No.57

MODEL ENGINEERS' WORKSHOP

THE PRACTICAL HOBBY MAGAZINE

SPARK EROSION MACHINE

Electrical Discharge Machining capability

ENGRAVING TOOL

Clear lines on scales and dials

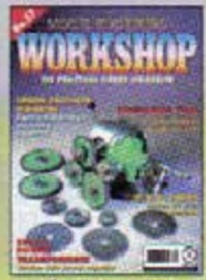
M.E.W. INDEX

Issues 45 to 56 inclusive

SMALL POWER TRANSFORMERS

Custom built power supplies

57
9 770959 690034
FOR ENTHUSIASTS BY ENTHUSIASTS
NEXUS
16TH APRIL - 10TH JUNE 1999 £3.00



Published by
Nexus Special Interests
Nexus House, Azalea Drive,
Swanley, Kent BR8 8HY
Tel: 01322 660070
Fax: 01322 668421

EDITORIAL

Editor
Geoff Sheppard

Group Editor
Ted Jolliffe

PRODUCTION

Designer
Rachel White

Copy Control Manager
Carrie Dogan

Printed By
St. Ives plc (Andover)

Origination by
Derek Croxson Ltd.

SALES

UK Sales Manager
Mark Colyer

Classified Sales Executive
Sharon Hope

Northern Area Office
Carrington Business Park,
Manchester Road, Carrington,
Manchester M31 4YR
Tel: 0161-776 4460
Fax: 0161-777 6524

MANAGEMENT

Group Managing Director
Tony DeBell

Divisional Managing Editor
Dawn Frosdick-Hopley

Divisional Sales Manager
Roy Kemp

Group Marketing Manager
Aileen O'Connor

Group Circulation Manager
William Pearson

SUBSCRIPTIONS

Nexus Subscription Services, Tower House, Sovereign Park, Lathkill Street, Market Harborough, Leicestershire, LE16 9EF.
8 issues UK £24.00, Europe & Eire £28.88, Sterling Overseas: £31.44 (surface mail) £34.48 (air mail), US$ overseas $47(surface mail) $52 (airmail) Cheques payable to Nexus Special Interests Ltd.
USA Subscription Agent: Wise Owl Worldwide Publications, 4314 West 238th Street, Torrance, CA 90505-4509 USA. For Visa/Mastercard orders in USA telephone (310) 3756258 Fax (310) 3750548. Pacific Time 9am-9pm Weekdays, 10am-6pm Weekends.
USPS 010876

NEXUS

CONTENTS

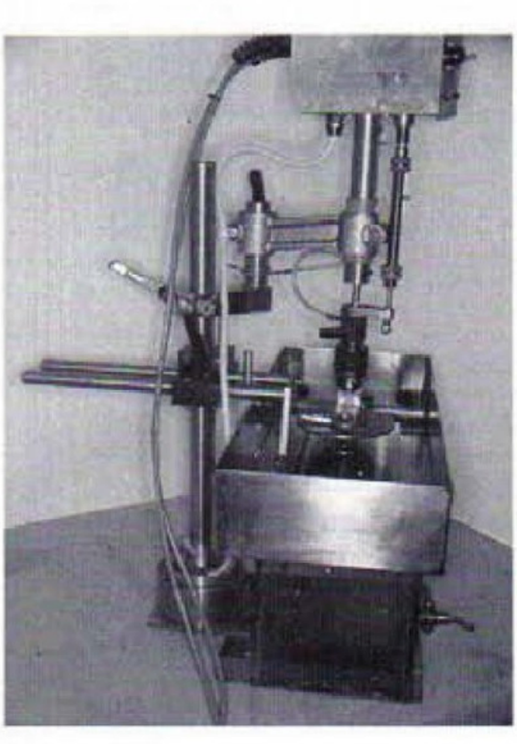
Issue No. 57

Editor: Geoff Sheppard
Nexus Special Interests, Nexus House, Azalea Drive, Swanley, Kent BR8 8HY tel. 01322 660070 fax. 01322 667633

SUBSCRIPTIONS AND BACK ISSUES HOTLINES:
ORDERS:
01858 - 435344
ENQUIRIES:
01858 - 435322
LINES OPEN 8am - 6.30pm

On the cover

Ivan Law designed and made this impressive Universal Spiralling and Differential Indexing Dividing Head. The 24DP change wheels were cut by hobbing. Further information on forming hobs is given in Dr. Giles Parkes' article which starts on page 37



Peter Rawlinson's description of his Spark Eroder starts on page 47 with details of the electronic control system. The mechanical components will be covered in subsequent articles

ON THE EDITOR'S BENCH

There seems to have been, in recent weeks, a flurry of radio and television programmes looking at historical and industrial archaeological subjects. Our local BBC station ran a series of short programmes over a week, looking at a variety of projects in the region; some of the Adam Hart-Davis history programmes have been given a re-run and the irrepressible Fred Dibnah has started a new series on the Industrial Age. The latter is covering a different aspect each week, the textile industry and iron and steel being typical subjects. Not only are preserved installations visited, but also a good range of the industrial museums which specialise in demonstrations of processes in addition to displays of inanimate objects. There have been some quite spectacular shots of such activities as pouring molten iron and forging billets of red hot steel. An amusing moment occurs in each programme when Fred, after enthusing over some item from the past, appears to be slightly embarrassed to have to declare "And don't forget, you can also visit our Web site"!

I am probably biased, but I was somewhat surprised, after the first programme, to read one of the TV critics in a broadsheet newspaper declaring, in effect, that such programmes are a total waste of time as Britain's industrial base is as good as dead and buried (and good riddance too seemed to be implied), so no-one would be in the least interested. I am not sure of other readers' experiences, but wherever I go, I find that such attractions are very popular and generally well supported. TEE Publishing's annual 'Museum and Rally Guide' seems to get thicker every year and, although it contains the occasional 'museum now closed' entry, these are far outweighed by the new listings. More and more people seem to be willing to take an active part, either in a hands-on capacity or by fund raising, so that interesting artefacts from the past can continue to be enjoyed by future generations. I sometimes think that 'the Establishment' is unable to understand that many people can gain as much inspiration and enjoyment from viewing an elegant piece of machinery as they can from studying a famous painting or piece of sculpture. Many of the Victorian engine houses are as breath-taking as the more widely recognised pieces of historic architecture. I suppose they are just not 'fashionable' - just like being an engineer!

One of the places of interest covered in the local programmes is one with which I have recently become involved, and I was able to be there when one of the well-known lady reporters and her cameraman paid a visit. As always, about three hours were spent filming the site and conducting interviews, and the result was a two and a half minute news feature, but several of the interviews were repeated on local radio throughout the day. The site is that of the one remaining brass battery mill on the Bristol Avon. It is not widely appreciated that the stretch of river between Bristol and Bath was, during the 1700s, the centre of the brass industry in England. The celebrated Abraham Darby was active here, at Baptist Mills in the centre of Bristol before turning his attention to iron and moving his operation to Coalbrookdale.

The reason that the brass industry was established in the Avon Valley was that the necessary ingredients and power sources were close to hand. Copper ore was transported from Cornwall by sea, the navigable Avon providing a convenient route to a point where coal from the South Gloucestershire coalfield could be brought to the river bank at Hanham and Conham, where smelting operations were established. Deposits of calamine, the carbonate ore of zinc, were discovered in the Mendip Hills, just to the south, and the fast-flowing Avon provided the means of driving water wheels which powered the necessary machinery.

The Saltford Brass Mill is the one remaining mill building which is substantially complete, having been operational until the 1920s. Although none of the brass working machinery remains, one of the water wheels exists in near working condition, with the remains of another inviting restoration. A major feature is the one remaining reverberatory furnace in the area which is in almost complete condition. The introduction of this type of annealing oven was a major step forward in the processing of brass as it kept the products of combustion away from the metal, and so obviated contamination.

Unfortunately, there is almost no trace left of one of the most interesting pieces of machinery. Batteryware is brass hollow ware (pans and bowls and the like) produced by hammering sheet brass into the desired form. The hammering was carried out using stands of tilt hammers driven by the water wheels. The base of one anvil remains, well below floor level, but no drawings, sketches, photographs or other information can be found relating to the original installation. The only modern sketch available has been created from a description provided some years ago by an old craftsman who had seen the hammers when they were still in position. His recollections have been compared with an early photograph of a similar set of machinery, located in Germany, and many of the details found to tally. This is not surprising, as the German brass industry had been established long before the British one, and skilled operatives had been enticed to the Avon Valley from Germany and the Low Countries.

A growing and dedicated team is slowly bringing life to Saltford Brass Mill, under the direction of Mrs Joan Day, an internationally recognised authority on the brass industry and author of 'Bristol Brass; The History of the Industry', a book which is regarded as the definitive work. A collection of the sort of brass ware which would have been made at the mill (including some items which were actually produced there) is gradually being assembled, and together with diagrams and photographs form a display which can be viewed by visitors on a series of open days arranged throughout the year. These have been well supported by the public, with increasing numbers attending as knowledge of the restoration spreads. It is anticipated that the television coverage will give things a boost.

Saltford Brass Mill is just one of hundreds of similar attractions around the country where enthusiastic teams are determined to preserve something which they feel is worthwhile. I know that significant numbers of the readers of this magazine are connected with similar enterprises, their home workshops making a significant contribution to the restoration activities.

Another project in which we take an interest is located in South Devon. Space considerations mean that news of it will have to wait until another time, but a press release from Help the Aged tells us of another success in that part of the world. The Brixham Model Engineering and Craft Club have been awarded a grant of £1847 by the Help the Aged Millennium Awards Scheme to enable a number of their members to share their interest with other people of all ages, by holding exhibitions at schools and craft fares and to be able to show videos to make the skills more accessible to beginners. These Awards are made to people aged 60 and over in rural areas to enable them to start a new project which uses their skills and life experiences to benefit the community.

Congratulations to the Brixham Club. We wish them well in attracting recruits to our fascinating hobby, and hope that they will let us know how they fare in using the award to spread the word.

MAKING SMALL POWER TRANSFORMERS

Electrical devices are being used for an ever increasing number of applications in the home workshop. Philip Amos gives some hints on making an essential part of many power supplies - the transformer

1: Typical 240/110 volt small power transformer with plug & lead for primary and socket for secondary connections. Coils are enclosed with metal shields and a carrying handle is provided. Note ventilating louvres in metal end shields.

Introduction

Why does one want to build a small power transformer? Probably because a suitable one can't be purchased either new or second-hand. What type of transformer might be required? It could be one to reduce mains voltage to a safer (say) 24 volts or perhaps to allow 110 volt North American equipment to be used with 240 volt UK, Australian or NZ supply (or vice versa). Maybe a special transformer is needed as part of the electric supply for an electroplating system. A typical transformer is shown in **Photo. 1**.

What is considered to be a 'small' transformer? Possibly the largest which can be safely connected to a domestic outlet - say 15 amp, although most would not be this big.

Theory

This is a pragmatic article so only a minimum of theory is provided. For a complete account consult a text such as Reference 1 (which uses vector analysis to treat such matters as losses, efficiency and voltage regulation).

A transformer comprises a steel core around which are wound (usually) two coils of insulated copper wire. It is used to change supply (primary) voltage, V1 to a higher or lower (secondary) voltage, V2.

Diagrammatically a typical transformer is shown in **Drawing 1** where there are primary and secondary coils N1 and N2 having resistances R1 and R2 related by a central core which is earthed.

The ratio of primary to secondary voltage is equal to the ratio of turns wound on the primary N1 or secondary N2 coils

i.e. $\frac{V1}{V2} = \frac{N1}{N2}$

The currents (primary I1 & secondary I2) which flow in the windings during operation are in inverse ratio to the voltages

i.e. $\frac{I1}{I2} = \frac{V2}{V1}$

Some transformers have only one winding with a tapping lead brought out from part way along the coil. This is called an autotransformer; they are not much favoured as there are some safety concerns with their use. Others, such as in radios, may have several windings for different purposes.

Safety

It is obviously important, with any electrical equipment, that contact must not be made with energised (live) parts, so these must be suitably insulated and preferably mechanically shielded as well. Likewise the windings of a transformer must have wires of sufficient capacity to carry the intended current without overheating. The core should be earthed (grounded).

Materials

In modern commercial practice many synthetic materials are used for insulating and structural parts of equipment; likewise transformer cores can be wound from special steel tape (e.g. Hipersil) into toroidal or rectangular shapes **(see Drawing 2)** which are varnish impregnated and baked solid. In the latter case the core is usually sawn in half, has its cut faces ground flat and then is clamped together (after inserting in the coils) with a steel band and fastener similar to those used with packing cases.

However, in this article, traditional materials from former times are described. Cores are of conventional laminations of electrical grade sheet steel. Wires are of synthetic varnished copper. Insulation is brown wrapping paper, cardboard, cotton tape and varnish. Varnished cambric sleeving is used in some areas. These insulating materials are typically 0.7 to 1.0mm thick (brown paper), 0.3 to 3.0mm thick (cardboard) and 0.25mm thick (cotton tape).

Rating

The output rating of a transformer is usually expressed as so many VA, which is the product of the volts and amps of one coil - say the secondary. Thus if the secondary provides 100 volts and 5 amps, its rating is 500 VA.

Sizing

Cores

For the kind of transformer described in this article there are two distinct types:

(a) Core Type

In this style the core form is like a cube with a squared hole through it. The coils are wound on opposite legs of the core as depicted in **Drawing 3**.

The core is built up from I shaped laminations, with alternate layers arranged as in the drawing. The stacking of laminations in opposite directions in alternate layers facilitates the passage of magnetic flux around the core past the air gaps.

(b) Shell Type

This type is the more common. It is like a cube with two squared holes through it. The coils are wound on the central leg of the core as shown in **Drawing 4**. In this case the core is made up of E and I shaped laminations as indicated in the drawing, again with alternate layers reversed for the same reason.

The steel used for many years in Australia for transformer cores (Stalloy) came in lamination thickness of 0.36mm.

This material is a hard, high silicon (5%) substance. It is usually stamped out in a power press and would be difficult to manipulate in a home workshop. Thus the best way to get E and I laminations may be to buy an old transformer of appropriate dimensions, even if the windings are burned out.

It is important to minimise core losses (heating) due to eddy currents induced in the laminations by the operation of the transformer. While the air gaps in the plane of the laminations are effective in this regard, the natural oxide film (or even rust) on the face of the laminations also helps by interrupting the eddy current paths. Usually the insulation of these flat surfaces is also improved by a thin coating of varnish.

From the point of view of coil winding, it is convenient if the core cross section is square i.e. the stack height 'b' equals the core width 'a' - see **Drawing 5**.

The power handling capacity is determined by the cross sectional area (a x b) of the central leg of the core i.e. its width times the height (total thickness) of laminations. This capacity can be easily found from the formula:

$A = 116\sqrt{VA}$, where A is the area in mm^2

Typical lamination proportions are shown in **Drawing 6**.

Windings

Round copper wire can be obtained with synthetic varnish insulation in either one, two, three or four layers. The two layer type (with trade names like Bicalex or Bicalon) seems readily available. Tables may be found in various publications (e.g. Reference 2) which show diameter, cross section area, turns per unit length for wires for each thickness of insulation, weight, resistance, and current carrying capacity for maximum temperature rise over a maximum ambient temperature. The reference is in US terminology but can readily be converted to metric of course. I have done this in the tabulation below for a selection of sizes.

The continuous current carrying capacity is for a maximum wire temperature of 100 deg. C with a maximum ambient of 57 deg. C and is based on 700 CM (circular mils) per amp. This equates to 1819 amps per square inch or 2.82 amps per square mm.

In cases where the desired current rating leads to a very robust wire size, it may be easier to wind two or more wires in parallel to achieve the result.

How many turns are required on each coil? The formula given in any text for a transformer performance is:

$$N = \frac{0.226 \times 10^8 \times V}{f \times A \times B}$$

where N is the number of turns, V is the voltage, f is the frequency in Herz, A is the cross section area in mm^2, and B is the flux density in lines per mm^2.

In most home workshop cases f = 50 and B is about 124 so:

$$\frac{N}{V} = \frac{3620}{A}$$

Thus:

TABLE 2

Core Cross Section mm	Area mm^2	$\frac{N}{V}$	VA
20 x 20	400	9.1	12
25 x 25	625	5.8	29
30 x 30	900	4.0	60
40 x 40	1600	2.3	190
50 x 50	2500	1.4	464

To take a worked example:
let us design a transformer 250 to 100 volts 500 VA output (5 amp).

Core cross section $A = 116 \times \sqrt{500} = 2594 mm^2$

This would be obtained with 50.9 x 50.9mm, so use 50 x 50mm.

Assume that a core lamination to **Drawing 7** is available - a stack 50mm high will be necessary. The turns per volt for this core cross section is 1.4 from the above **Table 2**.

Thus primary turns = 250 x 1.4 = 350
and secondary turns = 100 x 1.4 = 140

Full load current in the primary coil = $\frac{100}{250} \times 5 = 2$ amp.

From **Table 1** this would require 19 SWG and for the secondary use 16 SWG.

For double insulated wire:-

Primary

350 turns of 19 SWG at 0.85 turns per lineal mm requires 412mm axial length of coil. If there are coil side cheeks (say 2mm thick at each end) then the available space between will be 96mm, so $\frac{412}{96}$ or 4.3 layers will be required i.e. the winding runs into the fifth layer.

Secondary

140 turns of 16 SWG at 0.55 turns per lineal mm requires 254mm axial length - 2.6 layers on a 96mm width to match the primary coil axial length.

Even if side cheeks are not provided it is better not to run the windings right to the edge of the available coil space lest the wire insulation be abraded by contact with the core.

In this example the transformer would produce 100 volts on the secondary at no load. If it is important to achieve 100 volts at full load it is necessary to do some more calculations to ascertain how to modify the design.

Each winding resistance is given by the expression:

Mean length of turn x Number of turns x Resistance per unit length

The mean length of turn is assessed from **Drawing 8**.

Primary

Mean length of turn = 213mm
So R1 = 213 x 350 x 0.000021 = 1.566 ohms
Voltage drop = I1 x R1 = 2 x 1.566 = 3.13 volts

Secondary

Mean length of turn 241mm
So R2 = 241 x 140 x 0.0000082 = 0.277 ohms
Voltage drop = 5 x 0.277 = 1.38 volts

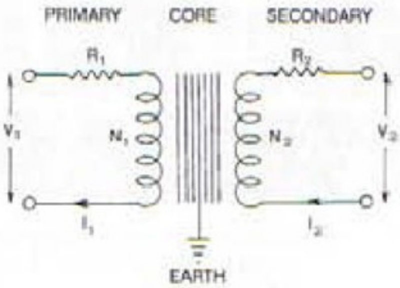
The above is for resistive voltage drop only and ignores leakage reactance voltage drop; however it illustrates the point without serious error. Hence instead of 250 volts acting effectively on the transformer primary winding we have 250 - 3.13 or 247 volts approx. With the turns ratio of: $\frac{140}{350}$

this generates a secondary voltage of

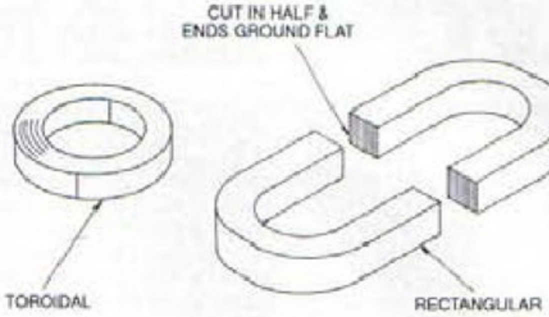
TABLE 1 WIRE DATA

Wire Size SWG	Bare Dia. mm	Double Insulated Dia. mm	Copper Area mm2	Turns per mm	Ohms per m	Continuous Current Capacity Amps
26	0.46 0.5	0.51 0.55	0.164 0.196	1.96 1.82	0.103 0.08	0.462 0.553
24	0.56	0.66	0.245	1.52	0.069	0.691
20	0.91 1.0	1.07 1.15	0.657 0.786	0.93 0.87	0.026 0.022	1.852 2.217
19	1.02	1.17	0.811	0.85	0.021	2.287
18	1.22 1.5	1.37 1.65	1.167 1.767	0.73 0.61	0.0145 0.0096	3.291 4.983
16	1.63 2.0	1.83 2.20	2.075 3.142	0.55 0.45	0.0082 0.0054	5.852 8.860
14	2.03 2.5	2.24 2.70	3.242 4.909	0.45 0.37	0.0052 0.0034	9.142 13.843
12	2.64	2.84	5.479	0.35	0.0031	15.451

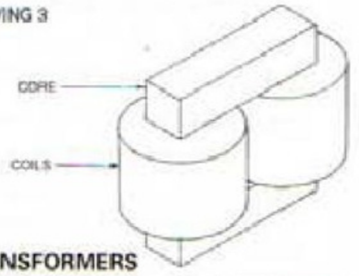
DRAWING 1. **TRANSFORMER DIAGRAM**



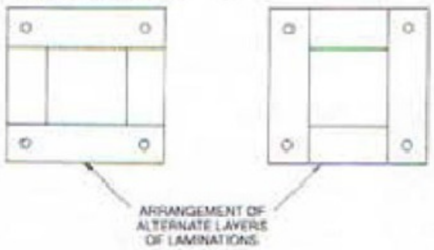
DRAWING 2 **TAPE WOUND CORES**



DRAWING 3

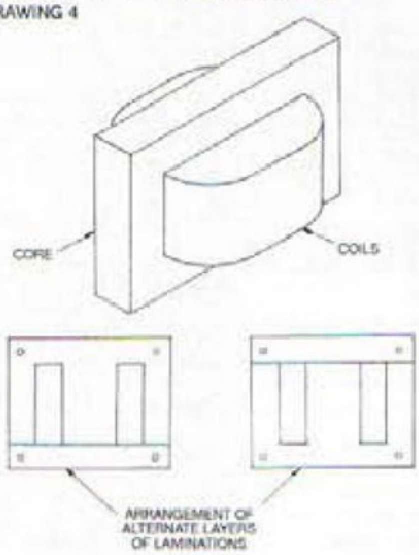


CORE TYPE TRANSFORMERS

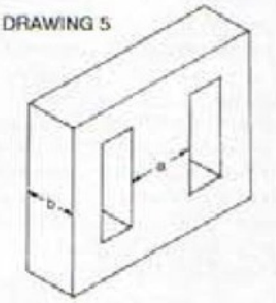


SHELL TYPE TRANSFORMERS

DRAWING 4



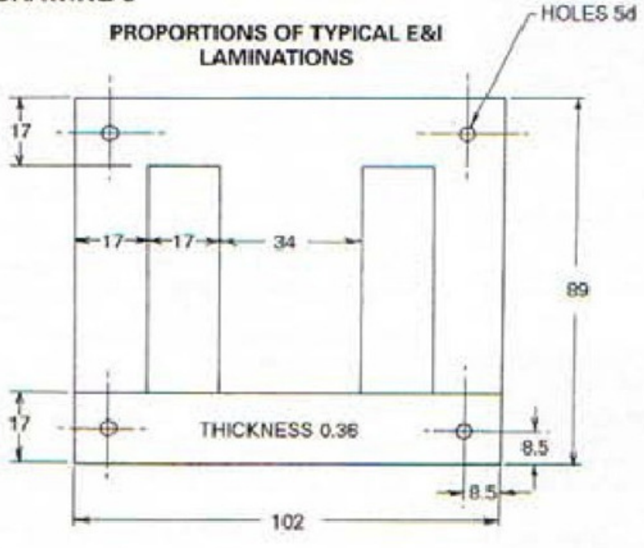
DRAWING 5



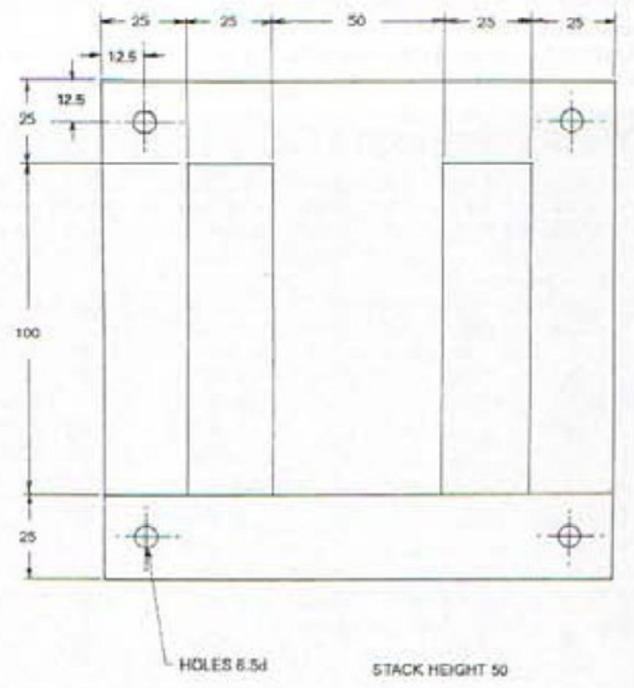
CORE CROSS SECTION

DRAWING 6

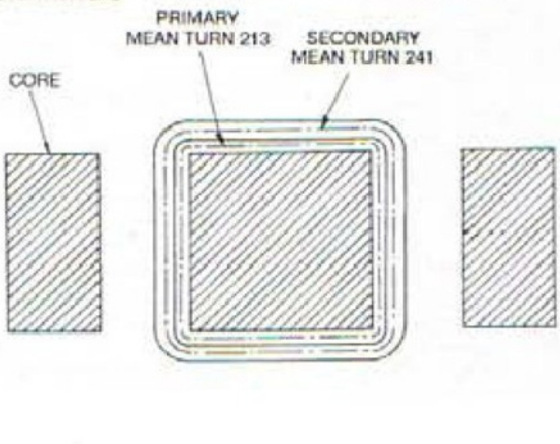
PROPORTIONS OF TYPICAL E&I LAMINATIONS



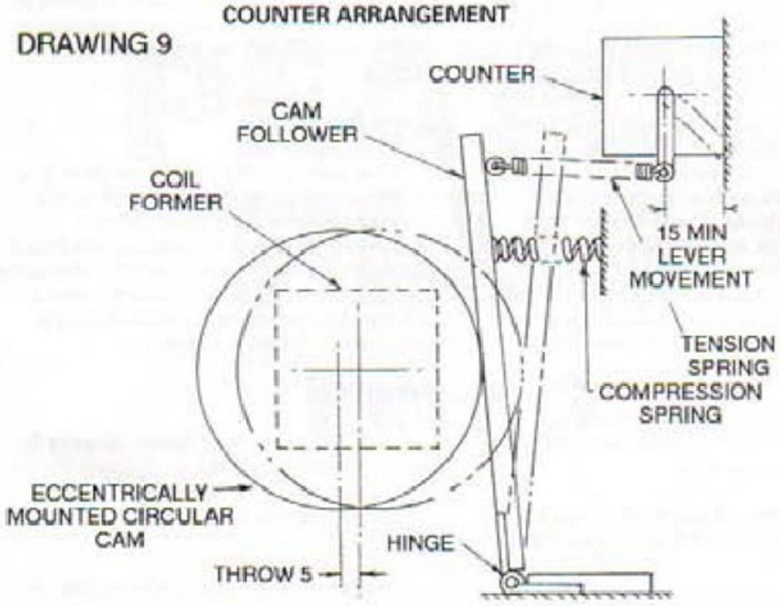
DRAWING 7 **ASSUMED LAMINATIONS FOR EXAMPLE**



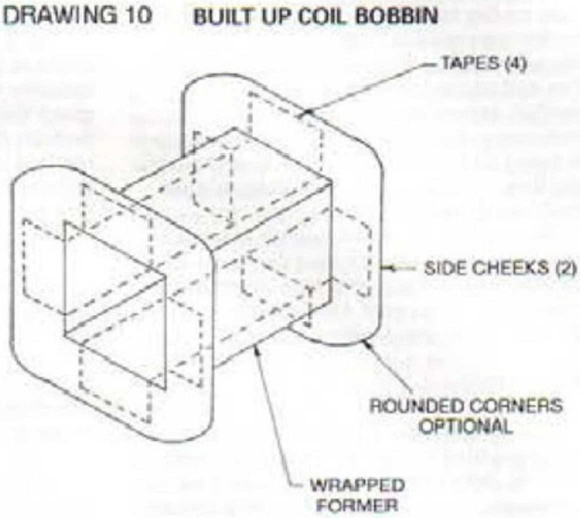
DRAWING 8 **EXAMPLE CROSS SECTION**



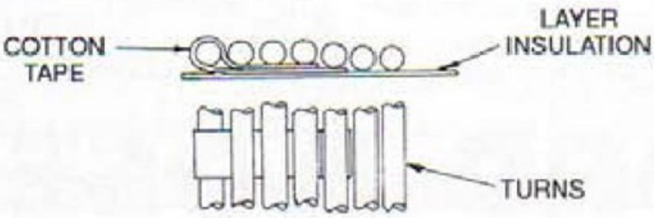
DRAWING 9 COUNTER ARRANGEMENT



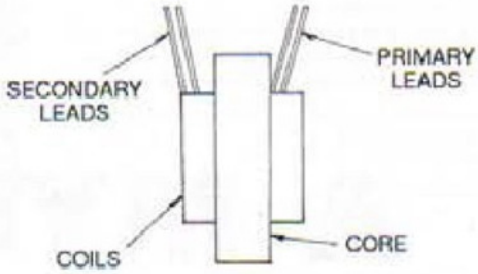
DRAWING 10 BUILT UP COIL BOBBIN



DRAWING 11 END TURN BRACING



DRAWING 12 WINDING LEADS



98.8. The voltage drop in the secondary coil must be subtracted from this (1.4 volts) yielding 97.4 volts across the load, so if 100 volts is wanted across the load, the turns ratio must be increased. It is necessary to retain the primary turn numbers to maintain the turns per volt figure and hence the maximum core flux density to avoid possible core saturation. Thus the secondary turns must be increased:- $\frac{100}{97.4} \times 140 = 144$

This will result also in an increase in the no-load voltage to:- $\frac{144}{350} \times 250 = 103$

Construction

Drawing 8 shows the cross section of the example transformer. The inside coil, usually the primary, is wound on some sort of former or bobbin, into the inside of which the core laminations can later be stacked. Note that sometimes the coils are wound side-by-side rather than one on top of the other.

At its simplest, a piece of timber having a cross section the same as the core is wrapped with one or more layers of brown paper or cardboard which is held together with varnish or cellophane or PVC tape, and the insulated copper wire is wound on this former with the wires laid closely side by side. There may be shaped cardboard ends to act as supporting cheeks at each end of the winding. The whole bobbin may be a one piece plastic moulding, but for the home workshop probably the cardboard approach is the easiest as the material is the most readily obtainable.

When a full layer of wire has been wound on, some form of interlayer insulation is usually wound on over it before the next layer of wire is wound on top of the first (in the opposite axial direction). Such interlayer insulation may well comprise one or several layers of brown wrapping paper.

This winding process continues until the required number of turns has been wound on for that particular winding.

At this stage interwinding insulation (maybe of cardboard or a number of layers of brown paper) is wound on, and then the secondary winding is wound on, as before, over the primary.

It is clear that this winding process can be done very readily with the timber former in the lathe between the 4 jaw chuck and the tailstock, with a washer over the point of the tailstock centre to prevent excess penetration, and with the wire guided in some way (over a deep pulley mounted on the topslide perhaps), so that the lead screw can move the guide at exactly the rate required to lay each turn beside its neighbour. Some tension must be maintained on the wire so that the guide pulley can be effective, but this is easily done by hand - maybe with a leather glove or mitt to overcome possible friction on the skin. If the leadscrew travel does not exactly match the required turns per unit axial length, set it for slightly more turns per unit length, as this will tend to wind the wire closely turn to turn.

It is also possible to rig up a mechanical (Veeder type) counter so that each rotation of the lathe mandrel knocks up another count. In this way an accurate check of the number of turns is produced - see **Drawing 9**.

This winding set up and process is also described by L.C.Mason in Reference 5.

It may be appropriate to make up a bobbin from cardboard to assist in winding the coils. A typical one is depicted in **Drawing 10**. Four pieces of cotton tape are laid on the winding mandrel before the former of several layers of cardboard is wound on. The cardboard side cheeks are cut out to shape and placed over the mandrel, after which the tapes are glued to the cheek faces to hold all together.

If side cheeks are not fitted, the stability of the winding can be improved by including loops of cotton tape wound in as shown in **Drawing 11**.

If tappings of the windings are to be brought out, make these protrude about 100mm from the winding and twist the loop together so that the remainder stays tight on the coil. The twisted loop can be further insulated by slipping over it a tube of varnished cambric or plastic 'spaghetti'. The end of the loop is then bared of varnish, tinned and soldered to a connecting lead or lug. It is usually simpler to bring all leads out at one end of the coil, but they can be on opposite sides of the core -see **Drawing 12**.

The ends of the windings are treated in much the same way and are tied back into the winding using cotton tape as described above. A final layer of insulation covers the outside of the winding.

Assembly

The laminations are now inserted into the coil with E's and I's alternately other way up. When the space is as full as can reasonably be pushed in, clamping pieces are bolted on the outside of the core to hold the whole thing together and, in most cases, also provide mounting arrangements for the transformer. A protruding copper shim inserted between two laminations before clamping makes a useful earth connection.

The whole assembly should now be warmed to say 50 deg. C and immersed in good quality oil based varnish and left to soak for about an hour. Then it is removed and allowed to drain, and then to dry. This process should be repeated a couple of times. Finally a baking of the varnish at about 100 deg. C will harden it so that the whole transformer becomes a fairly solid block.

The primary can now be energised and the core checked with a neon leakage detector screwdriver. If satisfactory then check the voltage across the secondary with an AC voltmeter. It should give a reading of your designed voltage. If it does the transformer can be placed in service. If it doesn't you must establish what is wrong:

(a) If there is no voltage there is probably a break in the secondary coil (or even maybe the primary).

(b) If the voltage is too high or too low, you may have wound the wrong number of turns.

(c) If the transformer gets hot or smells of burning there may be a short circuit in one of the windings e.g. between layers.

In all cases it will probably be necessary to rip it apart and start again. In regard to fault (a) it is probably worth while checking winding continuity in the primary when it is first wound before pressing on to the secondary, so as to meet the trouble as soon as it arises. In regard to faults (b) and (c), the more care exercised during the manufacture so as not to scratch through the wire insulation or the layer insulation, the less likely it will be to encounter trouble.

Conclusion

There seems to be no reason why any home workshop operator cannot safely and effectively build a small power transformer, and it does not require much special equipment to be made for the lathe - nor are the materials difficult to obtain. Just handle the process carefully and a good result should emerge.

References

1. J & P Transformer Book - Stigant & Lacey - 8th edition 1941

2. ARRL Handbook for Radio Amateurs - 1995

3. Radiotron Designer's Handbook - F. Langford Smith - 1944

4. Philips Manual of Radio Practice for Servicemen - 1947

5. Using the Small Lathe - L.C.Mason - 1983

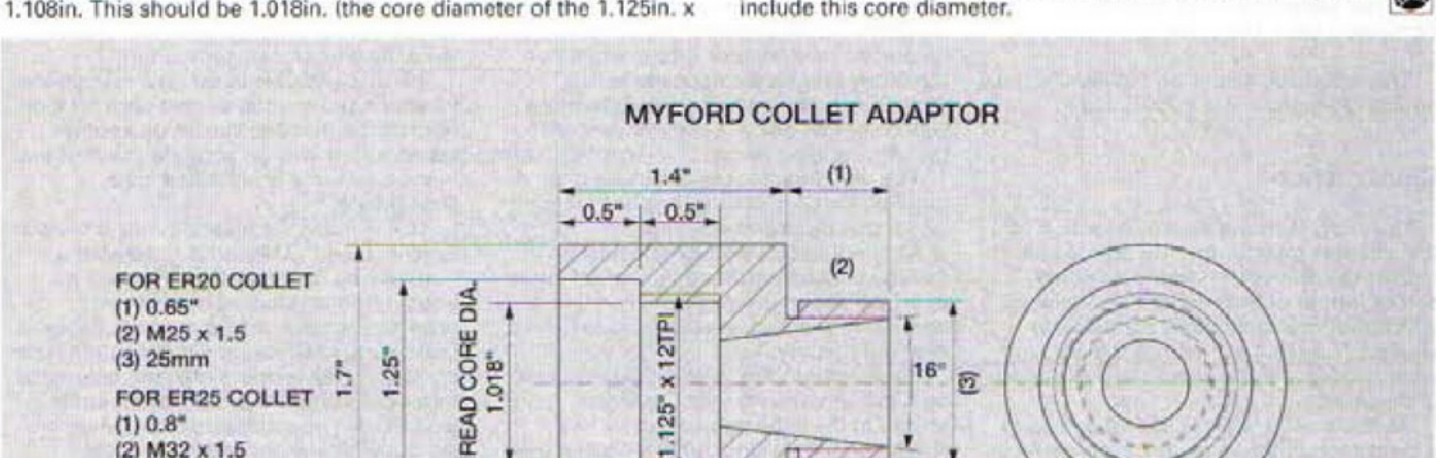
6. Standard Handbook for Electrical Engineers A E Knowlton - 7th. edition 1941

A MYFORD NOSE COLLET ADAPTOR

A correction

A reader has pointed out an error in the text of Dr. Giles Parkes' article (M.E.W. Issue 56 Page 55) on the accessory which allows ER20 and ER25 pattern collets to be fitted to the Myford 7 Series mandrel nose. The bore diameter before threading is quoted as 1.108in. This should be 1.018in. (the core diameter of the 1.125in. x 12 tpi Whitworth form thread). Apologies to anyone who has scrapped a chunk of material through opening out the bore to the wrong diameter.

To clarify the situation, we have amended the drawing to include this core diameter.



PEATOL PLUS

Part 2

Tony Jeffree continues his description of the additions to his small lathe by detailing the leadscrew and the screwcutting gear train components

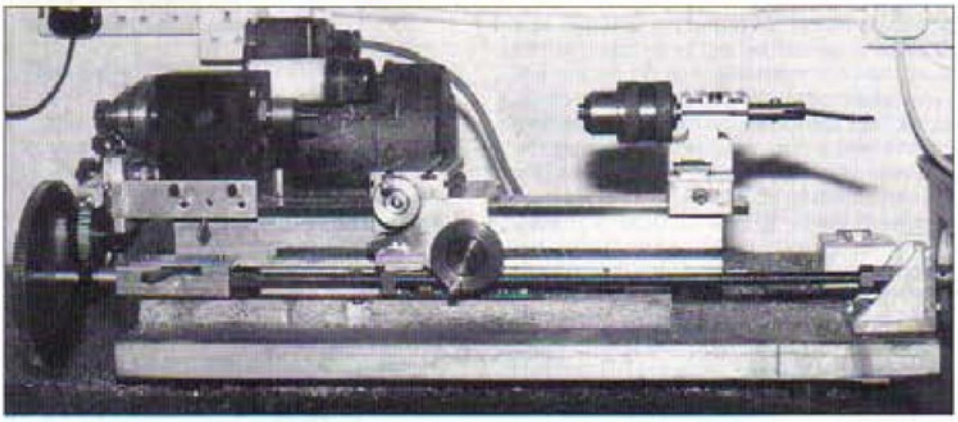
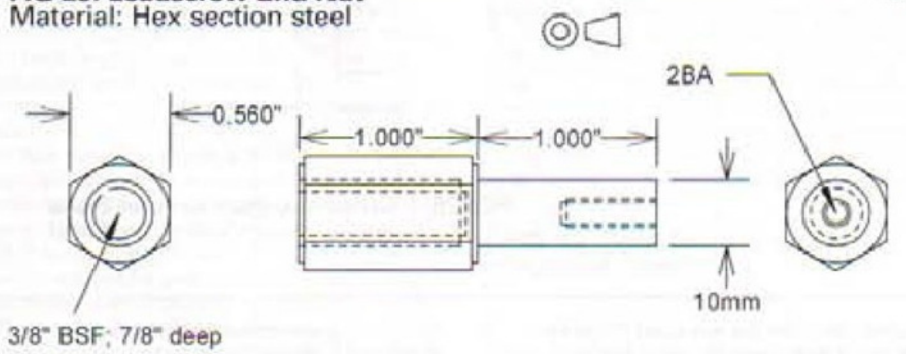


FIG 23. Leadscrew End Nut
Material: Hex section steel



The Leadscrew

The leadscrew is a length of 3/8in. BSF studding, giving 20 tpi. One end screws into the threaded portion of the clutch output shaft; the other end has an end nut attached **(shown in Figure 23)**, which is located in a simple aluminium bracket that carries the leadscrew thrust bearings. A handwheel is attached to the right hand end of the leadscrew.

