

No.86

NOVEMBER 2002

£3.25

MODEL ENGINEERS' WORKSHOP

THE PRACTICAL HOBBY MAGAZINE

ROTARY GRINDING
A minimalist approach



SIMPLE TOOLS
Chisels and saws

**TAILSTOCK
FLOATING
DIEHOLDER**



MODEL ENGINEER EXHIBITION
29TH - 31ST DECEMBER 2002
SANDOWN PARK, ESHER, SURREY

SEE US AT
DONNINGTON
& SANDOWN

CHRONOS

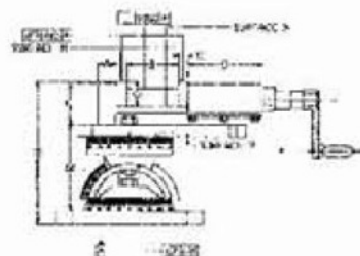
L I M I T E D

ALL
PRICES
INCLUDE
VAT + UK
CARRIAGE

SEE
US AT
SANDOWN
29th-31st
Dec

NEW!!

PRECISION 2" MODULAR MACHINE VICE



This new vice is made of close grained cast iron and is extremely versatile. The rotary base is adjustable through 360° and the tilting action moved 45° each side. The really unique feature about this unit is the fact that the vice assembly can be removed and replaced with a 4" x 5" slotted milling table (supplied as standard). Another great feature is that when removed the vice assembly can be used independently as a low profile (50mm high) milling vice as the base has useful mounting lugs.

£115!!

H	L1	W1	H1	A	B	C	D	E	F	R
130	125	100	22	20	50	9	72	24	38	80

SET OF TUBE BENDING SPRINGS 1/16 - 3/32 - 1/8 - 5/32 - 3/16

CODE
S0111

PRICE
£3.95

105 PC POLISHING & GRINDING SET

TO SUIT MINICRAZ B10
CODE
PS200

PRICE
£8.95

OPTICAL CENTREPUNCH

CODE
OP270

PRICE
£87.95

LITTLE HOGGER SET OF INDEXABLE ENDMILLS 3/4 DIA SHANK

Code
LHS

Price
£29.95

ALIGN POWER TABLE FEEDS (110V)

Code

To Suit
CX68 Bridgeport Type
CX69 Major/Minor Type
CX70 Transformer
CX71 Bridgeport & Trans
CX72 Major/Minor & Trans

Price

£259.00
£259.00
£44.00
£289.00
£289.00

QUALITY DRILL CHUCKS WITH KEY

Code
CX73
CX69A

Capacity
13mm JT6 Mount
16mm JT6 Mount

Price
~~£20.00~~ £19.00
~~£24.00~~ £22.00

VERTEX BSO DIVIDING HEAD

Complete with Headstock,
Tailstock, Div. plates, Test Certificate



CODE PRICE
S057 ~~£255~~ £199!!

**GENUINE
VERTEX**

VERTEX ROTARY TABLES & ACCESSORIES

Code	Item	Price
S058	HV4 4" Rotary Table	£135.00
S059	Div Set for HV4	£ 49.95
S060	Tailstock for HV4	£ 55.00
S061	HV4 + Div Set + Tailstock	£220.00
S062	HV6 6" Rotary Table	£145.00
S063	Div Set for HV6	£ 49.95
S064	Tailstock for HV6	£ 55.00
S065	HV6 + Div Set + Tailstock	£230.00
S066	HV8 8" Rotary Table	£220.00
S067	Div Set for HV8	£ 65.00
S068	Tailstock for HV8	£ 74.00
S069	HV8 + Div Set + Tailstock	£320.00



New MT2 Chuck
Adaptor with Myford
Thread to suit HV6
Code Price
S070 £24.95

SECURE ONLINE ORDERING AT WWW.CHRONOS.LTD.UK

PRICES INCLUDE VAT & CARRIAGE (UK MAINLAND)

CHRONOS LTD UNIT 8 EXECUTIVE PK 229/231 HATFIELD RD ST ALBANS HERTS AL1 4TA

PRICES ARE CORRECT AT TIME OF GOING TO PRESS AND ARE ONLY AVAILABLE WHILE STOCKS LAST

TEL (01727) 832793 - 5 LINES FAX (01727) 848130 WEBSITE WWW.CHRONOS.LTD.UK

EMAIL SALES@CHRONOS.LTD.UK



EDITORIAL

Editor

David Fenner
Tel/Fax: 01738 583832

Editorial Administrator

Sarah White
sarah.white@nexusmedia.com

PRODUCTION

Designer

Carol Philpott

Production Manager

Sifa Symons

Printed By

Polestar (Colchester)

Origination by

Atelier Data Services

SALES & MARKETING

Group Sales Manager

Colin Taylor

Sales Manager

Tony Robertson

Marketing Manager

Rebecca Bradberry
Tel: 01322 660070

CIRCULATION

Circulation Sales Director

Sharon Douglas

Circulation Manager

Kevin Maloney

Specialist Outlet Development

Emma Stammers

MANAGEMENT

Divisional Publisher

Dawn Frosdick-Hopley

Associate Publisher

Jez Walters

SUBSCRIPTIONS

8 issues UK £26.00, Europe £31.00, US Surface \$45.50,
US Airmail \$51.00, RoW Surface £31.50, RoW Airmail £33.50
UK SUBSCRIPTIONS AND BACK ISSUES:

Highbury Nexus Subscription Services, Link House,
8 Bartholomew's Walk,

Ely, Cambridgeshire CB74ZD

Tel: 01353 654422 Fax: 01353 654400

Email: nexus@wyverncrest.co.uk

(8.00am-6.00pm Mon.-Fri.)

USA SUBSCRIPTION AGENT:

Wise Owl Worldwide Publications,

1926 South Pacific Coast Highway, Suite 204, Redondo Beach, CA
90277-6145, USA.

For Visa/Mastercard orders in USA

Telephone (310) 944-5033. Fax (310) 944-9963.

Email: wiseowl@sprintmail.com

Web: www.wiseowlmagazines.com

Postmaster send address corrections to:

Model Engineers' Workshop

c/o Mercury Airfreight International Limited

365 Blair Road, Avenel, NJ 07001, USPS 010876

CANADIAN DISTRIBUTION:

Gordon & Gotch Periodicals

(Toll free 1 - 800 - 438 - 5005)

Published by

Highbury Nexus Special Interests Ltd,

Nexus House, Azalea Drive,

Swanley, Kent BR8 8HU



HIGHBURY
Nexus Special Interests

A SUBSIDIARY OF HIGHTON HOUSE COMMUNICATIONS PLC

**Highbury Nexus Special Interests Ltd is a
wholly owned subsidiary of Highbury
House Communications plc**

© Highbury Nexus Special Interests Ltd 2002

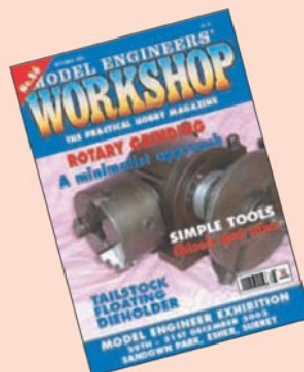
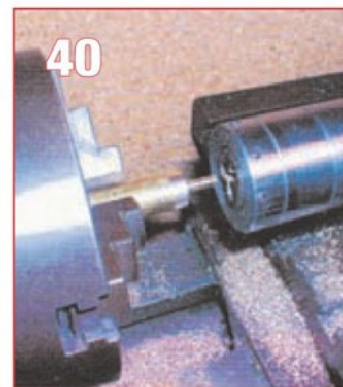
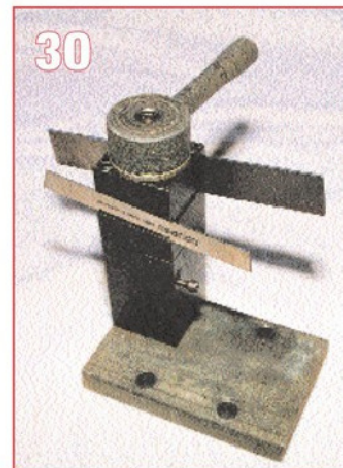
All rights reserved ISSN 00819-8277

The Publisher's written consent must be obtained
before any part of this publication may be reproduced in any
form whatsoever, including photocopies,
and information retrieval systems.

All reasonable care is taken in the preparation of the magazine
contents, but the publishers cannot be held legally responsible for
errors in the contents of this magazine or for any loss however
arising from such errors, including loss resulting from negligence of
our staff. Reliance placed upon the contents of this magazine is at
reader's own risk.

Contents

- 11 On the Editor's Bench**
Dave Fenner's commentary
- 12 Milling Projects (3)**
Clamp bars and parallels
- 15 Link Up**
Readers sales and wants
- 16 Motor speed control**
The humble washing machine is a ready source of useful parts
- 18 Simple tools – simple methods**
Chisels and saws
- 22 A tale of two readouts**
Operation and advantages
- 25 Next Issue**
- 26 Retrofitting ballscrews to a Wabeco mill**
A straightforward improvement to accuracy and longevity
- 30 Parting off on the Quorn**
Blade geometry and how to obtain it
- 37 Rotary grinding**
A simple and easily made accessory
- 40 Tailstock floating dieholder**
Accurate threads on inaccurate lathes
- 44 Angle milling fixture**
A useful set up aid
- 46 Chucks – how many?**
A collection described
- 48 Enhancements to Compumill**
Downfeed refinement and low cost DRO
- 51 A brief note on steel specifications**
An outline for beginners
- 52 Scribe a line**
Reader to reader
- 54 Model Engineer Exhibition 2002**
Entry form and notes



Front Cover

The chuck fitted to this industrial dividing head is unusual in having both self-centring and independent jaw adjustment.

T.E. Dominey describes his collection on page 46.

**TO ADVERTISE
CALL TONY ON
01322 660070
EXT. 2468**

AGENTS NEEDED



**You can earn extra
money by selling**

**MODEL ENGINEERS
WORKSHOP**

**at your shop, show,
club or class**

Call us NOW on 01322 616300

DON'T MISS A SINGLE ISSUE!

It can be difficult to find a copy of **MODEL ENGINEERS WORKSHOP** at local newsagents.

The ever-increasing number of magazines being published means that newsagents have less shelf space to display particular titles.

Specialist magazines especially get crowded out. There's a solution to this problem. Most newsagents provide Shop-Save and/or Home Delivery services.

Shop-save incurs no charge - simply ask your newsagent to order a copy for you. It will be kept on one side ready for you to collect.

Home delivered copies are ordered in the same way but generally incur a delivery charge.

A newsagent can order any magazine for you, whether or not the shop normally stocks it. If you buy your copies of **MODEL ENGINEERS WORKSHOP**

from a newsagent and want to make sure you get every issue, just ask at the counter.

