. With both threads cut it was just a case of a little cleaning up to do. I cut off the clamping lugs, filed them roughly to the diameter so that the Unimat wouldn't protest too much and put the almost finished adapter in the three jaw chuck, with the jaws expanded back against the bore. It had to be done gently because the Unimat doesn't like large diameters much, especially if the cutting is interrupted.

I skimmed everything and chamfered where necessary.

That left the oil blacking and that was soon done with my small propane torch and a container of used, well aired sump oil. I shall have no misgivings about the mechanics of threading on the Unimat, if I have to do it again.

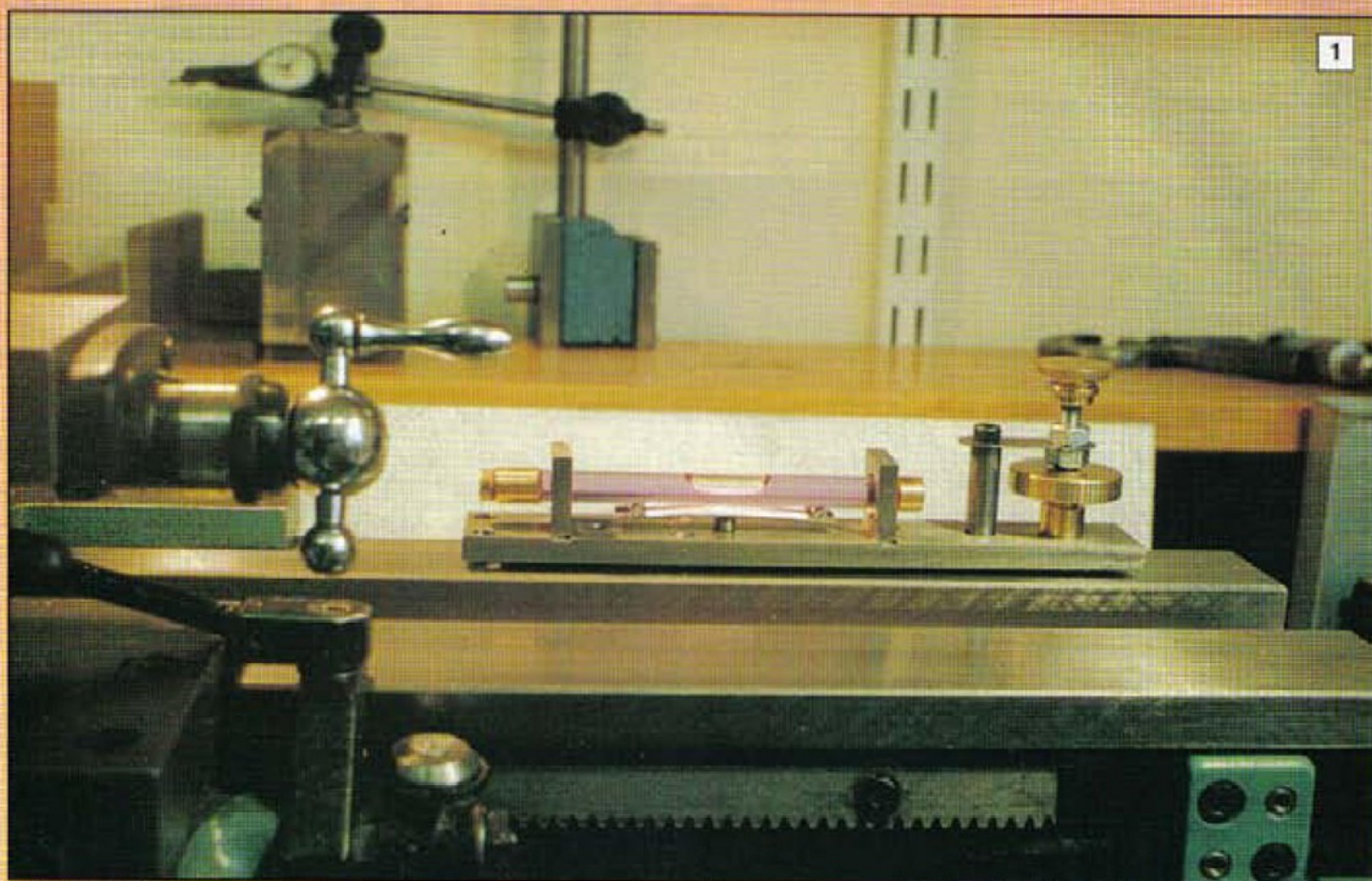
Large and coarse threads may be a problem to cut by hand, but the sort I did posed no problems. The adapter has been sent to America, I await the verdict, the preliminary one is satisfactory but Martin has yet to use it with one of the attachments it is meant for.

He is however, happy about the threads.



The gearing for the $1\frac{1}{2}$ mm pitch thread

A Very Sensitive Level



Peter Peters takes a different approach to making a sensitive vial in the construction of this precision instrument

My love affair with the lathe began in the metalwork room at King's School in Macclesfield where, in the 'Upper Fourth', I was to produce a tap wrench which I still have and is the best form of that tool that I've ever used. I can't remember what make of lathe it was, but it didn't turn truly parallel. A few years later I spent some of my war service gratuity on a used grey ML7 with tooling and accessories for £42. Over the years that followed it got barrowed about, slid up and down the cellar steps, kept under oily rags in damp garages, made new bits for old cars and fast bikes, models, inventions and prototypes until 'Retirement Lump Sum' became a reality. With a tear in my eye I relieved a nice fellow of £520 redundancy money and said farewell to the venerable ML7 which, although true in all its functions to less than a 'thou', (0.025mm) had never turned truly parallel. Soon 'her' joined 'him' in the indoor heated workshop to help in the hard labour of degreasing and setting up a shiny new

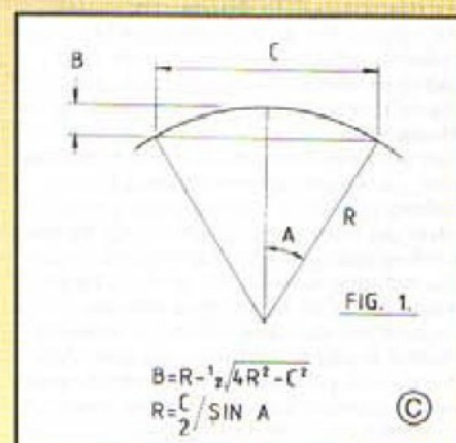
green Myford S7B. In the heady days that followed, with extensive powered cross slide movement, auto fine feed, brilliant finish and metric screwcutting, it was found that the lathe would not turn truly parallel!

The need

Reference to the maker's handbook and to 'very interesting' articles extracted over the years from *M.E.W.* and *M.E.* revealed that the lathe bed should be set-up not only dead level, but without twist from end-to-end, and the best way to achieve this would be to use an instrument called a Precision Level. The instrument would be applied longways to one bedway and the jackscrews beneath the feet of the bed adjusted to bring that bedway to the longitudinal horizontal. Similar action transversely at the headstock end and at the tailstock end would bring both ways into the same horizontal plane and without overall geometric twist along the bed. If the bed is naturally twisted, the tightening of the locknuts would apply the appropriate elastic torque to correct the twist. In plain words—if all is worked level there's no twist. In the event of dissimilar bedways or guideways, an adaptor would have to be contrived to ensure that both ways were in parallel horizontal planes,

Such an instrument would be sensitive to better than 3 thou per foot (1:4000) according to Myford, or capable of indicating a slope of 10 seconds of arc according to Bill Morris writing in *M.E.W.* Feb./Mar. '92 and Nov./Dec. '95. The latter would be the more sensitive and represents detection of a slope of 1:25000.

A note regarding units of measure - I here use SI units for everything except where supply of materials or old data or colloquialism brings up Imperial units, in which case the SI equivalent is put next in brackets. Sometimes, presently calculated SI



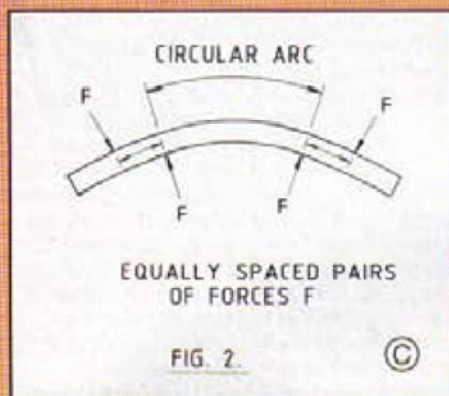


FIG. 2

values have to be compared with Imperial values from experience, in which case the latter is put next in brackets.

Gazing out of the workshop window to a distance of a small-bore rifle range or a bit more than a cricket pitch, it seemed to me that detection of a slope of 1mm in that distance was sensitive. It also seemed that the chances of finding such an instrument of the bubble variety, let alone the laser or optical pendulum type, to hire or borrow, would be very slim, and a vendor of a bubble vial of that sensitivity difficult to locate and probably prove expensive. So I resolved to explore the possibility of making my own.

Now, with the assumption that 10 seconds of arc to move the bubble a whole millimetre along the vial would be adequately sensitive, the question arose as to what would be the radius of curvature

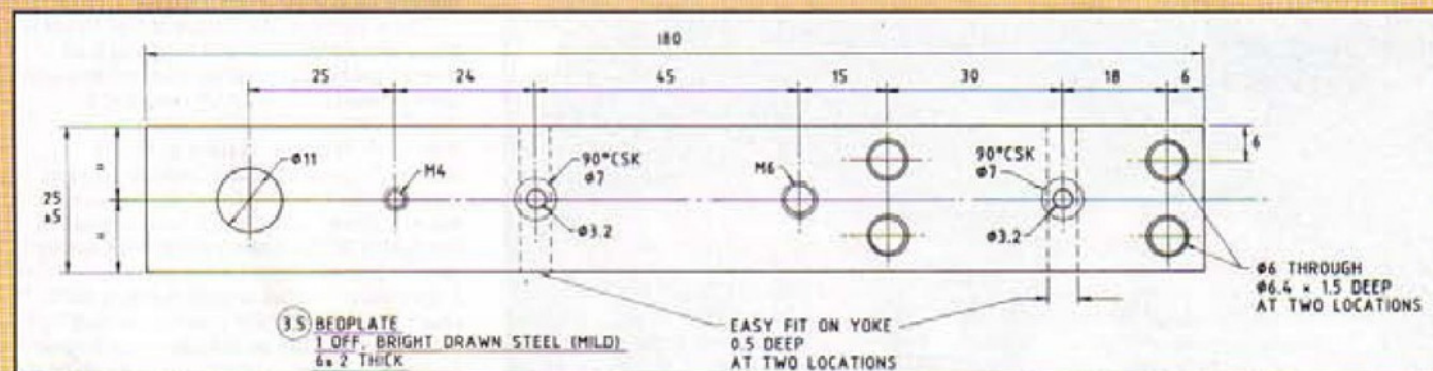
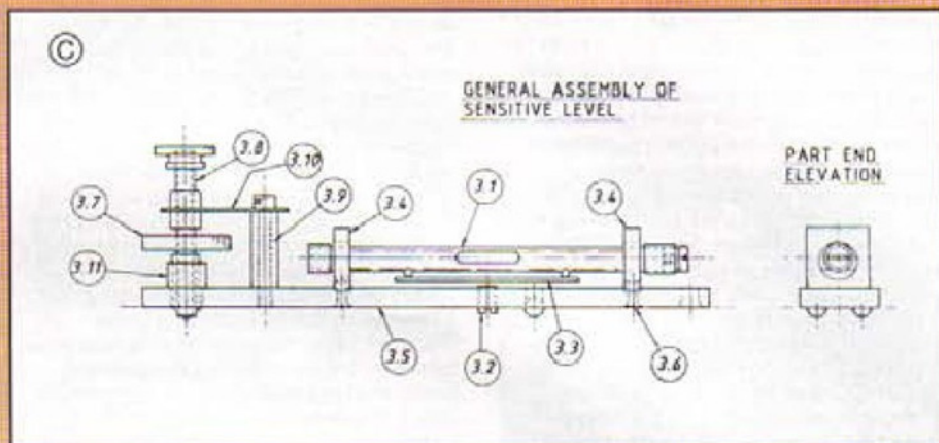
a perfectly circular curvature, (see Fig. 2). Now a piece of gauge glass tubing (costing pence and usually available from Blackgates Engineering in 6, 7, 8 and 10mm diameters) can be imagined—and this is the point of invention—can be elastically curved by carefully controlled forces within the instrument to produce a sensitive vial. The question then arose as to whether a conveniently short glass tube of adequate bore and practical wall thickness could be forced to assume a curvature of radius 21m without rupture. I thought the 6 and 7mm looked too small in the bore to give room for a nice big active bubble and the 10mm gave, in the calculation to follow, rather a high stress for soft glass, although much less than the maximum safe value for hard glass. So I opted for 8mm OD for the first

try. The formula for stress is simply $f/y = E/R$ or more usefully $f = Ey/R$. The stress f in the outermost layer of glass equals the elastic modulus E times the outside radius of the cross section of the tube y divided by the radius of curvature R .

Now, it's a quirk of nature that almost all glasses, soft or hard, soda or boron, crystal or flint, have about the same elastic modulus of 70×10^9 Newtons per square mm so there is no need here to enquire as to the composition of the glass of these tubes.

$$f = EY/R \text{ or } f = 70 \times 10^9 \times 4/21 \times 10^3 \text{ (all in N and mm)} = 13.3 \text{ N/mm}^2$$

Unlike many professional engineers, who keep for the whole of their career a fat



inside the top of the vial. A bit of quick trigonometry (see Fig. 1) and use of a scientific pocket calculator gives $R = 20626$ about 21 metres! Remembering that glass tubing was manufactured 'straight' by laying it when red hot into a charred wooden Vee-trough meant that some of it, by dint of poor workmanship or a warped trough, might be of 21m. radius, but how much to buy to have a chance of finding a piece of that radius—no chance.

To bore a Perspex block to a smooth barrel shape seemed possible, but when calculations using a computer to get the small difference b (see Fig. 1) between two large numbers gave 15 microns—give up.

Invention

A flash of memory—long ago in a lecture on static behaviour of elastic materials, I was fascinated to see an elegant formal proof that if equal and opposite couples are applied to an elastic prismatic beam then the portion of beam between them assumes



notebook full of useful data, I haven't. All I could remember was the safe long term working stress for window glass was 2400 p.s.i. (17N/mm²) and that hard glass as used for gauge glasses would be very much stronger, hence in the present application there would be little to worry about. However I feel it necessary to apologise in advance to about one reader! Whereas all 100 samples of a given ductile metal alloy will show ultimate stress within a few percent of each other, brittle materials show a wide spread, one in a hundred specimens of a given glass could rupture at 10 times the average and one in the same hundred could rupture at $\frac{1}{10}$ the average. Glass strength is very statistical! So if 100 readers make themselves a level like this one there's almost bound to be one fellow who screws on the force, breaks his glass tube, calls me a dunderhead, a fool and vows to ignore me in future. He could however buy two bits of tube and raise his chance of success! Seriously, there is a remote possibility of a fracture and an infinitesimal possibility of flying glass, so to be on the safe side the design is to include a transparent adhesive plastic film on the glass to restrain fragments.

Structural design

So to sketch pad and drawing board to produce Fig. 3. The forces required to deflect the glass tube 3.1 to its curvature are applied by means of the cone-ended M6 grub screw 3.2, divided equally by the

spring balance beam 3.3 and impinging on the glass tube through two bits of softish metal such as solder glued or fused onto the balance beam. The forces of reaction on the tube are applied by two yokes 3.4 of mild steel with soft solder cushions melted onto the inside of the holes in them. Glass ruptures at much reduced overall stress if very high local stresses are caused by hard sharp impingement, which generates minute cracks which then run to rupture. Hence the use here of solder seats which yield and conform to the tube under pressure, to increase the bearing area and eliminate the hard sharp impingement which the bare mild steel would otherwise inflict. The yokes 3.4 are restrained in position on the bed plate 3.5 by a close fit in shallow keyways milled in the plate, and the reaction forces are brought full circle by the yoke fixing screws 3.6, so balancing all forces within a closed system.

The balance beam 3.3 is made springy, so that the force on the tube can be applied gradually under control. The M6 grub screw 3.2 advances 1mm for a whole turn, and this advance is shared by springiness of the glass tube and the bed plate, which together amounts to very little, and the balance beam which must take the lion's share by deflecting say 1mm at that force, which will curve the glass tube to the desired radius of 21m. That force is easy enough to calculate, first the second moment of area (geometric stiffness) of the glass tube is given by $I = (D^4 - d^4) / 64$

where D and d are the external and internal diameters respectively.

$$\text{So } I = \pi (8^4 - 6^4) / 64 = 133 \text{ mm}^4$$

The moment of one couple is found from $M = EI / R$

where E is the elastic modulus of glass of about $70 \times 10^3 \text{ N/mm}^2$ and R is 20600mm.

$$\text{So } M = 70 \times 10^3 \times 133 / 20600 = 466 \text{ Nmm}$$

A moment arm of 20mm is chosen being as large as practical without making the size of the instrument unwieldy. In this way the force of impingement on the glass tube is also minimised. This force is then simply $466 / 20 = 23.3 \text{ N}$. Anyone who has difficulty visualising such a force could well reflect that 1 Newton is about the weight of one apple! There are two such forces to be applied, hence the grub screw has to exert 46.6 N to deflect the balance beam by 1mm. From this may be calculated the required stiffness of the balance beam, and stock material might then be selected to give that stiffness. The conventional formula for the deflection of a centre loaded simply supported beam is $\delta = W\ell^3 / 48EI$ or when juggled for convenience $I = W\ell^3 / 48\delta$

Now it is another quirk of nature that the elastic modulus E of all steels, whether free cutting mild, high carbon or alloy, hardened, tempered or annealed, is always about $200 \times 10^3 \text{ N/mm}^2$ so that no specific steel is required for reasons of stiffness. A nice working range for the bubble in the vial is taken to be 50mm, so the juggled formulae gives $I = 46.6 \times 50^3 / 48 \times 200 \times 10^3 \times 1 = 0.607 \text{ mm}^4$

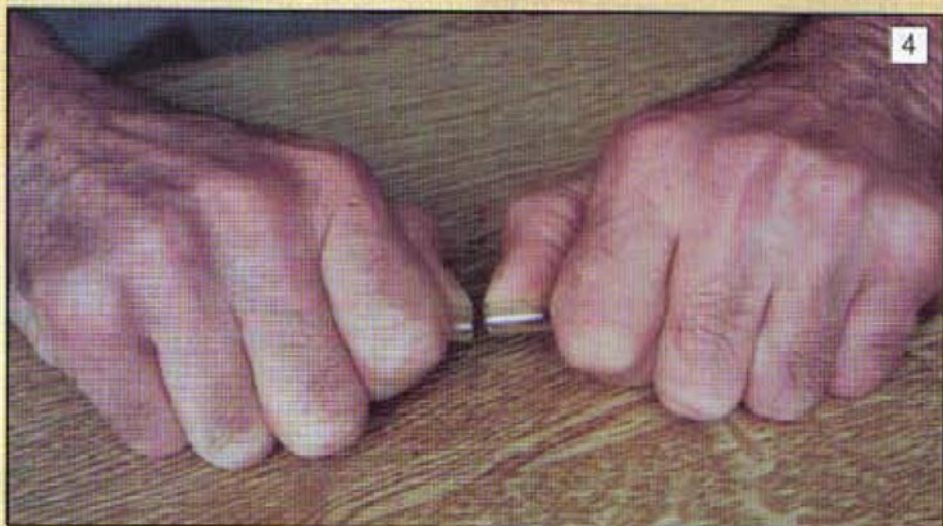
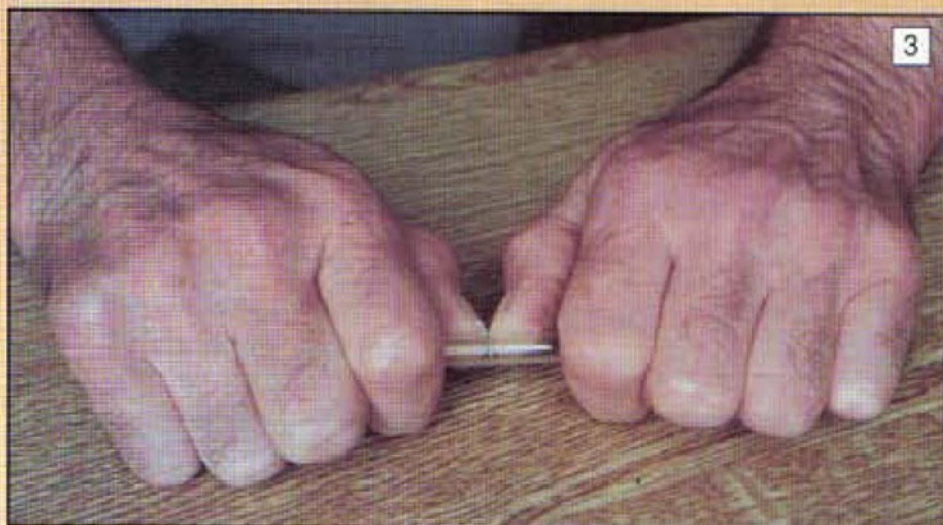
The balance beam is most conveniently made from flat stock for which $I = bd^3 / 12$, where b is the breadth and d is the depth.

So we have $0.607 = bd^3 / 12$ or again juggled for convenience $b = 0.606 \times 12 / d^3$

There being disinclination at first to get a piece of suitable steel and machine it all over to get the right value, a search is made for a catalogue item which would suit. Putting values into the formula it is found that $\frac{1}{16} \text{ in.}$ thick would have to be too narrow, $\frac{1}{32} \text{ in.}$ and 22 SWG would have to be too wide, but 20 SWG (0.96mm) comes out at 8.22mm wide, which is very close to the $\frac{3}{8} \text{ in.} \times 20 \text{ SWG}$ (9.53 x 0.96mm) spring steel in the catalogue of Blackgates Engineering, so that is selected. A quick check that stress in the beam is not too great is carried out as follows—maximum moment in beam $m = WL / 4 = 46.6 \times 50 / 4 = 583 \text{ Nmm}$, then the familiar formula $M = fZ$ is first juggled to $f = M / Z$ and $Z = bd^3 / 6$ is substituted to give $f = 6M / bd^3$. Now the numbers are put in to give $f = 6 \times 583 / 9.53 \times 0.96^3 = 398 \text{ N/mm}^2$ (25 t.s.i.)! It's a good job that spring steel is selected, for mild steel would yield at this stress and be unable to maintain the necessary force.