The studding chosen for the leadscrew should be as straight as possible. I managed to obtain two different samples, both of which proved, on close inspection, to be slightly bent. However, with careful straightening, I found that it was possible to produce a piece about 18in. long that was straight enough, so that any remaining inaccuracy was not visible to the eye on final assembly. The use of a suitable flat surface helps a lot in determining how straight (or otherwise) the studding is, and in making any necessary corrections.

The actual length of studding required will depend upon the chosen layout; as indicated earlier, I chose to place the right hand bracket sufficiently far beyond the end of the lathe bed so that it does not prevent removal of the saddle when the leadscrew is installed. An alternative would be to devise a way of attaching a bracket to the right hand end of the lathe bed. If you attempt to do this, and the attachment method requires holes to be drilled in the lathe, it is worth remembering that the aluminium extrusion that supports the lathe bed is filled with a concrete-like material!

Construction of the end nut is very similar to the technique described for the clutch output shaft. The same 0.56in. AF hex. section steel was used, and the same procedure, using a short length of studding as a mandrel, employed to ensure that the plain-turned portion is near enough concentric with the threaded socket. The nut has an axial 2BA-threaded hole in it that will provide a means of adjusting end play in the thrust bearings.

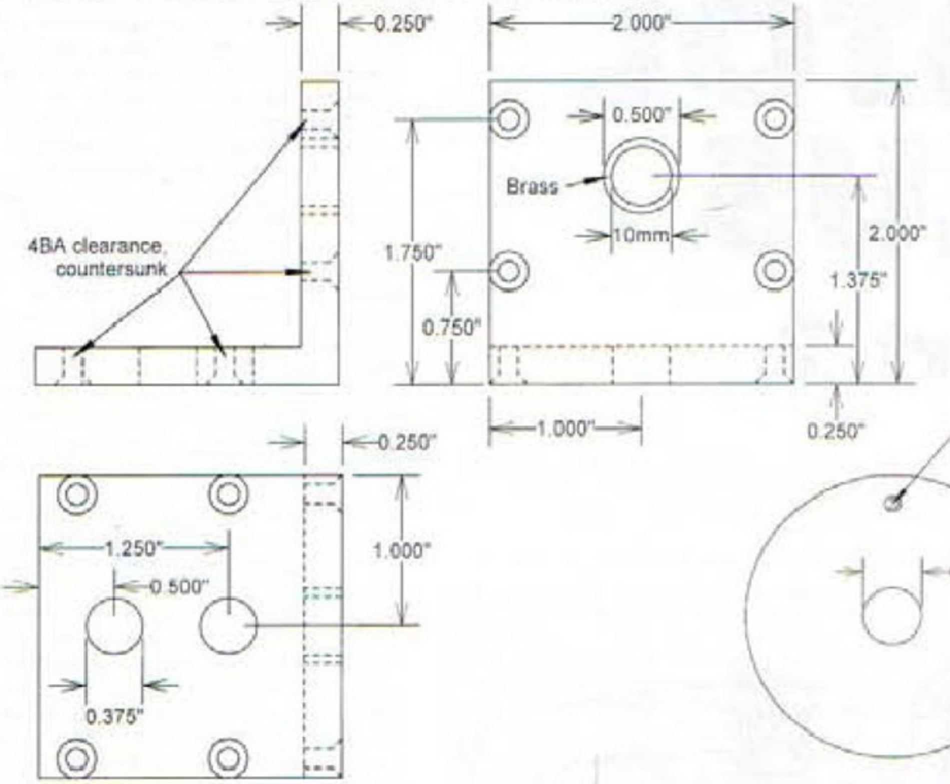
The leadscrew bracket is shown in **Figure 24**. It is fabricated from a 2in. length of 2in. x 2in. x 1/4in. aluminium angle, with two triangular supports **(Figure 25)** added in order to make sure that it is suitably rigid. The supports are held in place using 4BA countersunk screws, and the base of the bracket is drilled for 3/8in. bolts that will attach it to the baseboard of the lathe. The only difficulty in construction is deciding where to drill the hole for the bearing for the end nut. Careful measurement is required here, backed up with the use of washers under the bracket to adjust its height if necessary. The bearing itself consists of a 1/2in. diameter plain brass or phosphor bronze bearing, bored 10mm diameter, inserted in the bracket and supported by a pair of needle roller thrust bearings, one placed either side of the bracket. The brass insert is a simple turning job from 1/2in. diameter stock, and is a press fit in the bracket. The roller bearings are about 23mm in diameter, bored 10mm, and about 4mm thick; each bearing consists of three components - a roller cage and a pair of steel washers. The roller bearings can be obtained from Electromail (the mail order arm of RS Components - Ref. 7), Part No. 198-8850.

The bearing arrangement described here is a little excessive for most uses; it may be felt that a plain bearing will suffice, as is used on many commercial leadscrews. However, the arrangement described works very well, and one of my guiding thoughts was that I might be tempted later on to convert the lathe to CNC operation, where the ability to completely remove end play would be useful (See Richard Bartlett's series of articles on CNC machining, the first part published in Issue 41 of Model Engineers' Workshop).

When locating the bracket on the baseboard, care needs to be taken to ensure that the bearing is positioned such that the leadscrew will be parallel to the lathe bed when finally fitted. Drilling the mounting holes in the baseboard slightly oversize will help here, allowing some adjustment of the final position of the bracket. Once the bracket is mounted in place on the baseboard, the leadscrew can be cut to its final length. First, screw the clutch output shaft on to one end of the leadscrew, and soft solder it in place. Apply a little flux to the two parts and drop a couple of short lengths of solder wire into the threaded socket prior to screwing the two components together, heat the joint and apply more solder when the joint has heated up. An alternative would be to use Superglue as a retainer. Next, fit the end nut to the other end of the length of studding and measure the distance between the shoulders on the two end

FIG 24. Leadscrew Bearing Bracket
Material: Aluminium angle with Brass bearing inset

©



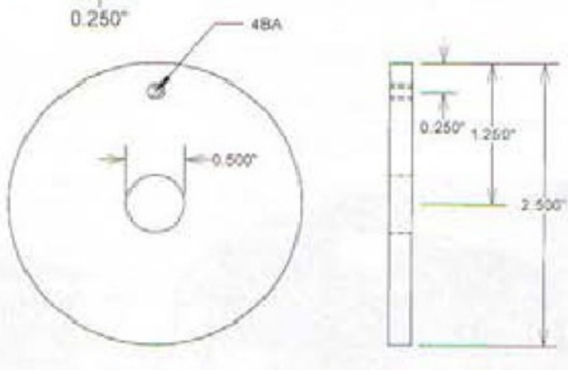
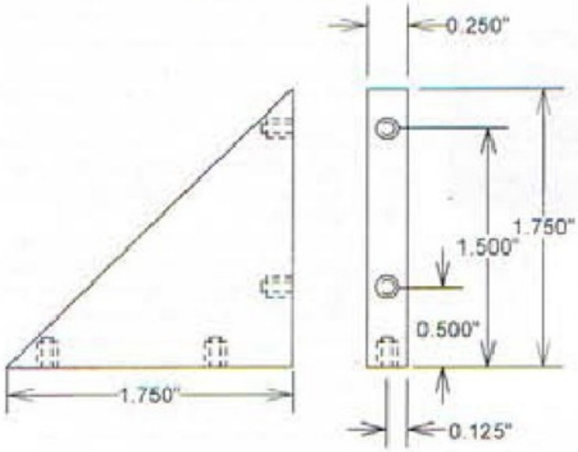


FIG 27. Leadscrew Handwheel Disc
Material: $^{3}/_{16}$" Brass



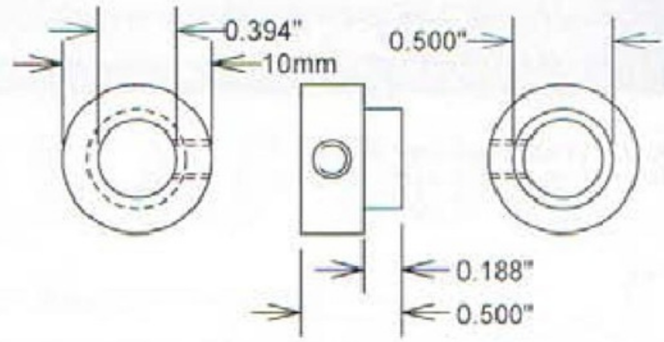


FIG 25. Leadscrew Bracket Supports
Material: $^{1}/_{4}$" Aluminium
Quantity: 2

FIG 26. Leadscrew Handwheel Boss
Material: Steel

nuts. Now measure the distance between the thrust face of the leadscrew bracket and the end of the dog clutch body. The difference between these measurements, and a bit to allow for the thickness of one of the needle roller bearings, tells you how much to shorten the length of studding. Cut off the excess, screw a $^{3}/_{8}$in. BSF nut onto the end, followed by the leadscrew end nut. The BSF nut is used as a lock nut, allowing fine adjustments to the screw length to be made once all is properly aligned.

It is now possible to fit the leadscrew in its final position. Unscrew the clutch body from its bracket, fit one of the roller bearings over the end of the leadscrew, and then fit the end of the leadscrew into its bracket. Fit the dog clutch body over the other end of the leadscrew, and screw it back in place on its bracket. The final position and height of the leadscrew bracket can now be adjusted, to ensure that the leadscrew will run parallel to the axis of the lathe in both the vertical and horizontal planes. Tighten the mounting bolts of the bracket, then adjust the end nut and its lock nut to remove all but a couple of thou. of end play between the clutch output shaft and the clutch body.

The final leadscrew component is the handwheel. This serves two purposes; firstly, the obvious one of allowing the leadscrew to be turned by hand, and secondly, it provides the end play adjustment for the leadscrew thrust bearings.

The handwheel boss, **Figure 26**, is machined from $^{3}/_{4}$in. diameter steel bar. A short length is faced on both ends to a final length of $^{1}/_{2}$in., bored 10mm to fit the end of the leadscrew end nut, and $^{3}/_{16}$in. of its length turned down to $^{1}/_{2}$in. diameter. A radial hole is drilled and tapped 10-32 UNF to take a grub screw. The handwheel disc, **Figure 27**, is a 2.5in. diameter brass disc, bored $^{1}/_{2}$in. at its centre to take the boss, and with a hole near the edge tapped 4BA to take the handle. The disc is soft soldered or Superglued onto the boss, the excess cleaned off and the handle fitted. The handle is simply a $^{5}/_{8}$in. length of brass rod, slightly waisted, and axially drilled 3.6mm to clear a 4BA domed head brass screw. The screw is passed through the handle, a 4BA nut Superglued in place so that the handle spins freely, and the completed handle is then screwed into place on the handwheel (Ref. 8). Any excess bolt length can then be cleaned off at the back of the handwheel. The final finishing touch to the handwheel is to mark 50 divisions on its circumference, corresponding to thousandths of an inch of travel of the saddle. This is relatively easy to do once the banjo components have been modified (see below), allowing a train of changewheels to be attached to the spindle. Choosing suitable combinations of wheels, it is possible to index the headstock, using a detent located between gear teeth to stop the rotation at each 1/50th. of a revolution. A scriber mounted in the tool post is used to score the edge of the wheel - a short line for the intermediate marks and a full width line for every fifth mark. A set of small number punches can then be used to number every fifth mark. Clearly, you have a choice as to which way you number the marks - ascending numbers indicating left hand travel, or vice versa - remembering of course that if a conventional right hand thread is used, the direction of saddle travel will be the reverse of the conventional 'sense'.

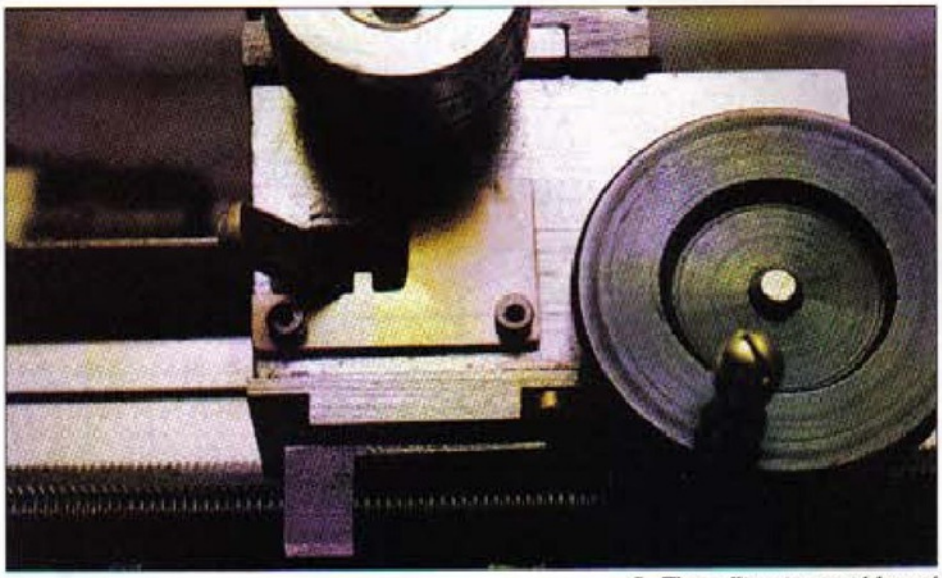
The second needle roller bearing and the completed handwheel are fitted to the end of the leadscrew, and any end float in the bearings is removed by means of a 2BA screw and washer screwed into the end of the end nut. The grub screw fitted to the handwheel boss is then tightened to hold the wheel in place.

The Split Nut Assembly

The arrangement described so far leaves 3/8in. or so of clearance between the lower edge of the saddle casting and the top of the leadscrew. The split nut assembly is attached under the left-hand end of the saddle casting **(see Photo. 6)**. The attachment involves a certain amount of modification to the saddle in order to provide a flat base for the split nut mounting plate and also to allow an operating lever to protrude through the side of the casting.

I must thank David Gingery for the idea behind the split nut design; the one described here operates in the same manner as the one he used in his lathe design, as described in his excellent series of books, 'Building Your Own Metal Working Shop From Scrap' (Ref. 9). Instead of the more conventional clamping action found in most lathes, the split nuts in this design are offset from each other, and are part of a carrier that is rotated to disengage them from the leadscrew. The prototype literally used two halved 3/8in. BSF nuts, offset by about 1/2in. and soft soldered onto a piece of 1/16in. steel plate to which was attached the operating shaft. This worked just fine, but was a little crude and potentially not terribly robust, so the final 'production' version was re-designed and involves machining the nut halves and carrier in one piece from 3/4in. square steel bar.

The final dimensions chosen for the split nut will depend upon the precise positioning of the leadscrew and, in particular, the distance between the top surface of the leadscrew and the underside of the split nut carrier plate **(Figure 33)** when the plate is fitted in position. Hence, it is advisable to make and fit the carrier plate first. This is machined from a rectangle of 1/4in. thick steel, 1 1/2in. x 1 1/8in.. The 3/8in. diameter hole will take the split nut pivot; the elliptical holes are used to mount the plate under the left-hand front edge of the saddle. The two short edges of the plate are thinned to 0.1in. over a 1/4in. width in order for the



6. The split nut assembly and operating lever

mounting screw heads not to foul the split nut. The 3/8in. hole is nominally centred 1/2in. from the edge of the plate; however, this dimension should be varied according to the position of the leadscrew. Measure the horizontal distance from the front face of the saddle to the axis of the leadscrew and use that as the distance for the centre of the hole. The elliptical mounting holes will allow corrections to be made later if necessary. The underside of the saddle casting should be filed or milled to form a flat, horizontal surface on which to mount the plate. Spot through the elliptical holes onto the under edges of the casting for three 4BA tapped holes; these will take cheese head or cap head screws to mount the plate in position. Place the holes so as to allow for fine adjustment of the plate position on final assembly.

Figure 32 shows the split nut. Machining commences by facing off both ends of a piece of 3/4in. square steel stock to a finished length of 2.2in., and axially drilling and tapping it 3/8in. BSF. The hole is drilled slightly off centre; the centre of the hole is shown as 5/16in. from one face and 3/8in. from each of the two adjacent faces. Setting up and drilling this offset hole is straightforward in the 4-jaw chuck.

Still using the 4-jaw, the 1/4in. diameter spigot is turned on the face that is furthest from the axial hole. The spigot is 1/8in. long. A 3/4in. diameter pad is turned on the same face while the piece is still in the 4-jaw; finally, the spigot is drilled and tapped 6BA. The piece is then milled (or very carefully filed) out to form the two split nuts, as shown in the diagram. I had the advantage of being able to use one of the new Peatol CNC mills to do this **(See Photo. 7)**, but it should also be possible using the vertical slide. Milling continues until there is 1/16in. of material left at the thinnest part of the 'carrier' plate (1/8in. thick under the 3/4in. diameter pad). At this point, if the work has been done accurately so far, the threads should be barely visible on the areas that have been milled out. The dimensions quoted here are based on the assumption that the distance between the carrier plate and the leadscrew is 1/8in., as was the case in my prototype. If the measured distance proves to be greater than this, adjust the thickness of the carrier plate either by changing the positioning of the threaded hole (i.e. move the hole

FIG 33. Split Nut Carrier Plate
Material: Steel
©

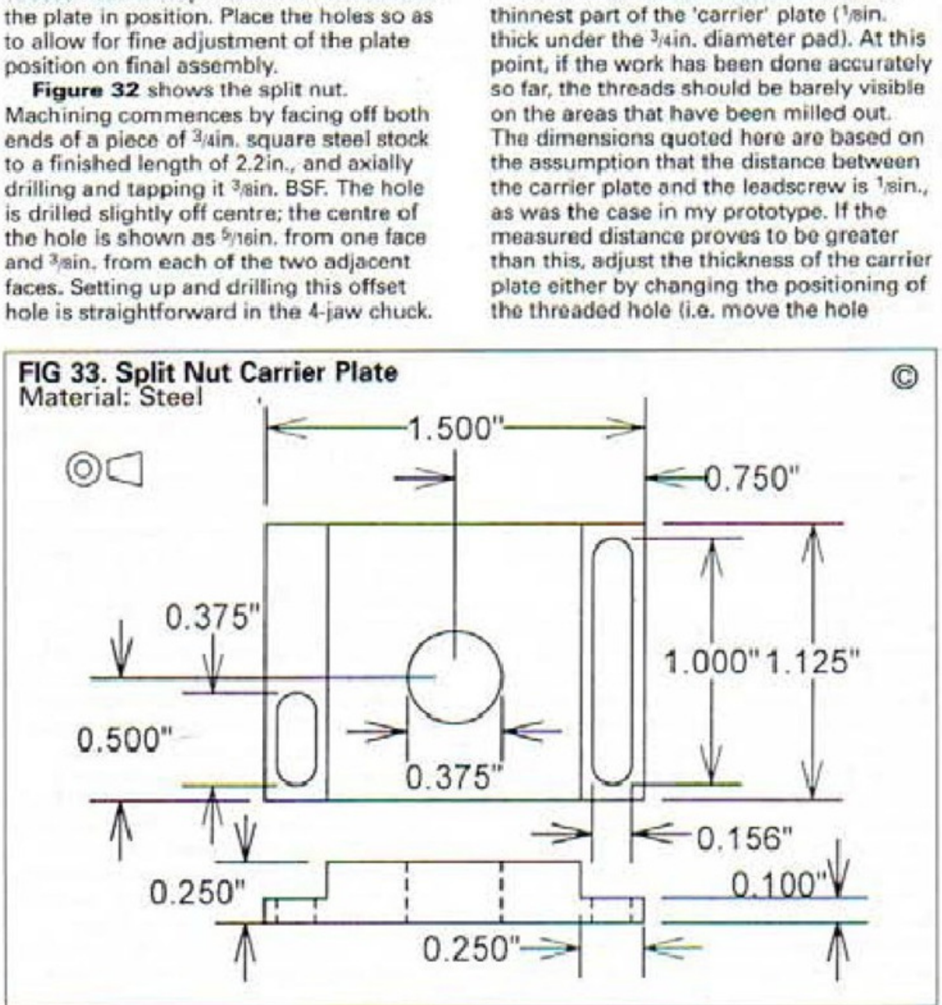


FIG 32. Split Nut
Material: Steel

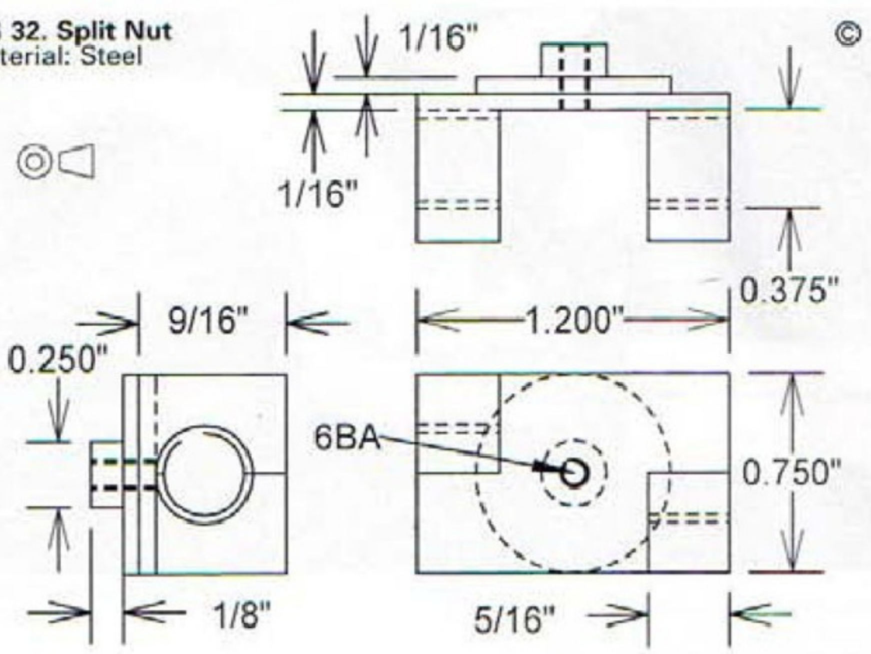
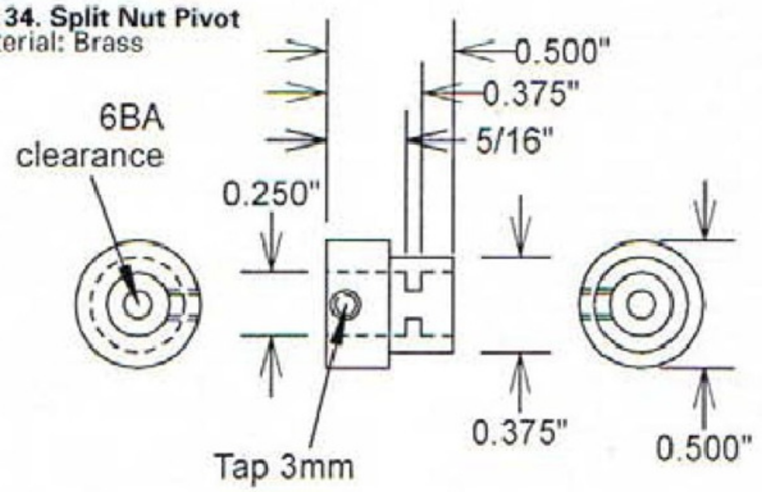
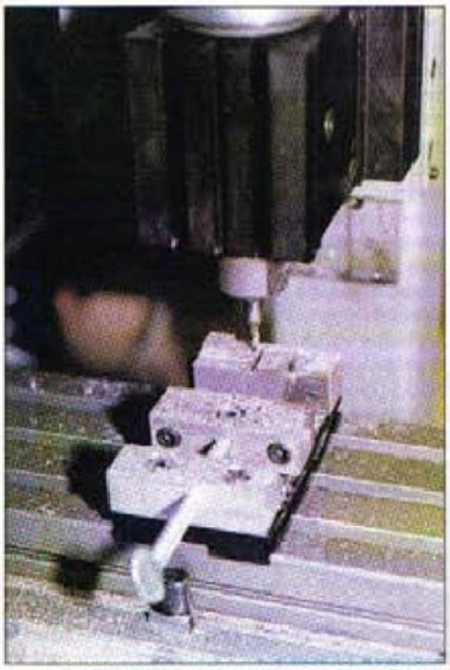


FIG 34. Split Nut Pivot
Material: Brass





7. Machining the split nuts in a Peatol CNC milling machine

further off-centre) or turn down less of the back of the nut (i.e. leave a shorter spigot and thicker pad). The function of the spigot is merely to locate the nut relative to the shaft that it is mounted on, so can be as little as 1/16in. long if need be. If there is much more space than can be accommodated by these adjustments, then try starting from larger stock. Clearly, if you find that there is less than 1/8in. clearance below the plate, then it is straightforward to remove more material from the base of the saddle casting to make room.

The split nut is pivoted through the hole in the carrier plate by means of a brass pivot **(Figure 34)**. This is turned down from 1/2in. brass bar; first turn 1/4in. of its length down to 3/8in. diameter - the intent is that this should be a close running fit in the hole in the carrier plate. Also, the length of this section should be adjusted to very slightly more than the thickness of the carrier plate, so that the pivot and nut will turn freely, but with minimal play, once assembled. Bore through to clear a 6BA bolt (2.8mm), then counterbore 1 1/4in. diameter to a depth of 1/8in. to take the full depth of the spigot. Check that the spigot goes fully home. Part off, reverse and finish to a total length of 1/2in.; counterbore from the 1/2in. diameter end, aiming to leave a shoulder of about 1/16in. of metal. Drill for a 3mm (or equivalent size) grub screw.

The mounting plate, split nut and its pivot can now be assembled. Push the thin end of the pivot through the hole in the mounting plate, from what will be the upper face when assembled (the non-rebated face). Push the spigot home from the other side. Fit a 6BA cap head screw through the hole in the pivot, and tighten the assembly. Check that the split nut pivots freely and that there is minimal play; adjust the pivot length if necessary.

The final components are the split nut boss **(Figure 35)** and the split nut lever **(Figure 36)**. The latter is simply a length of 1/4in. x 1/8in. brass with a pivot hole drilled to take a 6BA screw and a small (1mm diameter) hole. The latter hole will take a small spring, such as the ones that are found in retractable ball-point pens.

The boss is turned from 3/8in. diameter brass. Reduce it to 1/4in. diameter over a length of 3/16in. and part off to a total length of 5/8in.. Cut a 1/8in. wide slot in the fat end, to a depth of 3/8in. to take the lever. Cross drill with a 6BA tapping drill, then open out one half to clearance size (2.8mm) and countersink. Tap the other half 6BA. File off the 'back' of the boss, removing about 1/16in. of material. The lever can now be fitted, with the short end protruding from the back of the boss and pivoted on a 6BA countersunk screw. Make up a short spring, using a ball-point pen spring or similar, so that the overall length is approximately 1/2in. and there is a loop at either end. Thread one end through the 1mm hole in the operating arm.

The final operations involve cutting a slot in the front face of the saddle to allow the operating arm to protrude through from the back of the saddle. The slot needs to be about 1/2in. long, with two notches about 1/8in. deep in the lower edge. The notches locate the operating arm in the engaged and disengaged positions and therefore need to be cut at an angle; the best approach is to cut the slot first, test assemble the lever in position and mark out the positions for the notches. The position of this slot should be such that the arm is horizontal when it is located in either notch; i.e., cut the slot so that the bottom edge of the two notches is approximately 9/16in. above the upper face of the carrier plate. Note that to disengage the split nut, the arm does not need to move very far, and that care should be taken to ensure that when in the disengaged position, the split nut does not foul the foot of the lathe when the saddle is near the headstock. I found that the land between the two notches needs to be no more than 1/8in. wide in order to allow the nut to disengage properly and not to foul the foot - **see Photo. 6**. You will also notice from this photo that much trial & error with this arrangement forced me to cover up earlier attempts with a small brass plate which carries the final notches - this may prove to be a good solution for others as well!

Final assembly of the split nut involves fitting the arm and boss to the split nut pivot and locating it with the grub screw

FIG 35. Split Nut Carrier Boss
Material: Brass

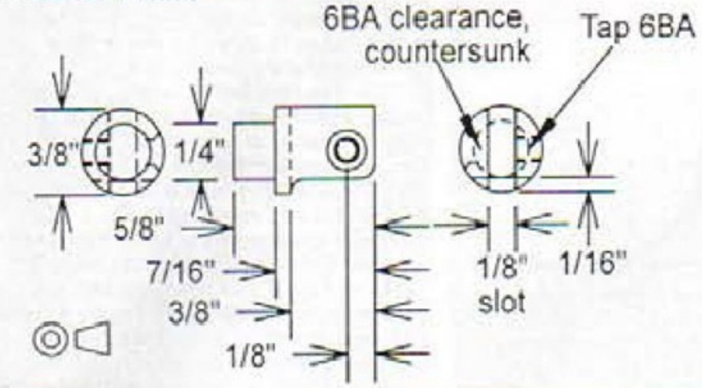
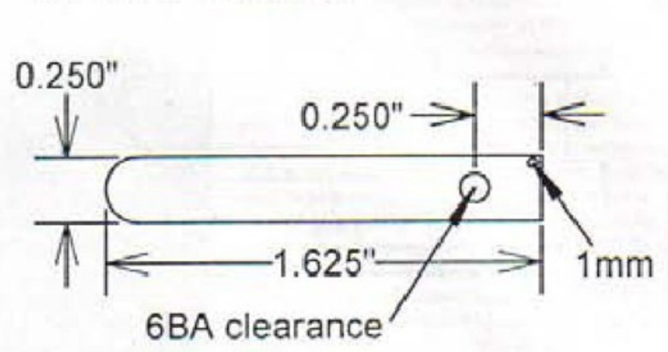


FIG 36. Split Nut Carrier Lever
Material: 1/8" Thick Brass

©



so that, when the operating arm is in the engaged (furthest left) position, the split nut aligns with the axis of the leadscrew. In order to access the grub screw, this can only easily be done with the saddle removed from the lathe. It is necessary to provide a means of locating the free end of the operating arm return spring inside the saddle casting. The simplest approach here is to drill a 2.8mm (6BA clearance) hole through the left-hand end of the saddle, about 1/2in. down from the top edge and 1/2in. in from the front. A 6BA screw and nut can then be used to locate and tension the spring. Once in position and tensioned, the spring should be just strong enough to keep the operating arm located in the notches.

Loosen the carrier plate's mounting screws so that the plate can be adjusted for alignment, and re-fit the saddle with the operating arm in the disengaged position. Check the operation of the split nut, adjusting the position of the mounting plate as necessary. The aim here is to ensure that, when the nut is in the engaged position, it does not deflect the leadscrew from its normal axis. You may find that a small amount of filing inside the saddle casting is necessary in order to allow the carrier to be correctly located and for the pivot not to bind against the wall of the casting. Finally, tighten the mounting plate screws.

At this point, it should be possible to engage and disengage the split nut, and to drive the saddle via the leadscrew handwheel.

The Banjo Components

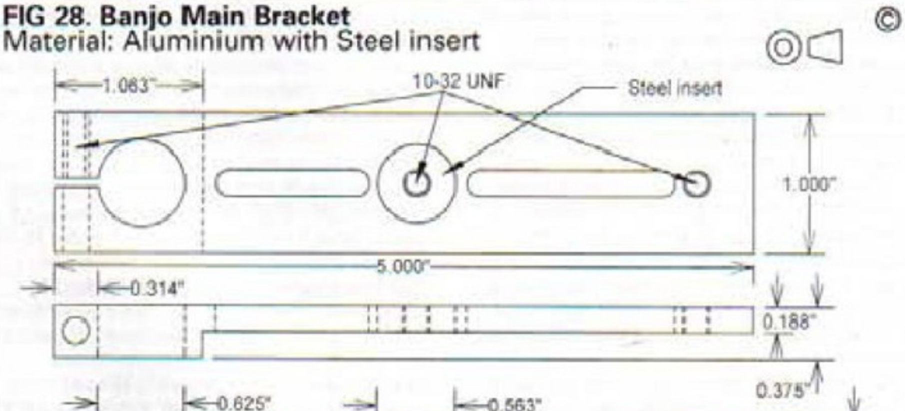
The 'banjo' arrangement used in the Sherline kit is slightly unconventional, partly due to the fact that they always use 60 DP gears for the first driver and driven wheels. Two aluminium brackets are provided; the main bracket **(Figure 28)** mounts on a boss at the left hand end of the leadscrew and, in the normal Sherline set-up, the auxiliary bracket **(Figure 29)** mounts on the far end of the first. Rather than make a purpose built banjo from scratch, I decided to retain the Sherline parts and modify them to suit the new application. The main bracket, in this application, will mount on the turned section of the dog clutch body. The diagrams show the modified versions of these components; **Photo. 8** shows the components alongside the studs made for use with them. The resultant banjo allows a more (but not completely) conventional arrangement. For many gear trains, the fine feed set-up described below being an example, only the main bracket is required; however, the auxiliary bracket allows a wide range of configurations to be supported. For those who choose not to use the Sherline parts, both of these brackets can be easily constructed from aluminium, brass or steel strip.

The main bracket starts out with a 5/16in. diameter hole and a 10-32 UNF pinch bolt at one end; a UNF 10-32 threaded hole at the far end, and a 9/16in. hole about half way between. The pinch bolt end of the bracket is 3/8in. thick; the remainder of its length is milled out at the back of the bracket to half that thickness. The modifications involve cutting the two oval slots shown in the diagram, both 3/16in. wide, and filling the central hole with a steel insert, drilled/tapped 10-32 UNF at the centre. The insert is a press fit, assisted with Superglue for good measure. If making a bracket from scratch, don't bother with the central threaded hole; simply form one slot by joining the two shown. (It might make sense not to bother with the other threaded hole either - simply extend the slot to where the hole is. Also, I would probably not bother to mill the bracket to half thickness - much easier to leave it at 3/8in. thick for the whole of its length.) The slot lengths are not critical - the one nearest the pinch bolt end is about 1in. long, the other about 1.5in. long.

8. Banjo components and changewheel studs

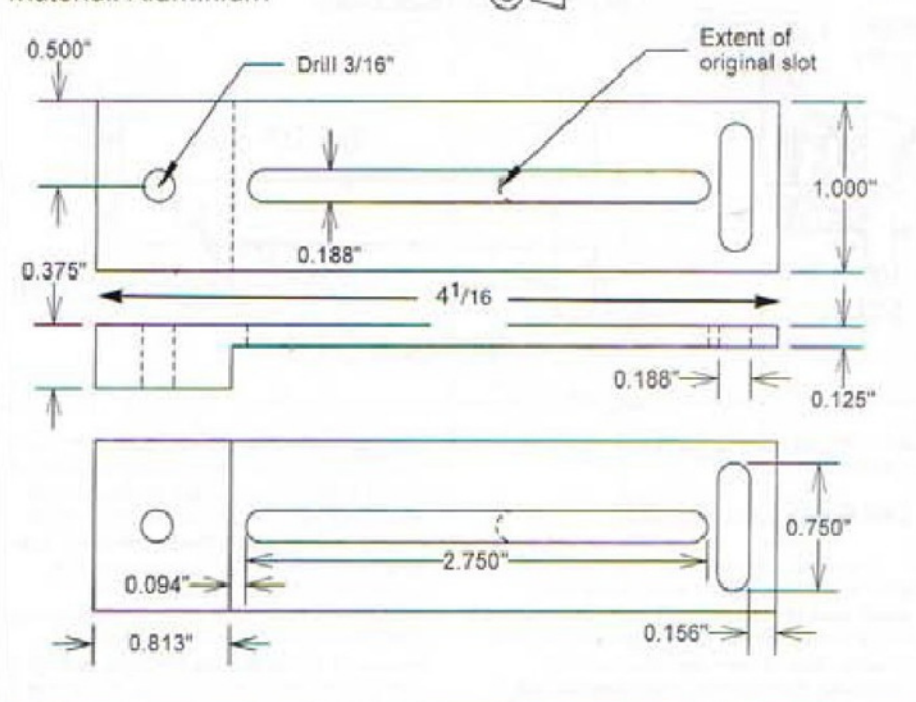
FIG 28. Banjo Main Bracket
Material: Aluminium with Steel insert

©



The auxiliary bracket is 4 1/16in. long, 3/8in. thick for the first 13/16in. of its length, and 1/8in. thick for the remainder of its length. If making up one of these from scratch, there is little point in retaining the thickened section; use a length of 1/8in. thick material. There is a pair of slots in the thin end, arranged in a T, and a 3/16in. hole at the thick end to take a 10-32 UNF bolt. The modification to this part involves

FIG 29. Banjo Auxiliary Bracket
Material: Aluminium



extending the longitudinal slot towards the thick end; the resultant slot is 2.75in. long.

The final components for use with the banjo brackets are the long and short studs, **(Figure 22 - see Issue 56)**. These differ only in the lengths of their bases; the short studs mount directly on the main banjo bracket and the long studs mount on the auxiliary bracket. The auxiliary bracket is mounted on the 'back' of the main bracket (it is mounted using either of the two threaded holes, with a 10-32 socket head bolt through from the back). Hence, the long stud needs a base that is 3/16in. longer than the short stud, in order for the shoulders of these studs to be in the same plane when the banjo is in use. **Photo. 9** shows the auxiliary arm mounted on the main arm, with both types of stud fitted.

The studs are turned from hex. section steel - nominally 0.470in. across flats, but this dimension is unimportant. They consist of a plain-turned section that is nominally 1in. long, drilled and tapped 4BA, and a hex. section shoulder that is drilled and tapped 10-32 UNF. As before, the hex. section is relieved to present a circular section to the bracket on one side, and the bobbin on the other. The 1in. length should be just a couple of thou. longer than the length of the bobbins, to ensure that the bobbins run freely on the studs when held in place with 4BA retaining screws and washers.

9. Banjo components assembled

Fine Feed Set-up

The moment of truth has now arrived - the leadscrew is in place, along with tumbler reverse, dog clutch and split nut, and the banjo components have been constructed or modified, so all that remains is to install some wheels and see what happens.

The leadscrew is 20 tpi, or 50 thou of saddle movement per revolution. Given the size of the lathe, it will generally be the case that its cutting tools will have small tip diameters, and hence, it is highly desirable to employ a really fine feed. In order to achieve this with a small number of gear wheels, I decided to use an overall reduction ratio of 24:1 as the fine feed, achieved by using two 20T driver wheels, one 80T and one 120T driven wheels. This ratio gives a saddle feed of a touch over 2 thou. per spindle revolution, which seems to work quite well.

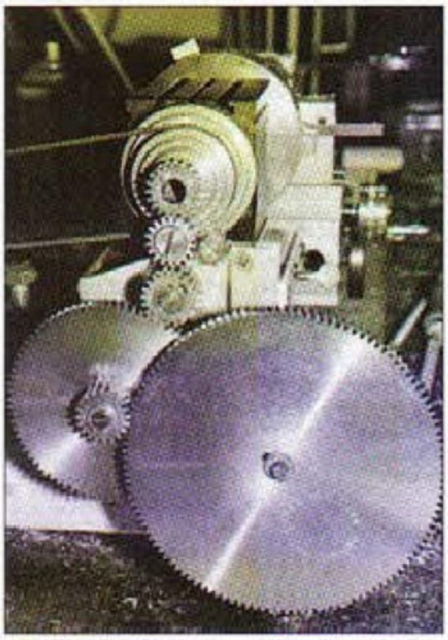
The 20T wheels are again HPC Part No. G-24-20-PG, the 80T and 120T wheels are Part Nos. G-24-80-PG and G-24-120-PG respectively. The 120T wheel is a monster, approximately 5in. in diameter, and needs to be used as the final driven wheel, held on the clutch input shaft. This is one of the major reasons for allowing suitable overhang at the left hand end of the lathe, as this wheel hangs well below the lathe foot. In order to make use of these wheels some modification is necessary. The 20T wheels come with a bore size of 0.3125in., which needs to be opened out to 3/8in. using the techniques described above. Having done that, all four wheels need a 1/8in. wide keyway cut in the bore. The easiest way to do this is to drill a 1/8in. hole as close to the bore as possible and to open it out by careful filing. The wheels should then fit nicely on the various bobbins already constructed.

The fine feed set-up needs just the main banjo arm, fitted with a single short stud and bobbin by means of a 10-32 UNF socket head bolt from the back of the arm. First, fit one 20T wheel to the tumbler output bobbin, retaining it with a 4BA screw & washer. Fit the 80T wheel and second 20T wheel to the stud, using a spacer of a suitable thickness between the two wheels. Suitable spacers can be made up very simply by cutting washers of varying thicknesses (for example, 1/8in., 1/4in. and 1/2in. will prove useful for various configurations), with a 3/8in. hole, and a keyway cut as described for the wheel modifications. Fit the banjo arm to the clutch body and adjust the position of the stud to make it possible to fit the 120T wheel to the clutch input bobbin. It will be necessary to insert more spacers onto the bobbin before the 120T wheel; it should be fitted so that it is flush with the extreme end of the input shaft. Retain the 120T wheel with a 4BA screw & washer. Adjust the stud position so that the 20T wheel meshes nicely with the 120T wheel, and tighten up its 10-32 UNF bolt. The banjo can then be rotated up until the 80T wheel meshes nicely with the 20T wheel on the output of the tumbler, and its clamp nut tightened. **Photo. 10** shows the fine feed installed and ready to go.