To avoid disappointment, fill out and hand this form to your newsagent to reserve your copy:

**PLEASE RESERVE/DELIVER A COPY OF
MODEL ENGINEERS WORKSHOP
FOR ME**

Name: _____

Address: _____

Postcode: _____ Telephone: _____

Model Engineering Workshop Ad Index

ADVERTISER	PAGE
BW Electronics	6
Camden	5
Chester (UK) Ltd.....	OBC
Chronos Ltd.....	IFC
Classified	62-64
Compucutter	6
EB Engineering	6
Emco	56-57
Folkestone Engineering.....	7
G & M Tools.....	65
GLR.....	8
Home and Workshop.....	IBC
JC Payne Ltd	66
Machine Mart.....	9
Meridienne Exhibitions	7
Mill Hill Supplies	8
Model Engineering Services.....	6
Newton Tesla.....	58
Nexus Special Interests.....	4/10/54-55/60-61
Project Machinery.....	66
Tracy Tools Ltd	66
Warco	59

THE ONE-STOP BOOK SOURCE FOR ALL MODEL ENGINEERS!

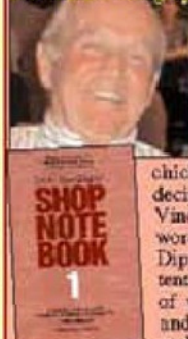
How to Run a Lathe [1942] [South Bend]	£ 7.65
The Amateur's Lathe [Sparey]	£10.55
Lathe Operations [1937] [Barritt]	£14.15
Lathe Handbook No. 1 [1925]	£ 8.25
Ornamental Turning [Walshaw]	£11.75
Keep Your Lathe in Trim [1934] [South Bend]	£ 4.10
Improvements & Accessories for your Lathe [Radford]	£15.50

South Bend Lathe Booklets (c 1930s)	£ 7.90
Lathe Notes Vol. 1 (c. 1920)	£ 5.65
Lathe Notes Vol. 2 (c. 1920)	£ 5.65
Lathe Notes Vol. 3 (c. 1924)	£ 5.65
Lathe Notes Vol. 4 (c. 1920)	£ 5.65
Chucks Review & Restoration [1913-17]	£ 5.65
Machine Tool Adjustment (c. 1920)	£ 5.65
Precision Lead Screws, Gears & Pantographs	£ 5.65
Rabbitt Bearing Techniques [1912-1925]	£ 5.65
How I pour Rabbitt Bearings [Gingery]	£ 7.50
Running a Milling Machine [1941] [Colvin]	£ 7.80
Milling Machine Operations [1937] [Barritt]	£ 9.90
Milling Machine Kinks [1908] [Colvin & Stanley]	£ 5.85
Milling Machine Practice [1940]	£ 4.20
Shaper Operations [1937] [Barritt]	£ 8.30
How to Run a Metal Working Shaper & Drill Press [1961] [South Bend]	£ 6.65
Shapers [1943] [Stierli]	£ 9.35
Working Sheet Metal [Gingery]	£ 8.40
Practical Metal Plate Work [1907] [Haduck]	£ 9.90
How to Do Aircraft Sheetmetal Work [1942]	£13.30
Repoussé Metalwork [1905] [Horth]	£ 9.00
Plastics for Modellers [Weiss]	£ 9.50
Old Time Mechanics: Secrets of Hand Scraping [1919]	£ 3.40

Gear Cutting Practice [Colvin & Stanley]	£14.25
Advanced Machine Work [1925] [Smith]	£29.65
Elements of Machine Work [1919] [Smith]	£17.45
Shop Theory [1942] [Henry Ford Trade School]	£17.10
Model Engineering - a Foundation Course [Wright]	£20.95
Model Engineers Handbook [Tubal Cain]	£11.55

"Workshop Practice" Series:	
No.1 Hacking, Tamping & Heat Treatment [T.Cain]	£ 7.85
No.2 Vertical Milling in the Home Workshop [Thorp]	£7.85
No.3 Screwcutting in the Lathe [Cleeve]	£8.20
No.4 Foundrywork for the Amateur [Aspin]	£7.85
No.5 Milling Operations in the Lathe [T.Cain]	£7.85
No.6 Measuring & Marking Metals [Law]	£7.85
No.7 The Art of Welding [Vause]	£7.85
No.9 Soldering & Brazing [Tubal Cain]	£7.85
No.10 Saws and Sawing [Bradley]	£6.85
No.11 Electroplating [Poyner]	£7.15
No.12 Drills, Taps and Dies [Tubal Cain]	£7.85
No.15 Workholding in the Lathe [Tubal Cain]	£7.85
No.16 Electric Motors [Cor]	£7.85
No.17 Gears and Gear Cutting [Law]	£7.85
No.18 Basic Benchwork [Oldridge]	£7.85
No.19 Spring Design & Manufacture [Tubal Cain]	£7.85
No.20 Metalwork Machining Hints and Tips [Bradley]	£7.85
No.21 Adhesives and Sealants [Lanumas]	£7.85
No.22 Workshop Electrics [Weiss]	£7.85
No.23 Workshop Construction	£7.85
No.24 Electric Motors in the Home Workshop	£7.85
No.26 Home Workshop Hints & Tips [Smeed]	£6.40
No.27 Spindles [Sandhu]	£8.20
No.28 Simple Workshop Devices [Tubal Cain]	£8.20
No.29 CAD for Model Engineers [Brown]	£7.85
No.30 Workshop Materials [Weiss]	£7.85
No.31 Useful Workshop Tools [Bray]	£7.85
No.32 Unimat III Accessories [Loader]	£7.85
No.33 Making Clocks [Bray]	£7.85
Model Engineer's Workshop Manual [Thomas]	£25.75
Machinery's Handbook (26th edition)	£59.00
The Machinist's Bedside Reader [Lautard]	£23.40
The Machinist's Second Bedside Reader [Lautard]	£21.55
The Machinist's Third Bedside Reader [Lautard]	£27.70
A Treatise on Oiling Machine Tools [Lautard]	£ 5.75
Gunsmith Kinks I [ed. Brownells]	£22.55
Gunsmith Kinks II [ed. Brownells]	£22.55
Gunsmith Kinks III [ed. Brownells]	£24.00
Gunsmith Kinks 4 [ed. Brownells]	£26.60
Workshop Techniques [Thomas]	£28.35
Build a Power Hacksaw with Vice [Gingery]	£ 9.00

Uncle Dave Gingery's Shop Notebook 1 £7.60



Readers who have already come across the books of David Gingery, will appreciate that the man is an unsung genius. What you get in this little book is "a collection of chicken scratch, translated, deciphered and illustrated by Vince Gingery" - and take our word for it, it's all good stuff. Dipping into the table of contents at random, you get words of wisdom on the workbench and drawer construction, a rack for storing round rods, benchwork, drilling, reaming, grinding, lathe-work, faceplate work, chuck-mounted work, handles & arbors, a rocker arm, special holding fixtures, a miniature rotary table, etc., all from the man we rate as one of the great engineering writers of the 20th and 21st centuries. 58 pages of good sound advice and ideas, very well illustrated. Softcover.

"Build Your Own Metal Working Shop from Scrap" - Dave's first, and best-selling, series:

Book 1 The Charcoal Foundry	£ 7.60
Book 2 The Metal Lathe	£ 9.50
Book 3 The Metal Shaper	£ 9.50
Book 4 The Milling Machine	£ 9.50
Book 5 The Drill Press	£ 9.50
Book 6 The Dividing Head and De-luxe Accessories	£ 9.50
Book 7 Designing & Building the Sheet Metal Brake	£ 8.30
All 7 volumes purchased together	£56.10

POST & PACKING:

Prices shown INCLUDE post & packing within the U.K. If you buy more than one title, you save and any excess payment will be refunded. Overseas customers please allow 10% extra for surface mail delivery.

OUR GUARANTEE:

We want you to enjoy the books you buy from us, and to feel that you can deal with us in confidence. So - all books are guaranteed. If you find a book is not what you wanted, return it immediately for credit or refund; we don't expect you to keep and pay for items that aren't what you expected. We want you to be happy with your purchases from us - there is no other way to do business....

FREE BOOKLIST!

The books in this advert are a minute portion of our range of model engineering and related titles. All are described in our 80 page full colour illustrated Booklist, sent with all orders. Write, phone, fax, or view our website for a copy if you would like to see the list before buying - it is FREE!

Deep Hole Drilling [1910, 1926 & 1927]	£ 5.55
How to Build a Slip Roll Machine [Gingery]	£ 9.70
Build an EDM [Langlois]	£15.25
How to Build a Pipe Bending Machine [Gingery]	£ 8.65
The Finishing Touch-the how's and why's of painting models [Shepherd]	£ 6.25
Pressworking of Metals [1941] [Himan]	£18.45
Ent Iron Work [1903] [Haduck]	£ 9.60
Thermit Welding Process [1914] [Hart]	£ 4.70
The Charcoal Foundry [Gingery]	£ 7.60
Building a Gas Fired Crucible Furnace [Gingery]	£11.95
Iron Melting Cupola Furnaces for the Small Foundry [Chastain]	£18.05
Build an Oil-Fired Tilting Furnace [Chastain]	£17.65
Ornamental Metal Casting [Whitmoyer]	£ 9.65
Foundry Manual [1958] [US Navy]	£19.45
Forgework [1912] [Ilgen]	£10.05
How to Build a Full Size Forge from commonly available metal [Meador]	£ 9.00
How to Build a Blacksmith's Firepot [Meador]	£ 9.60
How to Run Three Phase Motors on Single Phase Power	£ 3.65

Alternator Secrets	£ 3.65
The Boy Electrician [1940] [Morgan]	£18.40
The Tesla High Frequency Coil [1910] [Haller & Cunningham]	£ 8.60
Build a Universal Coil Winder [Gingery]	£ 8.65
Design, Construction & operating Principles of Electromagnets for attracting Copper, Aluminium & other Non-Ferrous Metals [1951] [Crow]	£ 9.00
The Clock Repairer's Handbook [Penman]	£15.29
Watch and Clockmakers' Handbook, Dictionary and Guide [Britten]	£19.05
The Watchmaker's and Model Engineer's Lathe - a User's Manual (5th edition) [de Carle]	£18.19
How to Make a Weight Driven 8-day Wall Clock [Wickling]	£31.55

A Manual on the Hydraulic Ram for Pumping Water	£ 8.40
Pumps & Hydraulic Rams [1907] [Haduck]	£ 9.10
Brakedrum Windmill Plans [Piggott]	£14.30
The Stirling Engine Manual [Rizzo]	£30.25
The Stirling Engine Manual Vol. 2 [Rizzo]	£29.00
Building Simple Model Steam Engines [T.Cain]	£ 5.85
Building Simple Model Steam Engines Vol. 2	£ 6.85
Model Stationary and Marine Steam Engines [1964] [Harris]	£12.85
Experimental Flash Steam [1973] [Benson & Rayman]	£14.20