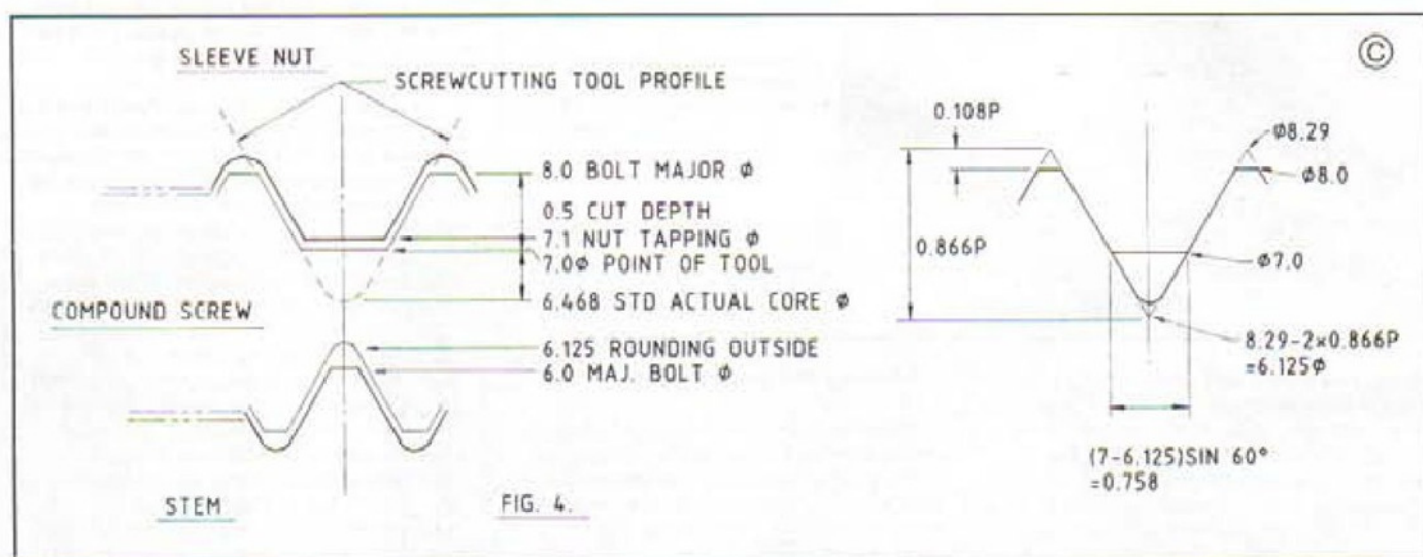
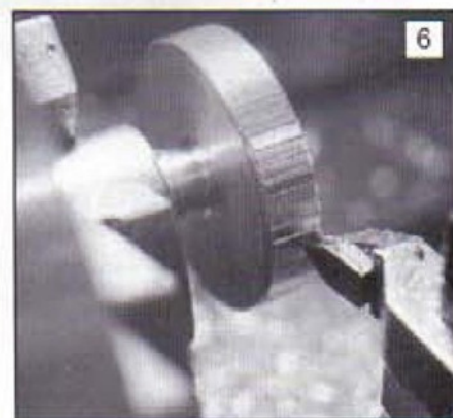
Design of the adjustment

Having a very sensitive vial mounted secure and stable on a bed plate with all forces except weight being self contained, it appears that the instrument has no adequate inherent precision. The circularity, parallelism and straightness of the glass tube is not assured, the amount of bedding down in the solder seats is unknown and the elasticity, precise shape and disposition of the various parts and the flatness of the bed plate are variable and immeasurable (at least by me!). The need is to have the instrument read zero reliably when resting in a stable manner on a flat surface which is horizontal to a precision of 1:25000. A tripod





thread form diagrams in *Model Engineer's Handbook* by Tubal Cain, reveals that 6.468 is indeed larger than 6.125 but only by 0.343, which halved to give the wall thickness leaves only 0.172mm of 'meat' - not much, in fact so little that it may shear

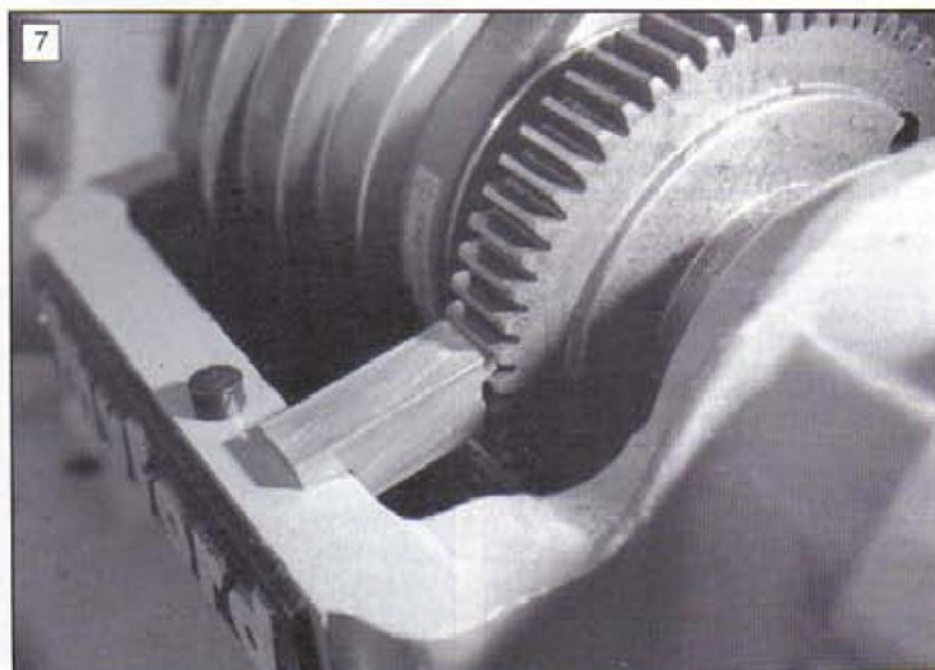


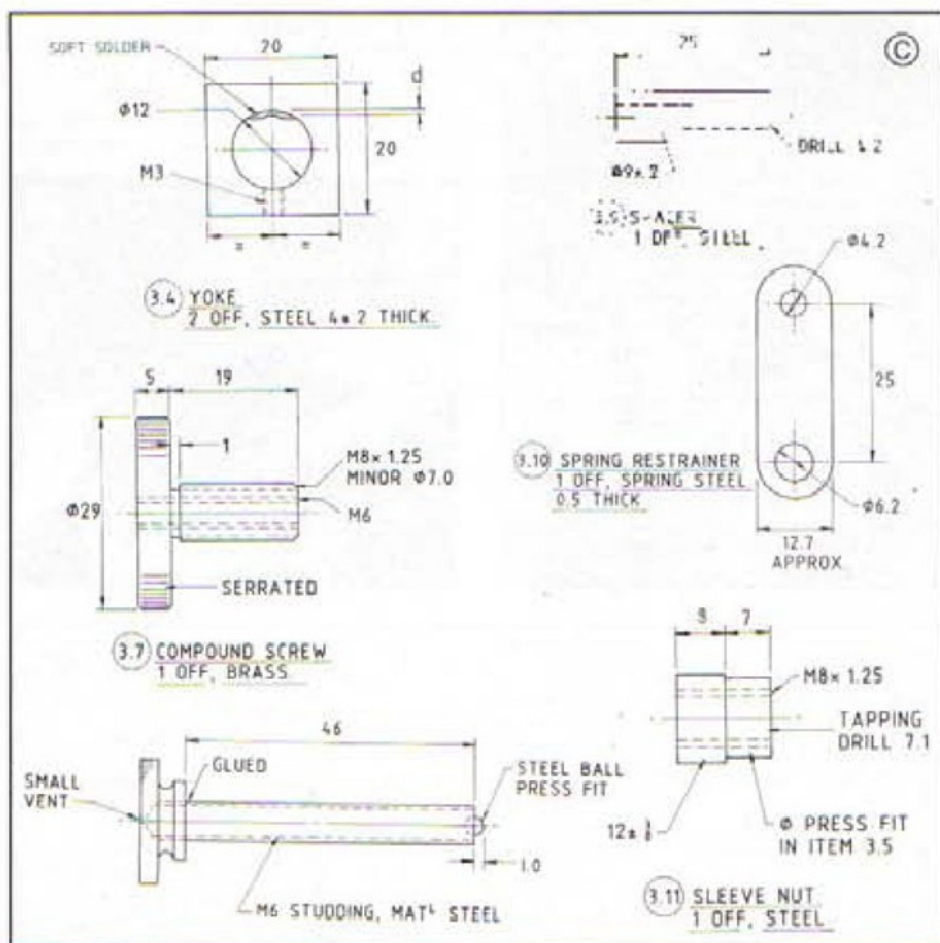
always conforms in a stable manner to any surface and defines a perfect plane in which those three contacts lie. Two fixed ball feet aligned transversely to the axis of the instrument and a ball foot with coarse and very fine adjustments on the axis enables the instrument to be zeroed and used to bring to level any plane surface bigger than its footprint. Lack of great precision in the transverse alignment of the fixed feet relative to the vial will not matter (as my maths master with a rare smile would put it 'the sine of very little is even less').

To make the adjustment of the third foot sufficiently sensitive, the use of a compound screw is indicated, that is a screw within a screw, so that one turn of say the compound screw (Item 3.7) will advance it by its pitch while retracting it by the pitch of the screwed stem (Item 3.8)—net result an advance of the difference between the pitches. An M8 x 1.25 outer screw with an M6 x 1.0 inner screw would advance 0.25mm per turn (equivalent to about 101 TPI). If the distance between the adjustable foot and the line between the other two is say 109mm, then $\frac{109}{0.25}$ is the required sensitivity, that is 0.0044mm is to be detected. An advance of 0.0044mm requires a rotation of the compound screw of $360 \times 0.0044 / 0.25 = 6.3$ degrees—an easily manageable amount on the thumbwheel. Such a small advance is about equal to the

thickness of domestic Cling film, hence a method of testing for final sensitivity is indicated. Now the compound screw is only possible if the core diameter of its male thread is greater than the crest diameter of its female thread. Referring to the metric

during threading or by an accidental knock in use. A simple way of increasing the wall thickness is to decrease the depth of the male thread to a clearance on the tapping size of its female partner. (See Fig 4). Screw cutting in the lathe using a truncated





60deg. tool is indicated and a bit of trigonometry applied to the thread diagram shows that the width of the flat at the point of the tool should be 0.76mm (See Fig 5). The tool is truncated by setting a micrometer to that dimension and carefully off-hand grinding the point of the tool until inspection through a magnifier shows the flat to match the gap in the 'mike'. (See Fig 5).

Design of the Vial

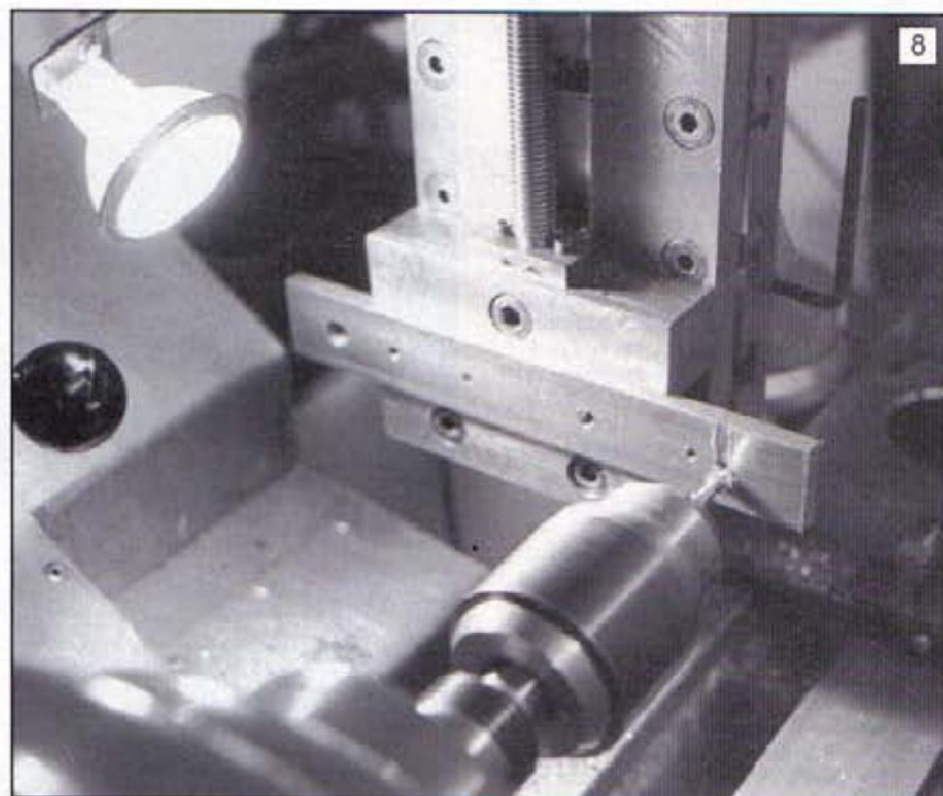
The liquid in the vial must be very fluid so that it may readily pass under the bubble, allowing the latter to move speedily to its equilibrium position. Moreover, it must not ever freeze for risk of bursting the vial or being inoperative on cold sites, must completely wet the internal surface of the vial and be coloured to make the bubble readily visible. Alcohol coloured bright yellow with fluorescein is traditionally used, but I found such dyestuff to be unobtainable in cheap small quantities. Methylated mineral spirit, commonly called 'meths', meets all the requirements and its gentian colour looks quite nice, especially if the top of the balance beam is painted white further to show-up the bubble. Glass vials are conventionally closed by drawing out in the flame to form a neck which, after filling is fused to form a seal over the bubble. Now I don't feel disposed to get a gas burner flame that close to meths and anyway, I want to experiment with different length bubbles so cemented metal ends, one with a screwed filler plug, are selected. The metal ends would be turned to have very thin walls to minimise thermal stress in use, as glass and brass have very different coefficients of thermal expansion.

Making the instrument

One of the satisfying aspects of designing and making tools, instruments, prototypes and functionally imitative models, as distinct from accurate models of full-size machines, is that materials to hand can be used ("cominandydrawer!") and individual whims can be incorporated. To that end a few notes on possible variations are not amiss.

The bed plate (Item 3.5) could be any stiffish metal from 4 - 8mm thick and 20 - 30mm wide, the yokes (Items 3.4) could likewise be 2 - 6mm thick or even stirrups of plastic or solder coated wire fixed to the bed-plate by any convenient means of long-term strength. The bearings on the spring balance beam (Item 3.3) can be of any soft metal or solder coated vee-notched little blocks. The thumbwheel does not have to be turned from the same bar as the compound screw, any nice wheel of about the right diameter with a boss suitable for boring or drilling and shrinking, pressing or gluing to the screw would do fine. The sleeve nut (Item 3.11), could be made of steel, then all mating screw flanks would be brass/steel and potentially of smoother action. Rusting of all the steel parts can be prevented by bluing, blacking, painting or my favourite lazy man's finish - a wipe of dilute Jenolite, allow to dry and polish with Mr. Sheen or Pledge furniture polish. The goal for the whole project is seen in **Photo 1**. Here the twin ball feet are set 100mm from the adjustable foot for use across the shears of a Myford S7 lathe which are 4.5 in (114.3mm) overall.

The glass tube for the vial (item 3.1) is cut to length using the method shown in **Photos 2 - 4**. The tube is first well nicked with the corner of a square or triangular file to the correct dimension, followed by application of a firm, prompt, symmetrical, increasing bending moment until the glass snaps cleanly at right angles. This is done by lightly gripping the tube in all the fingers of both hands and bringing the thumb nails tightly together on the tube precisely opposite to the nick, keeping the wrists stiff, the elbows are brought into the ribs and the tube is cut. The photos show bare hands doing the job in the manner familiar to generations of glassblowers and laboratory technicians, but unless you are well instructed by example and experience, it is wise to do the job wearing a pair of cotton gloves and safety spectacles. Accidents have happened where asymmetrical force has



been applied resulting in a jagged cut, a slip of the finger and an injury. A suitable brass rod is chucked in the lathe, drilled and bored to be a clearance fit on the tube, turned to an OD of only 1mm more, faced to length for the blank end, partly parted, corners 'broken' with a fine file and parting off is completed.

The filler plug end is similarly made, but drilled and tapped M5 before parting off. The filler plug is a cheese head M5 x 6 brass screw and standard fibre washer.

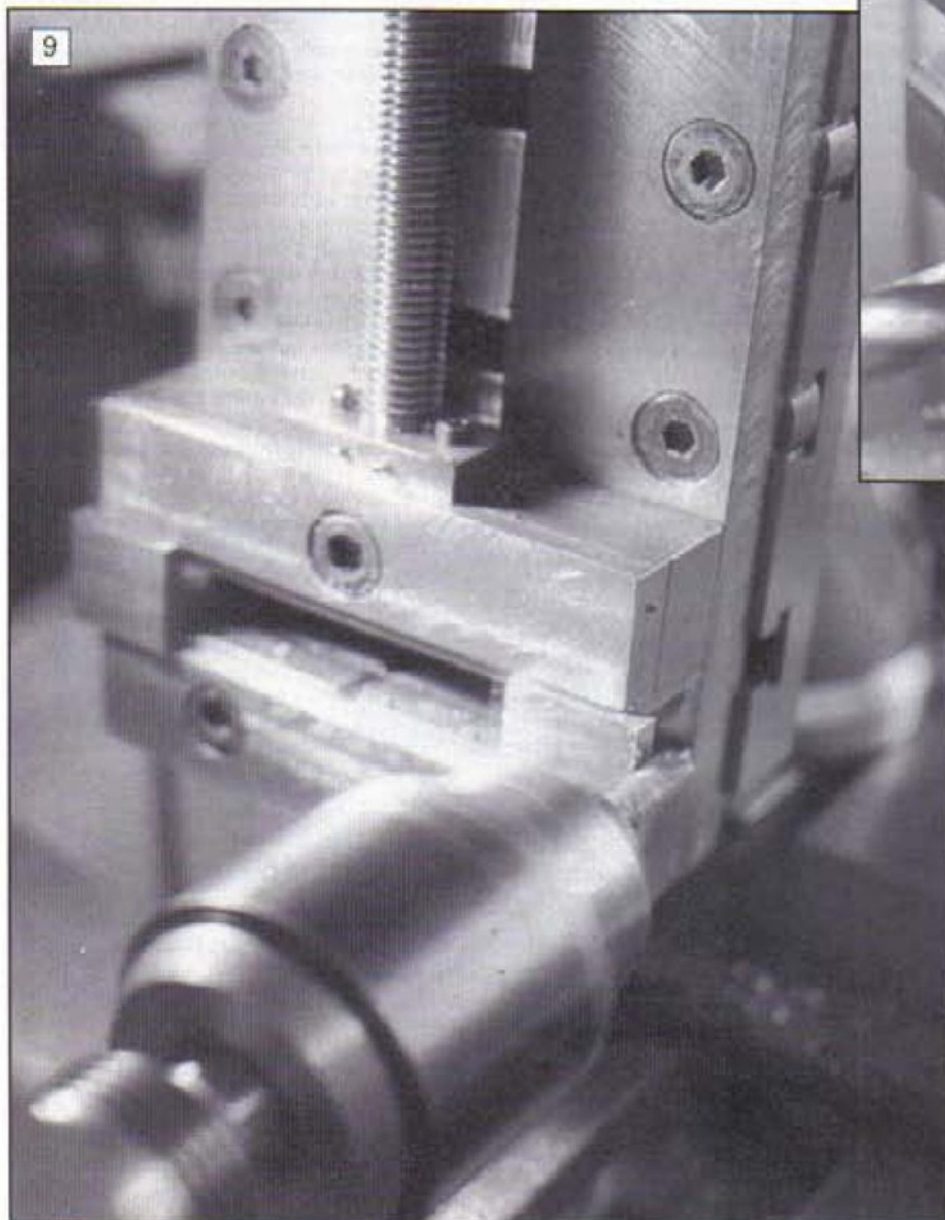
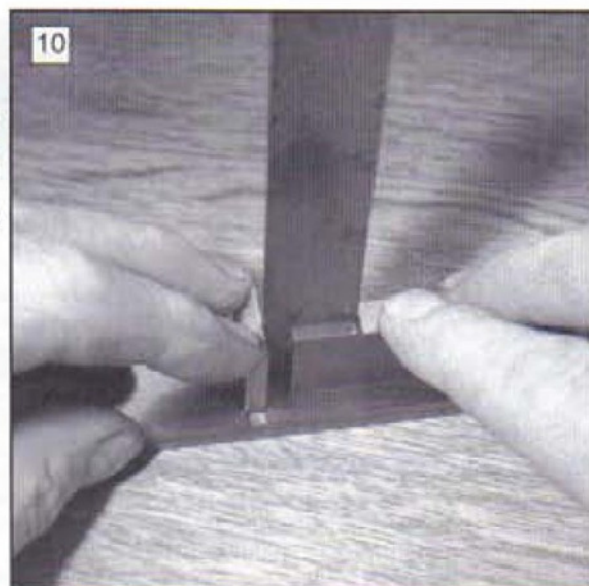
The ends of the glass tube are lightly buttered with freshly mixed Araldite, the bores of the brass ends are similarly treated and all are brought together with a push and a slight twist, (see **Photo 5**), inspected for a complete glue film and popped in the oven for half an hour at 100deg.C, (for gas—less than Mark 1). So much for the cookery, now a tricky operation—when cool, the vial is filled with meths to within 10mm of the top using a very fine funnel, a pipette, a medicine dropper drawn out in the flame to a fine tube or a small syringe. The screw plug with fibre washer is firmly driven home and the length of the bubble checked. The brass end is best held in a fold of paper in the pliers while driving the screw plug. Finally, the index marks are painted on the glass tube centrally and to correspond to the length of the bubble using a permanent

marker pen (I used a Staedtler Lumocolor 318). It is possible to measure the length of the bubble with a rule or vernier callipers as it passes slowly up the tube while being held on a fairly level bench. The safety coating of 'magic' tape is applied to the glass tube longitudinally and wrapped round with finger pressure to complete.