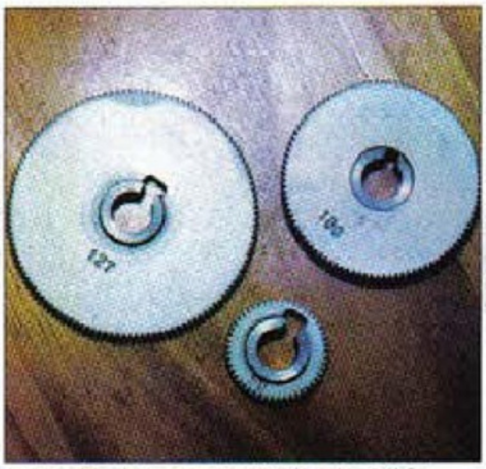
At this point it is advisable to make sure that all bearing surfaces are liberally lubricated, especially those that involve steel-to-steel contact, such as the bobbins and idler wheels.

Disengage the split nuts, set the tumbler in neutral, engage the dog clutch and make sure that all operates smoothly by hand. Engage the tumbler and switch on the lathe. The leadscrew should rotate nicely. Check that the clutch can be operated while the lathe is running; if not, polishing the D sections of the shafts may help. Try engaging the split nuts. This should not be forced; if all is nicely aligned, the nuts will click into place quite easily with a little rotation of the leadscrew, and the handle should be kept seated in its slot by the spring tension. If all is well, you are ready to use powered fine feed on your Peatol for the first time.

Obviously, the choice of gears described here is only one possible fine feed configuration; the use of a second stud opens up the possibility of using smaller wheels, albeit having to use six rather than four. One of the considerations, however, was that the 120T wheel seems like a useful wheel to have around in order to use the change wheels as the basis of dividing operations in the lathe. Another observation here is that if these wheels are to be used only for fine feed (i.e., if you do not intend to inter-mix them with the Sherline wheels for any operations), then there is no particular requirement need to stick to 24DP. The essential requirement is for the bore, keyway and thickness of the wheels allow them to be fitted to the bobbins. Equally, there is no particularly good reason why a fine feed shouldn't be configured using suitably sized pulleys and belts rather than gears, again as long as they can be fitted



10. The fine feed set-up, showing why it is necessary to allow sufficient space to accommodate the 120 tooth wheel



11. Sherline changewheels adapted for use on the Peatol by bushing

to the bobbins. In fact, pulleys and belts are in some respects more desirable, as they produce a lot less noise!

With the fine feed set-up described, it is quite acceptable to engage/disengage the split nut and the dog clutch while the leadscrew is rotating; however, it is extremely inadvisable to try operating the tumbler while the lathe is running.

Screwcutting Set-up

This is achieved in a similar manner to the fine feed set-up. For many, if not all, of the screw pitches that you will want to use, the 24DP wheels in the Sherline kit can be used, and can be combined with the 24DP wheels used for the fine feed configuration. The banjo arrangement allows a wide range of configurations to be used; if necessary, further bobbins can be made up in order to allow more than two intermediate studs to be used if this proves to be necessary.

The 60DP wheels provided in the Sherline kit are one 50T two 100T and one 127T wheel. These wheels can obviously only be used as a matched driver/driven pair, as they cannot mesh with the other wheels. Clearly, using both 100T wheels is not very interesting as it is easier to omit them altogether, and the 50T/100T combinations provide ratios of 1:2 or 2:1 that can be generated using a 20T and a 40T wheel (or 40T and 80T) from the 24DP set. Hence, it will almost certainly only be necessary to use the 60DP wheels if you wish to make use of the lathe to cut metric threads, using the 127T wheel in combination with a 50T or 100T wheel. In order to make use of these wheels it is necessary to adapt them to fit the bobbins. As supplied, they have a 9/16in. bore and a keyway that is about 7/32in. wide. These need to be reduced to give a bore size of 3/8in. with a 1/8in. wide keyway. The simplest approach here is to turn a length of steel tube, with a 3/8in. bore and an OD that will give a press-fit into the 9/16in. bore. The keyway can then be milled or hack-sawed straight through the wall of the tube, leaving it with a 'C' shaped section. This can be cut into lengths to form adapters for the 60DP wheels, pressed and/or Superglued in place. I chose to cut these to 5/16in. in length, to match the thickness of the HPC gears, but this is not essential. **Photo. 11** shows three modified Sherline wheels; 50T, 100T and 127T.

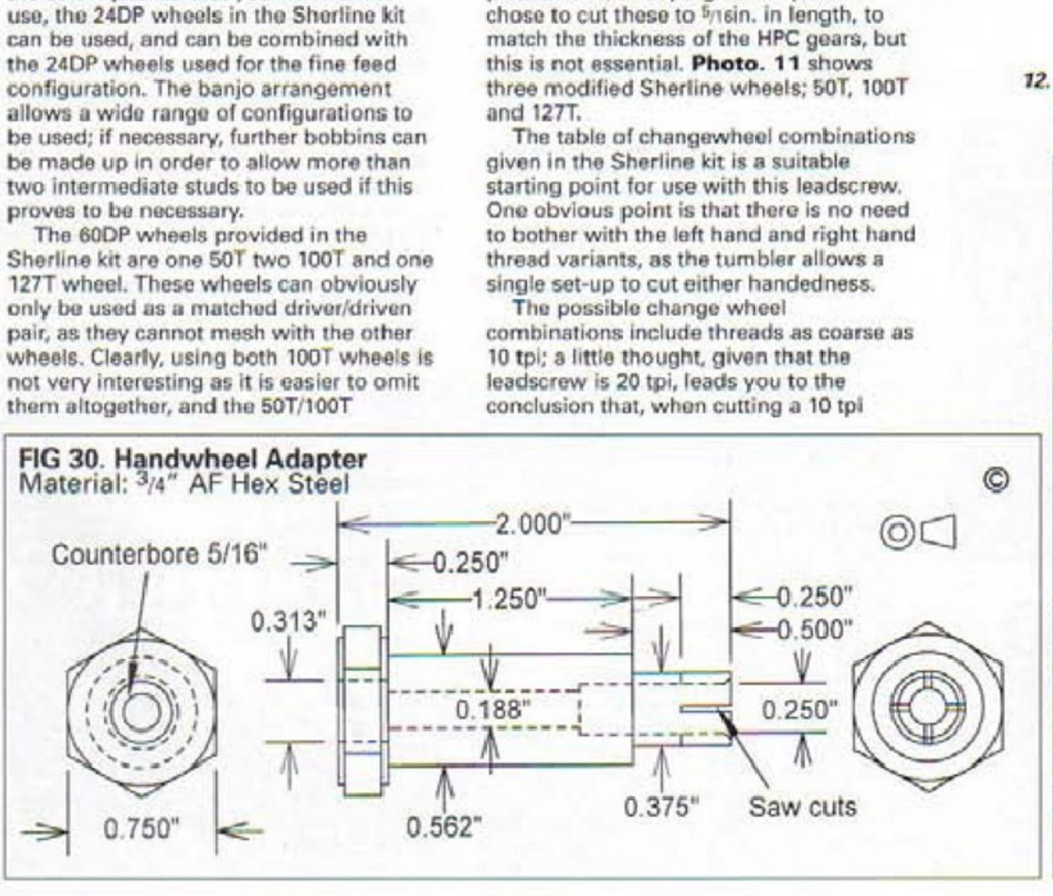
The table of changewheel combinations given in the Sherline kit is a suitable starting point for use with this leadscrew. One obvious point is that there is no need to bother with the left hand and right hand thread variants, as the tumbler allows a single set-up to cut either handedness.

The possible change wheel combinations include threads as coarse as 10 tpi; a little thought, given that the leadscrew is 20 tpi, leads you to the conclusion that, when cutting a 10 tpi thread, the leadscrew will be rotating twice as fast as the lathe spindle. In the case of my own lathe, the slowest spindle speed attainable is around 450 RPM; hence, when cutting 10 tpi under power at the low speed setting, the leadscrew would be doing a cool 900 RPM! I have actually tried this - interestingly enough, the experiment was one of the reasons why the tumbler plate is so substantial, as the first version of the tumbler plate operating arm buckled and broke under the forces exerted on it by the gear train! This is almost certainly one of the reasons why Sherline include a substantial 4in. diameter handwheel in their kit, which is used to hand-drive the spindle at more leisurely speeds. Another reason is that the Sherline kit uses the 60DP wheels in all set-ups; I doubt whether these are really up to the job of operating under power. Hence, when cutting coarse threads, and when using the metric conversion wheel, running under power is not a good idea.

Similarly, attempting to engage the dog clutch under power, with a coarse screw cutting set-up, is not a smart move - the shock load on the gear train when the dog engages is a little disconcerting! However, disengaging the clutch under power is not a problem.

Figure 30 shows an adapter that will allow the Sherline handwheel to be used to drive the Peatol lathe spindle, as seen in **Photo. 12**. The handwheel has a 9/16in. bore and is fitted with a grub screw; the adapter passes through the handwheel, and is fitted into the 3/8in. bore of the Peatol pulley and it's attached 20T wheel. A 1.75in. 10-32 UNF socket head bolt passes through the adapter, and screws into a conical nut **(Figure 31)** that expands the end of the adapter to grip the bore. The hexagonal head simplifies tightening the 10-32 bolt.

FIG 30. Handwheel Adapter
Material: 3/4" AF Hex Steel



12. The Sherline mandrel handwheel can be fitted by using the adapter detailed in Figure 30

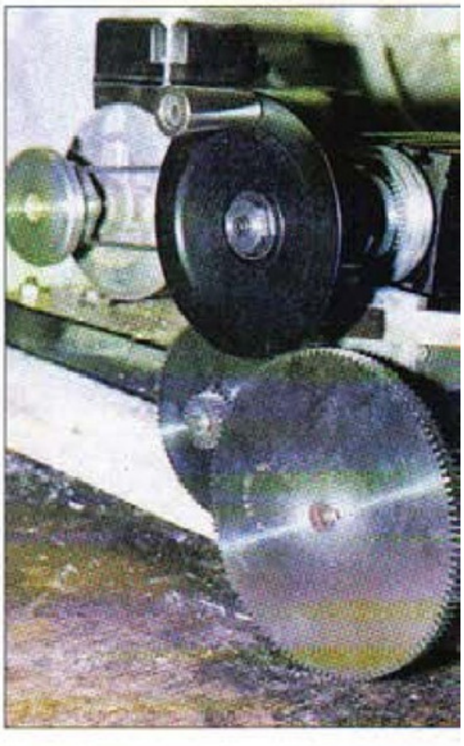
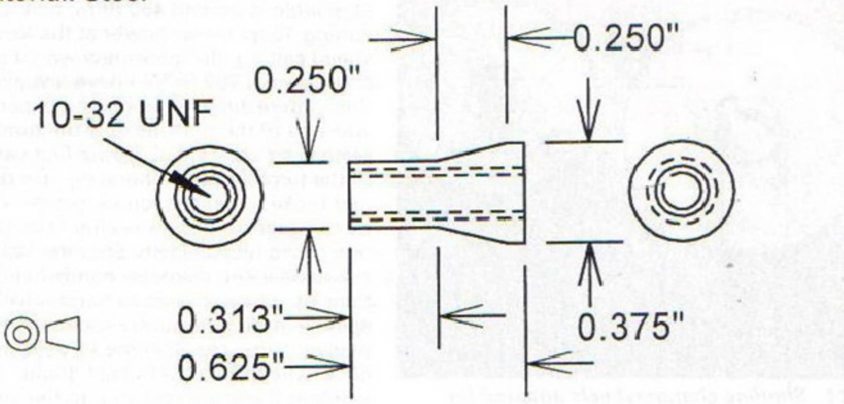


FIG 31. Conical Nut
Material: Steel



The adapter is made from 3/4in. AF hexagonal steel stock. A 1/4in. shoulder of hexagonal material is left at the head end; the next 1.25in. are turned down to 9/32in. diameter, and the remaining 1/2in. turned down to 3/8in.. Drill the piece axially 3/16in. diameter, counterbore 1/4in. diameter to a depth of 3/4in. and add a slight internal bevel at the thin end. Part off to length, reverse and counterbore 5/16in. to a depth of 1/4in. to take the bolt head. Remove from the lathe, and make two cross cuts in the thin end to a depth of 1/4in. to allow the collet to be expanded by the conical nut. The latter is a simple turning job using 3/8in. steel stock, tapered then drilled and tapped 10-32 UNF.

A Word on Safety

It cannot be emphasised too strongly that exposed gear trains have infinite ability to attract and consume loose objects, such as ties, hair, fingers and so on. With the fine feed configuration described here, the 24:1 reduction in rotational speed is accompanied by a corresponding increase in torque! Needless to say, getting anything that contains nerve endings trapped in these gears is going to be, at the best, a very uncomfortable experience. Hence, my advice to anyone that builds and uses this design to cover the changewheels during operation at all times. I have not offered a cover design here, as mounting arrangements will inevitably differ according to baseboard layouts and so on; however, it should be a trivial job to fabricate a suitable cover from thin metal sheet, or even thin plywood.

References and Notes

6. The design is based around a 20 tpi leadscrew in order to keep the thread cutting capability essentially the same as the Sherline lathe. As 3/8in. BSF studding, taps etc. may not be readily available outside the UK, it may be appropriate for some readers to choose a different thread for the leadscrew. A suitable alternative here would be 7/16in.-20 tpi (UNF). There should be sufficient room in the design to accommodate the extra diameter without too much difficulty.

7. Electromail, P.O. Box 33, Corby, Northants, NN17 9EL, U.K.
Tel: 01536 204555 Fax: 01536 405555

8. The standard handles fitted to the Peatol cross-slide and saddle traverse handwheels can readily be modified in a similar manner to produce 'deluxe' spinning handles that are much more comfortable to use. The standard handles are a press fit in the handwheels; carefully twist them out with a pair of pliers, drill axially, and re-fit with a 4BA bolt and nut as described above. Conveniently, the holes in the handwheels seem to take a 4BA tap without further drilling.

9. Gingery, David J, 'Building Your Own Metal Working Shop From Scrap, Volume 2: The Metal Lathe', ISBN 0-9604330-1-5.

LINK UP

FOR SALE

● 'Model Engineer' 1970 - 95. 40 bound volumes 136 - 175
£6 per vol. + P & P or offers for the lot.
Tel. 01386 858738 (Broadway, Worcs)

● Milling arbor, 19 1/2in. long, 7 collars and nut. Morse taper. Also arbor arm support. £20 each or £30 the two.
Tel. 01253 354478 (Blackpool)

● Three jaw chuck, 6in., with inside and outside jaws. Very good condition.
Tel. 01708 720355 (Romford)

Would readers wishing to use this facility please note that the maximum total value of items accepted for a 'For Sale' entry is restricted to £50. To advertise goods of a greater value, please refer to our Classified Advertisement Department

WANTED

● Complete set of issues 1 to 40 or 1 to 53 of M.E.W.
Kern Schwartz, 2675 Fox Farm Rd, Worthington MN 56187 USA
Tel. 507 376-6675, Fax. 507 376-6082, E-mail: kerns@rconnect.com

● User manual for Raglan vertical milling machine (or photocopy). Costs reimbursed.
A. Petrie Tel. 01786 824546 (Dunblane)

● Quick-Step Mill.
Tel. Ray on 01327 351274 (Northants)

● Model Engineers' Workshop Issues Nos. 43 and 45.
Gerry Langley 01733 320139 (Peterborough)

● Raglan 5in. Variable Speed Centre Lathe, spare parts and accessories or complete machine, any condition.
Tel. Derek on 01457 876603 (Oldham, Lancs)

● Cowell's 90 Basic Lathe, used and in good condition.
Dodds Tel. 01902 883134 (Sedgeley, West Midlands)

● Wheel cutters, 42 & 34DP for cutting wheels for a Congreve clock.
Tel. 01708 720355 (Romford)

● M.E.W. Nos. 4 to 15 inclusive and No. 38. I have for sale or exchange M.E.W. Nos. 2, 36 and 40 and various other model engineering magazines.
George Winspur Tel. 01643 843200 (Kent)

● Moore and Wright wooden toolmaker's cabinet No. 1007 or 1008, Eclipse lathe tools 519SL, 523S, 521R, 522L and 633S, Eclipse angle plates 199 to 203 and 301 to 303, WGM (Wirth & Gruffat) high speed milling head, ISO30, motorised 3ph for Senior 67 outillage mill, made in Annecy (Pringy), 74 France - Schaublin70TO. Willing to swap a Burnerd lever operated collet chuck, LO fitting (for Colchester Student round head etc.), without EC collets.
J. E. Berserik, Archipel 23-09, NL-8224 GR Lelystad, The Netherlands

EXCHANGE

● HSS BA dies, some taps (mostly Goliath) for HSS Metric Coarse dies and taps. Metric jobber twist drills (mostly Presto) for HSS Metric, Morse taper 1 / 2.
Syd Yates, Maes-Y-Pentre, Tiers Cross, Haverford West, Pembs. SA62 3ER Tel. 01437 890379

AN AUTO-FEED TAP-WRENCH FOR LATHE AND MILL/DRILL

Alan Munday suggests a way of providing a positive feed for a tap

I have always had difficulty in getting taps to start cutting and also have found that normal tap wrenches are inconvenient to use on a small lathe. After lots of thought, an automatic feed for the tap seemed the best solution, and now that I have an auto-feed tap wrench, tapping is no longer a problem.

Design and Manufacture

Figure 1 shows a general arrangement of the wrench with a tap installed, and **Figure 2** shows the component parts. The tap wrench is operated by a spanner on the hexagon portion. The dimensions for the parts will depend upon the dimensions of the tap for which you want the wrench. The only important features are:

1. The hexagon section of the tap holder should be sufficiently large to give enough thread length for the grub screws to hold the tap tightly.

2. The stud and the sleeve thread must have the same pitch as the tap, but not necessarily the same diameter.

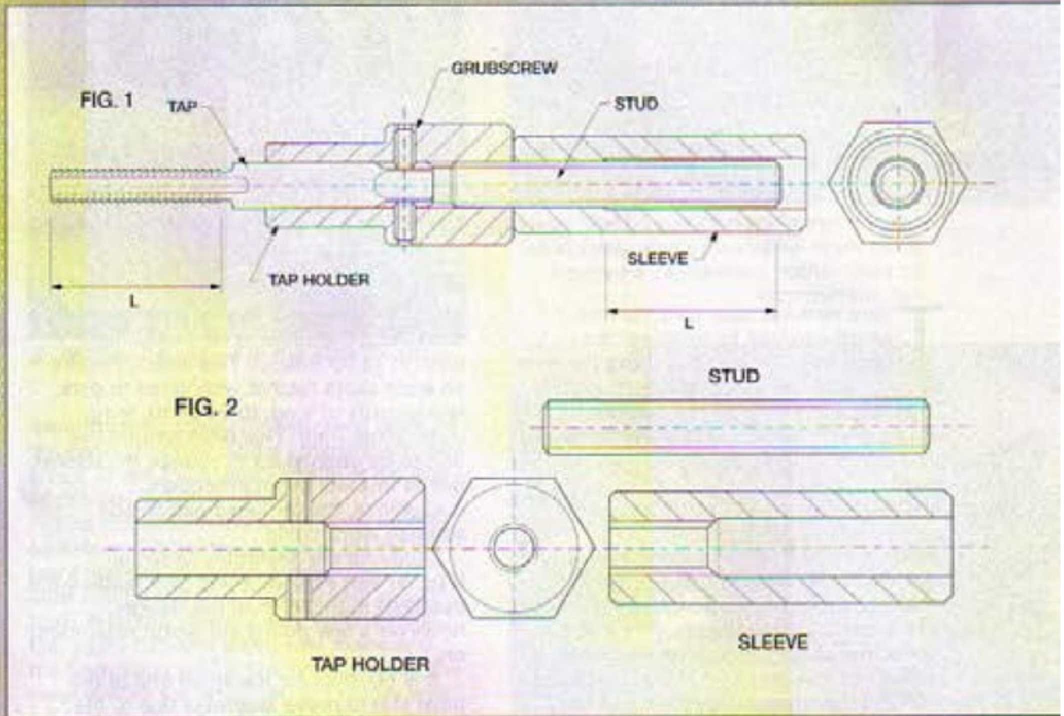
3. The sleeve diameter should be small enough to go into the tailstock chuck or the one fitted to the mill/drill, as required.

4. The tap holder must be turned down as shown, leaving a hex. section only at the stud end. This is to reduce the radial forces when the spanner is applied to the tap.

5. The free length of the stud, when assembled, should equal the threaded length of the tap.

6. The stud must be locked into the tap holder, either a press fit or secured with a glue such as Loctite.

7. The inner ends of the grub screws should be ground flat and square to give the maximum diameter at the point of contact with the tap.



Any material will do for the tap holder as long as it can take the forces on the grub screws. Steel studding with a brass sleeve would avoid seizure, but any non-sticking combination of materials would do.

In Use

1. Insert the tap into the wrench and tighten the grub screws on to the square end.

2. Lubricate the stud then screw the sleeve fully on to it.

3. Drill the tapping hole into the job.

4. Remove the drill from its chuck, insert the wrench in its place and tighten the chuck onto the sleeve.

5. If working in the lathe, hold the headstock chuck still whilst rotating the tap holder with a spanner. In a mill/drill it would be necessary to hold the drill chuck or to lock the spindle.

6. The gap between the tap holder and the sleeve shows the tapping depth precisely. **Photo. 1** shows the wrench in use on a lathe. Note the gap between the tap holder and the sleeve.

A thought for the future

If taps were to be made like the one shown in **Photo. 2**, then you only need to make a sleeve to have an automatic feed arrangement.

1

2

LINE ENGRAVING TOOL

Having made a dividing head, Harold Hall needed a means of marking the division lines on the new dials for his milling machine. This practical tool produced excellent results

1. The finished engraving tool

There remains now only the line engraving tool to complete the equipment required to make the new dials for my Hobbymat milling machine. The dials and a few more minor items which were created when making the tool are also described.

The design

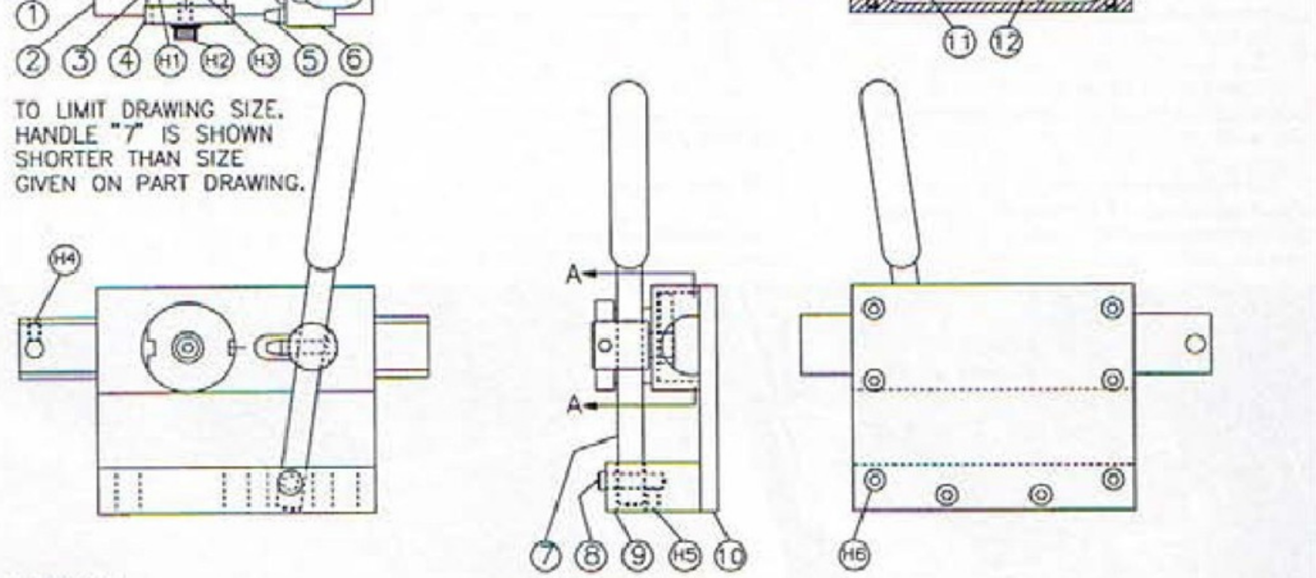
I decided that the engraving tool should be a compact unit and that the ratchet which controls the line length stops should be enclosed. In most cases, line lengths will be based on a repeating sequence of ten:- long, four short, medium, four short; this for tens, units, fives, units and back to tens. In my case, the initial dials were for a metric machine and I decided to calibrate them in steps of 0.025mm as this would replicate those on the Hobbymat lathe.

Also, as I operate a mixed measurement workshop, 0.025mm is very close to 0.001in. (0.000984in.). This would require an eight tooth ratchet with stops to give line lengths of long, three short, long, three short, long. This does require the unit to be opened up to change the ratchet but as this will be an infrequent occurrence, the enclosed design still seemed worthwhile.

Studying the Assembly Drawing **(Fig. 1)** and **Photo. 1** will give readers the essential ingredients of the design, however a few points are worth expanding on.

It is possible for the small end of the pawl (11) to move sideways due to the clearance between hole A and its bearing on the slide operating post (6). Even if the clearance was made much less, sideways movement would still be possible due to the narrow width of the pawl bearing. The effect of the sideways movement, if towards the slide (1), would be for the pawl to catch on the top of the slide and not drop into the next tooth of the ratchet, causing an error in indexing the stop disc (4). The 12mm wide by 1mm deep slot in the slide prevents this happening.

It was felt that a little friction added into the ratchet/stop disc carrier assembly would help to prevent this overshooting if the tool is operated quickly, or if the stop disc is knocked. For this, the stop disc carrier (3) has fitted into it two sprung



HARDWARE
H1. 4mm DIA, STEEL BALL AND SHORT COMPRESSION SPRING. 2 OFF.
H2. M4 X 10 SOCKET HEAD CAP SCREW. 1 OFF.
H3. M3 X 6 SOCKET GRUB SCREW. 2 OFF.
H4. M4 X 6 SOCKET GRUB SCREW. 1 OFF.
H5. M4 X 6 SOCKET GRUB SCREW. 1 OFF.
H6. M4 X 10 SOCKET HEAD CAP SCREW. 8 OFF.

FIG. 1 ASSEMBLY

loaded balls which pull the ratchet wheel (12) against the inner surface of the slide body (2). This provides the friction required whilst still permitting easy rotation.

Another important factor of the ratchet design is that, with the operating handle advanced slightly, the stop disc becomes free to rotate. It can therefore be moved to the require position for starting, or during engraving, should this get out of sequence.

The flat on the rear of the slide has an important purpose, which is to ensure that the slide seats on its sides, without the need for it to be made a precision fit in the slide body. Accepting that a precision fit between slide and body cannot be guaranteed, then it has to be accepted that the slide will be smaller in diameter than the hole into which it fits. In this case, the peak of the slide surface will contact the base of the curved surface in the slide body, and sideways movement of the slide will be possible. By making the flat on the slide, the contact between slide and slide body will be on the sides, no matter how much smaller the slide is than the hole. A secondary advantage is that it makes room for the pawl and ratchet without the need to make the unit deeper.

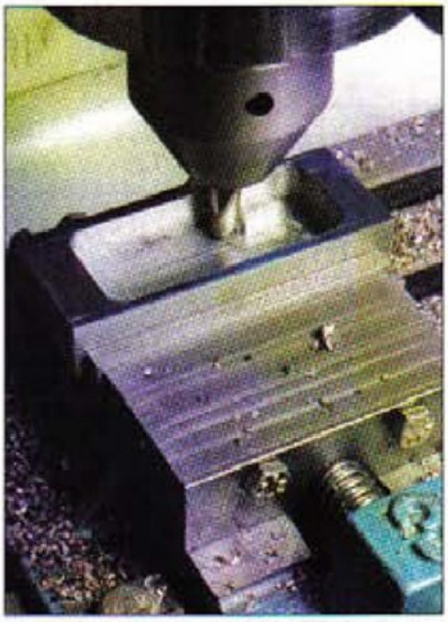
Manufacture

Once more I will only comment on those aspects of manufacture that warrant it. The main consideration when making the various parts is to ensure that the slide moves, but without perceptible shake, this being comparable to the movement of a lathe slide. However, as the slide is lever operated rather than by a leadscrew, this would make the unit tiring to operate, so the slide needs to be a little easier to move. With this in mind, but having left the drawings in line with the unit as made, it is probably worthwhile making the handle (7) longer, say 200mm rather than 125mm.

The slide assembly

In my case, due to not having 20mm diameter steel, the slide (1) was turned from a larger diameter. This was done with the outer end supported by the tailstock centre. The part was checked during turning to see if it was parallel along its length and a very slight taper found. The tailstock set over was adjusted and further cuts taken until it became parallel; it was then reduced to 20mm diameter. The drawing quotes 20mm diameter steel stock being used, but any reader going down this road should check to see if it is both parallel and straight. The diameter is not crucial as the slide body (2) is bored to suit. In retrospect, I feel the route I took due to material unavailability was in fact the preferable one.

Next, I started work on the slide body, cutting and machining it to length at 90mm, the thickness being left at 16mm at this stage. Now, considering milling the recess, I decided that stops on my milling machine in both the X and Y axes would make the operation easier as these could be used to control both length and width of the recess. The machine is already fitted with X axis stops which I always use when milling enclosed end slots, but Y axis stops



2. Milling the recess in the slide body

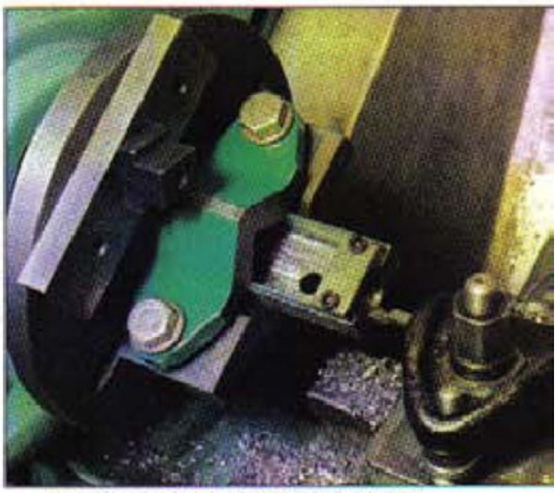
were missing. I therefore stopped work on the engraving tool whilst I made the Y axis stops. These I will detail briefly at the end of this article.

Like the slots in the angle plate for the balancing fixture, the edges of the recess were marked out using a height gauge after having covered the face with marking blue. With this done, a very light witness cut, some 0.05mm deep, was made and the four stops set for the extremities of the recess. With the stops set, the recess was machined, the process being shown in **Photo. 2**. Holes A, B and slot C were also formed at this stage. There remained now only the part in which the slide is fitted to be machined, and this caused me considerable thought as to the best way to complete the exercise. After much deliberation the following method was chosen:-

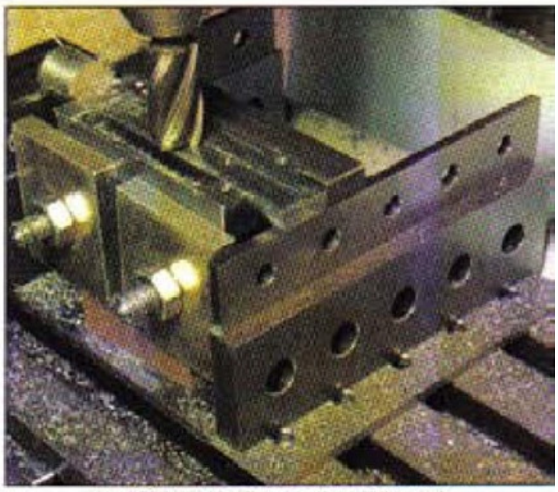
Two small pieces of steel were cut and drilled to fit across two holes B at either end. These would allow each end to be bored 20mm diameter as a continuous rather than an intermittent cut. Holding the part for boring in the lathe presented a problem, the 4 jaw not being big enough and I did not have a suitable angle plate for fitting to the faceplate to carry the slide body. This would have been the preferable route as it would have permitted me to bore through both ends at the same time. I suppose I should have added a suitable angle plate to my list of tools being made, but by this time I really did want to get those dials for my Hobbymat finished.

Eventually, the method shown in **Photo. 3** was decided upon. This did though mean that each end had to be bored separately as I could not hold the item in the Keates with the temporary cross piece fitted at that end. I had therefore to very carefully mark each end with the centre of the 20mm diameter, and use this to set it up in the Keates, with the aid of a centre finder. With this method of positioning the holes in each end, they were bored individually to be a close running fit on the slide, still being a round bar.

When complete the slide was found to pass through both bores almost precisely,



3. Boring the 20mm diameter in the slide body. The screwed-on cross piece ensures a continuous, rather than an intermittent, cut

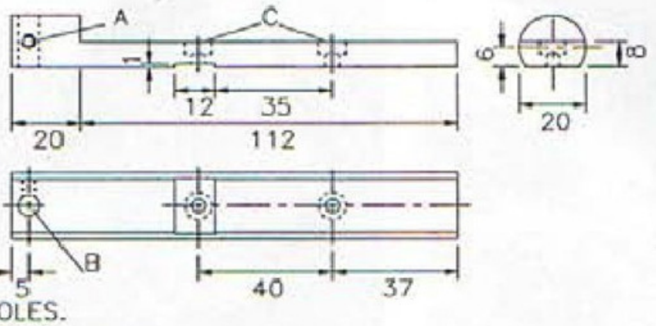


4. Milling the flat on the slide and reducing the thickness of the slide body at the same operation

with the use of some marking blue and a scraper a little adjustment was made, though this was minimal. Had the bores not aligned I do not know what I would have done. Back to the drawing board, as they say, no doubt. Luckily (or was it skill?), they were in line.

Next the slide had the first flat milled on it - the one which passes along the whole length of the part. It is essential that this is the same depth along the length or else, as will be seen later, the part will get wider along its length causing it to be loose at one end of its movement. With this in mind, the bar was set up on the milling machine, holding it in a vice and with each end supported by precision parallels. A very light cut of about 0.05mm deep was taken along the length to check if all was well. If it was taking more off one end than the other, even if only 0.01mm, then the cut would be noticeably wider at one end than the other. This is always a good way of checking in this situation.

The two holes C were then drilled and counterbored, initially to be used for holding the part together with the slide body for machining, as in **Photo. 4**. This time the assembly was held on an angle plate, but again the ends were supported

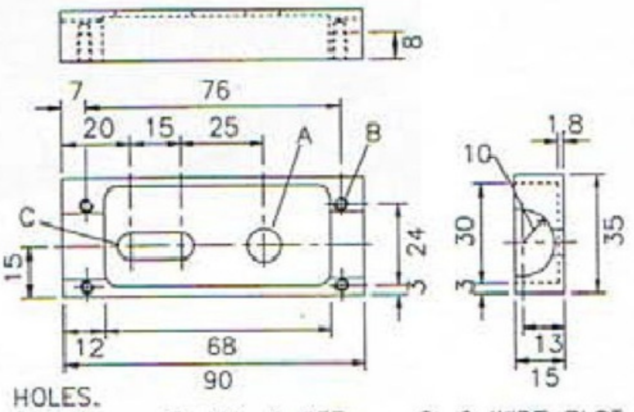


HOLES.
A. M4
B. 6. SEE NOTE.
C. 4.4 CB 7.5 X 4 DEEP. SEE NOTE.

NOTES.
1. DRILL HOLE B AFTER ASSEMBLY AND WHILST FITTED TO THE LATHE SO AS TO ENSURE HOLE IS AT CENTRE HEIGHT.
2. LEFT HAND HOLE C IS FOR USE FOR HOLDING THE PART TOGETHER WITH ITEM 2 WHEN MACHINING THE TWO PARTS SIMULTANEOUSLY. NOT USED FOR FINAL ASSEMBLY.

MATL. 20 DIA. MILD STEEL.
QTY. 1 OFF.

1. SLIDE

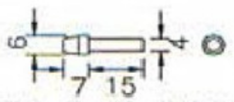


HOLES.
A. 10 B. M4. 4 OFF. C. 9 WIDE SLOT

MATL. 35 X 16 MILD STEEL QTY. 1 OFF.

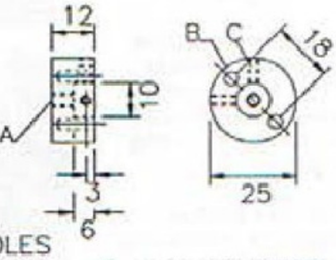
NOTE. REDUCE TO 15 THICK WITH ITEM 1 FITTED IN PLACE. AS A RESULT MACHINING THE FLAT ON ITEM 1 AT THE SAME TIME.

2. SLIDE BODY



MATL. 6 DIA. MILD STEEL
QTY 1 OFF.

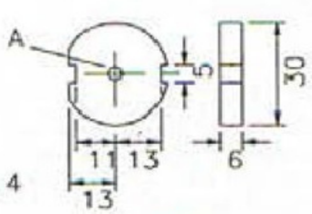
5. STOP PIN



HOLES
A. M4 B. 4.1 10 DEEP. C. M3

MATL. 25 DIA. MILD STEEL.
QTY. 1 OFF.

3. STOP DISC CARRIER

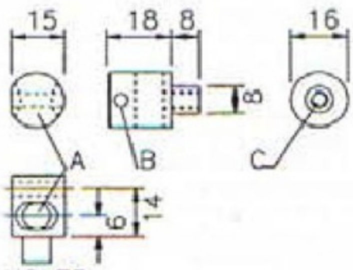


HOLE. A. 4

MATL. 30 DIA MILD STEEL
QTY. 1 OFF

THIS GIVES LINE LENGTHS OF +2 AND +4. MAKE EXTRA DISCS FOR OTHER LINE LENGTHS.

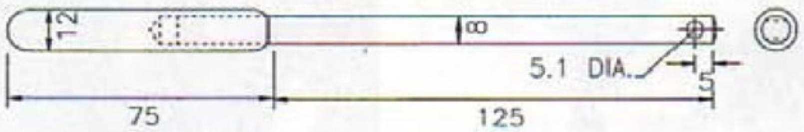
4. STOP DISC



HOLES.
A. 8.5. BELLMOUTH SIDEWAYS ONLY TO ALLOW FOR MOVEMENT OF HANDLE.
B. 4 C. M4

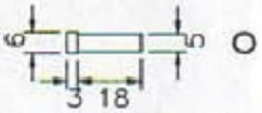
MATL. 16 DIA. MILD STEEL.
QTY 1 OFF.

6. SLIDE OPERATING POST



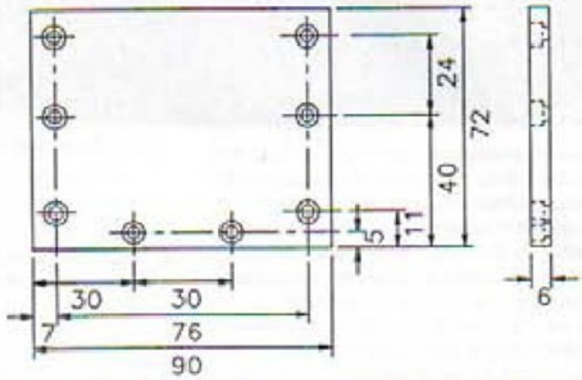
MATL. 12 DIA. AND 8 DIA. MILD STEEL.
QTY. 1 OFF.

7. HANDLE



MATL. 6 DIA. MILD STEEL
QTY 1 OFF.

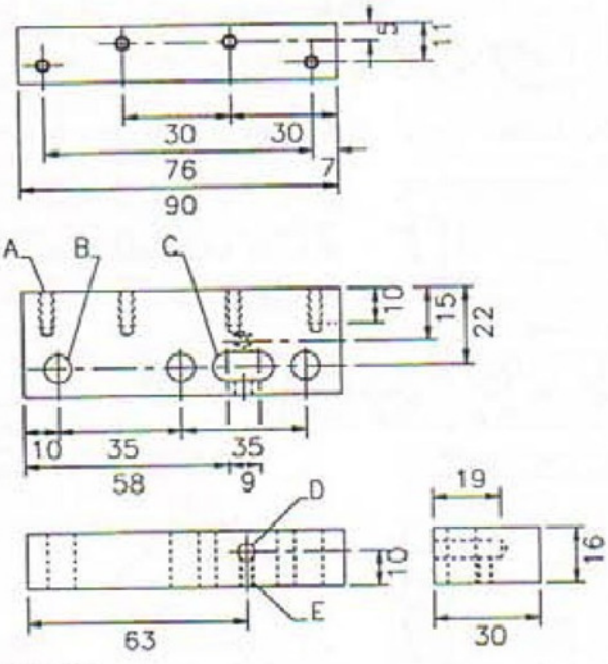
8. HINGE PIN



HOLES. 4.4, CB 7.5 X 4 DEEP. 8 OFF.

