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MODEL ENGINEERS' WORKSHOP

Issue No. 78

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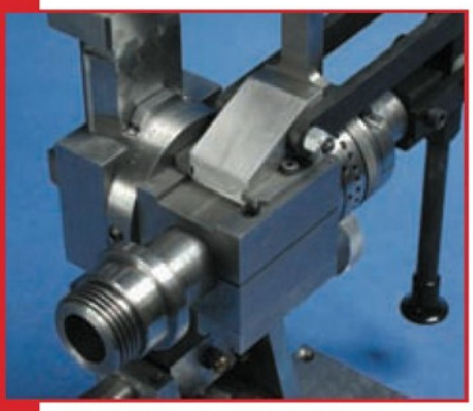
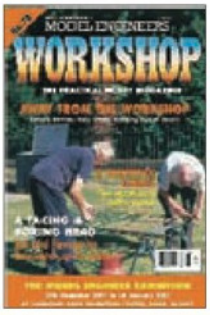


We continue our series on the Raymac cutter grinder- see page 23



Front Cover

Members of a model engineering society carry out essential maintenance work on their miniature railway installation. When working away from the home workshop, some simply made items of equipment can make the job easier, as suggested by Trevor Marlow in his article which starts on page 35.

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Inside

Peter Rawlinson describes a tailstock turret, similar to the one seen above. See page 48.

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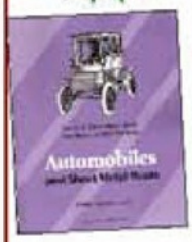

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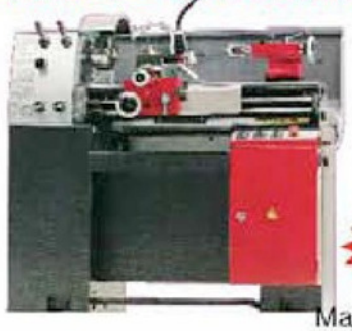

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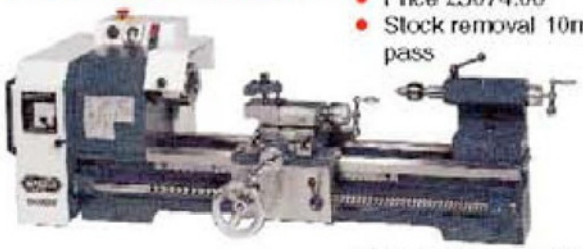

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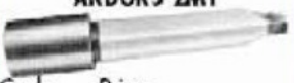

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ON THE EDITOR'S BENCH

As the contributions to our Scribe a Line column make clear, M.E.W. has a world-wide circulation. A significant proportion of our readership is in the United States of America and, although I have no positive information, it is highly likely that some of our subscribers have been affected, either directly or indirectly, by recent tragic events.

I know that I am speaking for everyone connected with the production of this magazine in expressing our heart-felt sympathy to anyone who has suffered in any way.

Having lived through WWII, I can recall the relief at the end of hostilities and the desire to "get back to normal". It seems evident that the nature of the current situation will make it difficult to identify a similar point in time, so it appears that things can never be the same again.

As far back as 1790, John Philpot Curran spoke of the price of liberty being eternal vigilance. It is no less true today.

HSE document

It is pleasing to see that the HSE book "Passenger -carrying miniature railways - Guidance on safe practice" has now been published. This is the culmination of the efforts of the Miniature Railways Liaison Group which was set up as a result of the seminars held at Wigan and Southampton some three years ago.

This Liaison Group, consisting of representatives from many branches of the hobby first produced an information sheet on safe operation and then tackled a revision of the old TN3, which dealt mainly with the design and construction aspects. The new book, HSG216 combines the results of these efforts and is very much a work produced by the hobby for the hobby.

Many, particularly the more independently minded spirits among us, have questioned the need for such publications, but as the HSE Inspectors who guided the deliberations of the Liaison Group have pointed out, without documentation we would be subject to the interpretation of the Health and Safety at Work etc. Act by local authority environmental health officers, who are likely to have little understanding of the finer points of operating a miniature railway. The ability to be able to point out conformance with a published HSE document may prove invaluable if difficulties should arise.

It has been proposed that the original guidance note should be revised to remove the railway aspects now covered by HSG216, so that the operators of miniature traction engines and road vehicles should still have something to which to refer.

HSE booklet HSG216 (ISBN 0-7176-2035-2) presents a wealth of information on miniature railways in an attractive and readable style on 22 copiously illustrated A4 pages printed in full colour on high quality paper and is available at £5.95 from booksellers or direct from HSE Books, PO Box 1999, Sudbury, Suffolk CO10 2WA, Tel. 01787 881165, Fax 01787 313, Website: www.hsebooks.co.uk

What's in a name?

In a previous editorial I asked for thoughts on the content of the ideal home workshop. One of those who has responded writes of the advisability, in some areas, of referring to the 'hobby room' rather than the 'workshop' to avoid potential interference from local councils and nosy neighbours. I have colleagues who have been careful to use the former term in planning applications, but I really do deplore the need to employ such euphemisms to disguise a perfectly legitimate activity. As long as a home workshop does not cause actual (as opposed to perceived) nuisance to neighbours and does not convene planning regulations by being used for commercial activities, then I believe that we should be able to describe our facilities as we wish. Any attempt by minor local government officials to interpret regulations to suit their own whims or prejudices should be strongly resisted.

Ron Drake steps down at Blackgates

Blackgates Engineering, well-respected supplier to the model engineering hobby, was founded by Phil Owen and Ron Drake back in 1976. Since then they have attended countless national and local model engineering exhibitions and club events, including Model Engineer Exhibitions at Wembley, Alexandra Palace and Olympia. Now, after 25 years, Ron has decided to retire from the business.

We join Phil and Jacquie Owen and their staff in wishing Ron a long and happy retirement, during which time we hope he will be able to catch up on those many projects which we are sure he would have liked to have attempted, but could never find the time. We feel sure that he will not be lost to the model engineering scene, and look forward to having those chats which were never possible when he was busy on the other side of the counter.

Au Revoir

Well, the time has come. All the rest of the content of Issue 78 is safely lodged with the design and production team, so I must write my final few words as editor. When I answered the telephone one evening back in August 1994, I really had no idea of the consequences. It didn't take me all that long to work out that I had been 'set up' by my old friend and co-conspirator Stan Bray. Thanks a bunch, Stan!

Taking on the magazine opened up a whole new vista. Although I knew the model engineering world reasonably well, having been 'inducted' at the age of fourteen and having written a few articles here and there, I really was not aware of what was involved in the publishing business. It has proved to be a most enjoyable if somewhat demanding experience which has proved possible only through the support of many people. Firstly, Ted Jolliffe, then Editor of Model Engineer, who guided me on my first steps through the maze. Next, his successor, Mike Chrisp, who has become a close colleague, with whom I consult on an almost daily basis. We bounce ideas off each other, check facts or just commiserate on the unfairness of the world! Most importantly, Mike and his wife Jean offer me hospitality whenever I need to travel in an easterly direction.

The 'Head Office' team has changed greatly over the seven years, being based first at Hemel Hempstead and now at Swanley. Editorial Publisher, Dawn Frosdick-Hopley (The Boss) has always been receptive to new ideas and suggestions, while our Editorial Administrator, Sarah White is a tower of strength. In the Design Studio, Carol Philpott has turned plain words, photos and drawings into attractive pages, never complaining when I have been late or have asked for last-minute changes. Draughtsman Grahame Chambers, now communicating electronically from his office in Paxos, Greece, has been responsible for many of the illustrations which grace the pages. Thanks to them all for their unstinting support.

An enormous vote of thanks must go to our contributors. Simply, without them there would be no magazine. Many have become personal friends who have always been ready to respond to a request for material or to spend time and effort investigating a possible subject for an article. Others are based many thousands of miles away, usually contacting by letter or e-mail, but with the occasional telephone conversation. Some authors have produced just the one item, while others keep a steady stream of contributions in the pipeline. Both are equally welcome to an editor who is trying to keep a balanced content in issue after issue. I would ask them all, and anyone else who feels that they may have a contribution to make to support our new editor.

Finally, the biggest thank-you of all must go to my wife, Gill, who has given her unfailing support from day one, putting up with many trials and tribulations, particularly on those days when things have not been running smoothly. Often to be seen at exhibitions, she has become an expert at booking-in models and has been known to be very persuasive at selling a year's subscription to someone who came looking for the odd back issue!

All best wishes to my successor, David Fenner. Please continue to give him all the support you have given me. I hope that he gains as much enjoyment from the job as I have.

LIMITS & FITS, TOLERANCES & SURFACE FINISH

Philip Amos describes the systems by which physical features of machined parts may be specified and how these may be related to home workshop machining

The design and manufacture of most equipment involves the shaping of components and fitting these together in assemblies. The skilled craftsmen who perform these tasks are the draftsman, the machinist (formerly called turner) and the fitter. In order to effect these processes rules have emerged from experience which nowadays are codified internationally to allow commercial exploitation.

This article examines what the requirements are for the home workshop and how these relate to what happens in industry.

Fits

This discussion concerns cylindrical apertures (holes) and cylindrical solid parts (shafts). The conclusions can be extended to squared gaps and pieces such as keyways and keys. However, it does not cover screw thread fits nor the more complex requirements of other shapes, which are specified with geometric tolerancing (concerned with, flatness, squareness, concentricity, straightness, positional accuracy and so on).

Essentially there are three types of fits, as shown in **Drawing 1**.

For a clearance fit, the hole diameter 'D' is larger than the shaft diameter 'd', so that the shaft can be moved through the hole axially and can rotate freely.

For the interference fit, the hole diameter is smaller than the shaft diameter, and the shaft must somehow be forced through the hole axially, and will not then rotate.

The transition fit is size on size. The parts can be pushed or wrung together, but cannot (easily) rotate after assembly - (but see later also under 'tolerances').

The 'allowance' shown on the drawing is the difference between hole and shaft diameters. It is positive for a clearance fit, negative for an interference fit, and zero for transition fits. For the same class of fit the 'allowance' increases with increase in diameter.

For practical use these three types are further broken down. One of the earliest systems of limits and fits was introduced in 1902 by the Newall Engineering Company, Walthamstow, UK. This had two classes of hole, and six classes of shaft, categorised by sizes of allowance; this could be thought of as 12 classes of combinations. See Appendix A which is derived from References 2 and 3.

Reference 1 describes eight classes of fit as listed in Appendix B, which had been tentatively recommended by the American Standards Association at that date (1916), but these do not seem to be any improvement on the Newall system.

Tubal Cain in Reference 4 (1981) tabulates 12 classes of fit, categorised by allowance - see Appendix C.

Following World War II great efforts were made to attain international standardisation of fits and the ABC countries (America, Britain and Canada) harmonised their national standards to achieve this for sizes up to 20in. or about 450mm nominal diameter. Their standards are based on ISO Recommendation 286. The US Standard is ANSI B 4.1-1967 revised 1974. The British Standard is 4500-1969. The Australian (and New Zealand) Standard 1654 is similar with only minor differences. Details of these can be found in References 5 and 6 which form a basis for Appendix D.

Systems

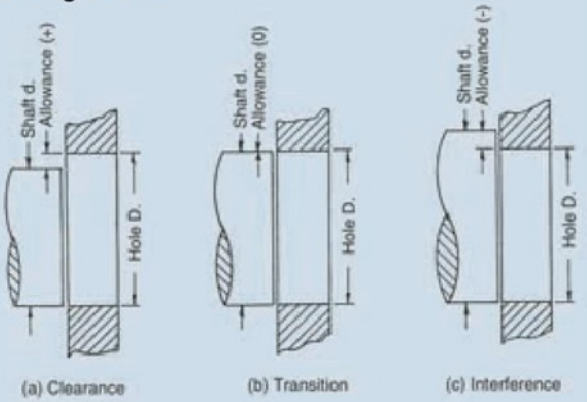
Most holes are produced by fixed tooling such as drills and reamers, so it is easier to machine the shaft to the required dimension to achieve the 'allowance' for a particular fit. Thus the more commonly based system(s) are called 'hole based' where the hole is produced to the nominal size (more or less - see later) and the shaft made to yield the 'allowance'. However, in some cases, as for example with a common shaft engaging several holes, it is more convenient to use a 'shaft based' system, where the shaft is produced to the nominal size (more or less - see later) and the holes made to yield the 'allowance'.

The national standards include both systems as alternatives. Normally the 'hole based' system is preferred.

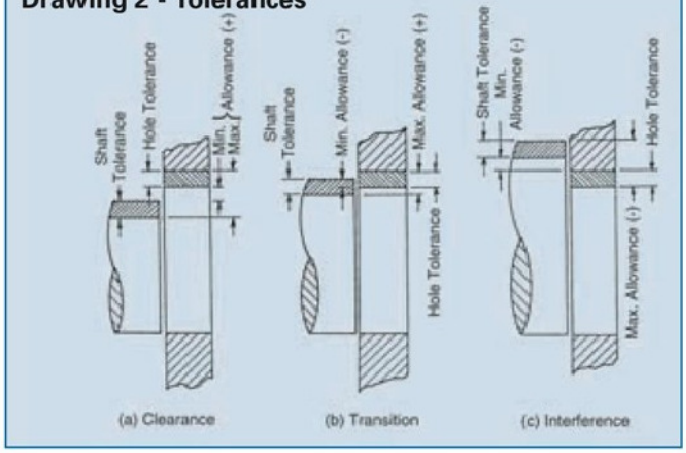
Tolerances

As in so many other areas the 'allowance' information provided by Tubal Cain in Reference 4 is the easiest to use in the home workshop for producing one-off fits. Here one can make one component, measure it, add (or subtract) the allowance, and then carefully make the mating component to suit. This happy situation is not possible for serial commercial production in industry, where machine variability and/or human skills

Drawing 1 - Fits



Drawing 2 - Tolerances



lead to a range of dimensional outcomes differing from the targeted nominal one. Thus, to produce economically it is necessary to allow some variations in a dimension which is called the 'tolerance'.

Drawing 2 shows how this 'tolerance' affects fit. It will be seen that the 'allowance' for a clearance fit now has a range (+) from:-

Smallest Hole with Largest Shaft
to
Largest Hole with Smallest Shaft.

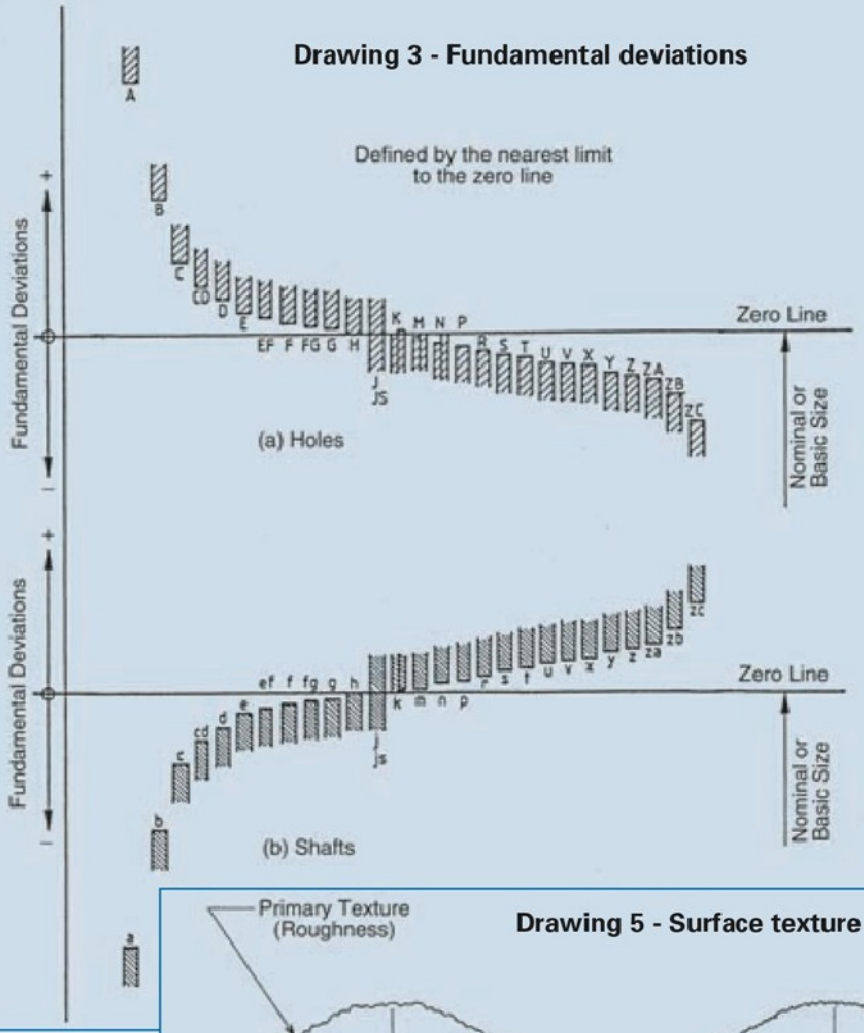
Similarly, for an interference fit, but with the 'allowance' range (-). However, for a transition fit the 'allowance' range may be (+) or (-), as seen in the drawing.

The national standards embrace two concepts:-

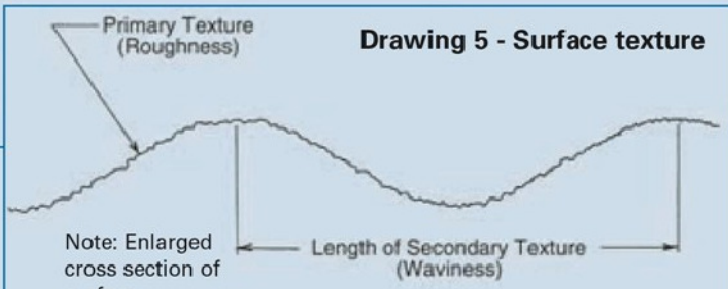
(i) 18 tolerance grades or bands. These are indicated by numbers IT01, IT0, IT1 ..... IT16 (each of which increases with increased diameter of the workpiece). e.g. for a nominal diameter of 12.5mm the tolerance grades (bands) range from 0.0005mm (IT01) to 1.1mm (IT16) ,whereas for a nominal diameter of 125mm they range from 0.0012mm (IT01) to 2.5mm (IT16).

(ii) 27 fundamental deviations, each of which also increases with increased diameter of the workpiece. Holes are indicated by capital letters and shafts by lower case letters. These define how the tolerance band is disposed relative to the nominal diameter of the workpiece. e.g. an

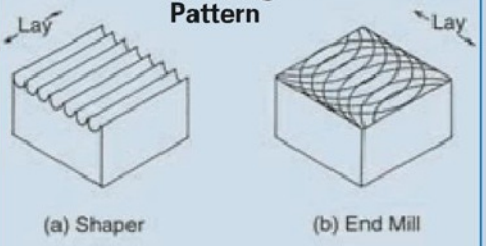
Drawing 3 - Fundamental deviations



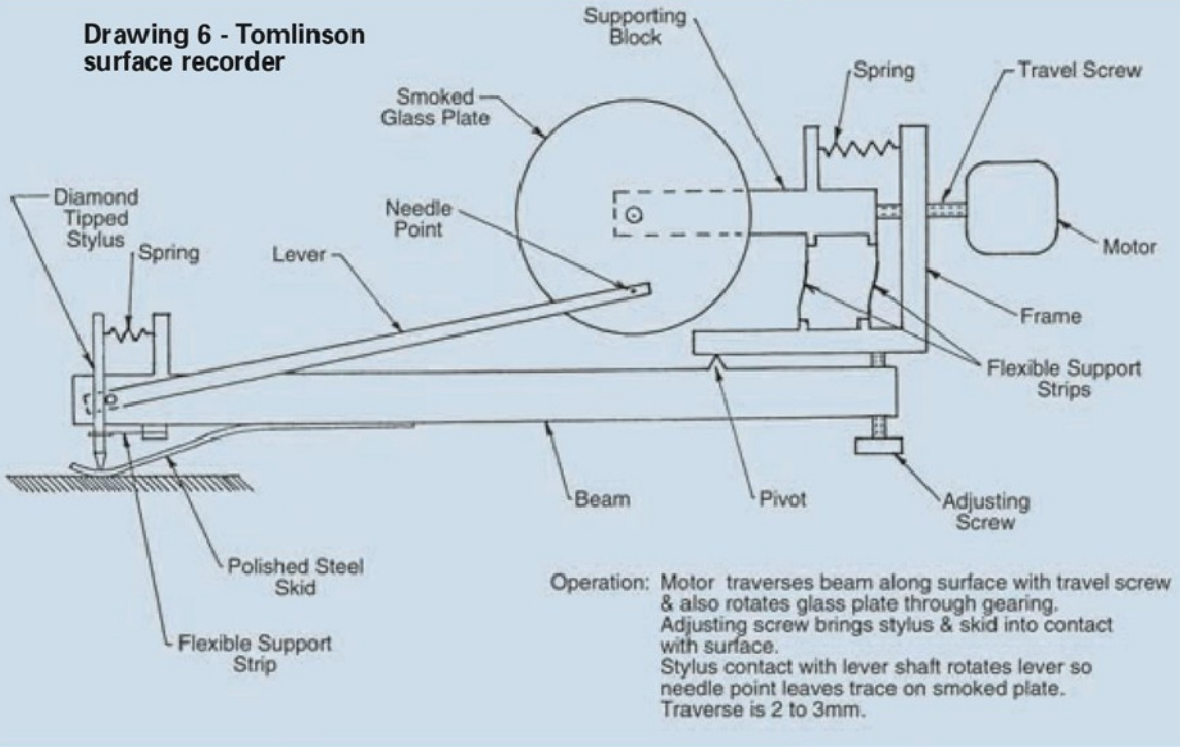
Drawing 5 - Surface texture

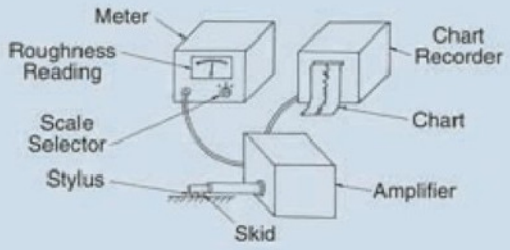


Drawing 4 - Pattern



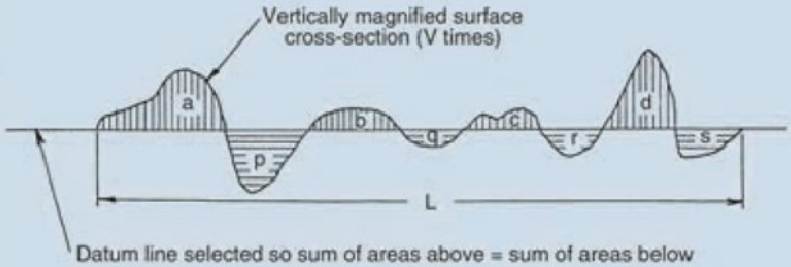
Drawing 6 - Tomlinson surface recorder





Drawing 7 - Surface measurement instruments

Drawing 8 - Roughness measure



Datum line selected so sum of areas above = sum of areas below

$$\text{Average Height Index (Ra)} = \frac{\text{Sum of areas}}{\text{Length}}$$

$$= \frac{a + b + c + d \text{ etc.} + p + q + r + s \text{ etc.}}{L \times V}$$

H hole has one end of the tolerance band coinciding with the nominal diameter - see **Drawing 3**.

These concepts result in an enormous range of possible combinations, but for general use a selection has been made as a guide. Appendix D shows for the 'hole based' system diagrammatically, numerically, and descriptively, 10 of the 14 fits listed in the British (and Australian and New Zealand) Standard. These 'tolerances' or 'limits' compared to the nominal dimensions allow commercial serial production of components which will assemble together with the 'fit' required by the designer. Thus the parts are interchangeable; any shaft can be fitted to any hole and achieve the required fit.

Sometimes the tolerances required by the Standard are too tight to permit adequately low cost production of the components. In such a case the parts are produced to more relaxed tolerances and are then measured and separated into groups in a series of narrower tolerance bands. Then a particular group of shafts can be assembled to an appropriate group of holes to achieve the 'allowance' for the required design fit. This is called selective assembly. A typical case is the fitting of pistons into internal combustion engines.

For the home workshop, the national standard tolerances for a particular fit and nominal diameter can be used to decide just how close to the calculated 'allowance' (as per Tubal Cain) one has to go to ensure the desired outcome, as even the most accomplished worker may not be able to achieve spot-on perfection when making a mating component. See **Appendix E** for examples.

Interference Fits

As the shaft is bigger than the hole for interference fits, some means must be adopted to get the parts into place. For press fits a lead-in taper on the shaft can allow this, and for light press fits (such as dowel pins) a chamfer may be sufficient.

For shrink fits, the part with the hole is heated to expand the hole, and the shaft then inserted. When it cools down the hole contracts and grips the shaft. This produces hoop stress in the (hole) part and in extreme cases the part can fracture. Hence it is necessary to assess the stresses which will be produced and choose a fit which will ensure these do not exceed the strength of the material. The approach to these calculations is outside the scope of this article, but it is treated fully in References 1 and 5. These references also give information on pressures required for press fits and temperatures for shrink fits.

A converse of the shrink fit is the expansion fit where the shaft temperature is reduced to cause it to contract before inserting it in the hole (at room temperature). When it warms up to normal temperature the shaft grips the hole. This process is probably of less interest in the home workshop as the lowest temperature available is usually the family deep freeze at about 0 deg. C. Industrial users would probably use liquid nitrogen at a temperature of -195 deg. C.

Surface Finish

All processes leave the surface finish imperfect to a greater or lesser degree - from the 'as cast' surface to a 'highly polished' mirror finish. Different processes leave different patterns on the surface, so it is often difficult to judge comparative roughness of two surfaces made by different processes - **see Drawing 4**. These patterns are sometimes used for artistic decoration e.g. 'engine turning' circular patterns on silver cigarette boxes.

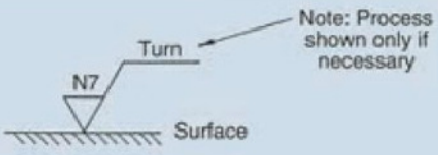
Surface texture is the overall condition of the surface and is divided into primary texture (roughness) and secondary texture (waviness) - **see Drawing 5**. The height of the hills above the valleys is much less than their breadth e.g. for roughness, heights may be from 0.000025 to 0.0001mm and breadths 0.005 to 0.25mm. Similarly for waviness, heights may be from 0.002mm with breadths from 1 to 25mm.

Flaws are random imperfections in the surface (such as inclusions or blowholes in castings) which are usually ignored in the assessment of the surface unless function or aesthetics dictate otherwise. The lay of the surface is the direction of prominent tool marks, grain or pattern of the surface roughness. Surface roughness measurements are taken across the lay as this gives best comparison between differently processed surfaces and the highest readings. Some surfaces (e.g. lapped or superfinished) do not exhibit lay and in such cases measurements may be taken in any direction.

In the period between World Wars I and II some attempts were made to address this matter of surface finish in a quantifiable way. In Reference 7, two symbols were recommended for drawings; 'f' on castings for surfaces where extra material had to be provided so that the surface could be machined; and 'V' with a letter and number enclosed to identify the process and describe the fineness of the finish - see Appendix F. These latter could only provide subjective guidance. Shortly before World War II there came available sets of machined samples for comparison purposes (usually in a range of different machine processes to match that of the surface under consideration. Using the finger tips (or better still the fingernails) drawn across the surface of the sample and of the workpiece, a more meaningful assessment of surface roughness could be made. A typical set is described in Appendix G.

For laboratory purposes between the Wars surface roughness could be determined by the use of an optical flat

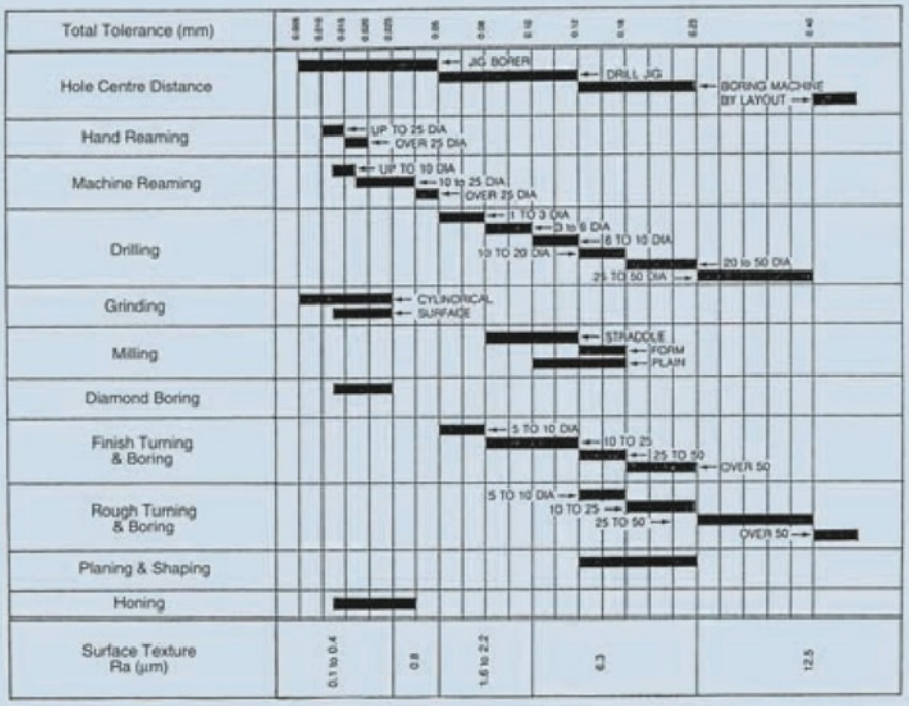
Drawing 9 - Roughness designation



Roughness Grade Number	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
Ra (µm)	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50

Note: Some drawings may show the actual Ra value on the symbol instead of the grade number.

Drawing 10
Commercial Process Outcomes



and a microscope. This was a most cumbersome approach, so some sort of mechanical system was required which could use a stylus traversing the surface, to amplify and record the vertical movements relative to a datum. The Tomlinson instrument (diagrammatically shown in **Drawing 6**) effected this, but again was cumbersome and only suitable for laboratory use.

Just after World War II came the first electro-mechanical apparatus, such as the Talysurf by Rank-Hobson-Taylor, which I first saw demonstrated in 1950. This yields a chart of the (magnified), surface roughness and also a meter reading of the average height. This instrument moves a diamond stylus with a tip radius of 0.0025mm across the surface for a traverse of about 12mm.

Magnifications available are:-

Vertical	x 1000 to x 50000
Horizontal	x 20 to x 100

Bench and portable models are available. Similar machines can be obtained from Moore & Wright (Surfscan), Mitutoyo (Surftest) and others. The general arrangement is depicted in **Drawing 7.**

They all are costly items (typically $A2500 to $A20,000 for Mitutoyo) and unlikely to be found in the home workshop.

The roughness average height index 'Ra' is determined as shown in **Drawing 8**; it is expressed in microns (micro-meters). Grades of texture have been agreed as maxima to specify for surfaces. These are shown in the table on **Drawing 9**, which also shows how they are depicted on drawings.

Fine surface finish can be important for functional reasons e.g. a metal mirror or the anvil faces of micrometers or the surfaces of gauge blocks. It is also important where surfaces move in contact with each other (shafts in bearings etc.). Even if the 'allowance' is correctly provided on new components, if the surfaces are inappropriately rough, then after an initial wearing in, the tops of the 'hills' will be worn off and the 'allowance' thereby increased so that the fit becomes relatively looser.

Fine surface finish may, however, be required only for aesthetic reasons - exhibition standard models, or to make accurate tools look right.

To some degree, fine tolerances and fine finishes tend to be produced by the same processes. The chart shown in **Drawing 10** is derived from information in References 5 and 6, and is intended to give a guide to what can be expected from commercial processes in industry.

Assuming that you are using the recommended speed, feed, depth of cut, tool angles and coolant (see Reference 9), then the quality of surface finish obtainable cannot be better than that of the tool cutting edge so, for the finest work, a mirror finish on the tool is desirable.

If you cannot get access to a surface roughness measuring instrument, then you must rely on touch, sight and experience and the process used to achieve the grade of finish you require. Attention is drawn to the excellent article by Dr. Peter Clark on methods he adopts to attain superior finishes on components made in the home workshop (Reference 10).

Conclusion

Once the principles of limits and fits are understood, it is fairly straightforward to decide or to work out what tolerances are appropriate for the job in hand. Obtaining the desired surface finish requires close attention to the processes used and to ensuring that all relevant parameters are considered.

References

1. Mechanical Engineers Handbook - L.S.Marks - 1916
2. General Engineering Workshop Practice - J.D.Walton & Others -1944(?)
3. Know Your Lathe - Boxford -1977
4. Model Engineers Handbook - Tubal Cain - 1981
5. Machinery's Handbook - Revised 21st Edition - 1982
6. Fitting & Machining - R.Culley, General Editor - 1988
7. Australian Standard Drawing Practice - CZ-1 1941 - Institution of Engineers, Australia
8. Precision Toolmaking & Measurement - E.C.Maskiell & W.Galbraith - 1978
9. Finish & Dimensions - Philip Amos, M.E.W. Issue 37, Sep./Oct. 1996
10. The Appropriate Finish for Workshop Tools & Equipment - Dr. Peter Clark, M.E.W. Issue 60, Aug. 1999.

Appendix A (see chart)

Appendix B

Classification of Fits

Class 1 - Loose Fit

Allowance	(+) 0.0025 $\sqrt[3]{d^2}$
Tolerance	Hole 0.0025 $\sqrt[3]{d}$
	Shaft 0.0025 $\sqrt[3]{d}$

Considerable freedom where accuracy not essential - agricultural and mining machinery; controlling apparatus for marine work; textile, rubber, candy and breadmaking machinery; some ordnance material.

Class 2 - Free Fit

Allowance	(+) 0.0014 $\sqrt[3]{d^2}$
Tolerance	Hole 0.0013 $\sqrt[3]{d}$
	Shaft 0.0013 $\sqrt[3]{d}$

Running fits for speeds over 600 rpm and journal pressures over 600 pounds per square inch. For dynamos, engines, some machine tool and automotive parts.

Class 3 - Medium Fit

Allowance	(+) 0.009 $\sqrt[3]{d^2}$
Tolerance	Hole 0.0008 $\sqrt[3]{d}$
	Shaft 0.0008 $\sqrt[3]{d}$

Running fits under 600 rpm and journal pressures less than 600 pounds per square inch. For sliding fits and more accurate machine tool and automotive parts.

Class 4 - Snug Fit

Allowance	0.0000
Tolerance	Hole 0.0006 $\sqrt[3]{d}$
	Shaft 0.0004 $\sqrt[3]{d}$

Closest which can be assembled by hand. Parts not intended to move freely under load.

Class 5 - Wringing Fit

Allowance	0.0000
Tolerance	Hole 0.0006 $\sqrt[3]{d}$
	Shaft 0.0004 $\sqrt[3]{d}$

Also called tunking fit.