The compound screw (Item 3.7) is made by chucking a short length of suitable bar and carrying out a series of operations as follows:-

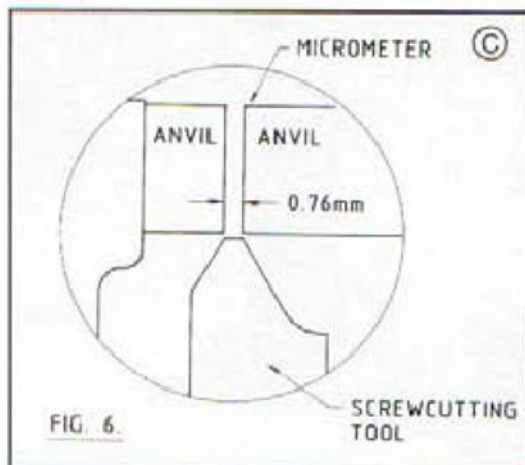
Centre drill and drill 5.3mm, start the M6 x 1.0 thread by tapping from the tailstock (to complete by hand after parting off), turn the spigot for the 8mm screw, turn the recess, screwcut the truncated M8 x 1.25 to a minor diameter of 7.0mm, face and turn the OD of the thumbwheel, cut the serrations, lightly chamfer the corners, remove burrs with fine abrasive paper and part-off to thickness.

Photo 6 shows the method for cutting the serrations using a screwcutting tool fixed on its side in the toolpost, the cut is



applied by means of the carriage handwheel. Indexing is achieved by making a simple sprag for the bullwheel as shown in **Photo 7**, the backlash being taken up solidly before each cut. The serrations for the prototype were cut, possibly slightly away from the best sequence being last in the series of operations just described, hence **Photo 6** shows the part the opposite way round in





the chuck. The piece for the bedplate (Item 3.5) is sawn from BDMS flat, mounted in the special large vice on the large capacity vertical slide, the machining operations are carried out by taking co-ordinates from the drawing and setting the cross-slide and vertical slide feedscrews appropriately. Looking back, I think it would have been easier, sufficiently accurate and less prone to error to have marked out the workpiece then used a needle shaped centre-finder in the mandrel chuck. As it was, a great deal of arithmetic was necessary in deriving and setting co-ordinates. The bedplate shown in **Photo 8** was subject to some development work and two of the holes are not as shown on the drawing - that on the left is too small and the fifth from the left is unnecessary. Centre drilling, drilling, tapping, keyway cutting and de-burring operations are conducted by swapping tools at each setting, the ends of the piece are cleaned-up with the side of a slot drill set at a suitable cut. The piece is then reversed in the vice to countersink the yoke fixing screw holes and drill the ball sockets. A pair of ball sockets is located at the end of the bed to enable the instrument to be used at its maximum span and another pair are located at a shorter span for use transversely on a small lathe. Extra pairs can be drilled for use at other spans as necessary, but not beyond the centre line of the bed. The holes are made by centre drilling, drilling 6mm right through and counterdrilling 6.4mm to a depth of 1.5mm to provide a seating for the $\frac{1}{4}$ in. (6.35mm) steel balls (obtainable from most cycle dealers). While the vice on the vertical slide is still set-up, the yokes (Item 3.4) can be machined. Firstly the sawn blanks are cleaned up with a slot drill (**Photo 9**), fixed square into the keyways with a spot of Superglue (**Photo 10**), spotted through the bedplate with a 3mm drill, unfixed by a sharp knock, marked to ensure subsequent same way assembly, marked out, centre popped, drilled about 12mm diameter (**Photo 11**) followed by drilling and tapping M3 for the yoke fixing screws. The yokes are next prepared for soldering by painting their flanks with a correcting fluid resist followed by resting a chip of solder in a puddle of flux and applying the flame until the solder runs and wets the steel to form a neat saddle for the vial (**Photo 12**). The spring balance beam (Item 3.3), is sawn from the strip, its centre marked out and heavily centre punched for its engagement with the point of the grubscrew. The bearings for the vial are

made by clipping 10mm lengths of 3mm diameter solder, such as is used for capillary end-feed pipe fittings, and fixing them with Superglue 25mm, each side of centre and athwart the beam. The upper surface is painted white with any suitable material. The grub screw (Item 3.2), can be stock M6 x 10 hex skt. or slotted cone point grubscrew, or made from any convenient piece of M6 studding or bolt by cutting slotting and pointing by any means desired. The Spacer (Item 3.9), is drilled 4.2 and faced to length from any suitable bar.

The Spring Restrainer (Item 3.10) is cut from any strip steel of reasonable width and about 0.5mm thickness—I used a bit of steel

strapping such as used commercially in vast quantities for securing bales, boxes and bundles for transhipment. If hole punches of the right diameters are available, they allow the neatest method, but otherwise the use of a suitable centre drill in the bench drill press, the workpiece being firmly clamped in the vice, gives a smooth effective and controllable way of producing circular holes, albeit tapered, but at 0.5mm thick this doesn't matter. Diameter is checked during the process by trying to insert the shank of a suitable drill. The screwed stem (Item 3.8) is cut from any smooth and precise piece of M6 stud or screw, the bottom being then ball-ended as you fancy - I used a $\frac{1}{8}$ in. steel ball pressed into a 3.1mm hole, but a dome end filed in the lathe would suffice. The coarse adjustment thumbwheel can be of any convenient provenance—mine came to hand by scrapping an old brass desk lamp and was drilled and tapped M6, vented by drilling through 1.0mm and retained in place with adhesive. The lock nuts can be standard M6 nuts or locknuts or specials can be made with C-spanner holes or little fixed tommy-bars, or whatever is preferred. The sleeve nut (Item 3.11) is a straightforward turning, drilling and tapping job, but remember to drill 7.1mm for tapping so as not to cause fouling of the truncated thread on the compound screw. The smaller diameter can be turned to be a press fit in the bedplate or can be turned 0.05mm less than the diameter of the hole in the bedplate for fixing with retaining adhesive.

Assembly and zeroing

First the dimensions 'd' shown on Item 3.4 should be adjusted by draw filing the solder saddles on a round file or on a twist drill or by hand scraping to be within a few 'thou' of each other and preferably be saddle shaped to help restrain the vial parallel with the bed. The yokes are then screwed firmly to the bed, ensuring no protrusions of head or tail of the screws. The bed is then best cantilevered from the vice while the spring balance beam and vial are held in right relative positions and the grubscrew lightly engaged. A quick check on parallelism and position of the parts and the grubscrew can then be tightened one whole turn. Check that the middle of the beam is not touching the vial - if it is, then the solder bearings will have to be made deeper. Steel balls are then glued into the appropriate recesses, the sleeve nut is fixed in place and the

compound screw with its spring restrainer, nuts and knob assembled. The restrainer is anchored to the bed plate with an M4 x 40 screw shortened to avoid protrusion below the bed.

To zero the instrument any finely adjustable flattish surface is required, I used the lathe bed on its jacking screws but a surface plate resting on a rock steady base and propped at one end with shims or screw jacks would do, so would any truly flat article big enough to support the instrument and be finely adjustable about the horizontal. This surface is then carefully adjusted to horizontal using a good carpenter's or fitter's level. When the surface is correctly adjusted, and the level is turned end for end, the bubble comes to the same position relative to the index. Set that level aside and substitute the present instrument in the same area and lined-up the same way. Ensure the compound screw is about in the middle of its travel and holding its thumbwheel steady adjust the stem until the bubble floats free of the ends of the vial and settles somewhere in between. The bubble may take up to half a minute to settle such is the sensitivity of the instrument and don't lean on the bench! Deflection of the bench under the weight of your hands may be sufficient to give a false reading. The stem is further very carefully adjusted to bring the bubble somewhere near the centre of the vial and the locking nuts tightened evenly onto the spring restrainer. The adjustable surface and the instrument are now coarsely adjusted and so in precise terms, each have their own errors.

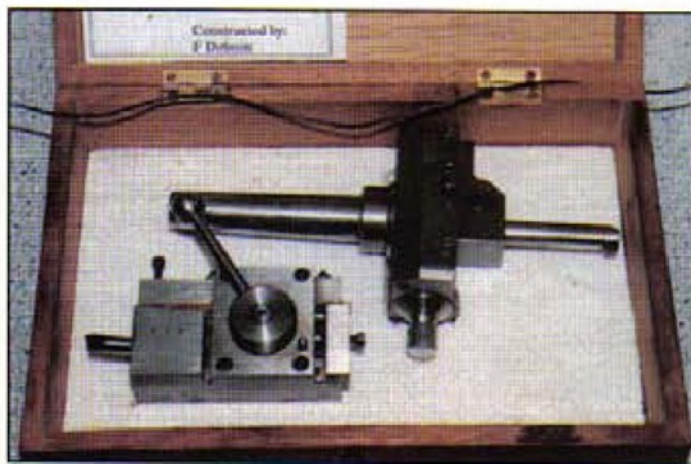
Procedure for fine adjustment is now carried out as follows:

- 1) Turn the instrument end-for-end, carefully noting the off centre distance of the bubble for each way round.
- 2) Place the instrument the way round that gives the lowest off-centre distance and adjust the surface until the bubble comes between the index marks—now the surface error equals the instrument error.
- 3) Turn the instrument end-for-end and bring the bubble only half-way back to its place between the index marks by adjusting the compound screw on the instrument and checking with a rule or vernier calliper.
- 4) Adjust the surface to bring the bubble the remaining distance to rest precisely between the index marks.
- 5) Check that the bubble settles in the same position when the instrument is turned end-for-end. The instrument is now zeroed and incidentally, the surface is also horizontal (or dead level!) in the direction of the instrument.

Back to the beginning

Having made and zeroed the instrument, it can now be put to good use levelling and de-twisting the lathe bed, levelling the mill bed, the bench and the surface plate so that a bubble clinometer can henceforth be used as an accurate way of setting-up angles—a sudden thought occurs—wouldn't it be nice to design and make a wedge-cum-sine bar to convert the VSL into a Very Sensitive Clinometer?





Nicely made and well presented, a precision boring head and retracting screwcutting toolholder in a fitted storage box. Builder is F. Dobson of Chichester SME.



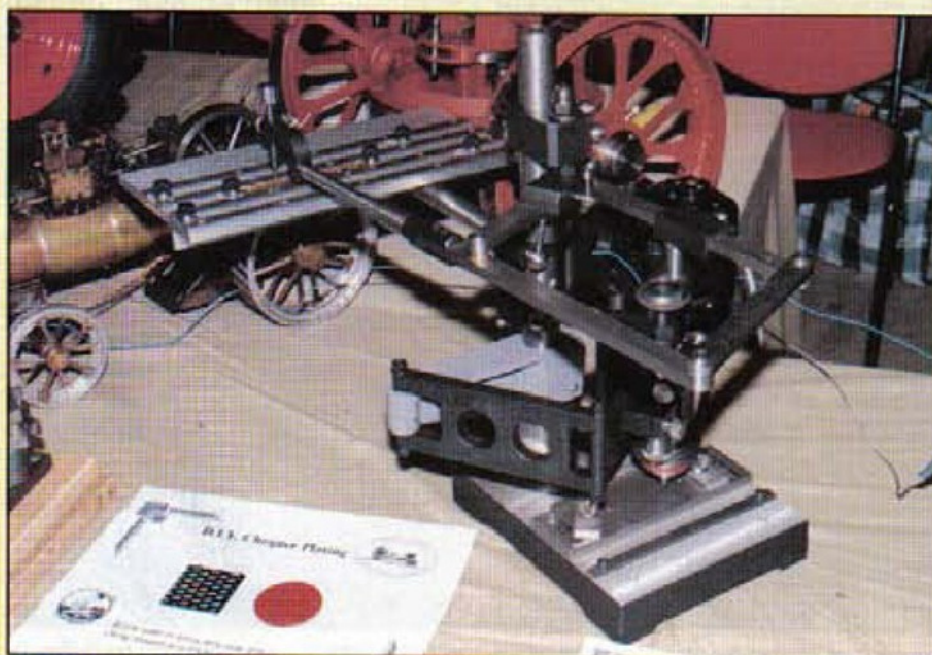
An interesting design, well executed, a dividing head made by Ted Walley of Fareham M.E.

BRIGHTON & HARROGATE SHOWS

The early part of 1996 has seen two excellent exhibitions, at opposite ends of the country. Mid February brought the long established Brighton International Modelworld, staged in the luxurious surroundings of the Brighton Centre, while at the end of April, the third Harrogate show, now titled the National Model Engineering and Modelling Show (to distinguish it from the N.A.M.E.S. exhibition) took place on the Great Yorkshire Showground.

These two shows are somewhat different in format, but they both enjoy the strongest support from local model

engineering societies and from the model engineering trade, and good examples of tools and equipment are to be seen at each.



Once made, you wonder how you managed without it, the rest of the members of Worthing MES seemed happy with this engraving machine made by a member.



Gratifying to see a design from MEW on exhibition. This cross drilling jig is the design of Dyson Watkins (MEW 33) is the work of P.L. Wilmshurst of Polegate DMEC.

MODELWORLD 96

Brighton Modelworld is organised by the Sussex Association of Model Railway Clubs, with Gerry Collins (now Editor of the *SME* Journal) and Derek Rebbetts in charge. As may be expected, the emphasis is on the smaller gauge railways, with the majority of the scales and gauges well represented. The stands of the various clubs and societies which represent the different aspects of this branch of modelling were arranged in an imaginative manner, which allowed anyone not familiar with the finer divisions between the degrees of fidelity to gain at least an initial understanding.

The larger gauges were not ignored, however, and the live steam tracks operated by Brighton & Hove SMLE and Polegate DMEC did brisk business, giving rides to young and not so young.

The Nexus organisation was well represented over the weekend, and the *Model Engineer* editorial team was invited to judge the model engineering stands, when the Worthing DSME proved to be the popular winners of the Proops Shield. Mike Chrisp also found time to take the photos of a number of the items of tooling which were displayed on the stands, as can be seen in this report.

HARROGATE EXHIBITION

North Yorkshire was showing hints of Spring, somewhat delayed by the chilly weather when we gathered at the Great Yorkshire Showground, but the steam vehicle owners didn't seem to be in the least perturbed, and the clouds of condensate provided plenty of atmosphere for photographers. The welcome inside the hall was as warm as it could ever be, as one would expect from a gathering of Yorkshire model engineers. The show was sponsored by Eventex (UK) Ltd., whose Exhibition Director, Simon Boak was at the door to greet us, while Exhibition Manager, Louis Rex was inside, making sure that all ran smoothly.

The layout was simple, with trestle tables available for those exhibitors who were not providing their own stand structures. This encouraged many of the traders who specialise in those secondhand treasures of tools and equipment to spread their wares in a manner which encouraged close inspection and brisk business. Several of the stands were operating informal 'Can anyone guess what this is?' quizzes, as some of the more obscure items surfaced from the pile.

Outstanding in the competition section was a device labelled as an 'Engineering surface plate, designed to avoid jig making', designed and built by Geoff Allen of Wortley, Sheffield. A better description would probably be 'A tilting compound table', but readers should be able to judge for themselves in the near future, because Geoff has promised us more details.

The other overwhelming impression was of **BIG** steam road vehicles. 4in. and 4½in. scale seemed to be commonplace, and 6in. was also represented. The irrepressible Eric Hughes of Newton



Tooling for the older lathe need not be a problem. All these tools, roller filing rest, scissor type knurling tool, Lammas three way toolholder, swing clear boring toolholder and engraving tools for protractor and circular scales were made for an elderly Drummond lathe. Builder is R. Spilman of Worthing DSME.



This design dates back to MEW No. 1. The optical centre punch and aligning tool, in a fitted box were made by a member of Chichester SME.



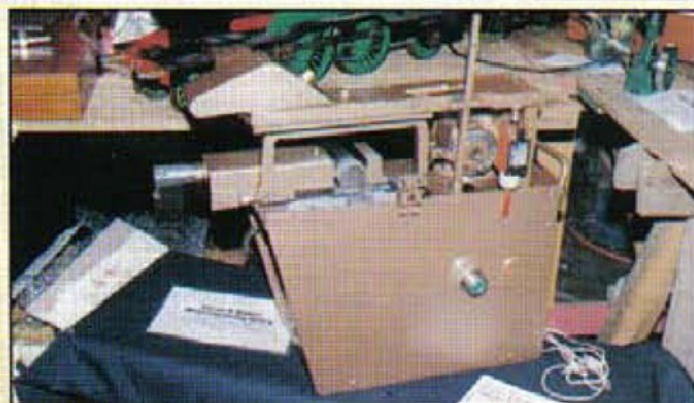
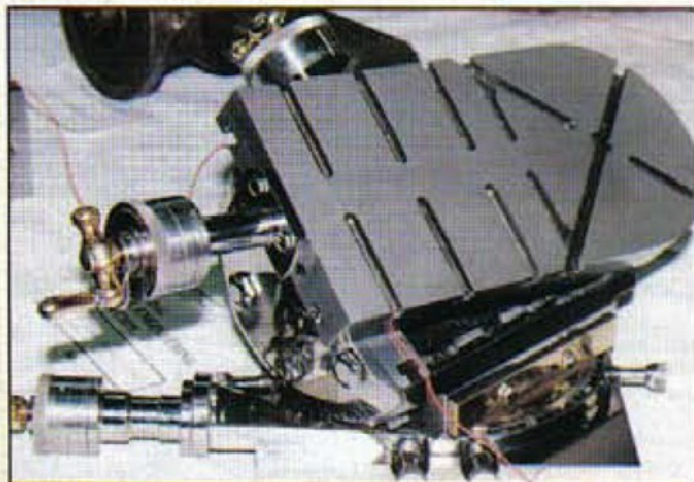
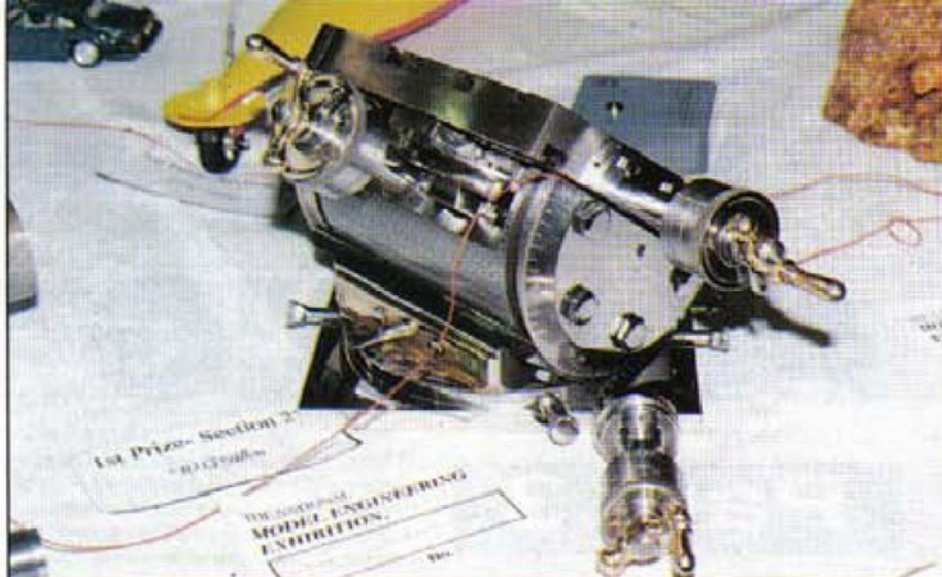
Where it all started for many model engineers of today; Meccano modelling at its finest. This complex working model of a 50 ton blocksetting crane was made by Geoff Tomlinson, who exhibited a potted history of the prototype near the model.

Abbey, Northern Ireland was operating at 12in. to the foot, speeding round the roads of the Showground in (or should it be 'on') his replica of an 1899 Locomobile Steam car.

York City D S M E won the award for the best club stand for the third time, with a most impressive display, but the judges' task was not an easy one, as several of the other clubs had displays of which they could feel justifiably proud.



Right & Below: Winner of the 1st prize in Section 2 was this elegant and versatile tilting compound table by W.G. Allen. We hope to provide a description of this tooling in a future issue.



Made entirely from scrap material this is a very effective power hacksaw. Builder Barry Keal of Lincoln DMES tells us that no plans are available.



Another power hacksaw, this to the Duplex design (plans from Hemingway) is the work of Dave Drury, Vice Chairman of York City MES. Dave is a recent convert to metal working after years of boat modelling. We wish him well for his future endeavours.

This Gear hobbing Machine is the made-from-castings version of the T.D JACOBS design, which was featured in M.E in 1974. It was exhibited together with a fitted case containing hobs, arbors, mandrels and change wheels and a gear hob relieving slide by J. Bentham. A well made and unusual piece, it attracted a lot of interest.

MOTORISED MILLING HEAD

Part 3

Mark Figes concludes this series with the final items (including further information on parts originating from the Dore Westbury machine), plus some hints on assembly and commissioning

Depth Stop Assembly (DS)

This is another bit of light relief after the spindle. Machine up all parts to drawing, then trial assemble Q1 with the depth rod. Slide on the quill to check the reference dimension on the stop block. It's a bit tight for space around there, but there is room. Slide the block over the rod and spot for the 2BA tappings.