MATL. 90 X 6 (OR 75 X 6) MILD STEEL.
QTY. 1 OFF.

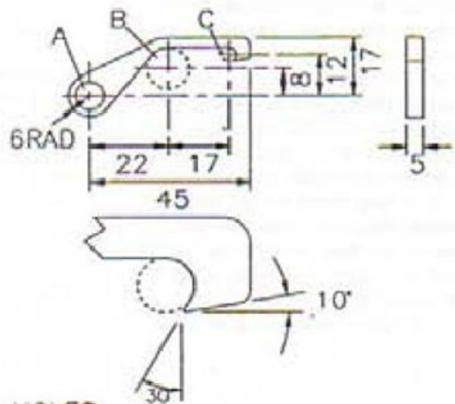
10. ANGLE UPRIGHT



HOLES.
A. M4.
B. 8.1
C. 8 WIDE SLOT.
D. 5
E. M4.

MATL. 30 X 16 MILD STEEL.
QTY. 1 OFF

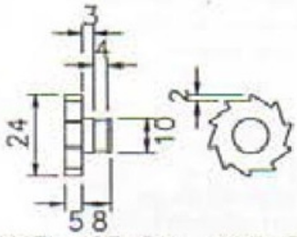
9. ANGLE BASE



HOLES.
A. 8.2
B. 12
C. 4

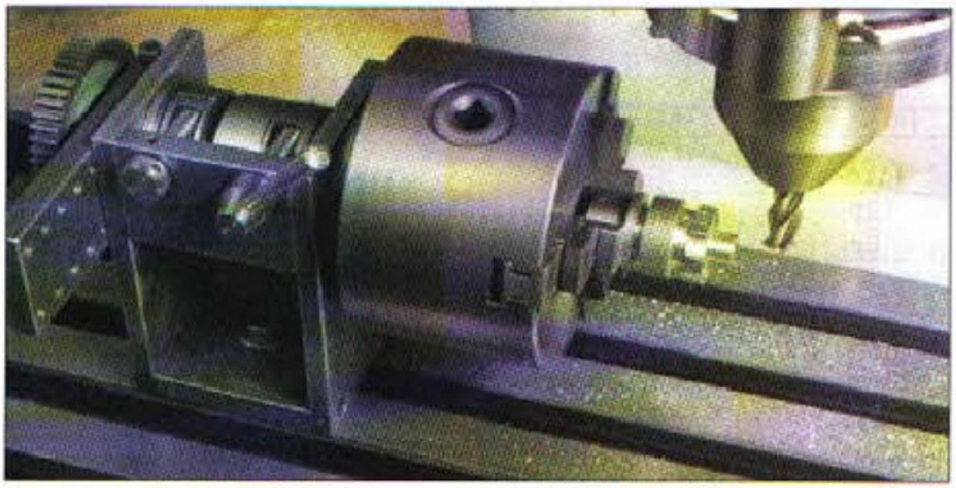
MATL. 5 THICK MILD STEEL.
QTY. 1 OFF.

11. PAWL

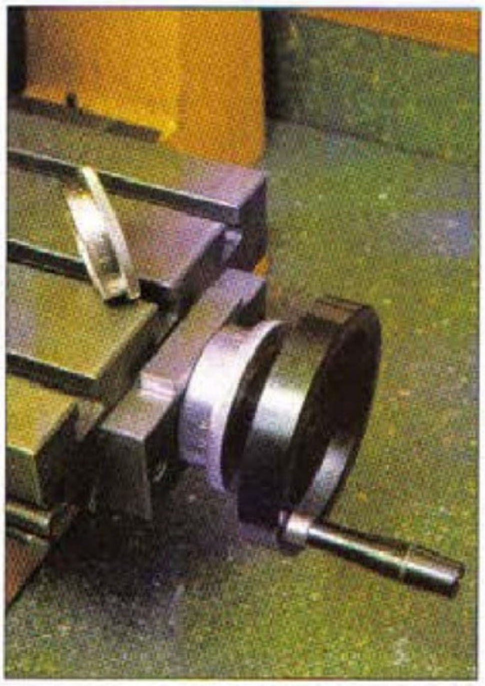


MATL. 25 DIA. MILD STEEL
QTY. 1 OFF.

12. RATCHET WHEEL



5. *Using the dividing head to make the ratchet wheel*



6. *The new dial fitted to the milling machine. The original dial is standing on the machine table for comparison*

by precision parallels. Once more a very light cut was taken to ensure that the same amount was being taken off along the length. A word of warning here; the two screws will cause the slide to bend, as there can be no support between the slide and the body at this point. They must therefore be tightened only just sufficiently for the machining to take place. Even so, when eventually assembled with the angle upright (10) the slide will be tight and will require lightly filing and scraping to get the required ease of movement.

The holes A and B were then drilled and the 12mm wide groove made and the slide was complete.

Remaining parts

These are all easy to make and need no detailed explanation. The pawl (11) is mostly hand work and makes a nice departure from machining, of which this type of project largely consists. As already explained, I made two ratchets (12), one with 10 teeth and one with 8 teeth. I include **Photo. 5** showing one being cut, just to show the dividing head in use on the milling machine. The part was initially turned on the lathe and then transferred to the dividing head, complete with chuck, for cutting the teeth. After these were cut it was returned to the lathe for parting off.

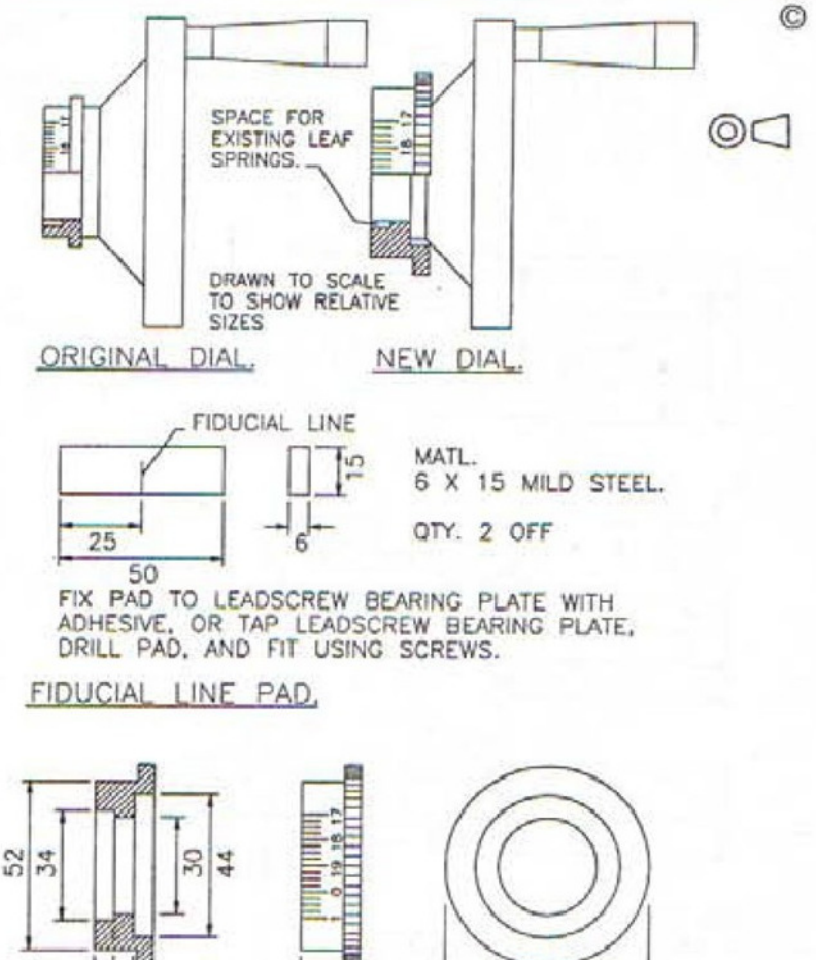
Assembly

The parts were generously deburred and assembled, a little light oil being applied to the slide and the pawl bearing. If over-ambitious with the lubrication, it could get on to the pawl and cause it to grip the inside of the body, preventing it falling under its own weight, there being no spring to assist. This brings me to a point of design. Should anyone wish to orientate the unit such that gravity will not operate the pawl, then a spring would be required. It should not be difficult to include this feature.

The Dials (at last)

Having decided that, rather than recalibrating the existing dials, I would make new dials, it became possible to change their size. This was beneficial as the existing dials were rather narrow, giving little room for the lines and numbers, which as a result were rather small. By making the new dials larger in diameter as well as width, the lines and

FIG. 2



MATL. 65 MILD STEEL. QTY. 2 OFF

SEE TEXT RE DIRECTION OF ROTATION OF NUMBERING

LINE LENGTHS. 3 AND 6 CHARACTER HEIGHT 3

LEADSCREW DIALS FOR HOBBYMAT MILLING MC

numbers could be larger as also could the distance between the lines.

As the Hobbymat milling machine has been popular in the past it is probable that some readers who have the machine will consider making these improved dials. I have therefore included dimensioned drawings for them **(Fig. 2)**. **Photo. 6** shows the original and new dials.

Turning

A single piece of steel, 45mm long, enough to make the two dials was fitted into the three jaw chuck and faced, centre drilled and supported with the tailstock centre. The area for the markings was turned, leaving it a little over size, followed by knurling as per drawing, but of sufficient length for the two dials plus the parting off blade. The next step was to partially carry out the parting off operation. The blade was entered into the workpiece until the base of the groove was at about 40mm diameter.

In view of the large diameter, the reverse jaws of the chuck had to be used and, as a result, only some 12mm length of the workpiece was gripped by the jaws. This, together with the large diameter, was the reason for supporting the workpiece with the tailstock centre for the knurling and partial parting off operations.

Next, the workpiece was bored through, 30mm diameter, thereby ensuring that the inside diameter of both dials would be identical. This was essential as subsequently they would be mounted individually on a stub mandrel for further machining. The 34mm diameter bore on the first dial was also made at this stage.

The workpiece was then reversed in the chuck and the outside diameter for the second dial turned, again a little oversize. The 34mm bore was also produced at this setting. The part was then transferred to the vice and split into two using a hacksaw, followed by returning to the lathe for facing the rough ends and machining the 44mm diameter bores.

A piece of 40mm diameter bar was placed in the three jaw and a mandrel turned to support the dials for further machining. This was made a very close sliding fit and was tapped M8 in the end so that the dials could be held using an M8 screw and large washer. Each was then fitted to the mandrel and the outside surface which would bear the markings finished to size. The corners of the knurling were also lightly chamfered and it was now time to carry out the engraving.

Engraving

The dividing head, together with chuck and mandrel, was mounted on the bed of the lathe, the mandrel not having been removed from the chuck so as to maintain concentricity. Despite my very best intentions when making the dividing head, I found that the mandrel did not run true. Not wishing to be too hard on myself, the error was no more than 0.025mm total indicator reading, and this was also at a distance of around 100mm from the dividing head spindle nose, so not bad going really. Now this degree of error would, in most cases, be of little consequence, even when cutting gears. However, when cutting lines only some 0.1mm deep it may cause them to appear differently on one side compared to the other, so I did not want to chance it. Opening the chuck a little, rotating the mandrel slightly, retightening, checking and repeating the process a number of times found a spot with minimal error. In retrospect, the four jaw chuck should be used in critical applications when transferring chucks from one machine to another. This would permit easy adjustment should this prove necessary.

Photo. 7 shows the set-up with dividing head and engraving tool for carrying out the operation. The dividing head is fitted with a 40 tooth gear and the forked detent used to double the number of divisions to 80. The cutting tool was made with a 50 deg. internal angle and a flat, rather than a fully pointed end. The width of the flat was around 0.1mm. Depth of cut was 0.1mm and, after cutting, the burrs were removed with a very smooth needle file, giving clean and easily visible lines.

Numbering

One unfortunate aspect of the otherwise excellent Hobbymat machines, both mill and lathe, is that right hand threads are used for all of the leadscrews. The result of this is that the direction of movement in some cases differs from the normal convention, that is, clockwise rotation causes the item being fed to move away from the operator. Also the norm is for the numbers on the dials to increase in value for away movement. This shows up another oddity with the Hobbymat machines, in that the lathe conforms to this whilst the mill does not.

The leadscrew for the saddle has to be turned anti-clockwise for the saddle to move away, but the numbers do increase, as is the norm. However, on the milling machine, both dials are identical, the result of which is that on the Y axis leadscrew (which has also to be turned anticlockwise for away movement), the numbering decreases in this direction.

I decided therefore to depart from the method used by Hobbymat for the milling machine and make one dial with numbers running one way and the other dial the reverse. The result of this is that whilst direction of rotation for away movement differs from machine to machine, all the machines in my workshop now have calibrations that increase in value with away movement.

The knurled portion is raised, making it easier to grip when in use. An additional bonus of this is that the side of the flange was used to position the number punches. By holding the punches against the flange the impressions were precisely positioned. I had considered also making a number punching jig but decided that this approach should work equally well, as it did.

When using number and letter punches, if the punch is not held perfectly upright, it is easy to produce impressions which are deeper, and as a result wider, on one side. This is particularly so when punching on curved surfaces. Having made the impression with a firm single blow with the hammer, the result was inspected. If the result was uneven, the punch was carefully re-engaged with the impression and tilted slightly in the appropriate direction and given a further hammer blow. By this method the inconsistent depth was corrected.

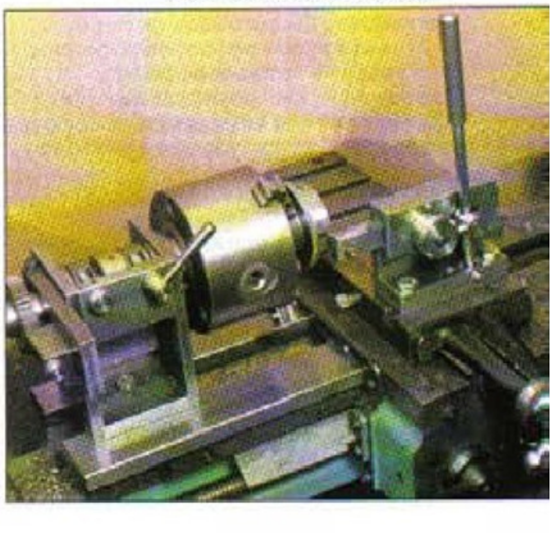
Having completed the dial it was again inspected to see that the impressions made were visually of equal depth. Any that were on the faint side were deepened as follows:- the punch was engaged with the existing impression and tilted slightly first one way and given a light hammer blow and then the other and given a second blow. After each hammer blow it was necessary to check that the punch was still precisely engaged before hitting it again. This is advisable as it is quite easy for the punch to bounce out without it being realised, producing a ghost impression. It is also good practice to hold the punch into the existing impression with a firm downward force to ensure that it is properly engaged.

After completion, the burrs thrown up by the punches were removed, again using the very smooth needle file. When cleaning up punched characters in this way it can be found that the ultimate impression is less prominent than anticipated, as removing the burr reduces the depth and therefore the width of the lines. If this has happened, it is much more difficult to locate the punch accurately to deepen the impression, and ghost characters can easily result. A good approach is to punch a few characters on a scrap of steel and to remove the burrs from some of these. If the end result is satisfactory use the untouched characters as a guide for those being made on the part being made. If not acceptable make some deeper impressions and repeat the check on these.

The increased diameter of the dial requires the fiducial line to be raised. This was done by adding a small 6mm thick block marked with a single line. Fixing this was done using adhesive, though if you prefer, it could be fitted using screws threaded into the leadscrew bearing plate. The fiducial line pad can be clearly seen in **Photo. 6**.

Having completed and fitted the dials, I can report that the end result is dials that are much easier to read and the larger, more accessible, knurled portion makes them easier to set. In all, a very worthwhile project.

7. Engraving the new leadscrew dial using the dividing head and the engraving tool mounted on the lathe



The Y axis stops

Photo. 8 and the Arrangement Drawing **(Fig. 3)** show the stop arrangement produced and should give sufficient guidance for anyone wishing to use the principle for their own machine. Dimensioned drawings would serve little purpose as they would not be applicable for the vast majority of such machines.

As there was very little space between the stop bar and the lower slide there was limited space for the lower slide apron which was further reduced by the stop collar. To minimise the effect of the stop collar on the space available, this was made with an off centre hole (see drawing).

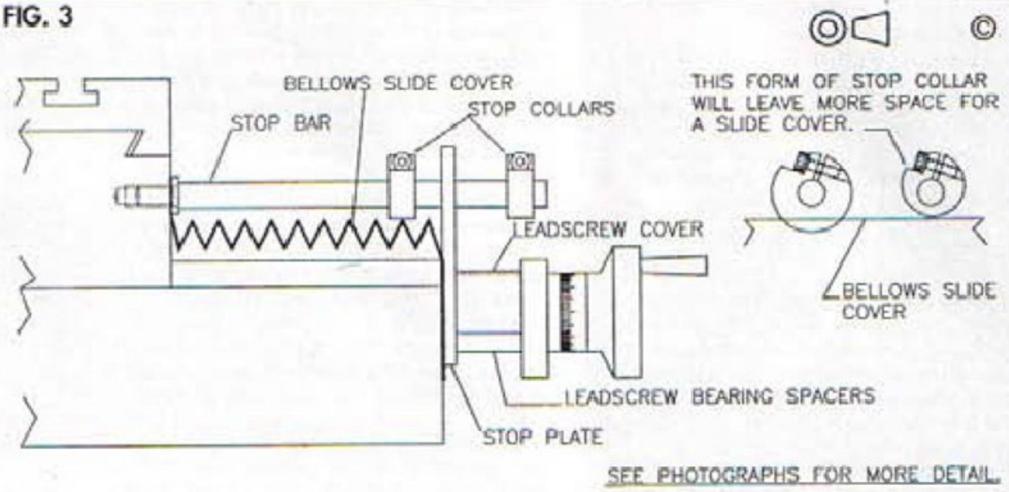
The original X axis stop, modified earlier (Ref. A), consisted of a bar held by two screws to the upper part of the lower slide. After modification, the lower of the two screw positions became vacant and this was used for fixing the stop bar which was made with a threaded extension for the purpose. Where a suitable tapped hole is not available, drilling and tapping one should present no real problem.

As the length of the stop bar would, when the table is forward, come quite close to the handle and somewhat obscure the leadscrew micrometer dial, the leadscrew bearing was packed forward with spacers, as can be seen in **Photo. 9**. Fortunately, the leadscrew was long enough to cope with the new position, but had it not been, the spacers could have been omitted as they are by no means essential. Having packed the bearing forward, there was a gap between the spacers where swarf could fall onto the leadscrew. The curved piece of sheet steel seen at the bottom of **Photo. 9** is a cover to prevent this. It is seen fitted in **Photo. 8**.

The stop plate is made from a piece of 6mm thick steel. I would have liked this to be thicker but it was the only material I had that was at all suitable and it is liable to flex a little when the stop collars contact it. It does not therefore have that positive feel that the X axis stops have. However, by carefully watching to see the point at which the stop collars contact the stop plate, errors in the stop position can largely be eliminated. Where the position is critical, a record of the micrometer dial reading can be made and worked to. At least it will not be necessary to count leadscrew turns.

Should a thicker piece of metal become available I will no doubt replace the existing plate, but I do not consider the situation warrants the cost of purchasing a piece of steel specially for the application.

FIG. 3



Y AXIS STOP AND SLIDE COVER BASIC ARRANGEMENT

Lower slide apron

A consequence of the stops being fitted was that the lower slide apron I had previously fitted (Ref. B) was no longer suitable. Not wishing to forgo this facility as it helps considerably in protecting the lower slide and reducing the time spent cleaning it, some alternative was desirable. The only possible solution appeared to be a bellows form cover. Knowing that the folded form would give the cover strength, I decided to fold it from thin cardboard. This was acquired from a large cornflakes packet and, so as to make it more resistant to oil and the like, it was varnished with polyurethane varnish after bending.

A 15mm x 3mm mild steel bar holds the cover to the slide, being fixed in the centre by the stop bar passing through it and by an M4 screw into the slide, at either end. Two short metal bars hold the front end of the cover, though at the time the photographs were taken double adhesive tape was being used.

The cover appears to be standing up to the task very well and I expect it to last at least a year or two. I will though fold two or three and fit one and keep the others in reserve.

Should any reader fit such a cover, and I think it well worth while, without the stop arrangement, then it is possible that, without the stop bar to restrain it, it may spring up in the middle. In this case a bar rather like the stop bar but shorter and smaller in diameter could be fitted. It would not need any support at the front end. Alternatively, a metal rod resting in the centre fold would add weight and probably achieve the same objective.

A final comment

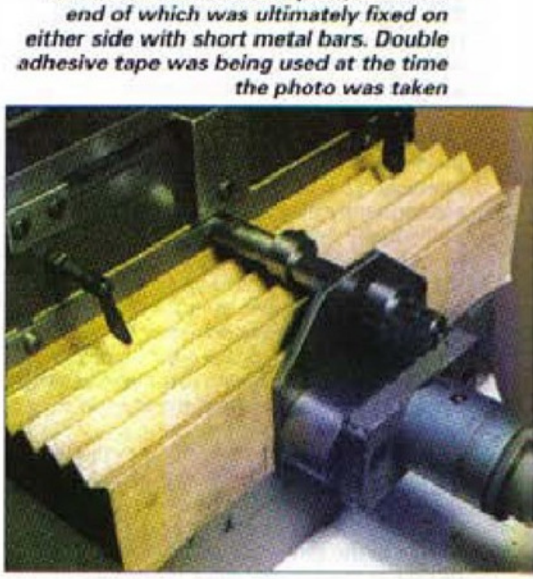
I now conclude this series which surely will have items in it that will be of use to many readers of this magazine, but, few if any will make all the items that have been covered. It does though show how the need to make a particular item generates the need for another which it turn generates another. No wonder that many of us spend practically all our workshop time making tools. It has though for me been a very satisfying period in the workshop, particularly making the three major items, the dividing head, faceplate balancing fixture and the engraving tool, especially having taken them from the drawing board right through to the finished articles.

References

A. Milling machine table stop. M.E.W. Issue 16 page 45.

B. Protect that slide. M.E.W. Issue 9 page 29.

8. The completed Y axis stops which were used whilst carrying out the operation shown in Photo. 2. Also visible is the new folded slide apron, the front end of which was ultimately fixed on either side with short metal bars. Double adhesive tape was being used at the time the photo was taken



9. The leadscrew bearing is spaced away from the main body of the milling machine with round spacers. The cover to protect the leadscrew is shown removed at the bottom of the picture

INDEX FOR ISSUES 45 TO 56 OF M.E.W.

The information contained in this index supplements that published in Issue 45 and brings the information up to date to Issue 56. As mentioned on Page 36, a computer generated index is available for those who have suitable equipment on which to run the software.

SUBJECT INDEX

This section is arranged by Subject, listing Articles, Quick Tips and Letters to Scribe a Line. The key to the letters in the second and seventh columns is given at the end of the table. Columns five and six, e. g. 48 23 refer to the particular Issue and page number.

ANGLEPLATE	C	MULTI PURPOSE MOUNTING	UNIVERSAL PARALLEL CLAMP	48	23	A
ANGLEPLATE	M	KEATS ALTERNATIVE	KEATS ALTERNATIVE	52	24	A
BEARINGS	M	ROLLING BEARINGS, HOMEMADE	FACEPLATE BALANCING FIXTURE	55	12	S
BENDING	C	TUBE BENDERS	HELICAL TUBE BENDERS	55	25	A
CHUCKS	C	3/4 JAW CHUCK FITTING AID	TONS TIPS	52	62	A
CHUCKS	C	4 JAW CHUCK LARGE	HOME MADE 4-JAW CHUCK	50	28	A
CHUCKS	C	COLLET CHUCK ADAPTOR	MYFORD NOSE COLLET ADAPTOR	56	55	A
CHUCKS	C	MILLING CUTTER CHUCK	ACCESSORIES FOR SMALL LATHE	51	25	A
CHUCKS	C	WORKHOLDING DEVICE	FOUR JAW CHUCK FIXTURE	53	35	A
CHUCKS	M	3/4 JAW SERVICING	TALE OF TWO CHUCKS	54	55	A
CLAMPING	C	VERSATILE CLAMP VERTICAL	VERSATILE CLAMP	55	57	A
CLAMPING	M	PLASTER OF PARIS USE OF	WAYS AND MEANS	55	64	L
COMP AIR	M	COMPRESSOR FROM SCRAP	AIR COMP-GARAGE/WORKSHOP	51	57	A
COMPUTER	M	ENGRAVING BY COMP CONTROL	CNC FOR PRACTICAL ENGINEERS 5	45	52	A
COMPUTER	M	ENGRAVING CHARACTERS	CNC FOR PRACTICAL ENGINEERS 6	47	60	A
COMPUTER	M	INTERNET	MODEL ENGINEER & THE INTERNET	56	63	A
COOL/LUBR	M	RUST AVOIDING	WATER BASED COOLANTS	50	65	L
COOL/LUBR	M	SYRINGE LUBRICATOR	APPLICATION OF CUTTING FLUID	56	66	Q
DIVIDING	C	DIVIDING ATTACHMENT S7	FROM THE PLANS SERVICE	45	62	A
DIVIDING	C	DIVIDING HEAD CNC CONTROL	CNC MILLING MACHINE PT4	56	47	S
DIVIDING	C	DIVIDING HEAD MULTI USE	FAILED ATTEMPT 2	54	35	A
DIVIDING	C	DIVIDING HEAD MULTI USE	FAILED ATTEMPT 1	53	43	A
DIVIDING	C	INDEXING TABLE	FACE GEARED INDEXING TABLE	52	35	A
DIVIDING	M	DIVIDING BY 3, 4 OR 6	SIMPLE INDEXING	48	63	L
DRILLING	C	COUNTERBORES MAKING	C/WHEEL QUADRANT MYFORD S7	56	37	S
DRILLING	C	DRILL SPNDL TAILSTOCK MTD	TAILSTOCK DRILLING ATTCHMNT	46	52	A
DRILLING	P	TYPES USING & SHARPENING	DRILLS AND DRILL SHARPENING	50	44	A
ELECTRICAL	C	MACHINE TABLE STOP SYSTEM	AUTOSTOP FOR MILL MC SELFACT	51	35	A
ELECTRICAL	M	BRUSH REPLACEMENT	MOTOR PROBLEMS?	54	33	A
ELECTRICAL	M	COMMUTATOR REPAIR	MOTOR PROBLEMS	56	65	L
ELECTRICAL	M	MOTOR AC S/PH REVERSING	DATA BOOK INF-ELECTRIC MOTORS	45	64	L
ELECTRICAL	M	MOTOR AC S/PH REVERSING	REPLACEMNT FOR A DEWHURST SW	46	13	A
ELECTRICAL	M	MOTOR AC SEWING MC	INEXPENSIVE MOTORS	56	65	L
ELECTRICAL	M	MOTOR AC SPEED CONTROL	DC MOTOR SPEED CONTROL	48	63	L
ELECTRICAL	M	MOTOR DC SPEED CONTROL	DC MOTOR SPEED CONTROL	48	63	L
ELECTRICAL	M	TRANSFORMER SPOT WELDER	SPOT WELDERS - TRANSFORMER	48	62	L
ELECTRONIC	M	ELECTRNC SEQUENCE CONTROL	REPLACEMNT FOR DEWHURST SW	46	13	S
EXHIBITION	M	BRISTOL 1997	DO U KNOW WHAT U ARE MISSING	46	44	A
EXHIBITION	M	HARROGATE 1998	HARROGATE EXHIBITION	51	55	A
EXHIBITION	M	HOROLOGICAL INST 1997	BRITISH HOROLOGICAL INSTITUTE	49	65	A
EXHIBITION	M	MODEL ENGINEER EX 1998	67TH M.E. EXHIBITION	49	52	A
EXHIBITION	M	MODEL ENGINEER EX 1999	68TH MODEL ENG EXHIBITION	56	33	A
EXHIBITION	M	PRIMROSE VALLEY 1998	MODELLING BY THE SEA	51	37	A
EXHIBITION	M	SMEE CENTENARY 1998	SIMPLY, THE BEST	53	50	A
GEAR	M	GEAR HOBBING MC HISTORY	SPENBOROUGH GEAR HOBBING MC	53	63	L
GEARS	C	FORM RELIEVING TOOL	FROM THE PLANS SERVICE	48	53	A
GEARS	C	PINION DIVIDE/MILLING ATT CLOCK	PINION LEAF MILLING ATT	52	16	A
GEARS	P	GEAR CUTTERS HOBS	GEAR HOBBING IN THE HOME SHOP	56	14	A
GRINDING	C	CHUCK BLOCKS MAGNETIC	SURFACE GRINDING WITH QUORN	49	16	S
GRINDING	C	SURFACE GRINDER SWINGTYPE	SWING SURFACE GRINDER 1	45	12	A
GRINDING	C	SURFACE GRINDER SWINGTYPE	SWING SURFACE GRINDER 2	46	20	A
GRINDING	M	FLATTENING A WORN STONE	MAKING A 75MM SQUARE	45	49	S
GRINDING	M	GRINDING WHEEL DATA/USES1	UNDERSTANDING GRINDING WHEELS1	48	12	A
GRINDING	M	GRINDING WHEEL DATA/USES2	UNDERSTANDING GRINDING WHEELS2	49	20	A
GRINDING	M	METHODS AND MACHINES	GRINDERS AND GRINDING	47	23	A
GRINDING	M	SURFACE GRINDING	SURFACE GRINDING WITH QUORN	49	12	A
HISTORY	M	GLASS ENG LATHE RESTORED	19THCENT GLASS ENG LATHE	53	18	A
INST/SERV	M	FEEDSCREW NUT REPLACING	ADJUSTABLE FEEDSCREW NUTS	48	19	A
INST/SERV	M	OVERCOMING A WORN BED	CORRECTING LATHE TAPER	56	66	L
INST/SERV	M	RENOVATING A MYFORD 'M' 4	LATHE UPGRADE ON A BUDGET 4	45	34	A
INST/SERV	M	RENOVATING A MYFORD 'M' 5	LATHE UPGRADE ON A BUDGET 5	47	12	A
INST/SERV	M	RENOVATING A MYFORD 'M' 6	LATHE UPGRADE ON A BUDGET 6	48	35	A
MARKING	C	ENGRAVING ATT FOR MILL MC	CLOCK DIAL ENGRAVING TOOL	45	26	A
MARKING	M	GLASS ENAMELLING	GLASS ENAMELLED BADGES	48	22	T
MEASURING	C	DIVIDER/CALLIPER	BOB LOADER'S CALIVIDER	48	46	A
MEASURING	C	HARDNESS TESTER	FROM THE PLANS SERVICE	46	50	A
MEASURING	C	MARKING OUT AIDS	AIDS TO MARKING-OUT	56	20	A
MEASURING	C	MICROMETER STEP MEASURE	OFF-SET MICROMETER	55	16	A
MEASURING	C	PCD MARKING OUT DEVICE	PCD MARKER SET	49	56	A
MEASURING	C	TRY SQUARE SMALL	MAKING A 75MM SQUARE	45	48	A
MEASURING	C	VEE BLOCK-ELECTRO MAGNET	MAGNETIC 'V' BLOCK	50	34	A
MEASURING	M	CENTRE PUNCH RESTORING	RESTORING AN AUTO CNTRE PUNCH	47	41	A
MEASURING	M	DTI BASE MAGNETIC	HANDY MAGNETIC BASE FOR DIAL G	45	64	L
MEASURING	M	HEIGHT GAUGE DIGITAL ATT	DIGITAL ADAPTATION	50	17	A
MILLING	C	CNC MILLING MACHINE PT1	CNC MILLING MACHINE PT1	53	25	A
MILLING	C	CNC MILLING MACHINE PT2	CNC MILLING MACHINE PT2	54	14	A
MILLING	C	CNC MILLING MACHINE PT3	CNC MILLING MACHINE PT3	55	18	A
MILLING	C	CNC MILLING MACHINE PT4	CNC MILLING MACHINE PT4	56	44	A
MILLING	C	CROSS DRILLING/MILLING	MILL/DRILL CENTRING DEVICE	47	52	A
MILLING	C	HORIZONTAL MILL ATTACHMENT	RIGHT ANGLE DRIVE-VERT MILL	51	15	A
MILLING	C	MILLING SPINDLE 1	QUICK-STEP MILL SPNDL-LATHE 1	52	52	A
MILLING	C	MILLING SPINDLE 2	QUICK-STEP MILL SPNDL-LATHE 2	53	52	A
MILLING	C	POWER TRAVERSE	SELF ACT FOR THE MILLING MC	50	40	A
MILLING	C	SINE PLATE FOR MILL TABLE	SINE PLATE	49	40	A
MILLING	C	VERTICAL SLIDE/VICE	FROM THE PLANS SERVICE	47	58	A
MILLING	M	CNC MILLING MACHINE	FUTURE PROJECTS	52	42	A
MILLING	M	HEAD RISE/LOWER GUIDE	IMPROVING PRECISION OF MILL/DR	50	57	A
MILLING	M	QUICK-STEP MILL REVIEWED	ADVANCE IN LATHE MILLING ATTS	52	50	A
MISC	C	BUSHING TOOL	CLOCK BUSHING TOOL	53	12	A
MISC	C	MAGNIFIER BENCH MOUNTED	BENCH MAGNIFIER	51	13	A
MISC	C	SCREW JACKS WEDGE TYPE	ADJUSTABLE PARALLEL JACKS	46	18	A
MISC	C	SPACE SAVING MC HANDLES	FOLDING HANDLES FOR MC TOOLS	45	58	A
MISC	M	BOOK REVIEWS	FIRESIDE READING	56	31	A
MISC	M	DIGITAL PLAN PRINTING	FROM THE PLANS SERVICE	50	63	A
MISC	M	MAKING A MODEL LATHE	HOLBROOK C LATHE IN MINIATURE	45	74	A
MISC	M	METALOCK REPAIR KEYS	REPAIRS TO CRACKED CAST IRON	50	66	L
MISC	M	METALOCK REPAIR KEYS	METALOCK REPAIRS	51	64	L
MISC	M	MINIATURE MACHINE TOOL	MINIATURE TOOL & CUTTER GRINDR	51	23	A
MISC	M	MINIATURE MACHINE TOOL	HOLBROOK "C" LATHE 1/6TH SCALE	54	26	A
MISC	M	MINIATURE MACHINE TOOL	MINIATURE BRIDGEPORT MILL MC	47	45	A
MISC	M	OVERCOMING ERRORS	FIXING MISTAKES	54	22	A
MISC	M	RIVETING,CHUCK FITTING	TONS TIPS	52	62	A
MISC	M	SPARK ERODER	FUTURE PROJECTS	52	42	A
MISC	M	THREE WELDED ACCESSORIES	WHERE THERE'S A WILL	47	51	A
MISC	M	WHITE SPIRIT RECLAIMING	SAVING WHITE SPIRIT	46	36	Q
MISC	M	WINDOW BLIND LATHE COVER	LATHE COVER	55	34	Q
MISC	P	PRODUCTION AIDS STUART10V	JIGS AND FIXTURES-SMALL LATHE	51	29	A
MISC	P	WORKSHOP PHOTOGRAPHY	WORKSHOP PHOTOGRAPHY	52	27	A
MISC	P	WORKSHOP PHOTOGRAPHY	SPREADING THE LIGHT	55	51	A
POWER TRAN	M	BELTS POLYURETHANE	DRIVE BELTING FOR THE UNIMAT	49	64	L
POWER TRAN	M	LATHE COUNTERSHAFT	LATHE UPGRADE ON A BUDGET	48	35	S
REVIEW MC	M	GUILLOTINE-PRESSBRK-ROLLS	THE TRIPLE MACHINE	51	39	T

KEY TO THE SYMBOLS USED IN THE ABOVE SECTION OF THE INDEX

Column 2

C = Construction, P = Process, M = Miscellaneous

Column 7

A = Article, T = Trade, L = Letter, Q = Quick Tip, S = Subjects

Index by Author, Subject, Issue and page number

LOADER	BOB LOADER'S CALIVIDER	48 46
LOADER	EXPERIMENT IN CUTTER HOLDING	53 37
LOADER	MAKING A 75MM SQUARE	45 48
LOADER	MOTOR PROBLEMS? CHECK YOUR BRUSHES	54 33
LOADER	WORKSHOP PHOTOGRAPHY	52 27
MACHIN	ADDITIONS TO THE QUORN	54 42
MACHIN	LEADSCREW DRIVE FOR THREAD MILLING	49 33
MACKENZIE	MODIFICATIONS TO THE HOBBYMAT	51 45
MAJOR	HOLBROOK 'C' LATHE IN MINIATURE	45 24
MARKS	RESTORING AN AUTO CENTRE PUNCH	47 41
MELLOWS	HOLBROOK 'C' LATHE IN 1/6TH SCALE	54 26
MCMAHON	LATHE SPINDLE DEPTH STOP	50 27
MORRIS	FACE GEARED INDEXING TABLE	52 35
MORRIS	UNIVERSAL PARALLEL CLAMP	48 23
NEAVE	ACCESSORIES FOR A SMALL LATHE	51 25
NEWMAN	VERSATILE CLAMP	55 57
NOAKS	AIR COMPRESSOR FOR THE GARAGE/WORKSHOP	51 57
OXLEY	MYFORD S7B LATHE ENHANCEMENT	50 12
PARKES	MYFORD NOSE COLLET ADAPTOR	56 55
PAYNE	QUICK-STEP MILLING SPINDLE FOR THE LATHE 1	52 52
PAYNE	QUICK-STEP MILLING SPNDLE FOR THE LATHE 2	53 52
PENNEY	CLOCK BUSHING TOOL	53 12
PETERS	DIGITAL ADAPTATION OF A HEIGHT GAUGE	50 17
RAWLINSON	CNC MILLING MACHINE PT1	53 25
RAWLINSON	CNC MILLING MACHINE PT2	54 14
RAWLINSON	CNC MILLING MACHINE PT3	55 18
RAWLINSON	CNC MILLING MACHINE PT4	56 44
RAWLINSON	FOLDING HANDLES FOR MC TOOLS	45 58
RAWLINSON	FUTURE PROJECTS	52 42
RAWLINSON	MAGNETIC 'V' BLOCK	50 34
RAWLINSON	MILL/DRILL CENTRING DEVICE	47 52
RAWLINSON	P.C.D. MARKER SET	49 56
RAWLINSON	QUICK RELEASE SOFT VICE JAWS	48 39
RAWLINSON	RIGHT ANGLE DRIVE-VERT MILL	51 15
RAWLINSON	TAILSTOCK DRILLING ATTACHMENT	46 52
RAYSSIGUIR	IMPROVING-PRECISION OF MILL/DRILL	50 57
SHEPPARD	68TH MODEL ENG EXHIBITION	56 33
SHEPPARD	ADVANCE IN LATHE MILLING ATTS	52 50
SHEPPARD	DO YOU KNOW WHAT YOU ARE MISSING	46 44
SHEPPARD	FIRESIDE READING	56 31
SHEPPARD	FROM THE PLANS SERVICE	45 62
SHEPPARD	FROM THE PLANS SERVICE	46 50
SHEPPARD	FROM THE PLANS SERVICE	49 37
SHEPPARD	FROM THE PLANS SERVICE	48 53
SHEPPARD	FROM THE PLANS SERVICE	47 58
SHEPPARD	HARROGATE EXHIBITION	51 55
SHEPPARD	MODELLING BY THE SEA	51 37
SHEPPARD	PARTING	49 46
SHRUBSOLE	LATHE UPGRADE ON A BUDGET 4	45 34
SHRUBSOLE	LATHE UPGRADE ON A BUDGET 5	47 12
SHRUBSOLE	LATHE UPGRADE ON A BUDGET 6	48 35
SMITH	ADJUSTABLE FEEDSCREW NUTS	48 19
STARK	REPLACEMENT FOR A DEWHURST SWITCH	46 13
SWALLOW	FIXED STEADY WITH BUSHES	56 12
TROBE	SPREADING THE LIGHT	55 51
TURNBULL	STEADY SETTING DEVICE	54 12
VAUGHAN	BORING HEAD WITH A DIFFERENCE	49 28
WADE	AUTOSTOP FOR MILL MC SELF-ACT	51 35
WADE	SELF ACT FOR THE MILLING MC	50 40
WALE	TALE OF TWO CHUCKS	54 55
WALKER	AIDS TO MARKING-OUT	56 20
WALKER	BENCH MAGNIFIER	51 13
WALKER	OFF-SET MICROMETER	55 16
WALKER	SMALL INSTRUMENT VICE	47 35
WILKES	SIMPLE TAPPING AID	52 34

MODEL ENGINEERS' WORKSHOP INDEX CROSS REFERENCE LIST.