Building the Atkinson Differential Engine [Gingery]	£14.00
Building the Shay [Hiraoka]	£40.65
Introducing Model Traction Engine Construction [Haining]	£ 8.20
Model Locomotive Boilermaking [Farmer]	£13.75
Model Stationary and Marine Steam Engines [1964] [Harris]	£12.85
Locomotive Valves & Valve Gears [1921]	£21.60
Injectors: theory, construction & working [1893] [Pullen]	£12.20
La Locomotive a Vapeur [1952] [Chapeau] - English edition	£59.75
The Tesla Disc Turbine [Chairs]	£ 6.80
The Non Rotative Steam Engine [Kelly]	£ 8.80

☆☆ VIDEOS! ☆☆

Welding Institute Video Guides-	
No. 1 MIG Welding (51 mins)	£24.65
No. 2 MMA Welding (54 mins)	£24.65
No. 3 Oxy-Acetylene Welding, Brazing & Cutting (54 mins)	£24.65
Fundamentals of Machine Lathe Operation [NEW version] (95 mins)	£29.95
Advanced Aspects of Machine Lathe Operation (20 mins)	£29.95
Cutting Screw Threads on the Lathe (65 minutes)	£25.95
Grinding Lathe Tools (125 mins)	£29.95
How to Cut Spur Gears (40 minutes)	£24.95
Rudy Koshaupt on Milling (120 mins)	£29.95
Operating a Horizontal Milling Machine (150 mins)	£29.95
Operating a Shaper (120 mins)	£29.95



MAL ORDER (No Stamp required in the UK) to:

CAMDEN MINIATURE STEAM SERVICES,
Freepost (BA 1502), Rode, Frome. BA11 6UB

24 hour phone: 01373 - 830151
fax: 01373 - 830516 www.camdenmin.co.uk



The **SPRINTER** All Steel 5c Collet Chuck

4" Dia (100mm)

With steel back plate to suit Myford nose spindle 1 1/8" Dia x 12 TPI.

(Photo shows fitted with backplate.)

Both chuck & back plate can be purchased separately.

Comprises of chuck Body, closing nut, back plate and locking spanner.

Price complete including VAT £125 (Carriage Extra)

Back plate is supplied pre machined with drilled and tapped holes, and locating spigot requiring a final skim to ensure concentricity or plain, with just the 1 1/8" dia x 12 tpi thread, to suit the Myford Nose Spindle.

For details Telephone / Fax 0121 551 3274 / e-mail: eb.engineering@virgin.net or write to:- EB Engineering Unit 17, All Saints Industrial Estate, Hockley Birmingham B18 7RJ

© British Made



Compucutter fully described in machine building manual

Machine Building Manual

(also includes Compumill & Mini machines)

Hardcopy

£25 + p&p (£5 UK)

CD

£25 inc.

Compucut system

Interface

Compucut software

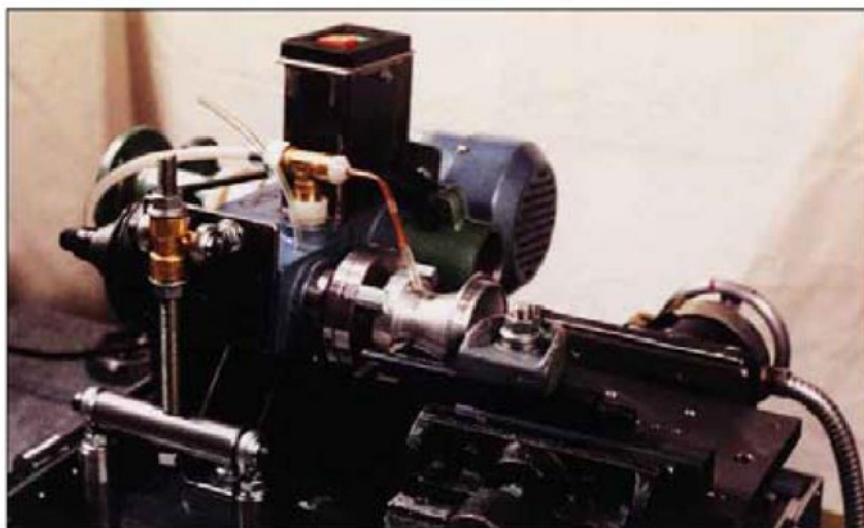
Compucut manual

£250 + p&p (£6 UK)

Compucut Software +

Compucut Manual

£100 + p&p (£5 UK)



shown here in 2 axis mode, turning a pulse jet intake

Note: Compact rigid design utilising readily available iron castings (pillar drill & X, Y, vice)

Tel: (02476) 473851 Email: compucutters@compuserve.com Web: www.compucutters.com

For info pack send SAE to:

Compucut, 17 Lime Tree Avenue, Tile Hill, Coventry CV4 9EY England

KITS FOR TWO TOOL AND CUTTER GRINDERS

THE SOPHISTICATED

THE SIMPLE



THE
QUORN

THE KENNET

FOR INFORMATION ON THESE AND
OTHER KITS S.A.E. TO

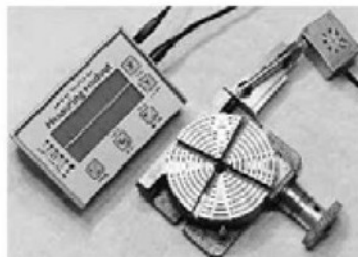
MODEL ENGINEERING SERVICES

PIPWORTH FARM, PIPWORTH LANE, ECKINGTON, SHEFFIELD S21 4EY

PHONE 01246 433218

www.lawm.freeserve.co.uk

BANISH STRUGGLES



Sensors can be recalibrated, e.g. to read degrees on a rotary table or teeth for use as a dividing head (see photo)

BW Electronics, 12 Mussons Close, Corby Glen, Grantham, NG33 4NY
Tel/fax: 01476-550826 • Website: www.bwelectronics.co.uk

by fitting BW Electronic's new measuring readout

- large bright LED display
- inch /mm conversion
- zero datum for both axes
- two independent datums
- positions can be preset
- radius / diameter working
- halfway point calculation
- unclip sensors and move them between machines

Complete system (332 display, two 361 sensors, power supply, manual): £425 (incl. VAT and p+p)

Folkestone Engineering Supplies

F.E.S. - run by a model engineer enthusiast, for model engineers.
Fast friendly service, competitive prices, no minimum order value, no VAT and large stocks.

Why not ask for our free catalogue or visit our web site.
Fasteners (metric & imperial), ferrous and non-ferrous metals (round, hex, square, flat, etc), also off-cuts (subject to availability).
Goods supplied mail order or callers (by appointment) welcome.

Tel: 01303 894611 email metal2models@btopenworld.com
www.metal2models.btinternet.co.uk

A small sample of our stock and prices are shown below.
Metal priced per 300mm/11.8" length, larger sizes are priced by the 150mm, 75mm and 25mm.

	BMS	Brass	Aluminium	Stainless-Steel
1/4" Rnd	£0.25	£0.42	£0.39	£0.78
1/2" Rnd	£0.68	£1.41	£1.18	£2.68
3/4" Rnd	£1.34	£3.35	£1.97	£5.04
1.0" Rnd	£2.08	£5.75	£3.35	£6.48
1/4" Hex	£0.28	£0.46	£1.00	£1.38
1/2" Hex	£0.68	£1.58	£1.50	£2.60
3/4" Hex	£1.92	£3.71	£3.10	£8.04
1.0" Hex	£2.84	£5.87	£4.20	£10.92
1/4" Sqre	£0.28	£0.79	£0.50	£1.55
1/2" Sqre	£0.87	£2.88	£1.41	£3.77
3/4" Sqre	£1.77	£5.12	£2.65	£5.86
1.0" Sqre	£3.18	£10.31	£4.95	£8.32

See us at
Sandown
29th-31st
December
Stand
A41

BMS available in EN1A, EN8, EN16T and EN24T

Socket Screws - price per item (Quantity discount available)

cap head M3x6mm 11p M3x8mm 10p M3x10mm 9p M3x12mm 10p

cap head 1/4" BSPx1/2" 30p 1/4" BSPx3/4" 30p 1/4" BSPx1" 32p

grab/set 4BAx1/8" 16p 4BAx3/16" 17p 4BAx1/4" 16p 4BAx3/8" 21p

grab/set M3x3mm 8p M4x4mm 7p M5x5mm 8p M6x6mm 8p

62 Canterbury Road, Hawkinge, Kent CT18 7BP

Open weekdays (0900-1600)

Satur day mornings (0900-1200)



If you are
reading this
it proves
advertising
works.

INTERNATIONAL

Model Boat

SHOW

Warwickshire
Exhibition Centre

Fosse Way, near Leamington Spa,

Warwickshire

on the junction of the A425 & A455

The only
major 3 day
Marine Modelling
Exhibition
in the U.K.

8-10 November 2002

10.30am
- 5.00pm
Daily
(last admissions 4pm)

Admission: Adults £6 Seniors £5 Children £3.50

Family Ticket £16 (2 Adults and up to 3 children)

Telephone 01926 614101

email: info@meridienne.co.uk

Organised by: Meridienne Exhibitions Ltd., The Fosse, Fosse Way, Leamington Spa CV31 1NN

LOCOMOTIVE DRAWINGS & CASTINGS

Thinking of building your first Locomotive or starting another one. See below what we have to offer.

Send for an itemised list of any of our range of 45 selected Locomotives.
Top quality Drawings, Cast Iron or Gunmetal Castings.