Remove the quill, drill and tap the casting, then fit the block. Slide the quill in to the casting and lock. Clean off the bonding surfaces of the quill and the stop, apply Loctite and assemble, using a block of wood to push Q1 in to place, using the capstan. Lock the quill and leave to set.

Dore Westbury Parts

Spindle Head 312

It's a lump to look at, but all the major machining has been done except facing off the bottom of the head casting to give a nice square surface for the depth stop to bear on. This is a modification from the standard part.

Set the head, ground side on the surface plate with the quill tube in. With a surface gauge, determine the best face to work from, i.e. the face which is most parallel to the surface plate, which becomes the datum. Set up on the mill by clamping the quill tube true to the Y-axis and clamp firmly. Many tend to go over the top when tightening tee bolts; the Senior M1 has $\frac{1}{2}$ in. slots in the table, and no way do you need a $\frac{1}{2}$ in. bolt and swing on the end of a foot long wrench! I find moderately tight $\frac{3}{16}$ in. bolts adequate. If movement occurs, the clamping isn't right. Once clamped, face off to a good finish, removing the minimum amount of metal.

The $\frac{1}{2}$ in. BSW hole is best drilled, spotfaced (using the special tool shown on the drawing if needed) and tapped using the horizontal spindle, with the head clamped to a large angle plate. The slot has a $\frac{1}{16}$ in. hole

at its end, drilled before slitting. The slot can either be cut with a hacksaw or set up on the mill and cut with a slitting saw.

The $\frac{3}{16}$ in BSF tapped hole for the worm box should be as near to centre line as possible and tapped squarely, for it because the pivot stud forms the key for the quill. The $\frac{1}{4}$ in. BSF hole is spotted from the worm box later. On large items that won't fit the pillar tool, I use a block of steel about $\frac{3}{4}$ in. thick, drilled to clear the tap, and use this to guide the tap. Tap the 2BA hole to lock the spring box, the tappings in the top of the casting being spotted from S1.

Pivot Stud 406

Little comment is required on this item, but the threads must be true to the axis, so it's best to screwcut them.

Handles 411, 313 etc.

I find the easiest way to do these is to make the two separate parts for each and then mark off the lever positions on assembly.

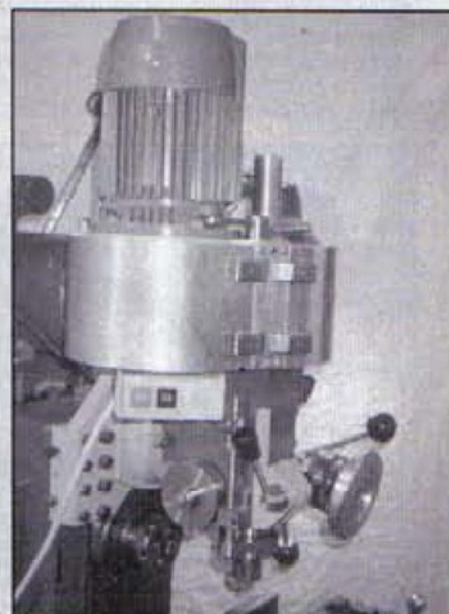
Pinion Shaft 425

This comes with the teeth cut. One end is turned down and centred. Careful setting in the 4 jaw is required, plus support from the fixed steady for facing, drilling and tapping of the capstan end. The hole for the drive pin in the capstan hub is jig drilled from this item later. Reverse in the lathe and set up in the 4 jaw with tailstock support, not forgetting a bit of copper sheet to protect the teeth from the chuck jaws. When the $\frac{1}{2}$ in. dia. is complete, support with the steady to drill and tap.

The flat can either be milled or filed (mill for me every time) and drilled for the spring pin (Item 428), which needs the slot cut in it and must be facing the right way on assembly (have a dummy run first).

Capstan Hub 426

This is straightforward. Bore to a nice sliding fit on 425, reverse and turn the taper. Break and polish the edges - they're your fingers! Using the 3 jaw and a block to the lathe bed, index the arm positions. The way I drilled and tapped this was by bolting it to a tilting angle plate. If you do not have such an attachment, mill up an angled block of metal or even hardwood. Drill the drive pin hole, then use it to jig drill 425 before pressing in the pin and opening up 425 to clearance.



Spring Housing 432

This can be obtained as an iron casting, but I machined mine from a blank of FCMS. Either way machine the spigot and bore at the first setting. The spigot should be a good, but not tight fit in the head, and the bore is meant to be a clearance fit. The groove is to prevent the grub screw bruising. Reverse and bore to rule sizes, again deburr, break and polish the edges. I cut the spring slot with a hacksaw and file; don't make it too tight.

Spring Cover Casing 435

Again a casting or FCMS blank. I prefer to face and bore. Finish with a reamer if you can, then reverse to machine the outside diameters to rule sizes. Deburr, break and polish.

Wormshaft Bracket 405

This is one awkward lump to machine. The late G.H.Thomas once said something like "there are probably a dozen ways of doing a job, and every one is right". As long as you get the result you want - carry on, but I tackled it as follows:-

Set up in the 4 jaw with the face that bears on the side of the head butted against the jaws, and set the boss running true. Nothing looks worse than a boss bored drunkenly. There will be a lot of out of balance forces here, so keep the speed down to about 200 RPM.

Centre, drill, bore (you will need quite a long bar to clear the projections) and ream, then face at the same setting. Turn up a

$\frac{1}{2}$ in. dia. push fit stub mandrel and push the casting on (if you get a slack fit on the mandrel, stick the casting on with a drop of super glue - gentle heat, about 200 deg. C, with a gas torch, will break the bond later), with the large flange bearing against one of the jaws to act as a driving dog. Face off the large flange to rule dimension, or enough to get a good clean face (the stud 406 can be altered to suit if need be).

Tricky this; the wormshaft bearing hole is angled at 3 deg. to the mounting face for the helix angle of the worm. Clamp the casting to either an angle plate or vertical slide on the lathe, boss to tailstock. Set the angle with a protractor from either a faceplate or the edge of the boring table, adjusting the feedscrews to get the position. Lock all the slides, then using the tailstock as a pusher, centre, drill and ream.

Set up on a stub mandrel with super glue again to face the boss end. Having removed it from the mandrel, reverse and set up again to face off the large flange. The recess for the thrust bearing is not critical on diameter, but it is on depth. When bored, the bearing (use it as a gauge) should stand proud by a few thou, to provide clearance for the micrometer dial. There is no need to turn the outside of the flange, but I did for appearances, to the same diameter as the micrometer dial.

Set up and face the boss where the clamping screw seats with an end mill. This is not strictly necessary, but I like nuts to seat properly. You can either file the slot to fit the stud or, as I did, set up on the rotary table and mill the slot on the radius. I drilled and fitted a Bennett type oiler on the top of the casting to oil the shaft.

Leave the marking of the head casting for the locking screw tapping until you have assembled the worm. This ensures that you get the right meshing with the pinion.

Worm and wormshaft 413 & 412

The worm is supplied ready cut and bored. The worm shaft should be turned and screwcut between centres then the worm Loctited on to the shaft.

Micrometer Dial 418

These are fun (if you like it that way!). They can be tricky, but this way cuts down the fiddling about. Grip by the boss in the 3 jaw, turn all over and face, bore the recess for the O-ring and knurl. Obtaining a clean knurl is helped by plenty of coolant and cleaning the work with a toothbrush between passes. Reverse and grip in the reverse jaws, using pieces of card to protect the knurling and set to run true to the OD. Set over the topslide to $6\frac{1}{4}$ deg., as if you are turning a taper that increases towards the chuck. Set a boring tool upside down, so that it cuts on the 'back' of the bore. Bore the $\frac{5}{8}$ in. dia. parallel before using the topslide to bore the taper to $\frac{1}{2}$ in. long. Do not alter the topslide setting, because in this way you get two mating tapers, even if they are not exactly to spec.

Graduating

A lot will depend on what equipment you have, but 200 divisions are not easy to obtain. I suggest that you consult G.H.Thomas book on Dividing and Graduating, surely the definitive work on the subject for the model engineer. When the graduations are done, stamp the numbers. $\frac{1}{16}$ in. looks good, rising to the left. A jig is best to keep the punch aligned to the work. You now have a lump of metal with curlies of swarf sticking out, so set it

up in the lathe at 200 RPM, hold a strip of brass against it to knock off all the curlies, then using a fine cut Swiss file, well doused in coolant, dress down all the raised areas around the stampings and lines. Wipe the file clean regularly and keep it wet. This should leave a lovely grained finish. I do not use emery cloth, as it blurs the image.

Cone Nut 414

For something so simple, these can be a pain to get right. The extra effort is worth it, as I don't like wobbles. Face, drill and tap the blank, and part off about 15 thou over length. Prepare, from a short of $\frac{3}{4}$ in. bar, a one time stub mandrel with the thread screw cut and

adequate relief at the shoulder. Screw on the blank, face off and reverse. Face off and turn the taper to drawing dimensions. The large end of the taper should protrude from the rear face of the dial by 0.015 inch.

Handwheel 414

Any method that produces a true running handwheel can be used. The drawing states "clean up all over". Probably easiest to grip by the boss, turn as much as you can, then reverse in the chuck and turn the boss and bore. Reverse once again and countersink. I didn't fit the handle. I always seem to hit my head on them when working close up! With an elevating knee type of machine there's much less handwheel cranking, and I don't miss the handle at all.

Assembly

The golden rule for good assembly is cleanliness. With ferrous items, I boil them in washing soda, but don't use this with aluminium. This seems to be the best way of getting all the swarf, oil and grit out of castings especially and of course, from machined surfaces. You know they're clean when they come out, as in a cold damp atmosphere you can watch them rust as they dry. WD40 is an excellent protector. Water soluble degreaser, followed by a hot wash is a good alternative.

The assembly drawings show what's needed. The tricky part is putting the spring in its box. You will need three lengths of soft iron binding wire (florists), two pairs of gloves, a dummy spring end of the pinion shaft and a friend! I managed to do it single handed, but that's not my idea of fun. There's a lot of power in these springs, so take care. Wearing gloves, hook the end over the catch pin and with the lathe in lowest back gear, start to wind the spring up, keeping the tension as you go. When nearing the end, your friend wires the coils together by slipping the wire between the spring and bar and twisting the ends with pliers.

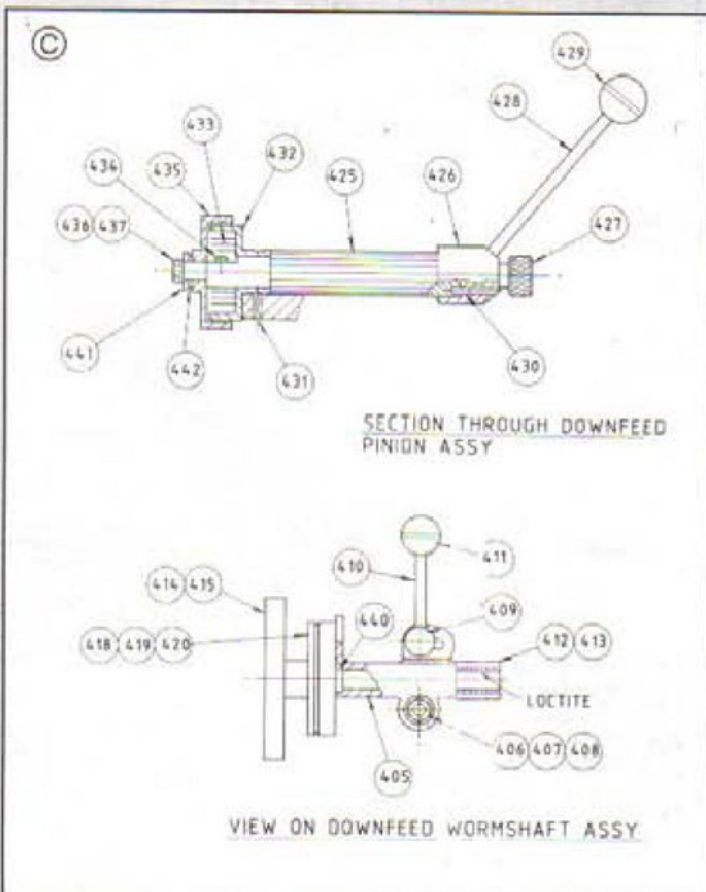
Carefully remove it from the dummy and slide in to the spring case, hooking the end in the slot. With you holding the spring in to the case, your friend cuts the wires and pulls them out, the spring hooks over the pinion easily and the rest of the assembly follows on. Use clean grease on the thrust bearing in the downfeed worm and adjust to as near zero end float as possible.

Final Set-up

The general photo's and GA's will show any details on assembly I've not covered. The switch I used was a simple on/off push button. It has no overload or no-volt release, but is compact and cheap. If in doubt about any electrical problems, get a qualified electrician to sort it.

Belt Tension

TBA (The manufacturers of Poly V) state



that the best method is by measuring the deflection. The easiest way of determining this is, if the belt does not exhibit a slack side when running, things are not too far out. It is better to have a Poly V that is slightly over tensioned. Poly V's tend to scream if slipping.

Set-up

With the MMH set up on the mill, now comes the acid test. Set up a DTI offset in the collet and do a turn round test (a sheet of plate glass on the table makes this a lot easier).

First set the MMH vertical in the X axis, then check for any run out on the Y axis. If you've none (lucky or what?) fine—you are just a genius. I had 0.002in. on a 2½in. radius which is pretty good. If you have a large error, check the fit of the knee on your mill. One way of seeing is to turn the DTI so that it's on the Y axis and then tighten the locks. The movement can be alarming! To correct this, slacken the jack and gib bolts and insert a shim, re-tighten and test. When you have the correct reading (dead zero doesn't seem to happen on mill heads!) cut a full size shim and retain in place with either grease or super glue.

When you are satisfied, mark the fiducial line on the swivel head.

Happy Milling!

References

Model Engineer, Vol. 165 No. 3887 - Vol. 166, No. 3893: *Poly V Belt Drives*, G.F. Deane.

The Model Engineers Handbook, (Tubal Cain, Nexus Books), shrink fits and general information.

Screwcutting In The Lathe, (Martin Cleeve, Nexus Books)

Poly V Design Manual, (TBA Belting)

Cutting Tool Guide, (Clarkson Osborn International)

Bearing Handbook, (NSK-RHP UK Ltd)

Sandvik Inserted Tooling, (Greenwood Tools Ltd)

Sumitomo Inserted Tooling (Nigel Kelly—Penco)

MOTORISED MILLING HEAD

Parts List

(Note: Components described in Parts 1&2 have already been listed)

DOWNFEED PINION ASSEMBLY GROUP

Part No.	Qty.	Description
425	1	Pinion Supplied with teeth cut
426	1	Capstan Hub Steel (See Item 438)
427	1	Retaining Screw Steel 1 dia. x 3 (Also Item 441)
428	3	Capstan Arm Steel 5/16 dia x 15
429	3	Plastic Knob Tapped 5/16 BSW
430	1	Roll Pin 1/8 dia.
431	1	Grub Screw 2 BA x 1/4
432	1	Spring Housing From casting
433	1	Spring
434	1	Spring Anchor Steel 1/4 dia. x 1
435	1	Spring Cover From casting
436	1	Hex Setscrew 5/16 BSF x 3/4
437	1	Washer 5/16
441	1	Washer Steel (See Item 427)
442	1	Crinkley Washer

DOWNFEED WORMSHAFT ASSEMBLY

Part No.	Qty.	Description
405	1	Wormshaft Bracket From casting
406	1	Wshaft Pivot Stud Steel 1/2 dia. x 12½ (Also Item 412)

407	1	Hex. Nut 3/8 BSF
408	1	Plain Washer 3/8
409	1	Wshaft Brd Clmp Steel 3/4 dia. x 4 (Also Item 419)
410	1	Lever Steel 5/16 dia. x 3
411	1	Plastic Knob 1 dia. tapped 1/4 BSF
412	1	Wormshaft Steel (See Item 406)
413	1	Worm
414	1	Handwheel From casting
415	1	Csk Screw 1/4 BSF x 5/8 (For Item 414)
418	1	Micrometer Dial
419	1	Cone Steel (See Item 409)
420	1	'O' Ring 7/8 dia.
440	1	Thrust Bearing

DEPTH STOP ASSEMBLY

Part No.	Qty.	Description
DS1	1	Stop Nut (Upper) Steel 3/4 dia. x 2½ (Also Item DS1A)
DS1A	1	Stop Nut (Lower) Steel (See Item DS1)
DS2	1	Stop Block Steel 3/4 x 1 x 1½
DS3	1	Stop Bar Steel 5/8 dia. x 7½
DS4	1	Clamp Screw Steel 1/2 dia. x 1
DS5	1	Pawl Spring Steel 0.020 x 3/16 x 7/8
DS6	2	Cap Screw 2 BA x 1 (DS2 to Item 312)
DS7	1	Hex Bolt 5/16 BSF x 1/2 (DS3 to Q1)
DS8	1	Ch.Hd Screw 8 BA x 1/4

NOTE:-

Items in the Part No. range 312 to 442 available as a kit of part-finished or stock materials from Model Engineering Services, Pipworth Farm, Pipworth Lane, Eckington, Sheffield S31 9EY.

Poly V Belts, Ball Bearings, Collets, Collet Closing Ring and Closing Ring Wrench available from NS & A Hemingway, 30 Links View, Half Acre, Rochdale OL11 4DD



TRADE COUNTER

New range of Taiwanese power tools

On view at the recent Harrogate show was an impressive range of new power tools from Rexon. This company claims to be the seventh-largest manufacturer in Taiwan, and also to be the world's biggest producer of vertical pillar drills. It manufactures more than one million power tools a year for woodworking and metalworking.

A new British subsidiary was established earlier in the year on the Barbot Hall Industrial Estate, Rotherham, South Yorkshire, with the full support of

the Rotherham Industrial Development Office. Rexon carries ISO 9001 certification, and its machines are CE approved.

A well illustrated catalogue contains details of a full range of bench and floor mounted drill presses, scroll, band and table saws, a 1in. bandsaw and wood lathes. The quoted prices appear to be competitive, and if the performance of the equipment matches the appearance of the examples displayed at Harrogate, any of these machines would make a welcome addition to the model engineer's workshop.

Rexon Ltd., Summit 1, Mangham Road, Barbot Hall Industrial Estate, Rotherham, South Yorkshire S61 4RJ

Tel. 01709 361158 Fax. 01709 821966

Hemingway on the Internet

N. S. & A. Hemingway of Rochdale, Lancs, have built up a reputation as suppliers of quality attachments, accessories and material kits for workshop equipment, of which the Payne Quick Step Mill is outstanding. They have now decided to embrace the new technologies by publishing their catalogue on the Internet. For the present, orders will still have to be placed by post or telephone, but potential

customers all over the world can now study the list of products on their screens. Statistics provided by the system indicate that the first few weeks of operation have seen much activity, and that other suppliers to the model engineering world are watching this development with more than passing interest.

For those readers who are not considering using this new means of communication, the traditional catalogue will, of course, continue to be available by post.

The Hemingway catalogue may be viewed at

<http://www.fotec.co.uk/mehs/hemingway> or obtained from N. S. & A. Hemingway, 30 Links View, Half Acre, Rochdale, Lancs OL11 4DD Tel. 01706 45404

New catalogue from Woking Precision Models

The Spring 1996 catalogue from Woking Precision Models of Oundle is still in the conventional form, but contains much of interest to readers of M.E.W., including castings and materials for a number of items featured in the Workshop Equipment section of the Nexus Plans Service. Castings for the well-known 'Potts' range of designs are also stocked, together with other castings and materials for workshop projects.

Castings for a wide range of internal combustion engines from such designers as Westbury, Sparey, Chenery, Jones and Whittle (Eric, not Sir Frank!) are listed, plus those for a small number of stationary steam engines, including Stan Bray's Hick Oscillating Engine.

Woking Precision Models, 10 New Street, Oundle, Peterborough. PE8 4EA Tel. 01832 272868 Fax. 01832 272760

Camden Booklist No.34

Adam Harris of Camden Miniature Steam Services (or, more probably, his 'Girls') has sent us their Spring catalogue of engineering books and videos which originate from a number of countries. Mainly concerned with 'transport' subjects, it also contains ten pages of items relating to engineering practice and skills, including horology and foundry practice. Many reprints of nineteenth and early twentieth century publications describe operations and techniques which are applicable in the home workshop of today, and which would be of particular help to the newcomers to our hobby. More recent developments are not ignored, however, as the Aero Engine section lists the latest publications dealing with the construction of model gas turbine engines.

Camden Miniature Steam Services, Barrow Farm, Rode, nr Bath BA3 6PS Tel. 01373 830151 Fax. 01373 830516

Power Capacitors introduce a new motor speed control system

Manufacturers of the well known Transwave range of converters, Power Capacitors of Tyseley, Birmingham, were also at Harrogate, and were demonstrating their new frequency converters (inverters) designed for motor speed control from a 13 amp socket. Designed to meet the latest EC directive on EMC, the system is based on the IMO Jaguar Cub range of single phase inverters, and is for use only with delta connected 200/240v three phase motors. Electronic variation of speed from zero to twice the nominal speed of the motor, plus forward/reverse capability is controlled from a keypad, which also features an emergency stop facility, using dc injection braking. A digital display indicates motor speed, current and other parameters. The system can be adapted to operate more than one motor, up to the maximum rated loading of the drive.

Power Capacitors Limited, 30 Redfern Road, Tyseley, Birmingham B11 2BH Tel. 0121 708 2811 Fax. 0121 765 4054

Abrasives galore!

The new Sanding Catalogue from CSM Trade Supplies contains over 3000 stock items for sanding, grinding and polishing. These are mainly abrasive materials, in all available forms, but a selection of sanding machines is also stocked. The majority of the abrasives listed are by Hermes and are suitable for many applications from DIY painting and decorating through to industrial applications. They will work many materials including wood, metal and plastics. Of particular interest is the Webbrax range, which consists of nylon fibres onto which are bonded aluminium oxide or silicon carbide grains. It is claimed that, because of the web-like structure, this material never clogs and that the dust can be dislodged by tapping the sanding pad against a solid object or by washing it in running water.