This list indicates subsequent references to earlier items, in the form of a letter (L), or a correction/update (U). L05/39 indicates a letter in Issue 5 and published on page 39.

The columns are Issue No. of the initial item, Page No., Type of Item:- A - Article, L - Letter, Q - Quick Tip, T - Trade and S - Embedded subject. To use the list look up the issue and page number of the item you are studying to find if there has been any further data. As there may be more than one letter to a page, it may be found that the cross reference refers to another letter on the same page.

This list covers issues 1 to 44. Subsequent indexes will have a cross reference list to cover the range of the previous index, that is, next time issues 45 to 56 as per this index. This is necessary as letters and updates can occur many issues after the initial item.

Issue No.	Page	Type of Item	Cross Ref.
1	28	A	L05/39
1	70	A	L03/74
2	8	A	L19/09
2	22	A	L03/74
2	26	A	L03/74
			L04/31
			L05/59
3	8	A	U07/29
			L23/67
3	19	A	L05/38
			L05/59
3	25	Q	L04/32
3	40	A	L04/30
3	44	A	L04/30
			L15/08
3	48	A	L05/38
3	60	A	L04/31
			L05/59
			L11/05
3	62	A	L06/47
3	67	A	L05/39
3	70	A	L04/30
3	75	L	L04/30
4	12	A	L06/48
4	18	A	L06/47
4	29	Q	L06/48
4	49	A	L16/07
4	52	A	U05/07
5	14	A	L08/06
			L10/09
5	26	A	U05/51
5	40	A	L07/28
5	46	A	L07/29
5	60	A	L07/30
5	64	A	L07/30
			L07/31
6	33	A	L10/07
6	47	L	U07/40
6	59	A	U07/40
			L10/08
6	64	A	L09/06
6	66	A	U07/40
6	68	A	U08/05
7	18	A	L08/07
7	22	A	U08/27
7	33	Q	U09/05
7	34	A	L08/07
			L08/08
7	54	A	L09/06
8	6	L	L11/08
8	7	L	L09/09
8	30	A	L09/09
			L10/69
8	48	A	E09/05
			L09/09
			L10/06
			L13/09

Issue No.	Page	Type of Item	Cross Ref.
9	8	L	L10/07
			L11/09
			L12/07
9	16	A	L10/07
9	20	Q	L11/09
9	24	A	L10/08
9	37	A	E10/05
			L19/09
9	46	A	L10/07
			L11/09
9	49	Q	L11/05
10	38	A	L12/07
11	7	L	L13/07
11	9	L	L13/10
			L23/66
11	13	A	L14/11
11	14	A	L13/10
11	23	A	L14/07
11	32	A	U12/68
			A13/13
12	7	L	L14/08
12	9	L	L13/10
13	7	L	L15/06
13	12	A	L14/08
13	16	A	L15/08
13	18	A	L15/06
			L16/10
13	38	A	L15/08
13	66	A	L18/08
			L20/69
14	9	L	L19/09
			L19/10
14	9	L	L16/10
14	10	L	L15/08
14	14	A	L15/06
			L16/08
			L17/09
14	61	A	U16/44
15	7	L	L17/11
15	17	A	L16/11
			U17/71
15	30	A	L18/09
			L18/10
15	44	A	L17/08
15	48	A	L17/11
15	58	A	L18/08
16	6	L	L18/12
16	6	L	L20/65
16	7	L	L18/09
16	7	L	L20/69
16	15	A	L18/10
16	24	A	L18/09
16	50	A	L18/13
16	57	T	L18/11
16	66	A	U18/71
17	9	L	L20/65
17	27	A	L19/08

Issue No.	Page	Type of Item	Cross Ref.
17	36	A	L25/71
17	50	A	L18/12
17	56	A	L20/67
			L26/65
18	8	L	L20/69
18	9	L	L20/69
18	9	L	L20/68
18	10	L	L20/68
18	11	L	L24/60
18	24	Q	L22/67
18	26	A	L20/66
18	32	A	L21/71
18	38	A	L20/67
19	10	L	L21/71
19	15	Q	U21/11
19	58	A	U31/12
20	12	A	L23/65
20	21	A	L22/67
20	23	Q	L22/71
20	24	A	U25/67
20	37	A	L23/68
20	46	A	L22/67
20	51	Q	U21/11
20	65	L	L23/66
21	16	A	L25/71
21	26	A	L23/65
21	34	A	L22/70
			L25/70
21	40	A	L23/67
21	57	A	L24/68
22	33	A	U25/11
22	47	A	L24/70
22	57	T	U28/33
22	59	A	L24/70
22	67	L	L28/67
22	68	L	L24/68
22	68	L	L24/67
			L26/63
22	71	L	L24/66
23	40	T	L25/70
23	64	Q	L25/70
23	67	L	L25/72
24	29	A	U25/11
24	32	A	L26/65
24	39	A	L26/63
24	54	A	U26/66
24	58	A	L25/69
			L26/64
24	67	L	L25/72
24	69	L	L25/69
24	70	L	L26/63
25	20	A	L26/64
25	24	A	L28/68
25	35	A	L27/68
25	40	A	L28/68
25	48	A	L25/71
25	55	A	L28/66
25	72	L	L28/66
26	15	A	U27/61
26	34	A	L28/66
			L28/67
26	58	A	L29/70
26	63	L	L28/66
26	65	L	L29/70
26	65	L	L29/71
27	17	A	U32/71
27	18	A	L30/72
27	56	A	L30/74
28	21	A	L30/73
28	22	A	U34/31
28	45	S	L29/70
28	53	A	L31/69
28	61	A	L29/72
28	67	L	L32/71
29	60	A	U35/29
29	66	A	L31/71
29	72	L	L30/72
			L31/69
30	12	A	L31/71
30	23	A	U31/31
30	24	A	L31/70
30	32	A	U33/52
30	62	A	U32/25
31	42	A	L32/69
32	45	A	L36/65
34	36	A	L36/65
			L37/68
			L39/68
35	12	A	L36/66
35	35	A	L36/66
			L37/67
			L38/68
36	65	L	L37/68
			L39/68
			L41/64
38	67	L	U38/11
			L40/66
			L40/67
40	20	A	L41/64
40	24	A	L42/64
			L46/66
41	24	A	L48/62
43	12	A	L46/66
			L48.62
43	64	L	L44/64
44	12	A	U46/12
44	16	A	U46/12
44	42	A	L46/66

M.E.W. DATES

Issue No.	Cover Date	Issue No.	Cover Date
1	Summer 1990	29	May/June 1995
2	Autumn 1990	30	July/August 1995
3	Winter 1990/91	31	September/October 1995
4	April/May 1991	32	November/December 1995
5	June/July 1991	33	January/February 1996
6	August/September 1991	34	March/April 1996
7	October/November 1991	35	May/June 1996
8	December 1991/January 1992	36	July/August 1996
9	February/March 1992	37	September/October 1996
10	April/May 1992	38	November 1996
11	June/July 1992	39	December 1996
12	August/September 1992	40	January/February 1997
13	October/November 1992	41	March/April 1997
14	December 1992/January 1993	42	May/June 1997
15	February/March 1993	43	July/August 1997
16	April/May 1993	44	August/September 1997
17	June/July 1993	45	October/November 1997
18	August/September 1993	46	November 1997
19	October/November 1993	47	December 1997
20	November/December 1993	48	January 1998
21	January/February 1994	49	20 March 1998
22	March/April 1994	50	15 May 1998
23	May/June 1994	51	10 July 1998
24	July/August 1994	52	4 September 1998
25	September/October 1994	53	30 October 1998
26	November/December 1994	54	27 November 1998
27	January/February 1995	55	24 December 1998
28	March/April 1995	56	19 February 1999

It should be noted that Issues 1 to 6 were never formally numbered and that Issues 7 to 11, although numbered, did not carry these on their covers.

COMPUTERISED INDEX FOR M.E.W.

The computerised index for M.E.W. continues to be available. It has recently been updated to cover Issues 1 to 56 and is, in fact, five indexes of Articles, Letters, Quick Tips and embedded subjects.

It contains sorting and search facilities, and any or all of the five can be combined as required. An update facility allows the user to add records as new issues are published and a full editing capability can be used to tailor the index to the particular needs of the user.

The index is compiled using Borland dBase IV, with a valid agreement with Borland for its distribution in this form. System requirements are a 286 machine or later with DOS 3.3 and a minimum memory of 640k base plus 1M extended RAM. Running in this configuration could be a little slow, so 2M or more of extended RAM is to be preferred. At least 3.5M of free hard disk space is required. The index comes on disk accompanied by a small instruction manual with flowcharts.

The Model Engineers' Workshop Computerised Index is available from CAHW Systems, 23 Fieldway, Berkhamsted, Herts. HP4 2NX on 1.44MB disks for £18.00 in the U.K., £20.00 non-U.K.

Purchasers of earlier versions of this index should contact the above address for information on an update service.

GEAR HOBBING IN THE HOME WORKSHOP

Part 2 - A DEVICE FOR MAKING GEAR CUTTING HOBS

The next stage of the gear hobbing process is to produce a suitable hob. Dr. Giles Parkes describes a lathe attachment which will form the teeth on a gashed hob blank

1. The device set up to cut and back off the teeth on a gashed hob blank

As discussed by Ivan Law in Part 1 of this series, a gear cutting hob is basically a worm with helical gashes and backed off teeth. The device to be described **(Figure 1)** produces a worm with axial gashes and backed off teeth, the cutting and backing off being done at the same time. The problem of cutting and backing off teeth on helical gashes is beyond me, but this device works, as do the hobs it produces, although not perhaps to professional tool room standards.

A hob with nine teeth on its circumference will need a device to produce it which puts cut on and retracts the tool nine times per revolution. This action is provided by a ninety tooth gear on the back of the catch plate **(Figure 2)** driving, via an idler, a thirty tooth gear mounted on a spindle revolving in a column attached to the lathe bed; this in turn drives a three lobed cam via a flexibly jointed shaft, the cam pushing the tool forward nine times per revolution, with springs pushing it back **(Photo. 1)**.

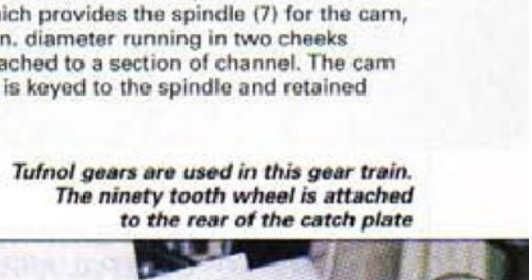
The device

You first require the ninety tooth gear and, being in a chicken and egg situation, you will have to cut this gear one tooth at a time. Great accuracy does not matter in the first instance as you will soon be able to cut an accurate one when you have a hob and hobbing machine. This device is designed to fit a Myford Super 7: Myford gears are 20DP 14.5 deg. Pressure Angle (see Issue 56), so the blank for your ninety tooth gear needs to be 4.6in. diameter. It will need to have its centre removed so that it fits over the lathe register and the nut of the catch plate peg and it is then fixed concentrically onto the back of the catch plate with 2BA screws and $^1/_8$in. spacers. I drilled and tapped the fixing holes first in both gear and catch plate and took the centre out with the gear fixed to the front of the catch plate. That is all the gear cutting done, as you use the Myford thirty tooth gear and any appropriate size gear for the idler.

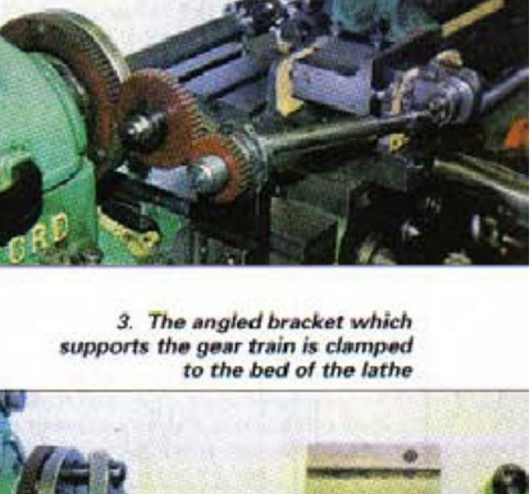
The thirty tooth gear is keyed to a spindle which runs in a column attached to the front of the lathe bed **(Photo. 2)**. The latheway bracket (13) fixes to the lathe bed and supports a horizontal pillar bracket (16) on which the pillar (18) stands. A banjo (17) is also attached to the column to carry the idler **(Photo. 3)**. The universal joint on the gear spindle (19) and the spindle itself are made from $^5/_8$in. bar with a $^5/_{16}$ x $^7/_{16}$in. slot in its end, the $^3/_8$in. spindle being turned on the other end. The other side of the first UJ (24) is $^5/_8$in bar, also with the $^5/_{16}$in. slot. It is drilled axially $^5/_{16}$in. and slotted $^1/_8$in. for most of its length. The lugs of the UJs are cross drilled 3mm or 3.15mm if you must, and just opened out with the tip of a $^1/_8$in. hand reamer. The swivel is made from $^5/_{16}$in. square $^1/_4$in. long and cross drilled $^1/_8$in. in both $^5/_{16}$in. dimensions. $^1/_8$in. silver steel is used for the pins, one of which is $^5/_8$in. long, but the other two are $^1/_4$in. each with $^1/_8$in. knurl on one end. The long pin is pressed in first, using the vice, followed by one short one from each side, knurled end going in last of course. I am told that commercial UJs in this size have only external lubrication, which is what these home made ones are going to get.

The other end of the drive for the cam is a second UJ (25) but this time the long arm is $^5/_{16}$in. round with a hole cross drilled for a $^1/_8$in. pin which slides in the hole and slot in the first UJ long arm (24) **(Photo. 4)**. The other end of the $^5/_{16}$in. is glued into the $^5/_8$in. bar which forms one side of the second UJ, the other end of which provides the spindle (7) for the cam, $^3/_8$in. diameter running in two cheeks attached to a section of channel. The cam (6) is keyed to the spindle and retained

2. Tufnol gears are used in this gear train. The ninety tooth wheel is attached to the rear of the catch plate



3. The angled bracket which supports the gear train is clamped to the bed of the lathe



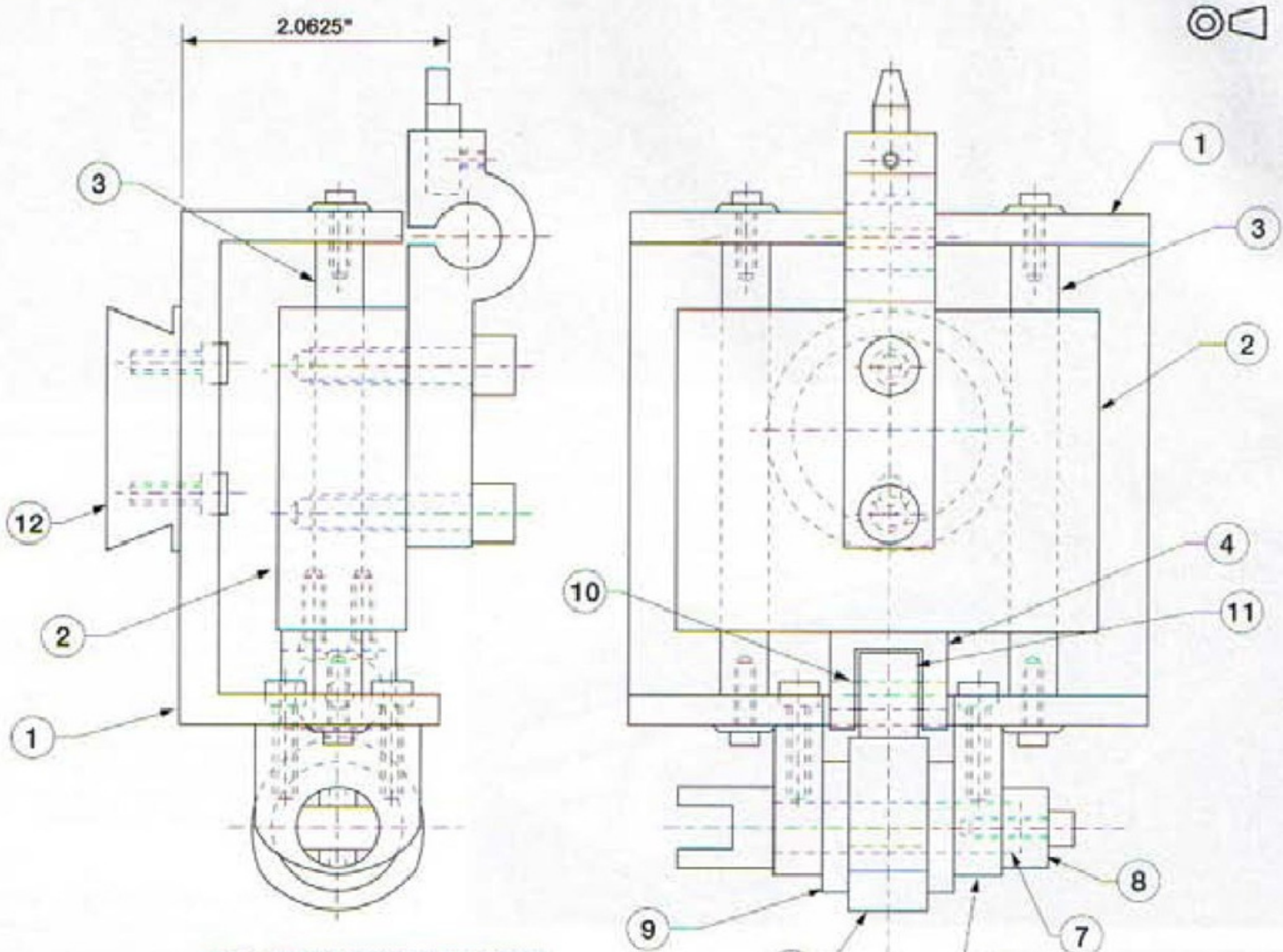


FIG. 1 BACKING OFF TOOL
GENERAL ARRANGEMENT

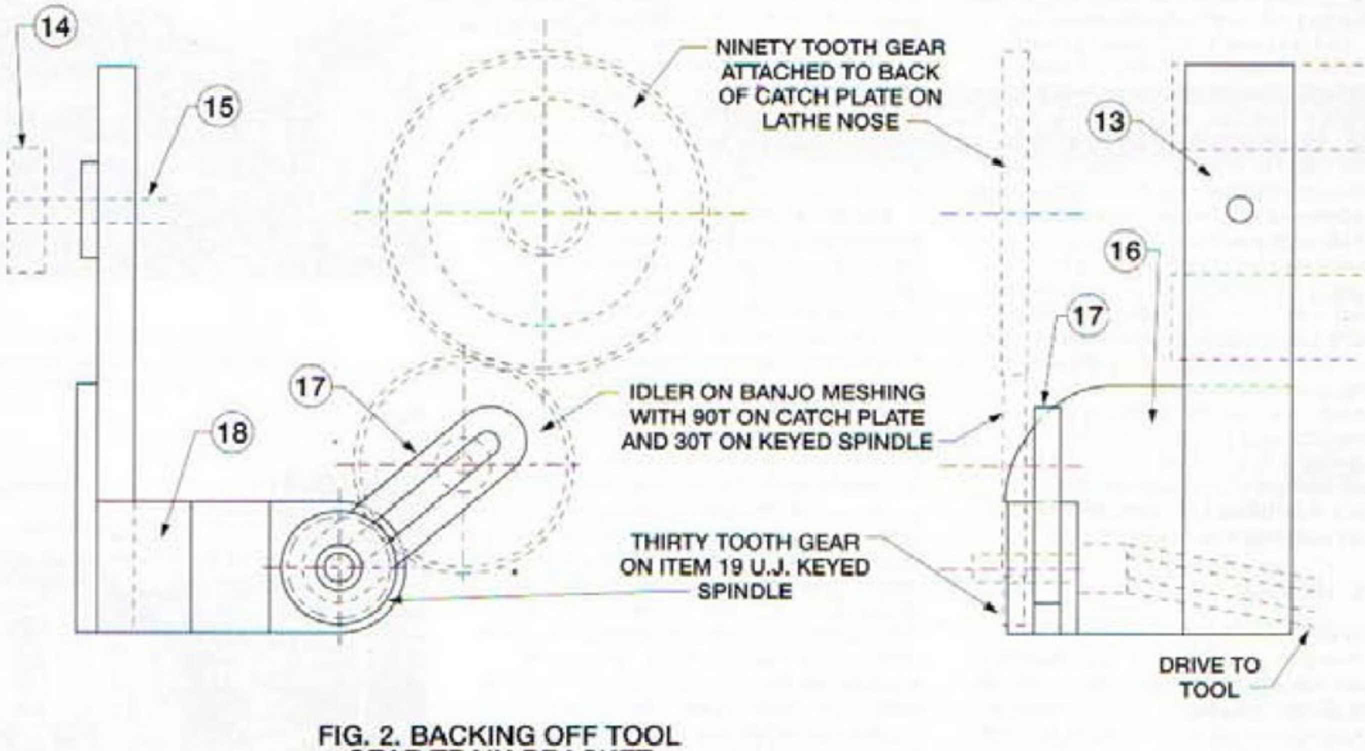


FIG. 2. BACKING OFF TOOL
GEAR TRAIN BRACKET
GENERAL ARRANGEMENT

between the cheeks by a cap (8) on the end of the spindle. Spacers (9) make it all snug **(Photo. 5)**. The cam (6) itself has three high spots and is made from a piece of 1.4in. diameter x 5/8in. mild steel. It is perhaps better left slightly larger on diameter and bored and reamed 3/8in. then a 1/8in keyway cut in it to a depth of 1/16in. A mandrel is made from any conveniently sized piece of hexagon which is turned down and keyed to be a good fit in the cam blank which, when fitted, is turned to 1.4in.. Marks are then scribed on the blank circumference at 120 deg. spacing, but these must be in correct relationship to the flats on the hexagon. With the hexagon in the three jaw chuck and one jaw towards you, clamp a square to the hexagon so that the long arm of the square is parallel to the lathe bed, across the ways; the face of the hexagon should thus be vertical and a line can be scribed on the circumference of the cam at centre height. You may find that the mandrel lock will secure the chuck in exactly the right position. If so, loosen the hexagon and turn it 120 deg. and scribe another line on the cam then repeat for the third line. If the mandrel does not lock in a suitable position another method of dividing will have to be used - e. g. - a mandrel dividing head. We now come to turning the cam throws: pack the jaw of the chuck which has a line on the blank in line with it with a 3mm packing and tighten the chuck. Machine the blank to a depth of 30 thou. and each end of the cut should touch a line. If they do not you will have to increase the thickness of the packing with shims, but do not be tempted to increase the depth of cut. Leaving the packing against the jaw, move the hexagon round 120 deg., repeat the cut for the other two cam faces and you should have a fairly accurate three lobed cam. If the cam faces extend beyond the scribed lines, all is not lost, but you will end up with a slightly smaller cam with a slightly different throw. This can be compensated for by the relative position of the carriage - up to a point! Don't case harden the cam yet as the tips may not all be concentric; stoning the tips when the tool is set up produces a practical solution to the problem, and the cam can then be hardened.

The chassis (1) of the tool is a piece of 4in. x 2in. channel with the bottom machined flat, both inside and out. A slot will be needed in one side for the eccentric device, the cheeks (5) of which are fixed to the side of the channel with cap head screws. A spigot (12) is fixed to the bottom to fit the hole in the Myford cross slide.

The carriage (2) is a block of cast iron. It needs both top and bottom to be machined flat and is then clamped to the Myford cross slide together with the chassis, parallel spacers between to bring the carriage to correct height for drilling. The holes for the two rails are drilled and reamed right through both chassis and carriage. You may have to improvise a long enough drill which will go right through at one setting. I used a normal machine reamer to its full depth first and then a home-made silver steel reamer with an oblique face to follow it for the last bit. Two 3/8in. silver steel or PGMS rails (3) were cut to length and held in the chassis by screws in the ends and washers, after spot facing the chassis holes. The carriage must be a good sliding fit on the rails.

Fixed to the back of the carriage is a bracket (4) for the roller onto which the cam bears. It is straightforward and I used two 5/8in. x 1/4in. roller bearings with a spacer between for the roller (10).

The tool holder is the swan necked device described in MEW No 29 and is held onto the cast iron carriage with 5/16in. BSW cap heads. A second tool holder, with the tool offset from the centre line, makes life very simple for backing off the crests and need not be swan necked.

The return springs on the two rails between the chassis and carriage at the front are each half of the spring from the Myford tool post and seem about the right strength. Obviously the order in which the various parts are assembled is rather important. Finally the tool must be ground to shape; it is important for the tool to have nil or negative back rake and I used an old 1/4in. centre drill, of which I have far too many! The tip width is as for the axial pitch and DP of the hob and the tool is set to the helix angle by a datum flat on the side.

The hob

First and foremost is the question of what material to use for the hob. 20 carbon steel case hardened will probably be adequate for cutting gears in aluminium, brass or Tufnol, so this is where I started. Having made one hob, I progressed to thinking about silver steel and high speed steel. Both are possibilities but the necessary heat treatment is not easy to arrange although it is hoped that one supplier will be able to organise something in this direction. My hob blank is made from 1 1/4in. inch bar of 20 carbon steel which was cut to length - about one inch - and drilled and reamed 3/8in. to fit the hobbing machine hob spindle.

Gashing the hob

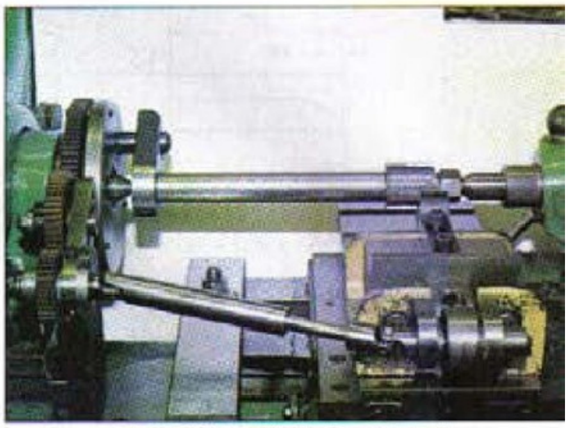
The blank is set up on a mandrel in a dividing device and nine equal axial gashes are cut. The 1.25in. bar has a circumference of 3.928in. and dividing this by 18 gives 0.218in. for each tooth and each gash. To allow for each tooth to be fully backed off, every gash should be slightly wider than every tooth - say 0.225in. for the gashes. Using a 0.075in. slitting saw - because I have one - in the vertical mill, the blank is gashed 0.145in. deep so that the top edge of the cut is on a radial line: the blank is then indexed round for the next cut and so on, until nine are complete. The cutter is then lowered 0.075in. and a further nine cuts made to 0.155in. depth. The cutter is then raised 0.35in. and a further nine cuts made to a depth where the tip of the saw just meets the previous gashes. The cutting edges of the hob will, of course, be the radial slits and it is important that the gashes are marginally wider than the teeth.

Cutting the teeth

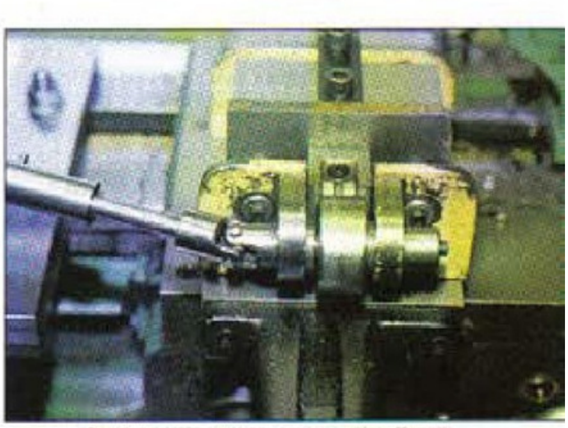
The emergent hob is mounted between centres on a mandrel and the gear train set up for the required DP, module or pitch. What you are basically cutting is a worm with the gashes already in it, but you have a choice; you can either cut the worm first and then gash it and back off the teeth or you can cut and back off the teeth all in one operation on a previously gashed blank. Before you make your choice, consider carefully the Slow Drive Train paragraph below.

To cut the worm first, the tool is set up in the normal toolpost and set over to the helix angle of the worm and the worm is cut in the normal way to correct tooth depth, and the worm is then gashed. The tool is then set at the correct helix angle in the spring tool holder on the backing off device which is set up on the cross slide and geared to the mandrel. You have to fiddle with the tumbler gears with the leadscrew engaged so that the tool will cut evenly on both sides of the worm and you also have to fiddle with the engagement of the idler with the catch plate gear so that the tool begins to retract just after it reaches the back edge of the tooth. This fiddling is best done by turning the mandrel with a handle and with the back gear disengaged; it may be unorthodox but you will soon get the idea, and it works. (Incidentally, the cross slide is always returned to the right by disengaging the back gear and turning the mandrel handle). You then put on the cut so that it is only just cutting on the back edge of the tooth and continue to put on cuts at one thou. increments until the cut starts at the front edge of the tooth. Zero the dial and continue backing off to full tooth depth. Do not disengage tumbler or leadscrew, as you still have to back off the crests of the teeth.