Appendix A

TOLERANCES IN STANDARD HOLES								2 CLASSES
	Nominal Diameters	0" to 1/2"	1/2" to 1"	1"+ to 2"	2" + to 3"	3"+ to 4"	4"+ to 5"	5"+ to 6"
CLASS A	High Limit ...	+.00025	+ .0005	+ .00075	+ .001	+ .001	+ .001	+ .0015
	Low Limit ...	- .00025	- .00025	- . 00025	- .0005	- .0005	- .0005	- .0005
	Tolerance ...	.0005	.00075	.001	.0015	.0015	.0015	.002
CLASS B	High Limit ...	+ .0005	+ .00075	+ .001	+ .00125	+ .0015	+ .00175	+ .002
	Low Limit ...	- .0005	- .0005	- .0005	- .00075	- .00075	- .00075	- .001
	Tolerance ...	.001	.00125	.0015	.002	.00225	.0025	.003
FORCE FITS	ALLOWANCES ON SHAFTS FOR VARIOUS FITS							
	Nominal Diameters	0" to 1/2"	1/2" to 1"	1"+ to 2"	2" + to 3"	3"+ to 4"	4"+ to 5"	5"+ to 6"
CLASS F	High Limit ...	+ .001	+ .002	+ .004	+ .006	+ .008	+ .010	+ .012
	Low Limit ...	+ .0005	+ .0015	+ .003	+ .0045	+ .006	+ .008	+ .010
	Tolerance ...	.0005	.0005	.001	.0015	.002	.002	.002
DRIVE FITS								
	Nominal Diameters	0" to 1/2"	1/2" to 1"	1"+ to 2"	2" + to 3"	3"+ to 4"	4"+ to 5"	5"+ to 6"
CLASS D	High Limit ...	+ .0005	+ .001	+ .0015	+ .0025	+ .003	+ .0035	+ .004
	Low Limit ...	+ .00025	+ .0075	+ .001	+ .0015	+ .002	+ .0025	+ .003
	Tolerance ...	.00025	.00025	.0005	.001	.001	.001	.001
PUSH FITS								
	Nominal Diameters	0" to 1/2"	1/2" to 1"	1"+ to 2"	2" + to 3"	3"+ to 4"	4"+ to 5"	5"+ to 6"
CLASS P	High Limit ...	- .00025	- .00025	- .00025	- .0005	- .0005	- .005	- .005
	Low Limit ...	- .00075	- .00075	- .00075	- .001	- .001	- .001	- .001
	Tolerance ...	.0005	.0005	.0005	.005	.0005	.005	.0005
RUNNING FITS								
	Nominal Diameters	0" to 1/2"	1/2" to 1"	1"+ to 2"	2" + to 3"	3"+ to 4"	4"+ to 5"	5"+ to 6"
CLASS X	High Limit ...	- .001	- .00125	- .00175	- .002	- .0025	- .003	- .0035
	Low Limit ...	- .002	- .00275	- .0035	- . 00425	- .005	- .00575	- .0065
	Tolerance ...	.001	.0015	.00175	.00225	.0025	.00275	.003
CLASS Y	High Limit ...	- .00075	- .001	- .00125	- .00150	- .00200	- .00225	- .00250
	Low Limit ...	- .00125	- .002	- .0025	- .00300	- .00350	- .00400	- .00450
	Tolerance ...	.005	.001	.0025	.00150	.00150	.00175	.00200
CLASS Z	High Limit ...	- .005	- .00075	- .00075	- .001	- .001	- .00125	- .00125
	Low Limit ...	- .00075	- .00125	- .0015	- .002	- .00225	- .0025	- .00275
	Tolerance ...	.00025	.0005	.00075	.001	.00125	.00125	.0015

Class 6 -Tight Fit

Allowance (-) 0.00025 d
Tolerance Hole 0.0006 $\sqrt[3]{d}$
Shaft 0.0006 $\sqrt[3]{d}$

Light pressure needed to assemble. Drive fits in thin sections or extremely long fits in very light sections. For automotive, ordnance and general machine manufacturing.

Class 7 - Medium Force Fit

Allowance (-) 0.0005 d
Tolerance Hole 0.0006 $\sqrt[3]{d}$
Shaft 0.0006 $\sqrt[3]{d}$

Requires considerable pressure to assemble parts which are joined permanently. For locomotive wheels, armatures of dynamos and motors, crank discs on their shafts. Also for shrink fits on medium sections or long fits. Tightest recommended for cast iron holes which are then stressed to their elastic limit.

Class 8 - Heavy Force & Shrink Fit

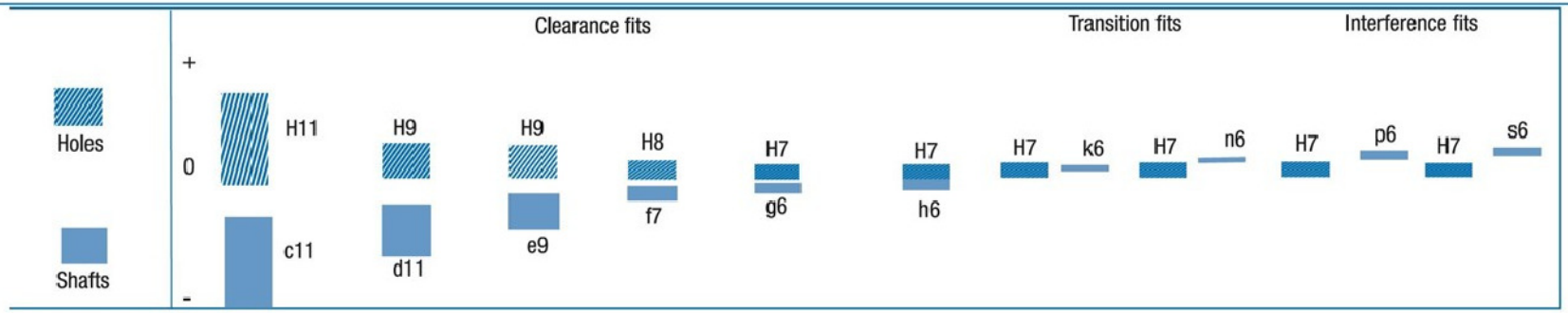
Allowance (-) 0.001 d

Tolerance Hole 0.0006 $\sqrt[3]{d}$
Shaft 0.0006 $\sqrt[3]{d}$

For steel holes. Causes excessive stress for cast iron holes.

My notes:-
(i) Classes 4 and 5 seem to be identical.
(ii) Hole and shaft tolerances for all interference fits are identical

Appendix D



Basic size (mm)		Upper and lower deviations for tolerance class (Values μ																			
Above	Up to & incl.	H11	c11	H9	d10	H9	e9	H8	f7	H7	g6	H7	h6	H7	k6	H7	N6	H7	p6	H7	s6
		+	-	+	-	+	-	+	-	+	-	+	-	+	+	+	+	+	+	+	+
0	3	60	60	25	20	25	14	14	6	10	2	10	6	10	6	10	10	10	12	10	20
		0	120	0	60	0	39	0	16	0	8	0	0	0	0	0	04	0	6	0	14
3	6	75	70	30	30	30	20	18	10	12	4	12	8	12	9	12	16	12	20	12	27
		0	145	0	78	0	50	0	22	0	12	0	0	0	1	0	8	0	12	0	19
6	10	90	80	36	40	36	25	22	13	15	5	15	9	15	10	15	19	15	24	15	32
		0	170	0	98	0	61	0	28	0	14	0	0	0	1	0	10	0	15	0	23
10	18	110	95	43	50	43	32	27	16	18	6	18	11	18	12	18	23	18	29	18	39
		0	205	0	120	0	75	0	34	0	17	0	0	0	1	0	12	0	18	0	28
18	30	130	110	52	65	52	40	33	20	21	7	21	13	21	15	21	28	21	35	21	48
		0	240	0	149	0	92	0	41	0	20	0	0	0	2	0	15	0	22	0	35
30	40	160	120	62	80	62	50	39	25	25	9	25	16	25	18	25	33	25	42	25	59
		0	280																		
40	50	160	130	0	180	0	112	0	50	0	25	0	0	0	2	0	17	0	26	0	43
		0	290																		
50	65	190	140	74	100	74	60	46	30	30	10	30	19	30	21	30	39	30	51	30	72
		0	330																	0	53
65	80	190	150	0	220	0	134	0	60	0	29	0	0	0	2	0	20	0	32	30	78
		0	340																	0	59
80	100	220	170	87	120	87	72	54	36	35	m) 12	35	22	35	25	35	45	35	59	35	93
		0	390																	0	71
100	120	220	180	0	260	0	159	0	71	0	34	0	0	0	3	0	23	0	37	35	101
		0	400																	0	79
120	140	250	200	100	145	100	84	63	43	40	14	40	25	40	28	40	52	40	68	40	117
		0	450																	0	92
140	160	250	210	0	305	0	185	0	83	0	39	0	0	0	3	0	27	0	43	40	125
		0	460																	0	100
160	180	250	230																	40	133
		0	480																	0	108
180	200	290	240	115	170	115	100	72	50	46	15	46	29	46	33	46	60	46	79	46	151
		0	530																	0	122
200	225	290	260	0	355	0	215	0	96	0	44	0	0	0	4	0	31	0	50	46	159
		0	550																	0	130
225	250	290	280																	46	169
		0	570																	0	140
250	280	320	300	130	190	130	110	81	56	52	17	52	32	52	36	52	66	52	88	52	190
		0	630																	0	158
280	315	320	330	0	400	0	240	0	108	0	49	0	0	0	4	0	34	0	56	52	202
		0	650																	0	170
315	355	360	360	140	210	140	125	89	62	57	18	57	36	57	40	57	73	57	98	57	226
		0	720																	0	190
355	400	360	400	0	440	0	265	0	119	0	54	0	0	0	4	0	37	0	62	57	244
		0	760																	0	208
400	450	400	440	155	230	155	135	97	68	63	20	63	40	63	15	63	80	63	108	63	272
		0	840																	0	232
450	500	400	480	0	480	0	290	0	131	0	60	0	0	0	5	0	40	0	68	63	292
		0	880																	0	252
				Loose clearance		Average running		Average location		Precision loation				Push/drive				Press		Shrink	

Appendix C

Tubal Cain Allowances

(Soft conversion to metric)

Allowance equals constant plus variable amount. Shaft size to be less than (-) or greater than (+) hole diameter.

Fit Class	Constant (mm)	+ Variable Amount (mm per mm dia.)
Large Clearance	-0.076	-0.0050
Small Clearance	-0.051	-0.0030
Easy Run	-0.038	-0.0023
Normal Run	-0.025	-0.0015
Close Run	-0.015	-0.0008
Precision Run	-0.013	-0.0007
Slide	-0.008	-0.0005
Push	-0.004	-0.0004
Wheel Keying	0	0
Drive	+0.008	+0.0005
Force	+0.013	+0.0008
Shrink	+0.013	+0.0015

Tubal Cain states that these allowances are for nominal diameters of 3 to 50mm and notes that they are NOT suitable for pistons where an allowance for thermal expansion is required.

Appendix D (see chart)

Appendix E

Comparative Examples

I. A sliding fit is required for two components of nominal diameter 12.5mm.

From Appendix C the allowance needed is:-

(-0.008) + (12.5 x -0.0005) = -0.01425mm

From Appendix D a sliding fit (H7 h6) for 12.5mm nominal diameter has tolerance limits:-

Hole 0 to +0.018

Shaft 0 to -0.011

giving a range for the allowance of 0 to 0.029 which is about double Tubal Cain's suggestion.

II. Two parts of 12.5mm nominal diameter are to have a normal running fit.

From Appendix C the allowance required is:-

(-0.025) + (12.5 x -0.0015) = 0.04375mm

From Appendix D for average running (H9 e9) the tolerance limits are:-

Hole 0 to 0.043

Shaft -0.032 to -0.075

giving an allowance range from 0.032 to 0.118; i.e. from ¾ to twice the Tubal Cain suggestion.

Appendix F

Description of Surface	Process	Degree	Symbol of Finish	Examples
As produced	Casting (including ordinary fettling), Rolling, Forging, Drawing, Extruding, etc.	As produced	None	Surface of general castings and rolled sections, etc.
Dressed (No machining allowance required.)	Dressed by Chipping, Filing, Grinding, Sand-blasting, Shot-blasting, etc.	Dressed	D1	Surfaces which are required to be clean and smooth, for handling or appearance; or prepared for painting.
	Smoothed and dressed by Filing, Grinding, Drawfiling, Emery Cloth, etc.	Smooth-Dressed	D2	Non-working surfaces of machines and instruments which mus be well finished for appearance, bu which cannot be machined economically.
	Dressed and polished by grinding and buffing.	Dressed and Polished	D3	Highest dressed finish for appearance. Preparation for electro-plating.
Machined	Turning, Boring, Milling, Planing, Shaping, Slotting, Drilling.	Rough machined	M1	To bring an object to required shape, to provide surface or tool clearance, seatings
		Medium machined	M2	Surfaces which have to be finished smoothly for appearance. Seatings and parts in contact. (Stationary or with slow movement). Flange faces. Most general work.
		Fine machined	M3	Bearings, Journals, Slides and parts in conact (good fit, quick moving).
Ground	Machine Grinding	Rough ground	G1	Parts ground to size using course grinding wheels. Seatings, lathe tools, etc.
		Medium ground	G2	Parts ground to close sizes with very good surfaces. Tools, Journals and contact surfaces of moving parts.
		Fine ground	G3	Parts requiring special surfaces to highest degree of dimensional accuracy.
Filed	Hand filing	Rough filed	F1	Parts to be brought to sie or shape and which do not require a smooth surface.
		Medium filed	F2	General work to close sizes with good surfaces.
		Fine filed	F3	Fitted parts. Measuring or gauging surfaces of tools and instruments, etc.
Reamered	Hand or Machine Reamering	Fine finish	R	Holes to be smoothly finished to close sizes for bearings, fitted bolts, etc.
Scraped	Hand Scraping	Finest finish	S	Plane surfaces to highest degree of accuracy.
Lapped	Lapping	Finest finish	L	Mainly used for very closely fitting cylindrical moving parts such as valves and plungers for hydraulic instruments, etc.

Appendix F (see chart)

Appendix G

Surface Roughness Standard Samples

Set of 30 specimens ⅞in. by ⅜in. electroformed solid nickel, comprising:-

3 for Lapping	2, 4 and 8 microinch
3 for Reaming	16, 32 and 63 microinch
6 for Grinding	2, 4, 8, 16, 32 and 63 "
6 for Horizontal Milling	16, 32, 63, 125, 250 and 500
6 for Vertical Milling	as for Horizontal Milling
6 for Turning	as for Horizontal Milling

Mitutoyo manufacture. Currently available in Australia for about $A 200.

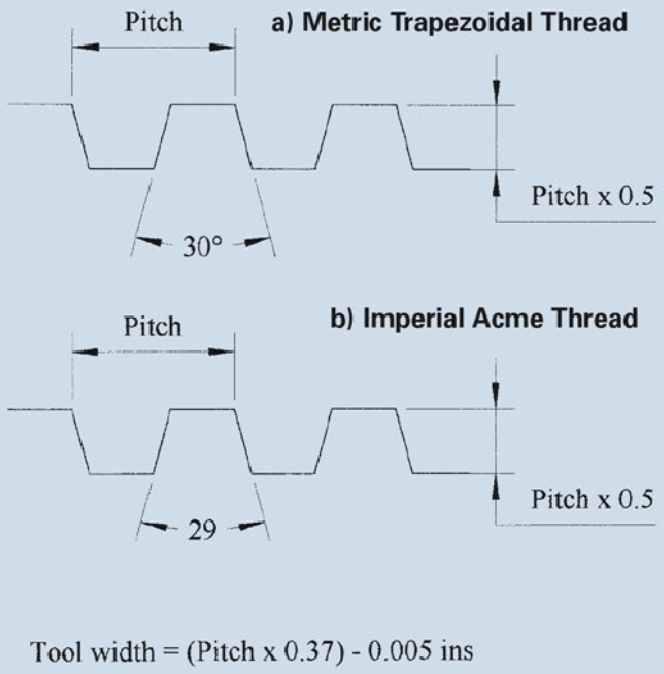
FREE-WHEEL HOBBING A WORM WHEEL

You really can produce useable wormwheels without a precision hobbing machine. Bill Morris tells how

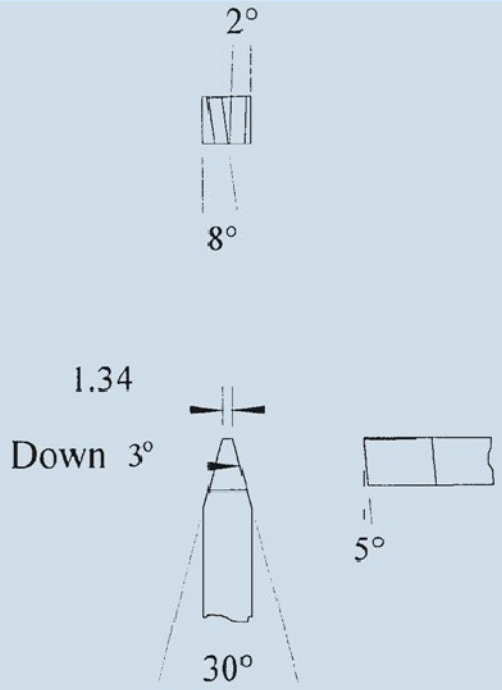
Together with two others of the Palmerston North Model Engineer's Society I have made a start on building a Jacobs Gear Hobbing machine, as recently described by Harold Hall in a series of articles in M.E.W. Fin Mason's considerable wood-working skills produced the patterns that the Milson Foundry of Palmerston North have converted into their usual high quality castings, free from holes or hard spots. Our New Zealand version has been beefed up to allow more metal in the slides and also has a platform extending to the rear to allow the motor to be mounted directly on to the machine. Brian Wiffin has used his recently re-built 12in. shaping machine to produce the large flat surfaces with relative ease and his vertical milling machine to produce the dovetail slides, on the grounds that it is nearly as easy to produce three sets on a large machine as it is to produce one. Early in the project, I moved away from Palmerston North to a very small and isolated town in the Far North of New Zealand and this has meant that I have had to confine myself to producing smaller items for the consortium, like feed screws and nuts and the universal couplings

Early on, we decided to work to metric measurements and settled on a standard 3mm pitch by 10mm diameter for all the feed screws. Had I known the tedium I was letting myself in for in cutting nine metric feed screws on a lathe equipped with an 8 tpi leadscrew I might have been swayed into adopting 10 tpi feed screws instead! Although my lathe has metric conversion gears, the clasp nut has to left engaged and the lathe run backwards to start each new cut until the screw has been completed.

In his articles on the hobbing machine Harold discussed the worm drive of the machine and how to produce it (M.E.W. Issue 59, p 32). While it is easy to produce a worm wheel once you have a hobbing machine, it may not be so well known that it is feasible to produce useable worm wheels without one. Another of my allotted tasks for the consortium was to produce the worms and wheels and, while they may fall short of professional standards, they are relatively easy to



Drawing 1 Thread proportions



Drawing 2 Threading tool

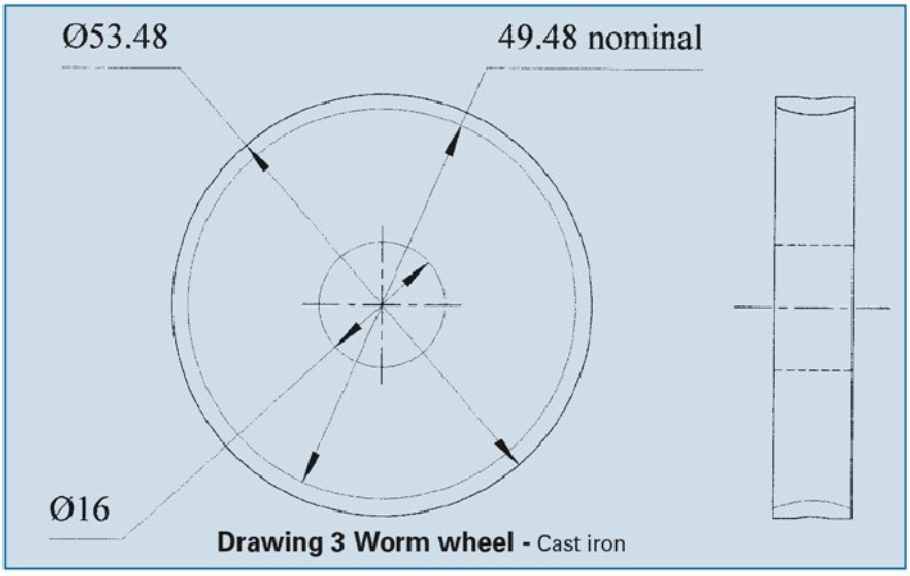
1. A finished worm and wormwheel and the hob used to form the teeth on the wheel

produce using equipment likely to be found in many an amateur's workshop. I have just completed three worms and worm wheels **(Photo. 1)** by the "free-wheel hobbing" method and they run together well, in spite of ignoring many of the finer points of design. Centre distances can be adjusted during the manufacture of the machine if one chooses (as we have done) to depart a little from the drawings.

Design Aspects

It is perhaps easiest to start and understand the design process with the worm, as it is the familiar screw thread. An Acme form is specified, with a 29 deg. included angle, not too different from the metric standard of 30 degrees. An outside diameter of 1in. is given and the given pitch of 0.157in. is within half a thou of 4mm pitch, so that those whose lathe can cut a 4mm thread can follow the specification very closely. For those who are locked in to Imperial threads, a 6½ tpi thread has a pitch of 0.154in., very close to the specified pitch. I settled on metric sizes but the principles easily convert to Imperial sizes. This is a very good point to remind you that the thread has to be a LEFT HAND one. Write it in big letters now on your design sketch!

We settled on 25mm outside diameter, 4mm pitch, 30 deg. included angle, the so-called metric trapezoidal thread **(Drawing 1a).** The depth from crest to root is half the pitch, just as in an Acme thread **(1b),** so in our example, the tool will have to feed in 2mm. The width of the tool tip has to be 0.366 x pitch - 0.125 = 1.34mm (0.37 x pitch -0.005in. for Acme). The thread angle is the angle whose tangent is the pitch divided by the circumference or



Drawing 3 Worm wheel - Cast iron

$\tan^{-1}(4/25\pi)$, in this case 2.91, so that the ***right hand*** flank of the threading tool **(Drawing 2)** will have to have a clearance of at least this amount if it is not to foul the thread; and 8 deg. rather than the usual 5 deg. is a safe value to settle on. The left hand flank can have less than the usual clearance, say 2 degrees. The top surface of the tool can slope downwards 3 deg. from left to right so that the rake face is normal to the helix angle, but this is perhaps an unnecessary refinement with a relatively small helix angle. It also reduces the tip width slightly but that can be ignored too; the beauty of the hobbing process is that it will produce a wheel with the teeth of the correct form even if the actual pressure angle is non-standard. Machinery's Handbook gives slightly different values to the ones I have used, but as amateur's producing one-off matching parts, we don't have to worry about interchangeability.

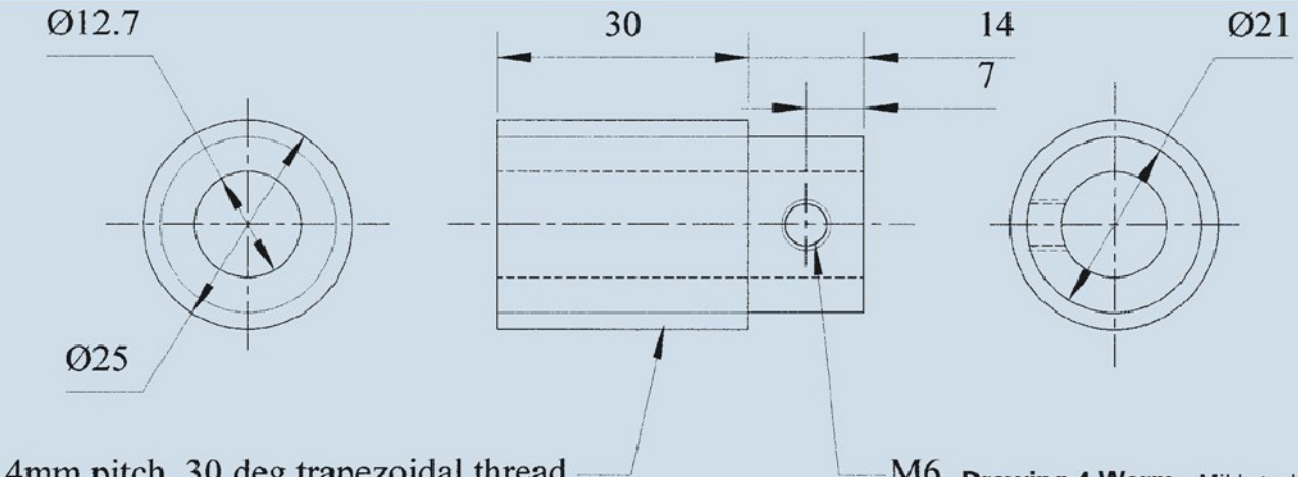
Knowing the pitch of the worm, 4mm, and the number of teeth, 40, we can easily arrive at the approximate outside diameter of the wheel. The circular pitch is 4mm so the outside diameter is

$(40 + 2) \times 4/\pi$ or 53.48mm **(Drawing 3)**.

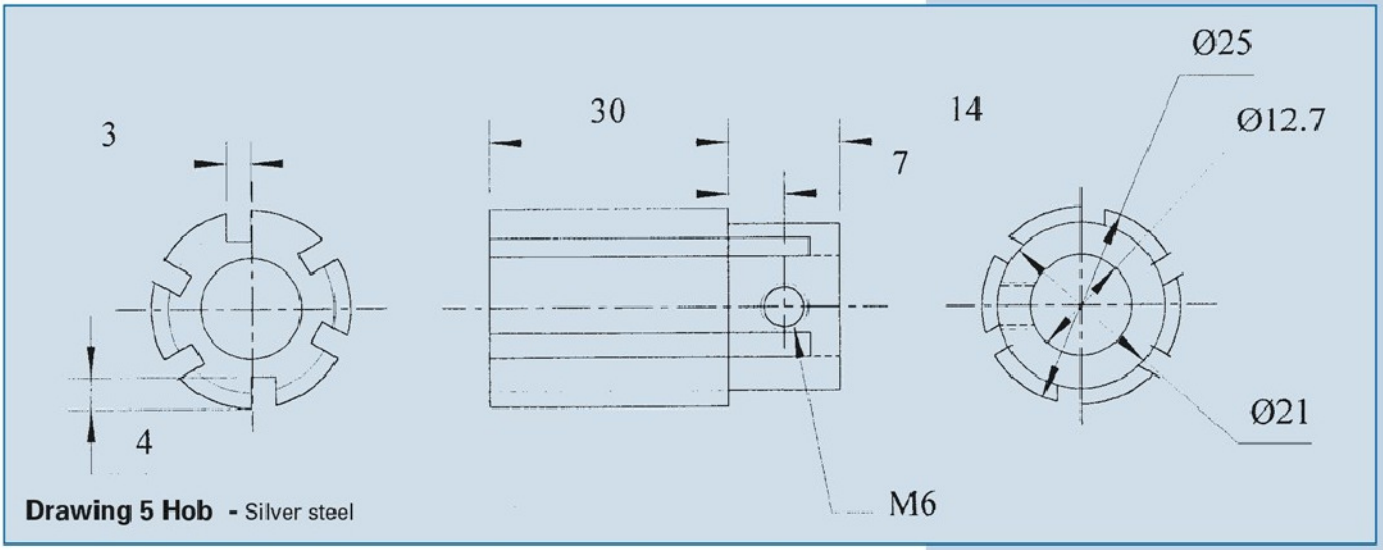
We don't have to worry about the exact depth of the wheel teeth, as that will be set by the hob and we will be able to see when the teeth have been excavated to full depth. If we exceed that depth, the teeth will simply be thinner than intended, but the worm and wheel will still run together more-or-less correctly and will eventually run themselves in.

Worm and Hob

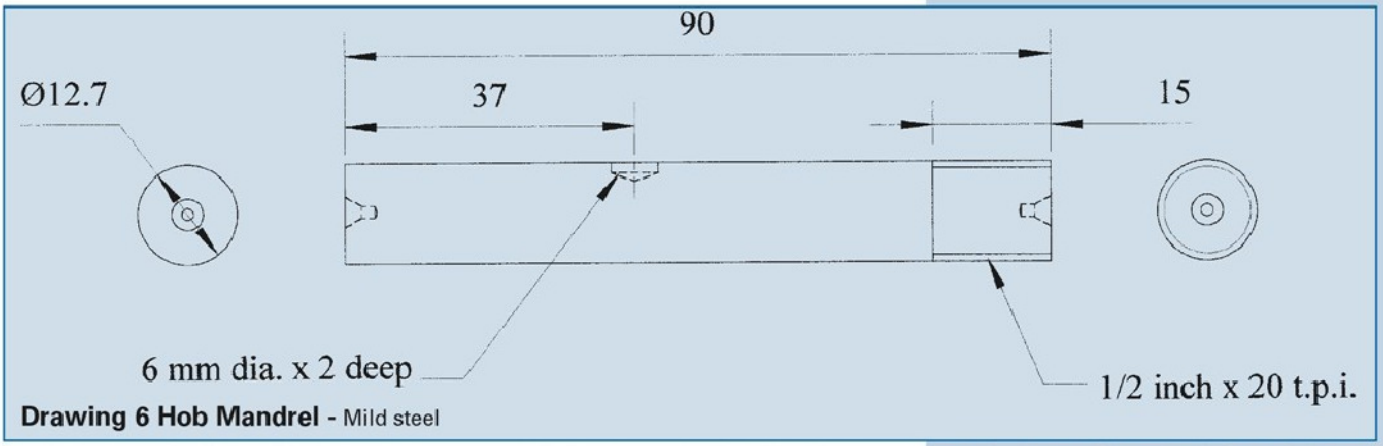
The next step is to make a hob and the worm together, starting by turning blanks according to **Drawing 4**. As the hob is going to be mounted on a mandrel and the worm on a shaft, they can be mounted on a mandrel in tandem for turning and screw cutting. The worm is of mild steel and presents no problems, but the hob is of silver steel which is considerably tougher to cut and a 4mm pitch thread in this material is a hefty proposition for a small lathe. Any lack of rigidity can lead to jamming and disaster, as I found out for myself when I tried to cut the two between centres. I found it was best to hold the mandrel in the 4-jaw chuck for its superior concentricity, rigidity and grip; slippage in the chuck leads to a disaster with different origin but same effect. For the same reason, make a substantial dimple in the mandrel for the grub screws. The outboard end is, of course, supported by the tailstock centre **(Photo. 2)**. Unless you have an all-metric lathe with threading indicator, the lathe is going to be reversed at the end of the cut without disengaging



Drawing 4 Worm - Mild steel



Drawing 5 Hob - Silver steel



Drawing 6 Hob Mandrel - Mild steel

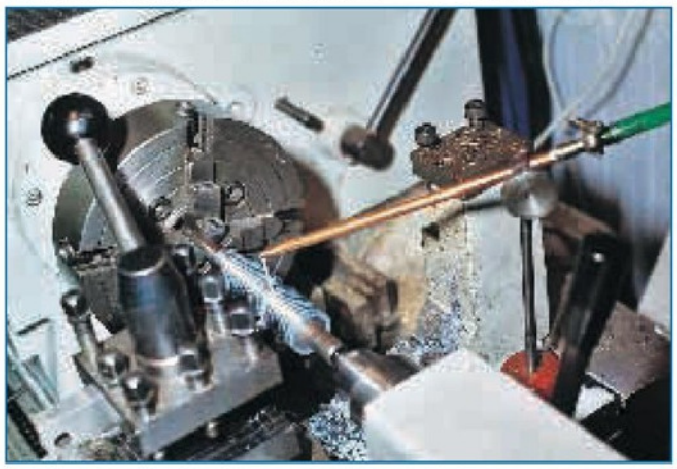
the feed nut, so don't forget to leave somewhere for the tool to go at each end as the lathe slows to a stop. Bear in mind too that if you try to reverse a single phase motor ***before*** it has stopped, it will keep on going in the same direction as before, usually with a nasty crunching sound as the tool hits a chuck jaw or tailstock centre...

The threading tool cannot easily be ground free hand and some sort of grinding jig will be required and ideally a tool and cutter grinder like a Quorn. 6mm or 1/4in. square HSS bits held in a holder are more economical and also make it easier to set the tool square to the workpiece. With a substantial thread like this you should certainly set over the top slide. For a 30 deg. left hand thread it needs to be set over to the left at 75 deg. to the lathe axis, as shown in the photos. The corollary of this is that the top slide will be fed in not 2mm but

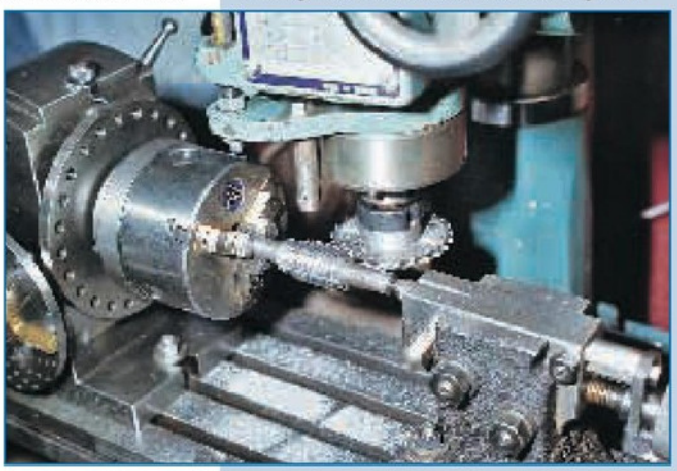
$2/\cos 15\ \text{deg.} = 2.07\text{mm}$.

Except perhaps at the very beginning, take very small cuts, say 0.04mm for the first 0.5mm, 0.03mm for the next 0.5mm and 0.02mm thereafter. Because of the boredom of reversing the lathe at the end of the cut, the temptation is always to put on a bit more cut than the set-up can stand, to speed things up, and before you can do anything about it, there is a dig-in with ruined workpiece, chipped tool and possible damaged top slide. When cutting left hand threads, the tool moves away from the head stock though the motor switch is moved in its normal sense. This can lead to confusion, with the switch being operated in the usual sense to run the tool away from the head stock, only to run the tool into the chuck before the lathe can be switched off. By now, you will have guessed that I have experienced all these potential disasters. The best advice I can offer is that if you feel you are losing concentration, stop and take a rest.

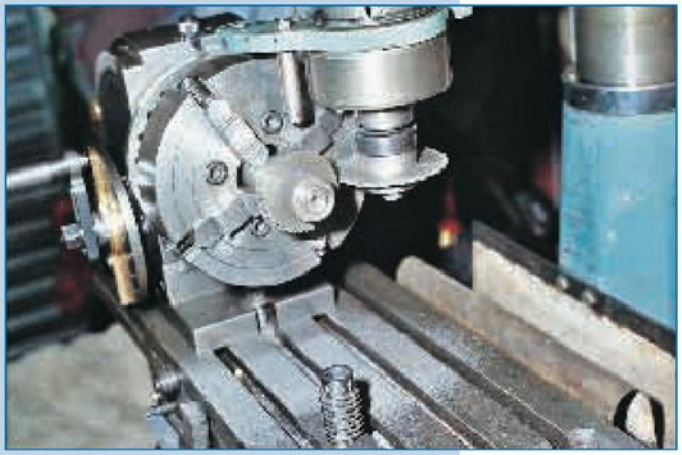
When the thread has been cut to full depth, remove burrs with a fine flat file and just break the corners with a fine three-square (triangular) file. Remove the completed worm from the mandrel but leave the hob-to-be where it is and transfer to dividing head or other dividing device for gashing the teeth. Think carefully about its eventual direction of rotation in the milling machine, which has nothing at all



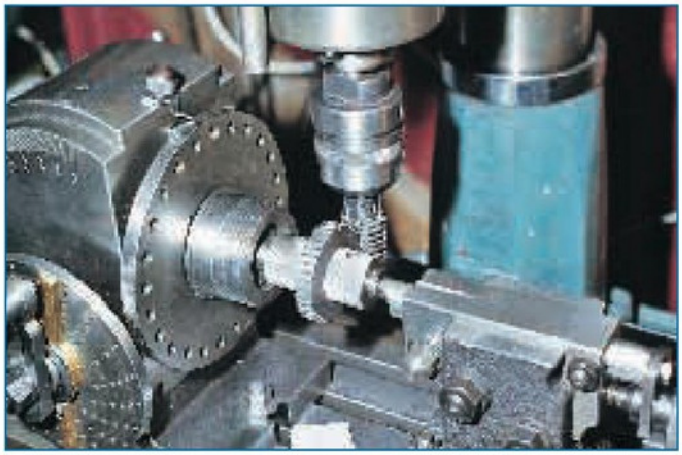
2. Thread cutting both the worm and the hob at the same set-up



3. Gashing the hob to create the cutting teeth



4. Gashing the worm wheel prior to hobbing



5. Hobbing the worm wheel

to do with its being a left hand thread. Looking from above, this will usually be clockwise and the face of the teeth has to be exactly radial. Think very carefully - twice or more. Study **Drawing 5** and think again before you cut metal. As **Photo. 3** shows, I happen to have a 3mm thick milling cutter and this gives a much better finish as well as being less nerve racking than using a 3mm end mill. I made six gashes, each 4mm, deep and they were almost free from burrs. A vigorous attack with a wire brush before hardening removed most of them and a further attack afterwards did for the rest.

The section of the hob seemed to be thin and symmetrical enough to avoid cracking when quenching in water, but remember to quench it by putting it into the water along its axis rather than on its side. The ubiquitous wire coat hanger comes in useful for handling it when red hot. Tempering temperature is 240 deg. Celsius or dark straw, but you can't temper something of this size by holding in a flame and watching. Most domestic electric ovens can reach this temperature, but don t rely entirely on the thermostat. Polish the end of the hob so you can check the tempering colour after it has been in the oven for an hour or so.