7.1/4"G	Tich	0-4-0	3.1/2"G	Britannia	4-6-2
7.1/4"G	1366	0-6-0	3.1/2"G	Molly	0-6-0
5"G	Dholpur	2-8-4	3.1/2"G	Cent. Lamb	0-4-0
5"G	Butch	0-6-0	3.1/2"G	Petrollea	2-4-0
5"G	Chub	0-4-0	3.1/2"G	Iris	0-6-0
5"G	Simplex	0-6-0	3.1/2"G	Doris	4-6-0
5"G	Springbok	4-6-0	3.1/2"G	Rainhill	0-2-2
5"G	King John	4-6-0	3.1/2"G	Heilan Lass.	4-6-2
5"G	Dean Goods	0-6-0	3.1/2"G	Rob Roy	0-6-0
5"G	2251	0-6-0	3.1/2"G	Miss 10 to 8	4-4-0
5"G	Firefly	2-6-2	3.1/2"G	Juliet	0-4-0
5"G	Mogul	2-6-2	3.1/2"G	Virginia 4-4-0	
5"G	Peggy	0-4-0	3.1/2"G	Maisie	4-4-2
5"G	Twin Sisters	0-6-0	3.1/2"G	City of Truro	4-4-0
5"G	Pansy	0-6-0	3.1/2"G	P.V. Baker	0-6-0
5"G	Tich	0-4-0			
5"G New	Comboyne	4-4-2T	Radial Tank - L.S.W.R. 415 Class		
5"G New	Nine Elms	0-4-2	L.S.W.R. A12 Class with Beyer Tender		
5"G New	Salisbury	4-4-0	L.S.W.R. 460 Class		
0"G	Princess Coronation	4-6-2	2.1/2"G	Southern Maid	0-6-0
0"G	Morris de Cowley	4-6-2	2.1/2"G	Austere Ada	2-8-0
0"G	Hertford Hall	4-6-0	2.1/2"G	Olympiade	4-6-0
0"G	Royal Scot	4-6-0	2.1/2"G	Fayette	4-6-2
0"G	Josie	4-6-4	2.1/2"G	Purley Grange	4-6-0

BUILD OUR POPULAR HORIZONTAL MILL ENGINE

1" Bore x 1.1/2" Stroke - Slide Valve
Length of Baseplate 12" - Diameter of Flywheel 6"
Height 6" - Width 6" - Weight 4.1/2 Kilos
Complete with full building Manual
Unbeatable value at this price
£110 + £5.95 Carriage inclusive of VAT

MULTI-TUBULAR BOILER KIT

Runs on Coal - Gas - Spirit
4" dia. x 16swg Copper tube - 8.1/2" high
25 5/16" x 20g Copper tubes
Firebox 3.1/2" dia. 3.1/2" long
Working pressure 80psi
Suitable for above or similar engines
£55.00 + £5.50 Carriage inclusive of VAT

Both the above were serialised
in Model Engineer Jan 96-Aug
97 Built and serialised by Stan
Bray in Brays Bench

G.L.R. DISTRIBUTORS LTD. UNIT C1, GEDDINGS ROAD, HODDESDON, HERTS. EN11 0NT

Web site - www.glrmodelsupplies.com

E-Mail - peteglr@btopenworld.com

Tel. 01992 470098 Fax. 01992 468700

Send six First Class stamps for Catalogue. Hardback or CD

SEND FOR PRICE LIST OF ANY OF THE LOCOMOTIVES ABOVE

DORMER H.S.S. Drill Sets

Made in England

**SPECIAL
HALF PRICE
OFFER**

- * SET 202 1 to 6mm x 0.1mm (51 Drills, Metal Case)
Normally, £89.66 HALF PRICE £44.83
 - * SET 203 6 to 10mm x 0.1mm (41 Drills, Metal Case)
Normally, £187.25 HALF PRICE £93.63
 - * SET 204 1 to 13mm x 0.5mm (25 Drills, Metal Case)
Normally, £109.45 HALF PRICE £54.73
 - * SET 18 1/16 to 1/2in x 1/64in (29 Drills, Metal Case)
Normally, £137.80 HALF PRICE £68.90
 - * SET 14 Letter Drills A-Z (26 Drills, Metal Case)
Normally, £245.15 HALF PRICE £122.60
 - * SET 12 Number Drills 1 to 60 (60 Drills, Metal Case)
Normally, £160.33 HALF PRICE £80.20
- Please add £2.50 P&P on above Metal Cased sets
- * SET 61/80 Number Drills 61 to 80 (Plastic Case)
Normally, £77.50 HALF PRICE £38.75
 - * SET 31M 0.3 to 1.0mm (20 Drills, Plastic Case)
Normally, £58.70 HALF PRICE £29.35
 - * SET 513 1/6 to 1/4in x 1/64in. (13 Drills, Plastic Case)
Normally, £24.64 HALF PRICE £12.32
 - * SET 613 1 to 6mm x 0.5mm. (13 Drills, Plastic Case)
Normally, £22.50 HALF PRICE £11.25



TOS LATHE CHUCKS

(Crch)

NEW LOW PRICES

3 and 4 Jaw Self-Centring
Lathe Chucks

	Old Price	Price Now
3 Jaw Self-Centring		
80mm (3 in.)	£60.75	£57.75
100mm (4 in.)	£67.95	£63.95
125mm (5 in.)	£74.75	£71.00
160mm (6 in.)	£95.75	£91.00
4 Jaw Self-Centring		
80mm (3 in.)	£77.25	£71.00
100mm (4 in.)	£85.00	£75.50
125mm (5 in.)	£91.75	£84.00
160mm (6 in.)	£128.75	£120.00

Part-Machined Backplates (bored & threaded)

Myford (1 1/8" x 12 tpi) 4 in. - £25.00 5 in. - £29.75

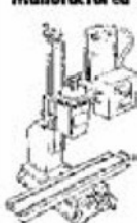
Boxford (1 1/8" x 8 tpi) 5 in. - £29.75 6 in. - £39.75

Unmachined Backplate Castings

3 in. - £8.75 4 in. - £9.50 5 in. - £12.50
6 in. - £18.50 8 in. - £28.50

SHERLINE MINIATURE LATHES AND MILLING MACHINES

Manufactured to high standards in the U.S.A.



Sherline Milling Machine

Throat Depth 2 1/2 in.
Table Size 2 1/4 x 13 in.
X Travel 9 in.
Y Travel 3 in.
Z Travel 6 1/2 in.
Electronic Variable Speed
Control 70 to 3000 rpm
PRICE £495 + £10 Carr.

Sherline Lathe

Centre Height 1 1/2 in.
Dist. between centres
8 in., variable speed
control as mill above.



PRICE £495 + £10 Carr.

Price includes 3 jaw lathe chuck and tailstock drill
chuck. Huge range of accessories. Send for the free
Sherline 46 page brochure and our price list.

BOOK: Tabletop Machining by Joe Martin

A basic approach to making small parts on miniature
machine tools. 338 pages. Price £32.00

SKODA QUALITY LIVE CENTRES at Reduced Prices



MT1 - was £29.00 now **£25.00**

MT2 - was £35.00 now **£29.00**

MT3 - was £45.00 now **£39.00**

SIEVERT L.P.G. EQUIPMENT

Starter Set for Model Engineers

Comprises 3061 Regulator, 2 metre Hose,
3486 Handle, 3511 Necktube & 2941 Burner
Special Offer £97.50 - Normally £114.45

Other Sievert items also available



We have many more items for Model Engineers - Send for our free catalogue - Satisfaction or refund.

All prices include VAT and post (except where stated) - Major credit cards accepted.

MILLHILL SUPPLIES, 66 THE STREET, CROWMARSH GIFFORD, WALLINGFORD, OXON OX10 8ES

Tel. 01491 838653 • Fax. 01491 825510 • E-mail: sales@millhillsupplies.co.uk • Website: www.millhillsupplies.co.uk



Clarke METAL LATHE - CL300M

ONLY £399.95
£469.95



Full range of accessories available

BEST SELLER

- Power feed
- 300mm between centres
- 1/4" NPT thread screw cutting
- Gear change set
- Self centring 3 jaw chuck with guard
- Electronic variable speed
- Compound rest slide & 4 way tool post

Machine Mart

WEBSITE ORDER ONLINE
www.machine-mart.co.uk

where Quality costs less

44 SUPERSTORES NATIONWIDE

Clarke 6 SPEED METAL LATHE WITH 12 SPEED MILL/DRILL HEAD - CL500M

ONLY £699.95
£822.95

Full range of accessories available



Shown with optional floor stand ONLY £119.95 EX VAT £140.94 INC VAT

- 450mm between centres
- Compound slide with 4 way tool post
- Power feed screw cutting facility
- Forward/reverse lathe operation
- Clutch for independent mill/drill operation

Clarke DRILL PRESSES

FROM ONLY £33.95
£39.95



- Safety cutout on belt guard
- Table tilt 0-45° left and right
- Depth gauge
- Chuck guards