I prefer the second option and cut and

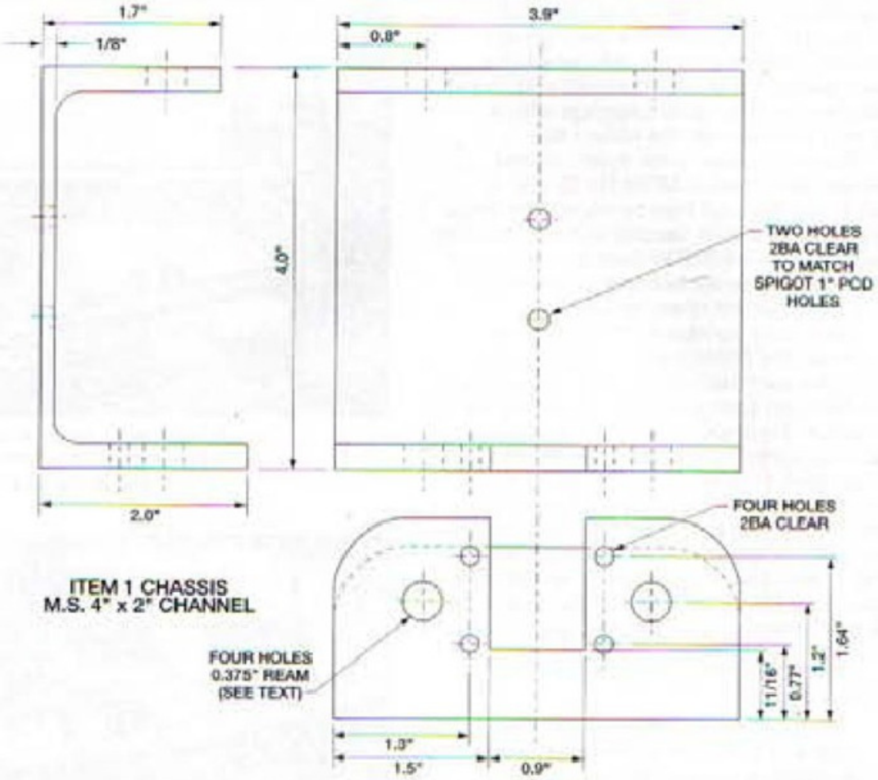


4. A telescopic shaft, equipped with universal joints, transmits the drive to the cam

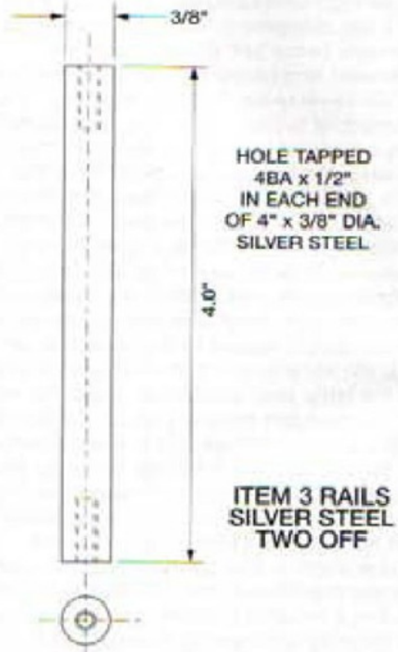


5. The cam bears on a roller fitted to the end of the tool holder.

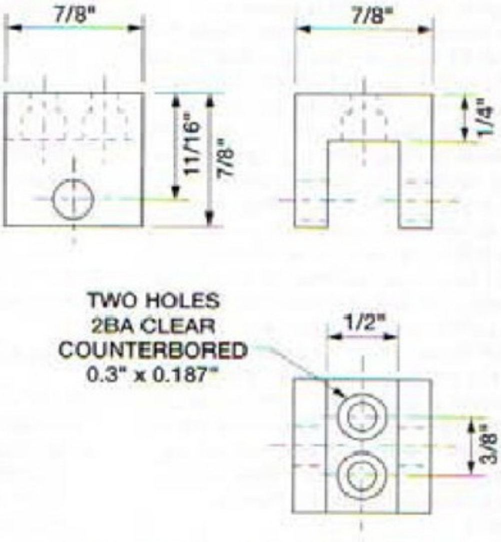
©



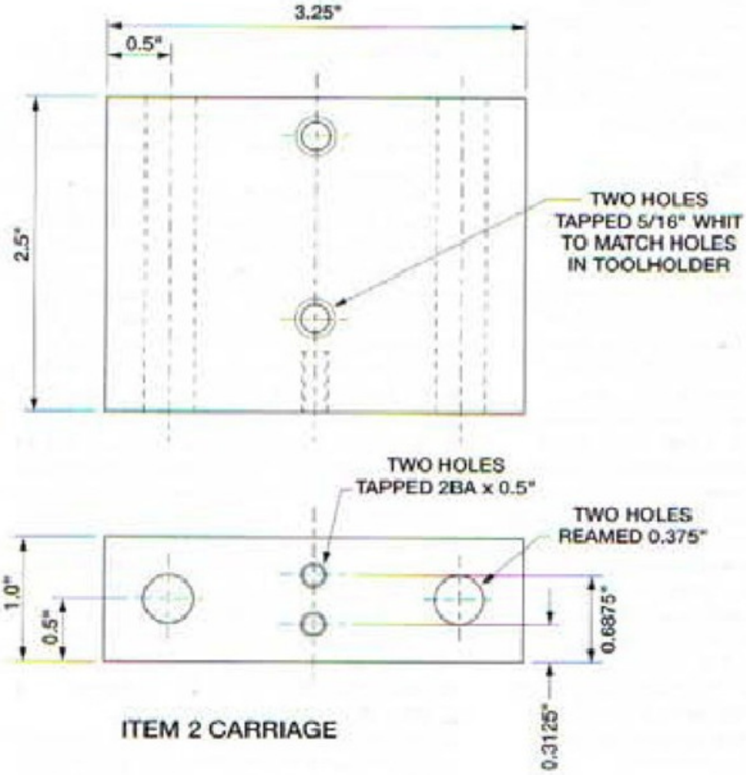
ITEM 1 CHASSIS
M.S. 4" x 2" CHANNEL



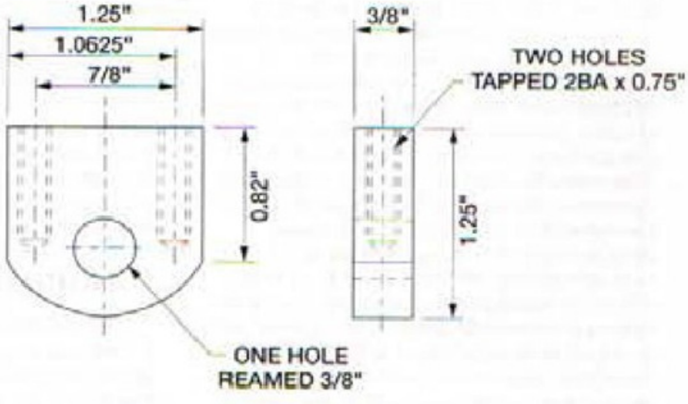
ITEM 3 RAILS
SILVER STEEL
TWO OFF



ITEM 4 ROLLER BRACKET
M/S



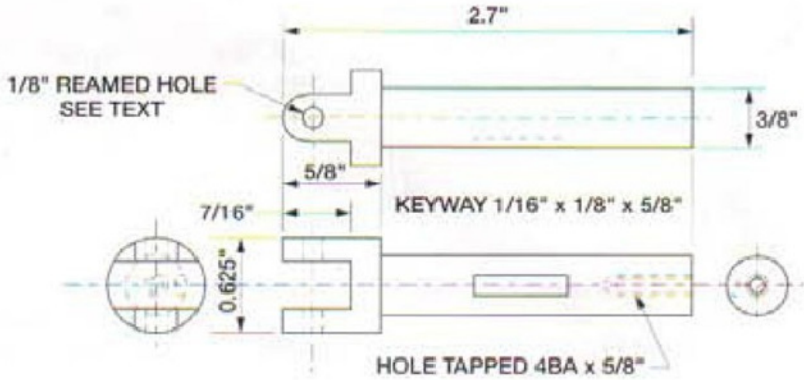
ITEM 2 CARRIAGE



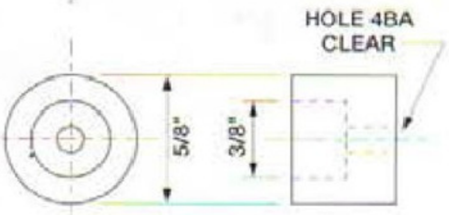
ITEM 5 CAMSHAFT CHEEKS
TWO OFF M/S

©

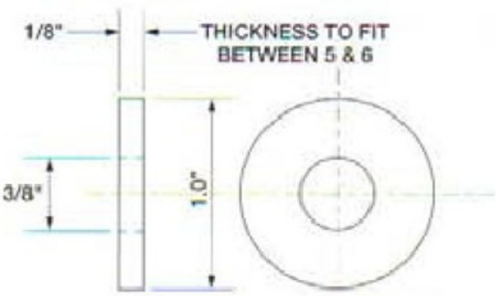
ITEM 6 CAM
CASE HARDENED



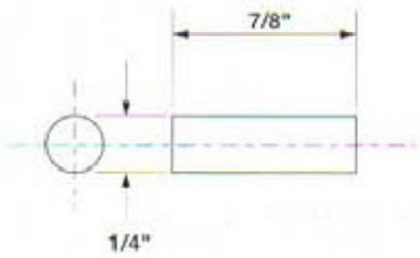
ITEM 7 CAMSHAFT
M/S



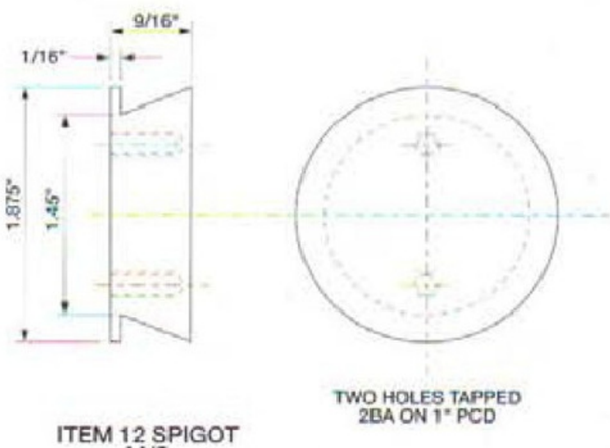
ITEM 8 CAMSHAFT CAP
M/S



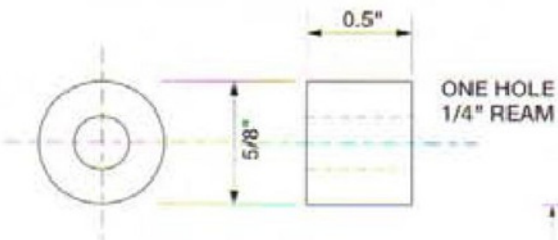
ITEM 9 SPACERS
M/S TWO OFF



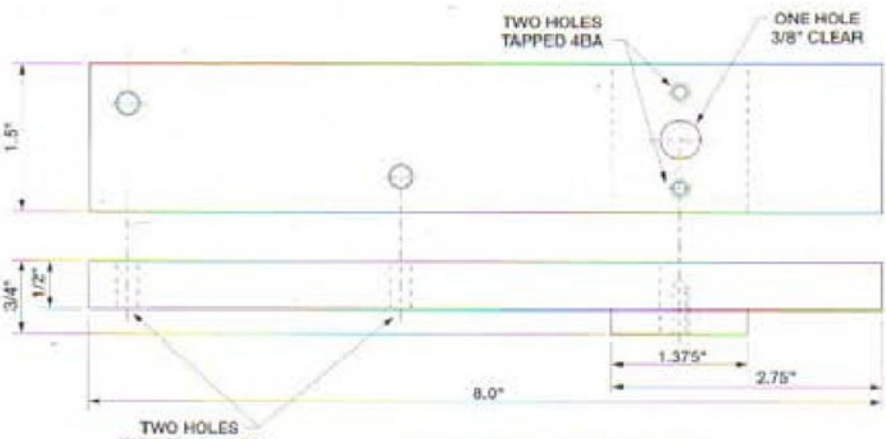
ITEM 10 ROLLER SPINDLE
M/S



ITEM 12 SPIGOT
M/S

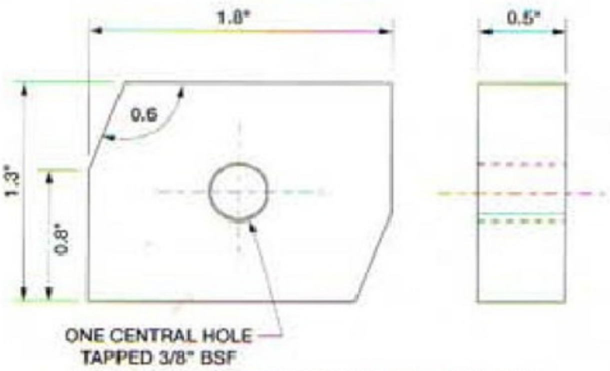


ITEM 11
ROLLER

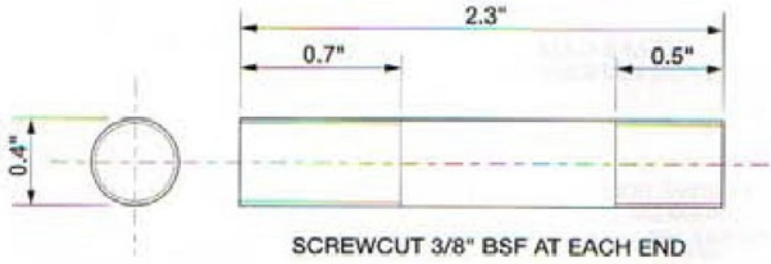


ITEM 13 LATHEWAY BRACKET
M/S

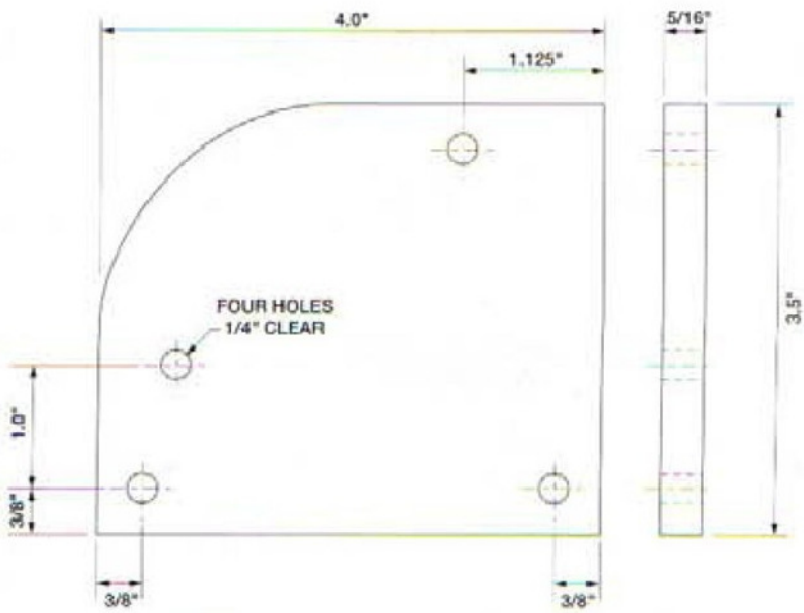
©



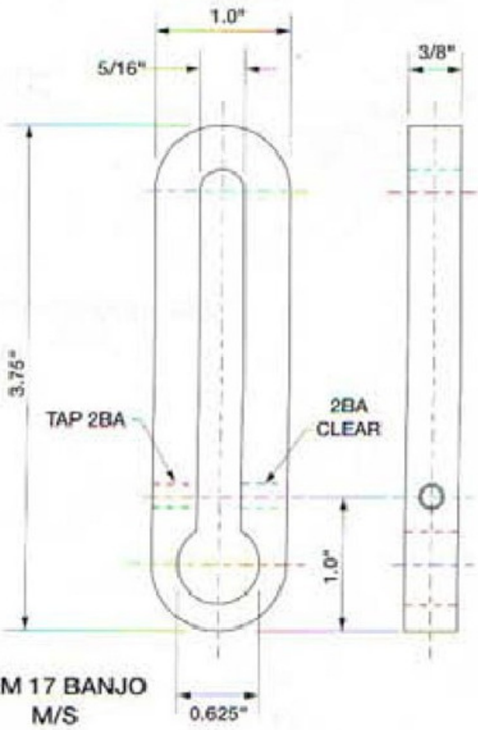
ITEM 14 LATHEWAY BRACKET CLAMP
M/S



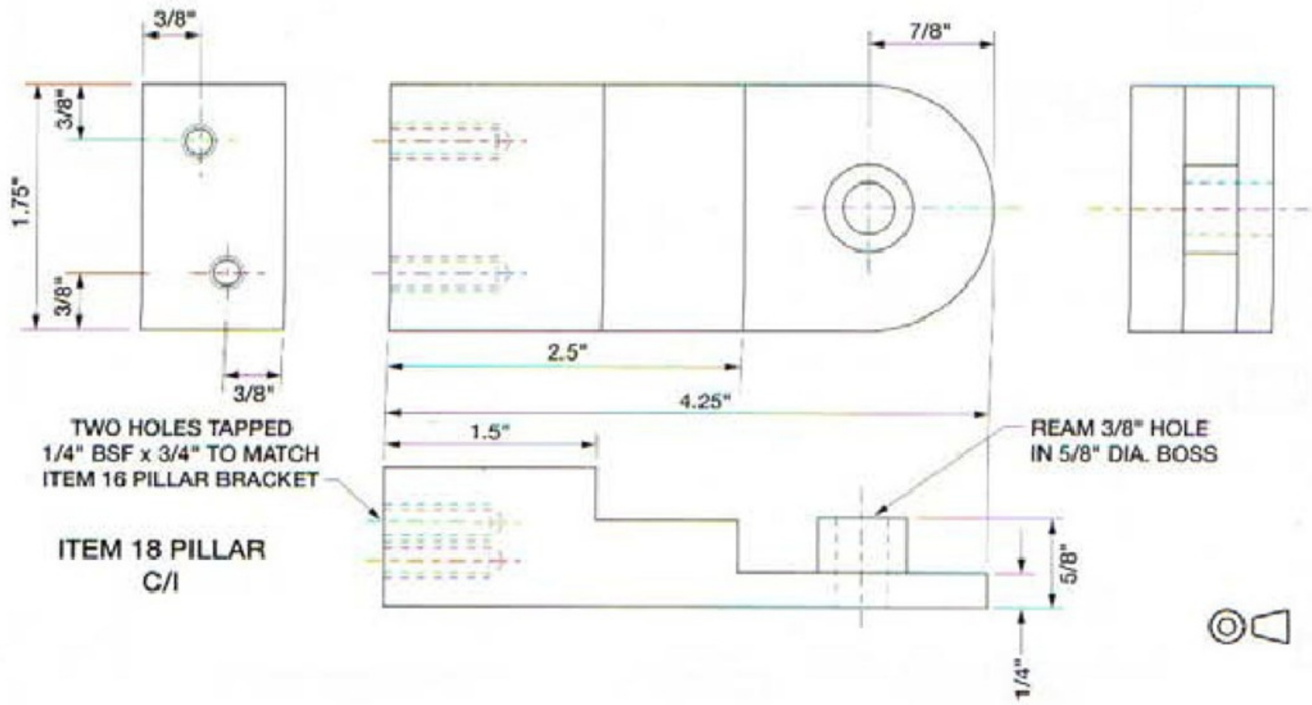
ITEM 15 CLAMP STUD
M/S



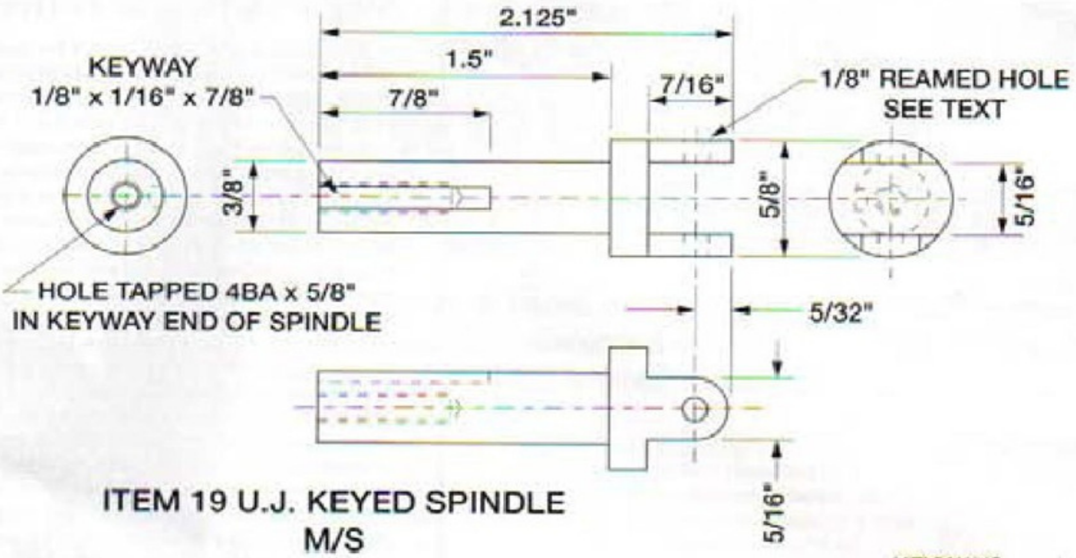
ITEM 16 PILLAR BRACKET
M/S



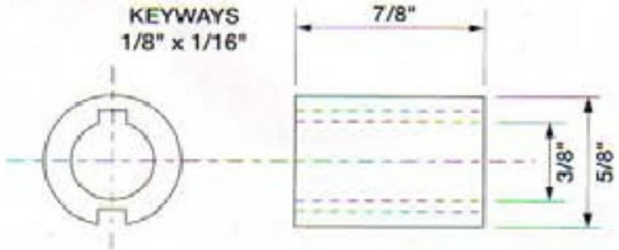
ITEM 17 BANJO
M/S



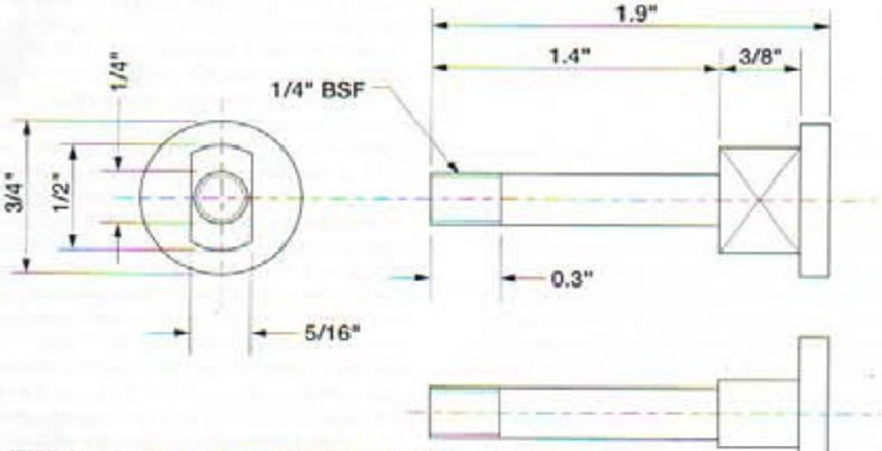
ITEM 18 PILLAR
C/I



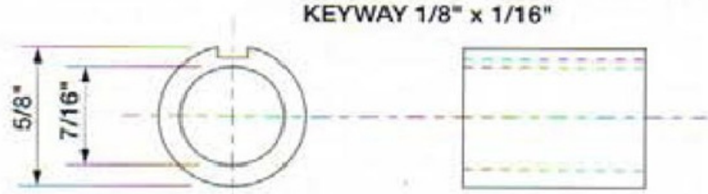
ITEM 19 U.J. KEYED SPINDLE
M/S



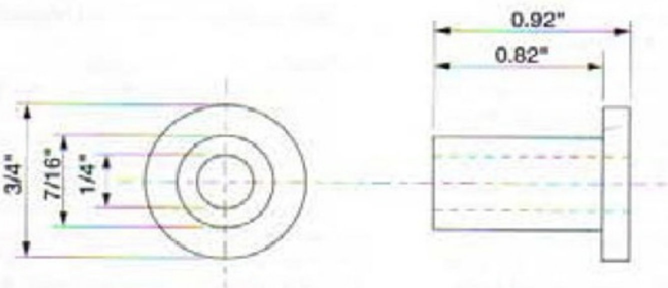
ITEM 19 DOUBLE KEYED BUSH
M/S (TO FIT ITEM 19)



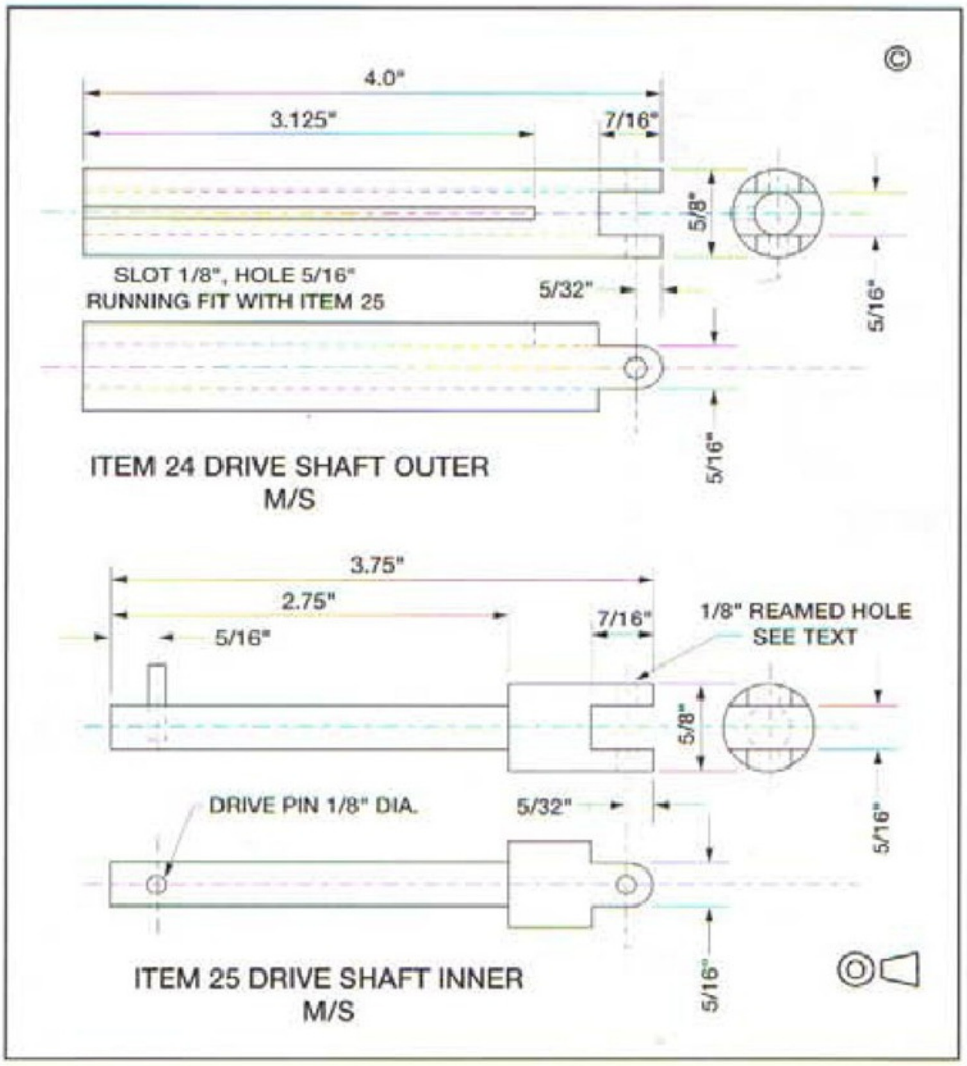
ITEM 21 CHANGEGEAR SPINDLE
M/S



ITEM 22 CHANGEGEAR BUSH
M/S



ITEM 23 CHANGEGEAR SPINDLE BEARING
PH/BRONZE



back off at the same time. With the hob on the mandrel between centres and the backing off device on the cross slide, the catch plate and idler gears have to be meshed so that the tool starts to retract just after passing the back edge of the tooth, as before, and I find it easiest again to use the mandrel handle with back gear disengaged. In this second method, the leadscrew is not engaged until cutting starts. The cross slide is now positioned to the right of the work and the tumbler and leadscrew are engaged and both are left engaged until the job is finished. A first cut of about one thou. at the back edge of the tooth seems sensible and the mandrel can be turned by the handle for the first traverse. The tool is withdrawn via the cross slide screw and the saddle is wound back to its starting position. The next cut is put on - about two and a half thou. - and this time the back gear lever is engaged and the clutch let in: at the end of the cut the clutch is disengaged, the tool retracted, the back gear lever is disengaged and the saddle is again wound back by hand. The back-gear lever is engaged again by fiddling with it - it is well worth making an extension to the back gear lever to bring the knob to a handy position - the next cut put on and away you go again. When the tool starts its cut at the front edge of the tooth - dial reading about 30 thou., - zero the feed dial, carry on cutting in one thou. increments until the required depth of tooth is reached and you almost have a hob. Do not disengage the half nuts or the tumbler.

The next job is to back off the crest of each tooth with a wider flat ended tool. I found it convenient to remove the tool holder and replace it with one in which the tool is offset to one side in the holder by about the pitch of the worm, so that it cuts the crest of each tooth. The cross slide dial must be zeroed again with the tool just touching the back of a crest and it is obvious that the tool must be narrow enough to cut only one crest at a time! The whole procedure is then repeated as before until the tool starts its cut at the front edge of each tooth. If all is well you can now disengage everything.

My hob was then casehardened and I sharpened it on a Stent tool and cutter grinder because I am lazy and have neither the skill nor the elbow grease to sharpen it with a stone.

I have since made several hobs from machinable high speed steel which have subsequently been hardened professionally and they seem to be excellent. The original case hardened hob is still my favourite and I have cut spur gears in all materials with it, including cast iron and steel, the latter being done in twenty thou. increments to depth. Softer materials are cut at one pass.

Left hand hobs are cut just as easily, as in cutting a left hand worm, but the tool will need to be ground for that purpose. The worm wheel on the Helix /C.E.S. hobbing machine requires a left hand hob, but that is another story.

Single tooth gear cutters

This device is equally useful for backing off the teeth on single tooth gear cutters. Without modification, the gear train will back off nine tooth cutters and, by modifying the train, cutters with teeth that are multiples of three can be done - e. g. 12 and 18. A button tool is used to cut the requisite profile on the circumference of the blank which is then gashed with the requisite number of teeth and held on a mandrel between centres. The button tools described previously in M.E.W. No 7, pp59 - 63, and No 41, pp52 - 55 can be fixed on the carriage and the device used without the leadscrew being engaged. I fixed the buttons to a spring tool holder to avoid jams. Every tooth is backed off on every revolution of the headstock - as opposed to the Eureka Tool which cuts only one tooth on each revolution - so the lathe must be run very slowly to avoid a sort of machine gun effect. I used a mandrel handle for the purpose, but have now set up a slow drive train.

Slow drive train

It has been pointed out that the vibration caused by the reciprocating movement of the carriage and tool could upset the alignment of the lathe saddle with the lead screw and half nuts. The speed and frequency of the reciprocation seemed to be the cause of the concern and this, of course, is dependent on the rpm of the mandrel. The bottom back gear on the Super 7 gives a mandrel speed of 27 rpm and, without sophisticated electronic devices, it is difficult to lower this. The same objective can be achieved by an additional drive motor. I had a spare 1450 rpm 1/8 hp motor and so I fitted it with a pulley of 1.65in. outside diameter and section to match the Myford motor pulley. The motor was fixed in such a position as to allow it to drive the 4.3in. Myford motor pulley - the main motor switched off, of course, thus giving a mandrel speed of about 10.3 rpm in bottom back gear: I am advised that driving the main motor pulley with the additional motor has no ill effect on the main motor and the set-up works well: there is no longer danger of the machine gun effect!

Set up for 20DP hob 14.5 degree PA

Gear train;
Super 7, no gearbox:- Mandrel 55: banjo 35/40: leadscrew 50

Super 7B with gearbox:- Mandrel 55, two idlers, input 35, gearbox 4A
Myford leaflet No. 712U gives trains with gearbox for DP and Module.

Tool;
29 deg. included angle with 0.048in. tip width, nil or slight negative back rake.

Depth of tooth; 0.108in.

A similar version of this device was first shown to me by Mr John Buckley of Helix Engineering. I am very grateful to him for the idea- all I am responsible for is a few minor modifications of detail and adapting the device to fit the Myford lathe.

1. A collection of discarded items has been brought together to make a useful machine

A SURFACE GRINDER MADE FROM ODDS AND ENDS

Most owners of home workshops take a delight in making something useful out of other peoples' discarded equipment. Hubert Peters, being no exception, relates how he built a small surface grinder

I suspect that every model engineer is an inveterate hoarder. I cannot pass by a car boot sale, an exhibition or a club event, without investigating the odds and ends offered for sale. One never knows when that object may come in useful - some year! Workshop storage is thus cluttered with junk, as it is known by the less perceptive!

I visited a nearby club event some while back and, amongst other 'junk', acquired a compound slide - probably part of a long-defunct plain lathe. I duly smuggled this into the workshop, and decided that this was a good time to review the extent of my collection. I have often wished for a small surface grinder, and amongst the 'junk' I found all the components:-

The vertical milling attachment from my venerable Emco VP10 lathe (without the milling head, which is now attached to the overarm of my horizontal milling machine).

The Emco toolpost grinder. (I have seldom used this on the lathe, because of the difficulty of keeping grit out of the bedways.)

A small Eclipse magnetic chuck, acquired many years ago in some deal, and never used.)

The compound slide mentioned above.

A piece of bright steel, 1in. thick x 8in. wide.

My first problem was to replace the leadscrew action of one of the slides with a more rapid motion. I thought of a rack-and-pinion replacement, but even my collection did not contain a suitable example. I then considered the lever system used on hand shapers, and decided that this would be a reasonable method of providing the reciprocal motion. This system of levers needed careful design, to avoid trapping. I am a poor draughtsman, and so I resorted to a model made of chipboard **(Photo. 2)**. This method must appear crude to a real designer, but it worked well for me!

The heavy plate formed a good foundation for the little machine, and it was easy to bolt the vertical post to the base, after facing the bottom of the casting in the milling machine.

Attaching the toolpost grinder to the block which previously held the milling head, proved to be more complicated. I turned a copy of the circular end of the milling head from a spare chuck backplate casting. The two bolts which run in the circular slot, allowing the milling head to swivel, were quite difficult to make, as the arc of the head of the bolt must match the diameter of the existing slot. I first turned the bolts and then bolted them into a square bar which, when held in the four-jaw chuck, enabled me to match the diameter of the slot. It was then easy to cut the taper, using the topslide. I am glad to say that these tricky bolts work perfectly - having samples to copy was a great help.

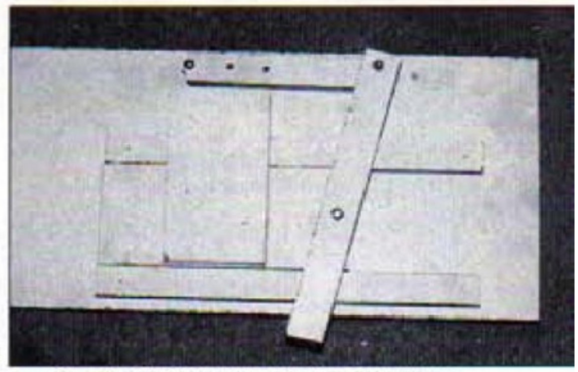
I took the easy way of attaching the toolpost grinder to the swivel - by using an existing angle plate. Not very elegant, but quickly completed.

I then made the lever system using $^3/_4$in.x $^3/_8$in. bright steel, following the dimensions of the wooden model, and was delighted to find that the system worked efficiently. The lever was completed with an old file handle.

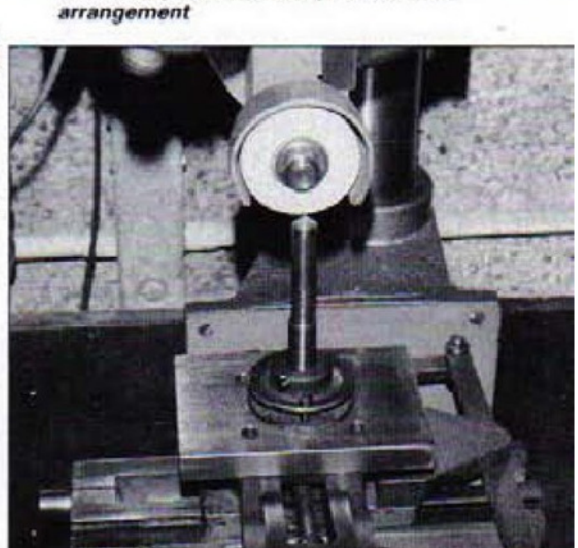
Now that the toolpost grinder was mounted on the swivel, it was easy to find the optimum position for the compound slide. Once in position, a little judicious scraping was necessary to achieve a smooth traverse, without shake. I removed the toolholder from the compound slide, and replaced it with a plate large enough to accommodate the magnetic chuck.

Now came the moment of truth - would it work? It did! After grinding the first trial piece, I found that the machine was not grinding parallel. I used the grinder to true up the 5 $^1/_2$in x 4in. plate - quite a large surface for the little grinder but, taken slowly, all was well and the plate is now true, with a gleaming finish. The next trial piece was still not true, and I therefore ground the face of the magnetic chuck, and all is well, with the result exactly parallel.

I soon needed to dress the grinding wheel and found that an old iron vee pulley, bushed to hold the stem of the diamond, made a quick, if inelegant holder **(Photo 3)**.



2. The chipboard mock-up of the lever arrangement



3. The diamond wheel dresser is not terribly elegant, but is effective

By chance, I conceived this surface grinder before the publication of the most informative series of articles in MEW by Alan Jeeves. I am very grateful for this information, as I am a novice at surface grinding.

I have written this short account, without any constructional details, as any other similar 'lash-up' will depend on the available equipment. This is a very small machine of limited power, but it greatly extends my workshop abilities - especially when faced with hardened steel. It has also opened up large spaces in which to store still more 'junk'!

I hope that this short account will encourage other model engineers to view their collection of odds-and-ends with a new eye

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

A range of tool holders can be fitted to the dovetail location, including the widely used pattern which accepts $\frac{3}{8}$in. square tools. Additionally, a new range of parting tool holders can be accommodated, the standard version of which houses a $\frac{5}{8}$in. x $\frac{3}{32}$in. wedge section blade mounted with a 4 deg. downward location. Two blades are available, one with 3 deg. top rake incorporated, suitable for machining steel, and the other with no top rake.

Myford Rear Tool Post for Interchangeable Tool Holders

A number of turning operations can be carried out conveniently by using a rear mounted tool. These include parting off, facing and chamfering, generally requiring the tool to be mounted square to the lathe axis. Myford have introduced a new rear tool holding system which accepts interchangeable tool holders of the Dickson pattern, thus allowing a variety of tools to be mounted with repeatability of location.

The unit consists of a Base which incorporates a tenon for accurate location in a long cross-slide and features a three bolt clamping arrangement. A spigot on the top surface of the Base provides an accurate location for the Mounting block which, once set in the required angular position, can be clamped by the rear tee bolt.

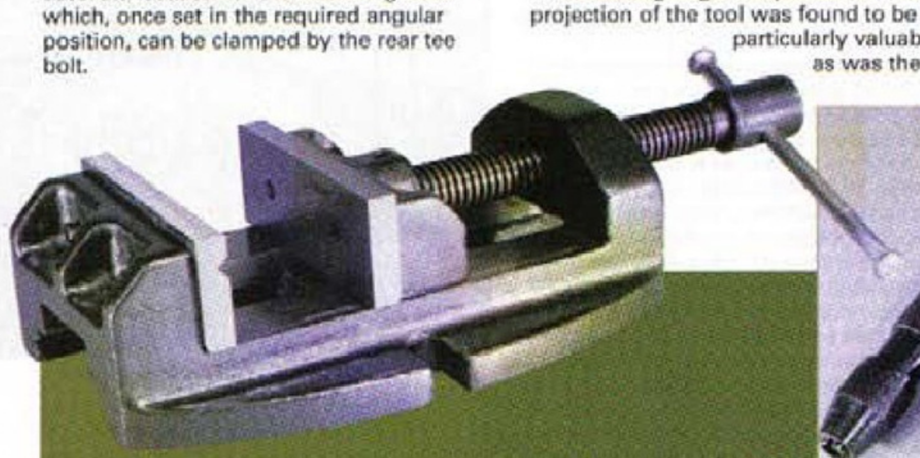
A second holder is designed to take smaller section ($\frac{5}{16}$in. x $\frac{1}{16}$in.) taper blades and has a horizontal blade location, making it particularly suitable for parting small diameter brass. Completing the set is a holder for a double ended ISCAR tool holder which houses an inserted throw-away tip and is intended for use on larger steel sections.

Tested on a Myford Super 7, the unit was found to incorporate a high degree of rigidity combined with an ease of tool adjustment which, once set, could be relied upon. The ability to adjust the height of the cutting edge independent of the projection of the tool was found to be particularly valuable, as was the facility of removing the tool completely to improve access and reduce the chances of injury to knuckles when handling the workpiece. The unit thus provides the advantages of a rear mounted tool system with minimal encroachment on workpiece space or accessibility.

Basic sets are available for Myford Series 7, Series 10, 254+ and 254S/R lathes and consist of a Base, a Mounting Block, a Parting Blade Holder and a $\frac{5}{8}$in. high speed blade, together with the necessary wrench and hexagon keys. The common price for each of the basic sets is £95.52 including VAT. The small parting blade holder is £27.50, a matching blade with no top rake costing £4.03.

The large holder for the ISCAR blade costs £27.95, the blade itself £61.17 and a suitable tip £9.04. A holder for $\frac{3}{8}$in. square tools is available at £20.48.

Myford Limited, Wilmot Lane, Chilwell Road, Beeston, Nottingham NG9 1ER Tel. 0115 9254222 Fax. 0115 9431299 Email: Myford@btinternet.com



Drill press vice offer from Chronos

Chronos have notified us that they are now distributors for the Neal range of drill press vices, and have forwarded a sample for examination. This example is very well finished and features an adjustable keep plate below the movable jaw, thus making it possible to reduce jaw lift to a minimum. The jaws are hardened and ground, with a vee in the stationary jaw. A parallel test piece was held firmly, the jaws closing squarely. The screw features a square thread of good appearance and there was no perceptible shake in the threaded body.

The vice performed well when used for the intended duty and the suppliers claim that it could be used for light milling, but no attempt was made to use it in this way.

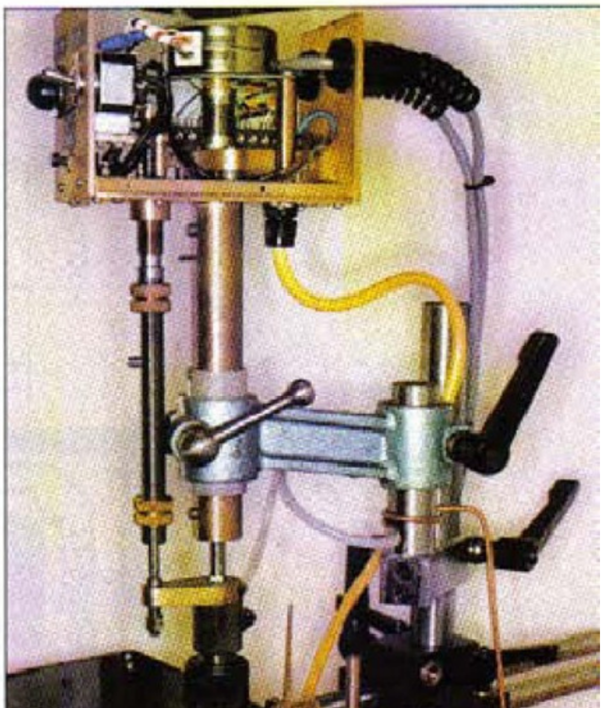
Two models are currently available, the Neal80, which has a jaw width of 3in. and an opening of 3 $\frac{1}{2}$in. and a larger version, the Neal100 which measures 4in. on both dimensions. The former costs £22.00 including VAT and carriage (UK mainland) and the latter £24.95.

As a special introductory offer to readers of M.E.W., Chronos are offering (while stocks last) a free set of four pin vices in a plastic storage wallet (worth £7.95). Mention the magazine when placing your order.

Chronos Limited, Unit 8 Executive Park, 229/231 Hatfield Road, St. Albans, Herts AL1 4TA, Tel. 01727 832793 Fax. 01727 848130 Email: chronll@aol.com

SPARK EROSION MACHINE

In his article 'Future Projects', published in Issue 52, Peter Rawlinson outlined the design of a spark erosion or electrical discharge machine. He starts the detailed description of the unit by providing information on the electronic control system and the printed circuit board on which many of the components are mounted.



1. The completed spark erosion machine

As a first article on the Spark Eroder (**Photo. 1** - subsequently to be known as the 'S. E.' to save typing), I thought that I would start with the electronics that are required to operate the drive mechanism and, in particular, the printed circuit board (PCB) which is at the heart of this part of the machine.

Although I was a Mechanical Design Engineer by profession, employed in the heavy engineering side, I acquired a knowledge of electronics as I was a ham radio operator for many years, call sign G8BJR (High Frequency only - I had no 'sense of rhythm' for Morse). I also had to be conversant with power electrics for part of my work. On the amateur side, I found no problem with valves, but never got on with transistors. In those days there were no such things as 'chips', not silicon ones, anyway.

With regard to the electronic side of this project, I have borrowed heavily from other sources and acknowledge these with gratitude. The main design of the electronic circuitry and the basic PCB is the work of Robert Langlois of Ontario Canada (published some while ago in that most excellent American journal 'Home Shop Machinist'), and to him I am most indebted. I have also drawn heavily on his test procedures, but have checked these with my own working circuit boards. The PCB has been redrawn to incorporate my own ideas and to accommodate parts available in Britain. I have also incorporated a plug-in system.

If any reader has doubts about the competence required, be assured that it can be readily built by anyone with average home workshop skills, but I would suggest that the best way is to work in groups with complementary talents, an arrangement which should help when solving any problems. Working together should also make it possible to reduce the costs.

Control circuit

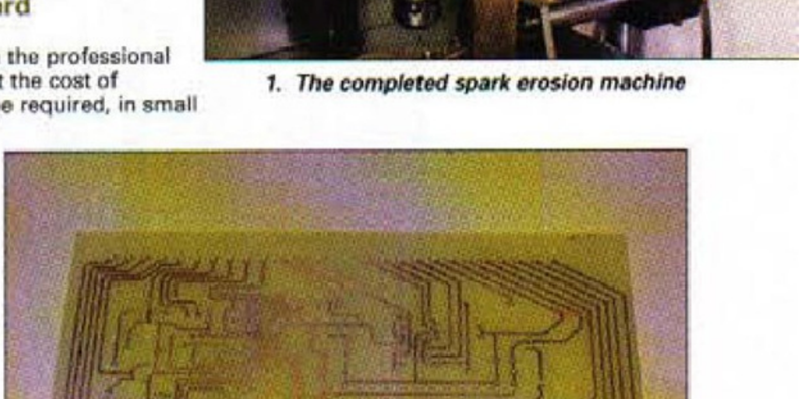
The electronics which control the movement of the electrode by means of the stepper motors are shown theoretically in **Figures 1, 1a and 2**, the last of these being simply the rectification circuits which convert the AC supplies into the necessary 5 and 12 volt sources. The AC power packs will be detailed in the next article.

Printed Circuit Board

Having checked with the professional companies, I found that the cost of making PCBs of the type required, in small quantities, is completely prohibitive, so I decided to have a go at making my own.

For those who do not wish to go to the trouble of making the PCB, a pre etched and drilled board will be available, as will a fully populated and tested board, but more of that later.

As a matter of interest the board has 273 drilled holes of either 0.8mm or 1.4mm diameter. Mine were drilled on the CNC mill which I described in recent issues of M.E.W.



2. The etched printed circuit board. The name is included as an aid to orientation. Substitute your own for posterity!

As I had not previously made a PCB, I was starting from scratch. As always, I hope that my mistakes will help you to avoid similar problems. My first actions were to read the excellent articles in M.E.W.s Nos. 26, 27, 33 and 34 by Ray Stuart and a book called 'How to design and make your own PCBs' by Mr R. A. Penfold. The above are very good and I do not intend to rewrite them or to take extracts, but just to give a little guidance where I can, from the amateurs point of view.

The printed circuit board in question (**Photo. 2**) is too complex to lay out other than by the use of a computer aided drawing package and even then is likely to be very time consuming if a dedicated software package is not available. At the time of doing this, I had just got my first standard CAD system and was enjoying the experience of making mistakes. It took therefore an inordinate amount of time to complete the layout and it has since been modified a number of times to give the final configuration.

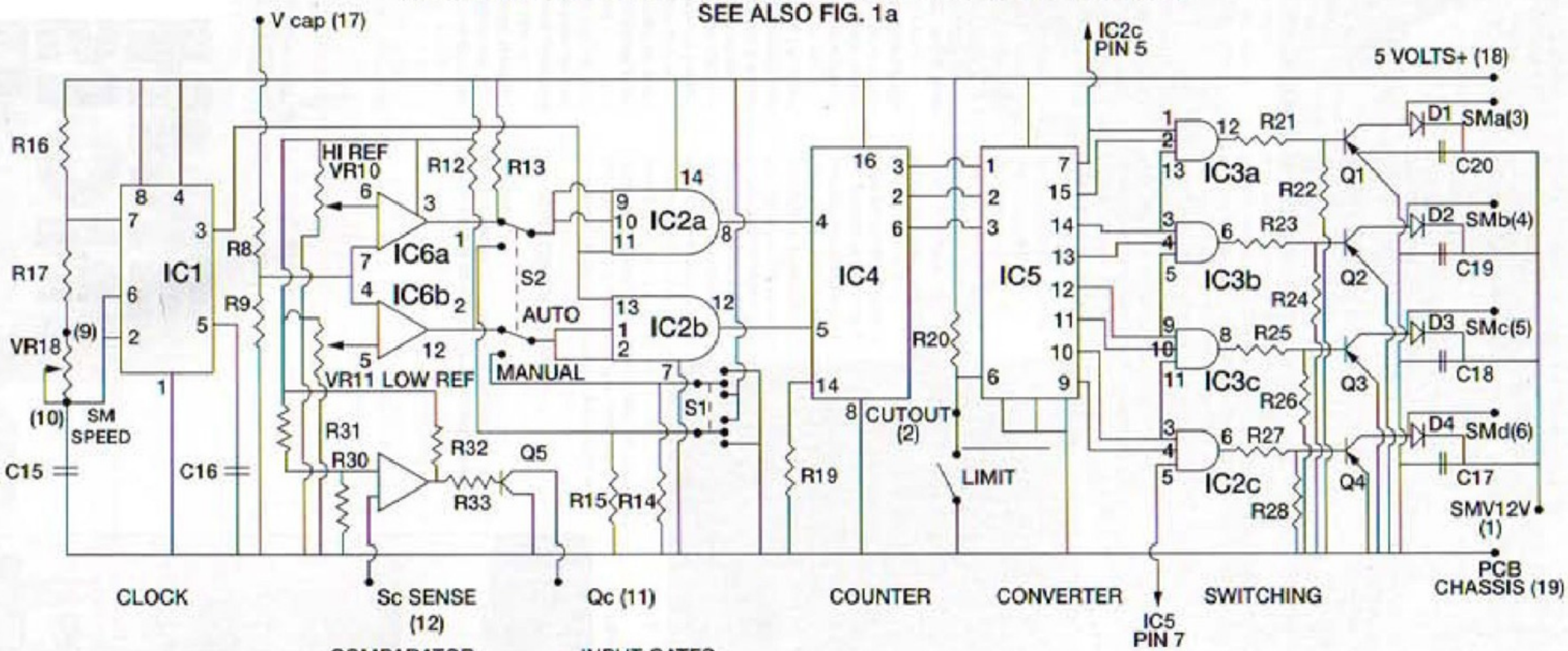
The layout (**Fig. 3**) is full size and the dimensions shown on it must be adhered to or the various components will not fit in the drilled holes. I have made arrangements for Wren Engineering to be able to supply an etched board or fully built board. However, for those who would like to have a go themselves, a negative can be made by taking the magazine to a good copy house which can print onto film.