Wormwheel

By comparison, making the worm wheel is child's play. Drill, ream and rough turn a cast iron blank and mount it on a threaded mandrel, something like the one shown in **Photo. 4** for turning the outside diameter to the chosen dimension. Transfer it to your dividing device, tip the latter nose up 3 deg. if attacking from the rear and make forty radial gashes with a fairly thick slitting saw, as shown in the photo. The width of the gashes needs to be enough to admit the tips of the hob teeth and the depth just a little less than the full depth of the teeth, say 1.9mm. I happened to have a milling cutter with a vee already ground on the teeth, so I used it instead of a slitting saw. This done, bring the dividing head down to the horizontal and mount the gear blank between centres on a mandrel so it can rotate freely without any shake **(Photo. 5).**

I made a simple mandrel to hold the hob in a collet milling chuck **(Drawing 6)**, but other holding solutions are possible. Line up the gear blank and the hob, engage the teeth of the hob with the gashes on the blank and start up the milling machine at a slow speed, about 80 rpm, reminding yourself if necessary that amateurs do not need to hurry and that carbon steel loses its hardness rapidly much above 250 degrees. The hob should rotate the blank and as you gently feed the blank into the hob you should be rewarded by the sight of fine shavings falling on to the table of the machine. When this point is reached, allow the blank to make at least a full revolution before putting on a little more cut. You will know that you have reached full depth when the hob begins to excavate little scallops in the edge of the wheel and this is a good point at which to stop hobbing. Going deeper will give a slightly larger area of engagement, but since we simply want a worm and wheel that will run well together, there is no point in pushing our luck. To prove to yourself that they will indeed run well together, brush away all chips, replace the hob with the worm, engage one with the other leaving a little backlash, apply some oil and switch on. If there are no graunching noises, and there shouldn't be, speed up.

The result should certainly be superior to running a worm against a spur gear, (Harold's options 2 and 3) and cheaper than his first option of buying the gears. Mild steel running on cast iron should give long service. I and the two others in the consortium certainly hope so! With a little ingenuity, all the processes except for gashing the worm wheel and hob can be done on a lathe alone. The hob can be gashed with a file, as there is no need for any great accuracy of dividing as long as the faces of the teeth are radial. The gashes on the worm wheel do not have to be set to the helix angle of the worm if one is prepared to live with cosmetic blemishes, but they do have to be fairly accurately divided, though the hobbing process will correct minor inaccuracies.

TRADE COUNTER

Please note that, unless otherwise stated, Trade counter items have not necessarily been tested. We give news of products and services which have been brought to our attention and which we consider may be of interest to our readers

The Engineers Emporium on the Web

L A Services of Bramcote, Warwickshire have alerted us to the fact that they now have an on-line catalogue at www.theengineersemporium.co.uk. It covers some 64 different categories of items, plus a Miscellaneous section.The site is being added to as new stock arrives and existing stock is being added as and when time permits.

L A Services Ltd., Bramcote Fields Farm, Bramcote, Warwickshire CV11 6QL

Tel. 01455 220340 Fax 01455 221036 E-mail: engineersemporium@zetnet.co.uk

Surplus Bits & Pieces from BW Electronics

Well known for their competitively priced digital read-out systems, BW Electronics of Corby Glen also stock a wide and ever-changing range of surplus equipment.

Their latest 16 page list features many hundreds of items grouped into Miscellaneous, Measuring, Fluids (air, water etc. fittings), Optical, Fastenings, Clamping, Drive Components (bearings, gears etc.), Electrical, Electronic, Materials, Vehicle and Process Control. The problem is that many items could fit in to two or more groups, so it is neceesary to scan everything, just in case!

Many of the items listed bear the names of well-known manufacturers and would be of interest to the home workshop enthusiast.

BW Electronics, 12 Mussons Close, Corby Glen, Grantham NG33 4NY Tel./Fax 01476 550826. www.bwelectronics.co.uk

THE RAYMAC CUTTER GRINDER

This third instalment of the description of Raymond McMahons versatile machine deals with the remaining items of the work head unit

Circular Dovetail (Item 46)

The Circular Dovetail can now be made. It works on the same principle as the top slide fitting on the Myford Super Seven lathe, my thinking being that if it was good enough for the lathe it would be good enough for me!

The Ring to which it is attached is graduated in degrees - centre zero **(Photo. 1)**, these graduations allowing the head to be set to the desired position in order that the nose or helix angle of the cutter can be ground. For the helix part of the cutter the head is set horizontal, but for the nose it has to be tilted 7 deg. for the primary angle. When backing off of the teeth is required, the cutter is tilted even further to the secondary angle of 14 or 15 deg. when the graduations allow it to be easily reset. Some cutters, depending on their diameter, are only ground with the primary angle.

The machining of the plate should be started with the spigot end facing the tailstock, thus ensuring concentricity - make sure the two narrow locating rings are machined at the one setting. After parting off, the face can be finished.

Locking Pins (Item 47)

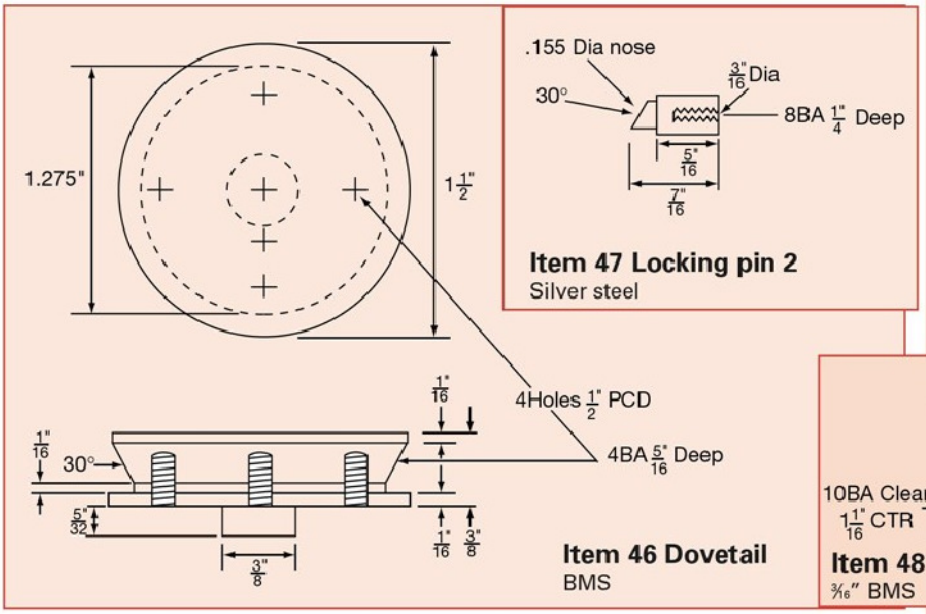
The two Locking Pins should be treated with care. They are locked in place using two Allen grub screws and it only takes a little nip of the screw to lock up the complete system. Over-tightening may result in the pins not being able to be removed, thus preventing dismantling should this ever be required so, as a precaution, I have drilled and threaded the pins 8BA so that extraction may be possible should they ever become stuck. Silver steel should be used for the pins which can be hardened. The reduced portion at the head is quite important, being there to take care of any distortion that may take place at the extreme tip end of the taper. Slight distortion can be caused at this point by the compression of the screw, thus preventing withdrawal, so the reduced portion will allow for this. With normal use and no over-tightening you shouldn't have any problem.

Degree Setting Ring (Item 50)

Although this unit is attached to the collet head as a separate item, I did think about the possibility of making it up along with the head, as one complete unit. This was ruled out as I thought it would be easier to carry out the various machining operations if they were treated as separate tasks.

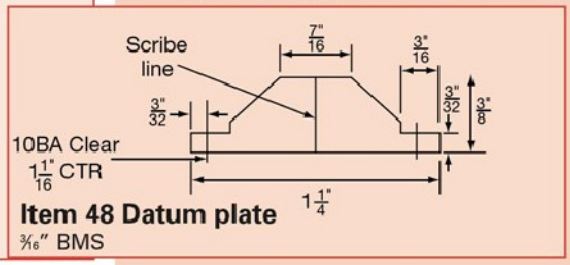
The blank for this should be cut 5/8in. thick to allow a holding shoulder, which should be machined just under 1/8in. wide. If you use the alternative set of chuck jaws, you will find that all the machining and graduating can be carried out without removal from the chuck. The shoulder can be removed at the very end, the recess that fits the Dovetail being very carefully machined for a very close fit.

As before, the graduations should be

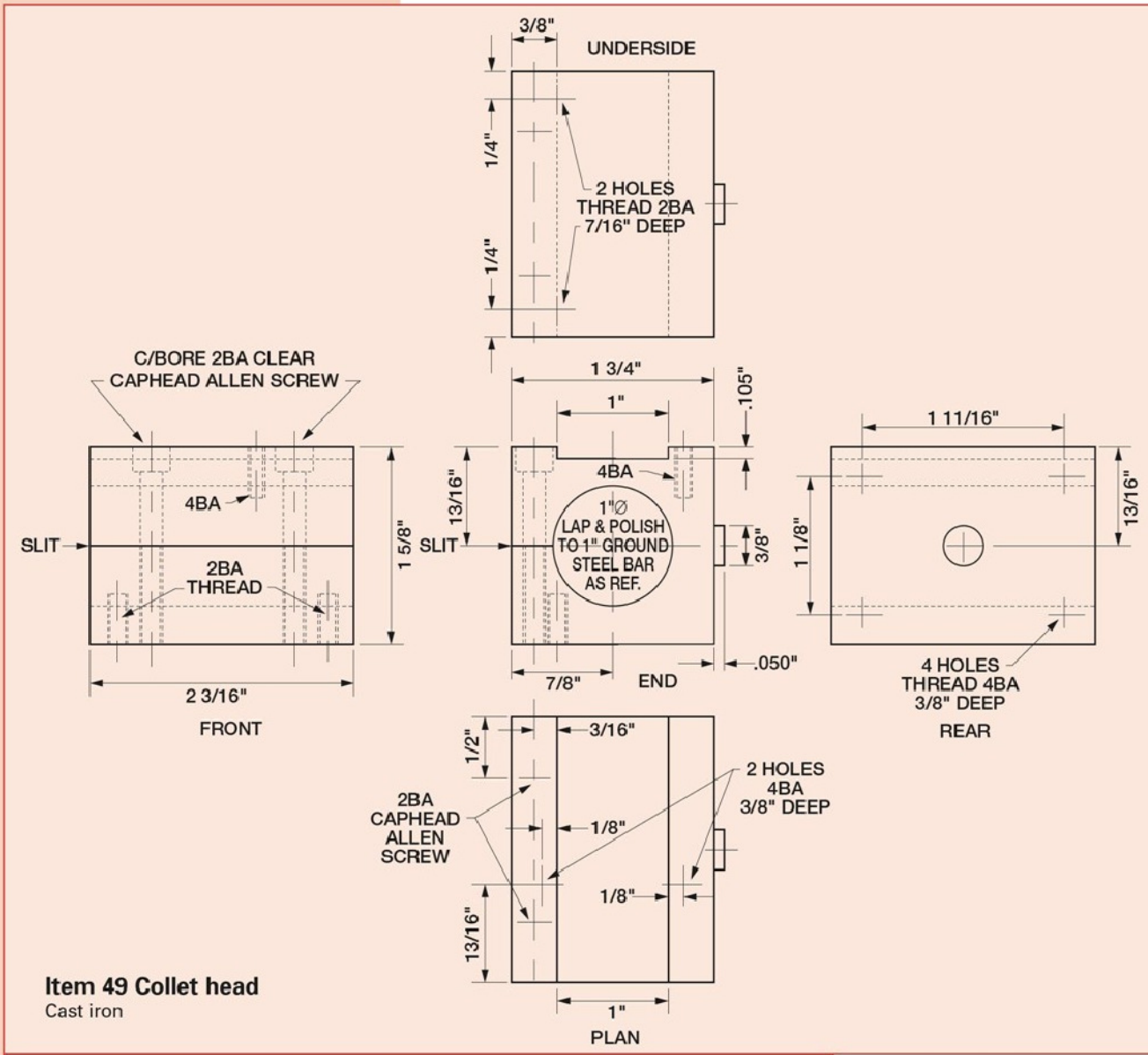


Item 46 Dovetail
BMS

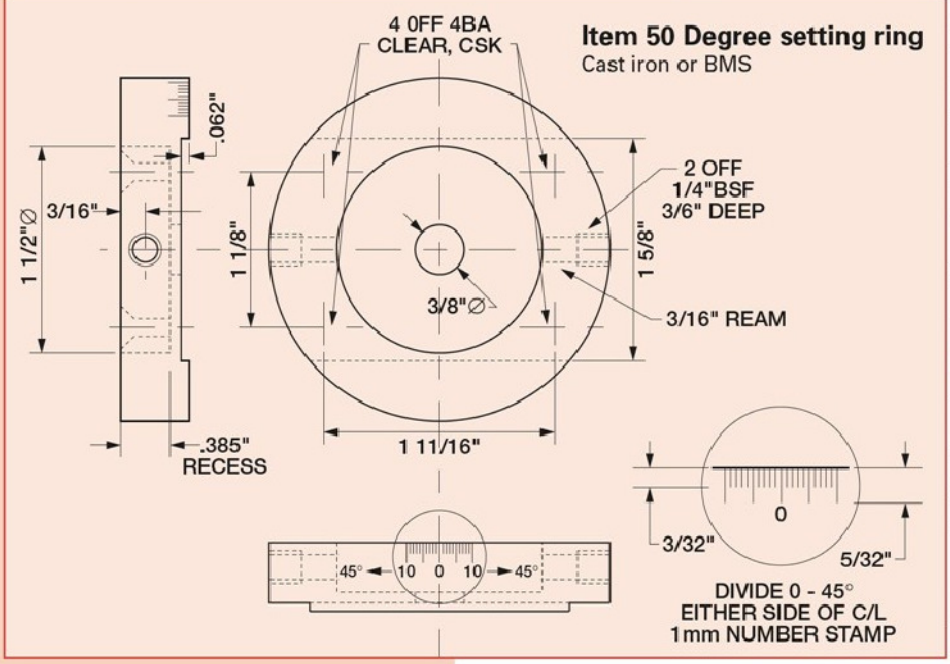
Item 47 Locking pin 2
Silver steel



Item 48 Datum plate
3/16" BMS



Item 49 Collet head
Cast iron



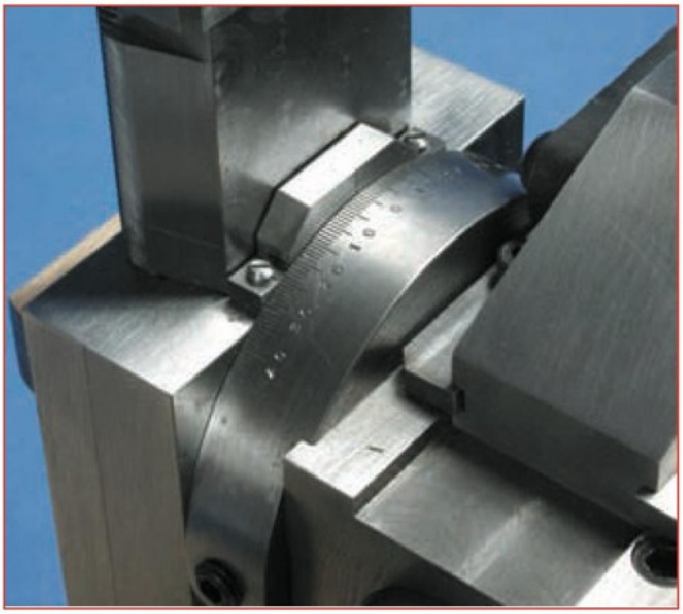
Item 50 Degree setting ring
Cast iron or BMS

added while the blank is still in the chuck. You will find that the graduations are very close together, so make sure that your scribing tool has a very fine point, but take care not to go to deep or you might lose it. Don't worry about the machining of the channel at this stage. The number stamping can be carried out using the little jig described previously. You will have to make appropriate spacers so that the figures are aligned in the correct position.

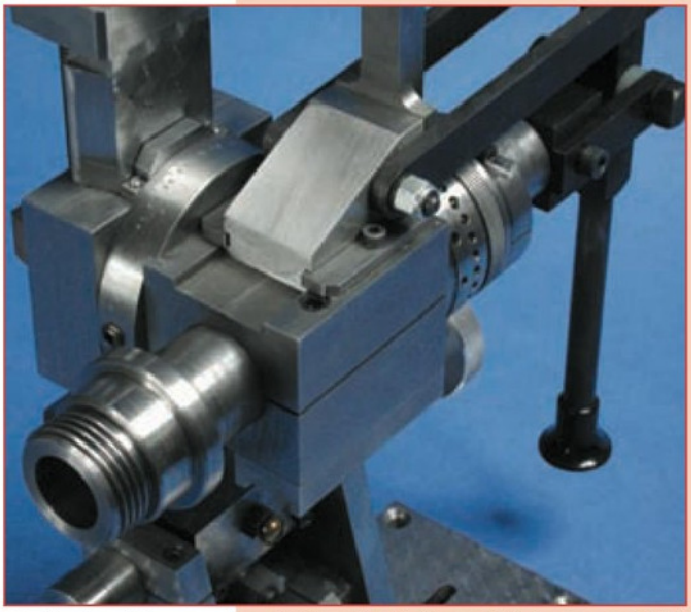
Take care when drilling the holes for the locking pins, which should be reamed. You will find that because of the shallow depth of the 1/4in. BSF thread you are likely to have to start the thread with the second tap. Make sure that you don't go too deep with the tapping drill and this also applies when threading.

Collet Head (Item 49)

The Collet Head **(Photo. 2)** was machined from a chunk of cast iron. If you have a suitable piece of steel it will do just as well, but cast iron is preferred. When you have it sized it up, set it up in the 4-jaw chuck and machine the small locating spigot first. Remove and then locate the head into the Degree Setting Ring, clamp in place and make sure that the zero setting is vertical and at right angles to the top surface of the Collet Head. When satisfied, carefully scribe a fine line, following the top and bottom edge of the block where it meets the face of the ring. You can now machine the



1. The collet head can be pivoted 45 deg. either side of horizontal (Photo. Mike Chrisp)



2. The head houses the spindle collet holder which features a 2MT socket capable of housing Myford collets. Other methods of holding the cutter to be ground could be incorporated to suit the builder's needs (Photo. Mike Chrisp)

shallow locating channel in the ring, being careful to make it make it a neat fit.

When it came to machining the bore of the Mk. 2 Collet Head, I increased the diameter to 1in. allowing the use of standard ground stock for various mandrels that might be required in the future. The bore must be very carefully measured so I made up a plug gauge which was 2 thou. undersize, providing an allowance for lapping and polishing.

I decided to use my trusty micrometer boring head for the machining operation as, in the past I have found that this method produces a very accurate and parallel bore. The operation proved to be very simple as I found that I could mount my Myford machine vice on the cross-slide, in which the block was set with a bit of packing underneath to bring it to the correct height **(Photo 3)**. After checking that everything was square and secure, the job was finished within half an hour. The workpiece could be clamped directly to the cross-slide or even mounted in the 4-jaw chuck and bored in the conventional manner. If so, use a good heavy boring tool, then the bore can be finished to size using one of those handy little three-stone hones that are now available. For gauging the finished bore I was able to obtain a piece of 1in. diameter ground bar, remembering to wash out the bore after honing. Slitting and drilling completes the head and shouldn't present any problem.

Spindle Collet Holder (Item 51)

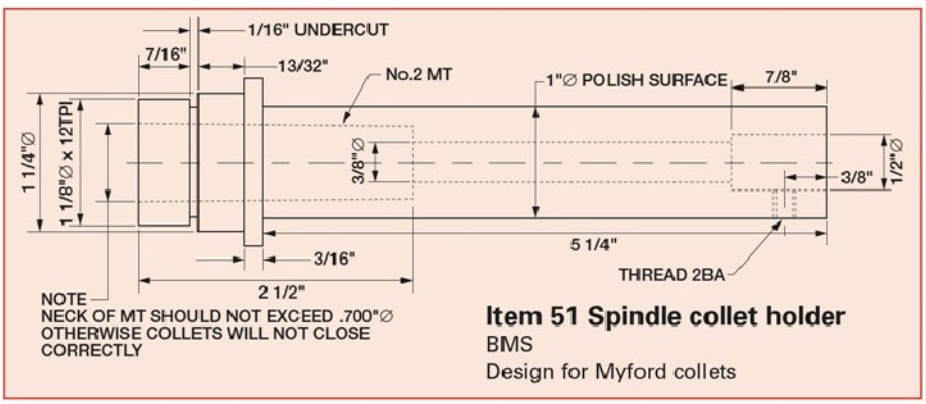
There is a fair bit of metal to be removed when making this item. I was fortunate in being able to obtain a blank which already bored out for the No. 2 Morse taper, but I will describe the machining sequence as applied to the Mk. 1 version, which was almost identical.

Centre the bar at both ends and mount between centres, then carefully machine down close to the 1in. diameter - within one or one and a half thou. will do. Finish the surface with very fine emery, 500 grit is suggested. I usually mount a piece on a square of surface-ground steel and use it like a sanding block, but very carefully moving it along and measuring as I go. If finely machined in the first instance you will end up with a surface almost equal to a ground finish. Reverse the Holder and re-mount between centres, remembering to protect the newly machined surface, and finish machine the nose. When complete, mount in the 4-jaw and support the nose in a fixed steady, then through-bore and machine the taper. It is important that the mouth of the taper does not exceed 0.700in. diameter, otherwise the collets will not close correctly. If you do happen to exceed this diameter there is some margin which will allow you to re machine and shorten the nose, thus correcting the error. You can check that all is well by mounting a selection of different diameter collets in place with appropriate blanks of material, ensuring that they lock up. When satisfied, finish the tail counterbore.

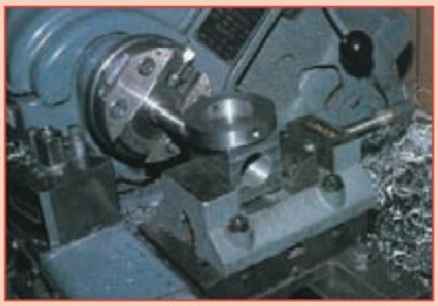
There is a Knurled Knob (Item 52) to be made for the end of the spindle, this being used only when grinding the helix angle and the nose of end mills and similar. Its purpose is to pull the end of the Spindle Collet Holder, with cutter, against the Support Finger. During this operation, twisting the spindle to follow the helix is also necessary. With a little practice, full control is quite easy, helped by the large diameter of the knob. The direction of the helix makes it preferable to start the grinding of the cutter at the shank end and work towards the nose, this method allowing much better control of the drawing and twisting action. There is also a simple Stop Collar (Item 53) to be made, this being fitted to the spindle to limit the forward movement when grinding the helix angle. Use a brass set screw for location, so as not to damage the surface of the spindle.

Cutter Support (Items 54, 55.56 & 57)

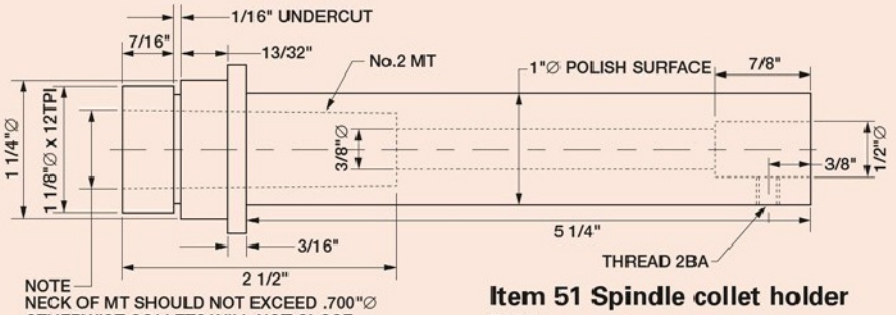
This assembly **(Photo. 4)**, simple as it is, was given a lot of thought. After careful consideration, I opted to make it part of the Collet Head as, once set, it would



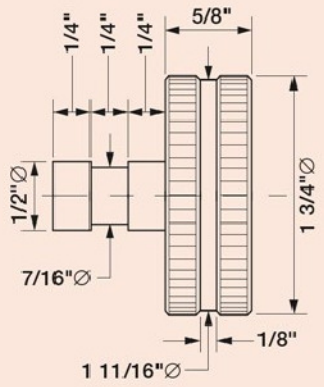
Item 51 Spindle collet holder
BMS
Design for Myford collets



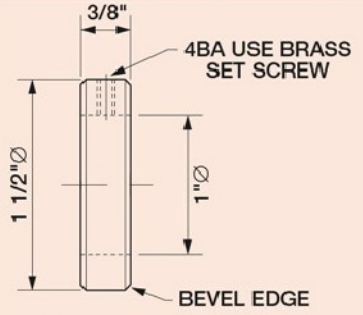
3. Boring the spindle hole on the collet head



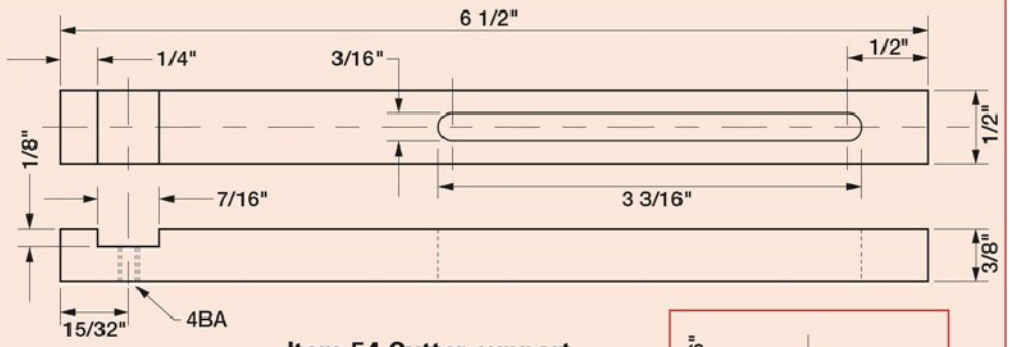
Item 51 Spindle collet holder
BMS
Design for Myford collets



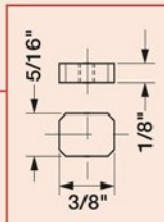
Item 52 Knob
BMS



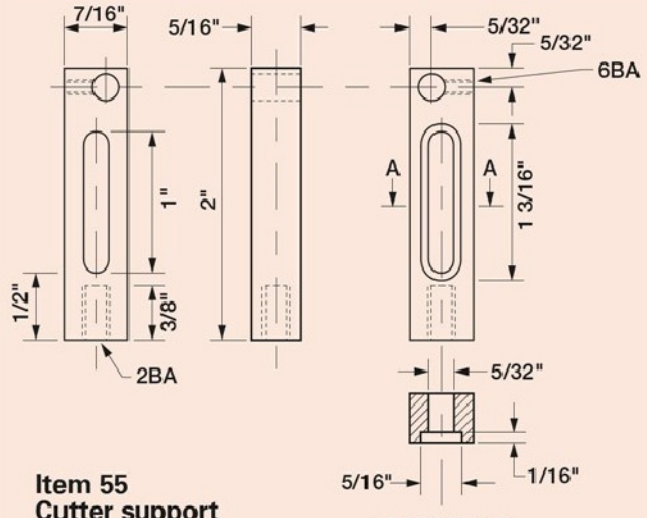
Item 53 Stop collar
BMS



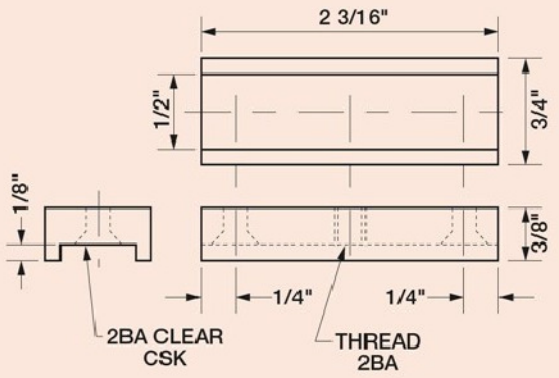
Item 54 Cutter support



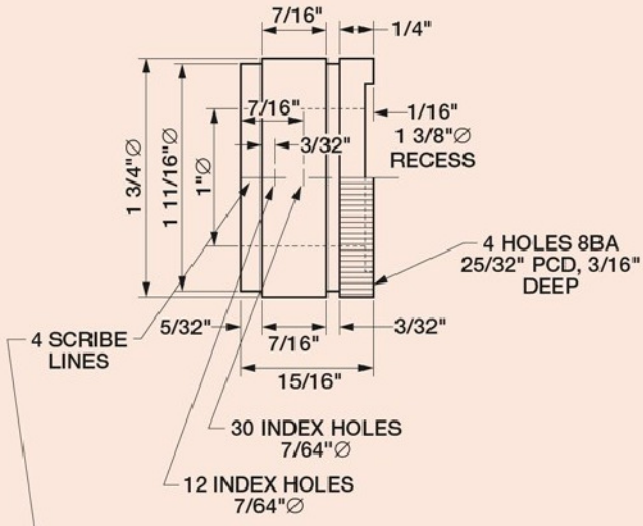
Item 57
Cutter support nut
BMS



Item 55
Cutter support



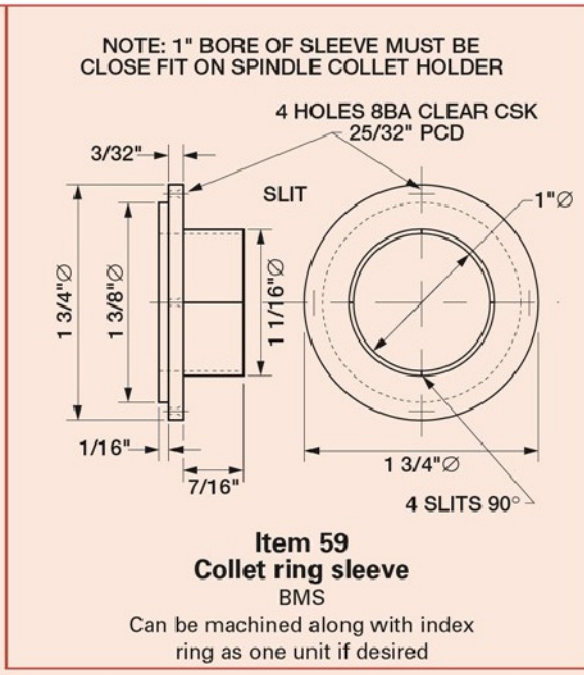
Item 56
Cutter support



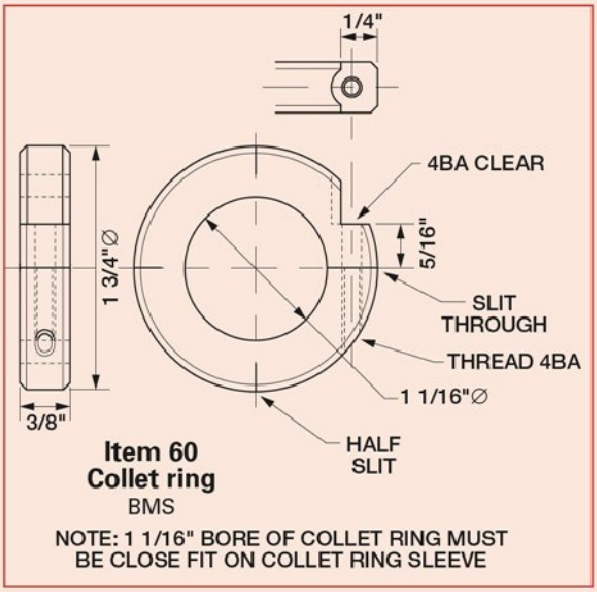
NOTE: 1" BORE OF INDEX RING MUST BE
CLOSE FIT ON SPINDLE COLLET HOLDER

4 - 1/4 DIV. REF. SCRIBE LINES - POS'N
LOCATED ON C/L WITH AID OF INDEX
PLUNGER UIT HOLES

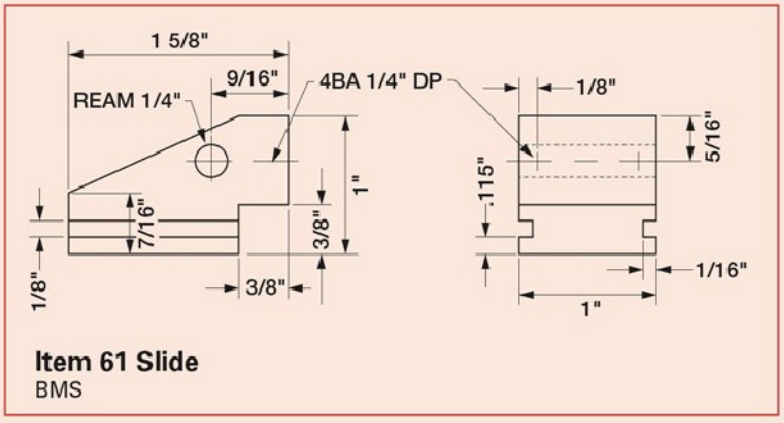
Item 58
Index ring



Item 59
Collet ring sleeve
BMS
Can be machined along with index ring as one unit if desired



Item 60
Collet ring
BMS
NOTE: 1 1/16" BORE OF COLLET RING MUST BE CLOSE FIT ON COLLET RING SLEEVE



Item 61 Slide
BMS

remain in the correct position whether or not the head was tilted or parallel. A simple sliding arm would take care of the cutter length, while another at right angles would take care of the cutter diameter. A set screw would look after the height adjustment. There is a small collar, with a set screw, which can be dropped in place to maintain centre height if the cutter support is removed. All the locking and adjustment screws are within easy reach.

Two varieties of tool rest can be used with this design, one machined from 3/16in. round silver steel and hardened, or the traditional flat spring blade which can be made from a piece of a broken hacksaw blade or spring steel. There is a 2BA hole in the end of the sliding support to accommodate the latter. Setting the centre height of the tool rest is very easy in this particular design, as all one does is to mount in the collet a piece of round silver steel, a portion of which has a flat machined to the exact centre line. The tool rest or follower can then be set to this centre line.

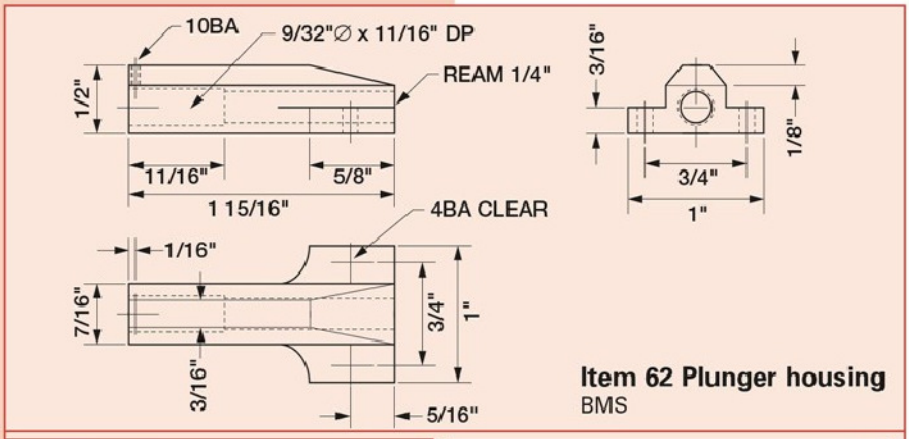
4. The cutter support assembly is a simple arrangement which can be adapted to accommodate a number of forms of tool rest (Photo. Mike Chrisp)

Optional Indexing System (Items 58, 59, 60, 61, 62, 63, 64, 65, 65a, and 66)

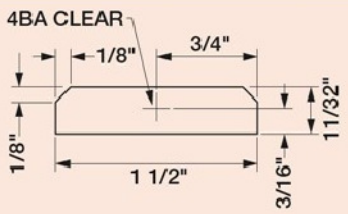
In the event of the cutter support not being used for its primary function - that of supporting and locating the cutter in the required positions, according to the number of teeth it may have - it is necessary to have some other form of dividing arrangement. I therefore decided that a simple direct indexing system would have to be fitted, the obvious answer being to add an Index Ring (Item 58) to the Collet Holder and to couple this with a simple plunger arrangement **(Photo. 5)**.

I must confess that the latter caused me a bit of heart searching as to the design. The usual horizontal arrangement was not able to be machined directly into the block as there was just not enough material to accommodate it, although it could have been be added on. Another consideration was that if this solution were adopted, the Plunger would be locating into a hole that would be hidden from view. To overcome this, I came up with the design shown. As you can see, it is a vertical arrangement, and because the unit is built on to a simple slide it is possible to have more than one set of holes in the ring. When not required, the assembly can be removed.