Full range of drill vices available to

* Includes wet T slot table & workbits

Clarke DRILL PRESSES

FROM ONLY £33.95
£39.95



Full range of drill vices available to

* Includes wet T slot table & workbits

MODEL	QUICK FEED	SPD	WHS	EX VAT	INC VAT
CDP300	10mm	5	•	£33.95	£40.74
CDP300S	10mm	5	•	£33.95	£40.74
CDP310	10mm	5	•	£33.95	£40.74
CDP310S	10mm	5	•	£33.95	£40.74
CDP315	10mm	5	•	£33.95	£40.74
CDP315S	10mm	5	•	£33.95	£40.74
CDP320	10mm	5	•	£33.95	£40.74
CDP320S	10mm	5	•	£33.95	£40.74
CDP325	10mm	5	•	£33.95	£40.74
CDP325S	10mm	5	•	£33.95	£40.74
CDP330	10mm	5	•	£33.95	£40.74
CDP330S	10mm	5	•	£33.95	£40.74
CDP335	10mm	5	•	£33.95	£40.74
CDP335S	10mm	5	•	£33.95	£40.74
CDP340	10mm	5	•	£33.95	£40.74
CDP340S	10mm	5	•	£33.95	£40.74
CDP345	10mm	5	•	£33.95	£40.74
CDP345S	10mm	5	•	£33.95	£40.74
CDP350	10mm	5	•	£33.95	£40.74
CDP350S	10mm	5	•	£33.95	£40.74
CDP355	10mm	5	•	£33.95	£40.74
CDP355S	10mm	5	•	£33.95	£40.74
CDP360	10mm	5	•	£33.95	£40.74
CDP360S	10mm	5	•	£33.95	£40.74
CDP365	10mm	5	•	£33.95	£40.74
CDP365S	10mm	5	•	£33.95	£40.74
CDP370	10mm	5	•	£33.95	£40.74
CDP370S	10mm	5	•	£33.95	£40.74
CDP375	10mm	5	•	£33.95	£40.74
CDP375S	10mm	5	•	£33.95	£40.74
CDP380	10mm	5	•	£33.95	£40.74
CDP380S	10mm	5	•	£33.95	£40.74
CDP385	10mm	5	•	£33.95	£40.74
CDP385S	10mm	5	•	£33.95	£40.74
CDP390	10mm	5	•	£33.95	£40.74
CDP390S	10mm	5	•	£33.95	£40.74
CDP395	10mm	5	•	£33.95	£40.74
CDP395S	10mm	5	•	£33.95	£40.74
CDP400	10mm	5	•	£33.95	£40.74
CDP400S	10mm	5	•	£33.95	£40.74
CDP405	10mm	5	•	£33.95	£40.74
CDP405S	10mm	5	•	£33.95	£40.74
CDP410	10mm	5	•	£33.95	£40.74
CDP410S	10mm	5	•	£33.95	£40.74
CDP415	10mm	5	•	£33.95	£40.74
CDP415S	10mm	5	•	£33.95	£40.74
CDP420	10mm	5	•	£33.95	£40.74
CDP420S	10mm	5	•	£33.95	£40.74
CDP425	10mm	5	•	£33.95	£40.74
CDP425S	10mm	5	•	£33.95	£40.74
CDP430	10mm	5	•	£33.95	£40.74
CDP430S	10mm	5	•	£33.95	£40.74
CDP435	10mm	5	•	£33.95	£40.74
CDP435S	10mm	5	•	£33.95	£40.74
CDP440	10mm	5	•	£33.95	£40.74
CDP440S	10mm	5	•	£33.95	£40.74
CDP445	10mm	5	•	£33.95	£40.74
CDP445S	10mm	5	•	£33.95	£40.74
CDP450	10mm	5	•	£33.95	£40.74
CDP450S	10mm	5	•	£33.95	£40.74
CDP455	10mm	5	•	£33.95	£40.74
CDP455S	10mm	5	•	£33.95	£40.74
CDP460	10mm	5	•	£33.95	£40.74
CDP460S	10mm	5	•	£33.95	£40.74
CDP465	10mm	5	•	£33.95	£40.74
CDP465S	10mm	5	•	£33.95	£40.74
CDP470	10mm	5	•	£33.95	£40.74
CDP470S	10mm	5	•	£33.95	£40.74
CDP475	10mm	5	•	£33.95	£40.74
CDP475S	10mm	5	•	£33.95	£40.74
CDP480	10mm	5	•	£33.95	£40.74
CDP480S	10mm	5	•	£33.95	£40.74
CDP485	10mm	5	•	£33.95	£40.74
CDP485S	10mm	5	•	£33.95	£40.74
CDP490	10mm	5	•	£33.95	£40.74
CDP490S	10mm	5	•	£33.95	£40.74
CDP495	10mm	5	•	£33.95	£40.74
CDP495S	10mm	5	•	£33.95	£40.74
CDP500	10mm	5	•	£33.95	£40.74
CDP500S	10mm	5	•	£33.95	£40.74
CDP505	10mm	5	•	£33.95	£40.74
CDP505S	10mm	5	•	£33.95	£40.74
CDP510	10mm	5	•	£33.95	£40.74
CDP510S	10mm	5	•	£33.95	£40.74
CDP515	10mm	5	•	£33.95	£40.74
CDP515S	10mm	5	•	£33.95	£40.74
CDP520	10mm	5	•	£33.95	£40.74
CDP520S	10mm	5	•	£33.95	£40.74
CDP525	10mm	5	•	£33.95	£40.74
CDP525S	10mm	5	•	£33.95	£40.74
CDP530	10mm	5	•	£33.95	£40.74
CDP530S	10mm	5	•	£33.95	£40.74
CDP535	10mm	5	•	£33.95	£40.74
CDP535S	10mm	5	•	£33.95	£40.74
CDP540	10mm	5	•	£33.95	£40.74
CDP540S	10mm	5	•	£33.95	£40.74
CDP545	10mm	5	•	£33.95	£40.74
CDP545S	10mm	5	•	£33.95	£40.74
CDP550	10mm	5	•	£33.95	£40.74
CDP550S	10mm	5	•	£33.95	£40.74
CDP555	10mm	5	•	£33.95	£40.74
CDP555S	10mm	5	•	£33.95	£40.74
CDP560	10mm	5	•	£33.95	£40.74
CDP560S	10mm	5	•	£33.95	£40.74
CDP565	10mm	5	•	£33.95	£40.74
CDP565S	10mm	5	•	£33.95	£40.74
CDP570	10mm	5	•	£33.95	£40.74
CDP570S	10mm	5	•	£33.95	£40.74
CDP575	10mm	5	•	£33.95	£40.74
CDP575S	10mm	5	•	£33.95	£40.74
CDP580	10mm	5	•	£33.95	£40.74
CDP580S	10mm	5	•	£33.95	£40.74
CDP585	10mm	5	•	£33.95	£40.74
CDP585S	10mm	5	•	£33.95	£40.74
CDP590	10mm	5	•	£33.95	£40.74
CDP590S	10mm	5	•	£33.95	£40.74
CDP595	10mm	5	•	£33.95	£40.74
CDP595S	10mm	5	•	£33.95	£40.74
CDP600	10mm	5	•	£33.95	£40.74
CDP600S	10mm	5	•	£33.95	£40.74
CDP605	10mm	5	•	£33.95	£40.74
CDP605S	10mm	5	•	£33.95	£40.74
CDP610	10mm	5	•	£33.95	£40.74
CDP610S	10mm	5	•	£33.95	£40.74
CDP615	10mm	5	•	£33.95	£40.74
CDP615S	10mm	5	•	£33.95	£40.74
CDP620	10mm	5	•	£33.95	£40.74
CDP620S	10mm	5	•	£33.95	£40.74
CDP625	10mm	5	•	£33.95	£40.74
CDP625S	10mm	5	•	£33.95	£40.74
CDP630	10mm	5	•	£33.95	£40.74
CDP630S	10mm	5	•	£33.95	£40.74
CDP635	10mm	5	•	£33.95	£40.74
CDP635S	10mm	5	•	£33.95	£40.74
CDP640	10mm	5	•	£33.95	£40.74
CDP640S	10mm	5	•	£33.95	£40.74
CDP645	10mm	5	•	£33.95	£40.74
CDP645S	10mm	5	•	£33.95	£40.74
CDP650	10mm	5	•	£33.95	£40.74
CDP650S	10mm	5	•	£33.95	£40.74
CDP655	10mm	5	•	£33.95	£40.74
CDP655S	10mm	5	•	£33.95	£40.74
CDP660	10mm	5	•	£33.95	£40.74
CDP660S	10mm	5	•	£33.95	£40.74
CDP665	10mm	5	•	£33.95	£40.74
CDP665S	10mm	5	•	£33.95	£40.74
CDP670	10mm	5	•	£33.95	£40.74
CDP670S	10mm	5	•	£33.95	£40.74
CDP675	10mm	5	•	£33.95	£40.74
CDP675S	10mm	5	•	£33.95	£40.74
CDP680	10mm	5	•	£33.95	£40.74
CDP680S	10mm	5	•	£33.95	£40.74
CDP685	10mm	5	•	£33.95	£40.74
CDP685S	10mm	5	•	£33.95	£40.74
CDP690	10mm	5	•	£33.95	£40.74
CDP690S	10mm	5	•	£33.95	£40.74
CDP695	10mm	5	•	£33.95	£40.74
CDP695S	10mm	5	•	£33.95	£40.74
CDP700	10mm	5	•	£33.95	£40.74
CDP700S	10mm	5	•	£33.95	£40.74
CDP705	10mm	5	•	£33.95	£40.74
CDP705S	10mm	5	•	£33.95	£40.74
CDP710	10mm	5	•	£33.95	£40.74
CDP710S	10mm	5	•	£33.95	£40.74
CDP715	10mm	5	•	£33.95	£40.74
CDP715S	10mm	5	•	£33.95	£40.74
CDP720	10mm	5	•	£33.95	£40.74
CDP720S	10mm	5	•	£33.95	£40.74
CDP725	10mm	5	•	£33.95	£40.74
CDP725S	10mm	5	•	£33.95	£40.74
CDP730	10mm	5	•	£33.95	£40.74
CDP730S	10mm	5	•	£33.95	£40.74
CDP735	10mm	5	•	£33.95	£40.74
CDP735S	10mm	5	•	£33.95	£40.74
CDP740	10mm	5	•	£33.95</	

SUBSCRIBE
NOW!

Only 95p

for your first issue!



▲ Aimed at sports bike riders; Fast Bikes packages industry-benchmark road tests, with: topical, humorous, informative and entertaining lifestyle features.

▲ Filled with top charts, slick tuning tips and the best looking laydees on the planet. Fast Car is the 'Daddy'.

▲ Whether you simply enjoy reading about classic cars or are looking for practical advice, Classics is the essential companion.

GREAT MAGAZINES

Save up to 33%

PLUS



FREE VOUCHER

offering you a great holiday discount with every subscription!*



Highbury House Communications PLC may share information about you with other companies within the Highbury House Communications PLC group and with other reputable companies so that we may let you know about products and services, which may be of interest to you. If you would prefer not to receive this information, please tick applicable box. Subscriptions will begin with the next available issue. Open to UK residents only. This offer closes 26th February 2003.

* Terms and conditions apply.



HIGHBURY HOUSE
Communications PLC

Exclusive Subscription Offer

From the UK's best publisher of special interest magazines.

- First issue only 95p
- Free discount voucher
- Great magazines!

Subscribe today to any of these magazines and get your first issue for only 95p! Then you only pay £2.99 per issue thereafter. This is one of many special subscription offers available on over 40 Highbury House magazines. Look out for more fantastic titles in your next issue.

Just complete your details below or phone our **subscription hotline on**

01353 654434

QUOTE REF: OVW01

YES! I would like to subscribe to:

- ☐ **FAST CAR** 6 issues for £15.90 ☐ **FAST BIKES** 6 issues for £15.90 ☐ **CLASSICS** 6 issues for £15.90
☐ **FAST CAR** 12 issues for £31.80 ☐ **FAST BIKES** 12 issues for £31.80 ☐ **CLASSICS** 12 issues for £31.80

Is this a renewal of a current subscription? ☐ Yes ☐ No

Method of Payment

- ☐ Cheque (made payable to Highbury House Publishing Ltd)
☐ Mastercard ☐ Visa ☐ Switch Cardholder's name: _____

Card no: [] [] [] [] [] [] [] [] [] [] [] [] [] [] [] [] Issue no: [] [] [] [] Valid date: [] [] [] []
 Expiry date: [] [] [] [] Signed: _____ Date: _____

My Details

Title: _____ Forename: _____ Surname: _____

Address: _____

Postcode: _____ Tel: _____ E-mail: _____

I would like a gift subscription for:

Title: _____ Forename: _____ Surname: _____

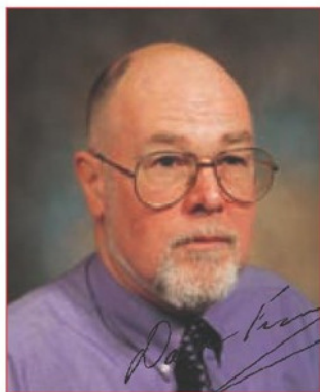
Address: _____

Postcode: _____ Tel: _____ E-mail: _____

PLEASE RETURN YOUR COMPLETED COUPON TO:

Highbury Subscriptions, Link House, 8 Bartholomews Walk, Ely, Cambs CB7 4ZD
 Tel: 01353 654434, Fax 01353 654400, wss@wyverncrest.co.uk

OVW01



ON THE EDITOR'S BENCH

information contact Meridienne Exhibitions Ltd. on 01926 614 101

International Model Boat Show

Celebrating its fifth anniversary this established event (the only three day show aimed exclusively at marine modellers) promises to be even bigger and better for 2002. Two indoor pools will offer displays by exhibiting clubs, as well as free sailing. The larger pool extends to 1500 square feet, and includes a harbour and other skill testing features.

The exhibition will be held at the Warwickshire Exhibition Centre, conveniently located on the Fosse Way near Leamington Spa, just a few miles from the main motorway network in the Midlands. Ample free car parking, disabled access, and full restaurant facilities are available.