CSM Trade Supplies, 6 Peacock Lane, Brighton, East Sussex BN1 6WA Tel. 01273 559660

Hobbymat lathes and the Universal Metal Bender

C.Z. Scientific Instruments Ltd. have announced that they have closed the department responsible for model engineering supplies, following the purchase of the company's shares by Jenoptic of Jena. This German group specialises in laser based scientific equipment, and it has been decided to concentrate on this aspect of the business. At the time of the announcement, no arrangements had been made to establish new representation for either the Hobbymat machines or the metal bender, but servicing, spares and accessories would be available from the following sources:-

Hobbymat:- Hobbymat (U.K.) Ltd., P.O. Box 310, ST. Albans, Herts. AL3 6DH. Tel. 01727 765767 Fax. 01727 765896

Universal Metal Bender:- Mill Hill Supplies, 66 The Street, Crowmarsh Gifford, nr Wallingford, Oxon. OX10 8ES. Tel. 01491 838653 Fax. 01491 825510

Waterborne polyurethane acrylic coatings

From Protec comes a new range of durable, self levelling coatings which can be applied by brush or airbrush without using thinners. Claimed not to yellow or craze, this material can be used as a varnish or as a 'dope', which will turn tissue into a strong, thin modelling material. Available as clear gloss or clear satin, it is said to be able to provide protection to even the most frequently handled items.

Protec Hydrocoatings, Tel. 0151 691 0149 Fax. 0151 605 1666

Steam Heritage Museums & Rally Guide 1996/7

The latest version of this annual publication covers much more than the title suggests, as it also has sections on Industrial, Transport, Ship, Aircraft and Military items. The comprehensive events diary is backed up by advertisements from many of the major event organisers, allowing would-be participants to make contact.

A number of the railways and museums are participating in a discount voucher scheme of the 'money off' or 'two for one' variety, so that the dedicated visitor could benefit to the order of £50 or so, but would need to travel from New Romney in Kent to Bo'ness, West Lothian, via Beer, Devon and Leiston, Suffolk.

Well cross-indexed by geographical location, type of attraction and date of event, this Guide is invaluable to anyone who enjoys our industrial heritage.

TEE Publishing, The Fosse, Fosse Way, Radford Semele, Leamington Spa, Warwickshire CV31 1XN Tel. 01926 614101 Fax. 01926 614293

Indices for Acorn and RiscPC machines

Contributor Brian Cockledge points out that owners of Acorn 'A' series and RiscPC computers need not miss out on computerised indices to Model Engineers' Workshop, Model Engineer or Engineering in Miniature, as they are available as shareware on a disc from the ArmClub PD Library for £1. They are in Arcscan text format, Arcscan 111 being available from Beebug Ltd (Tel. 01727 840303)

Nick Evans, ArmClub PD Library, 19 Woodberry Way, London N12 0HE



WE VISIT - RON PAGE

Ron Page has a well equipped workshop near Hastings. It was opportune to visit during the period of the recent Modelworld Exhibition of Brighton, and to record some of Ron's workshop items and techniques

When visiting the Brighton Modelworld earlier in the year, we took advantage of the opportunity to accept a long standing invitation to visit Ron Page in Hastings. We had met Ron previously at a number of exhibitions because several trade exhibitors, particularly those showing machine tools and attachments, have taken advantage of his experience and his communication skills by including him in their demonstration teams. We were to bump into him again at a later date at the Harrogate exhibition - quite a long haul from Hastings!

In the modelling field, Ron is a traction engine enthusiast, having now built a total of eight, ranging in scales from 1in. to 4 1/2in.:1foot. The current resident of his workshop is a 3in. scale Allchin. A well-detailed trailer, for use behind this engine, is nearing completion. The next project will represent a change of interest, because Ron is planning to establish a 3 1/2in. gauge tramway for the garden.

The first impression gained when entering the shop is that it is difficult to envisage this as just being the hobby room of an amateur engineer, such being the size and range of the machinery and other equipment which it houses. It transpires that, after taking early retirement from a post with one of the national utilities, Ron set up as a jobbing machinist, and equipped a workshop accordingly. When he 'retired' for the second time, he found himself with a home workshop which it would be difficult to better.

The building started as a small free-standing workshop situated at some distance behind the domestic garage. The first stage of the expansion consisted of bridging the gap between the two buildings, and then, of course the inevitable happened and the back wall of the garage disappeared, leaving the car to live on the drive. The original workshop is now what can be best described as the fitting and fine machining area, housing a venerable long bed Myford Super 7B, a Chester vertical mill and a George Thomas pillar tool. Below substantial (and tidy!) benches are neat rows of metal drawer cabinets, which provide ample storage space for the many hand tools and attachments which Ron has acquired or made over the years. Many projects have come from the pages of M.E.W., the Myford being currently equipped with a taper turning attachment and a tailstock turret.

Moving into the linking area, one

encounters a Harrison LS lathe, a Meddings pedestal drill and a home built Stent tool and cutter grinder. Most of the former garage space is occupied by two large milling machines, the vertical unit being by Elliott, while the horizontal is a Harrison. This larger equipment is all three-phase, powered through a N.D. Electrical converter, with a pilot motor being used as a smoothing device for the smaller motor of the Myford. The boring head fitted to the vertical machine is also from a design published in M.E.W., but Ron is trying an alternative method to that used by Mark Figs when adding a turret head to the horizontal mill. To be seen in the photos is a head assembly from a Chester machine grafted on to the

1: Looking back towards the original workshop area, we see the two larger milling machines, the Harrison lathe, the pillar drill and the cutter grinder.

horizontal support arm of the machine. Ron reports that the experiment is progressing well, and could provide the solution for those who do not wish to construct all the parts, as Mark has done.

Another Page project is a set of substantial powered bending rolls. Based on a double size version of the George Thomas design, these rolls will accommodate 6mm steel plate, and the 3/4hp three phase motor makes light of such jobs as traction engine wheel rims. Ron has promised to share some of his ideas with readers of M.E.W., so we look forward to seeing some very practical and workmanlike projects.

3: Neat racking above the lathe ensures that all tooling is close at hand.

4: The well equipped long-bed Myford Super 7B stretches into the distance!

5: The powered bending rolls are a substantial unit.

7: The most recent traction engine project, the 3in. Allchin

8: The trailer for the Allchin nears completion. Also in view are the pillar tool and the Chester mill.

2: Ron sets the Chester turret head true on the Harrison horizontal mill.

6: The boring head fitted to the Elliott mill.

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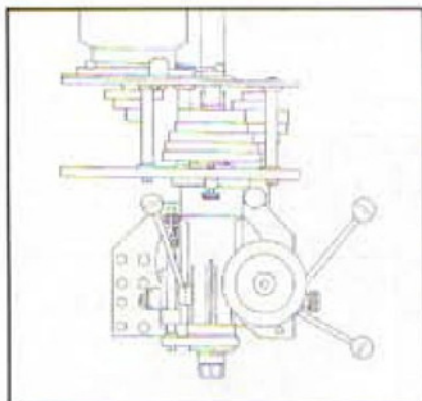
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- Reader to reader service • help
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● A copy (or photocopy) of an article on making a model pulse jet that featured in a 1950s/1960s *Aeromodeller* Annual.

John O. Smith 256 Stone Road, Hanford, Stoke on Trent ST4 8NJ
Tel. 01782 717671 (work)
01782 658886 (home).

● A pair of raising blocks for Myford ML7 lathe. Will pay cash or swap for tooling.

J. Allcock, 34 Lauder Close, The Northway, Sedgeley, West Midlands DY3 3XN

● For Aciera 1670 tapping machine, motor pulley, chuck, plus any information (manual, parts list, user instructions).

John Tyson, 3 Friars Rise, Penrith, Cumbria. CA11 8DF

● For Bond's Simplex petrol engine type 1931, Drawings and information. Also if any reader has built one, please make contact.
Tel. (Surrey) 01737 843374

● For Excel 3 1/2 in. non screwcutting lathe, handbook or other information to purchase or copy. Costs reimbursed.
T. Figa, 122 The Drive, Ilford, Essex. IG1 3JG

● For Selecta Homemaster Workshop, speed control unit and coupling unit (motor revs at 7000rpm)
Bill Griffin, 52 Fifth Street, Mentone 3194 Victoria, Australia.

● For Parkinson No.1NA universal milling machine, operators manual/handbook. Willing to purchase or pay expenses to copy. I have the spare parts list and sales catalogue for the above, which I can copy.
S. Trendall, 15 Waterloo Road, Crowthorne, Berkshire RG45 7PB.
Tel. 01344 774886

● A copy of *The Myford Lathe Handbook* by Ian Bradley, to purchase. Also 1 1/8 in. UNF tap.
W. L. Moorley, 5 Inveresk Road, Tilston, nr. Malpas, Cheshire. SY14 7ED.
Tel. 01829 250454.

● For Aciera F1 milling machine, specific literature (not a general Aciera sales brochure). I would particularly like pictures/descriptions of the many

accessories, and also a service manual. Costs reimbursed. Anyone offering actual accessories or spares is likely to get their arm bitten off!
Tel. (Sussex) 01903 770888.

● In the '57/'58 period, Model Engineer carried adverts from two Companies, A. N. Clark (Engineers) Limited of London SW19 and P. B. Engineering of Coventry, offering a clutch mechanism for mounting directly on the motor shafts of lathes etc. Does anyone have any specific details of either of these, or one for sale? All replies answered.
B. W. Lawson,
Tel. (Kent) 01322 227120.

● Information for a pantograph engraving/milling machine which I am rebuilding. The machine, probably late '40s or early '50s, has a logo on each side of the main casting, 1MA or TMA, but no other serial numbers. All expenses reimbursed.
Lloyd, 3 Victory Road, Downham Market, Norfolk PE38 9RU.
Tel. 01366 382823.

● For 1948 Myford (Drummond) 'M' Type lathe:- Both headstock (back gear) pulley guards, catchplate, hand turning rest, fixed steady and any accessories, particularly the overhead drive assembly. Also wanted, Drummond 'J' type hand shaper.
Andrew Curl, 15 Boxed Close, Leagrave, Luton, Beds. LU4 9HN.
Tel. 01582 490818 (after 7p.m.)

● Issues 11 and 12 of *Model Engineers' Workshop* (the ones containing Parts 2 and 3 of *Milling for Beginners*)
Jay Friedman, 1530 September Chase, Decatur, Georgia 30033, USA

● Help with a Bofford. I get a very poor finish with my Model AUD Norton gearbox lathe. I suspect the head bearings, but have no idea where to get new ones or how to fit them. I have no background in engineering.
Please can any reader lend me a manual for copying and/or give advice. All costs gladly reimbursed.
Julian Forsey, 41 Sibley Road, Thornbury, Bristol BS12 2EP.

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EXCHANGE

● I have a copy of *The Isle of Man Railway* by J. I. C. Boyd which I would exchange for any literature on the construction of *Tich* or *Simplex*.
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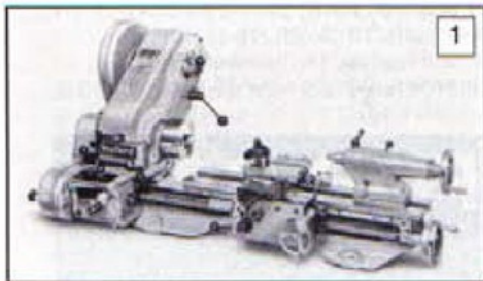
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'Mr. Whittaker of Pennance, Cornwall, apologises that, due to personal circumstances, he has been unable to reply to those who kindly responded to his query printed in Issue 28, but wishes to thank them all for taking so much trouble to be of assistance'

A BEGINNER'S GUIDE TO THE LATHE

Discussion and correspondence with some of our newer readers has made us aware that many of them are seeking instruction in basic lathe work. Harold Hall has put together a series of articles which will take them through the basic steps. In this introduction, he describes some of the features to be evaluated when acquiring this type of machine.

Part 1



1: One of the most popular makes of lathe available for the amateur is the Myford range, made in Nottingham, U.K. Seen here is the Super 7. These lathes have a vast range of accessories available, this one is equipped with a screw-cutting gearbox and power cross slide facility. It is fair to say that more has been written in the model engineering press about accessories and extras for this range of machine tools than any other make.



2: This Unimat machining centre, which combines the function of lathe, drilling machine and vertical milling facility in one small machine. Has electronic speed control to the motors as a built-in feature.

The Lathe

Very few home workshop owners would argue with the statement that the lathe is

the number one machine for the home workshop. For many years, it was the only machine found in most home workshops, except maybe for a simple drilling machine. However, the availability of more affordable milling machines, particularly the mill/drills, has changed this situation considerably in recent years. Even so, there are still more than a few workshop owners who rely on the lathe for all their machining activity. The articles by Bob Loader are a fine example of what can be done using a lathe only, and a small one at that.

This article is the first of a series devoted to helping beginners in the various processes of using a lathe for turning operations. I believe that there will be something of help for beginner and experienced user alike. While being a series, each part will be a stand alone article on a particular aspect of turning.

Choosing a lathe

Most readers will already own a lathe, and this first article of the series will be off little benefit to them, but correspondence and readers surveys have indicated that there are more than a few for which a lathe is still an item for the future. There are also those who have purchased a lathe, perhaps a rather old or small machine; these are adequate for many users, but sometimes they are found to be too small for the jobs envisaged by others. Such users are sometimes reluctant to move onto another lathe, in case they make another mistake. This brief introductory article will, I hope, be of benefit to such readers.

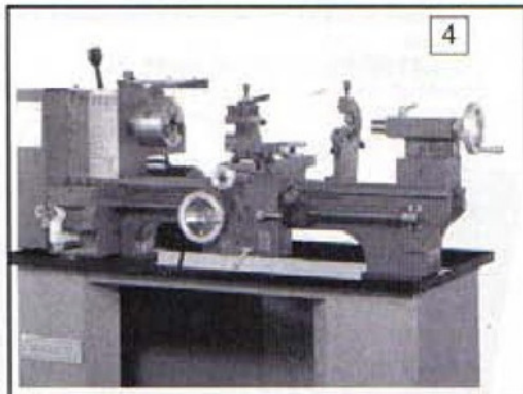
In writing this article, I assume the reader has a basic idea as to the workings of a metal working lathe and to the terms used. I will not spend time defining the meaning of terms, such as saddle, tailstock, leadscrew and others. If the reader really is a total beginner then one of the many books that commence at this level would be worth purchasing*.

What to buy

Choosing a lathe is a much more involved than choosing a milling machine, as there are many more facilities, built in



3: At the recent Primrose Valley Modelling Week your editor, Geoff Sheppard, and M.E. Technical Editor Mike Chriss ran the workshop section. Mainstay of the machine tools was this machining centre, loaned by Chester Machine Tools. Here we see Geoff undertaking a repair job on the lathe, with an interested group of onlookers assessing the machine's performance.



4: Messrs Warco offer a wide range of machine tools for home, and industrial workshops. Designed specifically for the model engineer is this model 918, which comes with a very full specification as standard. Included are 3 and 4 jaw chucks, faceplate, fixed and travelling steadies, 4 way indexing tool post, Norton quick change gearbox for Imperial or metric screwcutting centres and a maintenance tool kit. A vast range of extra equipment is available from the suppliers.

and available as accessories. A particular concern is that some facilities not provided with a new lathe, cannot be bought later, as the lathe is not designed to accept them. It is not intended to review available lathes, ending with a recommendation on their value for money; this would be far too involved for the time and space available. The final choice is totally in the hands of the purchaser. I hope the contents of this article will make the would-be owner better informed and better able to make this choice.

Capacity

The specification regarding the size of a lathe gives an accurate indication as to the size of work that can be undertaken. The basic specification will almost always quote distance between centres and centre height above the bed. Twice the centre height will give the maximum work diameter that can be accommodated. In some countries this figure is quoted instead of the centre height, and in this instance is quoted as the swing.

Equally important, and quoted in the complete specification for the lathe, is the centre height above the cross slide. Whilst the distance between centres and twice the

centre height above the cross slide indicate the maximum component length and diameter, working at this size could be time consuming if much material has to be removed. It is preferable to purchase a lathe that has a larger capacity than is required for the bulk of the tasks likely to be undertaken, the maximum capacity being used only for that occasional large item. Nothing is gained by having a lathe longer than is required. However, do remember that, with headstock chuck, drill chuck and drill fitted, the possible workpiece length will be considerably less than the 'between centres' dimension.

Some lathes are provided with what is termed a gap bed. This is basically a lowered portion of the bed casting, adequately braced by the maker and situated close to the headstock. The extra swing in the gap enables a larger diameter to be machined. The width of this available feature is limited, it is only of use in very specific instances. Typically, the model engineer involved in making locomotives will find the facility invaluable for turning large driving wheels, should the lathe have insufficient centre height. A useful check is that the tool can be extended to reach the maximum swing. Available in the gap, there are machines where tool movement limits the maximum diameter which can be sensibly machined even on gap bed lathes.

Basic turning

All lathes are within their size limits, able to carry out basic turning almost equally well. To do this it will be necessary to move the tool both along the length of the workpiece and at right angles to it. The latter will always be by the cross slide. A fitment common to all lathes. However, for turning along the length most lathes will provide two methods. These are, the saddle moving along the bed, and by use of the top slide. Some lathes, mostly smaller ones, will not be fitted with a top slide, and using the saddle will be the only option. The lack of a top slide, particularly on smaller lathes, is not a great loss when involved in basic turning, but will be when it comes to machining short tapers.

One aspect that will be found irritating on some lathes when using the saddle for basic turning will be the absence of a split nut (commonly called half nuts) between saddle and lead screw. This will be especially so if one is used to operating a machine that has this facility. Its omission is most likely to be confined to the smaller machines, around 50mm centre height, though at least one recently introduced lathe with a 100mm centre height is made in a similar manner. It is easy to fall into the trap of assuming the split nut is provided for the purposes of screw cutting, as this is where its use is most prominent. It is no more essential for screw cutting than it is for basic turning. Its main purpose is to enable the saddle to be swiftly moved along the bed of the lathe without the necessity of operating the leadscrew handwheel. This is done, with the split nut open and using a rack and pinion, the pinion being driven from a handwheel on the apron at the front of the saddle. Without a half nut, moving the saddle can be time consuming, particularly so on smaller lathes that have a fine pitch

leadscrew, maybe 1mm. Do consider this carefully before purchasing a machine without this facility. I would suggest traversing the saddle the full length of the bed, both back and forward, to test your reactions to this situation prior to purchasing. The facility of adding a split nut cannot usually be purchased as an accessory at a latter date.

Turning tapers

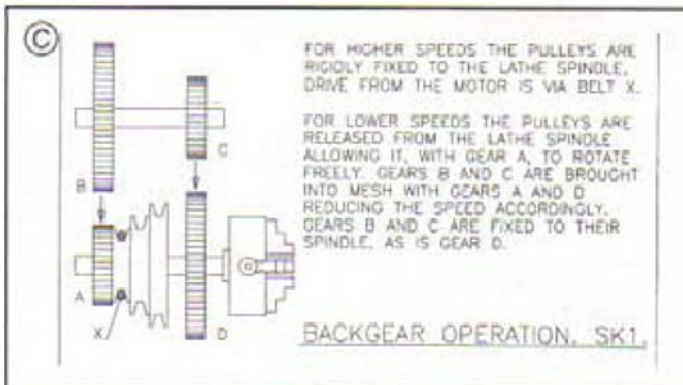
There are two methods of producing tapers that may be built into a lathe as purchased, each has its own limitations. Found most often, and probably the most useful, is the pivoted top slide. It is the only method that will produce tapers with a large internal angle. Some top slides will provide adjustment up to a full 90deg., others are limited to around 45 degrees. (Incidentally, this latter figure is insufficient for the normally recommended method of screw cutting, that is, where the tool is fed in at the angle of the thread. It is with care, possible to produce adequate threads by feeding the tool in using the cross slide, so the limit of 45 deg. is not that important). If the basic lathe is supplied without a top slide, one can often be purchased from the manufacturer as an add on accessory.

Another method of taper turning that will be provided as standard on some lathes, is to turn the work between centres and with the tailstock set off centre. Its advantage is that very long tapers can be provided, but only with a very small internal angle of a degree or two maximum. If the lathe being considered is not provided with a set over facility, neither will it be available as an add on accessory. I consider this to be one of the least used facilities in most home workshops. There are companies who specialise in accessories who provide a special set over centre, (a design for such a device was published in Issue 26 of M.E.W.(1)). It is worth commenting that, as smaller lathes are invariably made with a low selling price in mind, facilities are more likely to be omitted from the basic lathe. They are often available as accessories to be purchased separately.

A third method of producing tapers is by use of a taper turning attachment. The advantage of this unit is that it will turn longer tapers than the top slide, probably around 250mm, and with a larger internal angle than the set over tailstock, around 25deg. is a likely maximum. It can also be used in conjunction with the powered fine feed facility. This rather specialised and expensive item will only be available for some lathes, mostly the larger ones, and then only as an add on accessory.

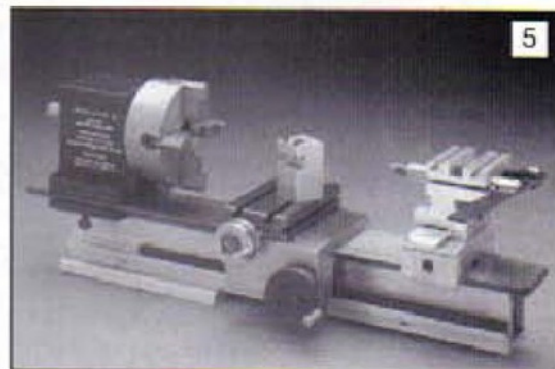
Speed control and range

Speed control is most likely to be by stepped pulleys, though a few medium sized lathes and most larger ones (outside the scope of the home workshop) will use



a geared head. These will select speeds using a combination of levers. Electronic variable speed control is also found on a few home workshop lathes, and mechanical variable speed also on some medium size industrial machines that may find their way into the home workshop. The speed range provided by variable speed systems, electronic or mechanical, will invariably be enhanced by limited belt/gear change methods. In a similar way, the speed range of belt driven machines will often be extended at the lower end by a simple gear train, normally known as the back gear, so called because on earlier machines it was normally mounted at the back of the headstock. The speed reduction is likely to be around 6:1 and each speed achievable by belt change will have a back gear equivalent speed of $\frac{1}{6}$ of this value, thus doubling the number of speeds available. Sketch 1 shows a typical back gear arrangement.