I believed that the simple way to transfer the image to the pre-sensitised board to be similar to that I used when printing photographs as a child, that is to sandwich the negative and the board between a piece of flat glass and a piece of board and to the let the sun do the work.

FIG. 1 CONTROL CIRCUIT

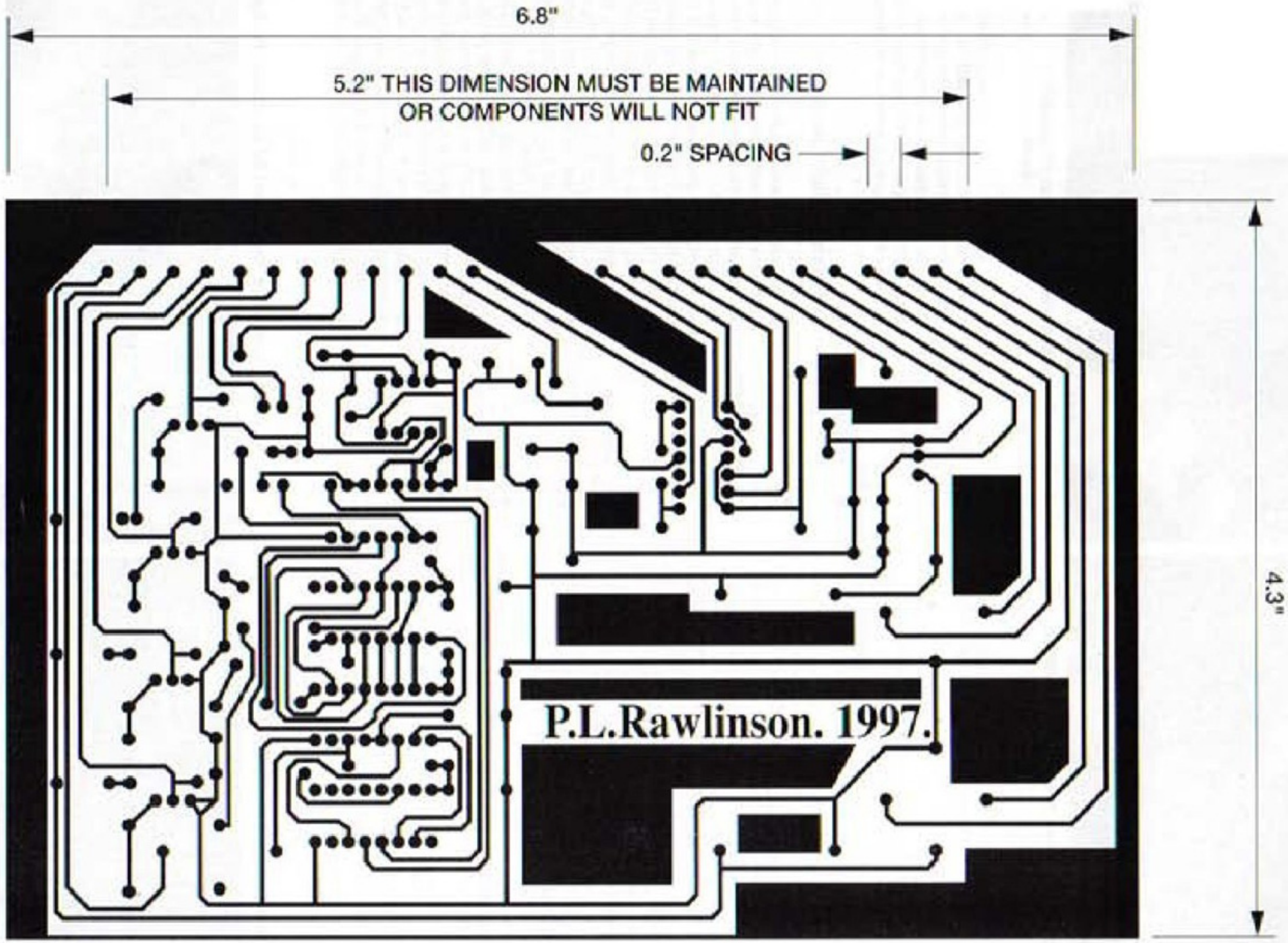
(BASED ON A DESIGN BY ROBERT LANGLOIS OF ONTARIO, CANADA)

SEE ALSO FIG. 1a



NUMBERS IN BRACKETS INDICATE POSITIONS ON TERMINAL SOCKETS 1 & 2

C17 TO C20 MOUNTED CLOSE TO STEPPER MOTOR

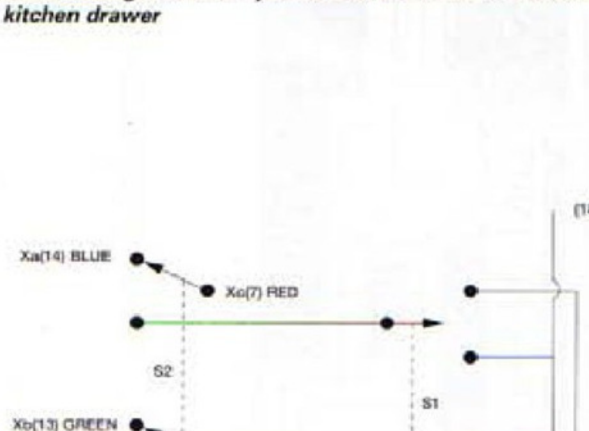


MATERIAL: SINGLE SIDED FIBREGLASS BOARD
CHECK COMPONENT SIZE BEFORE DRILLING ETC.
NOTE! NAME ON BOARD MUST BE READABLE
WHEN COPYING ONTO P.C. BOARD

FIG. 3. P.C. BOARD LAYOUT

3. The uv light box components were housed in a modified kitchen drawer

4. The bulb holders are mounted on a base board added to the front section of the drawer



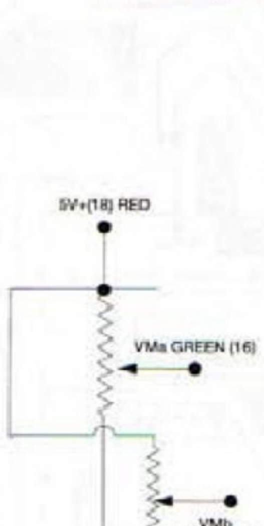


FIG. 1a SWITCH & POTENTIOMETER WIRING (SEE FIG. 1)

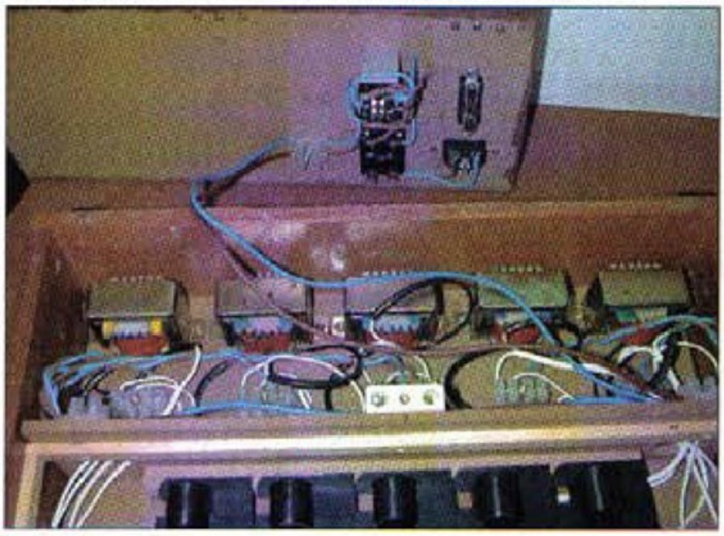
However, I found that this did not work and, after a number of abortive attempts, gave up. One attempt ended up with no tracks and copper where no copper should have been - in other words a negative.

Ultraviolet light source

I therefore decided that the only way was to acquire an ultraviolet light box, but on checking found that the price can vary between about £120 and £200, dependent on the size, so decided to make my own. I started looking for components and found switches, pilot lights, cable, rubber feet, a carrying handle, 0 to 30 minute timer, plugs, sockets, plastic card, hinges, catches and my 'friend up the road' contributed an old kitchen drawer of exactly the right size, which even looks the part (mahogany) **(Photo. 3)** - so far all for free!

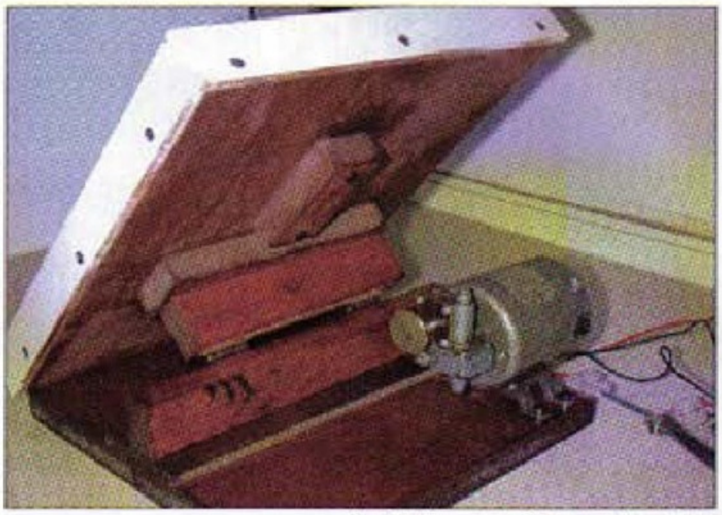
I still needed some electrical bits and pieces and a piece of flat plate glass, the latter being readily available from the local merchant. I started sifting through the catalogues for UV bulbs, starters, chokes and bulb holders. All were found with the exception of the bulb holders, so I had a problem. I then started looking at the job from another angle and found, in the

5. Chokes and other components go behind the divider



6. Plate glass and a foam lined lid complete the light box

7. A simple rocking table assists the etching process



8. The 'works' of the rocking table

Maplin catalogue, an ultraviolet light source. The complete unit cost just over £6 and consisted of a 4 Watt UV bulb, bulb holders, plug, switch, cable, choke, starter, capacitor and case. Five of these were purchased (Part Number MW36P at £3.25 + VAT each), and after completing the box I still have four switches and four 13 amp plugs and cables for future use.

I do not intend giving a blow by blow account as the unit is simple to build, but I have included a circuit **(Figure 4)** and a series of photographs to give a general idea of the layout. The units were taken apart after checking that all were working, then the parts cut on the band saw - a base board was cut to fit in the drawer and it was also fitted with a vertical divider. On the bulb side, three battens were fitted on the base and the bulb holder sections screwed down, the bulbs being set at 50mm centres **(Photo. 4)**. The chokes were screwed behind the divider (making sure that the divider was drilled for the cables before it was fixed) **(Photo. 5)**.

Wired up as the diagram and fitted with plastic card as a reflector, strips were then fixed to the inside to support the glass, remembering to give room for the foam plastic used to press the PCB material on to the negative. The foam is of course glued to the hinged lid of the box **(Photo. 6)**.

The UV box will light an area of 115mm x 270mm, but I was surprised to find that the light does not seem to spread past the ends of the glass bulbs, so be warned. A greater spread of light should be possible if the glass to bulb distance (20mm) is increased. It is also possible that a silver type reflector would give a better spread of light, but this must be of a type as used with halogen lights, having a crinkled surface so that the light is spread evenly.

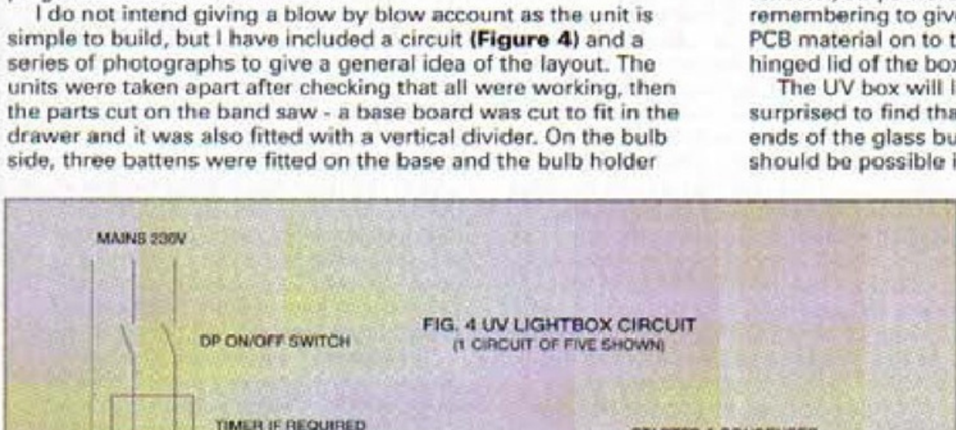


FIG. 4 UV LIGHTBOX CIRCUIT
(1 CIRCUIT OF FIVE SHOWN)

For a total of £35 I now have a box which works very well and which would cost over £150 commercially. For those who don't have such a deep junk box, many savings can still be made. Timing could be carried out using a watch, dispensing with the need for a timer, and such items as pilot light, handle and rubber feet could be omitted.

A false start

For the printed circuit board, I originally purchased standard board and a spray with

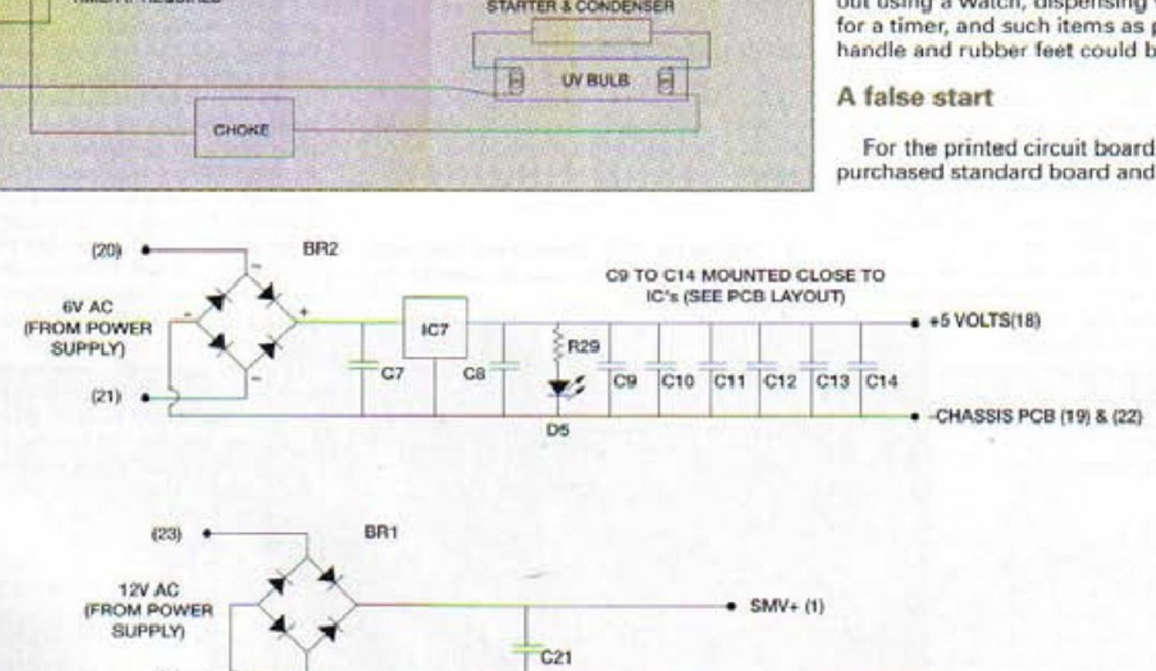
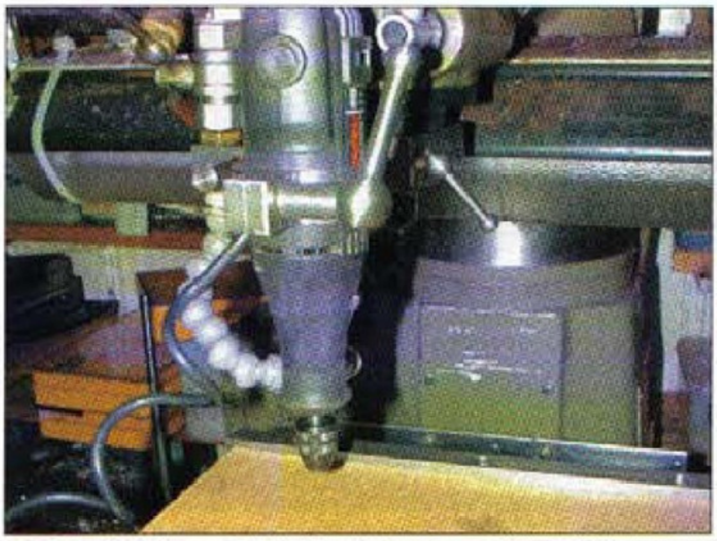
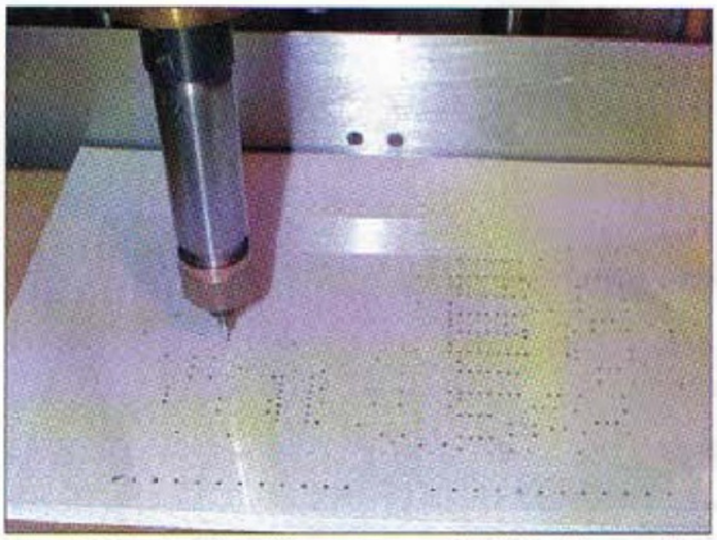


FIG. 2 RECTIFIER CIRCUITS



9. A small high speed drill adapted for use on the mill/drill



10. Proving the drilling program on the CNC milling machine

which to sensitise the surface, but found it difficult to get anything like an even coating. In the end I gave up and purchased a large board which is pre-sensitised and which only requires cutting to size. It has a protective cover which is peeled off immediately prior to use.

My 'negative' was printed using an inkjet printer, but problems were experienced with the ink not drying completely. Even after some weeks it was still smudgeable. I have been since advised to use thin drawing paper, but would be happy to hear of other solutions if they are available. The problem I can foresee with drawing paper is that because it is more opaque, it will require a longer exposure in the UV box, and this may allow the light to creep under the tracks. I have now been advised that they can be photo copied onto 'copier friendly' acetate.

Safety

Here let me say a few words about safety:- Do read all the instructions carefully and keep the hands out of the chemicals. Carry out all operations away from children, animals and food stuffs. Dispose of waste materials as directed on the container or check with the manufacturers. Dot expose your skin or eyes to the UV light for more than a few seconds or, better still, not at all. I suggest that a pair of locking forceps or similar are used to handle the boards throughout the process. Mine are extremely old and were originally used for removing hooks when fishing!

Exposure

I started out with some trial pieces of board about 30mm square, and it was found (using film) that a 10 minute exposure was required to give satisfactory results. I now think that another couple of minutes would have been better, but at least it gave a starting point. I then went on to prepare the full size board, and no problem was experienced.

Developing

It is necessary to follow the directions for the particular developer being used, as all seem to vary slightly. Maintain the recommended temperature by putting the dish of developer into another dish of hot water, and top up the outer dish from a kettle as required. Gently stir the chemical over the board, using a soft haired brush. Keeping the fluid moving helps to dislodge that material from the sensitised surface which has been destroyed by the chemical action. After a few minutes the board will start to look like the negative, with the tracks still covered and bright copper showing at all other places. At this stage take the board out and inspect carefully then, if all is in order, rinse thoroughly under running water to stop the chemical reaction.

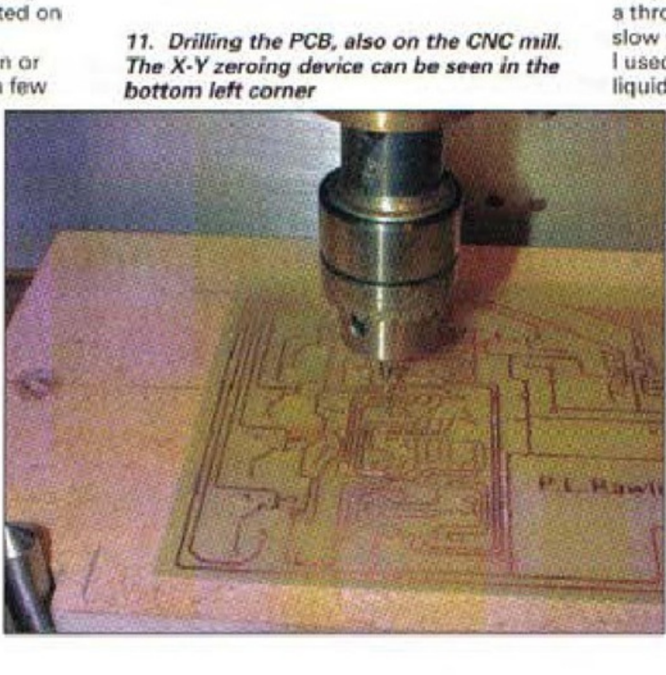
Etching the board

We now come to the etching process, for which a different chemical is used. As can be imagined, it is a much more aggressive one as it must eat away the copper. It is basically ferric chloride, but others are available, and I used the one from Maplins called PCB Etch Powder, Part No. MC49D. It is easy to use, is economic and will keep for several weeks. Mix according to the instructions and maintain at a temperature of 45 deg. C when etching. I used the same system as for the developer which required the outer tank to be emptied and refilled regularly to maintain the temperature. Of course, some kind of thermometer is essential and a glass one is ideal, but I have a fish tank digital type with a plastic sensor which was immersed in the chemical. It did a good job, with no problems, and is still OK, but whatever you do, make sure everything is washed well before storage.

The etching time was found to be considerably longer and indeed, each of my boards took 65 minutes to etch fully, although with the change in design this should now be much quicker, but it does give some idea of the time involved. The chemical should be kept stirred and the best solution would be to make a simple rocking table, using a board hinged to a base and a small model motor operating at some 20 rpm to give the rocking motion through a connecting rod, attached to give a throw of 5 to 6mm. It should cause a slow waft of the fluid across the board, but I used a small soft haired brush to keep the liquid moving. This appears to be very important where large surface areas of copper are involved as the etching always seems to start from the edges and, of course, if the large areas take a considerable time, then the edges of the tracks could become undercut. A suitable tilting table, which is now in use, is shown in **Photos. 7 and 8**.

Regular inspections of the board were carried out and when etching was complete it was removed from the chemical and washed thoroughly, using the forceps rather than fingers.

I then cleaned the board with a 'Garryflex' block which is a block of some 70 x 40 x 20mm, made up of a rubber compound impregnated with abrasive. These I generally use for metal finishing and they can be



11. Drilling the PCB, also on the CNC mill. The X-Y zeroing device can be seen in the bottom left corner purchased in various grades. The etch resist is removed sufficiently to give a bright copper sheen to the tracks.

It is next necessary to inspect the board closely to determine if any tracks are missing or conversely if any shorts are apparent. I checked with a magnifying glass and an ohmmeter and found one piece of track, about 2mm long, missing. This omission was corrected during the soldering in of the components. Two places were found where the etch had not cleared the material between the tracks, a fault more difficult to solve, but I ground the back edge of a scalpel blade to act as a hook scraper and this worked very well. It was also used where solder over- ran, and has now been put away carefully with the soldering gear for future use.

We now come to the drilling of the holes. Most of these are 0.8mm dia., but some are be larger, so it is best to check the components before commencing. If a small high speed drill like a Dremel is available, then it is worth making an adapter to mount it on the quill of your milling or drilling machine **(Photo. 9)**. After standing to drill a few holes, I decided to program my CNC mill to do the job **(Photos. 10 and 11)**; it was an interesting exercise but not really worthwhile for the two boards which I made.

A tip which should help is to make certain that, where possible, the rows of holes are parallel to one edge and to set a stop so that the board will slide along, requiring therefore manual positioning on one axis only.

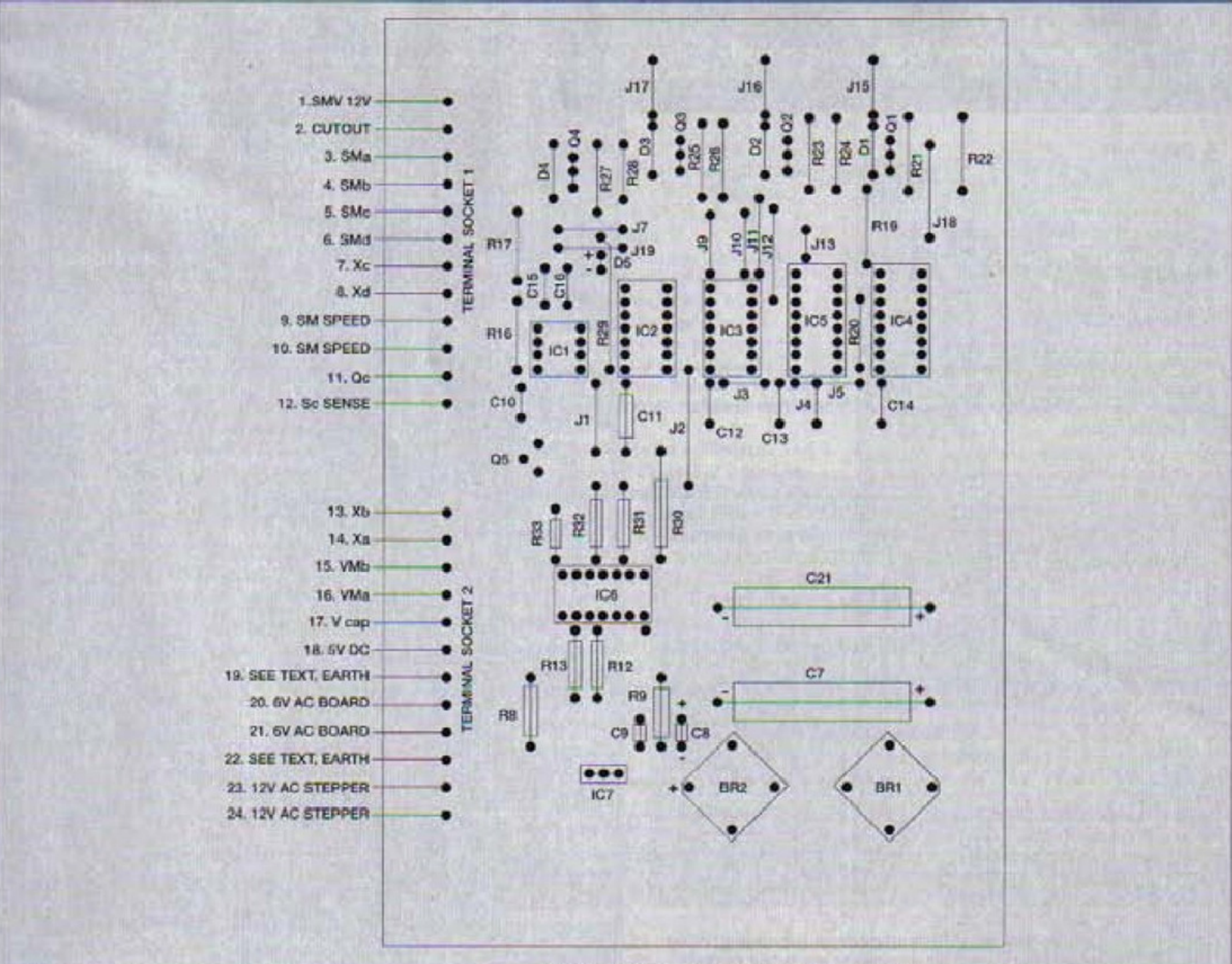
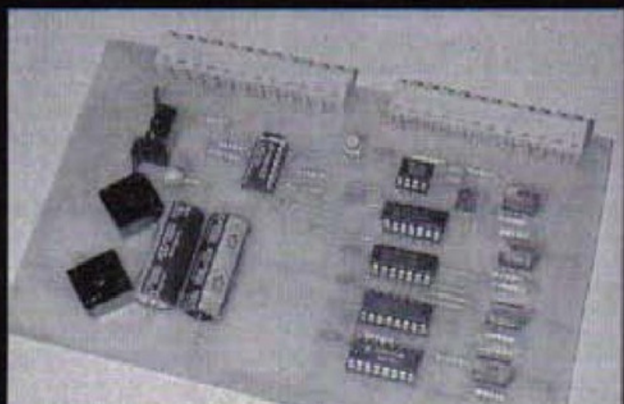


FIG. 5 PRINTED CIRCUIT BOARD COMPONENT LAYOUT

Adding components to the board

We now come to the fitting of the components, and this I did in a specific order for ease of working and to protect the components as much as possible. By the way, I understand that the current term for fitting the components is 'populating' the board. The position of the components is shown in **Figure 5** and **Photo. 12**.

Transistors are very susceptible to damage by excessive voltage, from the effects of static electricity and by heat. It is therefore wise to take some precautions, but I think that the highest priced transistor or integrated circuit that we use costs only about 62p., so no huge amounts of money are involved.



12. The populated board

Precautions:-

Make sure that the soldering iron is earthed.

Earth yourself (A wire round the wrist to a water pipe is all that is needed).

Keep the iron on the component for a maximum of three seconds.

Use a heat sink and short out the pins where possible. Use ordinary tweezers with an elastic band on them so that they will stay closed.

I made a simple jig from three pieces of MDF to hold the board, then soldered in the following order:-

1. Jumper leads
2. Resistors
3. Sockets
4. Capacitors.
5. LEDs.
6. Diodes.
7. Rectifiers
8. Transistors
9. Power Devices.

Many of the components have to be orientated in a specific direction, as follows:-

Diodes	Have a silver band which goes to the right of the board (output sockets at top).
LED	Flat to left of board.
Rectifiers	Positive DC pins to outer edges of board.
Chip sockets	These have a notch at one end. Nos. 1, 2, 3, 4, & 5 to the left, No. 6 to the top of the board.
Output Transistors	Metal plate to the bottom of the board.
Voltage Regulator	To the left of the board.

To clarify the above see the component layout drawing. What must be remembered is that the components are fitted to the 'back' of the board (i. e. the side without the copper tracks), so the layout of **Figure 4** is effectively a mirror image of that seen in **Figure 3**.

I populated the board completely first, without soldering, and then removed all but the jumpers. A piece of sponge foam was then used to hold the jumpers in place, the board turned over and then soldered. This is good practice as the components cannot be damaged. After trimming with sharp cutters close to the board, the joints were inspected to make sure that a good fillet of solder was present at each junction before following on in the same manner with item groups 2, 3 and 4.

It was next necessary to use a heat sink (tweezers) to arrest the travel of heat to the component and to also short out the pins. If you are worried, wrap a piece of copper wire around the legs, adjacent to the component, but do make sure it is removed before applying power! If a transistor or component is damaged, then cut the item off above the board and deal with each wire individually. This will help to obviate damage to the track on the PCB.

Parts List

Printed Circuit Board Materials (Maplin numbers quoted)

Pre-sensitised board	FA63T
Developer	YJ38R
Etchant	YX12N or MC49D
Etch resist pen	HX02C

Control circuit components (Type nos. and Maplin Nos. quoted except where stated)

Integrated Circuits and Transistors			
IC 1	LM555 QH66W	Farnell 409-327	
IC2, IC3	SN74LS10	YF08J	
IC4	SN74LS193	YF81C	
IC5	SN74LS138	YF53H	
IC6	LM339N	UH31J	
IC7	LM7805CT	AV16S	
Q1, Q2, Q3, Q4	TIP140	Farnell 426-830	
Q5	2N2222	UH54J	
Diodes			
D1, D2, D3, D4	IN4002	QL74R	
D5	Red 5v. LED	CK46A	
Rectifiers			
BR1, BR2	FarnellBV706-929		
Resistors			
R8	100K Q100K		
R9	4.7K Q4.7K		
R12 to R17	1K Q1K	(19 off)	
R19 to R28			
R32 & R33			
R29	470 Q470		
R30	2.2K Q2.2K		
R31 & R37	10K Q10K		
R35 & R36	4.7K Q4.7K		
R38	1K Q1K		
Potentiometers			
VR10 & VR11	10K Linear 0.2 Watt		JM71N
VR18	100K Linear 0.2 Watt		JM74R
Capacitors			
C7 & C21	1000µF 50v	AT19V	
C8	20µF 50v	WW73Q	
C9 to C20	0.1µF 50v	BX03D	(14 off)
Switches			
S1	DPDT Toggle (On - On		
FH00A			
S2	DPDT Toggle (On - Off - On)		
FH03D			
Heat Sink			
For IC7	TO220 KU51F		
Plugs and Sockets			
For IC1	8 Pin DIL	FJ63T	
For IC2, IC3 & IC6	14 Pin DIL	FJ64U	
For IC4 & IC5	16 Pin DIL	FJ65Y	
Terminal sockets 1 & 2	12 way	NE55K	
Terminal plugs 1 & 2	12 way	NE27F	

AN ADJUSTABLE TOOLPOST FOR THE UNIMAT

Bob Loader describes a simple toolpost which should make tool setting easier

I expect that there are plenty of Unimat users who, like me, use the standard toolpost. I expect too, that they sometimes get exasperated looking for the last piece of shim to centre the tool just right.

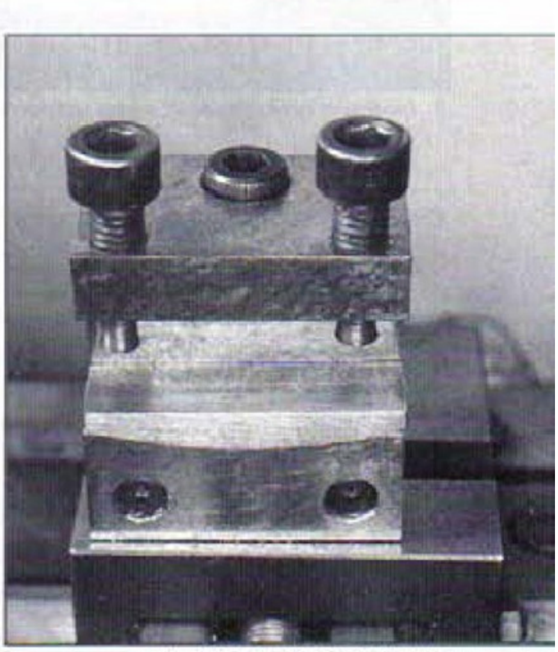
It is mostly my own fault for not making a Unimat sized toolpost with some adjustment. One like the excellent quick change one described by Harold Hall in Issue 50 would be ideal and I'm sure it could be made to fit the Unimat 3 with a bit of scaling.

Unfortunately, there is always another job which is more urgent or more attractive. I have though, sat down and thought out a quickly made one to tide me over until I can make a better one. It uses stock materials and the standard bolts and tee nut from the original one. There is some adjustment, because it is a cross between a single toolpost and an American one. American toolposts were the type we used on SouthBend bench lathes when I was an apprentice. It had a central stem, slotted to take the tool shank. The tool sat on a rocker which could be rocked to raise or lower the tool edge slightly to get it on centre.

There were disadvantages. Using the rocker too much could change the tool angles, and using a straight tool made cutting close to the chuck bad news for the front of the compound slide, which bore the evidence, from slight rub marks to deep gouges. We avoided knocking lumps off it by using cranked tool holders - not always convenient.

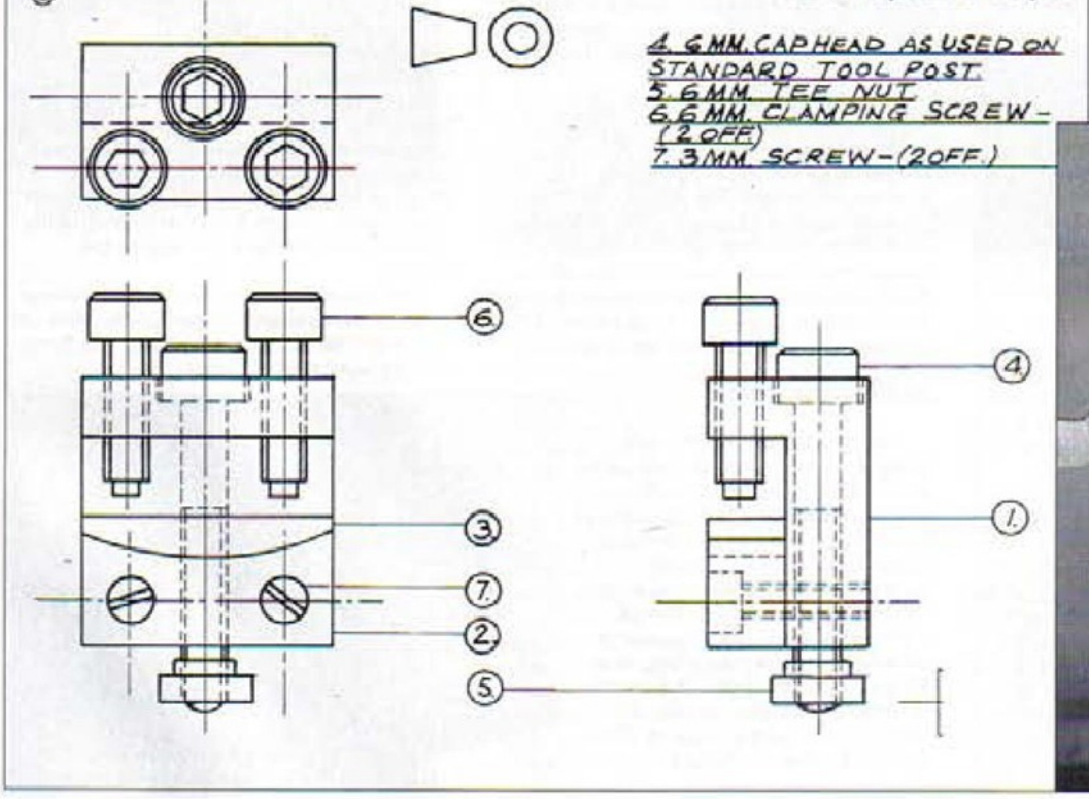
Fig. 1 shows the assembly. **Photo. 1** is the completed job and **Photo. 2** a tool set correctly. **Photos. 3 and 4** show what can happen if too much 'rock' is used, exaggerated a little, but I have seen settings almost as bad. Better tool selection or packers under the tool help to make things right.

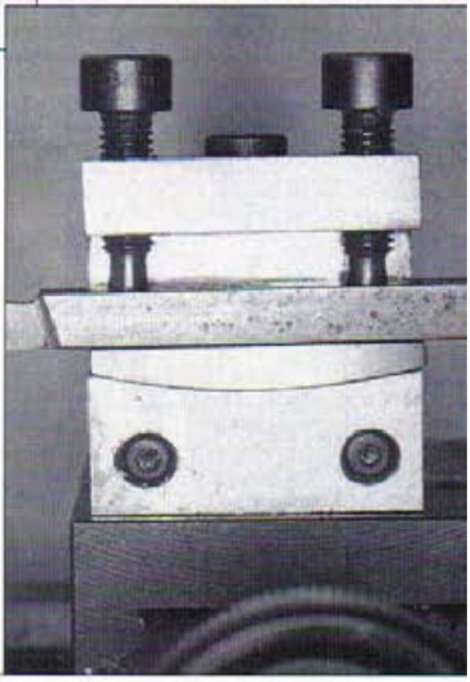
Notice that the spigots on the clamping bolts are overdue for trimming the mushrooming off: imagine if there were no spigots and the bolts had to be taken out!