The event will be open from 10am to 5pm (last admissions 4pm Friday 8th to Sunday 10th November, and ticket prices are Adults - £6, Senior Citizens - £5, Children £3-50, Family (2 adults plus up to three children) £16. For further

Out and about

"Farming Yesteryear" is organised by the Scottish Vintage Tractor and Engine Club and takes place in early September in the grounds of Scone Palace. Although the underlying theme is agricultural, the event is a forum for most historic things mechanical, including steam traction engines, tractors, farm and horticultural machinery, bicycles, motorcycles, cars, commercial vehicles, military vehicles, and stationary engines. On a "workshop" theme, the "portable" sawmill belt driven from a traction engine, produced its own

Variable Speed Drives

Elsewhere in this issue Dr Vassilii Zakharov describes a budget approach to motor speed control using washing machine parts. Inverter drives for three phase machinery are an accepted higher cost alternative, and it was noted in an earlier issue that government incentives aim to encourage the take up of such energy efficient equipment. Not many years ago the market was dominated by two or three names, however thumbing through the pages of one trade magazine revealed that around a dozen manufacturers are now competing in this area. It is to be hoped that this will make such equipment even more accessible since it provides an avenue to power cheap surplus industrial machines from the single phase domestic supply.

In the workshop

Work on the trailer has moved forward, with the main structure being essentially complete, while the brake mechanism and suspension control are in progress. A 1200lb. hand winch has been obtained, which with its 65 feet of cable should be sufficient since this will allow doubling around a pulley block if ever necessary. It

small mountain of sawdust during demonstrations.

Historically, the weather has almost always been kind to this event, however this year was the exception, with a succession of sharp downpours conspiring to dampen spirits in between the bright intervals. Fortunately the forecast was accurate, and waterproofs had been donned. With something over a thousand individual exhibits, this event can probably challenge the Glamis Extravaganza for the premier title for this type of event north of the border.

was noticeable that as fabrication work proceeded, the standard of welding improved visibly, a clear case of practice making, if not perfect, at least a few tentative steps in the general direction of the elusive perfection.

On a totally different topic, an acquaintance called by to raise the question of restoring a worn pre-war Wolseley king pin assembly. Examination and measurement showed slight wear on the hardened pin, and rather more on the bushes. At the time of writing he is attempting to track down new replacement parts, however if these prove unobtainable, then it may be a case of lightly grinding the pin diameter, either between centres, or using the Grind All, and then turning up undersize bushes to match.

DRO Developments

This issue includes articles relating to the two extremes of capital spend on such devices. Having some years ago fitted a two axis system to my Beaver Mill, I am well aware of the usual advantages. In addition, my rotary table has become all but redundant except for milling curved surfaces. A number of years ago, Richard Bartlett introduced Compucut, making affordable CNC available to the amateur workshop. Now in conjunction with software developed by Alan Good, he has come up with an ultra low budget system for positional readout, using computer mouse internals.

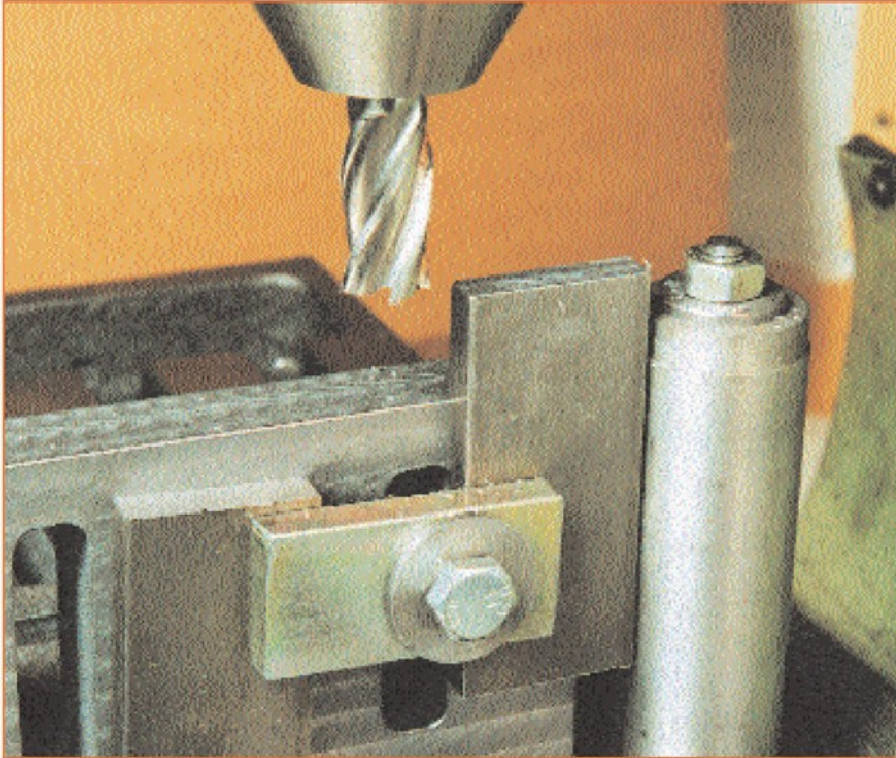
The recent arrival of relatively low cost readout scales of oriental origin has added a further mid range budget twist to matters. Fitted to a typical mill as supplied, they are less than totally convenient, in that one needs to almost prostrate oneself before the machine in order to peer at the smallish figures in awkward places (notably y axis). For additional cost, they can be connected to a remote repeater for more convenient reading.

Also using these scales, one of our local club members, John Curtis, has achieved a similar easy to read result by feeding the outputs of up to four such scales via a multiplexing board to a PC, giving large on screen digits. If scales are fitted to both quill and knee, then a corrected Z figure can be shown. Given that computers are now so cheap, this promises to add convenience to such a setup at relatively little cost.

It is hoped to feature an article on John's system, in the not too distant future, however prospective builders will require the production of a programmed chip (this being outwith most amateur capabilities), and as yet, no commercial arrangements have been made for this.



MILLING PROJECTS FOR BEGINNERS (3)



1. Machining the first end of the clamp, do machine towards the cylindrical square for added security.

For this the third part of the series we are producing two very simple items, one essential for use on the milling machine, the other almost equally so. The items are clamp bars and parallels.

The Clamp Bars

It would be tempting in the case of the clamps to cut a few short lengths of steel, drill a hole for the clamp stud, debur, and call it a day. We are in this though for the experience so will aim at a more professional finish and useful result. The dimensions on the drawing are for guidance only as size of machine, may dictate the size made. Do though ensure they are sufficiently robust, if in doubt be cautious and use a thicker material. Eight millimetres thick would seem a sensible minimum for use on all but the lightest milling machine. The slot and hole will of course have to suit the clamping stud size. I have suggested a set of dimensions in **Sk.1**.

First decide how many are to be made and cut off this number from the bar of material adding 1 to 2mm for final machining. As to quantity I would suggest 6 minimum. This may seem more than is likely to be used at any one time but as we shall see shortly other uses than direct

clamping do frequently occur.

Mount the angle plate and one of the cylindrical squares (as covered in the previous article) and first clamp as in **Photo 1**, you will need to make a simple clamp with a single hole if you do not have one. Use one of the other clamp pieces as packing for the clamp though it is best practice for the clamp packing to be just higher than the part being held. This I normally achieve by placing a thin piece of card under the part being used as packing. Machine the top face of the part and unless you have a large diameter cutter two passes will be necessary. In all milling operations it is highly desirable to machine towards the supporting items, in this case the cylindrical square. If machining was away from the square, that is from right to left in the photograph, the single clamp may not adequately hold the part. Eagle eyed readers may observe that the clamp stud could be higher in the angle plate slot, ensuring that the clamp held the part nearer the edge being machined for improved security. This though is not the case as I find that using a Tee nut in the slot enables nuts to be tightened without the need for a second spanner, and often a third hand. The T nut does though prevent the screw from being close to the slot end, and I intend to make some special nuts as shown in **Sk.2** for use in this way.

In section three of the series, Harold Hall focuses on two simple but essential accessories.

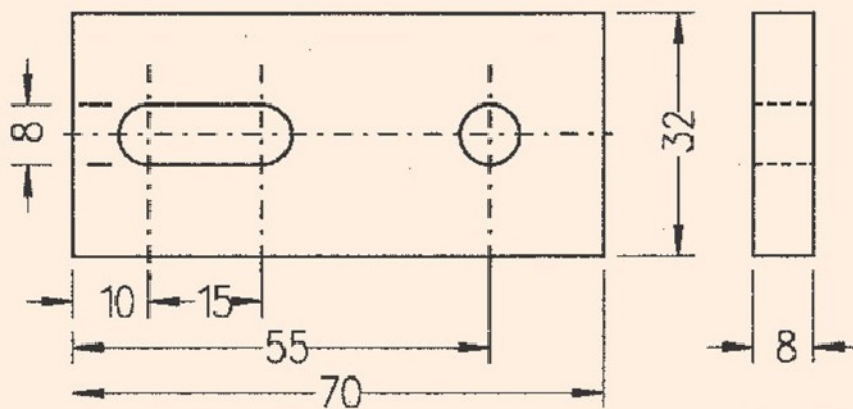
T nuts, other uses

Having trimmed the first end of all the clamps, machine the second in a similar manner, **Photo 2**. At first this may appear identical to photo 1 but closer examination shows that the part is being supported by a screw screwed into a T nut, illustrating a point made earlier that there are uses for T nuts other than pure clamping. When fitting, turn the screw until it contacts the bottom of the T slot and very lightly tighten. This then supports each part as they are fitted onto the angle plate so that each new part can easily be machined to the same length without recourse to measurement or reading leadscrew dials. A real time saving benefit when a number of identical parts are being made.

Secure clamping

Next mark out the parts for drilling the holes and just one with the width and length extremities of the slot to be made. Drill the single hole in each one and use this for securing them to the machine table as in **Photo 3**. I cannot stress too much to err very much on the safe side when it comes to securing parts for machining, one too many a clamp is very much better than one to few. With that in mind, placing support pieces, which do not actually grip the part, but prevent sideways movement, will give added security, often in places when an additional direct clamp cannot be applied, as will be seen through the series. They may also function as positioning stops when multiple components are being handled.

In this case a single screw fixing would probably suffice, especially as it is a slot being produced that will not tend to place any side load on the item. The support pieces in the photo do though perform a very important additional function. Mount first the clamp that had the slot positions marked onto it and position it using an engineers square of the front face of the machine table. Clamp it in place using the single screw then add the two support pieces as shown in the photograph. As you become more involved in milling machine activities such additional aids to completing the task will become necessary, so do make a habit of keeping these bits and pieces handy for possible future use. Of course the clamps now being made could perform this task for future operations, hence my comment



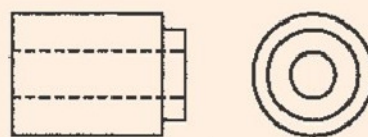
SUGGESTED SIZE ONLY, DIMENSIONS MAY CHANGE TO SUIT MACHINE AND CLAMP STUD SIZES.