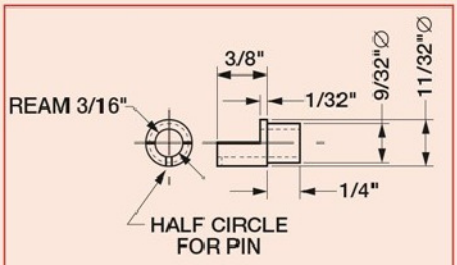
It is a straightforward item to make, but care is required when machining the bore to ensure that it is very close fitting. In my own instance I finished the bore by lapping. The split Collet Ring Sleeve (Item 59) is shown on the drawing as a separate unit, but if you wish you can make it part and parcel of the main Index Ring. Consequently you will not need to machine the recess, but you will need a longer piece of material to accommodate



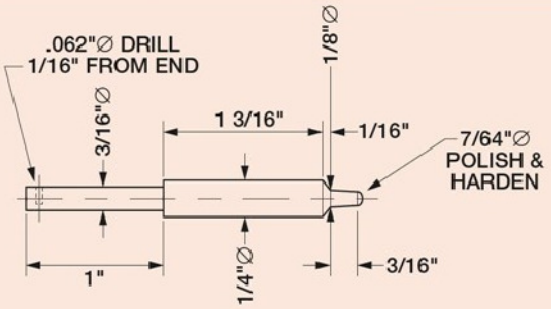
Item 62 Plunger housing
BMS



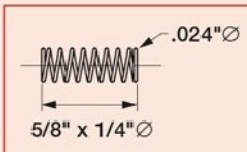
Item 63 Clamp plate
(2) BMS, ⅛" thick



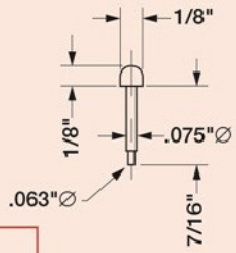
Item 64 Collar
BMS



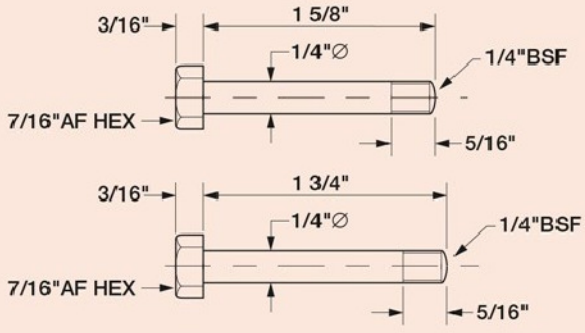
Item 65 Plunger
¼"ØSilver steel



Item 65A Spring



Item 66 Pin



Item 67 Hex bolts

the Collet Ring (Item 60), a simple split clamping ring which allows the index ring to be locked in any position on the spindle.

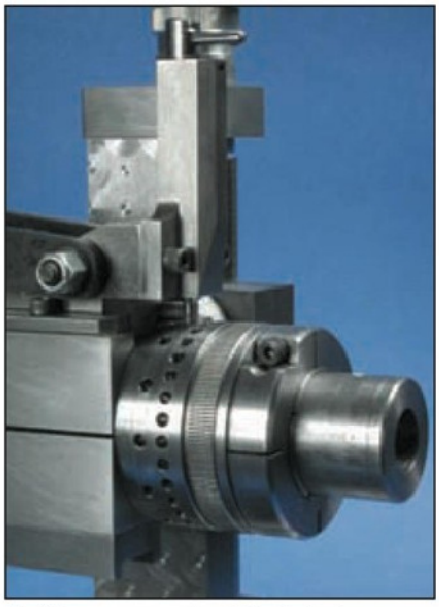
I would recommend that you use a new drill bit for drilling the index holes in the ring, there being 12 holes in one row, with another row of thirty next to it. These should be sufficient for most requirements, the selection of any combination within the 12 being easily made. As four divisions are likely to be the most popular, I have highlighted the four positions with a scribed line. When setting up, if you align this mark with the horizontal slit in the body of the Collet Head, you will find that the Plunger will automatically select the correct position. After the index holes have been drilled, remove the sharp edge at the point of entry. There is no need for an elaborate set-up -just hold a countersink between the fingers and give it a little twist at each hole.

The head of the Plunger is machined to 7/64in. dia. for part of its length and then tapers out to 1/8in. diameter at the shoulder in order to ensure positive location in the hole. Make sure you have a good polished surface on the nose of the Plunger, if possible using a collet to ensure the necessary accuracy when machining the reduced portion of the Plunger. This item is best made from a piece of silver steel which can be hardened.

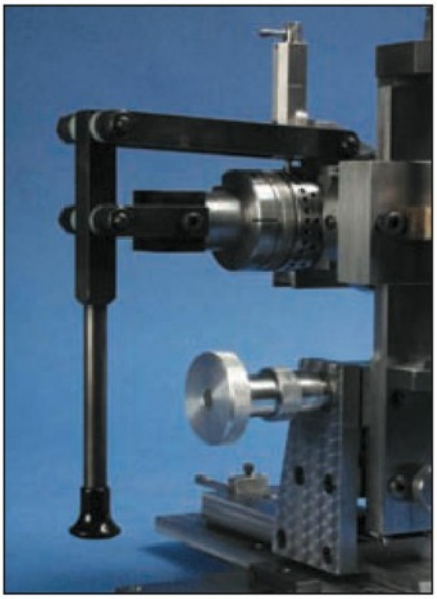
Optional Lever Attachment (Items 67 to 75)

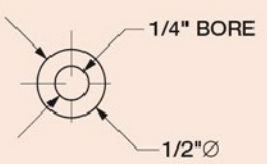
The problem of designing a piece of equipment is that one does one's best to try and keep it simple, while at the same time attempting to ensure that it is versatile . This can sometimes lead one to falling between two stools. However, I thought it would be worth the effort to include some form of longitudinal traverse arrangement for the collet holder, thus allowing the grinding of countersinks and Woodruff cutters. Although it would be restricted in its longitudinal movement, it would be a useful asset and, as it has turned out, it has also proved invaluable for dressing up the grinding wheels.

I thought it would be easier to traverse the cutter across the wheel since it is already mounted in a spindle, rather than traverse the grinding wheel across the cutter. The Index Ring, which has to be set initially, is released so that the accuracy of the movement is then left under the control of the pivoting arms and their fixings **(Photo. 6)**. If carefully made and adjusted there should be no radial play. My other slotting attachment for the lathe uses the same system and it has proved to be very precise in its operation for many years now.

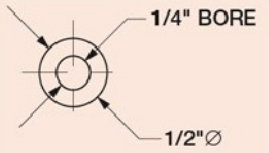


5. The components of the indexing system. The detent plunger housing can be moved to bring the plunger in line with the selected row of holes (Photo. Mike Chrisp)

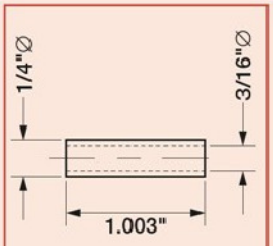




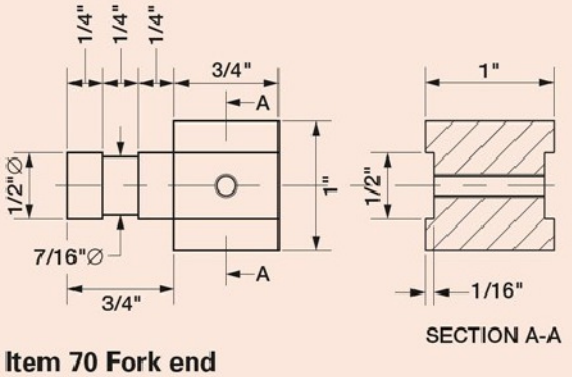
Item 68 Nylon spacer
2 off 3⁄16" thick



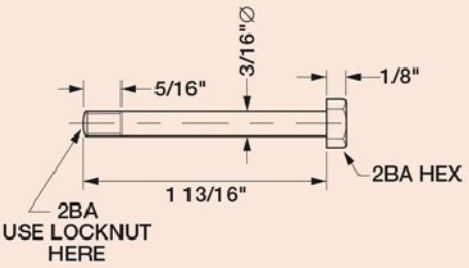
Item 69 Nylon spacer
2 off ¼" thick



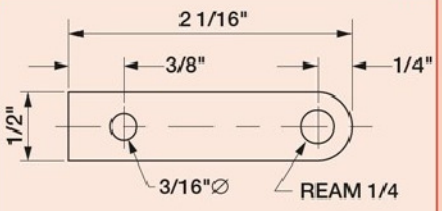
Item 70 Spacer
¼"Ø Silver steel
for use in slide index
plunger unit



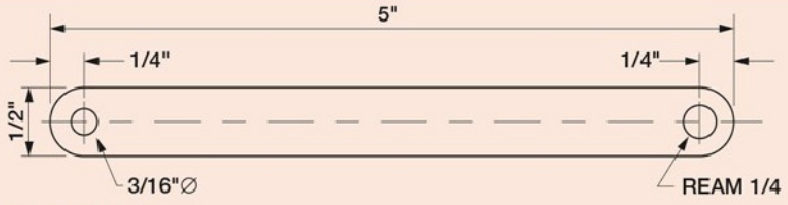
Item 70 Fork end
BMS



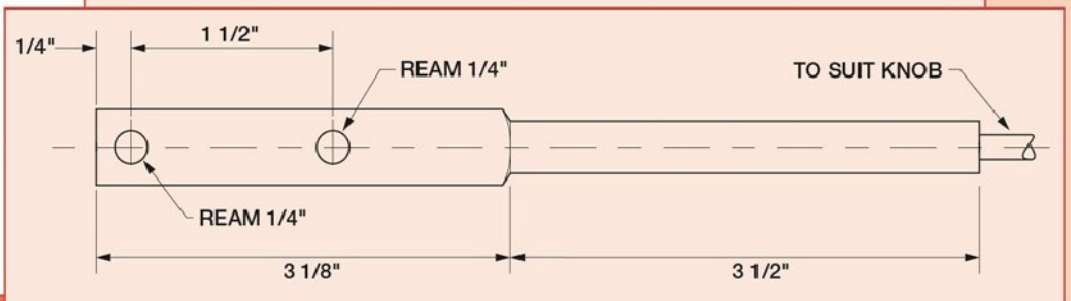
Item 72 Hex bolt
For use in slide index plunger unit



Item 73 Link
2 off 3⁄16" BMS



Item 74 Link
2 off 3⁄16" BMS



Ream all the holes in the Links in pairs and pay particular attention to the Spacer (Item 71). Its length is critical in order to maintain a sliding action without any radial play, so it should be just a few thou. longer than the thickness of the block in which it is located. The nut can be tightened down hard on the collars, with just enough clearance to allow the arms to swing without any side play. Some may wonder at the operating Lever being fitted so that it points downwards. In practice, due to the geometry of the system, I found that I had more control of the movement in that position. Also, when used as a slotting attachment in the lathe, as mentioned in my opening description, the Lever is in the correct position.

The operation for linear grinding when using the lever attachment and the index unit is as follows:- select an index hole on the Index Ring (which should be free on the Spindle), lock the end traverse block on the Spindle and grind the object, as required, using lever control. Lock the Index Ring on the Spindle, unlock the end traverse block, lift the Plunger and rotate the Index Ring, with Spindle, to the next required hole position. Insert the Plunger, lock the traverse block and unlock the Index Ring from the Spindle. Continue with grinding, repeating the sequence until grinding is complete. It really is quite a simple operation.

Another method, which is a little easier if you can use the finger attachment, is to index the cutter against the finger. Rotation to the next position after grinding is achieved by loosening the cutter in the collet and rotating it until contact is made once again with the finger.

Supplier

Full kits of materials and accessories are available from Model Engineering Services, Pipworth Farm, Pipworth Lane, Eckington, Sheffield S21 4EY Tel./Fax 01246 433218

LATHE PROJECTS FOR BEGINNERS (12)

Getting to grips with the faceplate

Harold Hall has designed this two-wheel knurling tool in such a way that it provides a number of opportunities for face plate work

1. The parts that make up the knurling tool with some features being incorporated with the use of the faceplate particularly in mind. Typically the recess in the mounting bar, centre top of the picture

It is easy to lose sight of the real purpose of each part of the series, for this one believing its aim is to make a two-wheel knurling tool. Whilst this is the end product, its main function is to discuss faceplate work with some instructions on knurling to conclude the two part article.

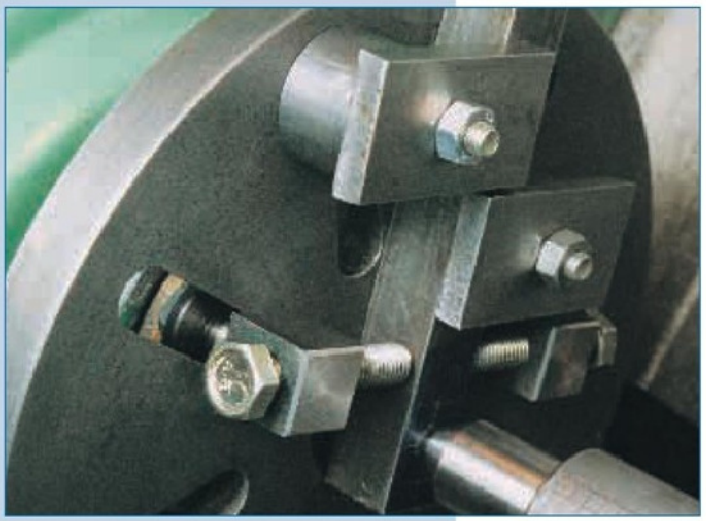
Two wheel knurling tool

In my view, this form of knurling tool (see assembly drawing, **Figure 1**), should be the standard for use on small lathes, as it minimises the load on the headstock bearings, which can be considerable when a single wheel tool is used. The design has been established to require faceplate operations and gives plenty of scope for getting to grips with the use of this accessory as a work holding device. **Photo. 1** shows the parts that go to make up the knurling tool.

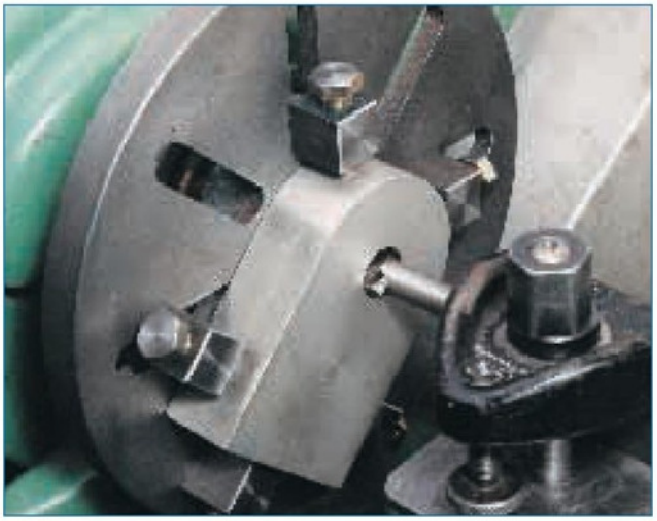
Faceplate work

This is the most varied of all forms of lathe work as the shape and size of the parts which can be mounted on the faceplate is far more diverse than that which can be held in a chuck. The task in hand often needs special items to be made to enable the part to be adequately and safely anchored, and it is that last aspect, safety, that must have first consideration. With such irregular parts, using a multitude of clamping devices, it is all too easy for one's person or parts of the lathe to come into contact with these as they rotate. Because of this, consideration must given to minimising any unnecessary projections. Clamping studs are a major problem, as only a limited range is likely to be available and there will be a temptation to use studs which are too long. If this is the case, do not hesitate cut down the studs to a safer length, I was about to write "a safe length", but realised that no set-up on the faceplate is totally safe.

Using suitable clamps is another major consideration; again these should be as small as is possible, yet of adequate strength for the task. It is worth noting that a shorter, smaller cross-section clamp can be stronger than a longer larger one which may bend more easily. Keeping the clamping arrangement more compact will be both safer and more secure. Invariably, a simple stud and bar clamp will require a



2. The mounting bar being positioned on the faceplate



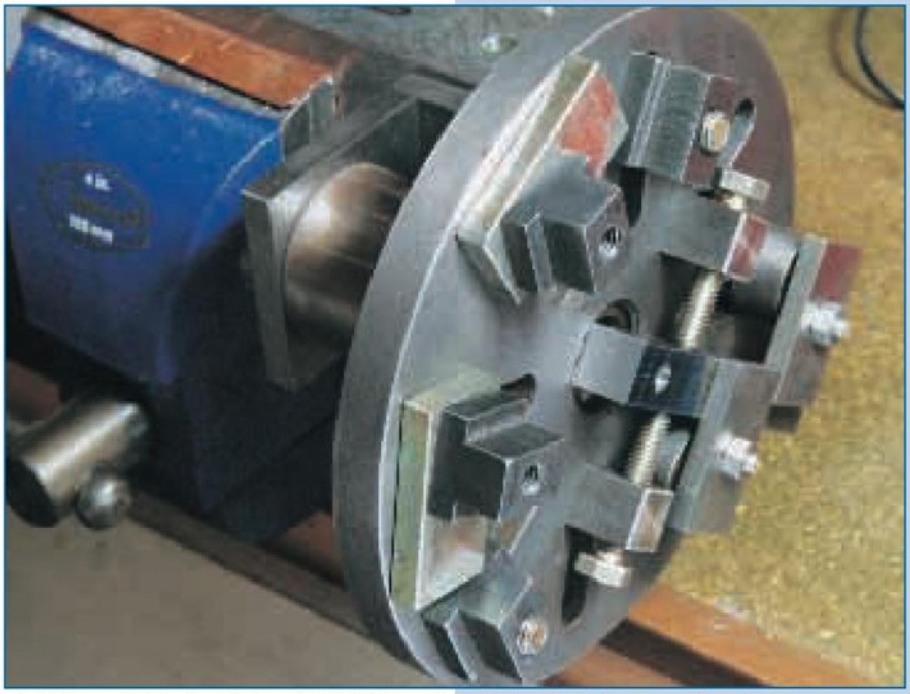
3. Faceplate dogs being used to clamp a large bearing block

packing piece under the free end, and this must be just taller than the part being clamped. Of greater significance in this case, where the clamp is moving rather than fixed as on the milling machine table, is that the packing itself should be captive to the faceplate. It is not unknown for a clamp to become free whilst turning is taking place, the outcome of which is that the piece of packing will be thrown from the rotating assembly and the clamping force will be lost. Both are likely to have serious consequences.

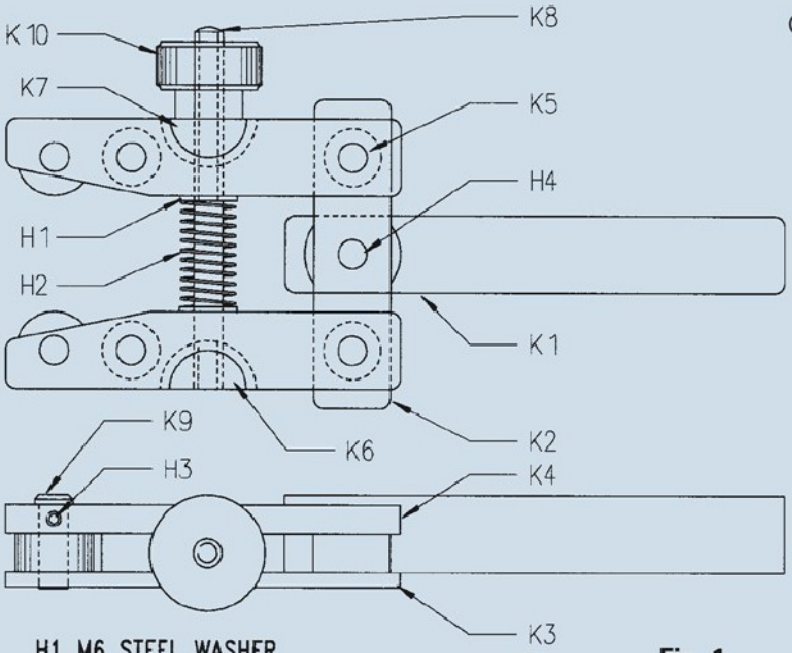
It was with these problems in mind that I developed the clamping system seen in **Photo. 2**, and briefly illustrated in **Sk. 1.** The set-up in the photograph also uses screw clamping dogs. The clamping system, described in a past issue of the magazine (Ref. 1), consists of a number of parts designed to make it capable of dealing with a range of component heights. Its main feature is that the stud is tapped into the packing piece, making the stud and the packing captive prior to the clamp being applied. With the stud secured in this way it cannot break free and also, if any one stud would benefit from slight repositioning, it can be loosened and moved without parts falling from the assembly. If it is not too big- headed of me, I cannot rate the system too highly as it really does make a potentially difficult operation much less hazardous.

The clamping dogs **(Figure 2)** will also make a valuable addition to your kit of parts for mounting items on the faceplate, typically the bearing block shown in **Photo. 3**. One major advantage of these is that they can be used to easily make final adjustments to the position of the part being held. They require little explanation as to the method of manufacture, but will give valuable additional experience in the lathe procedures so far discussed. A point I would like to stress here is not to be tempted to get by with normal washers, even the heavy gauge ones, when using slotted mountings. They are not sufficiently strong. It would be a good idea for a mini project, using a thin piece collet (M.E.W. Issue 69, page 29), to make a quantity of the commonly required sizes, probably M6, M8 and M10, with substantial thickness and in larger than normal outside diameters.

As an aid to security, always use at least three clamps in all but the simplest of set-ups. Items that just support the part can be a valuable additional safety feature (see comments re Photos 8 and 9).



4. Using a balancing fixture (Ref. 2) to assist in balancing the assembly. A much superior balance is achieved compared to balancing with the work mounted on the lathe spindle



H1 M6 STEEL WASHER
H2 COMPRESSION SPRING
H3 M3 X 5 SOCKET GRUB SCREW
H4 6mm DIAMETER X 18MM LONG HEADLESS RIVET

Fig. 1 Two wheel knurling tool assembly

Making the two wheel knurling tool

Mounting bar (K1)

Cut a length of 16mm square steel 101mm long and face each end whilst mounted in the 4-jaw chuck to give a 100mm length. Mark out and drill the 6mm hole and use this to locate it on the face plate, using the tailstock centre as shown in Photo. 2. Closer inspection of the photograph shows the assembly is very much out of balance and if the lathe were run it would vibrate severely. It is necessary, therefore, to balance up the assembly by the addition of some suitably placed weights. To do this the belt must be freed from the headstock pulley, allowing the mandrel to rotate as freely as is possible. Add the weights, spin the faceplate, and observe the result, making changes as the test indicates. For relatively light assemblies I find that tee nuts from the milling machine make useful

5. Boring the recess in the mounting bar

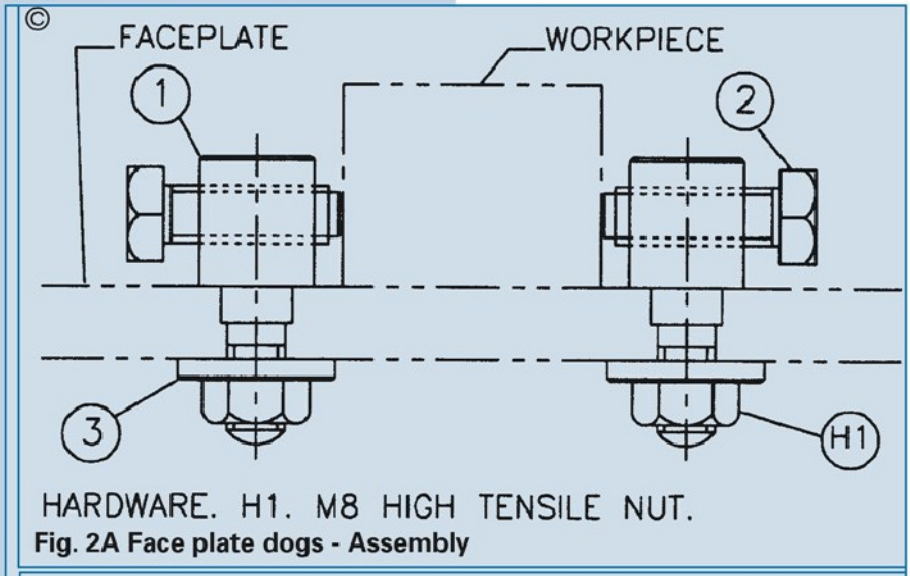


Fig. 2A Face plate dogs - Assembly

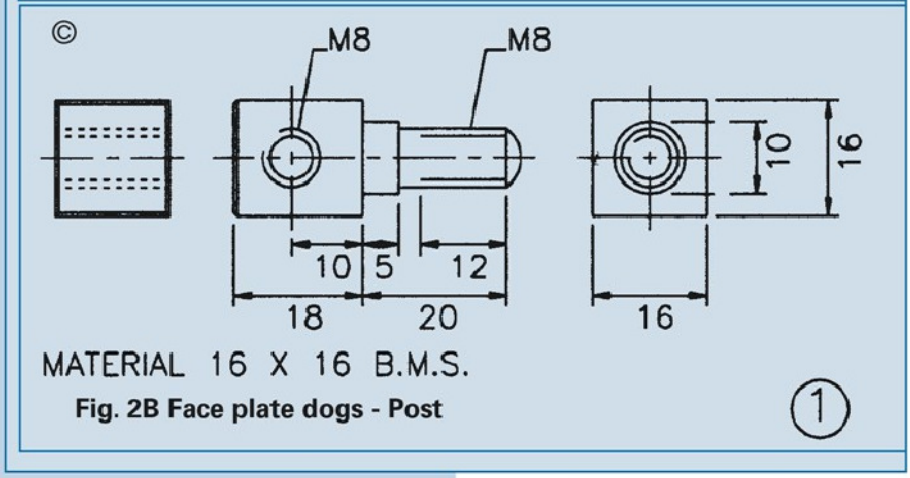


Fig. 2B Face plate dogs - Post

weights, see **Photo. 4**.

One problem with balancing face plates is that even with the belt freed from the pulley, drag from the lathe bearings can have a significant effect on attaining an effective balance. To overcome this, the dedicated balancing fixture (Ref. 2) with free running bearings, as seen in Photo. 4, will enable a much superior result to be achieved, enabling higher lathe speeds to be used.

Having mounted and balanced the assembly, move the cutting tool close into the work and turn the faceplate by hand to see that it rotates without fouling. This is not though foolproof, as the saddle and/or top slide will no doubt move closer as the work progresses, so do continue to take considerable care. This is an absolutely essential precaution which must be observed when working with the faceplate.

Enlarge the 6mm hole with a larger drill, say 10mm, to a depth of 5.5mm, followed by boring out to 20mm diameter and to a depth of 6mm. However, as the bore is 20mm diameter, but in a 16mm wide bar, the cut eventually becomes intermittent, as seen in **Photo. 5**. Providing the tool is sharp and robust, the operation should not be a problem.

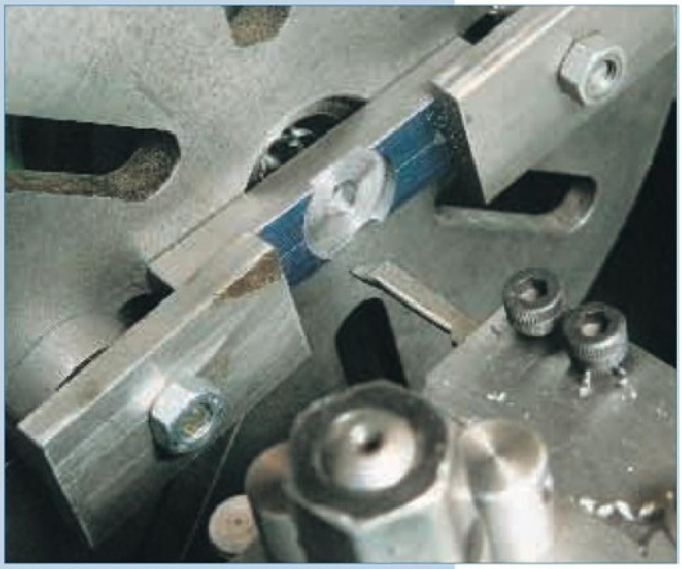
Cross piece (K2)

This is treated much like the mounting bar, but the assembly, being symmetrical, is automatically balanced, **Photo. 6**. Note how the clamping system easily copes with this assembly and two clamps are more than adequate.

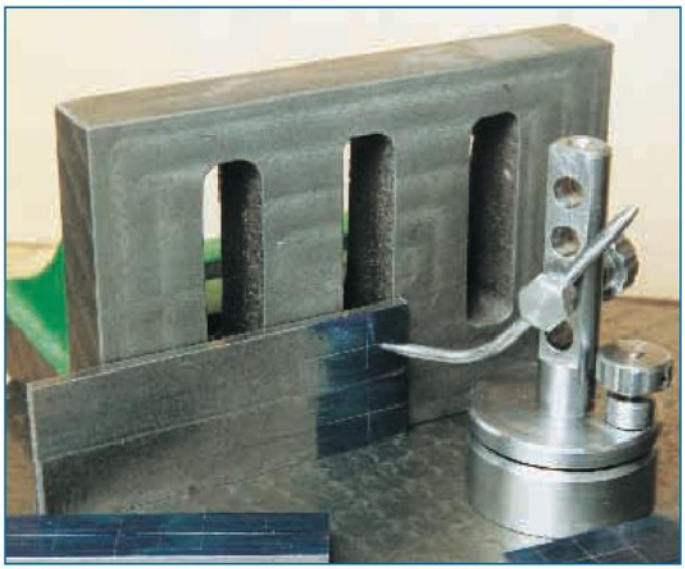
Arms (K3 and K4)

The four arms are almost identical, but with one pair being thicker to allow for a grub screw to be fitted for holding the wheel pin (K9). Cut the four pieces, just over length to allow for finishing. Debur, but do not machine the ends. Mark out the end 6mm diameter hole position on all four pieces and the remaining holes on one piece only. This is a job for the mini gauge made in the first part of the series, **Photo. 7**. Drill the 6mm end hole in all four pieces and then stack them up with a 6mm pin through the four parts. With this done, drill the remaining holes as a pack, ensuring as a result that all holes line up. Make another 6mm pin and fit this in the second 6mm hole.

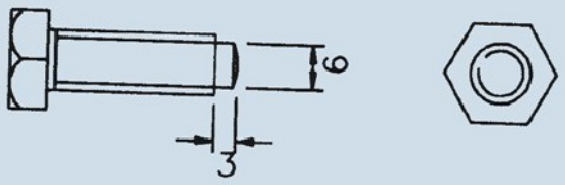
The task now is to make the half-round cut-out in the sides of each arm, doing this as shown in **Photo. 8**. With this intermittent cut there will be a tendency to move the parts sideways. As a precaution a fence is placed at the underside, just visible in the photograph, to support the arms. In fact, by positioning the fence prior to placing the arms, accurate location can be achieved with ease. To do this a lathe centre is fitted to the tapered socket of the mandrel and, knowing its diameter, spacers of the correct size used to position the fence. This procedure is seen in **Photo. 9**. The spacers being used are the thickness gauges described in Issue 73



6. Recessing the cross bar. A similar operation to that required on the mounting bar but the set-up here is much simpler, as the assembly is automatically balanced

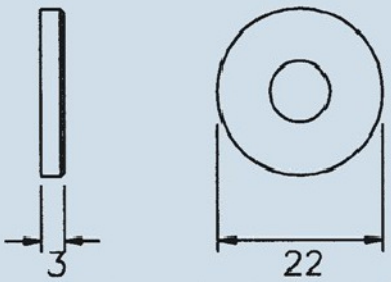


7. The mini surface gauge described in Issue 68 being used to mark out some of the parts for the knurling tool



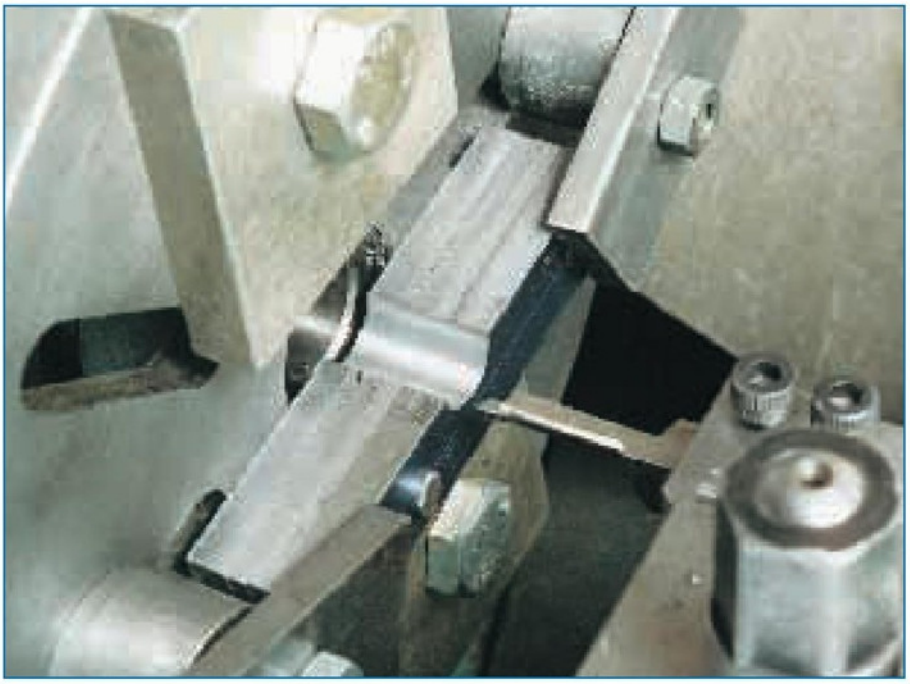
MATERIAL.
M8 X 25 HIGH TENSILE SCREW.
DOME END VERY SLIGHTLY TO
HELP MINIMISE DAMAGE TO
WORKPIECE WHEN USED.

Fig. 2C Face plate dogs - Clamp screw (2)



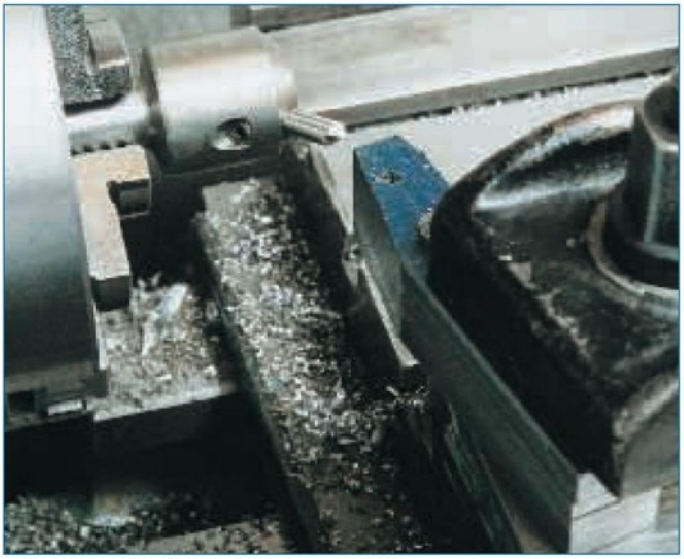
MATERIAL 22 dia. B.M.S.
HOLE 8.1 dia.