Again it is the smaller machines that may be limited in this aspect, though this is not always the case. Unless turning larger castings and the like (often mounted on the face plate) is envisaged, or screwcutting, the lack of lower speeds may not be a problem. The latter will benefit from speeds of a few tens of RPM and the lathe can be turned by hand using a special handle for the purpose. Some of the smaller lathes that do not provide slow speeds as standard will have slow speed attachments, and maybe even handles for manual operation, available as optional accessories. An ideal speed range will be in the order of 30 to 2000 RPM though often this will not be provided. Aim for the slower speeds if screw cutting and heavy work is likely, in particular intermittent cutting of castings. The higher speeds are required if smaller diameters are the main area of activity, say 8mm and below. For very small diameters, say 4mm and below, speeds higher than 2000 rpm would be advantageous, 3000 rpm or even 4000 rpm being worthwhile. These speeds are likely



5: A very basic, but none-the-less useful machine in the smaller sizes is the Peatol. This has no screwcutting facility, no motor is supplied, but has the advantage of being a very sturdy machine for its size. A range of accessories are available for the machine.

only to be found on small lathes specifically made for smaller work, typically clockmakers lathes and the like.

Whilst considering the drive arrangement it is worth commenting that some lathes provide a mechanical clutch at some point between motor and lathe spindle. The advantage of this is that frequent starting and stopping of the motor is avoided; worthwhile, as electric motors are unhappy with this style of operation, although this applies to some types more than others.

Screw cutting

Most lathes have the facility for screw cutting, but sometimes only as an add on extra. The essential feature of a screw cutting lathe is a leadscrew-fed saddle. To screw cut, a train of gears is set up between lathe spindle and the leadscrew to arrive at the required traverse relationship for the pitch required. Most medium size lathes will be supplied with gears and a means of mounting them. Other lathes, most likely smaller ones, may supply these as an add on accessory.

Many lathes now have a special gear box that enables the ratio between spindle and leadscrew to be selected using gear levers. This will be much quicker than setting up individual gear chains, but is of course very much more expensive. In some cases the gear box is available as an add on accessory that could be purchased later if one wants to limit the initial cost. It will also be possible to gauge how much screw cutting is being done and if the extra cost can be warranted.

Lathes with a split nut and used for screw cutting will benefit greatly by the inclusion of a thread dial indicator. If thread cutting is carried out only infrequently, it is possible to make do without this feature. Its purpose is to ensure that cutter and part cut thread, line up for subsequent cuts. By not disengaging the leadscrew half nut, its use can be avoided, but this requires winding the machine back by hand, a laborious task. This method has to be adopted when screw cutting on lathes without a split nut. A few lathes will run in reverse, making running

the cutter back easier. Not all lathes with a split nut and screw cutting facilities supply a thread dial indicator as standard, but it is usually available as an add on accessory on Imperial machines, very few with metric pitch leadscrews are supplied with this feature, as original equipment, or as an add-on extra.

Fine feeds

Using the screw cutting gear train, but with an increased ratio between lathe spindle and leadscrew, fine feeds can be achieved. This avoids laborious hand feeding over long lengths and uniform tool movement normally results in better finish to the work. The screw cutting gearbox will also have this facility built in. If screw cutting gears are provided almost certainly sufficient gears will be included to enable fine feeds to be set up. A few lathes have the facility of coupling this fine feed to the cross slide enabling automatic cross feeds.

Normally no provision is made to shut off the saddle feed at the end of its travel so it is not a feature that can be left unattended in use.

Electrics

Some machines are supplied without drive motor and associated controls, enabling the user to choose those best suited to his needs. This practice is becoming a rarity as most new machines will have a motor fitted, together with a means of switching it on and off. This may be a simple On/Off switch, perhaps incorporating reversing facilities, but these days, new machines should be supplied with 'no volt release' starters. Direct on line, no volt release starters can be purchased for fitment to any motor driven equipment.

Reversing is of limited use, and on lathes with screw on chucks, (probably the majority of smaller lathes), can be a safety hazard as running the machine in reverse can cause the chuck to unscrew.

Secondhand, ex-industrial machines are often fitted with three phase motors, which cannot be run on the normal domestic supply without alteration. However, nowadays it is possible to purchase single to three phase converters which will overcome this problem. Check on prices of this equipment, the bargain machine can suddenly become very expensive if one has to purchase such equipment before the machine can be run under power.

Accessories

There was a time when lathes were purchased without chucks, tool posts and other accessories included in the price, the advantage being that these could be purchased to a size and quality best suited to ones need and pocket. Nowadays, more lathes include these accessories in the basic price, sometimes a very wide range of items. When deciding on the lathe to buy, it is not only worth considering the items included with the lathe, but also those that are available for purchase later should they

eventually be needed.

Most accessories will be dedicated to the machine in question and can only be purchased from the lathe manufacturer or their retailer. A few items however can be purchased more generally, typically three/four jaw chucks. These may require to have a backplate machined and fitted to suit the lathe's spindle nose arrangement. To the beginner this can be quite a daunting task, having just purchased a new, or secondhand, lathe. Instructions for this operation were published in *M.E.W.* Issue 4 (2).

Metric or Imperial?

A lathe, like most workshop machines, is a machine with a long life, so you, or its subsequent owners, could be using it for very many years to come. I feel that it is preferable when selecting a new machine that one with metric calibration is purchased. Whilst a few workers are unhappy with the move to metric, it will, at sometime, become totally the system of the day, Imperial dimensions being of historic significance only. Whether this will be in five years, ten years or twenty-five years, I do not know, but I do know that the day will come.

Buying secondhand

Probably the most common request for help, addressed either to the editor, or to readers via *Link Up*, relates to secondhand machines, particularly those no longer in production. These requests, typically seek manuals, change wheels, accessories and present day sources of spare parts. The lesson to be learned from this is, try to buy a used machine that is still in production, or of reasonably recent manufacture, by a maker who is still in business. Do not assume that just because the manufacturer is still in existence that spares will be available for that 60 year old machine.

If however, sufficient funds are not available for a modern secondhand machine, look carefully at what is being offered. At least you may be able to re-negotiate the price if some parts are absent. If the older machine is all that can be afforded, do not be deterred. There are many ways of overcoming deficiencies, and many readers produce very fine work on such machines. Very often once you have a working lathe it can be used to make its own accessories.

Milling on the lathe

When choosing the lathe it is essential to decide whether it will be your sole machine, and therefore a lathe on which milling will also take place. If so, then you will need to consider what accessories are available to help you carry out the type of operations envisaged. Accessories for milling will almost always be purchased as extras, so study the maker's data to see what they provide. In the main it will be the choice between a simple vertical slide or an added milling head. One style of lathe, now available from several suppliers,



6: This example of a combined lathe/drilling and vertical milling machine is available from Machine Mart. Several other suppliers offer a similar machine, it is worth shopping around for a bargain. Advantages are a huge swing over the bed, and a lot of machine packed into a small area.



7: Those looking for a middle range machine, at reasonable cost may care to inspect this lathe offered by Paisley Machine Tools.

incorporates a milling head as standard. If milling is to take place on the lathe I would recommend that you obtain the largest lathe that you have space for and can afford. The reason for this is that the cross slide of the smaller lathe is very limited when it comes to space for mounting vices, angle plates or the workpiece itself.

Making the choice

If a new machine is envisaged, obtain a wide range of manufacturers' sales leaflets to compare specifications. Reading these will certainly add to your knowledge generally, as well as informing you on which machines certain facilities are to be found. Armed with this article and the manufacturers' specifications you will be much better placed when the choice is eventually made. Making a schedule of the major aspects will considerably aid comparison. This should

include centre height, centre distance, top speed, bottom speed, motor power. Such items as screw cutting could state, fitted, extra, not available.

Apart from cost, which for many of us will always be a major consideration, the type of work to be undertaken will be the dominant factor. If your hobby is already fairly well defined it will be so much the easier. Take an individual who is into making small model horse drawn vehicles. The work involved will be making small axles, hinge pins, very small nuts and bolts, maybe fake without threads, rivets etc.. In this case screw cutting and

heavy machining is unlikely and one of the smaller lathes would be ideal. The same would go for other activities such as miniature gauge railways. Making small steam engines, or smaller size locomotives, will involve some work on castings. For this, something a little heavier will be preferable, say an 80mm centre height lathe. Even so, full screw cutting facilities may still not be that important.

I believe that many set up a workshop without a clear idea as to its eventual use, and frequently spend much time making workshop equipment, probably with the aim of eventually taking up model engineering once the workshop is fully equipped. I did this as a teenager, and now, at the age of around 60, have almost arrived. But still only one small steam engine to date, maybe two when this article is published. If you fit into this category then purchase as capable a lathe as you can afford, I would suggest an 80mm centre height by 500mm between centres and fitted with basic screw cutting facilities. Fortunately lathes hold their value quite well compared to

many items. Should you realise eventually that your first purchase does not ideally suit your requirements, you will not have greatly lost financially. This will be particularly so if your first purchase was a secondhand machine where the initial depreciation had already taken place.

* *The Amateurs Lathe* by L.H. Sparey.
Nexus books £8.50 plus £1.00 p&p

References

1. A Tailstock taper turning attachment. *M.E.W.* Issue 26, page 12.
2. Fitting a chuck backplate. *M.E.W.* Issue 4, page 12.

Lathe suppliers — new machines

Myford Ltd, Chilwell Road, Beeston, Nottingham, NG9 1ER. Tel. 0115 925 4222. Fax. 0115 943 1299.

Emco Maier, 10 Woodshots Meadow, Croxley Business Park, Watford, Herts, WD1 8YZ. Tel. 01923 250051. Fax. 01923 243908.

Chester UK Ltd, Waverton Business Park, Waverton, Chester, CH3 7PD. Tel. 01244 336100. Fax. 01244 336036

Warco, Warco House, Fisher Lane, Chiddingfold, Surrey GU18 4TD. Tel. 01428 682929. Fax. 01428 685870

Peatol Machine Tools, M.E., 19 Knightlow Road, Harborne, Birmingham, B17 89S. (No Phone)

Machine Mart, Branches all over the U.K., phone 0115 956 5555. Fax. 0115 956 2900 for details of your nearest store.

Paisley Machine Tools, Sparks Lane, Cuckfield, Sussex, RH17 5JP. Tel. 01444 413122.



IN OUR NEXT ISSUE

Coming up in the SEPTEMBER/OCTOBER issue, No. 37, will be:

A CLOCK PINION MILL

David Penney describes a small special purpose machine which was much admired at both the Northern and Midlands exhibitions.

THE ROTABROACH

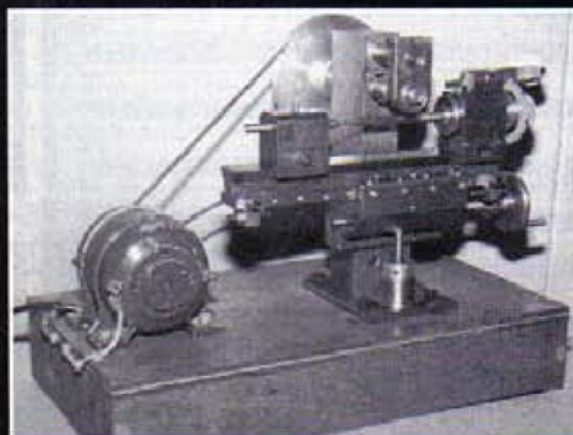
The capabilities of this useful tooling system are reviewed by Peter Rawlinson.

A TREPHINING TOOL

A design for this 'refined form of trepanning' tool comes from Dyson Watkins

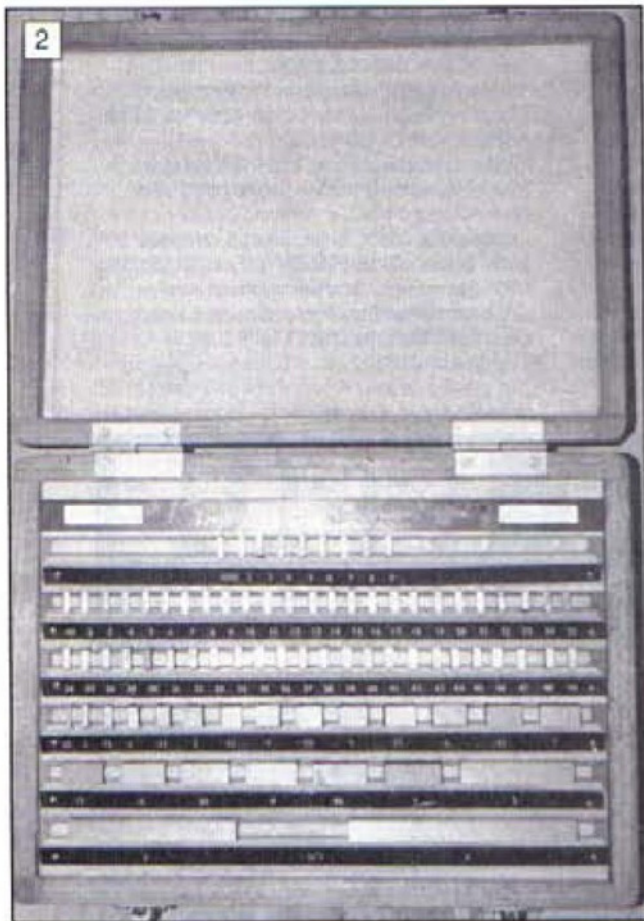
Issue on sale 25 August 1996

(Contents may be changed)



SLIP GAUGES, COMPARATORS AND THE WYKES GAUGE

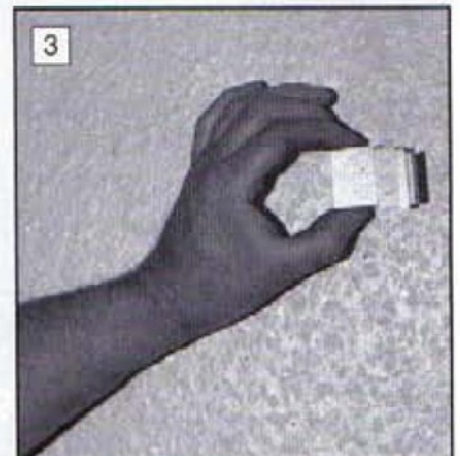
Alan Jeeves takes a look at some aids to precision measurement and describes an old instrument which is a worthwhile acquisition if seen on the secondhand market.



1 & 2: Two 81 piece sets of slip gauges



4: A 300mm block frame



3: Slip blocks 'wrung' together

SLIP GAUGES

Whenever accurate checks and comparisons have to be made in the workshop, one of the best methods of obtaining a precise standard of the stipulated dimension is by the use of 'slip gauges'. These gauges or slip blocks as they are often called, may also be referred to as 'Johansson' or 'Johnny' blocks, after the Scandinavian manufacturers of fine gauges, C. E. Johansson. They are supplied in different sets of varying numbers of pieces, and a gauge is built up by using the correct lengths of blocks, in combination, until the required size has been reached, the length being defined as shown in Fig. 1. For example, if a gauge of 0.316in. is needed, it can be obtained by adding together two blocks, one 0.116in. long and the other 0.200in. long. By utilising the range of blocks in the set, any dimension within the scope of the set can be achieved.

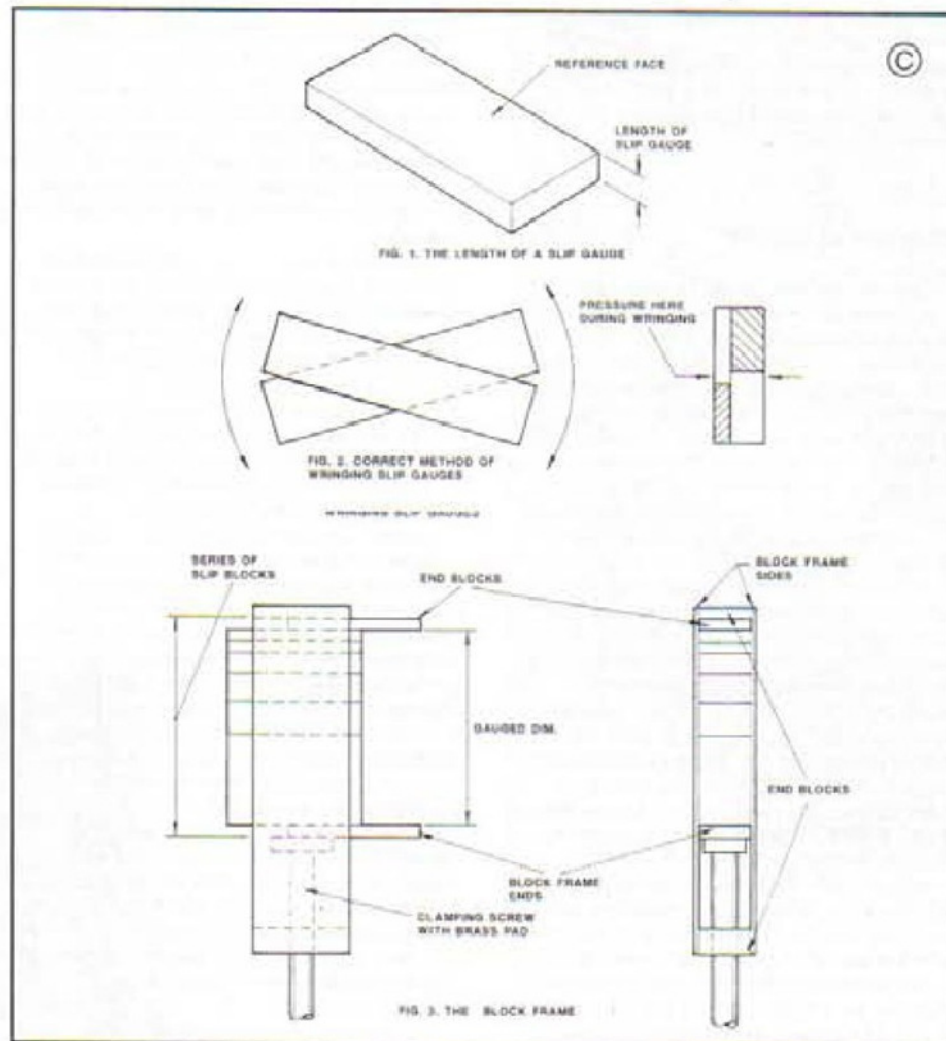
It will be clear that this particular set of precision equipment will have to be cared for meticulously if it is to provide many years of accurate service, so the sets are supplied in wooden or plastic cases, with individual dimensioned compartments for each separate piece. They should be returned to their correct compartments after use, and under no circumstances should any rust be allowed to form on their surface. If you have problems with dampness or condensation in your workshop, the set should be kept indoors and only taken into the workshop when needed.

The Blocks

The set of slip gauges is an expensive purchase, especially for the amateur, with even a modest new set running into £100's, so the best way of obtaining a set is usually by buying secondhand. Such manufacturers as Matrix, Keith, Pitter (P.V.E.) Broomfield (Huddersfield Slip Gauges), Mitutoyo and Johansson are all names which may crop up on slip gauge sets, all being makers of superb precision equipment, and names to watch out for when searching for used gauges. Sometimes a set may be made up of pieces from several different makers, and this is of no disadvantage whatsoever.

Very old examples of slip gauges were made from high carbon steel, which was properly hardened, ground and precision lapped, but such gauges are rare today, even on second-hand stalls. Nowadays, most slip gauges are made from either high chromium alloy steel or tungsten carbide. They are hardened in excess of Rockwell 65c and are precision ground and lapped to a surface finish which is finer than 1 micro inch CLA (Centre Line Average). This smooth, flat surface allows the blocks to be 'wrung' together, as we shall see.

Most blocks are now made with a cross section of 30mm x 9mm, and have rounded and blended corners and edges (although some of the longer blocks have chamfered corners), thus eliminating any sharpness which could scratch mating blocks or work with which they come into contact. Imperial slip gauges are manufactured in accordance



with BS 880 (1950) and metric gauges are to BS 4311 (1968). Three different grades of accuracy (and so cost) are normally available—workshop grade—inspection grade and calibration grade—in ascending quality of precision. The calibration gauges are, however, usually restricted to the task of calibrating precision instruments and are not normally to be found in jobbing workshops.

Imperial sets are to be found containing between 27 and 81 pieces, and metric sets containing between 9 and 103 pieces, although some sets may have more or less. By far the most common sets to be found through secondhand sources are the 81

piece Imperial sets in workshop grade, and made from alloy steel. As a guide to the accuracy of slip gauges, a table of tolerances is provided for Imperial gauges of workshop and inspection grades (Table 1), and as can be seen, they are manufactured to a very high standard of accuracy. Calibration grade gauges are even more precise, but are beyond the scope of normal workshop practices. As a matter of interest, when using calibration gauges to measure other grades of gauges being manufactured—a process known as 'traceability'—makers are capable of comparing the lengths of two 4in. blocks to within three ten millionths of an inch (3 x 10⁻⁷ in.), using an interferometer; an

TOLERANCES FOR IMPERIAL SLIP GAUGES (conforming to BS 880, 1950)

Units in 1 millionth of an inch

Size Over	Up to and Including	Workshop Grade			Inspection Grade		
		Flatness	Parallelism	Length of gauge	Flatness	Parallelism	Length of gauge
-	1in.	10	10	+10 - 5	5	5	+7 - 3
1in.	2in.	10	10	+20 -10	5	5	+10 - 5
2in.	3in.	10	15	+30 -15	7	7	+15 - 8
3in.	4in.	10	15	+40 -20	7	7	+20 -10

instrument which accurately measures wave lengths, and hence distances, by using interference patterns. What all this means is that the gauges in your set may be relied upon to give accurate comparisons and measurements.