SK11 Suggested clamp dimensions



WHEN USING A T NUT WITH THE FACE PLATE OR ANGLE PLATE, NUTS MADE AS PER THE ABOVE FORM WILL ENABLE BETTER USE OF THE SLOTS TO BE MADE

SK2 Modified T nut



SK3 Post

©

regarding making a sufficient number.

Fit a slot drill of a size that will cut the slot at one pass. If however a sufficiently wide slot drill is not available, then widen the slot with a second pass. (For this, I prefer to use an end mill rather than a slot drill, as I feel that the former may be more robust when cutting on one side only.) With the machine stationary lower the cutter so it is almost touching the workpiece. Then, with the cutting edges in line with the cross travel use the cross

feed to align the cutter with the marks on the workpiece, lock the cross feed in this position. Now rotate the cutter ninety degrees and traverse the table until the cutting edge lines up with the end mark and set the first table stop (bottom photograph 3) at this point. Knowing the length of the slot, and the diameter of the cutter, set the second table stop with the gap required, and traverse the table to check against the other end mark on the clamp. Various techniques may be found

useful for setting the second stop, distance gauges, a drill or bar of suitable diameter, each of which may be augmented by feeler gauges for fine adjustment. In each case check with micrometer.

Start the machine and plunge the cutter into the workpiece, say by 1mm, (or more if yours is a heavier machine), and make the first cut. Slot drills can be used in either direction, so plunge the cutter by a further 1mm and take a cut in the reverse direction. Continue until the slot breaks through on the other side. As the slot aligns with the T slot there is no danger of the cutter damaging the table surface. The positioning pieces on the table, and the end stops having been set, will make the repeat machining of the remaining clamps very straight forward.

You may consider that the single hole in the clamp is purely for this machining operation but we shall see later in the series that it has a very important role to play. Generously debur all edges and the clamps are complete.

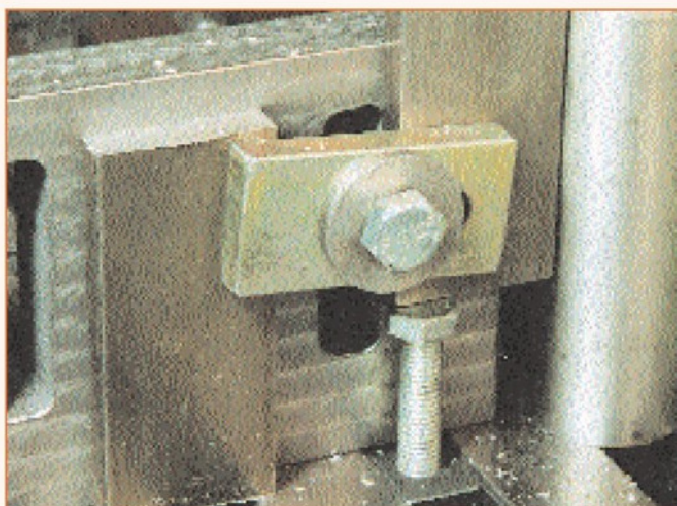
Parallels

Almost as essential as the clamps above are a set of parallels for use during milling operations. These could be commercially made items, ones made by the user, or, as so often is the case, just off-cuts from mild steel bar. Whilst in many cases the latter may be adequate, especially when used as a single parallel, two pieces of bar, especially if taken from different bars, may not be sufficiently identical. On the other hand the hardened and ground commercial variety will be of an accuracy rarely required and be a little on the expensive side. Of more significance though with these is that they will not be available in a sufficiently wide range of heights, especially if the cost is a consideration. Making your own is therefore a worthwhile option as the cost will be minimal and a wide range of sizes will present no problem.

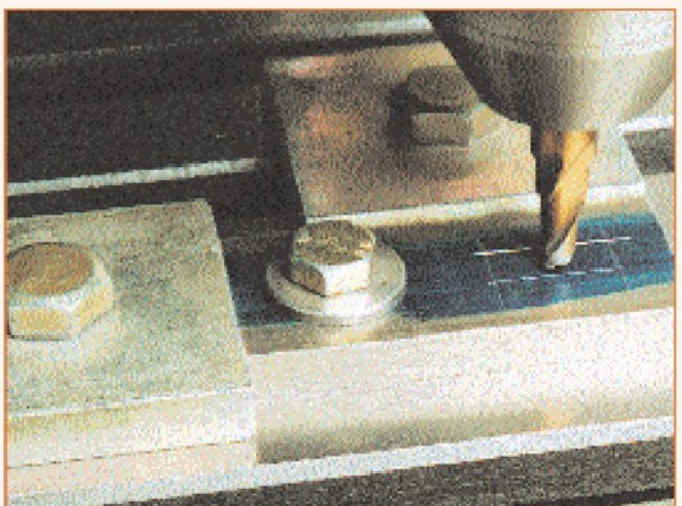
Parallel, How?

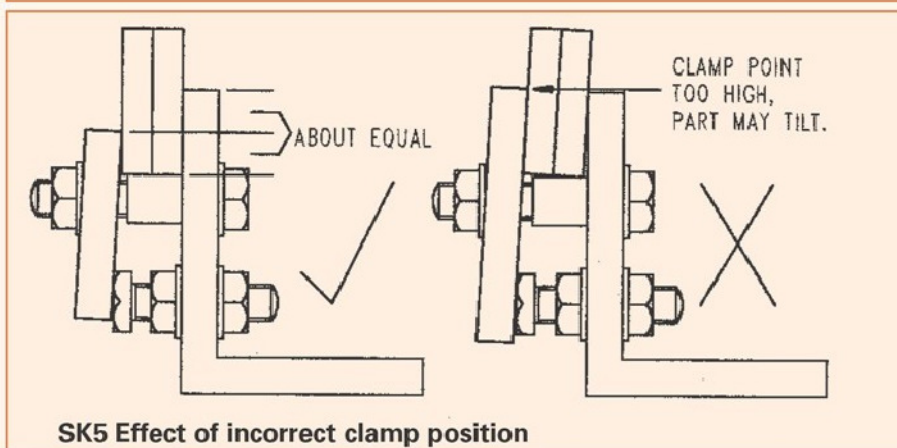
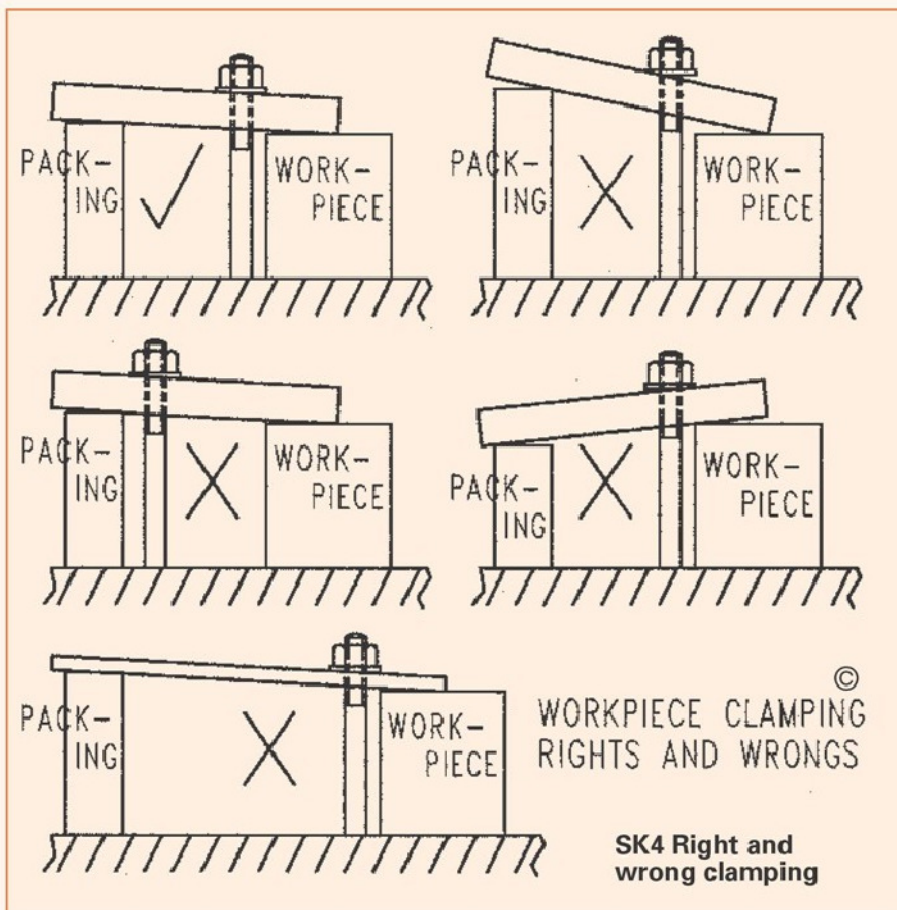
The aim will be to create parallels in pairs that are both parallel along their length and of exactly the same height, at least within good home workshop standards,

2. The positioning screw below the clamp piece enables all the clamps to be easily machined to the same length when machining the second end.

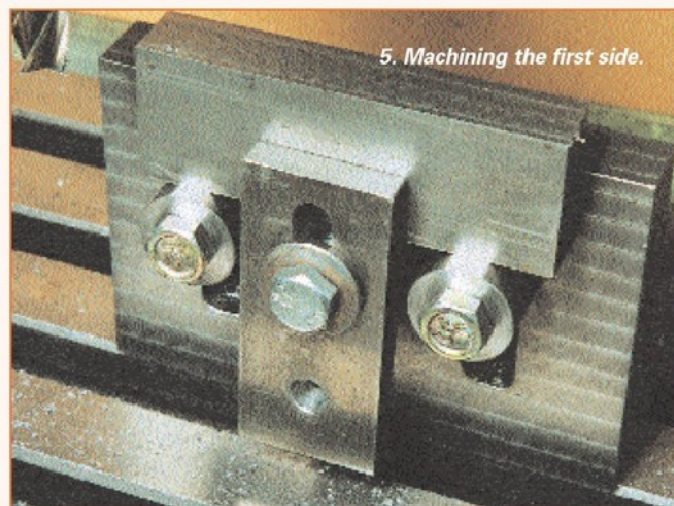
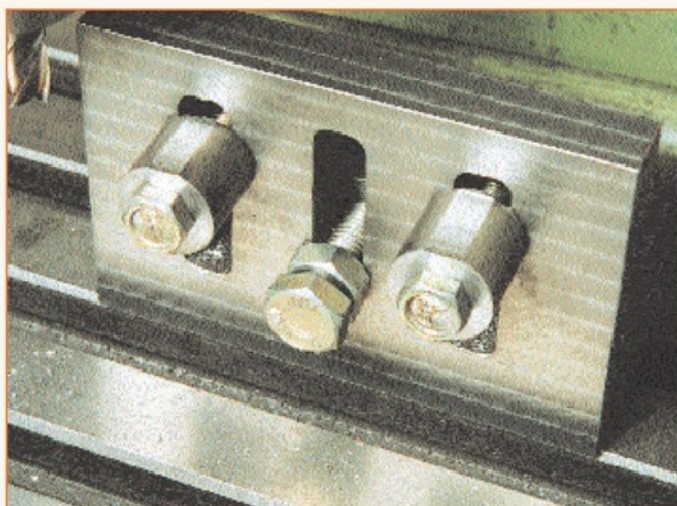


3. With the clamp having been marked with the position of the slot, setting the table stops for machining the slot in the first and remaining clamps is easy.