Fig. 2D Face plate dogs - Washer (3)

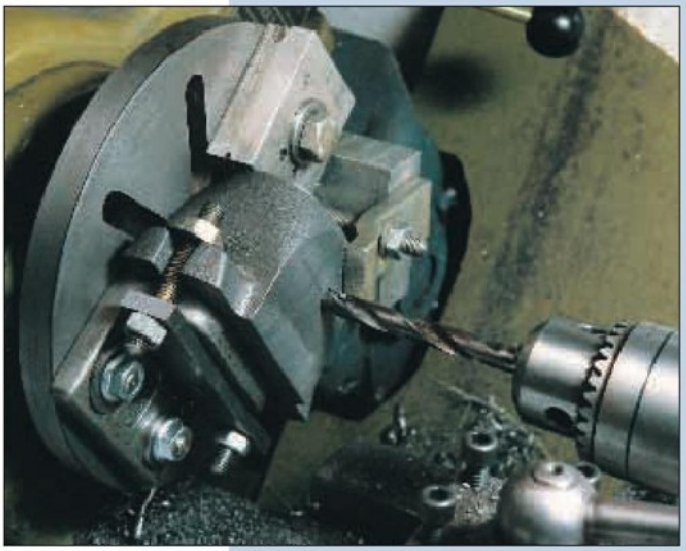


8. Making the half-round recesses in the arms; note the supporting block just visible below the arms

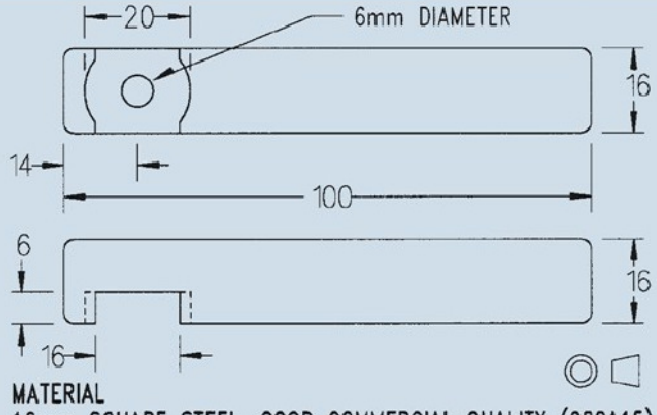
9. Using the width gauges (see Issue 73), to set the position of the arm supporting block seen in Photo. 8



10. Fly cutting the arms whilst held as a pack on the top slide

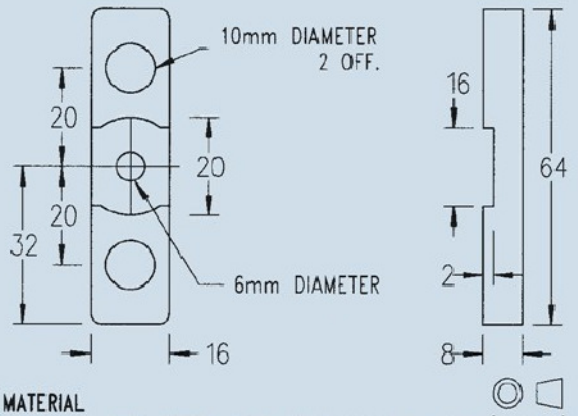


11. An example of a more demanding faceplate assembly than those discussed in this article



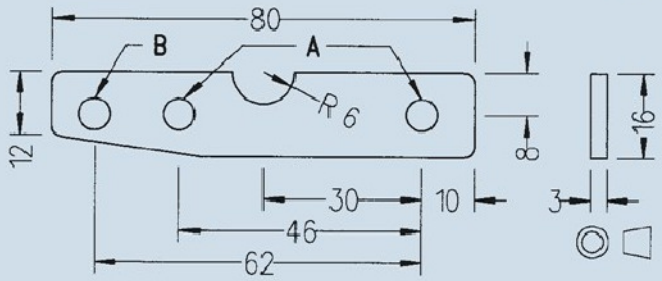
MATERIAL
16mm SQUARE STEEL, GOOD COMMERCIAL QUALITY (080A15)

Fig K1 Mounting bar



MATERIAL
16mm X 8mM STEEL, GOOD COMMERCIAL QUALITY (080A15)

Fig K2 Cross bar

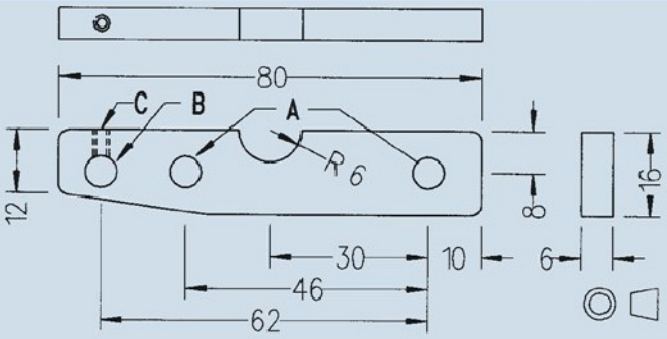


HOLES. A 6mm DIAMETER 2 OFF. B 1/4IN, DIAMETER 1 OFF

MATERIAL
16mm X 3mm STEEL, GOOD COMMERCIAL QUALITY (080A15)

QUANTITY 2 OFF

Fig K3 Swinging arm, thin



HOLES A 6mm DIAMETER 2 OFF. B 1/4IN. DIAMETER 1 OFF.
C M3 1 OFF.

MATERIAL
16mm X 6mm STEEL, GOOD COMMERCIAL QUALITY (080A15)

QUANTITY 2 OFF.

Fig K4 Swinging arm, thick

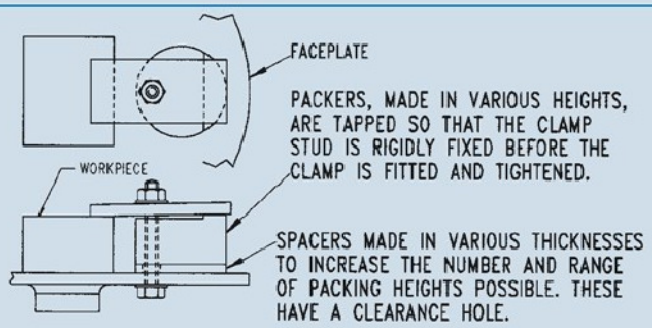


Fig SK1 Clamping system for face and angle plates

page 27.

Mount the stack (complete with pins) on the faceplate using the fence as an aid to positioning it, clamp in place and balance. The half-round cut-out can now be turned using a suitable boring tool. One problem exists though. It has been explained that a boring tool can only start from a pre-formed diameter which will provide clearance around the tool head, but in this case it is not possible to drill a hole. It is necessary, therefore, before fitting the component to the faceplate to partially file the cut-out. Commence the boring operation, taking care due to the intermittent cut. As the size approaches 12mm use the 12mm hole gauge (Issue 72 page 28) to check its size, continuing to enlarge the cut-out until the gauge just drops into it. As Photo 8 shows, even with the intermittent cut, a presentable finish can still be achieved.

With the pieces still as a pack, mount them on the top slide using the tool clamp and fly cut the tapered end, **Photo, 10**. This is a typical case of a task that can very easily be carried out on the lathe, probably more quickly than setting up the milling machine. Similarly, set up the stack so that the ends can be finished using the fly cutter. Make a generous radius on each of the four corners, using a file, whilst held in the bench vice and still with the parts joined as a stack. Finally drill and tap the M3 holes in the two thicker arms.

This completes the faceplate activity, the turned parts and assembly will be detailed in the next issue. Whilst the essential requirements of faceplate work, being safety and security, have been well emphasised, the examples are less demanding than will often occur. This, of course, is no bad thing, forming an introduction for the novice, but for an example of a more exacting situation see **Photo. 11.**

References

1. Faceplate and Angle Plate Clamps, M.E.W. Issue 20 page 24
2. Faceplate Balancing Fixture, M.E.W. Issue 55 page 12

METALWORK IN THE MIDDLE OF NOWHERE

We are aware that a substantial number of our readers are involved in activities which require them to practice their skills in locations remote from their workshops. Trevor Marlow offers a few suggestions which may help

1. Deliberately made to be near the limits of portability, a 'vice on solid four by two base' assembly that can be used flat on the ground, as seen here, on fold-away legs, or on a free-standing base. While it is really a two-man job to carry it about (make sure you get the light end!), it can be 'walked' on its corners

The more capabilities you develop in the engineering, metalworking, repair, fabrication and related activities, the richer your life will become. One aspect of that enhancement is that to all your friends and neighbours you will become identified as Mr Fixit, the person possessing such esoteric knowledge, arcane skills and special equipment that you can almost certainly fix that problem that is currently blighting their lives.

Let us admit that some approaches by such parties can be rather flattering, and that on such occasions we often have to fight to control the onset of smug expressions. Let us also admit however at the same time that some such tasks will prove to test our capabilities to the limit. Some tasks should be so darned simple ... and straightforward ... and yet they turn out to be a nightmare! When that happens, there are two primary causes of your frustration and distress. Firstly there is the knowledge that everything *should* be going smoothly, that you *should* in fact have finished the job some time ago. Secondly, there is the dawning realisation that the originator of the task is quickly shifting opinion from envious admiration of your skills to increasing disdain at your incompetence.

In this nightmare scenario, there are oft-recurring features. For instance, a degradation process such as rusting might have proved to be far more extensive than it appeared at first sight, or we might have been presented with a repair job on a notoriously difficult material such as, say, Mazak. In time we will inevitably have become better at the initial appraisal of the situation, and we may have become better at tackling the difficult jobs, in one way or another. There is, however, one situation that never seems to get any easier and tends to prejudice the prospect of a successful outcome, that being when task cannot be brought to your workshop, that place where all your tools and facilities are immediately to hand. Instead, circumstances dictate that the job has to stay in the barn, in the field, at the roadside, or whatever other awful location has been chosen by an unsympathetic fate!

Then, when you seek to weave your magic spells, everything you try to do, no matter how simple, will be beset by difficulties that you never meet in your workshop. For example, an item that will contribute to a repair is simply too long. Normally there would not be a problem: you would hold it in your vice and hacksaw down to an appropriate length. Try doing that in a field, even if you have brought the hacksaw! Sawing is only practicable when the blade can be kept in line with the early cut. If the workpiece is free to wobble or move out of that correct alignment, the blade will at best jam and at worst will break. Every other simple action that you attempt will be similarly bedevilled, be it bending, tapping, forging, filing, or drilling. This difficulty in working outside your workshop will not only constrain how useful you can be to others: it will equally constrain how effectively you can do your own jobs in other parts of your property, say at the bottom of the garden or on the roof. So, implementing remedies to the 'remote from the workshop' problems is a good idea irrespective of whether you are viewing the requirement altruistically or selfishly.

The biggest problem is that we are lacking a multi-functional 'thing' that serves variously to hold, to squeeze, to serve as an anvil, to provide a torque counter-reaction, or to provide a simple but steady rest while we do some marking out. We need a something that combines the values and virtues associated both with our heavy bench vices and our folding workbenches, such as made by Wolfcraft, Clarke, or Black and Decker.

There *are* such things as portable vices

2. A portable bench with all four legs independently adjustable, here set up on a pile of rubble to illustrate why it can be used almost anywhere. Notice the locking pliers clamped to the worktop, as might be used for lighter jobs The removable cords seen near the bottom of the front legs have been found to be a valuable asset when deploying the legs on fairly level ground.

of a 'middling' size that, clamped to a substantial surface, if available, would go a long way towards providing a reasonable working facility. The floor of a pick-up truck can be ideal: it is after all not going to be readily moved by mortals even if they have had a Weetabix breakfast, and it will not matter a lot if the various surfaces are scratched or suffer impacts. Alternatively, a simple construction such as shown in **Photo. 1** can be even more useful. Make from lengths of 'four by two' timber, screwed together with 3in. No. 12 screws, to which you bolt the biggest old vice that you can lay your hands on. Use big screws rather than big nails, as joints can then be re-tightened, and it is so much easier to modify the assembly if the need arises. It can be made an optimum size to go into the back of your vehicle, which for (say) an estate car might be something like 40in. square, but remember that in many vehicles the inner wheel arches intrude into the general floor space.

The resultant assembly, wood plus vice can, with modest effort (and perhaps an extra Weetabix), be lifted into the back of a vehicle, yet will have sufficient weight and inertial mass that workpieces of reasonable size can be sawn, hammered and squeezed under similar control to those in the vice in your workshop. It can be extremely beneficial to be presented with a sturdy workbench and vice when you lift the tailgate of your vehicle and, if the latter is seen as being in the workhorse category, i.e. one in which minor damage to surfaces is not seen as being of much consequence, you can choose to leave the assembly in the back of the vehicle, gaining the benefit of a reasonable working height in the process. A convenient stool will provide an environment in which you will be happy to work all day.

In addition, it is possible very easily to make your portable workbench free standing, in that the hefty dimensions of the woodwork allow you, simply by drilling holes and using 12mm threaded bar, to attach very sturdy legs (more four by two!) which fold away under the base during transportation or when not in use. To bring the legs into use all one does is to slacken the nuts, allow the legs to fall under gravity, adjust to the optimum working position and re-tighten the nuts. You need a nut at each end of the threaded bar, ideally with the more inaccessible one captive (or perhaps use good, old fashioned coach bolts) so that there is no need for a second spanner. Remember, though, it is a good idea to have a dedicated spanner tied to the woodwork, so that you **cannot** forget it!

Very large washers, or equivalent pieces of steel plate, should be used under the nuts so as to make full use of the clamping potential of the 12mm bar, which is more than enough to ensure total rigidity of the assembled worktable. Experience on rough ground will suggest that three legs can sometimes be better than four, but the 'clamp in any position' legs allow the four-legged versions to be made stable almost anywhere. An alternative arrangement is to make a supporting table as a separate entity **(see Photo 2)**. This will find many other uses, such that it could well be requisitioned for use in garden or greenhouse, and then you will have to make a replacement.

In view of the mass of the vice and its 'four by two' base, a support table need not be made from such massive materials, only requiring a high degree of stiffness and stability. A main surface from 18mm ply is about right, being light enough to take just about anywhere, but make sure the ply is of 'outdoor exposure' quality, because this item is likely to spend more time outdoors than indoors.

There can of course be occasions where our hefty 'vice plus rigid base' or even our 'portable middling-size' assembly is not appropriate, perhaps an attic, or down a manhole, or up a tree. As we get nearer to nature, shapes and surfaces become less regular and rectangular. We could find an appropriate fixing point in an attic for the portable vice, all those joists and beams being rectangular, but it is odds on that you would not establish a secure mounting in a tree. However, although trees do not feature convenient attachment surfaces, they do offer relative immobility, which can be exploited by the use of less conventional attachment techniques. The toggle action locking pliers, often sold under the 'Mole', 'Vise-Grip' or similar identities, can be very useful holding devices, and a variant known as a chain clamp is ideal for making attachment to highly irregular shapes and can even be assembled in series, **see Photo. 3**, allowing an iron

3. Chain clamps can be assembled in series to get a powerful 'high modulus' grip on almost anything. A recent application was to hold substantial flanges onto a dead tree trunk while the whole was jacked out of the ground. For some jobs, lots of tight turns using luggage ('bungee') bands can be even better.

4. Worth its weight in gold, this table edge clamp allows you to mount any appropriately sized set of locking pliers on to any handy solid structure. Occasionally found for sale in the better hardware stores.

grip onto a surprisingly large circumference. The idea is that you either position the workpiece **directly** under the chain, or secure some secondary holding system there, depending on the circumstances.

The chain clamps provide what we might term a 'high modulus' grip, i.e. they tend to provide either an over-tight grip or an over-slack grip, and need fine adjustment to be at that useful 'somewhere in the middle'. Conversely, there is wide availability of fastening devices at the other end of the modulus spectrum, e. g., the ubiquitous 'luggage bands' or 'bungee bands', made up of a highly elastic cord, cloth covered, in a range of lengths variously from a few inches to several feet, with rudimentary hook ends formed from plastic-covered wire. The key features concerning the use of these bands is the high elasticity of the rubber and the fact that the attainable grip depends on the number of times that you choose to wind the band (or bands) around the fixture/workpiece combination. The high degree of elasticity can compensate for any settlement at the various solid surfaces, whereas the grip of chain moles may slacken in these circumstances.

There is available, incidentally, a simple accessory to the range of locking plier equipment (standard jaw, chain, birdmouth etc.) that greatly enhances their versatility. **Photo. 4** illustrates a simple threaded clamp that can be attached to a table top or similar surface, providing a spring loaded housing into which the clamp handles slide easily and fit snugly. In addition to then being able to secure the object which requires attention, the utility of the range can be enhanced by gripping a second tool, perhaps one of the oh-so-useful miniature birdmouth pliers which will facilitate the most delicate or fiddly of tasks. You can, in effect, set up a third hand, something which can be a help, even in the workshop.

On those occasions when circumstances dictate that you have to work in the fields or in the woods, the availability of simple facilities such as those described above can make all the difference between success and failure, and whether or not you make it back in time for a pint before closing time. Surely either of those factors, alone, will justify any amount of forethought and preparation!

CONTROLLING SPRAYDRIFT - A Postscript

From Len Billinge, Langdon Hills, Essex

The article by Derek Brown in Issue 77 of M.E.W. in connection with paint overspray extraction is an exceedingly dangerous operation and should never be undertaken under any circumstances.

Paints, particularly the cellulose-based paints use volatile solvents with acetone, amyl acetate and similar solvents being the most common. These solvents have flash points ranging from well below zero and will produce an inflammable vapour at almost any everyday temperature.

When finely divided as in spraying, this vapour will form an explosive cloud, which can be ignited by even a static spark. Under the system suggested, all the vapours are being sucked through an open series wound commutator motor which produces a continuous high energy spark whilst running. Need I say more?

If Mr. Brown goes on using this arrangement he will sooner or later blow himself and his garage to Kingdom Come.

Only certified flameproof motors can be used for solvent vapour extraction (They are the type that pump petrol into your car).

The Cellulose regulations will tell you about all this, but remember, even household paints based on white spirit will give the same effect if passed through a vacuum cleaner.

Derek Brown replies:-

The old problem of flammable vapours is an interesting one, to which it is easy to over-react. Here are the facts as I see them:

To get a vapour explosion one needs to be within the explosive limits for the solvent being used. In our case if we were above the lower explosive limit, then there could be trouble; so let us examine the worst case.

The lower explosive limit for the normal range of solvent which we are likely to meet lies in the range 2 to 4%; so let us assume 2% by weight. That means that if the concentration of solvent in air exceeds 2% we risk an explosion.

A typical vacuum cleaner sucks 35 cfm (990.5 1/min) of air, exhausting it to atmosphere (i.e. into the garden). Air brush flow rates are typically low, but let us assume "all the stops out" and a delivery of neat solvent at 0.5 oz/min (14.2g/min).

Now at 20 deg. C one g/mole of air (29g) occupies 24l (by Avogadro's law).

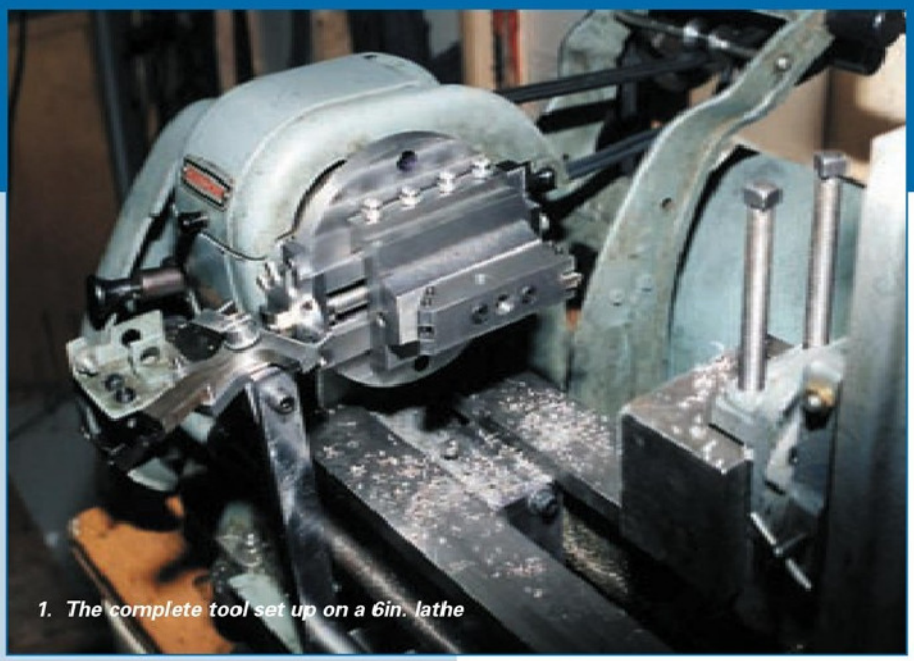
Therefore the rate of air discharge works out to 1,197g/min and the concentration of solvent in air is hence 1.2%, or a little over 50% of the lower explosive limit.

This is I believe a worse condition than we are likely to achieve in practice and the operation is safe as described.

Now in general I like the idea of a centrifugal fan if you can find one of suitable characteristic. Do, however, verify that it will handle the amount of air needed at the pressure drop dictated by the system. Vacuum cleaner manufacturers do know a thing or two about how to achieve a good flow rate through a small hose!

Finally I would say that the small workshop spraying proposition using an airbrush is a long way removed from that met in industry where large spray installations and corresponding sizes of solvent inventory are involved.

A FACING AND BORING HEAD



1. The complete tool set up on a 6in. lathe

Ted Wale of Porters Lake, Nova Scotia, talks us through the manufacture of a useful accessory for the workshop

In 1961 Edgar Westbury designed an interesting tool, the construction of which was published in Model Engineer (Ref. 1). He made no claim that the concept was original but it has many uses and is designed so that a modeller can make it with his tools. I recommend that readers should refer to Edgar's original article as it contains a lot of helpful information that I will not repeat here, in whole nor in part. It is not my purpose to pre-empt what Westbury did, but to build on his work and bring it up to date.

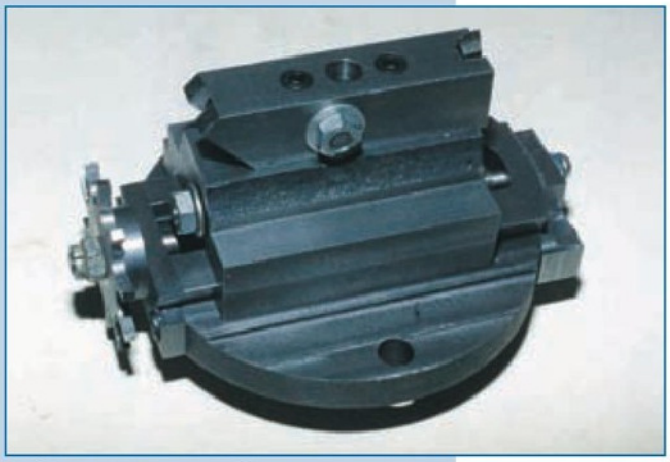
Quite a few years ago I decided to make one for myself and the end result is shown in **Photo. 1**. I found that it was/is a good project for those who, like myself, were learning some of the arts of metal work and machining and wanted to move on to something a bit challenging. Our editor thought that it would make a useful contribution to M.E.W. Because it is intended to show what a good learning project it is there are, perhaps, a few more pictures of the processes used and a few more details in the descriptions than would normally be the case. Our more advanced readers will disregard these. Also, times have changed and so have stock sizes and thread practices; many modellers these days have a milling machine and other equipment which, together with their lathe, have dials calibrated in thousands of an inch, while Westbury's drawing dimensions were in fractions. In addition I had decided to make a few changes to his mechanism and to provide the alternative catch pin assembly mounts to which he refers, as these allow its use on lathes other than the 6in. gapped bed lathe on which he based it.

All these considerations made me decide to redraw it all using decimal dimensions as well as incorporating the other changes. I thought that it would be appropriate to call it "A Facing and Boring Head" to differentiate from Westbury's "A Boring and Facing Head" although it is really a Mark II version of his original. I must compliment his memory on his design and hope that readers will have as much fun and self instruction as I did.

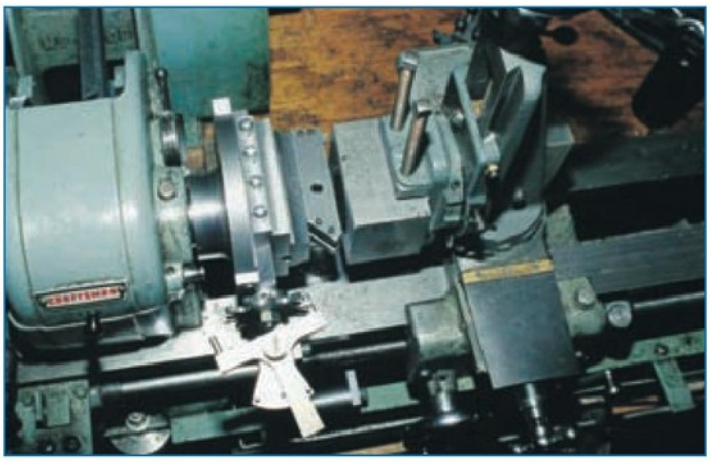
Function and purpose

The assembly, seen in **Photo. 2** and in **Fig. 1**, consists of a tool holder mounted on a slide, the whole rotating on the main lathe spindle. A leadscrew causes the slide to advance or regress across the back plate, under the action of a star wheel which is forced to rotate in one direction or another as its teeth are intercepted each revolution by a fixed catch pin. The tool is thus moved, step by step, across the work piece which is held in/on the cross-slide, as seen in **Photo. 3**. Depending on which tool mount is used, the result can be very similar to that obtained by using a flycutter in a milling or drilling spindle and traversing the work under the cutter. Here the cutter traverses over the face of the work. With the aid of a milling attachment for the lathe, mounted on the lathe cross-slide, a large area of work can be covered. For jobs requiring the boring facility, the tool position is adjusted manually between cuts, with the spindle stationary.

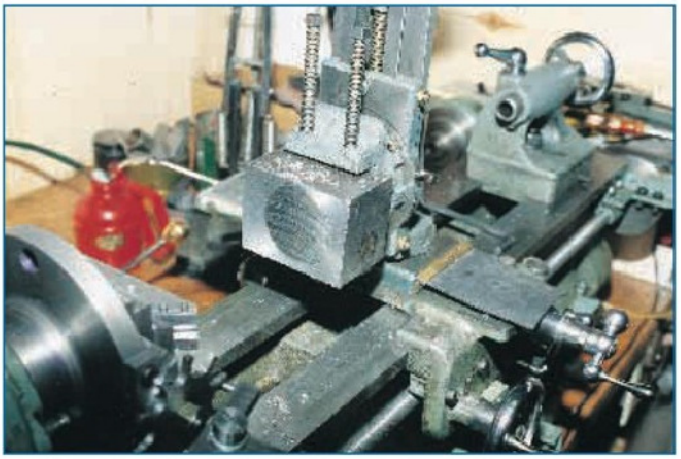
In facing work, there is one difference to the result obtained in other set-ups. Here the tool is incremented in short steps across the work face and not moved smoothly across it. To avoid or reduce ridges being turned on the work it is necessary to grind



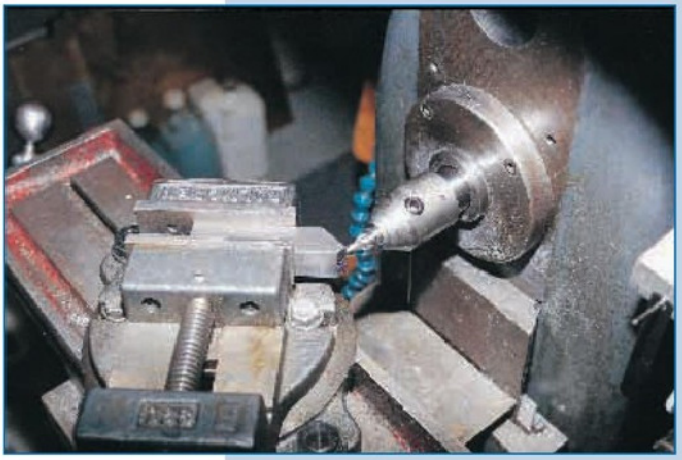
2. The rotating assembly



3. Overhead view of the tool in operation



4. View of workpiece after a clean-up of part of the face



5. Cutting the 45 deg. slot in the cutter block

the tool with a round nose which will span the increments of traverse. Such ridges are seen in **Photo. 4** where I used a sharply pointed tool to show the effect (the uncut part is the rough circle in the centre: the ridged cut part is outside that circle). With 28 tpi on the lead screw and ten teeth on the star wheel, the advance is 1/280in. per revolution, just under 0.004in. or 0.1mm. The design could be modified by reducing the leadscrew pitch to say 40 tpi giving 0.0025in. per rev and by increasing the number of teeth on the star wheel to say twelve, when the traverse increments would be just over 0.002in. Care is needed when increasing the number of star wheel teeth as there is definite limit beyond which the teeth will foul the catch pins.

There are five alternative positions for mounting the cutting tool (two 1/4in. square and three 3/8in. round) which give more than adequate coverage for most jobs; in fact I have not yet found one that could not be covered. With careful tool grinding and heavy cuts a significant amount of metal can be removed; similarly, a finishing cut with an appropriately ground tool will produce satisfactory results for the completion of the job. The back gear ratio is normal for most work.

Drawings

The drawings have been prepared without any tolerances being shown as it seems that is the way that most of us modellers prefer to work. We work by making parts fit together and, because it is very rare for more than one assembly to be made, this system serves the purpose well. So tolerancing and close fitting dimensions are replaced by the description in the text to achieve a good working fit where necessary. I hope that I have not missed any important points.

In addition, as mentioned above, decimal dimensions are used rather than Westbury's fractions. For convenience these are generally to three places. Readers can decide for themselves the best way to interpret them, as will those whose workshop machinery has metric calibrations.

In most cases I have retained the names that Westbury gave to the various parts.

Manufacture

There are, of course, many ways to plan the production work, depending on one's own preferences. In the text most of the processes are those that I used to make this mechanism. In a few cases they are those that I realized afterwards that I should have used.

The parts can be tackled in several steps as follows:-

A) All those which are part of the rotating assembly.

B) All those that make up the catch pin assembly.

A) is further divided into those that are critically related to each other and those that are made as parts and then fixed to others without any significantly tight tolerances. Readers are welcome to find a better way and I would be glad to hear about their improvements.

I will comment on each of the parts and assemblies as they are tackled in the following order:-

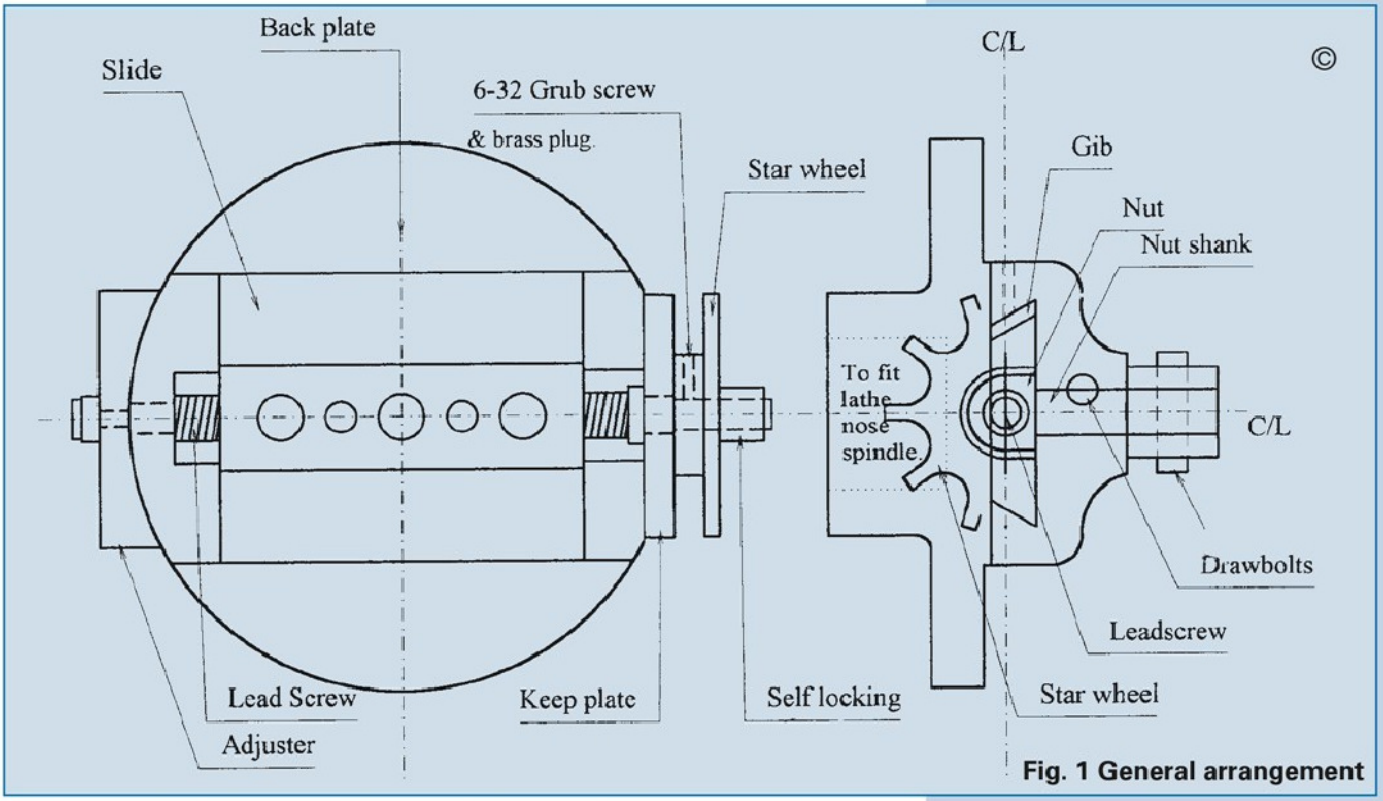
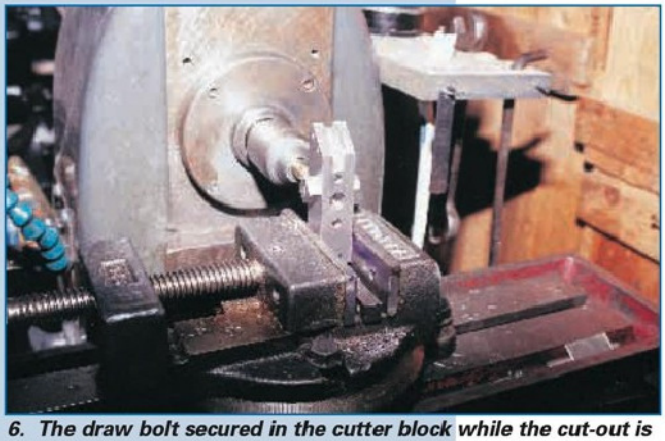
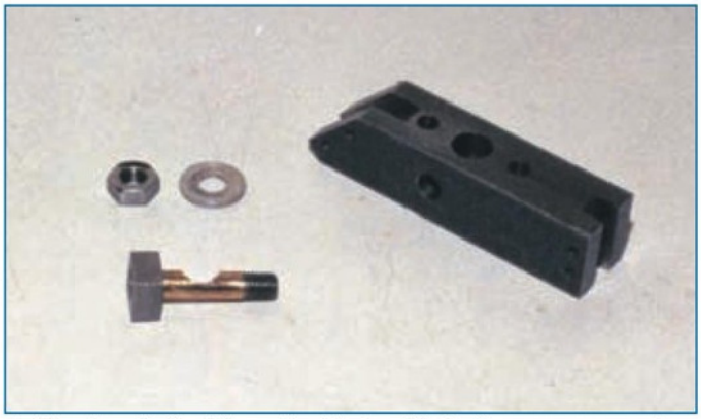


Fig. 1 General arrangement



6. The draw bolt secured in the cutter block while the cut-out is made



7. The draw bolt, of the cutter block, with the temporary second thread and nut

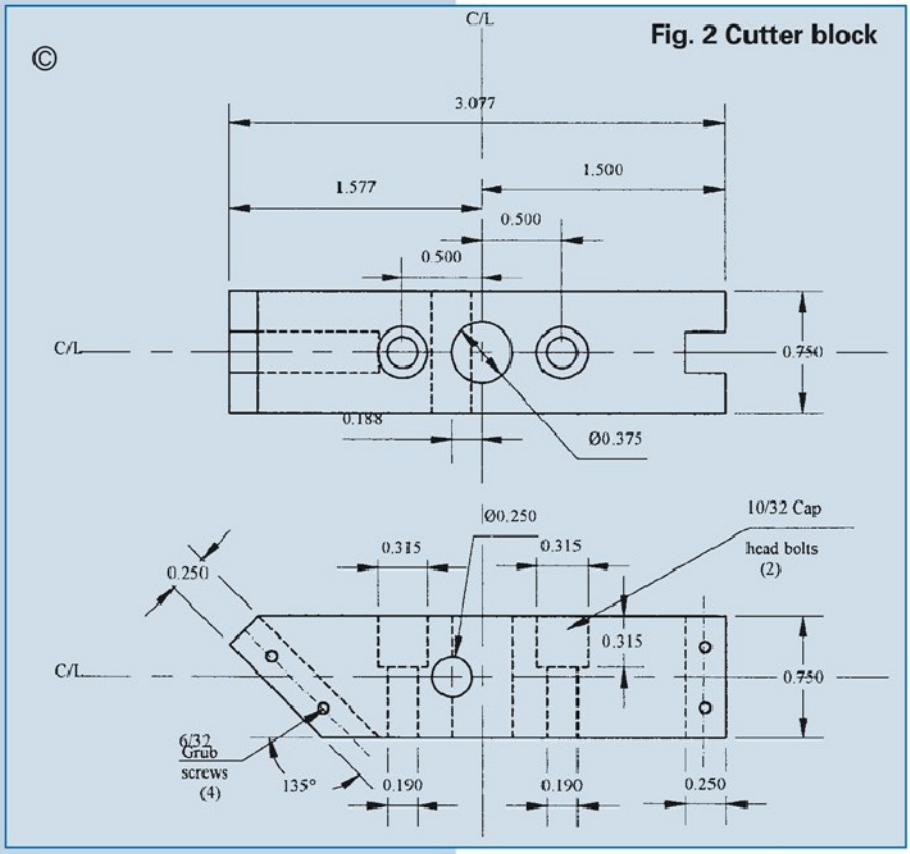


Fig. 2 Cutter block

8. The finished cutter block

Fig. 3 Tool draw bolt

A.1 General Piece Parts

Fig. 2. Cutter block
Fig. 3. Tool draw bolt
Fig. 4. Slide draw bolt
Fig. 5. Gib
Fig. 6. Adjuster
Fig. 7. Keep plate
Fig. 8. Star wheel

A.2. Critically Related Parts

Fig. 9. Slide nut
Fig. 10. Slide nut jig
Fig. 11. Leadscrew
Fig. 12. Back plate
Fig. 13. Slide

B.1. Catch Pin Parts

Fig. 14. Quadrant
Fig. 15. Interceptor lever
Fig. 16. Pivot screw
Fig. 17. Clamp block
Fig. 18. Support arm A
Fig. 19. Support assembly B
Fig. 20. Support assembly C

Following these, the actuating assembly and its operation, (Figs. 21 to 23), will be discussed.