The use of blocks

Let us take a set of 81 Imperial slip gauges as an example. The shortest length contained within the set will be found to be 0.05in., and the longest length is 4in. After the 0.05in., the next gauge is 0.1in. and the next nine pieces increase by 0.001in., that is to say from 0.1001in. to 0.1009in. The following 49 pieces increase by 0.001in. increments, (0.101in. to 0.149in.), and the next 18 sizes increase in $\frac{1}{20}$ in. stages up to 1in. Two, 3 and 4in. blocks complete the set.

Although individual blocks may be useful in order to gauge dimensions of that particular size, (e.g. 0.1005in.), the gauging range (where blocks are actually built up), does not commence until 0.1501in. (0.05in. and 0.1001in. stacked together), and even then can only be increased by 0.001in. steps between the sizes 0.151in. to 0.200in. The ascent of sizes by 0.001in. increments commences at 0.200in. and continues up to a practical size of 10in. (the total length of the complete inch size blocks). Sizes in excess of 10in. may be built up if required, but large numbers of blocks become involved, and are sometimes difficult to handle.

As a matter of fact, the maximum size that can be compiled from our 81 piece set is 26.5292in., and the number of different combinations between 0.200in. and 10in is 98,002.

When it is necessary to build up a series of blocks to make a specified dimension, all that is required is to note this dimension and to deduct from that the length of the individual blocks as they are removed from the set. Starting with the smallest blocks (0.001 sizes if called for), the dimension is systematically built up. If we are looking for a gauge of say 2.1464in., we start by selecting a block of 0.1004in. (which will take care of the 0.004in. at the end), then choose the remainder of the blocks accordingly.

e.g.	0.1004
	+0.146
	+0.9
	+1.0
	2.1464

Working this way it is a simple matter to build up any given dimension which the set will permit.

In order to get the blocks to be in close contact, they are caused to adhere together by a process which is known as 'wringing'. If they are properly wrung, the complete series should be as one, and a force which is considerably more than that which is due to atmospheric pressure is needed to separate them. The correct method of wringing the pieces together is illustrated in Fig. 2, and the surfaces of the blocks should be cleaned before attempting any wringing.

Sometimes, slip gauges need to be

used to construct a gauge for measuring outside dimensions, and if this is the case, the use of a 'block frame' may be helpful. All this apparatus consists of is a form of clamp which holds the blocks together, the two end gauges projecting proud of the others (Fig. 3). This method is used extensively for setting dial indicator type bore gauges when ring gauges are not available.

When a series of blocks has been built up to form a gauge which is to be used to check machined slots or similar features, there is the possibility, after prolonged use, that wear will affect the surface of the blocks. For this reason, a pair of 'protection slips' can be obtained. These blocks are supplied with a length of 0.1in., and should be used at each end of a series of blocks whenever possible. At suitable intervals the protection blocks are discarded and replaced with new ones. It is standard practice to use the same face each time for wringing, thus leaving the opposite face perfect as a reference face. Protection blocks will most probably be of no great concern to the amateur, but it is useful to know what purpose they serve if a set is acquired which contains two extra 0.1in. pieces. On much more infrequent occasions, 0.05in. protection blocks are encountered, as are 2mm and 1mm examples in a metric set.

Sometimes, the figure '20deg. C' or '68deg. F' can be found inside the slip gauge case. This indicates the correct ambient temperature at which the gauges should be used to attain optimum accuracy. Again, this stipulation should not concern the amateur a great deal.

Metric Slip Gauges

When using metric slip gauges, the sets are normally designated 'Grade 2', 'Grade 1' or 'Grade 0' instead of 'workshop', 'inspection' or 'calibration' grades. The use of metric blocks is essentially the same as that of Imperial blocks, but the increments between the different pieces is much finer. For example, whereas an Imperial set contains 9 blocks covering 0.1001in. to 0.1009in. in 0.001in. stages, the metric set will include 9 blocks, 1.001mm to 1.009mm in 0.001mm steps. (0.001mm = 0.0004in.). Where the Imperial set has 49 blocks ranging from 0.101in. to 0.149in. in 0.001in. steps, the metric set has 49 blocks from 1.01mm to 1.49mm in 0.01mm stages, which equals 0.0004in. Again, where the Imperial set has 19 blocks from 0.05in. to 0.95in. in $\frac{1}{20}$ in. stages, the metric set has 19 blocks from 0.5mm to 9.5mm in stages of $\frac{1}{2}$ mm. The remaining blocks consist of 10mm to 100mm in 10mm stages. Many metric sets are sold without the 9 pieces in 0.001mm increments, as

these can be obtained separately as a completely different set.

COMPARATORS

Instead of direct measurement using conventional instruments, a very exact method of evaluating dimensions is by comparison. If a feature of the component which is being made is compared with an object of a known dimension, it will disclose if the component is over or under size. This method of measurement can be achieved by the use of a comparator. A comparator for scrutinising external dimensions consists essentially of three parts—a flat datum upon which the reference object or work is placed, a radiused contact point and, connected to this contact, an accurate scale with an indicator giving readings about a zero mark. The scale is free to move independently of the indicator needle, thus permitting the zero point to be adjusted.

Slip blocks are a positive way of obtaining an accurate reference, but other objects can be used; rollers for example. When the exact size of the reference item has been ascertained, (which, of course, should be the same as that required on the work being gauged), it is placed on the flat datum and is carefully passed under the radiused contact point, the radius making for a progressive approach to the object being traversed beneath it. As the object journeys under the contact point, the indicator on the scale will move in a positive direction. When it has moved to its maximum position, the adjustable scale is set at zero, and the reference item slid

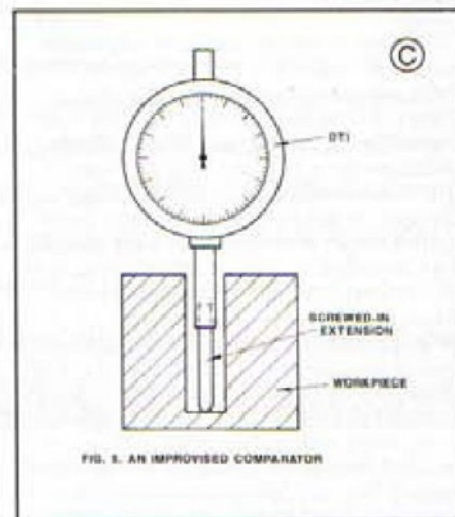


FIG. 5. AN IMPROVED COMPARATOR

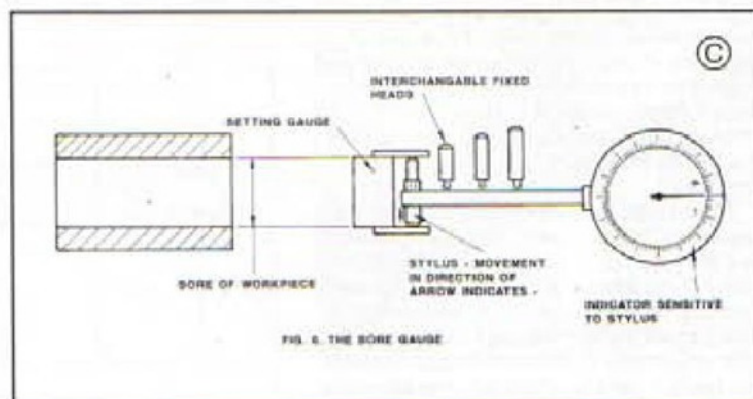
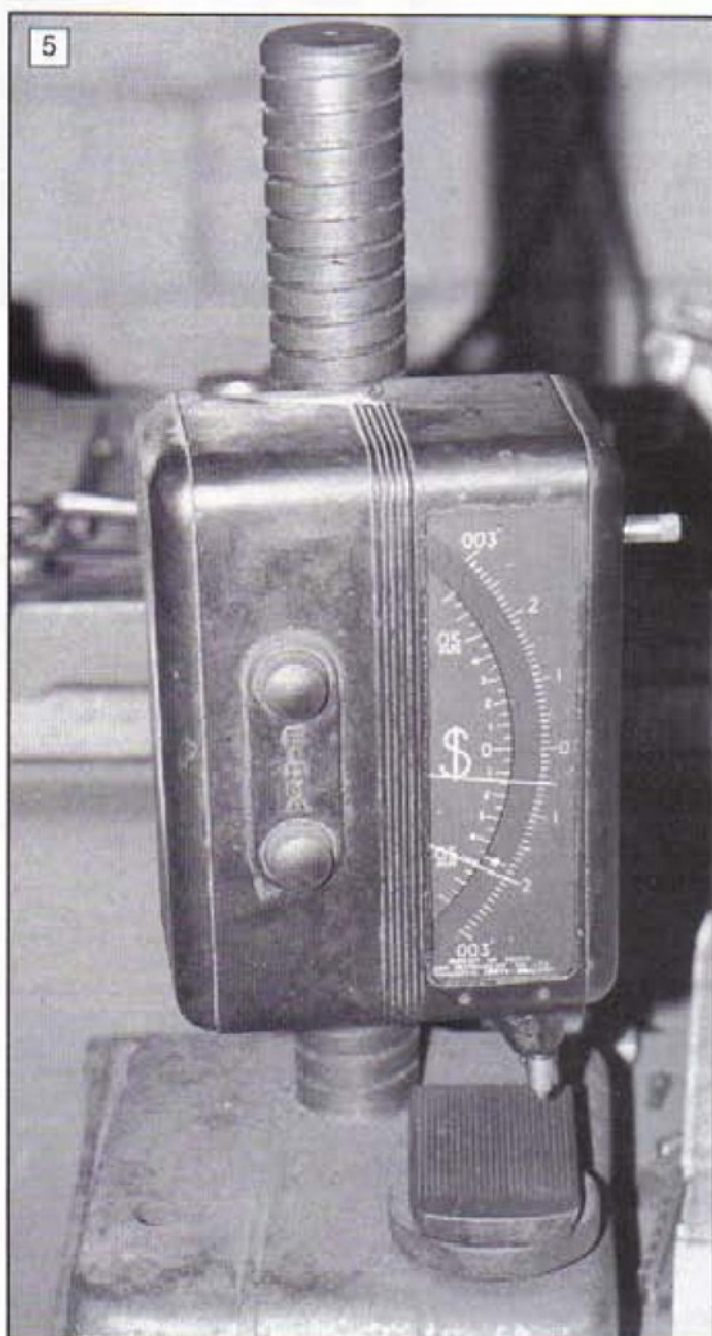
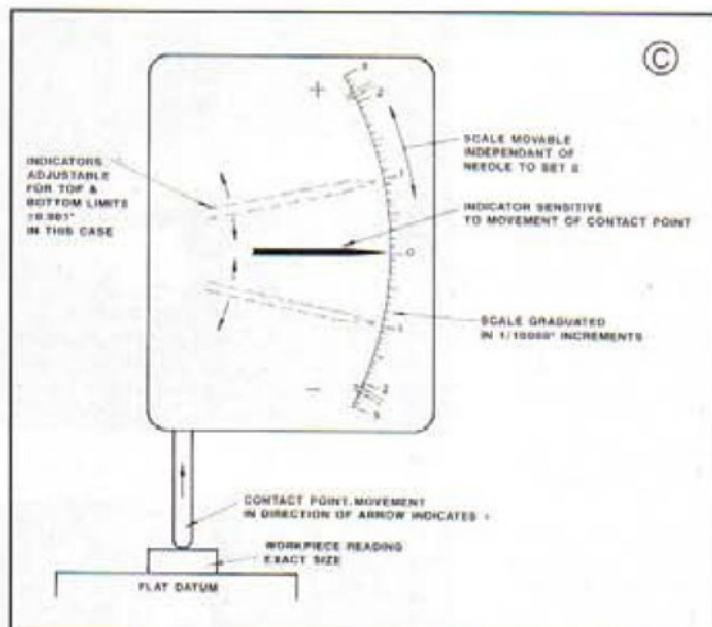


FIG. 6. THE BORE GAUGE



5: A comparator reading in tenths of a thou.

under the contact point several times to confirm the correctness of the zero position. From now on, any component which is passed under the contact point can be precisely evaluated from the indicated reading. If the reading is + 0.001in., the component is 0.001in. larger than the gauging standard. If it reads - 0.001in. the component is 0.001in. smaller, and so on.

The use of this technique also takes tolerances into consideration, and the scale provides the dimensional range within which the component must come (within say, ± 0.001 in.). Comparators only allow for a small deviation each side of the zero, typically 0.005in. These instruments, therefore are clearly for precision work only. Most also incorporate two additional reference needles which can be adjusted to top and bottom limits, thus the acceptability of the component can be seen at a glance.

On some comparators, the dial head moves up and down on a column, to bring the contact point and the centre of the scale as close as possible to the work. On other models, the flat datum is able to be raised or lowered relative to the contact point.

For commercial use, comparators with numerical scales such as that shown in **Photo 6** are largely out of date. The modern comparator (along with measuring instruments, clocks and watches etc.) has a digital read out and is operated electronically. What this means to the amateur is that



6: A simple comparator, constructed from a dial test indicator and a surface plate

obsolete instruments can often be obtained at quite reasonable prices from surplus suppliers.

Improvised Comparators

An improvised comparator can be set up using a standard dial test indicator with a surface plate (**Photo 7**) and is used in a similar manner to the unit described above. The range of the scale is obviously much greater.

Accessories are obtainable for the dial test indicator, such as different contact points and spindle extensions for checking slots (**Fig. 5**), and these accessories can be screwed on to the tip of the spindle, increasing its versatility as a comparator. Some dial test indicators have two free moving reference needles (like comparators).

A very useful item which is becoming popular with amateur engineers is a granite based column onto which a dial test indicator can be mounted. The base measures typically around 6in. x 6in. x 2in. thick, flat to an accuracy of 0.0001in. and weighing in excess of 10 pounds, thus providing a stable and accurate platform on which to carry out the comparison.

Comparing internal dimensions

The comparators so far described

are unable to deal with internal dimensions such as bores. These features demand a different type of instrument called a bore gauge (Fig. 6). This type does not measure internal sizes directly, but again compares them with a master gauge which can be a ring gauge or one built up by using slip gauges and a block frame (Fig. 3). The bore gauge is supplied with a variety of interchangeable heads, which are of different lengths, and cover the range of the instrument, say $\frac{1}{2}$ in. up to 2 in. It is set-up with the master gauge and the rotating dial zeroed. After a couple of test readings, it is ready for use on the component under test. It is read in exactly the same way as the dial test indicator, and is, as a rule, graduated in 0.0001 in. or 0.002 mm.

THE WYKES GAUGE

"Almost indispensable to the intelligent mechanic". So stated Buck & Hickman Ltd. of this useful small tool in their early 20th. century catalogue. It has the appearance of a screw cutting gauge, but is in fact also invaluable for performing other tasks in connection with the manufacture of engineering components. The Wykes Gauge appears from time to time in various magazines, when a reader sends in a photograph of his own example and throws it open to other interested parties to explain to him exactly what it is.

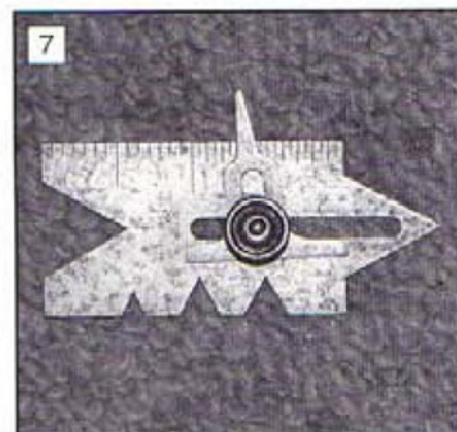
The Wykes Gauge was patented in the USA on September 11th. 1883 by one J. Wyke as 'Wyke's improved universal gauge' and was manufactured by J. Wyke & Co. of E. Boston, Massachusetts. I say 'the Wykes gauge', but in fact, two models were produced, which were of different sizes and had slight variations to the design. The smaller of the two, the No.1 gauge measured $2\frac{3}{4}$ in. long by $1\frac{3}{16}$ in. wide, and was made 0.041 in. (19 gauge) thick. It was provided with various 'V' notches for gauging screw cutting work, and could be obtained in either 60deg. (for American threads) or 55deg. (for English standard threads). Each version, though had a notch for the alternative thread angle—English standard gauges having a 60deg. notch and vice-versa. A large male 'V' gauge was cut at one end, to the angle of whichever standard was chosen. One edge of the tool was equipped with a 2 in. long ruler scale graduated in $\frac{1}{14}$ in. and $\frac{1}{20}$ in. increments, and on the reverse side, in $\frac{1}{24}$ in. and $\frac{1}{32}$ in. increments.

That which made this particular gauge different to a simple screw cutting gauge was the fact that it had an adjustable attachment fitted to it, called an auxiliary gauge. This auxiliary gauge could be used as a small protractor, or even as a depth gauge, which made the Wykes gauge a very versatile accessory to the tool kit. A small thumb screw was used to secure the auxiliary gauge to the parent gauge, and a $1\frac{3}{8}$ in. long slot was

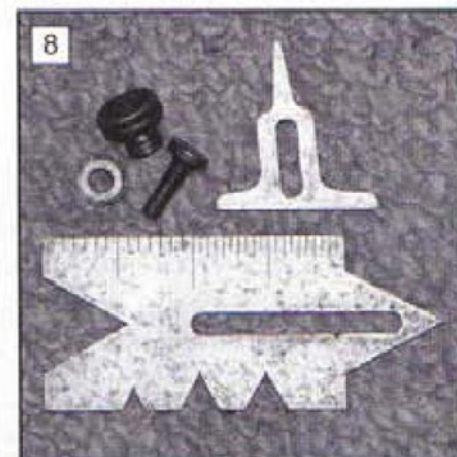
provided for the auxiliary to slide within.

The No.2 model was made 4 in. long, $1\frac{1}{2}$ in. wide, and $\frac{1}{16}$ in. (16 gauge) thick. It had a ruler scale which was similar to the No.1 gauge, except that it was 3 in. long. Two versions were also available, and the English standard pattern included thread gauges for 50deg., which covered the Holtzapffel standard thread and which was used widely by Whitworth for the spindle nose threads of some of his lathes. The auxiliary gauge slid in a slot which measured 2 in. long, and the auxiliary itself had a ruler scale along one edge (unlike the No.1) which extended to $1\frac{1}{4}$ in. of measurement. Both the No.1 and the No.2 models had slotted auxiliary gauges which allowed movement at 90deg. to the main slot.

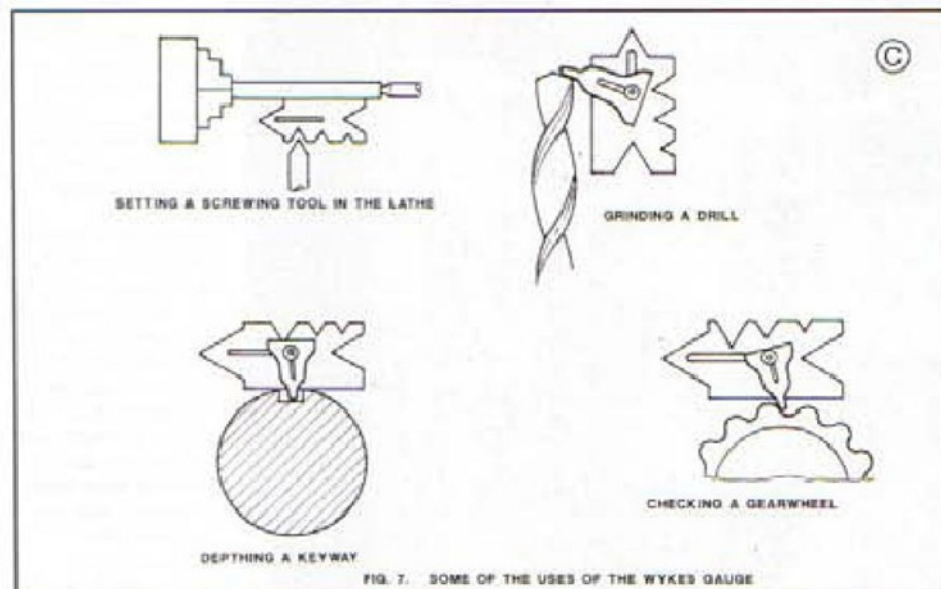
Apart from the turner, who was setting up for screw cutting in the lathe, and could use one of these gauges for aiding the grinding of his tools, as well as for setting the tool in the tool post, they could be used for gear cutting work, in the checking of angles and tooth depths. Toolmakers would also find them handy for work on their templates and jigs. Around the turn of the 20th. century, a No.1 Wykes gauge cost 4s 2d. (21p) from Buck & Hickman and a No. 2 gauge cost 7s 4d. (37p), which would have been quite expensive for that day. Today, a lookout should be kept for one of these gauges, which may turn up on a secondhand stall, and could perhaps begin a new life in an amateur's Workshop.



7: A Wykes Gauge



8: The gauge dismantled to show the auxiliary



QUICK TIP

Preparing iron castings for machining

Let the castings rust out in the open for as long as possible. To encourage the rusting process, wet the casting with spirits of salts beforehand or heat it and plunge it

into water. The sandy surface comes off with the rust, as does some of the hard skin. Finally brush with a wire brush.

Some of the internal stresses are relieved during this rusting process, but to achieve better stress relief, partially machine the casting, then lay it aside for some weeks before attempting final machining.

Pat Twist

SCRIBE A LINE

More on lathe alignment

From John Peters, Sowerby Bridge, West Yorkshire.

I thought Issue 32 on inspecting and overhauling machine tools was very informative. Bill Morris's advice on lathe inspection was really practical, but I'd like to offer comments on a couple of points.