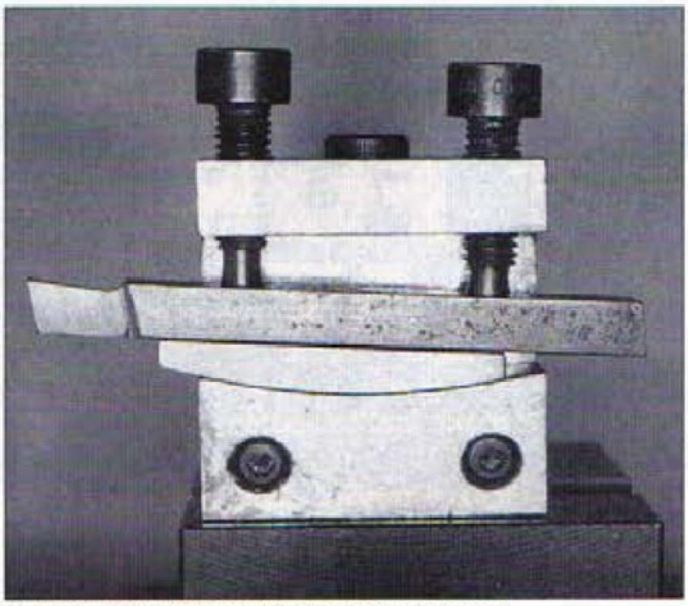
1. The completed toolpost

FIG 1. Adjustable Toolpost

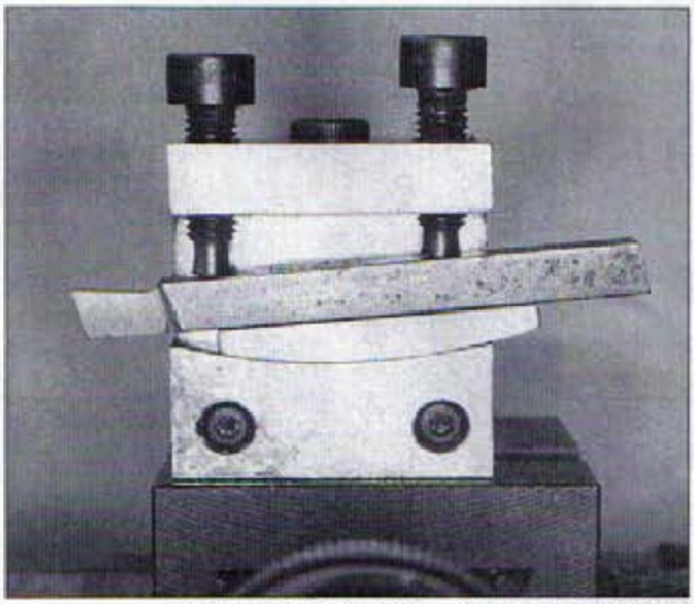




2. A tool correctly set, rocker almost level



3. Incorrect, rake increased, clearance decreased



4. Incorrect, rake decreased, clearance increased

Choice of materials

Construction is not difficult and mild steel will do very well. I have a weakness for using cast iron for jobs like this and, as I have lots of convenient off-cuts, I used it for the toolpost (Item 1). It just involved a bit of hacksawing and filing. Well, perhaps rather more than a bit, but I never mind a bit of hand work; it cuts the noise level down to comfortable CD listening and I had a new Goon Show one to listen to. At times I laughed so much I could hardly file straight.

5. Chiselling off excess material when there is a lot to come off

Ways of filing off large lumps

The hacksaw is, of course, the most valuable roughing tool in the box. There are times though, when the amount to be removed is too small to saw and very hard work to file. I use the method shown in **Photo. 5**. Sawcuts are made almost to the marked line, crossed by another set and the bits are chiselled off. A small chisel does the rough work much faster than the coarsest file, then all that is left is the cleaning up. **Photo. 6.** shows the final flattening using a fine small file and working on the block where the high areas were. The pressure of the fingers will pick them off, using short strokes. The marking out can just be seen; I always use a very broad black marking pen, they last for ages too.

6. Finishing off one surface of the toolpost

Toolpost

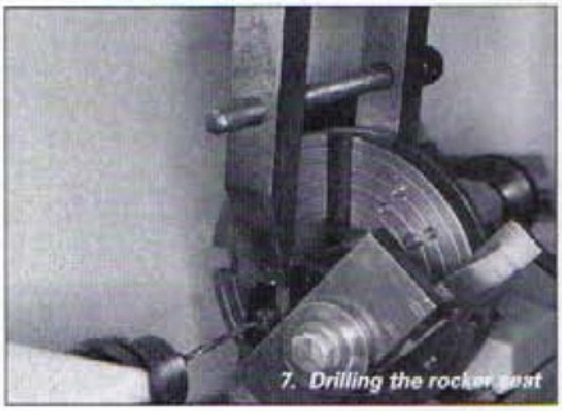
Whatever material is used it is an L shape with some holes drilled in it. There are other ways of making it but this is the method for the small lathe which does everything. It is important to make all the faces flat and square with each other. The only tiresome operation is the cutting off the slice to make the long leg of the L.

Drilling the holes

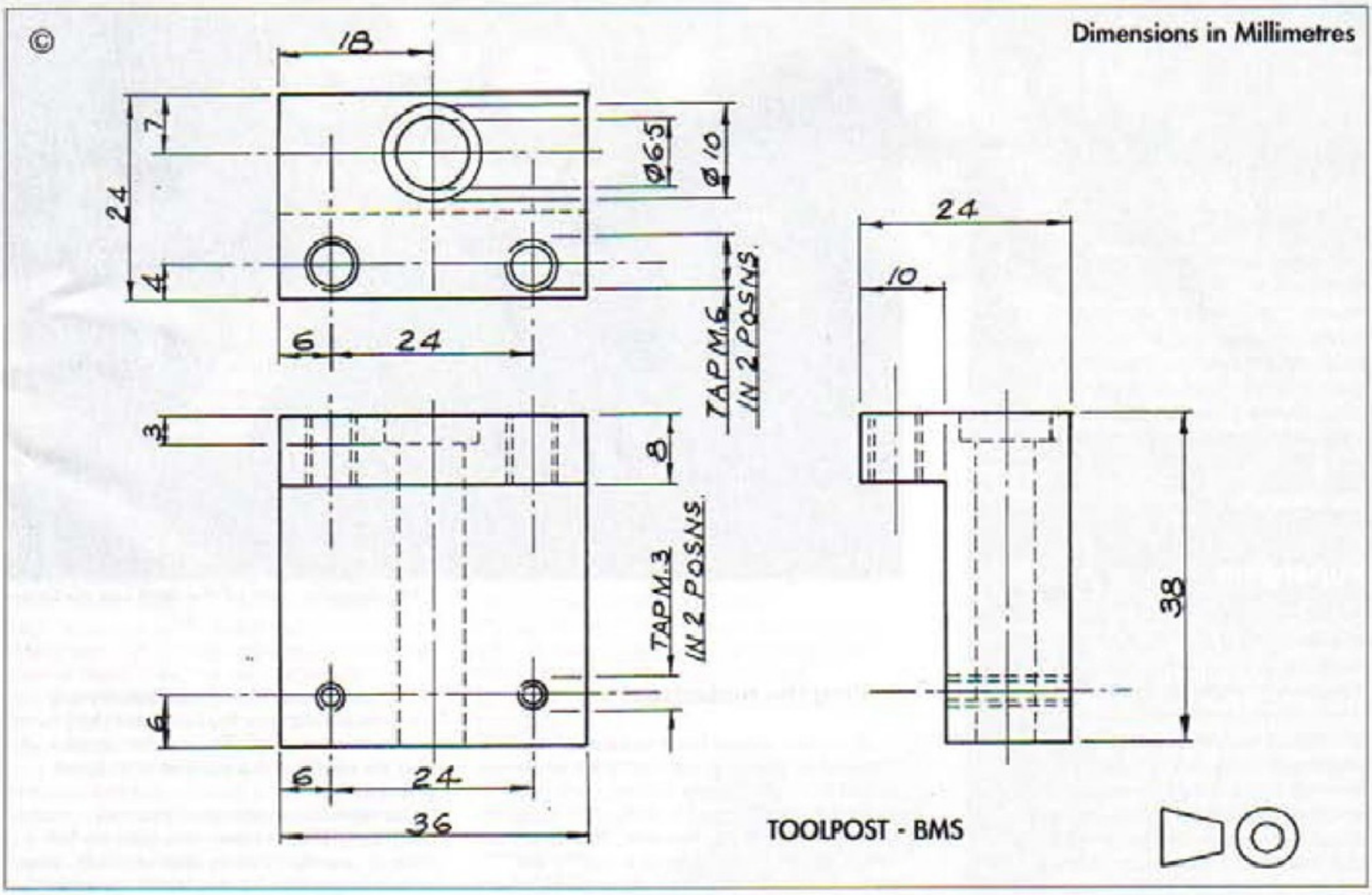
I use the lathe to drill in two ways. One way uses the face plate as a drilling table **(Photo. 7)**. Awkward shapes which are difficult to hold by hand can be clamped. I sometimes use a combination of clamping methods as in the photo. The other way is with the work clamped to the cross slide, using packing to adjust the height, as in **Photo. 8** which shows the centre drilling stage of the two tapped holes for the clamping bolts. The 6.5mm. hole is a different proposition and needs drilling by stages.

A series of drills with about 2mm between them will do the drilling of deep holes. The lathe lacks the power to take large cuts and this applies to drills as well as any other cutter; it will show its displeasure by stalling. The other problem is the swarf. Unless it is cleared frequently it will bind in the hole and add to the stalling.

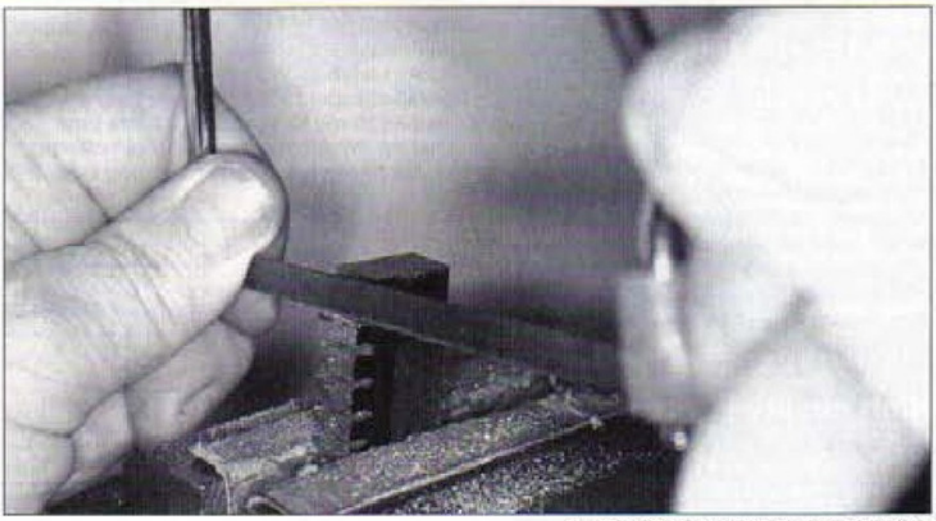
The counterbore for the head of the cap head screw can be done with a slot drill or end mill. The two small holes for the 3mm screws can be left till later.



7. Drilling the rocker seat



8. Centre drilling for the clamping bolts



9. Roughing out the internal radius

10. Finishing the internal radius

Rocker seat

This was made from 10mm mild steel and the 70mm radius was marked out and roughly cut by sawing to almost meet the line with cuts about 6mm apart, then a junior saw was used to follow the curve **(Photo. 9)**. Because the junior saw blade is fairly flexible it will follow the slight curve. A bit of careful filing will almost finish the curve, final finishing being done with emery cloth stretched over a radius of the right size **(Photo. 10)**.

To make the seat fit correctly and be able to take it off without losing the position, I used cap head screws as fitted screws. At that length (about 25mm) they have a plain length under the head which can be made to fit the holes accurately if they are carefully measured and drilled. This then combines the functions of a dowel to locate and a screw to clamp. It can be done in the same way with slotted screws like those I've drawn, as long as there is a plain diameter to do the dowel job.

Rocker

It is always easier to file an external radius, so the rocker didn't take long. Once again the material was mild steel. The fit can be made by trying the rocker on the seat against the light and picking off the high spots. If the top surface is kept flat and the top and bottom square to the sides, it should fit nicely.

QUICK TIPS

Splash guards

Araldite small block magnets to offcuts of Perspex or Lexan (obtainable from the local signwriter). Strategically placed on lathe or mill they will keep cutting fluid off you and the rest of the workshop. Don't treat them as swarf protection - they aren't. Keep your safety glasses on.

Bob Margolis

Superglue

Cyanoacrylate adhesives (superglue) are most useful in the home workshop. After the original packaging is opened, it seems very difficult to completely seal the container against the ingress of moisture in air, which causes polymerisation (hardening) of the adhesive liquid. Thus, in most cases, the container full goes hard and unusable after a couple of weeks. If the whole container is placed in a resealable plastic bag, excluding as much of the air as possible before resealing, the superglue seems to stay liquid for many months. If the original packaging is transparent it is possible to check whether the glue is still liquid and usable without opening the plastic bag. The same technique can be used with other adhesives supplied in tubes.

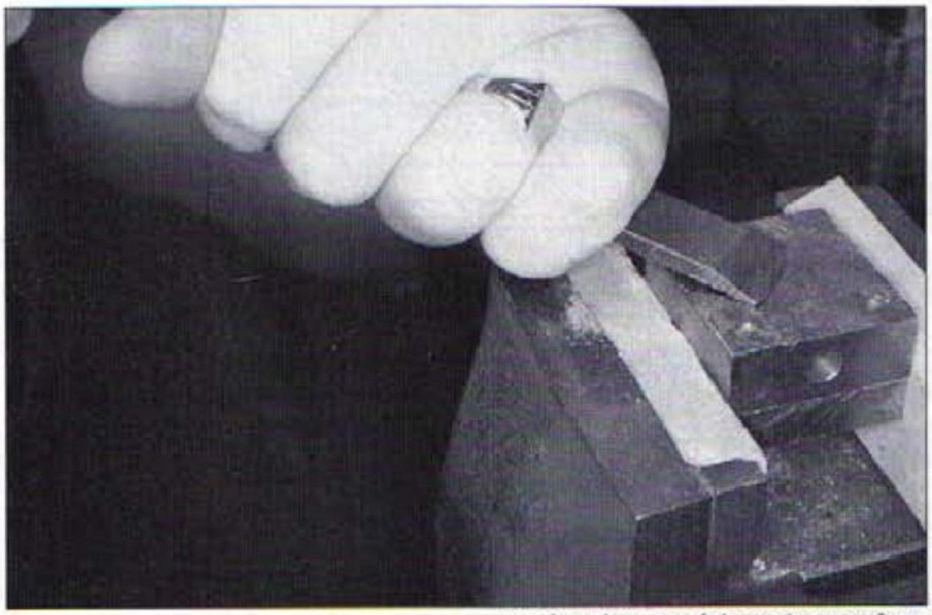
Philip Amos

High quality studs

A good supply of double end threaded studs of different lengths and diameters is available on old junked VW air cooled engine cases. They come in M8 and M10 coarse and M12 fine, the steel being of exceptional quality. Just a quick polish on the wire wheel and they come up like new, so too the nuts. Remove with either double nuts or vise grips with padded jaws. A few drops of penetrating oil works its way into the tapping in the magnesium alloy, and out they come. There are many possible applications, but hold-down studs is a favourite.

John Knuckey

QUICK TIPS



11. Scraping one of the toolpost surfaces

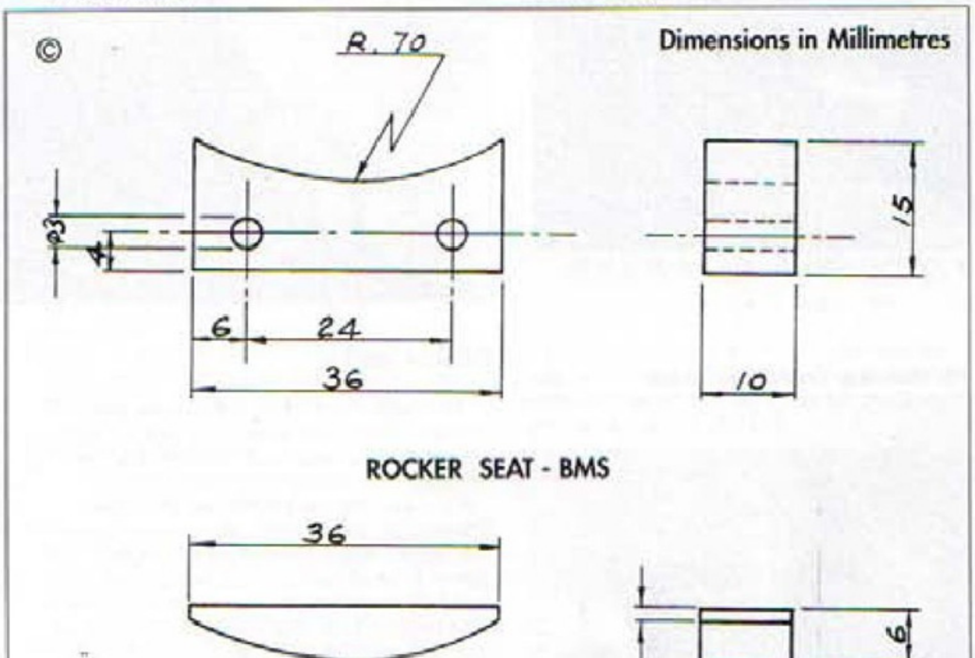
Drilling the rocker seat

When the rocker fits, the seat can be clamped to the toolpost and the holes drilled through. As my drilling methods make the clamping a bit difficult, I smeared some Loctite on the toolpost, clamped the seat to it and went to have a cup of tea. When I came back it was as cured as much as it would be and it just held enough to spot through. When the holes were tapped the only thing left was cleaning up.

As I have just found my favourite scraper, I spent a little time getting it stoned to my liking and still more time getting myself into the swing of scraping; if you haven't done any for a long time, it takes a while.

When I could do a little better than pathetic scratch marks, I scraped the surfaces where I could. I cannot resist a cast iron surface if a scraper is to hand **(Photo. 11)**.

So now I have an assortment of toolposts. There is one very tall one for when I need the raising block I made, one with a larger slot for the few tools which are too large to fit the standard one and the original one as supplied with the lathe. I shall still use the original quite a bit because the holders I made to take the tungsten carbide tips which I use a lot were made to fit it without any packing or shims. With that assortment I think I shall be equal to anything which comes along.



Take a Bow

Model engineers can seldom resist a challenge, and George Swallow was sure that he could improve on the tools used for a very special purpose

Are you a friendly model engineer? You will never find this character mentioned in the model engineering magazines, but he crops up regularly in others. Rather like the blacksmith round the corner in Model Engineer's bygone days, he is the one who can join together two bits of metal, make hurdy-gurdy bearings, find or make a nut that fits your World War 1 vacuum cleaner, or put the pedal back on your kid's bike. If you see a shifty character around on a track day, he is probably looking for you, having been told "They are all friendly; you just have to find them." Of course, once you have done one of these jobs, the word spreads. I do not discourage them, but I draw the line at anything that will take more than one afternoon.

Last year, I went to my usual violin-making summer school, and in an idle moment became interested in the group on the neighbouring benches making bows, the ones that go with violins, not with arrows. Of course, I could not resist examining their special tools, and a discussion of their scraper planes ended up by my offering to make an improved version.

The planes in use on the course were simple blocks of wood, with a blade set in a slot at 90 deg, and held in place with a wedge. They were very effective once set, but the setting was the very devil of a job with nothing but a hammer to do it. The temptation to carry on with a blade in need of sharpening must have been very great, and I therefore suggested that an adjustable version was easily made. The two planes shown here are the result.

I should perhaps explain first what it is all about. First-class bows are made from the heartwood of a tree called Pernambuco. It is frightfully expensive, a stick for one bow costing anything from fifty pounds up to many hundreds. Unfortunately, the quality is not uniform, even throughout the same tree, and second-class bows downwards are also made from it and there are similar timbers sailing under the name of 'Brazil-wood' that can confuse all but the professionals. The best quality timber is very dense and has a curly interlocking grain that defies splitting and ordinary planing. It can only be worked by knives, saws, and scrapers, and the scraping has to leave a glass-smooth surface, often having to keep the cross-section to a perfect octagon tapering from one end to the other. Musicians are very fussy, and a bow with scratches or chips out of the stick is totally worthless; perfection is the minimum requirement.

1. The two new planes, side by side

The Engineer's approach

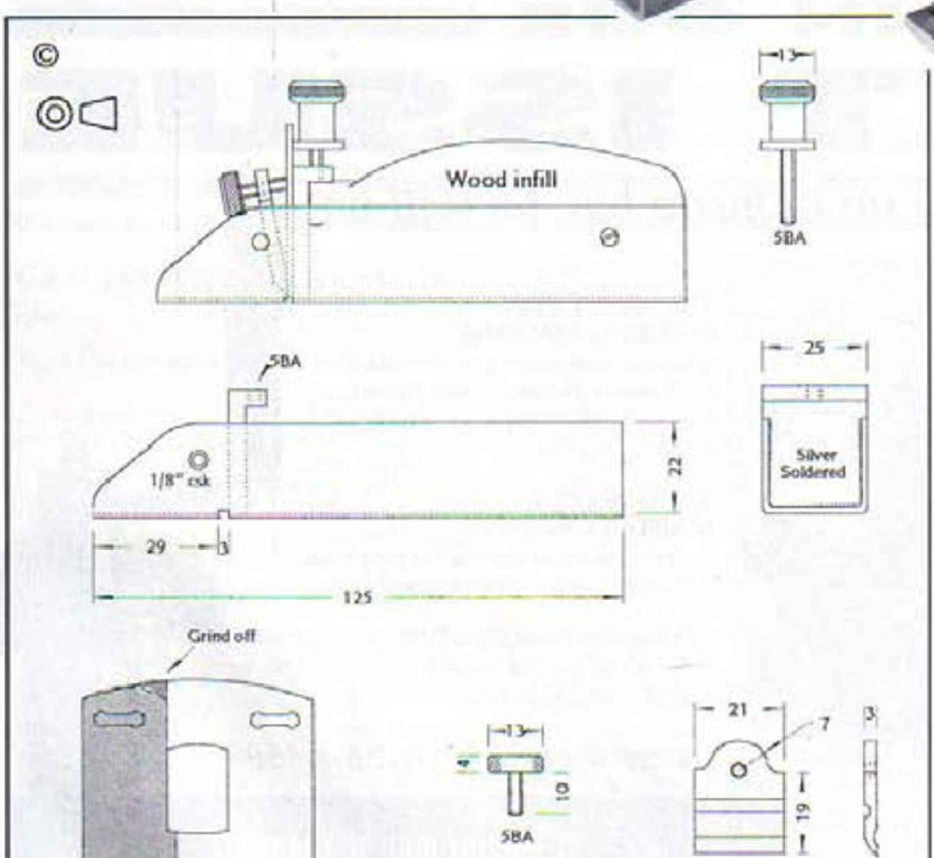
The construction of both planes is fairly obvious from the drawings and **Photo. 1**. The larger one was made from 1in. square steel tube with one side sawn off. The bed for the blade should be silver-soldered in place before the slot is cut in the bottom, and it can be made from bright steel angle (mine was the end of a loco cross-stay!). It should be bevelled on the front edge so that the solder fillet does not prevent the blade bedding down flat.

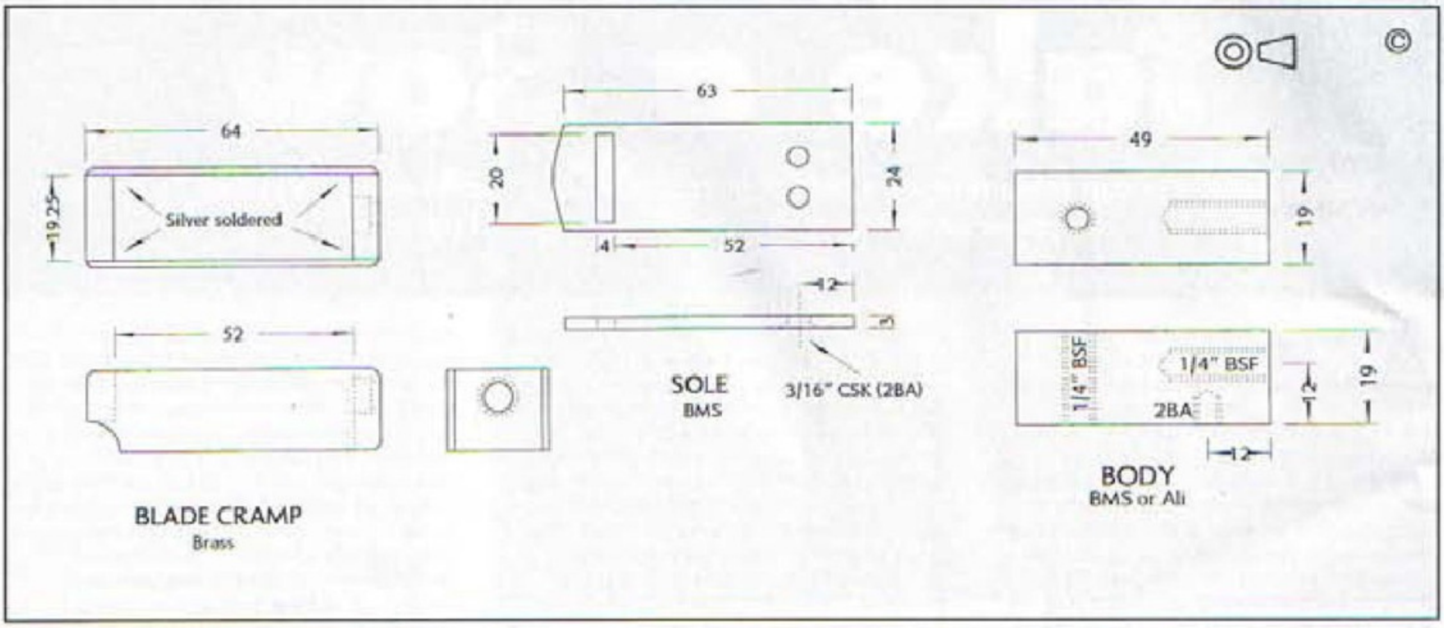
The blade itself was a section cut from a spokeshave blade, chosen because it already had two slots that would fit an adjustment screw, though slightly off-centre. An angle-grinder is best for cutting the blade, but the piece being cut off needs to be clamped to a substantial piece of metal so as not to draw the temper of the edge.

The clamp for the blade bears against a length of 1/8in. mild steel riveted over (gently - don't bend it) at both ends. The two screws are just plain turning jobs, and the wooden infill is only for comfort; the tool will work without it but you will get blisters on your hands!

Anyway, the finished tool was sent off and approved, but the approval came back with a request. Could I make a much shorter and narrower one?

At that size, the adjustment mechanism starts to get a bit fiddly, so after some thought I did a complete redesign, with the blade fixed and the sole moveable instead **(Photo. 2)**. In this smaller model, the sole is fixed at one end only and the other end is adjusted by a cap-head screw bearing on it, trimmed to length so that it will only





project a half-turn. The movement needed is no more than half a millimetre. The blade is held in place by a soldered box-like construction in brass, tensioned by another cap-screw in the back.

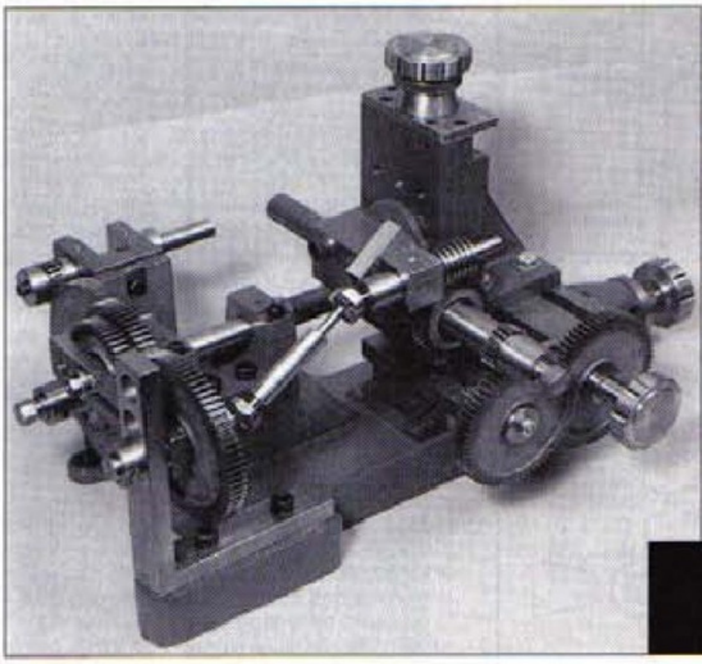
To set it, the blade is clamped with the sole flat on the bench with the setting screw fully home. Turning it anti-clockwise slightly then puts the cut on, and very small increments are possible.

This tool may be out of the ordinary run for most MEW readers, but you never know when you might get that tap on the shoulder at a track day!

2. Only four bits! The components of the smaller version

IN OUR NEXT ISSUE

Coming up in Issue No. 58 will be



THE 'CES' GEAR HOBBING MACHINE

In the third article on gear hobbing in the home workshop, Harold Hall starts the description of a purpose-built hobbing machine

AN INDEXING MANDREL HANDLE

Robert Newman suggests that one lathe accessory can be made to serve two purposes

SELECTING PROTECTIVE COATINGS

Philip Amos reviews the anti-corrosion treatments available for use on a range of metals

Issue on sale 11th June 1999

(Contents may be changed)

SCRIBE A LINE

Connecting rod machining operations

From Ted Wale, Nova Scotia

I have often seen model engines, both the locomotive and stationary types, where the connecting rod has been beautifully machined. These rods are not rods at all, but flat strips of steel machined with a slight taper from one end to the other. The outside profile is not difficult on a milling machine with a bit of care in the set-up; the taper and the rounded ends are a standard, if tricky, process.

HOWEVER, these flat rods have a recess machined in them to give a girder effect. These recesses have two characteristics which have to be reproduced if the model is to 'look real'. The bottom of the recess is flat, the sides are sloped so that the recess is a bit narrower at the bottom than at the top, the recess is parallel to the outside of the rod so the recess is also tapered as the rod is. Lastly, and by far the worst as far as I can see, the ends of the recess are rounded in two planes, from bottom to top and from upper to lower. Can this be done with a ball ended end mill? If so I don't quite see how. At least if one arranges the size to suit one could move the appropriately sized mill into the narrow end just enough to make the profile needed, but this does not seem to apply at the wide end where the tapered recess is narrower where the differently sized cutter would be entered.

Could one of our readers who has tackled this job successfully take a little time to write a blow by blow account of the tool movements? It would be very helpful to an amateur self-taught machinist such as myself.

Gear tooth geometry made clear

From Len Billinge, Langdon Hills, Essex

As a Johnny-come-lately to model engineering, I have had to strive to pick up some of the skills that most of my friends have taken for granted during their working lives. I have read 'Model Engineer' for years and 'Model Engineers' Workshop' since issue one, but many of the articles are technical and difficult to understand without a passing knowledge of trigonometry.

I have tried to understand numerous articles on gear cutting, all to no avail, being consistently defeated by mathematical calculations, pressure angles and involute curves, all unexplained and utterly meaningless to me. Then along comes Ivan Law (Gear Hobbing - No 56, February issue) to explain the intricacies of gears yet again to my addled brain and Bingo! In a couple of pages he brings the whole subject down to earth and makes the impossible possible.

"Wind a piece of string around a can of beans and the curve described by the end of the string when you unwind it is an involute curve". What could be simpler? And lathe tools that can be adjusted to the helix angle after thread cutting commences indeed, what next? This will have some of the M. E. pundits wringing their hands in despair.

My working life often took me into industry, and I would stand and stare at huge American Gleason machines producing spiral bevel gears for Land Rover back axles by 'generating' the teeth. How on earth can a machine 'generate' anything? I used to ask myself, but now all is clear.

Mr. Law has, I suspect, the rare and priceless ability to impart knowledge to others without trying to expound his own abilities at the same time, a gift sadly lacking in many of our schools today. Keep it up Mr. Law, I'm going out to buy your book 'Gears and Gearcutting'.

South Bend lathes

From Bert Martin, Verwood, Dorset

'A Tale of Two Chucks' by Ted Wale (Issue 54) raises an interesting point. Some years ago it was reported in the engineering press that South Bend Lathe Works had closed. Did it resurrect itself, or was it simply a case of mis-reporting?

My South Bend is a 9in. Model A, with 5 x 8 gearbox and a 3 1/2 ft bed. It carries a WD (1940) imprint, has Serial No. 444-Z on the same plate as the gear index chart and is driven by the adjustable horizontal motor drive, in every essential being the machine illustrated on Page 10, Fig. 15 of the Lindsay Publications Inc. reprint of South Bend Lathe Works 1942 Edition of 'How to Run a Lathe'.

The flat belt drive system is far from ideal in that it occupies too much space to the rear of the machine, though this is the only safe and practical position in which to mount an open drive of this type.

Does anyone out there have experience of swapping the horizontal drive for some form of underdrive or of fitting a new 'A' belt headstock, preferably turned on the same lathe before conversion, in place of the flat cone pulley?

Knowing the ancestry of Boxford lathes in the South Bend Model A, would a contributor with experience of both care to submit an article comparing them directly, giving us the do's and don'ts of using Boxford accessories in further modification of the considerable numbers of South Bend models still in owners' hands or available from used machine dealers?

Evening Classes with Tuition - Castleford, West Yorkshire

From Jack Salter, Sykehouse, Yorkshire

In a recent issue of M.E.W. you requested details of evening classes where tuition is provided. I attend an evening class, details as follows:- Whitwood Centre, Whitwood, Castleford, West Yorkshire. Wednesday evenings 6.30 - 9.00p.m.

This is held in a very large and fully equipped engineering training workshop and run by a professional college tutor.

All levels of ability are catered for, from those new to engineering who can follow a structured training programme (last term they made V blocks) through to experienced engineers who get on with their own projects.

There are still vacancies on this evening class and students may join at any point through the year. The college is well placed close to the M62 and A1, current students travelling from areas as distant as Bradford and Doncaster.

Reminiscences of a metrologist regarding face geared indexing tables.

From Derek C. K. Pearce (Librarian, Society of Ornamental Turners)

I found the correspondence in 'Scribe a Line' M.E.W. No 54 on Face Geared Indexing (Hirth radial spur gearing) most interesting as I was involved some 40 years ago in calibrating both the Hirth gear and Ball type indexing tables. Most of the face gear type tables I dealt with were extremely accurate, two manufacturers guaranteed an accuracy of 1/4 second of arc.

As far as I know the A. A. Gage Co., Detroit, Michigan, USA were the first to market a face gear (Hirth) indexing table which was sold under the name 'Ultradex'. Their standard range of face gear type indexing tables had table diameters of 7in., 12in. and 24in. The 7in. and the 12in. models could be fitted with either a sine base or sine table top, enabling a table to be rotated through very small angles, the setting of these sine attachments being either by slip gauges or a built in high accuracy indicator. A. A. Gage greatly improved on the standard 12in. and 24in. tables by making these models automatic with push button and read-out console units. These models were either all electric or pneumatic/electric. They also patented and made a rather novel Optic Mechanical Polygon comprising a small diameter 360 tooth *face gear table with a reflector at the centre of the table, making it ideal, in conjunction with an autocollimator, for checking rotary tables etc. I suppose the most interesting and challenging improvement in face gear indexing tables must have been A. A. Gages introduction of the Differential Ultradex face gear table, where a double sided face gear was sandwiched between the top and bottom gears of a face gear table, but with the difference that the top and bottom face gears of the table did not have the same number of teeth. The idea of differential face gearing has been known for some years as it was used in the 1930's (maybe earlier) by Simms in their magneto coupling to give a very fine adjustment as to when the spark occurred. This all spells bad news for one of the correspondents in Scribe a Line M.E.W. No 54 who thought he had discovered the novel idea of differential indexing of face gears.*

Moore Special Tool Co., Bridgeport, Connecticut, USA came to some agreement with A. A. Gage and presumably took over their patents etc. to make their own Moore face gear tables. Their object was to enhance the accuracy of this type of table and to restrict production to just a few models, rather than carry on A. A. Gage's programme of so many different models. Moores, in their usual way, took the calibration and manufacture of these table to the nth degree, using interferometry, highly accurate photo-electric autocollimators and their own specially designed and made Millionth Micrometer, used tangentially to the table periphery.

It may be of interest that it is usual practice to calibrate these types of tables in pairs, mounting one table on top of another. An autocollimator is pointed at a mirror mounted approximately central on the top table. By inter-comparing the two tables (taking autocollimator readings for various table positions) and even without knowing the errors of either of the tables, it is possible to derive the errors of both tables, so I guess Bill Morris ought to make another face gear table. I'm sure he will thank me for this suggestion!! Perhaps it's a good thing for me that Bill lives in New Zealand.

If anyone is interested in the method of calibration and the finer points of these face gear indexing tables, may I suggest they read the book 'Foundations of Mechanical Accuracy' by Wayne C. Moore. However, I think it's worth mentioning that, for forming the gear teeth, Moore's made their own very accurate Automatic Grinding Machine with a special grinding wheel that had been devised to overcome wheel wear. The gear teeth were finally lapped on another machine made by Moore's which automatically raised and lowered the face gears as well as rotating them. After using progressively finer lapping paste, the teeth were finally engaged and disengaged completely dry for hours to achieve as perfect as possible engagement.

Vernier couplings

From S. White, Handsworth, Birmingham

Mr Colin Porter of Blackpool writes (Scribe a Line) about an adjustable timing device for a Dunstall tuned Norton motorcycle. I did not own one, but can remember them racing, with success, in the 1960's.

So, Mr Porter should try to get a copy of 'Tuning for Speed' by Phil Irving, published by Turton & Armstrong. On pages 131/2 is an explanation of how such a hole and peg vernier device worked on a DOHC Manx Norton.

The author of this book is 'the' Phil Irving, of Velocette, A.J.S., Vincent-H.R.D. and Brabham-Repco Formula 1, so, worth reading!

'B' Series tapers

From J. L. Pemberton, Holmes Chapel, Cheshire

Thanks for a vary interesting issue (no. 56), particularly Tony Jeffree's leadscrew modification for the Peatol lathe - roll on Issue 57!

In connection with Philip Amos's article on machine tapers, I recently purchased a small bench drill, on which the chuck is stamped 'B16' for its internal taper, though the handbook describes it as MT2A, and it does appear to be a shortened MT2 taper. Is any data available on these 'B' tapers, which I have seen listed from B10 to B18?

Finally, for a cheap surface plate, try your local Woolworth's! Every few months, our local store has a variety of kitchenware articles made from polished marble, including a chopping board, which is a rectangular plate 11 ½in. x 9in. x ½in. thick, mounted on rubber feet. Judging by the quality of the reflected image in the polished top surface, the plate is flat to a fair degree of accuracy. Price? - £3.99! Check it out.

Drilling matching holes

From Ken Stringer, Walmer, Kent

I was interested in Mr. O'Keefe's letter in Issue 55. Like him, I have no engineering background whatsoever, my interest having developed through Meccano before the war.

For a number of years now, when I have to drill matching holes, I find it more convenient to stick the two parts together with superglue, rather than use toolmaker's clamps. A single sharp tap along the line of the joint separates without any need for heating.

I also use a blue colour marker pen with a broad felt tip instead of marking-out fluid. It is much quicker and easier to apply, and far less messy.

Elusive bubbles

From John McCrone, Dundee, Scotland

Does anyone know where I can get 'bubbles' for Rabone boat spirit levels? It seems that the manufacturers no longer repair or supply bubbles.

With reference to recent correspondence on screw thread information, it is perhaps worth a reminder that much useful data is contained in the 'Zeus Precision' Data Charts and Reference Tables pocket book which is available from many tool suppliers, including some of the model engineering specialists. The current price is about £2.90.

Unimat matters - Bob Loader replies

From Bob Loader, Milton Keynes

Some items published recently in 'Scribe a Line' deserve an answer.

Firstly, thank you Mr Butcher of Alness for your vote of confidence (Issue 55). I would love to write a book based on jobs for the Unimat 3. It is though, one thing to write a book and quite another to find a publisher. I can only be a bit enigmatic and say, "watch this space".

Thank you Mr Mills of Southampton and Mr Lait of Branston, for your informed and interesting comments about my adventure with the Unimat motor, in Issue 56.

As I stated in the text, the damage to the commutator was minimal and easily filed off with the finest of Swiss files. I looked carefully at the spaces between the segments but they needed no attention. My apologies for using the term 'emery cloth'. I used it in its generic sense, in the same way that we sometimes call a vacuum cleaner a 'Hoover'. I should have called it 'aluminium oxide cloth', for that was what it was. The business of putting the motor right was my usual mixture of improvisations and, so far, all is well and the Unimat behaves itself.

Finally, my thanks to Mr Wagstaffe of Congleton (Issue 56). I do know the Malvern district very well and was brought up there. I also did my apprenticeship and a fair bit of my adult work at R.R.E., mostly at the site which was based in Malvern Link.

Like you, Mr Wagstaffe, I have used a sewing machine motor as an accessory. The last time I did so was when I was drilling the holes in an index plate. A small chuck was fitted to the motor spindle with an adapter and the motor clamped to the cross slide. The indexing was done from the back of the Unimat spindle. I think it was the subject of an article, and it worked a treat.

I too, remember the Eclipse toolmakers' vice, a little beauty which I never owned, but was available in the stores and in fairly constant demand.