A1. General piece parts

Cutter block (Fig. 2)

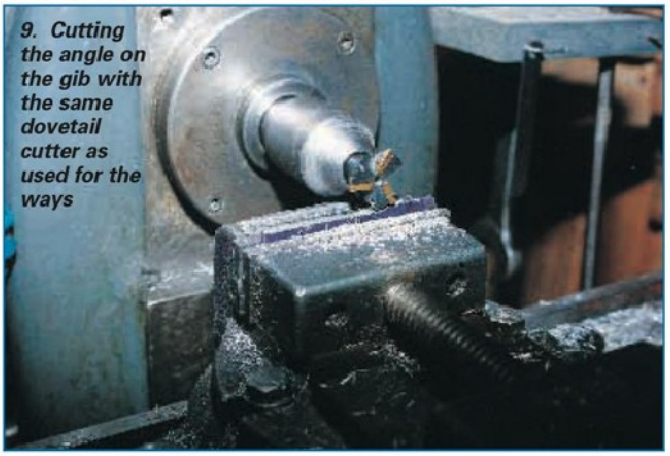
There is nothing unusual nor difficult in this. It is made from 3/4in. sq. mild steel by normal milling and drilling techniques. At each end it has a slot which, with grub screws, holds a square tool at 45 deg. or 90 deg. to the work piece. It also has a hole in the centre for a round tool. This is held by a draw bolt.

A typical step in machining the part is seen in **Photo. 5**.

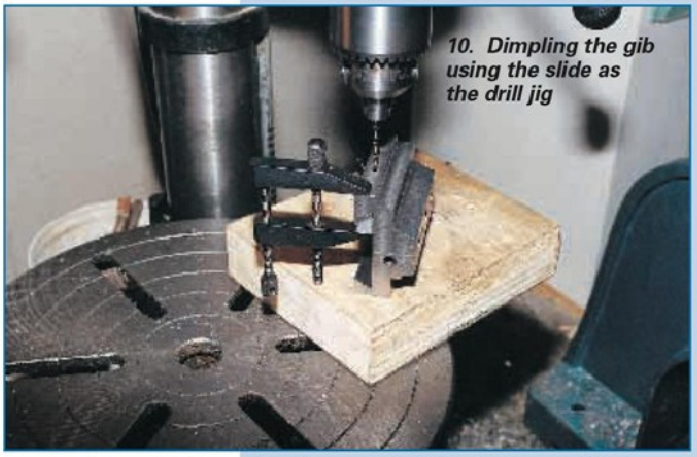
Tool draw bolt (Fig. 3)

Some readers may prefer an alternative method for the tool and slide draw bolts. It may be possible to devise a system in which the holes and scallops are drilled in one pass. However, the following worked for me and will be described.

The tool draw bolt is made from 1/4in. mild steel rod. There is a little trick in its machining. The rod needs to have a cut-out to grip the tool firmly and this is best made by passing the same cutter that was used to make the 0.375in. hole



9. Cutting the angle on the gib with the same dovetail cutter as used for the ways



10. Dimpling the gib using the slide as the drill jig

through again, with the tool draw bolt held in place. However, it needs to be prevented from rotating in the hole under the action of the cutter. One way to do this is to make the draw bar blank over-long and thread it at both ends. It can then be held firmly in the block by nuts at both ends as seen in **Photos. 6 & 7**. The unwanted threaded end is then cut off, as in **Photos 2 & 8**.

Slide draw bolt (Fig. 4)

This is very similar to the tool draw bolt (Fig. 3) except that it is longer and has three cut-outs. These are easily made by the same method of passing the cutter through the holes in the slide after the bolt piece has been secured by the second, temporary nut. The completed draw bolt is seen in **Photo. 2**.

Gib (Fig. 5)

This is made from a piece of 1/8in. mild steel. A 60 deg angle is cut on both sides **(Photo. 9)**, so that the gib nests nicely into the slide as seen in **Photo. 10**, where the dimples are being set by using the slide as a drill jig. To allow the gib to be clamped properly, an angled packing piece has to be made, as is seen happening in **Photo. 11**.

Adjuster (Fig. 6)

Made from a piece of 9/16in. or 5/8in. mild steel, it is cut to shape and the holes drilled. At this stage the fixing holes are drilled tapping size for the 1/4-28 bolts. It is then mounted on the face plate on the lathe and the 2.25in. radius cut to match the back plate.

The completed adjuster is clamped to the backplate, taking care that it is correctly aligned, and the fixing holes drilled in the backplate using the adjuster as the drill jig.

The fixing holes in the adjuster are now opened up to 1/4in. and counterbored for the cap screws.

The adjuster and the mounting holes in the back plate are shown in **Photo. 12**.

Keep plate (Fig. 7)

There is nothing out of the ordinary in this part, made from 1/4in. mild steel. The mounting holes should be dealt with the same way as were those in the adjuster and so here left at tapping size. The 0.3125in. hole should not be drilled at this time as its position is one of the critical dimensions and will be dealt with later.

The keep plate is seen mounted behind the star wheel in **Photo. 2**.

Star wheel (Fig. 8)

For readers who have hefty turning capacity, this may be cut from solid. However, it offers the opportunity to adopt some slightly unusual machining techniques, sometimes used to make clock parts.

To start, make a chucking piece from a piece of 1in. bar and turn a step of, say, 1/8in. at one end. Next, a piece of 3/16in. steel, more than 2in. square, has a hole drilled in it to fit the step and the two are silver soldered together. In the lathe the

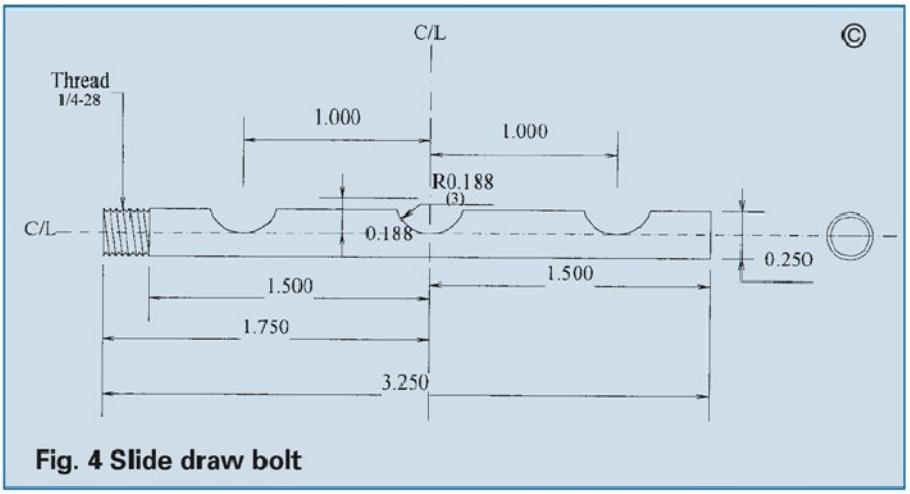
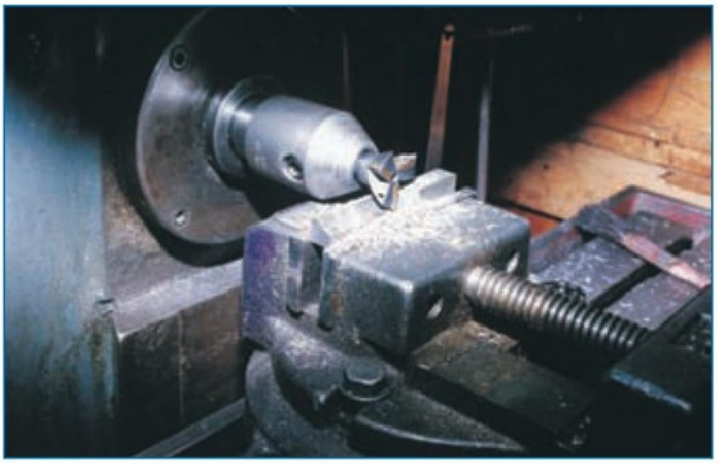
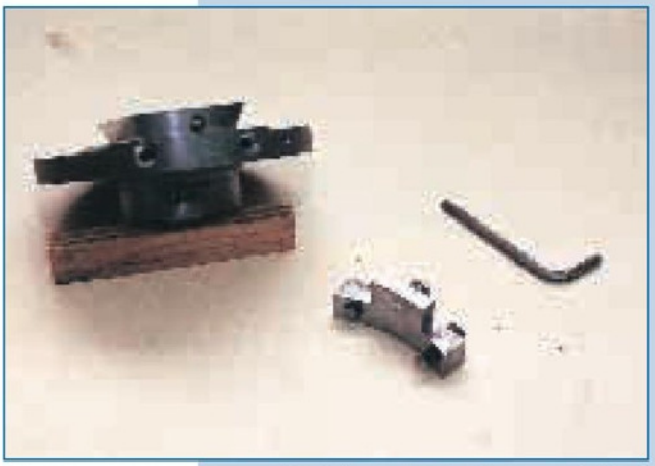


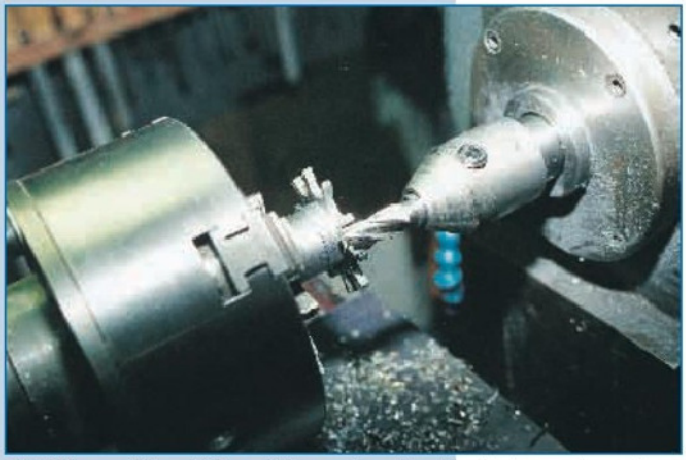
Fig. 4 Slide draw bolt



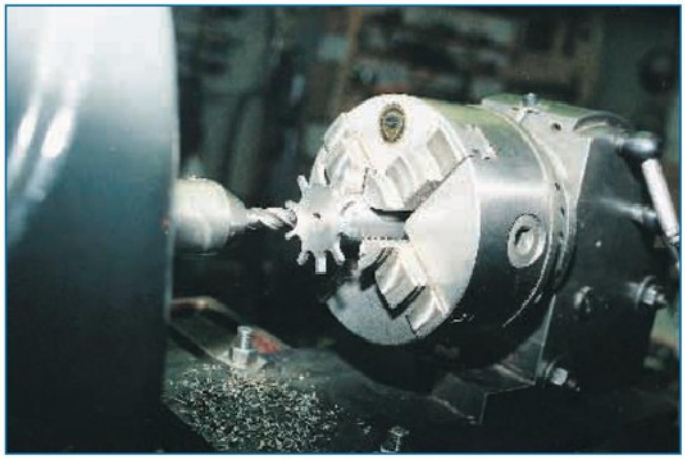
11. Making the angled support piece used to support the gib, as shown in Fig. 10. Again the same dovetail cutter is used



12. The adjuster piece used to take up the leadscrew end play



13. The position of the milling cutter after the first pass to make the teeth in the star wheel



14. The second pass, completing the teeth of the star wheel

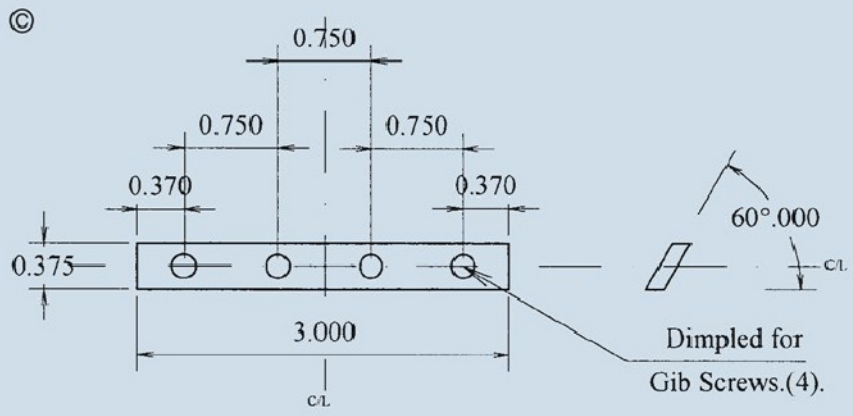


Fig. 5 Gib

plate is turned to 2in. dia, the front and back faces cleaned up and the thickness reduced to 1/8in. A piece of 1/8in. dia. rod is set in the shaft, about 1in. behind the wheel blank, **Photo. 15**, (though this is showing the completed wheel) and mount it in the dividing head so that this small rod is between the chuck jaws, so locking it for the next operations. This rod can be seen between the top two jaws in **Photo. 14**. The whole was set up on a horizontal milling machine.

In **Fig. 8a** are shown the cutting dimensions. The horizontal diameter is found and the table X axis dial is zeroed to this plus half the thickness of the 3/8in. cutter. On the Y axis the centre of the cutter is set 0.250in. above this point on the diameter.

The table is now traversed 0.419in. (0.231 + 0.186) to move the cutter into the position shown at A in Fig. 8a. The cutter is withdrawn and the wheel rotated 36 deg (for 10 teeth) for the next cut. This is repeated 10 times when the blank will look like **Fig. 8b (Photo. 13)**.

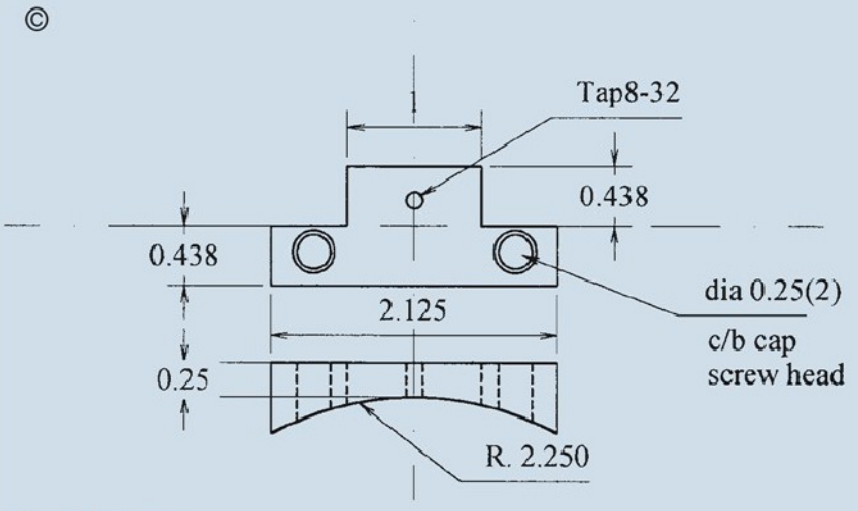


Fig. 6 Adjuster

The table is now raised 1/2in. so that the cutter centre is now 1/4in. below the centre line of the wheel. Traversing the cutter in by the same 0.231in. clears off the hook shape left by the first pass and leaves a straight 1/8in. tooth, **Photo. 14** (this is the same set-up as in Photo 13, but viewed from the other side). Note that the cutter completes its second travel into the tooth blank to exactly the same position as it did for the first travel on the previous tooth. Similar movements on a vertical miller would produce the same result of course. The completed wheel, still on its chucking piece, is seen in **Photo. 15.**

It only remains to drill and tap the 6-32 and 1/4-28 holes and to part off the wheel complete.

A2. Critically related parts

In this mechanism, there is a slide which moves along the ways by the action of a leadscrew rotating in a nut set in the slide. The action is very similar to the motion of the cross-slide of a lathe driven by its leadscrew.

If this action is to be free, but not sloppy and full of back-lash, the placing of the leadscrew bearings, the nut thread and the ways are critical in the relation of each to all the others.

Firstly, the ways and the faces of the slide that run on the ways must be uniform and result in the slide moving in a straight line both horizontally and vertically.

Secondly, the parts that cause this slide to move must themselves also move in a straight line, and this line must be parallel to the slide ways.

This means that this problem can be tackled in two parts by starting with the ways. These themselves split into two parts, which are that part of the ways that is on the back plate and that part which is on the slide. When the ways have been made so that the action is smooth and correct, then the leadscrew supports and the nut position can be sited to produce the action needed.

While watching these points carefully, the rest of the general machining work on the backplate, the slide and the leadscrew has to be carried out. It must be remembered that it is only when all the parts come together that the accuracy of one and all can be assessed, so it is essential to take as much care as possible with each of them.

15. The star wheel still on its chucking piece

Slide nut (Fig. 9) and Jig (Fig. 10)

The nut is made from square phosphor bronze stock which has to finish up at 0.625in. each way, so the starting stock has to be larger, say 0.750in.

The critical thing here is the position and alignment of the 0.375in. tapped hole in relation to the shank of the nut. It has to be drilled to an accuracy better than 0.001in. if good leadscrew action is to be obtained. Unless a high quality drill press and table are available it is unlikely that a satisfactory result will be achieved with such equipment. It should all be done on a milling machine, but equally accurate results can be obtained on a lathe although it is more awkward.

Here is how I did it. The stock was clamped to the table on a spacer and the end squared off. A position for the hole was found with feeler gauges and the table dials. This position was on the centre line and a little more than the 0.313in. required from the squared end, say 0.317/0.319in. The hole size for tapping 3/8-24 is Letter Q = 0.332in., and a centre drill, followed by a small pilot drill, followed by an undersized end mill gave a true hole that the final drill would follow accurately. If a Q drill is not available then a 21/64in. drill is within a few thou. – 0.328in.

Next, a plug gauge was made that closely fitted the hole just drilled. This gauge allowed all future set-ups on this part to be aligned always with the machine mandrel and the use of this gauge is implied where ever needed, if not so stated.

The sides carrying the hole (left and right on the drawing) were then brought to size either side of the hole (the gauge again): the sides parallel with the hole were brought down to within 3 to 5 thou. of the size and left oversize.

The 5/16in. radius at the end of the nut is not in itself critical and can easily be formed with hacksaw and file. It would make a good filing exercise. However, there is another way which yields a near perfect result and here is the chance to use it. It is worth doing as it has a wide variety of future uses and involves designing and making the simple jig shown in Fig. 10.

Some convenient sized milling cutter is chosen - the size is not in itself important, in these drawings a 1/2in. is used. A slot is cut in a piece of 1/4in. mild steel - here 4in. square- slightly larger than the cutter - here 0.550 inch. The nut stock is going to be held and rotated around the 0.328in. dia. hole, so a shaft is made, as in the top of Fig. 10, to bolt to the plate and to fit the nut hole. Time should be taken to make this fit as good as possible because there is a very short bearing surface (5/8in.). A hole is drilled for this shaft in the plate, 0.313in. from the position that the cutter will take when centred in the slot (this is the end radius of the nut).Two support pieces are mounted, one at each side of the plate, so that the top of each is at the same height as the top of the cutter. A short slot in the support pieces helps

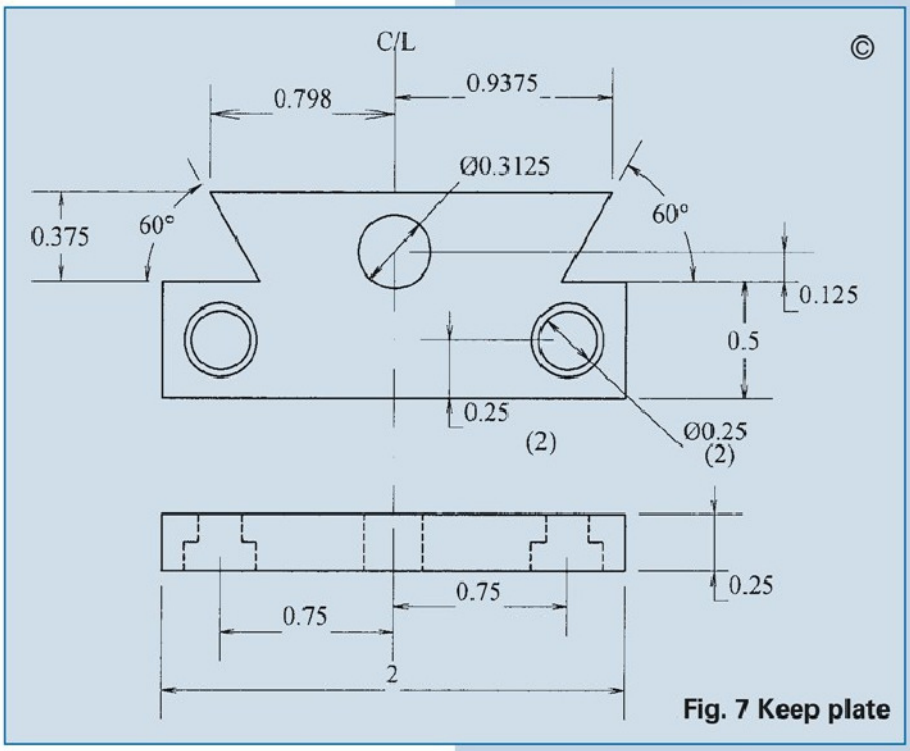


Fig. 7 Keep plate

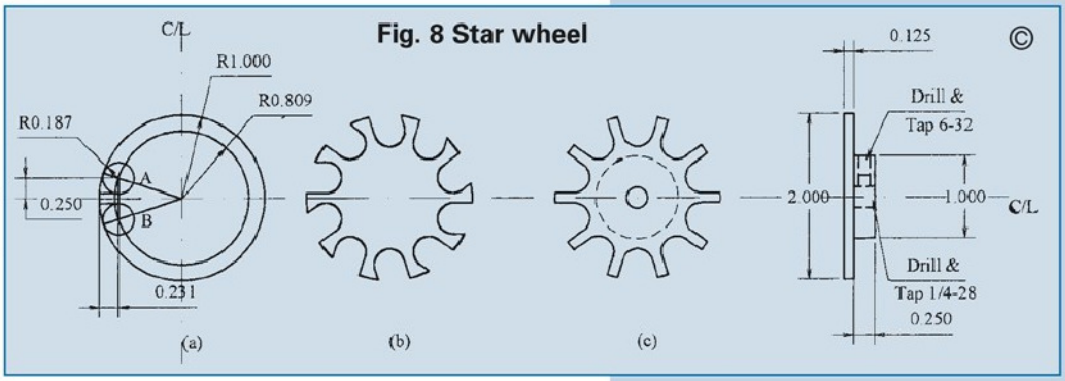


Fig. 8 Star wheel

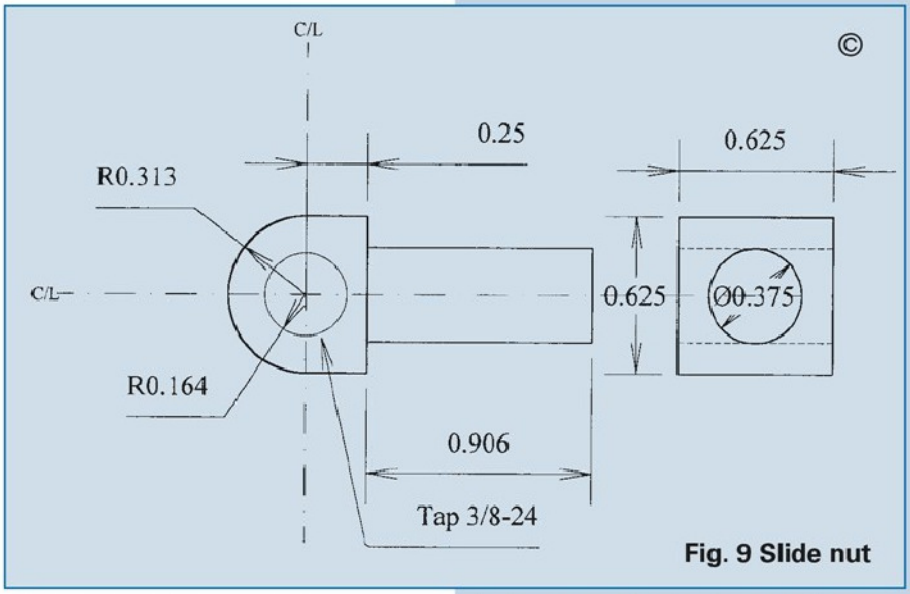


Fig. 9 Slide nut

16. Cleaning up the sides of the nut stock

17. Swinging the nut stock over the cutter to shape the radius on the end

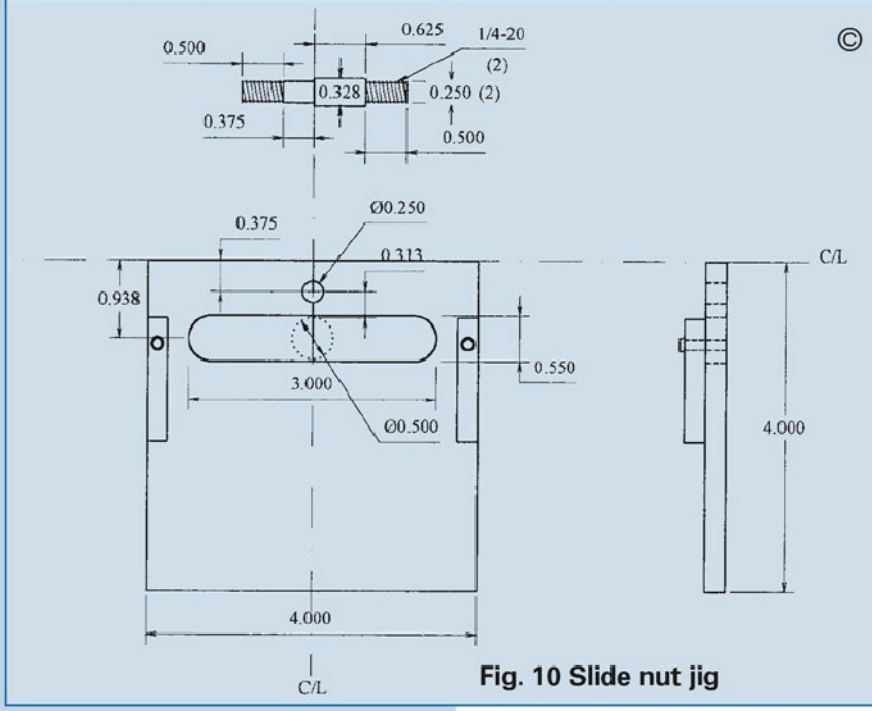


Fig. 10 Slide nut jig

accurate positioning.

The bronze nut piece is soft soldered to a long rod to use as a handle.

The whole assembly of jig and nut stock is set up on the milling machine, square and true, as seen in **Photo. 16**, particular attention being paid to ensure that the 0.313in. dimension is made correct by slight adjustment of the table height, with corresponding adjustment of the end supports.

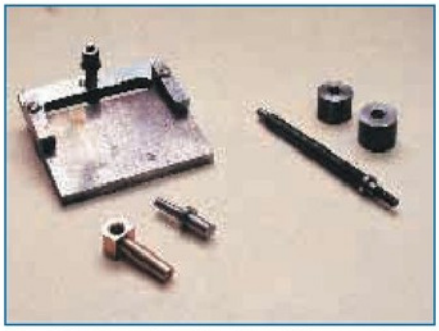
The machine is traversed with the stock held down on one support, then the other side is cut using the other support. This removes the 3 to 5 thou. left in the preparation (above).

A little care is needed in the final step. The table is moved so that the cutter just attacks the corner of the end of the stock and the handle swings the stock over the cutter to take a little cut off each corner **(Photo. 17)**. Only a few thou. at a time, the table is moved to bring the cutter closer to the central position and repeated cuts made by swinging the handle through 180 degrees. There is a lot of power in a milling spindle and any attempt to hurry the process by taking larger cuts will result in the handle and hand being unable to hold the work correctly - I know: I tried to hurry the first time I tried this process and a nasty crash occurred. It is just impossible to hold it. Eventually the cutter will reach a position directly under the shaft and the radius at the end will blend nicely into each side. Care must be taken that the cutter does not move beyond the central position, else the radius will not be parallel with the nut hole and the hole weakened. When this step is complete the end of the nut will look "right".

The piece should now measure 0.625in. across each face and the hole should be square to its faces. The handle is removed and the hole can now be tapped using the appropriate vertical spindle to ensure that the thread is true to the hole.

It only remains to set it up in a 4-jaw on the lathe and turn the shaft to the same degree of accuracy that has been applied to the all the other dimensions.

The completed nut with the gauge and jig is shown in **Photo. 18**, together with its mating part the lead screw.



18. The completed nut with its gauge and jig, beside the leadscrew

References

1. Model Engineer Vol. 124 p. 35 12/01/61 & p.100 26/01/61

2. Castings available from Southworth Engines, 6 Kennet Vale, Chesterfield S40 4EW

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The equipment and techniques involved in the application of this branch of electric arc welding are discussed by Trevor Marlow

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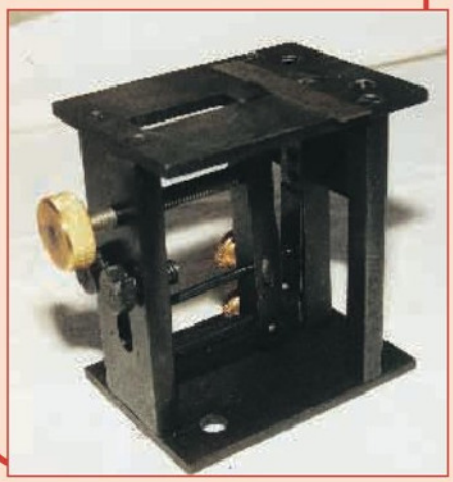
Peter Rawlinson investigates the use of inexpensive and readily available devices

AN IMPROVED THIN PIECE VICE

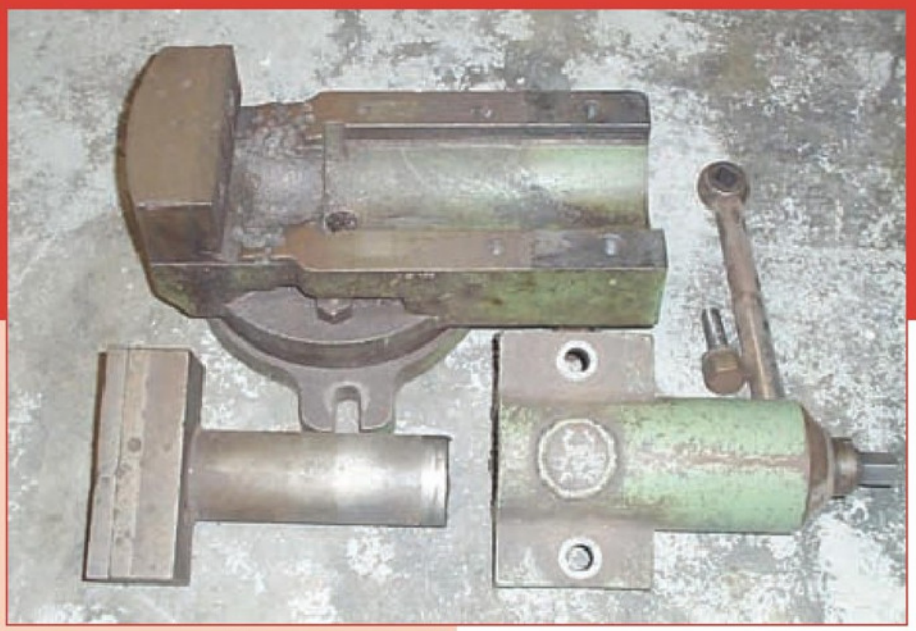
Philip Amos describes his version of a useful aid to bench work



Issue on sale 14th December 2001

(Contents may be changed)

RENOVATING A MACHINE VICE

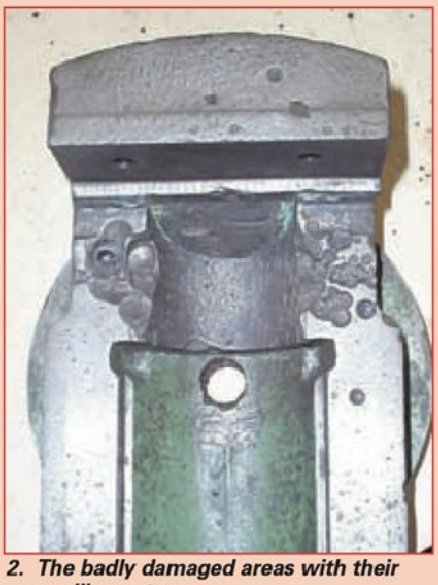


1. *The components of the machine vice, showing the generally poor condition*

Victor Elsendoorn of Sassenheim, The Netherlands, describes the renovation of a damaged machine vice during which two restoration methods were used, providing an opportunity to compare their effectiveness

Some years ago I bought an old pillar drill, and although the machine was in a reasonable state it came with a machine vice which had been very badly treated **(Photo. 1)**. Apart from the poor overall appearance, the biggest problem was that the bottom of the vice looked like the surface of the moon **(Photo. 2)**. Even the jaws of the vice were heavily damaged. I stored the vice away, waiting for a more convenient times to attend to it or to make a decision on scrapping. I recently reworked a grinding machine, this being a very time consuming but fascinating job. I am sure that most of you will have the same feeling when such a project is ready; you urgently need a job to do to test out the new machine, so I decided to use the vice as the first job for the grinder.

After disassembling the vice and making a careful inspection, it became clear that the biggest problem areas were the bottom slide surfaces, the right hand side being less damaged than the left. I decided to add new material to the right hand side by welding and, for the left, to mill out a section and to insert a blank of mild steel **(Photo. 3)**.



2. *The badly damaged areas with their moon-like craters*

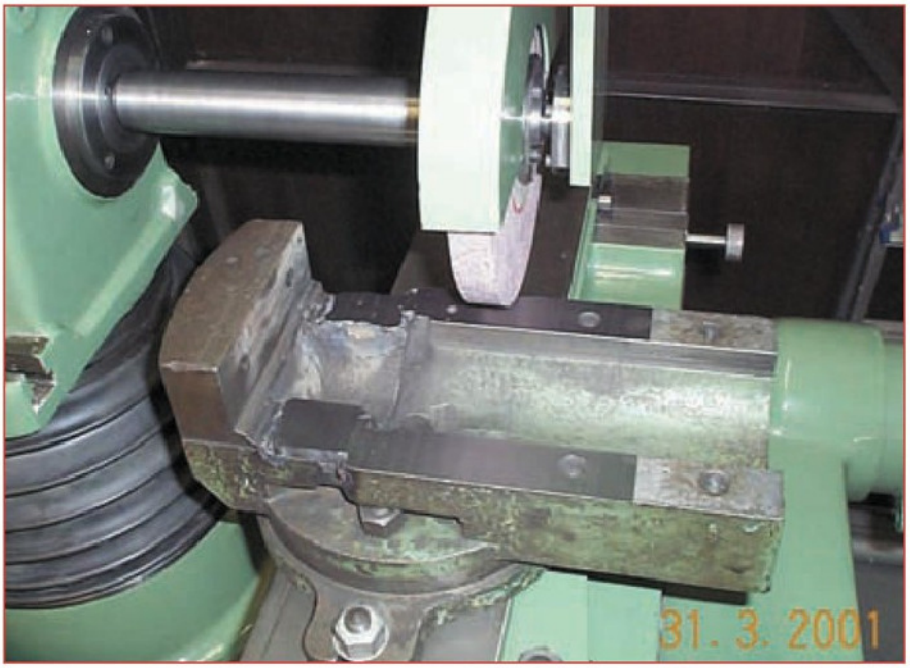
The welding process

Reinstatement of material by welding is, in principle, a straightforward process, but there is always a risk of introducing unacceptable stresses in the casting, as a result of which the vice body could break. To minimise this risk I started with short welds, by so doing causing the casting to heat up slowly, thus preventing tension building in local areas. It takes some time to add enough material, and what appears to be difficult is to make a neat square surface. However, with the help of a small angle grinder, the result was very acceptable, having added enough material to allow for subsequent surface grinding.