Bill states that a reduction of tool height (below the lathe centre line) of 0.01in. when cutting a 1in. bar results in a change of diameter of only 0.00005in. This should say that a reduction of tool height of 0.01in. when cutting a 1in. radius bar results in a change of radius of 0.00005in. On a 1in. diameter bar, the change of diameter would be 0.0002in. The same reduction in tool height has a bigger effect on a small bar than on a large one. For example, with a $\frac{3}{16}$ in. bar instead of a 1in. diameter bar, the change of diameter would be just over 0.001 inch. For comparison, the effect of twist in the lathe bed, on a lathe of $3\frac{1}{2}$ in. centre height, is that 1min. of twist, or 'wind', results in 2 thou. change in the diameter of what is being turned. (An angle of 1in. is about 3 thou. in 10in.)

In practice, setting the tool height too low often does not matter at all. Suppose you want the finished diameter to be 1in. Assuming that the lathe is correctly set up to turn parallel, if you check the diameter of the work with a micrometer as you go, and feed in the tool the last few thou using the cross slide, then the error will be undetectable. The tool tip may be a little low, and a little nearer to the lathe axis in the horizontal plane than 0.5 in., but that isn't what counts. Of course, if you then used the dials to feed the cross slide another 0.25in. in order to turn a section to 0.5 in diameter, it might matter. If the tool was 30 thou too low, the error would become nearly 2 thou oversize in this case.

If the lathe does not turn perfectly parallel, the situation is not really different. The additional errors due to incorrect tool height are still small compared with the errors caused by the lack of alignment. It is often said that tool height is very important when turning tapers by offsetting the tailstock. In this case, the (deliberate) lack of parallelism is quite large—on a workpiece 6in. long, the offset would be about 0.15in. for a No. 2 Morse taper. Yet if the offset is correct and the tool is set so that it turns the 0.700in. diameter in the correct place, the maximum error will be well within the British Standard of 0.0002in. throughout the length of the taper, even if the tool is as much as 0.015 in. too low.

The other misprint is where Bill says the head centre is allowed to be 0.02mm (0.0008in.) high - that is, above the tailstock centre. Quite apart from the minor misprint that 0.02mm is 0.0008in., not 0.00008in., new lathes will have the head centre below the tailstock centre. This is probably because the head centre will not

change in height during the life of the lathe as long as the bearings are kept adjusted, but wear on the lathe ways will gradually lower the tailstock.

PCB Design

From Harold Hall, Berkhamstead, Herts

Having been responsible for a small electro/mechanical design department for over 20 years, I experienced PCBs being designed, initially for just a few components on a single sided board, eventually double sided, then multi layer boards with hundreds of components fitted.

During this time, my knowledge of printed circuit board manufacture was established as a result of visits to the sub contract manufacturers of PCBs for our company. Even with this understanding, making my own PCBs at home was a non starter, due to a lack of the finer detail, the equipment and materials required, where to purchase these etc. The article by Ray Stuart (Issue 34, page 36), admirably filled these knowledge gaps for me, and I am sure has done so for many others. The article is to be commended to any reader who wishes to make PCBs, or, as Ray indicates, the process is well suited to making such items as plaques and nameplates.

I would, take issue with Ray on his comments on the current carrying capacity of varying size tracks, even though he does not quantify this. Most readers will be quite surprised at the capacity of a PCB track, typically a 5mm track having a thickness of 35mm (0.0014in., frequently known as 1 ounce), giving a cross section of 0.175mm², will carry a current of 10 amps. This compares with a cable having a cross section of 1mm being required for a similar rating.

The reason for the difference is complex, but mainly twofold. Firstly the absence of electrical insulation which also provides thermal insulation, and secondly, the rectangular form of the PCB track gives it a much larger surface area. The PCB track would have a periphery of 10.07mm, whilst a round conductor having an identical cross sectional area would have a circumference of only 1.48mm. The PCB track therefore has a much larger surface area to dissipate the heat generated, the main feature which determines current carrying capacity.

If we look at Fig. 2 in the article, we see that it is suggested that to double the thickness, doubles the current carrying capacity. In fact, it has a much lesser effect. For our 5mm PCB track, the periphery would increase only from 10.07mm to 10.14mm, thereby contributing little extra to the heat dissipation properties. However, twice the width would have a substantial effect, though not quite double, as the figures quoted for current carrying assume that there is a space of at least the

width of track between it and its neighbouring track. This blank board helps to dissipate heat being generated in the adjacent track. The following figures give guidance on the ratings of PCB tracks, and are based on a temperature rise of 30 deg. C

Current carrying, amps

Width	0.25mm	0.5mm	1mm	2mm	3mm
35mm thick track (1 oz)	1.3	2.4	4.2	6.8	8.5
70mm thick track (2 oz)	1.8	3.2	5.5	8.7	10.5

The above ratings assume that, if more than one high current track is present, that they are at least spaced by an amount equal to the track width, and that they are not connected to, or are close by, heat generating devices such as high power resistors.

For those wanting a little more technical detail, note that if a length of track is doubled in thickness, this is like putting two identical resistors in parallel. The effect is to halve the resistance value for that length of track. Now if the current is doubled, and noting that power dissipated in a resistor is watts = $I^2 \times R$ then, with twice the current, and half the resistance, twice the watts are dissipated.

As Ray indicates, PCBs are not solely for electronic circuits. Typically, a relay contact may be used in a control circuit with many other relays. A point to take note of, in this respect, is that a short circuit can easily fuse a track because of its very small cross section. The size of fuse that will protect a given size track is a complex situation, as it depends on the type of fuse and also the capacity of the power source. As a very safe rule of thumb, the rating of a portion of track should be no less than the rating of the fuse protecting it. In a multiple circuit this will necessitate the PCB track being sized to suit the fuse protecting it and not the current passing through it.

Ray Stuart replies

Someone once told me two reasons for a man to give up living: when one thought there was nothing more to learn, and when he stopped looking at women. Ignoring the latter sexist comment, I was therefore pleased to read Harold's comments regarding my article on making PCBs, which confirmed that there was still hope for me, as there are indeed many things for me to learn!

Most of my experience with PCB design related to low current circuits, where the current can be measured in milli or micro amps, and where track widths were measured in tens of thousandths of an inch. Where higher currents (in the order of a few amps) were concerned, a look-up table was used to define the track width. At some time I had been taught that double the thickness of track doubled the current capacity, but as only one ounce PCBs were used, I never thought to question it. However, thanks to Harold's informative letter, I now know better. I feel Harold's letter will be of interest to your

readers, to whom I apologise for misleading them, albeit unwittingly.

Following a conversation with one of your readers, Mr Voysey, who is building an X-Y table based on my article published in issue 27 of MEW, an error in the component list has come to light - Resistor pack RPI (8x1k) is shown as Farnell part number 219-150, it should be 148-981. My apologies for this error.

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More on the Martek drill sharpener

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

Reference Alan Bourne's article, in Issue No 35, on the Martek drill sharpener. I bought one of these some years ago and devised a similar set-up to Alan's for driving it. In use, I experienced constant trouble in preventing the drill being retracted by the tightened nylon collet when setting the depth of cut and cutting edge orientation. Subsequent heavy pressure on the drill would return it to the correct extension, but the nylon engaged in the drill flutes and rotated the drill point out of the correct orientation. I put the troublesome device out of sight and mind for a couple of years until I made the very successful four-facet drill sharpening jig (and an equally successful big brother) covered in Model Engineer for Jan 94.

These successes encouraged me to resurrect the Martek item and write to the firm asking for assistance. They replied quickly, pointing out that modifications had obviated many of the early problems and offering to update my example. I sent it off and they returned it, promptly, 'updated'. The collets were very slightly longer, but in the same material, and the cut adjustment grub screw had been omitted. The cut was therefore about $\frac{1}{16}$ in. — an appreciable loss of material at each sharpening. Three letters to the firm produced no reply. A lengthy telephone call elicited the information that Martek had gone into liquidation and, subsequently had been bought by PMS (Precision Machine Supplies) who want no truck with events prior to Feb 96.

So to the point of my letter, has Alan Bourne, or any other reader, found a solution to the problem of soft nylon collets or successfully operated a Martek sharpener without the cut adjusting grub screw?

Oil in small quantities

In our last issue, Mr Jerrard of Exeter appealed for help in finding a source of small quantities of machine lubricating oils. As always, readers have been quick to respond and it has been suggested that we should give the information wider circulation, as follows:-

From R.H. Craig of Budleigh Salterton:-

Single Grade (SAE 20) machine oil in 5 litre containers from Devon Chemical Co.,

10 Canal Road, Kingsteignton, Devon
Tel. 01626 65027

Both A.M.P. Thompson of Glasgow and J.E. Kirby of London point out that one of our regular advertisers, Chronos of St. Albans are advertising a variety of lubricating and cutting oils in both 1 litre and 5 litre packs. Mr. Kirby also suggests that some of the motor gearbox and final drive oils sold by car accessory shops may prove suitable.

Mr. Boyle of Dorchester has found a source of cutting oil at Wessex Chemical Factors, Unit 10, Woolsbridge Industrial Park, Three Legged Cross, Dorset Tel. 01202 823699 (Contact Mike)

Help on an Atlas milling machine

From H. Lord, Camberley, Surrey

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From Ted Wale, Nova Scotia, Canada

With reference to the query by H. Lord of Camberley on page 72 of Issue 34, the Atlas Machine Tool Co now trades under:-

Clausing Industrial Inc., 811 Eisenhower Dr. So., (that is Americanese for 'Drive South') P.O. Box 877, Goshen, In. 46527-0877 (that is Americanese for Indiana State) U.S.A. Tel. 219 533 0371. Fax. 219 533 0403

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I deal with them (her) often over my Atlas requirements and find them very helpful, but not too quick. Be patient, the answer will come in the fullness of time.

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(Editor's note:- Since receiving Mr. Lord's letter, yet another copy of the manual has arrived, this time from Mr. E.

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Talking of which, the old machine is up and running again and producing very acceptable results. Not bad for 'Another pile of old junk' (My wife's first impression). Of course, one thing leads to another. If you have a lathe, you need tools, plus a grinder to keep them sharp, and why not a bench drill? etc., etc.

Finally, on a different point, I have been reading the recent correspondence on the subject of metrication. If my recent experience of refurbishing so called 'obsolete' machinery is anything to go by, if people up and down the country are going to be throwing out their old Imperial equipment, they can throw it at me. Just because something is old doesn't mean it won't work. In fact, the older something is, the better it's likely to be. It takes quality to last.

Comments re Issue 35

From Bob Stark, Denbigh, Clwyd

Use of wood

Although over 40 years ago, the use of wood in the Mosquito surely is a good example of the suitable material. They were real engineering!

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Some time ago, I made a similar device which I think has some advantages over that published. This started life as a rough lump of cast iron, from, I think, a storage heater. It was first cut approximately to size with a large bandsaw, and then machined using the four jaw to make all faces parallel and square. This gave a piece approximately $2\frac{1}{2} \times 1\frac{7}{8} \times 3$ inches. Two holes were drilled and counterbored from the $2\frac{1}{2}$ in. face, as in the article. Next, a recess about $\frac{1}{8}$ in. deep was made on the $1\frac{7}{8}$ in. face, using a large end mill (held in the chuck!). Then the only tricky bit; another recess on the opposite face was made, taking great care to make the resulting face parallel to the first.

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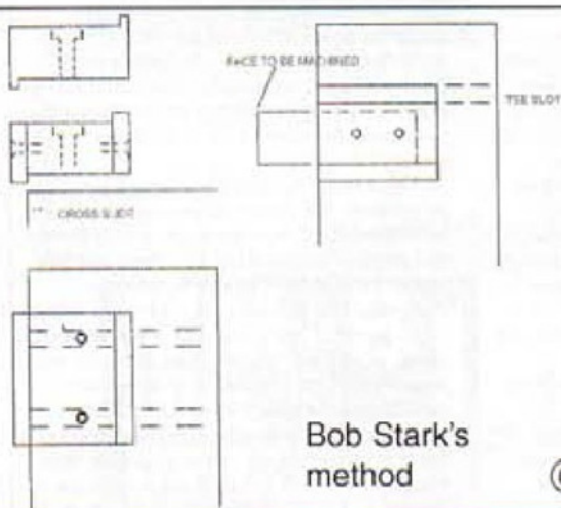
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Bob Stark's method

BMS, and simply bolting strips of $\frac{3}{8}$ in. BMS on opposite sides. This has the added advantage that the strip will fit in a T slot, and work can then be clamped in line with the lathe axis. (See drawing).

In use, this device is simply pressed against the edge of the cross slide (no need to check squareness against the chuck), and either bolted using appropriate length bolts and T nuts or clamped with the work held against the rear 'lip'.

Metrication - An Australian experience

From Stewart Gavin, North Rockhampton, Queensland

I have particularly noted the recent concerns from some U.K. readers with regard to the impact of the Metric System on their hobbies, finances etc.. I remember seeing many similar letters in Australian newspapers prior to us going Metric in 1976.

Here in Australia, twenty years 'down the track', some of the realities are:-

A basic understanding of both Imperial & Metric measures is essential in specific areas of Australian society.

Companies involved in the exporting of manufactured goods to Imperial-based countries may retain the Imperial measurement system and product line. This includes a portion of production from our steel mills.

Businesses that repair or otherwise work with goods from Imperial-based countries have often needed to retain Imperial tooling.

Metrication has caused retailers to have to carry additional stock in many tooling lines, and this situation is not likely to disappear for decades. All commonly used Imperial machine tooling such as twist drills, milling cutters, threading tools, and measuring instruments are just as readily available and in-demand today, alongside similar Metric equivalents, as they ever were.

Secondhand Imperial graduated machine tools, such as lathes, still command full market value, at least where hobbyists are concerned.

Personally, having spent the first half of my life using Imperial measurement, and thereafter using Metric exclusively in my job (Civil Engineering Draftsman) has left

me in the position that I can favour neither system outright. All my woodworking activities comprise new work, mainly furniture, and I use Metric measurements exclusively here. However in metalworking, the situation is different because I frequently work on components originally manufactured to Imperial specifications.

Some people may consider that Imperial measurements are to become completely obsolete in the very near future. This has no basis in fact. I, like many sectors of industry, will personally continue to utilise Imperial size tooling in my workshop for the following

practical & realistic reasons:

1. The presence of the United States as a major manufacturing power continuing to embrace the Imperial system generally.

2. The existence of both new & secondhand components produced to Imperial specifications.

3. The continued dominance of Imperial size/form threads, many of which have no Metric **standard** equivalent.

4. The distinct lack of availability &/or variety of metric equivalents in the more specialised tooling lines. These two factors have, on many occasions, influenced me to opt for Imperial and should be very thoroughly researched by any person considering major tool acquisitions. The quickest way to achieve this is to inspect current catalogues from the major tooling manufacturers in your country. You may find many commonly demanded items such as stub drills, three-flute end mills and specialised reamers to be completely unavailable in Metric sizes. Neither of the two major tooling manufacturers here in Australia produce Metric twist drills in 'stub' length as far as I am aware.

5. Cost difference of equivalent Imperial/Metric tools, fasteners etc.. This point requires constant checking by the purchaser. By way of example, I was involved in a private project recently. This project contained a large number of common metal thread fasteners and threaded rod. Either Imperial or Metric threads were to be used throughout for consistency. All fasteners were available 'off-the-shelf' and priced from one supplier. The total project cost amounted to just over £2000 (including labour), with Imperial fasteners totalling nearly £300. The use of Metric fasteners promised to add in excess of £100 this project. I was absolutely shocked by the comparison and needless to say, Imperial won the day. This example may have a reverse case in countries where Metric is traditional, my only advice is **beware**.

For those who are only just beginning to establish a workshop, it may be very nice to have it all Metric but I'm sure it will soon be found lacking in versatility, particularly when threads and special tooling become considerations. For those who already have an advanced Imperial-based workshop, I'm sure most have already accumulated some Metric tools, such as thread taps. For those who haven't, I would suggest only buying those items that you think you really can't

live without. Don't be tempted to sell off perfectly good Imperial tools for less than what they are really worth.

Dual measurement tapes, rulers and verniers are a great help for those who wish/need to work in both systems. A comprehensive, large, easy-to-read Metric Conversion wall chart, such as those distributed to industrial workshops by twist drill manufacturers, proves itself to be very practical. Metric spanners/sockets and a set of Allen keys are about the only other real necessities in metricating the workshop. Measurement instruments such as micrometers should only be purchased when you find you really need them.

With respect to the modification of Imperial graduated machines, I would seriously suggest that the owner change the feed screws/nuts to a metric thread (i.e. the compound rest & cross slide screws/nuts on a lathe and the table feed screws/nuts on a drill-mill) and just renumbering the dials **if required**. This will enhance machining operations where multiple rotations of the dials are required, while maintaining a rounded figure of measurement in metric. This is especially the case on milling tables. Metric thread pitches of 1.0mm, 2.0mm, 2.5mm, & 5.0mm are common choices depending on the size of the machine. Graduation dials, in most instances, may only require the removal and substitution of new numbers, as both measurement systems are decimal based.

Centre Drill Angles

From E.A. Fribbins, Long Ashton, Bristol

Reference Mr. Proctor's Letter (Scribe a Line, Issue 33), the centre drill is a combined drill and countersink which, as its name implies, is used for centring shafts for turning or grinding. The 60deg. countersink fits a standard lathe centre, the extended small drill ensuring that the point of the centre does not contact the work and allows for better lubrication.

Before centre drills, a small hole was drilled in the shaft, which was then countersunk with a drill whose point was a four sided 60deg. pyramid. For centring work in the lathe prior to drilling, nothing can better the hand graver. It's a bit of a knack, and like riding a bicycle, you will fall off a couple of times whilst practising, but once you've got it, you never forget.

News of a Danish lathe

From Erik Kammeyer-Andersen, København, Denmark

During a visit by a friend here in Copenhagen, I saw some back issues of your fine magazine, and in the December 91 / January 92 issue, No.8 page 7, a question showed up about a mystery lathe, asked by Mr. Steve Sinclair of Alnwick. Maybe he has already received an answer, but if not this may be of interest to him or to other readers.

The question was about a lathe called SR80. I know personally the manufacturer of the lathe SR80. He is now 80 years old, and sold his factory, which still make these lathes, some years ago. The former owner's name is Svend Rasmussen, and he

started building these lathes in 1946. It was, and still is, the only Danish lathe produced in this size, and is used by many small workshops, by both professionals and model engineers. I have several friends in our club 'Modeldampklubben', who use these lathes extensively, as it is possible to have a good box of accessories, including a vertical milling table, and the lathes are very reliable. Svend Rasmussen is also a long term member of our club, and builds stationary steam engines, but is at the moment finishing a portable in 1 1/2 in. scale, to drive a threshing machine which he built many years ago. The present manufacturer of the SR80 lathe is Gunnar Augustinus and his address is Stationsvej 7, DK6051 Almind, Denmark. Almind is a small town about 10 km north of the city of Kolding and about 30 km Southeast of Legoland in Billund. I know Gunnar well too, but have never seen his place. We have met several times at our club meetings, which take place at different locations all over our country, and from time to time I participate in the meetings in that part of the country. I know he will be delighted to hear from any customer from any part of the world and I know that he will provide good service.

Harness the new technologies

From Mark Figs, High Kelling, Norfolk

There must be many 'new age Luddites' among your readership, judging by the number of letters and comments in the magazine concerning new technology. I

think they must be scared of computer technology, which must have an analogy in Queen Victoria refusing to travel in excess of 40mph by train. I believe that the only time she did, she was dead, as owing to a delayed crossing from the Isle of Wight, the Southern Railway had to give it some hammer to get to London for the lying in state. Would she have been amused?

If the sales rep. from IBM had walked in to George Stephenson's works and showed him the PC and explained what it could do, -would he have shown him the door? -I doubt it. More like "Aye, we'll have six lad, set 'em up over there". Those early engineers were far sighted men, they had to be.

In refusing to accept new technology, this country's engineering base was very nearly destroyed. It will never again be what it was, but with luck something will be salvaged.

I'm sure that our esteemed editor wouldn't get half the number of contributions, let alone of the quality that we take for granted, if the home computer wasn't available. Try looking in a 70's copy of Model Engineer and compare the variety, content and layout!

Yes, of course I use a computer / word processor. You wouldn't be reading this without, I assure you, but what is it? Simply an idiot's typewriter. If my articles had to go in to hard copy, they would take for ever to produce. Stop and think. Could you write a set of technical instructions for just one component without going back and altering something?

New technology has replaced many of the filthy repetitive jobs in industry.,

Anyone who has worked a capstan or turret lathe will know what I mean. Noise, suds flying everywhere (including over you) and the chargehand / toolsetter doing his nut trying to maintain production and tolerance. No thank you, a week was enough for me!

The ostrich / Luddite attitude will stifle our hobby. We may not need (or want) a full blown CNC machining facility at home, but think of the spin off and methods that we've gained from them. We cannot forever go on trying to re-invent the wheel.

To sum up, the computer is a tool and a slave, albeit a willing and speedy one, but above all it's stupid (ask any computer teacher). It not only has to be told what to do, it also has to be told to do it. They can't think for themselves (please save us from the day they do), but they do relieve the drudgery, leaving man free to do what only he can, **be creative!**

Praise for a trade supplier

From N. Lancaster, Blackpool

I would like to say how pleased I was with the speed and efficiency with which Crawford Collets, Tower Hill, Witney, Oxon., OX8 5DS. Tel. 01993 703931. Fax. 01993 778310, dealt with a problem I had.

They make collets for Clarkson chucks and for other machines, that people have told me are impossible to obtain. They also manufacture the Dixon Quick Change Tool Post. Although they are not cheap, you get what you pay for, excellent quality

The NATIONAL MODEL TRACTION ENGINE RALLY & EXHIBITION

at the

WARWICKSHIRE EXHIBITION CENTRE

Fosse Way, Nr Leamington Spa, Warks
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on **13th & 14th JULY 1996**

See all types of model steam road vehicles - models from 1" to 6" scale and possibly some full size engines - in action in the arena outside the 9,600 sq ft exhibition hall. Inside the exhibition hall there will be a large display of models *plus* an operating 16mm scale live steam layout *plus* stands from all the leading trade suppliers.

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