The replacement process

The left hand side was milled out, another straightforward job. The recess was made less deep than the blank that was added, in order to allow for surface grinding. The insert was attached by welding along its bottom

3. *Machining the recess for the insert*



4. Surface grinding the restored areas. The welded insert can be seen on the slide nearest the camera

5. The appearance after re-grinding

sides, although fixing with Loctite could have been an alternative solution **(Photo. 4)**.

Surface grinding

When both sliding strips had been filled, the grinding process could start. The vice was mounted on the grinding machine, and with light strokes over the total vice width, the sliding strips where both ground. This process took some time, but the result was really good, resulting in a very nice looking and perfectly straight surface **(Photo. 5)**.

The vice was rebuilt and the top surfaces of the jaws were ground. By doing it in this way, I could make sure that these surfaces were parallel with the slides.

Painting

I am sure that most of you know how to do this, but a few remarks could be worthwhile. I use a chemical paint stripper, the advantage being that this remover gets rid of oil and dirt, as well as the old paint. I used standard metal primer followed by filler on the small scratches and holes. As a final coating a 'high solid' paint in a more or less standard machine green colour Ral. 6011. The result can be seen in **Photos. 6 and 7**.

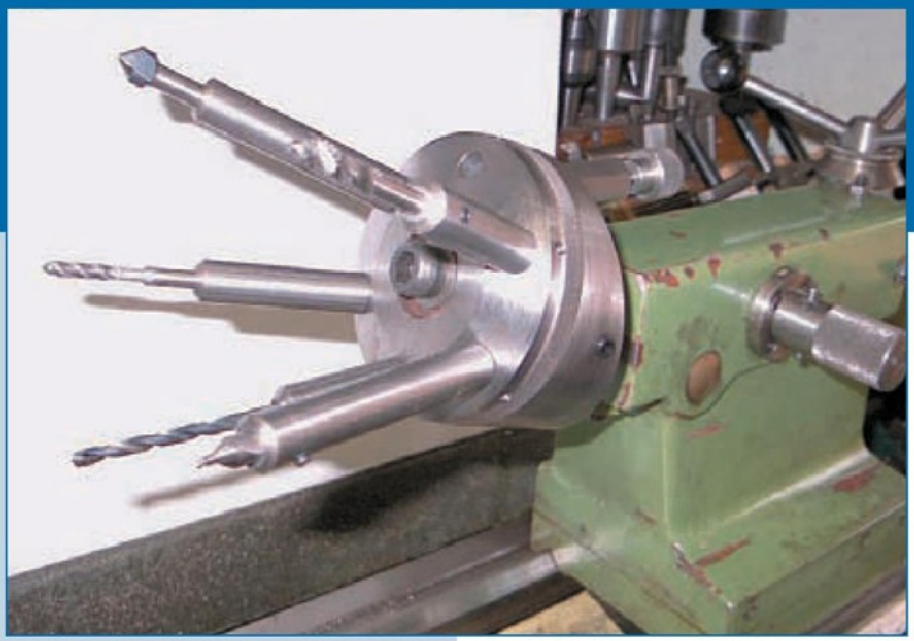
Conclusion

By comparing these two methods of repairing damage, it can be concluded that both methods are very effective, but the welding method is more appropriate for restoring small areas than for replacing large sections. Note that the welding process creates a new alloy out of the existing cast steel and the welding stick material and, because of the relative high percentage of carbon in the cast steel, the new alloy will be hard. The only way to machine this material is by grinding, so if you don't have a surface grinder, it would be better to use the other method, since milling can then be used to clean up the surface.

6. The refurbished components after repainting

7. Now reassembled, the old vice is a handsome addition to the workshop

A TAILSTOCK TURRET



Peter Rawlinson describes a lathe accessory which may be a time saver when a batch of similar components has to be machined

1. The tailstock turret allows up to six items of tooling to be positioned in readiness for a sequence of operations

This tailstock turret (Photo. 1 and Fig. 1) was built a few years ago for the mass production of some bosses required for welding on to some garden ornaments. It proved its worth then and has done so on many occasions since. Even for two or three components it can be worth taking the little extra time to set up the necessary tools.

As this unit was machined some while ago I have no photos of the set-ups or the machining operations, but most of the parts are simple to make. However, the body of the unit **(Item 1)** is somewhat tedious to produce as it involves cutting a piece of 4in. bar at an angle and then machining both surfaces. My first attempt was unsuccessful and I had to machine a second one. It just so happens that the discarded one has survived and is shown in **Photo. 2**. I cannot now remember why I rejected it but because I am like a squirrel and hoard anything that 'may come in useful', it's still here. Inspecting it now, nothing fundamentally wrong comes to light!

All the machining of this part must be carried out on the face plate and to this end I made up a hardwood wedge of the correct angle (15 deg.). As I did not feel that I could cut this angle accurately by hand, it was produced on the milling machine.

The machining sequence was firstly to clamp the piece of steel with its back face on to the block. This was facilitated by welding two bolting 'ears' to the sides of the block. The front face was then fully machined and the central hole drilled and tapped and a 10mm width of the outer diameter brought to final size.

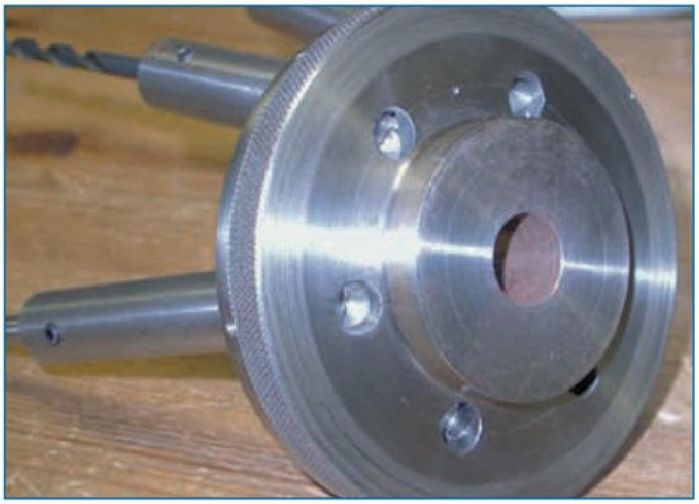
The second machining set-up used these same 'ears', the half-machined part again being clamped against the hardwood wedge. Of course, whereas the material was set up centrally for the first machining, it needed to be offset for the second. Again, all features were produced, including the counterbore and the 1/2in. UNF tapped thread. The 'ears' were then removed and the surface cleaned up with a grinder.

The next operation was to return the wooden wedge to the milling machine to drill and counterbored to accept the 42mm boss produced during the second facing operation. This allowed the part to be remounted on the wedge, securing it by means of bolts from the back into the tapped holes. Suitable counterbored holes were produced in the wedge. The assembly was once again set up in the lathe on the faceplate, the component being set to run true with the help of a dial gauge.

Safety first

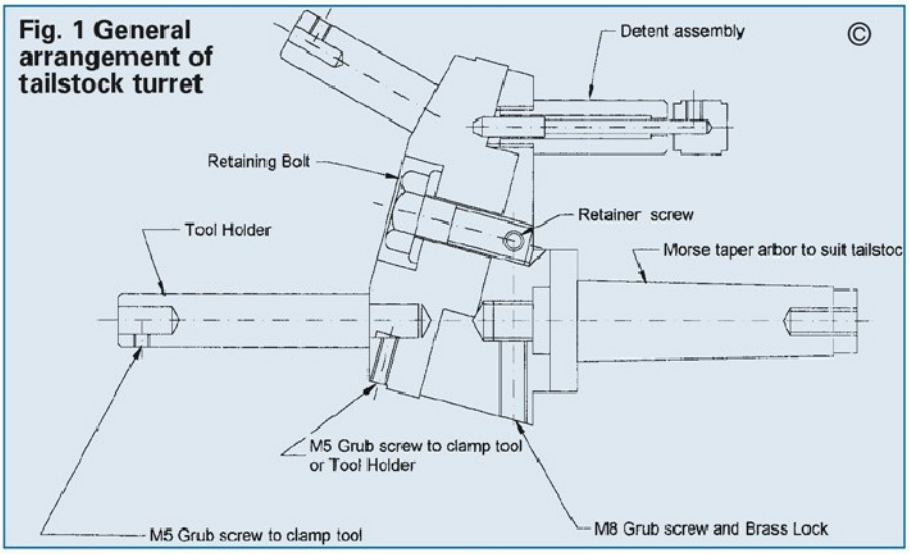
This procedure may appear to be somewhat complex but, once started, it all seemed to fall into place. However throughout all this turning the question of

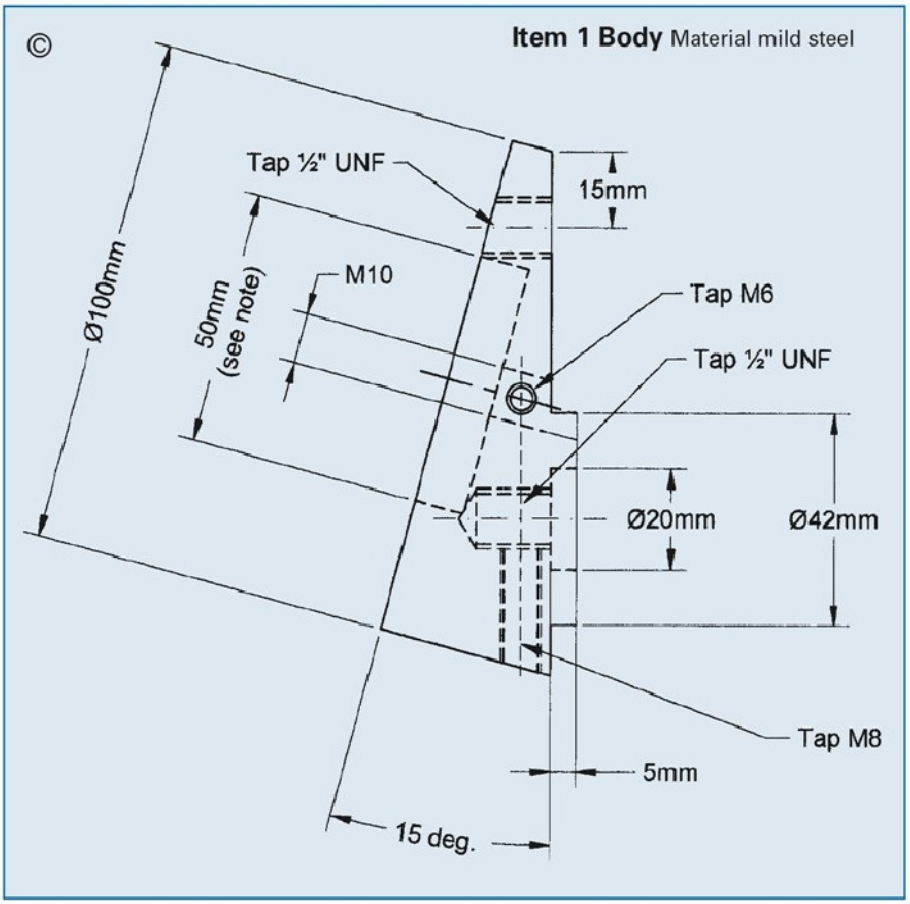
2. The discarded body, rejected for some long-forgotten defect



3. A rear view of the tool head, showing the holes into which the detent plunger locates

Fig. 1 General arrangement of tailstock turret





safety must be paramount. As Harold Hall stresses in his current article for beginners, face plate work introduces particular hazards. Every element used in the set-up must be securely mounted, so I would suggest that the hardwood wedge be made big enough to be capable of being bolted to the faceplate in its own right, rather than relying on one set of bolts to secure both it and the component being machined.

The other point to be watched is the balance of the assembly as it will be off-set during all machining operations and will have to be counter-balanced using suitable weights which can be bolted to the face plate. During the balancing operation do not check by spinning the set-up at high speed, but start off at a low speed and work up.

The Tool Head

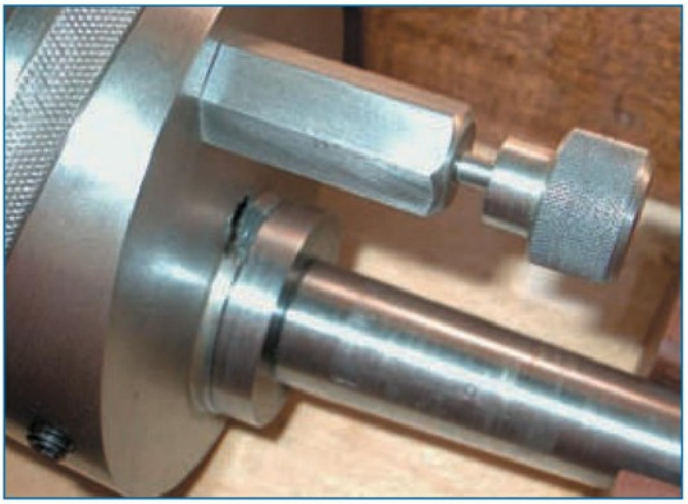
The tool head **(Item 2 and Photo. 3)** is machined all over and can be gripped in the 3-jaw chuck. I would suggest that the rear face be tackled first. When machining the front face, the central hole and counterbore are completed, but no other holes at this stage. To produce the face into which the tool holes will be drilled, the top slide will have to be set over to 15 degrees. If the angle of the hardwood wedge has turned out to be any other figure, then the top slide setting will have to be altered to match.

The smaller components

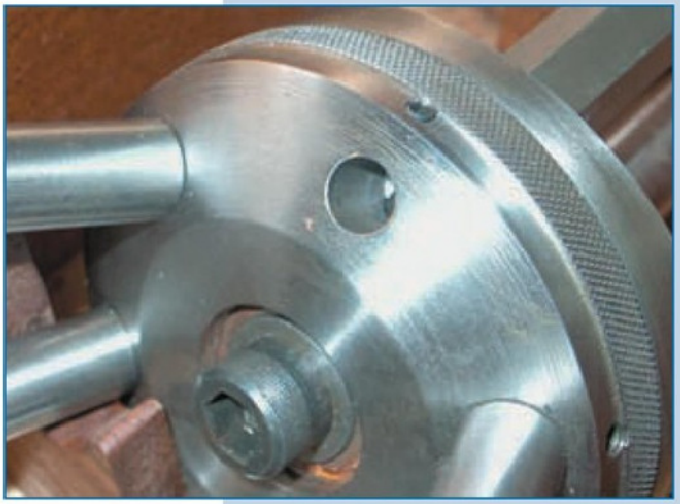
The next operations are the making of the arbor **(Item 3)** and the detent assembly. **(Fig. 2 and Photo. 4)** I would recommend that, if possible, a blank arbor of a suitable taper be purchased and modified, as I believe this to be the most economical and accurate method. The detent components are all straightforward turning jobs and require no particular instructions.

The tool head is retained in the body with an M10 bolt and washer. These can be commercial items, modified as necessary or can be made from scratch.

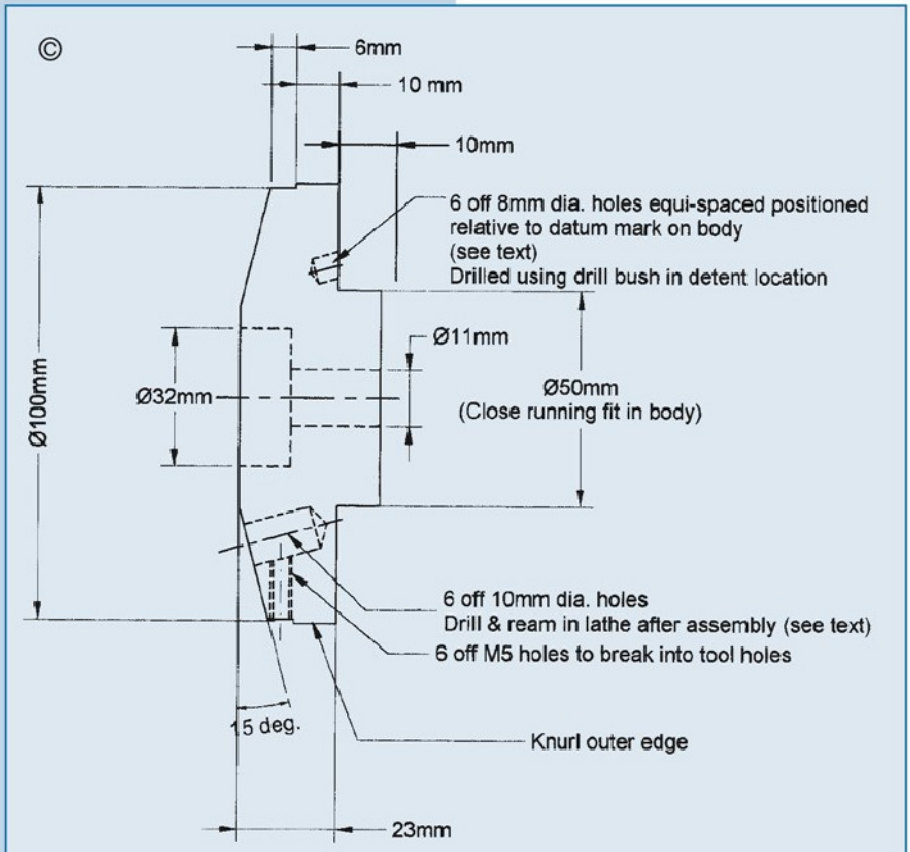
The remaining item to be made at this



4. The taper arbor and the detent assembly mounted in the body



5. The tool mounting positions in the angled front face of the tool head



Item 2 Tool head Material mild steel

6. The varying tool stand-outs are equalised by means of purpose-made tool holders

7. A countersink cutter in its holder

stage is the drill bush **(Fig. 3)** which will be used as a guide when producing the holes into which the detent plunger will locate. I have suggested that this may be hardened, but as there are only six holes to drill, this is up to the individual.

Assembly

We now come to the initial part of the assembly, the first operation being to scribe the tool positions on the side of the Head. This should be done as accurately as possible although if they are a little out it will not really matter, as will become clear in a moment. A scribed line is now required on the body and marked as accurately as possible, adjacent to the detent position (an error here could show up when the unit is being used). Mount the head to the body and clamp the two parts together with one set of scribed lines in alignment then, using the wooden wedge as support, drill the tool head for the first detent location with the aid of the drill bush. The remaining five holes can then be completed in the same way.

Fit the taper arbor and the detent components and check that the head rotates smoothly and that the detent is fully home in all positions, with no slop.

Both the arbor and the pivot bolt are retained by grub screws bearing against the threaded portion. In order to make life easier in the future if either of these components need to be removed or adjusted, it is advisable to fit brass clamping pads under the screws, thus preventing damage to the threads.

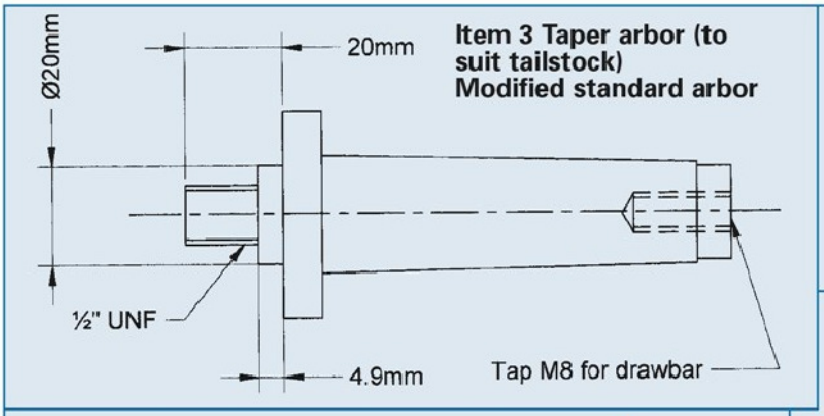
This is carried out in the following manner. After all the tapped holes have been completed, a short length of round brass rod of a diameter which will just clear the core of the thread is inserted into the grub screw hole.

The grub screw is now screwed in behind it until the brass piece is just visible in the main hole. The tap is then reinserted and carefully rotated until the full width of the piece of brass has been cut. A second cut may be required and I suggest that the tap is only partially withdrawn and the grub screw tightened a little more. The brass comes out with a half-moon of thread which will lock the main bolt, but not damage the thread.

Locating the tool positions

With the indexing system working satisfactorily, the assembly can now be mounted in the lathe tailstock, an appropriate centre drill fitted into the headstock chuck and the first tool position carefully spotted. After opening out with suitable drills, a reamer is finally used to give a smooth and accurate finish. By indexing the head through the other five positions, the remaining tool locations are completed in the same way. As can be seen, the accuracy of the detent holes governs the tool positions but by machining in this manner, the tool holes are accurately on the centre line of the lathe **(Photo. 5)**.

Finally the grub screw holes are drilled and tapped into the tool head.



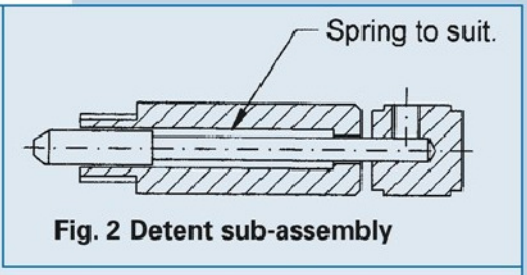


Fig. 2 Detent sub-assembly

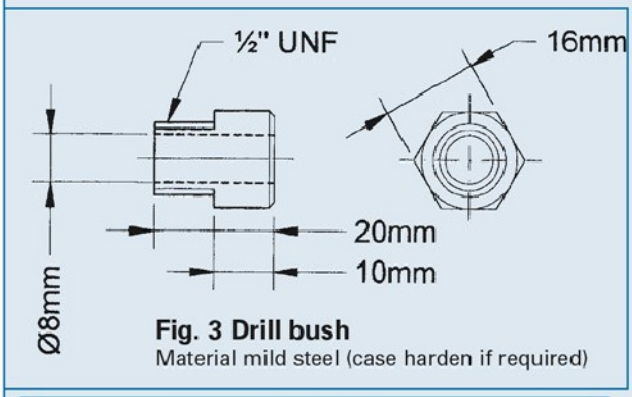
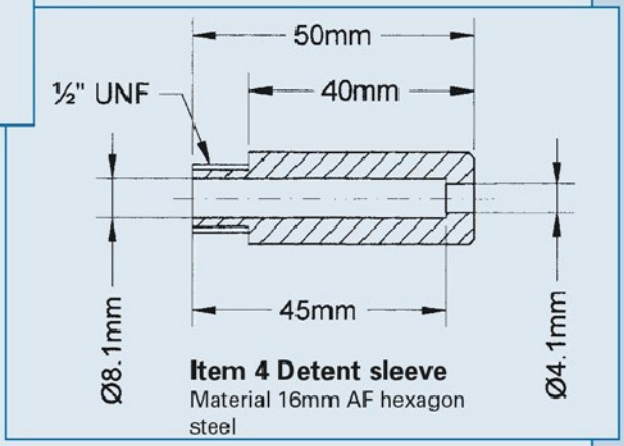
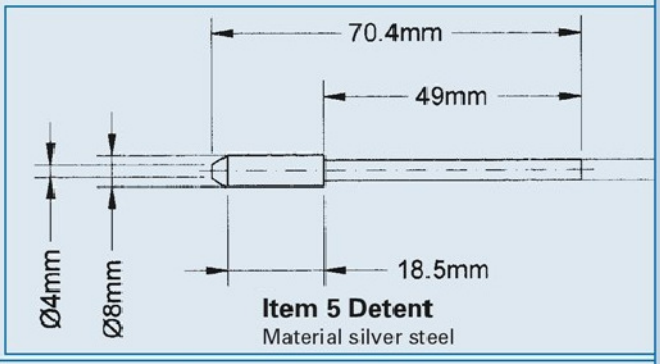


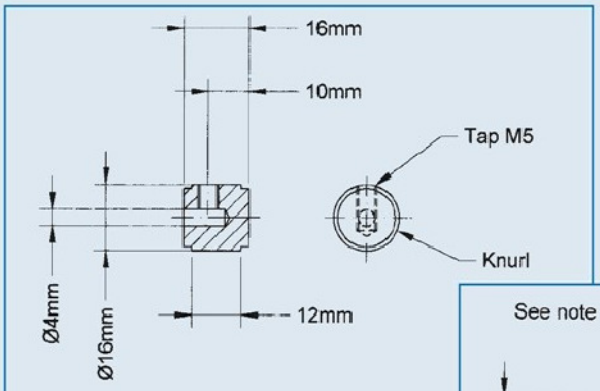
Fig. 3 Drill bush
Material mild steel (case harden if required)



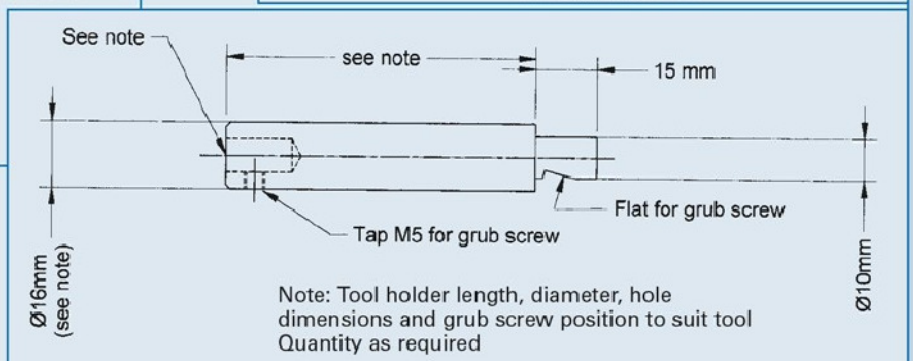
Item 4 Detent sleeve
Material 16mm AF hexagon steel



Item 5 Detent
Material silver steel



Item 6 Knob material mild steel



Item 7 Tool holder material mild steel

Tool Holders

In order for the turret to work satisfactorily, all the tools fitted need to have approximately the same stand-out from the tool head **(Photo. 6)**. If this is not the case, apart from requiring excessive tailstock travel for some tools, there is a danger of the longer items, such as drills, coming into contact with the lathe chuck when the shorter tools are in use. Tool holders **(Item 7)** should therefore be manufactured to equalise the lengths, that for the centre drill being likely to be the longest while that for the longest drill being the shortest. Typical examples are shown in **Photos. 7 & 8**.

8. An M10 tap needs a slightly shorter holder

The tool holders have a small machined flat so that the grub screw does not damage the spigot of the holders making it difficult to remove.

I hope that this article is of interest and, of course, if I can be of help, I am always happy to oblige (by phone only please, 01233 712158, Charing, Kent.)

SCRIBE A LINE

The Drummond lathe

From E. G. Frow, Durban, South Africa

Reading the articles on various old lathes in Issue 74 of M.E.W. put me in mind of a Drummond 'M' lathe on which I worked some 60 years ago. Amongst other things my department repaired and made various instruments. For this we had the Drummond, a drill press and a very good Schaublin instrument makers' lathe. The Drummond had seen better days but was still capable of good work- if humoured.

It was unusual for two things. It still had the original heavy treadle flywheel, but no treadle. Around the rim of the flywheel had been milled gear teeth and a three phase motor was mounted under the tray. The motor shaft had a long projection, with a gear machined at the end meshing with the flywheel. This worked very well and, of course, could be reversed. Its only disadvantage was that when switched off it ran on for some considerable time. It wasn't a good idea to switch into reverse momentarily as this drew a heavy current and the circuit breaker promptly tripped, which made one rather unpopular. As the department had a 110 volt DC supply, the problem was finally solved by injecting DC for a short time whenever the motor was switched off. This worked beautifully.

The other unusual thing was the chuck. This was a 4in. self-centring/independent one, the like of which I have never seen since. The way it was achieved was as follows.

The chuck body had the usual scroll and three grooves in the face. These, however, were twice as deep as usual and had two keys each side instead of one. Each jaw consisted of two parts, the inner meshing with the scroll, and having a semicircular groove with a circular key in its outer face. The second part of the jaw rode in between the outer keys and had a female screw thread on its inside edge, just like a conventional independent chuck. There was an adjusting screw connecting the two jaw parts. By these means, all jaws could be moved simultaneously via the scroll and its operating key, then the job could be made to run true by means of the individual screws.

Rotary tables. Yet another recycled source!

From John Jardine, Heckmondwike, West Yorkshire

Car windscreen wiper motors from the local breaker's yard cost about £5. They are small, lightweight and the ones I have come across have a very useful 40:1 reduction ratio. Try to get one of 'Bosch' manufacture as they seem to use parallel input/output shafts and separate adjustments for backlash and end float. As a finder's bonus there will also be an attached 100% rated 12V DC motor.

As an electronics engineer only recently beginning to be acquainted with this fascinating branch of engineering, I am not yet in a position to machine up the parts needed to make a 'real' rotary dividing table (nor would there be any pleasure buying one). In a rush and to avoid the complications of making division plates etc., I hooked a size 23 stepper motor directly to the input shaft of one of these wiper units and, with the addition of a programmed microcontroller, a small LCD and a few other 'bits and bobs', I can now just press a couple of buttons to let the motor drive through to any division ratio I want. Total cost of all the bits and pieces, about £25. For me though, the main appeal of this hobby is not the money saving aspect, it's simply the fun of the journey!

When is a bargain not a bargain?

From Barry Robinson, Solihull

At a recent autojumble I was tempted to purchase a Chinese manufactured digital height gauge, new in its box, at a price that was too good to be true. You've guessed it - when I got it home and fitted a battery it was too good to be true and the read-out wouldn't work. However, there was nothing lost as at a purchase price of £5 it still makes a cheap scribing block.

I would, however, like to try and get it fixed and wonder if anyone out there knows if spares are available or if repairs are possible. I can be contacted at 8 Grandborough Drive, Solihull, West Midlands B91 3TS or by e-mail at robinsonb@nvg.com

A cheap aid to better vision

From A. G. Forsbrook, St. Helens, Tasmania

First of all, let me say that M.E.W. makes most enjoyable reading. Hearing about peoples engineering problems and how they solved them, and sometimes applying the solutions in my workshop, at 73 years of age, is one way of keeping away from the devil (boredom). Thank you for your efforts.

I have had problems when working, as an amateur, with jewellery, mainly through not being able to see it properly. When searching around Australian engineering shops, I came across three eye loupes, in different magnifications, and cheap. However, I have not been able to keep a loupe in my eye socket, but the answer lay with a pair of cheap reading glasses with lenses made of Perspex or some similar material.

The trick is to cut a hole in the spectacle lens for the eye in which you wish to use the loupe, the diameter of the hole being appropriate for your loupe - mine was 1 1/8in. To locate the hole, get someone to mark your eye centre on the lens while you are wearing the glasses. From this centre mark, with dividers, a circle 1/8in. diameter smaller than the loupe, then chain drill a series of 1/8in. holes on that line to allow you to break out the centre piece.

I then used a Dremel drum sander to clean up the aperture, making the hole slightly tapered from the inside of the lens, testing it with the loupe as I progressed. I stopped while the loupe was still a fit against my eye.

By slipping the spectacle frame lower down my nose, I am able to see with both eyes when looking for a tool. I don't have to keep taking the loupe off my eye as it is held in the lens.

Taps and Stratagems

From Derek Cooke, Katoomba, New South Wales

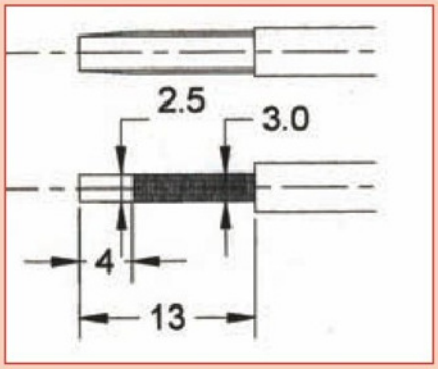
A letter from Ted Wale of Nova Scotia (M.E.W. Issue 72) dealing with the tapping of a non-standard thread rather tickled me, and Bob Loader's article, which included a section on tap manufacture, also struck a chord.

In the early '50s I was in rural veterinary practice in the English Lake District, and on a visit to the parental home (and my rather sketchy workshop), I took one of our instruments to repair. The job was straightforward except for the holder for the tiny light bulb. This had a thread of 0.45mm pitch and 4.5mm diameter. I tried Henry Osborne's shop at the West end of the Haymarket in Newcastle-upon-Tyne and, while they were unable to supply a tap, they directed me to an instrument mechanic at the Gateshead end of Stephenson's High Level Bridge. He made me a tap for the relatively modest sum of 7s 6d, and told me what size of tapping drill to use. I occasionally do "furrin" orders and ask the person to make a donation to Technical Aid to the Disabled (The Oz equivalent of REMAP), and recently used a similar tap to replace a missing piece in a rather ancient telescope. I have only used this method on brass, and doubt if it would work on steel (see sketch).

When I acquired my posh lathe, I made Acme and square thread lead and feed screws to replace the commercial studding fitted to my home-made lathe. For these I made taps as per Bob Loader to finish the brass nuts after lathe-cutting them most of the way. Awash with turps, they made the most piercing squeaks. It would fetch our terrier at the gallop. Otherwise the lack of backing-off didn't seem to matter a great deal.

The Original Tap

The material appears to be 3/16in. silver steel, and I guess was hardened by quenching in oil. The business end was turned down to 4.5mm dia. and threaded 0.45mm pitch, and then ground to a blade



shape. The corners were then being ground to an included angle of approx. 20 degrees. The trick is to grind the faces symmetrically, and to a point where there is no trace of the teeth on the corners. Looked at end-on, a square face should be presented, An aid to straight entry of the tap is essential.

Learning the hard way

From Peter Spenlove-Spenlove, Wigston, Leics.

With reference to pleas from newcomers to our hobby for sources of instruction and information, I agree that some basic bench/machine shop practice must be written about, as very few technical classes or workshops seem to teach it any more. I realise that many have "seen it all before" but, with luck you will get lots of new readers who are fed up with screens, mice and transistors, and who want to make things.

I learned a lot from LBSC's words in pre- and post-war issues of M.E. The modern generation seem to run him down, but they do not know the conditions of those days. My blowlamp would suddenly squirt raw paraffin like a flame thrower and I had to stamp out the flames. We brazed copper joints with brass wire and borax because silver solder had to be ordered from Bonds-o'-Euston road at huge cost. Soft solder came from the local plumber.

I used to heat my 2lb copper bit in the kitchen fire and use spirits of salts to solder tinplate and the like. My boring tools were forged on a lump of iron outside the kitchen door after heating an old square file in the fire. Most materials came from the scrapyard.

Kennions supplied rivets and screws by the dozen or ounce. Hacksaw blades cost a fortune and, being carbon steel, were easily worn out if you hit a hard spot. Iron castings were full of hard spots and chilled surfaces.

When my mother was asked "and what do you think that Peter would like for his birthday (or Christmas)?", the answer was "Money, so that he can buy more 'old iron' "! They didn't complain, though, as I usually managed to fix any broken items in the house and farm.

A mysterious lack of clearance

From Ray Price, Fishponds, Bristol

Could any reader help me with information on the lathe shown in the photograph? It was made by Griggs Motor and Engineering Co. Ltd., Twickenham, England.

The bed is 12in. x 3in., the whole lathe is 18 3/4in. long x 9in. high and the height from the top of the cross-slide to the chuck centre is just 1/4in! What on earth was this machine used for as, with so little clearance, how could you use a turning tool? It must have been minute.

I hope that someone can shed some light on this.

The CES Gear Hobbing Machine

From Arthur Davis, North Hykeham, Lincoln

Having almost completed the CES Gear Hobbing Machine, I have acquired some useful information which may be of assistance to other constructors.

The College Engineering Supply can provide a completely machined 40T wormwheel to suit the worm, priced at £15.80, which includes postage and packing. A 20 DP hob can be obtained from Terry Hill Tools, The Stables, Tichborne Road West, West Bolling, Bradford BD5 8AV at a cost of £50. This hob is manufactured by David Brown, the gearing specialists. I consider this to be a reasonable price for those constructors who have not the facilities or know-how to make this item.

I actually used this hob, in a special holder to fit the lathe toolpost, set at the correct angle to give clearance, to cut the LH worm for the hobbing machine. This gave very satisfactory results.

I also followed Harold Hall's excellent designs for the hob and work spindle drawbar system and also the universal joint. The latter worked perfectly when assembled.

Gear hobbing in the lathe

From John Whalley, King City, Ontario, Canada

I 'm very pleased that my letter to Scribe a Line (Issue 74) has generated some interest. It has already lead to a very pleasant correspondence with Dr. Giles Parkes.

Let me say, however, that there are two spots of bother with my device. Firstly I am unable to get in contact with the American publication, "Complete Metal Working Manual" by R. H. Cooley. It was published by Arco Publishing Company, Inc., 219 Park Avenue South, New York, N.Y. 10003. Copyright R. H. Cooley, 1967, to obtain permission to publish what is basically his idea with modifications, and a different change wheel and drive set-up to provide more flexibility in its use.

Secondly, it involves foundry work to produce three castings which do not lend themselves to easy fabrication. It's my understanding that most model engineers do not want to get into foundry work.

This being said, it is a very good way for the amateur to produce their own gears if they want to take the trouble to make their own hobs. Also, I am not sure if it would work on a lathe smaller than 10in. swing (5in. radius) as the cut is vertical and one has to be able to get the blank below the hob after the in-feed has been applied. My blanks run on an arbor between centres. Possibly some other arrangement using bearings in the main casting would solve this problem. I don't know anyone with a 7in. Myford to really see how much room there is.

I am more than happy to help anyone with an interest in this device, either by e-mail or direct correspondence, and while copyright is a problem, it shouldn't matter if drawings are exchanged between amateurs with no money involved.

(John can be contacted at johnwhalley@sympatico.ca)

Never throw anything away!

From Ian Rose, Kirriemuir, Angus

A number of the 'Quick Tips' published from time to time exploit some of the 'throw away' items which many of us use in the domestic scene.

This turned my mind to the humble disposable razor, some uses for which I offer for consideration:-

The handle with the head section broken off produces soft jaws for the small vice, used as is, partly split or slotted.

Unclipping the head reveals an ideal T-slot cleaning tool.

With blades removed, attach double-sided tape and a suitable piece of emery cloth for dressing those awkward areas.

The steel blades, although still sharp after use, provide small pre-punched 0.003in. shims.

From L. T. Beaton, Kincardine-on-Forth, Fife

A source of carbon steel suitable for making cutting tools can be found in scrap motor car drive shafts or half-shafts from commercial vehicles. The material should be heated to give a slow temperature rise to bright red, then held there for one hour per inch of thickness, followed by very slow cooling. This will allow it to be machined and shaped as required.

To re-harden and temper, treat as silver steel.

(Editor's note:- As was discussed in the correspondence columns of 'Model Engineer' some twelve months ago, it is probable that only components from older vehicles will provide suitable material. Modern alloy steels used by the motor industry may behave quite differently).

TO HELP YOU GET THE BEST FROM THE MODEL ENGINEER EXHIBITION

These notes are written purely for guidance. Full information is contained in the Competitors' Information booklet which is sent to every entrant as part of the information package. If you have an item and are unsure as to the Class into which it should be entered, leave that section blank and we will take care of it. The Judges have the right to move any competition exhibit into another class if they feel that by doing so its chances of gaining higher marks or a more appropriate award are improved.

If the item is offered as a Loan exhibit please indicate this by writing Loan on the form in the box identifying the Class. Loan models are not judged but carry all other privileges associated with competition entries.

Part built models are particularly welcome in the Loan Section; visitors like to see work in progress, and entry does not preclude the item being entered in competition when completed.

The classes listed below are those associated with mainstream model engineering.

Club exhibits

Where a club is exhibiting, each model should be entered on a separate entry form and clearly identified as a club exhibit by entering Loan/Club in the class section box. This ensures that we have a full record of all models on display during the show and facilitates matters of administration and insurance.

Additional forms

If you do not wish to deface your copy of the magazine we are happy to receive photocopies of the entry form, one for each model. We will be pleased to send out extra forms if required, so if you know of a modeller who is not a reader of one of our magazines but who you think may wish to participate, please advise them to contact our Exhibitions Office (01322-660070), or simply photocopy the entry form for them.

The success of the show depends largely on the number of models on display. Your work could well be the stimulus which inspires someone else to start in the hobby. There can be no doubt that this event is our showcase on the world of modelling in all its aspects. Every modelling discipline needs more and more participants, and it is by displaying not only the crème-de-la-crème, but also examples of work of a more achievable standard, that people are encouraged to join into the wonderful world of modelling, in whatever aspect.

We look forward to seeing a sample of your work at the show!

Engineering Section

A1 Hot air engines.
A2 General engineering models (including stationary and marine engines).
A3 Internal combustion engines.
A4 Mechanical propelled road vehicles (including tractors).
A5 Tools and workshop appliances.
A6 Horological, scientific and optical apparatus.
A7 General engineering exhibits – not covered by the above

Railway Section

B1 Working steam locomotives 1" scale and over.
B2 Working steam locomotives under 1" scale.
B3 Locomotives of any scale, experimental, freelance or based on any published design and not necessarily replicas of full size prototypes, intended for track duties.
B4 Scratchbuilt model locomotives of any scale, not covered by classes B1, B2, B3, including working models of non-steam, electrically or clockwork powered steam prototypes.
B5 Scratchbuilt model locomotives gauge 1 (10mm scale) and under.
B6 Kitbuilt model locomotives gauge 1 (10mm scale) and under.
B7 Scratchbuilt rolling stock, gauge 1 (10mm scale) and under.
B8 Kitbuilt rolling stock, gauge 1 (10mm scale) and under.
B9 Passenger or goods rolling stock, above 1" scale.
B10 Passenger or goods rolling stock, under 1" scale.
B11 Railway buildings and lineside accessories to any recognised model railway scale.
B12 Tramway vehicles.

Note:

Kitbuilt: any model containing a preponderance of commercially produced parts.
Scratchbuilt: wholly made by the entrant except wheels, gears, motor, engraved plates and small turning, etc. not exceeding 5% of the whole.
Rolling Stock: Where a rake is entered, competitors are asked to nominate one vehicle for judging purposes.

Marine Section

C1 Working scale models of powered vessels (from any period). Scale 1:1 to 1:48.
C2 Working scale models of powered vessels (from any period). Scale 1:49 to 1:384. Excl. miniatures as classified in C8.
C3 Non-working scale models of powered vessels (from any period). Scale 1:1 to 1:48
C4 Non-working scale models of powered vessels (from any period). Scale 1:49 to 1:384 excl. miniatures as classified in C8.
C5 Sailing ships and oared vessels of any period – working.
C6 Sailing ships and oared vessels of any period – non-working.
C7 Non-scale powered functional models including hydroplanes.
C8 Miniatures. Length of hull not to exceed, 15in for 1/32 in. to 1ft scale or larger, 12in for 1/25 in. scale, 10in. for 1/16 scale; 9in. for 1/8 scale. No limit for smaller scales.
C9 For any model boat built from a commercial kit. Before acceptance in this competition the kit must have been readily available for at least 3 months prior to the opening date of the exhibition and at least 20 kits must have been sold either by mail order or through the retail trade.
C10 Functional Model Yachts

Supporting documentary evidence of accuracy may be submitted by entrants in large and clearly identified envelopes.

Model Horse Drawn Vehicle Section

G1 Carriages & other sprung vehicles. (Omnibuses, trade vans etc.) Wagons, carts and farm implements. Caravans.

Junior Section

J1 For any type of model, mechanical or engineering work, by an under 14 year old.
J2 For any type of model, mechanical or engineering work, by an under 16 year old.
J3 For any type of model, mechanical or engineering work, by an under 18 year old.

All entries will be judged for standard of craftsmanship, regardless of the modelling discipline, i.e. a boat will not be competing against a military figure. Providing a model attains sufficient marks it will be awarded a gold, silver or bronze medal.

Model Vehicle Section

K1 Non-working cars, including small commercial vehicles (e.g. Ford Transit) all scales down to 1/42.
K2 Non-working trucks, articulated tractor and trailer units, plus other large commercial vehicles based on truck-type chassis, all scales down to 1/42.
K3 Non-working motor bikes, including push bikes, all scales down to 1/42.
K4 Non-working emergency vehicles, fire, police and ambulance, all scales down to 1/42.
K5 Non-working vehicles including small commercial vehicles (e.g. Ford Transit,) scale from 1/43 or smaller.
K6 Any available body shells including Concours, in any scale or material, to be judged on appearance only.
K7 Functional model cars/vehicles which must be able to move under its own power of any type. Can be either free-running, tethered or radio controlled or slot car, but must represent a reasonable full size replica.

Duke of Edinburgh Challenge Trophy

Rules and Particulars

The Duke of Edinburgh Challenge Trophy is awarded to the winner of the Championship Award at the Model Engineer Exhibition.

The trophy remains at all times the property of Nexus Special Interests.

The name of the winner and the date of the year in which the award is made will be engraved on the trophy, which may remain, at the discretion of Nexus Special Interests Ltd, in his/her possession until required for renovation and display at the following Model Engineer Exhibition.

Any piece of model engineering work will be eligible for this Championship Award after it has been awarded, at The Model Engineer Exhibition, a Gold or Silver medal by Nexus Special Interests Ltd.

No model may be entered more than once.

Entry shall be free. Competitors must state on the entry form:

That exhibits are their own bona-fide work.

Any parts or kits which were purchased or were not the outcome of their own work.

That the model has not been structurally altered since winning the qualifying award.

7. Nexus Special Interests Ltd. may at their sole discretion vary the conditions of entry without notice.

Loan Section

The Loan Section is for anyone wishing to display models on a non-competitive basis. Unfinished models will be eligible providing a good standard of engineering workmanship is displayed. FREE entry by normal competition application.

Self Delivery

If you intend to bring your model to the show personally please take note of and comply with the delivery times and instructions contained in the Competitors' Information pack.

UNDER NO CIRCUMSTANCES CONSIGN YOUR EXHIBIT DIRECT TO SANDOWN PARK EXHIBITION CENTRE. The staff there have no facilities to deal with them, and no insurance cover for such items.

The Early Bird

If you intend to visit the show on your own, with friends or as a member of a party, substantial savings on tickets may be had and queuing avoided by ordering your tickets in advance. A special Hotline is in place: Tel: +44 (0)1858 438897, Fax: +44 (0)1858 461739. The Hotline is open Monday-Friday 8am-9.30pm; Saturday and Sunday 8am-4pm. Call and place your order after 2nd October.

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THE MODEL ENGINEER Exhibition & Competition

LOAN/COMPETITION ENTRY FORM

A separate form is required for each entry.
Please send to:
Nexus Competition Entry
The Leys, Church Street,
Twyford, Buckingham MK18 4EU
Tel: 01322 660070 Fax: 01322 616319

ENTRY NO.

Office Use Only

CLASS | ENTRY NO.

PERSONAL DETAILS (Please print clearly)

Surname _____ Forename(s) _____

Address _____

_____ Post Code: _____

Home Tel No: _____ Daytime Tel No: _____ Age: _____

Model Club or Association membership _____

Value of Model (Nexus takes no responsibility if the value is not entered) £ _____

N.S.I. plan used? (Y/N) _____ How many years have you been a modeller? _____

Name and address of your local newspaper _____

_____ Publicity? (Y/N) ☐

My model will reach the exhibition via:
Post ☐
Personal delivery ☐
No. of boxes/crates ☐

Have you filled in your insurance value: (Y/N) ☐
Have you entered before? (Y/N) ☐
Are you supplying notes? (Y/N) ☐
Have you supplied a photograph? (Y/N) ☐

Signature:

Date:

Please tick this box if you would prefer not to receive mail from other companies which may be of interest to you. ☐

Do you subscribe to a Nexus magazine? (Y/N) ☐

MODEL DETAILS

Title of model: _____

Description _____

_____

Machinery used: _____

Type of construction: _____

Parts not made by you and commercial items: _____

_____

Name and address of your local newspaper _____

Scale: Length: Width: Height: Weight:

N.B. Please make copies including photographs of all information relating to your model as Nexus will not accept liability for any loss.

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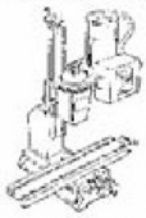

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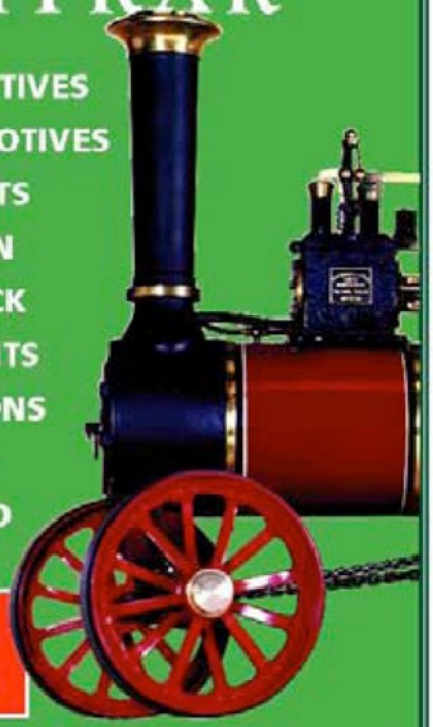

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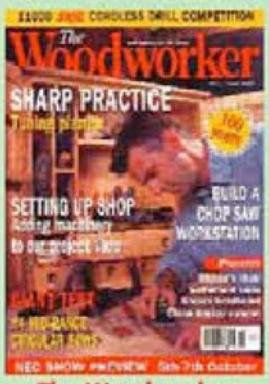

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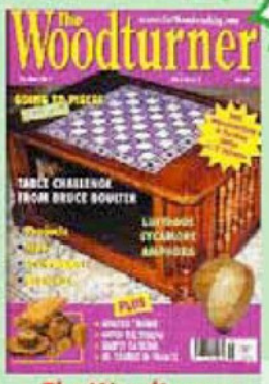

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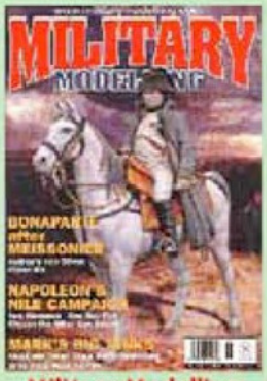

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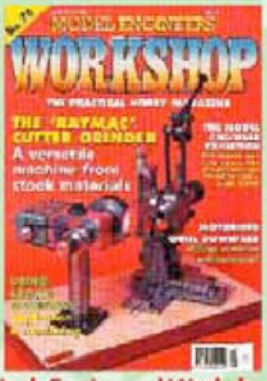

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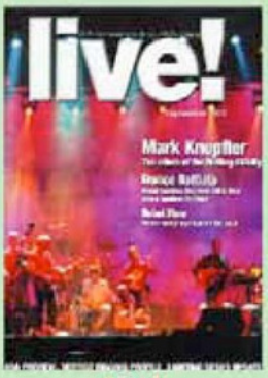

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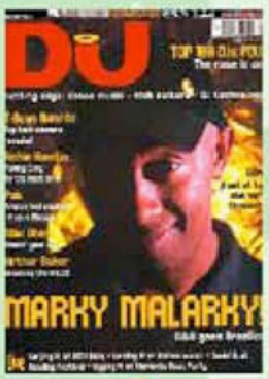

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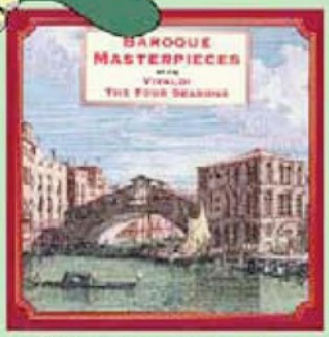

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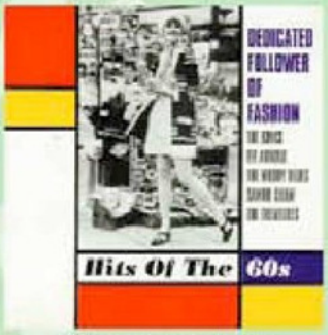

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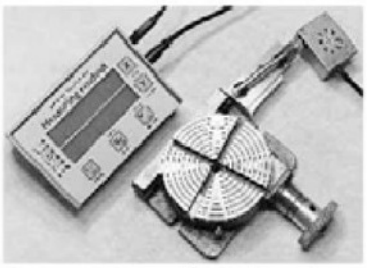

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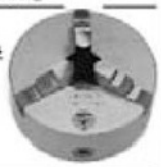

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From M25 North and West: Exit at Junction 10 onto A3 towards London. Exit onto A244 at Esher Common roundabout, signposted to Sandown Park. Turn right onto A307, Esher High Street at T-junction/traffic lights. Sandown Park can be found 1/4 mile along on left-hand side.

From M25 South and East: Exit Junction 9 onto A244 towards Esher, over roundabout at Esher Common, then as above.

By Train

From London and the North: From Victoria, Waterloo or Clapham Junction to Esher station (20-30 minute journey). Taxi rank at station or 2/3 mile walk as follows; left onto Station Road, right at T-junction onto A307. Sandown Park can be found 1/2 mile along on right-hand side.

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MYFORD ML10 36" x 12", changewheels, 3 jaw chuck, leadscrew clutch £750
MYFORD ML10 36" x 12", changewheels, 3 jaw chuck, face plate, cutting tools, switch gear ..... Late machine £825
MYFORD ML7 38" x 19", changewheels, 3 jaw chuck, we have a large selection of the popular model ..... From £700
MYFORD ML7 B 38" x 19", gearbox, 3 jaw chuck etc £1,250
MYFORD ML7 38" x 31", changewheels, 3 jaw chuck £1,125
MYFORD SUPER 7 38" x 19", changewheels, 3 jaw chuck, ... Choice £950 – £1,150
MYFORD SUPER 7 B 38" x 19", gearbox, 3 jaw chuck £1,250
MYFORD SUPER 7 38" x 31", changewheels, 3 jaw chuck ..... Choice £1,400
MYFORD SUPER 7, 38" x 19", 3 jaw chuck, power cross-feed, late model ..... Choice
MYFORD SUPER 7 B, 36" x 19", gearbox, Power Cross Feed, cabinet stand, tooling £2,750
MYFORD SUPER 7 B, 36" x 19", gearbox, Power Cross Feed, cabinet stand £2,950
RAGLAN CAPSTAN 10" x 24" 6 Station Turret, Cut off Slide, Collet Chuck (lever) & collets, Bar Feed, Variable Speed, Coolant £975
SMART & BROWN 2nd operation lathe, 3 jaw chuck, x-y slides, tailstock, stand ..... Just £300
VICEROY TDS 1 GBL 5" x 20", gearbox, power slides, 3 morse tailstock £1,200

TOO MANY LATHES TO LIST!!

MILLING MACHINES ..... V – Vertical, H – Horizontal

ACIERA F3 Universal Toolmakers precision mill, Table 24" x 6" + accessories and collets ..... Just in £2,000
ADCOCK AND SHIPLEY IES Horizontal/Vertical Head, 30" x 6" powered table and feed gears, coolant £1695
BOXFORD VM30 variable speed / 30 INT head, table 21" x 6" + Abwood vice and collet chuck £1,950
BRIDGEPORT Series 1 - 2 HP Variable Speed R8 Head, powered (gas/inx) table, 48" x 9" £2,950
BRIDGEPORT Belt head 2 speed (short motor) head, R8 powered head, variable speed 42" x 9" table ..... Very nice £4,250
CENTEC 2A vertical 2 mt swivel head 10" x 47A table £650
CENTEC 2B Horizontal, 1" arbor, table powered, 3 ph motor, single phase main motor £795
CENTEC 2E H/V, vertical head, 2 morse taper thumet, cabinet stand £1,400
ELLIOT OMNIMILL horizontal, hydraulic table feeds, 28" x 7" ..... Now £250
ELLIOT Turret mill R8-10 speed 70-3000 rpm, table 45" x 10" (powered) £1,500
EMCO FB2 (6 speed head) Bench Mill & Cabinet Stand, 240 volts ..... Just in £1795
EMCO FB2 Vertical 6 speed quill feed head 2 MT, powered 24" x 6" table, full coolant tray and cabinet stand and new 2 MT collet chuck ..... Very nice £2,250
HARRISON horizontal, 21" x 6" powered table ..... Now £250
HARRISON vertical 30 Int. Head, Late 2000 Revs Top Speed Model. All Gears for powered table & machine vice £1950
MARLOW MODEL 2 Turret Type Mill ..... Now £600
RAGLAN VERTICAL MILL 2 Morse taper, 2 speed motor, variable selector 175-2250 RPM, cabinet stand £1,150
TOM SENIOR Model E vertical milling machine table 23" x 9" , complete with cabinet stand, Glanicon collet chuck, Tom Senior machine vice, original 240 volts from new, probably the last one made in superb condition. £3,400
TOM SENIOR M1 horizontal, 28" x 6" powered table, 1" arbor £875
TOM SENIOR M1 VM, 28" x 6", 2 morse taper, 1" arbor. ..... Selection £1,200 – £1,450
TOS FQ3 AV vertical turret mill, 40 INT, 54" x 10" table, power tail-stock £1,950
VICEROY ADW vertical mill, 30 Int swivel head, powered table 24" x 6" ..... Very Clean £1,995

ENGRAVERS

SCRIPTA SA 3D engraver, bench machine ..... Swiss £525
TAYLOR HOBSON Model A (bench Machine) ..... very nice £425

DRILLS

AJAX 3 Morse Taper Drilling Machine, Power Feed £625
ASQUITH 14-54 001 Mk2 (Smt) Radial Drill ..... Immaculate coming in £3950
FOBCO 5" Bench, tilting table £325
FOBCO 5" Pedestal drill tilting table £345
MEDDINGS 4" pedestal drill £245
MEDDINGS 2 Morse taper pedestal drills ..... Choice £275
MEDDINGS MF2 10 Speed 2MT Bench 240 volts drill £350
POLLARD CORONA Pedestal n/i morse ..... From £100
SIP HDP 600B 1/2" Dmx Bench Drill ..... New £175
STARTRITE MERCURY 5" 4 speed bench drill £225
STARTRITE Mercury 5" pedestal drill, 240 volts ..... As New £300

GRINDING / BUFFING

CLARKSON MKI Tool and cutter grinder ..... Choice £550
CLARKSON MKII 6" x 12" tool and cutter grinder, graduated dials, universal head, centres, cabinet stand £1,750
EAGLE MODEL 4B MKII 24" x 6" table with 14" x 6" magnetic chuck + dust extractor £1,150
JONES AND SHIPMAN 540 Surface Grinder & Magnetic Chuck ..... Ex College/Clean no work £1650
MILFORD 12" Pedestal Grinder £325
R.J.H. Buffing Machine, pedestal model £325
VICEROY Grinder, pedestal model £145
VICEROY Buffers, pedestal models ..... Each £250
VICTOR EAGLE surface grinder, table 21" x 6" complete with a 14" x 6" magnetic fine pole chuck & extractor. 1.05 wet model £850

MISCELLANEOUS/FABRICATION MCH.

BOXFORD Vertical Slide complete £425
BOXFORD Turret attachment 4 1/2" + quantity of drill chucks £625
BOXFORD Thread dial indicator (mp) £55
MYFORD ML7 / Super7 rear tool post £40
MYFORD 254S Rear tool post £40
MYFORD Vertical slide/feed type copy £99
OLIVER – ADRIAN FIXER ..... Ass £55
LOCKWOOD GRADI HEADED 2mt Die Holder ..... New £40
LOCKWOOD GRADI HEADED 3mt Die Holder ..... New £40
TOM SENIOR DIVIDING HEAD + TAILSTOCK AND 3 JAW CHUCK £325
BRIDGEPORT SLOTTING HEAD ..... Rare £750
CENTROID 4 station drilling attachment for 2mt Drill £245
3 STATION Drilling attachment fro 2mt Drill £55
MIRACLE Flat Bar bender / 4" wide capacity £345
LOCKWOOD Test Bar / 2mt Bored New £39
LOCKWOOD Test Bar / 3mt Bored New £42
HEGNOR MK TROUT 2 small fretsaw £275
HOLDWIN 6" machine vice ..... Very clean £245
MAGNETIC chuck - 10"x5" fine pole ..... Never used £325
TOM SENIOR Model E pedestal stand £150
UNION tool and cutter grinder stand £135
ATLAS shaper 7" stand ..... As is £100
CLARKSON MKI £100
HARDINGE Capstan type toolpost (tick in type) £175
HARDINGE Headstock, bed stand, stand and motor £150
50 INT Tooling; Selection ..... Just in
HARRISON Sliding Head & Extension ..... Very rare £525
STARTRITE 352 Woodworking Band Saw £975
STARTRITE 14-5-5 Woodworking Band Saw £775
MITUTOYO 600mm Height Gauge no 520-150 ..... Boxed £225
ALCOSA GF 080/1 Rapid Melting Furnace £300
FLAMEFAST CRM 5005 Rapid Melting Furnace £425
GABRO BF 620-2, 24" Box and Pan General Use Folder ..... Choice £325/£425
WILLOW Bandsaw vertical 4 speed machine £400
MYFORD Burned Griptru 3 Jaw Chucks ..... Boxed £250
COLCHESTER/ARRISON D13 Burned 4 Jaw 6" light body independet chucks ..... Boxed £175
RJH 4" Linisher / Vertical (Build in Extraction) £525
ARBURG Plastic injection molding machine 04 Model £425
KASENIT oven (gas fired) ..... small £100
KASENIT oven (gas fired) model 2533 ..... £325
BONIARDI rolls (set each side and spare formers) ..... NOW £250
KILNS various ..... £200/£425
HAND Shaper £140
SCHAUBLIN 5040 high speed drilling head ..... Never used £525
TAPPING HEADS 1 2/3 Morse Taper ..... Selection Just Arrived
MICROMETERS and associated measuring tools ..... Still packaged as new
POTTERY WHEELS, kilns and associated equipment ..... Just In Cheap
SPECAC Powder type press £225
ELLIOTT Horizontal and Vertical dividing head & 3 jaw chuck £325
HARRISON L5 Taper turning attachment £325
HARRISON L5 Metric Gear ..... As is £250
HARRISON L5 Tailstock £245
HARRISON L5 Travelling steady £40
NEW FROM NEW ZEALAND - Machine vice, 55mm Jaws precision miniature type ideal for vertical slides and smaller milling machines £95
STARTRITE H6000 M Horizontal bandsaw, 1997 machine ..... As new £2750
SIP 1 TON MOBILE CRANE Manufactured 2000 ..... As new £375
MYFORD SAW TABLE for ML7 – Super 7 ..... £140
MITUTOYO grade A set of slips £245
WDS TOGGLE PRESSES, various ..... £50/£240
MARLOG KNURLERS (clamp type) £75
MYFORD coolant system ..... Hardly used £275
F.J. EDWARDS 24" hole cutter £525
RECORD NO.24 quick release bench vice £50
LINK 1.5 tonne vehicle crane + top hat £525
MITUTOYO 100-910 metric set micrometers £275
COLCHESTER CHIPMASTER/BANTAM turret capstan attachment £475
RAPIDOR 6" hacksaw machine £225
BENCH KNIBBELER, 240 volts £125
PRECISIMA CHINE VICES 4" and 6" swivel ..... New £70 / £140
NORTON/EDWARDS Abor presses ..... £75 / £145
AJAX 6" Hacksaw £425
SURFACE plates from 12" x 12" to 36" x 36" ..... Very Nice from £30
KEETONA 4ft trestle folder (6) £750
FLAMEFAST brazing hearth (good condition) 240 volts £140
ELLIOT 1 1/2, 14" shaping machine £950
ALBA 1A, 10" shaping machine ..... From £350
TES, BOXFORD / MYFORD quick change tool posts ..... British / New £75
WEBER 1 1/2 ton mobile garage crane, late blue colour £495
UNION 4 1/2" x 30" bench centres £175
HARRISON L5 Vertical Slide ..... Never used £345
HARRISON L5 Boring Table £155
DENTED VERTICAL QUILL feed heads ..... Each £750
ELLIOTT 1250 STURDIMILL vertical head ..... One off (rare) £525
RJH linisher 4" wide belt, pedestal £345
DENBIGH/NORTON No.2/3 Flypress ..... From £145
STEEL STOCK Just arrived – to collect only
ELLIOT U1/U2 Slotting Head £475
SWAGE BLOCKS ..... £125 / £145
J&S Universal Grinding Vice ..... Choice £275 / £325
BOX TABLES: Grade A and B, many sizes ..... £40 – £150
SLIPS/GAUGES Metric/Imperial, New Sets; 67,81 piece ..... £215 / £145
HORIZONTAL METAL BANDSAW 6" x 4 1/2" capacity ..... New £170
KASNET Mini Furnace ..... Each £175
COLCHESTER STUDENT/MASTER Round head, flangplates, small/large ..... £50 / £80
QUALTERS AND SMITH 6" Hacksaw £345
BORING HEADS 2/3 Morse, R8 Taper, Max. Cap 4 1/2" ..... New, each £90
ANVIL, 1cwt on stand £125
ODONI Machine Bed Clamps (pair) ..... Special £24.50
HEIGHT GAUGES by Chesterman, Starrett, Moore and Wright ..... From £95
ELLIOTT 10M Shaper, 10" stroke £325
DIE BOXES ..... From £45
TRANSWAVE 2kW Converter ..... New £250
TRANSWAVE 5.5kW Converter ..... New £375
TRANSWAVE MMC rotaryconverters now available ..... From £470
CROMPTON PARKINSON 4 HP, resilient mount, Bonded/Myford Super 7 Type motor ..... New £140
DEWHURST TYPE A Reversing Switch ..... New £54
RUBEOLITE trailer lamps/combined pair ..... New just £15
BARLOW ORMICK MODEL M915 lift ..... Mobile £375
MIRACLE Flat bar bender 6" wide capacity £145

WE ARE CONSTANTLY CHANGING OUR STOCK FASTER THAN THE ADVERTS CAN KEEP UP WITH US!!

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ALL PRICES EXCLUSIVE OF V.A.T.

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INTRODUCING THE NEW DB RANGE OF LATHE'S

From **£880**

Mini - Multi

- SWING OVER BED: 125MM
- SPINDLE BORE: 8½MM
- TAILSTOCK TRAVEL: 28MM
- SPEED RANGE VARIABLE: 100-2500
- RANGE OF THREADS: (INCH) 16-40TPI (METRIC) 0.4-1.25MM
- MOTOR: 250W
- NET WEIGHT: 25KG
- DISTANCE BETWEEN CENTERS: 200MM
- TAILSTOCK TAPER: MT1
- CROSS-SLIDE TRAVEL: 70

From **£350**

Conquest Lathe

- SWING OVER BED: 180MM
- SPINDLE BORE: 19MM
- TAILSTOCK TRAVEL: 60MM
- SPEED RANGE VARIABLE: 100-2500 RPM
- RANGE OF THREADS: (INCH) 12-52TPI (METRIC) 0.25-1.5MM
- MOTOR: ½HP
- NET WEIGHT: 38KG
- DISTANCE BETWEEN CENTERS: 300MM
- TAILSTOCK TAPER: MT2
- CROSS-SLIDE TRAVEL: 70MM
- DIMENSIONS: (LXWXH) 770X254X300

From **£445**

920 Lathe Deluxe

- SWING OVER BED: 229MM
- SWING OVER CROSS SLIDE: 133MM
- DISTANCE BETWEEN CENTERS: 500MM
- SPINDLE BORE: 19MM
- TAPER IN SPINDLE NOSE: MT3
- MOTOR: ¾HP
- 6 SPEED: 100-1800
- NET WEIGHT: 100KG

STANDARD EQUIPMENT:

- 4" 3-JAW CHUCK WITH 2 SETS OF JAWS
- 7¼ 4-JAW CHUCK WITH REVERSIBLE JAWS
- STEADY REST • FOLLOW REST
- MT#2 DEAD CENTRE
- MT#3 DEAD CENTRE
- 4-WAY TOOL POST
- FACE PLATE
- TOOL BOX & TOOL KIT
- TRAY & SPLASH GUARD

From **£850**

Model B-Super

- SWING OVER BED: 420MM
- DISTANCE BETWEEN CENTERS: 500MM
- MILL DRILL SPINDLE TAPER: 19MM
- TAILSTOCK BARREL TRAVEL: 80MM
- 7 SPEEDS 60-1300
- SWING OVER CROSS SLIDE: 160MM
- SPINDLE TAPER: MT3
- DRAW BAR: M12
- CROSS SLIDE TRAVEL: 180MM
- MOTOR: ¾HP
- NET WEIGHT: 155KG

STANDARD EQUIPMENT

- 4" 3-JAW CHUCK
- 2 DEAD CENTRES
- 6" BACKPLATE
- 1/2 DRILL CHUCK
- CHANGE GEARS
- MT#3 CHUCK ARBOR

£725

Comet Lathe

- SWING OVER BED: 250MM
- SWING OVER CROSS SLIDE: 133MM
- DISTANCE BETWEEN CENTERS: 550MM
- SPINDLE BORE: 19MM
- TAPER IN SPINDLE NOSE: MT3
- MOTOR: ¾HP
- 6 SPEED: 125-2000
- NET WEIGHT: 130KG

MILL ATTACHMENT

- SPINDLE TAPER: M13MM
- HEAD TRAVEL: 215MM
- SPEED VARIABLE
- RANGE: 0-3000OI
- MOTOR: ½HP
- NET WEIGHT: 45KG

£1115

Centurion

- SWING OVER BED: 420MM
- DISTANCE BETWEEN CENTERS: 520MM
- MILL DRILL SPINDLE TAPER:
- TAILSTOCK BARREL TRAVEL: 80MM
- 7 SPEEDS 160-1360
- SWING OVER SADDLE: 160MM
- SPINDLE TAPER: MT3
- DRAW BAR: M12
- CROSS SLIDE TRAVEL: 200MM
- MOTOR: 2 X ¾HP
- NET WEIGHT: 230KG

STANDARD EQUIPMENT

- 4" 3-JAW CHUCK
- 2 DEAD CENTERS
- 6" BACKPLATE
- 1/2 DRILL CHUCK
- CHANGE GEARS
- MT#3 CHUCK ARBOR

£1395

Craftsman Precision Belt Drive

- SWING OVER BED: 300MM • SWING OVER GAP: 450MM • SWING OVER SADDLE: 170MM
- DISTANCE BETWEEN CENTRES: 570MM • SPINDLE BORE: 36MM • SPINDLE NOSE TAPER: MT5
- CROSS SLIDE TRAVEL: 150MM • COMPOUND TRAVEL: 89MM • TAILSTOCK BARREL TAPER MT3
- TAILSTOCK BARREL TRAVEL: 92MM • RANGE OF SPEEDS: 1250-1200RPM • MOTOR: 11/2 HP
- NETWEIGHT 398KG

STANDARD EQUIPMENT:

- 6" 3-JAW CHUCK WITH REVERSIBLE TOP JAWS
- 8" 4-JAW CHUCK WITH REVERSIBLE TOP JAWS
- STEADY REST • FOLLOW REST
- STAND • 12" FACE PLATE
- SPLASH GUARD • THREADING DIAL
- 4-WAY TURRET TOOL POST
- 2MT# DEAD CENTERS
- T-SLOTTED CROSS SLIDE

£1725

Cub 620/630/640

- SWING OVER BED: 300MM • SWING OVER GAP: 430MM • SWING OVER SADDLE: 174MM
- DISTANCE BETWEEN CENTRES: 500/750/1000MM • BED WIDTH: 190MM • SPINDLE BORE: 38MM
- SPINDLE NOSE: DI-5 • SPINDLE NOSE TAPER: MT5 • CROSS SLIDE TRAVEL: 160MM • COMPOUND TRAVEL: 75MM
- TAILSTOCK BARREL TAPER MT3 • TAILSTOCK BARREL TRAVEL: 70 • RANGE OF SPEEDS: 9 60-2000RPM
- NUMBER OF INCH THREADS 33 • RANGE OF INCH THREADS 4-72 TPI • MOTOR: 11/2HP 240V PR 2HP415V
- APPROX SHIPPING WEIGHT 380KG

STANDARD EQUIPMENT:

- HARDENED AND GROUND GEARS IN HEADSTOCK
- BUILT-IN STAND • FOOT BRAKE • MOUNTED LIGHT
- INDUCTION HARDENED BEDWAYS • FACE PLATE
- JOG BUTTON AND EMERGEINCY STOP
- 4-WAY TURRET TOOL POST
- 6" 3-JAW CHUCK WITH 2 PIECE TOP JAWS
- 8" 4-JAW CHUCK
- STEADY REST / FELLOW REST • 2 DEAD CENTERS
- COOLANT SYSTEM W/BACK SPLASH • THREADING DIAL
- DIRECT READING DIAL CROSS SLIDE
- REMOVABLE CHIP TRAY

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