4. Posts fitted to the angle plate and lightly machined on top enable parallels to be positioned and machined to a fair degree of accuracy.

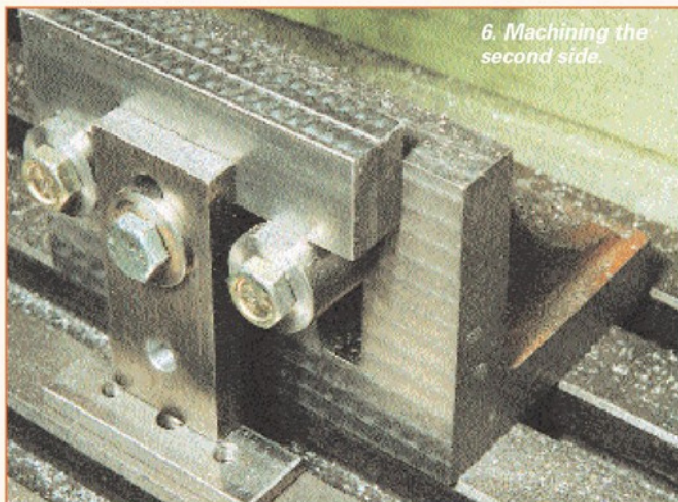


say within 0.02mm. At first sight this may appear a standard that is too close to be achieved, especially with regard to being parallel. How, after machining the first side, is the parallel positioned accurately enough for the second to be machined parallel to the first? This is the secret behind the method proposed.

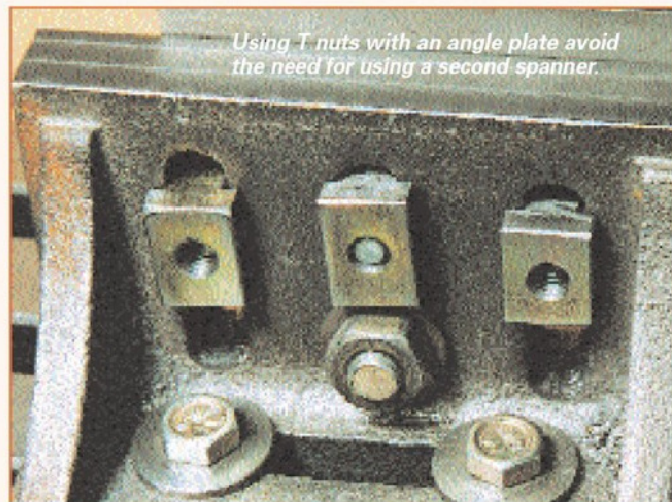
The heights of the parallels are not critical providing each pair are accurately the same, I would suggest nominal values of 10mm, 15mm, 20mm, 30mm, 40mm and 50mm. and say 8mm thick and 100mm long. Having cut your lengths of material, in various widths, machine the ends using the same setup as illustrated in photo 1 and generously debur the ends. Also remove any blemishes along the long faces and edges that affect the mounting of the pieces for machining.

Make two posts as Sk. 3, as you will see the dimensions are not that critical, and mount these onto the angle plate at approximately the same height, see Photo 4. Machine very lightly over the top surface of the posts to give two locating faces for the parallels to sit on. The small reduced end to the post avoids having to machine too close to the angle plate face. It will be necessary to mount the posts nearer the top of the angle plate for the smaller sizes, say 10, 15 and 20, then re-mount lower down and re-machine them for the larger ones. The screw seen in the centre slot acts as packing for the clamp when holding the parallels as in Photo 5. This should be set at a height just greater than the thickness of the two parallels, say plus 0.5mm. This would seem to be a good time to examine good practice in terms of clamping and rather than go into lengthy verbal description, Sk.4 should largely illustrate the do's and don'ts. Note that in this case, if the clamp is not positioned suitably the parallels may tilt as shown in Sk. 5. with obvious consequences on height accuracy.

With the first pair of parallels mounted machine the first side, remove and very lightly debur edges and ends. Turn over, and once more fit in place making sure that the mounting surfaces are scrupulously clean. Machine the second side, Photo 6, the piece of packing seen added below the clamp holds this at just the right height. Finally, remove, debur, and the first pair of parallels are finished.



6. Machining the second side.



Using T nuts with an angle plate avoid the need for using a second spanner.

Photo 7 shows the use of T nuts with the angle plate as mentioned earlier. This avoids the need to use two spanners and frees a hand to help elsewhere.

These parallels not being hard will be susceptible to damage on their edges, though if treated accordingly this should easily be avoided, a small wooden tray with separators would help at the storage stage. In any case any damage is likely to be local and can easily be removed with a file without effecting their overall accuracy. Of course if you have access to more advanced facilities, you may be able to have your parallels case hardened and then trued up on a surface grinder. However that falls outside the scope of the present discussion.

This now completes the basic kit shown in **Photo 8** and as the series progresses it will be seen to be adequate for completing some sizeable projects without further equipment. In the next section, we commence the construction of a boring head, the first of three substantial projects that bring the series to a conclusion. Even though the projects are quite sizeable the individual machining operations are mostly no more complex than those already met. The projects should therefore not present any major problem, even for the novice, but provide sufficient milling involvement to ensure that the newcomer would be well at home with the machine by the time the series is complete.



8. With the basic kit now complete we are ready for some advanced projects.

LINK UP

Would readers wishing to make use of this facility please note that the maximum total value of items accepted for a 'For Sale' entry is £50.

To advertise goods of a greater value, please contact our Classified Advertisement Department. Please indicate clearly if an item is intended for Link Up.

FOR SALE

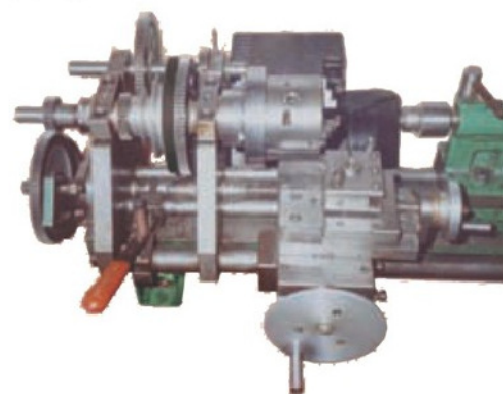
- MEM electric motor starter, for use on single phase, 240 volt coil and No Volt release. Reversing switch with wiring diagram. Both suitable for Myford or Boxford lathes or similar machinery. £30-00 the pair plus carriage, would split. Please contact Mr. J. E. Fletcher on 01723 362 537
- For Sale Picador Pulleys 4in. and 10in. with two S/A BB Plummer Blocks with bolts, collars, and washers £20-00 Please phone Mr G. R. Hughes on 02392 737 365 (Hants)
- For Sale Hemingway Knurling Tool kit £25-00. Dremel 210 drill stand (928 series tool) £10-00. Please phone Mr D. Pickup on 01373 832 681

WANTED

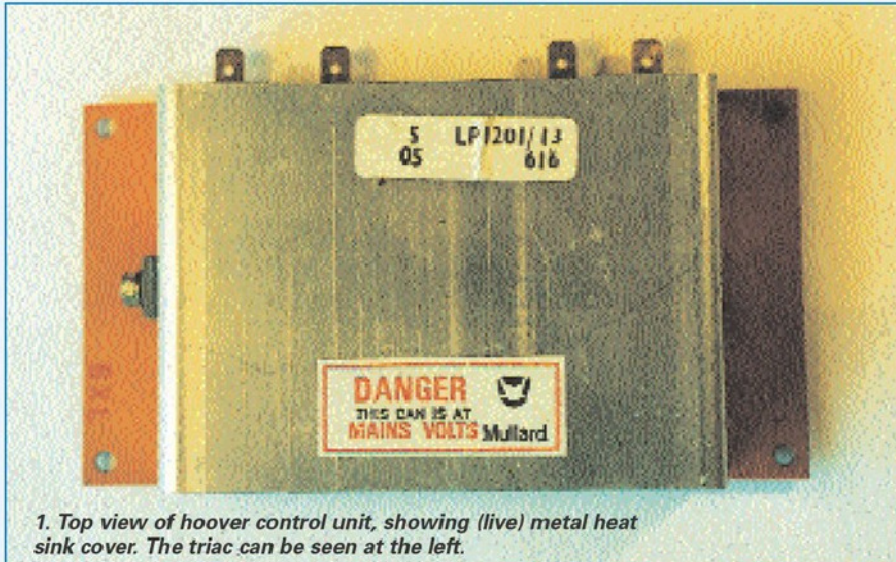
- Wanted instructions for construction and use of Dore Westbury Milling Machine Kit by Model Engineering Services. Will reimburse all costs. Also wanted, Acorn/ Ajax vice for Acorn/ Ajax 7in. shaping machine. Please phone Mr D. Pickup on 01373 832 681
- Wanted a mains electric motor not less than one sixth H.P. with an integral reduction gear -OR- a pair of spur gears to make a 10:1 reduction gear (similar to Myford gears) Please Phone Mr P.A. Twist on 01962 880 475
- Wanted copy of manual for Adcock and shipley Milling Machine model OEG. Please contact Warren Green, 15 McDonald Road Papatoetoe 1701, New Zealand, or e-mail greenest@ihug.co.nz All expenses reimbursed.
- Wanted help. I have recently purchased a small bench filing machine made by the Oliver Instrument Co.

Adrian, Michigan, U.S.A. Several parts are missing. Any information, manuals etc would be most helpful. Costs of photocopying etc will be gladly reimbursed. Please contact Stephen Tresidder, 17 Station Rd, Carnhell Green, Cambourne, Cornwall, TR14 0LY

- Wanted Information. Does anyone recognise the homebuilt lathe (see photo). I bought it from a friend a couple of years ago, and he had purchased it at a workshop clear out. I'd like to know who designed it. Please contact Kevin Quiney email: kcqup2u@ukf.net



MOTOR SPEED CONTROL



Vasilii Zakharov suggests a low cost approach to variable speed control which can be applied to many typical amateur size workshop machines.

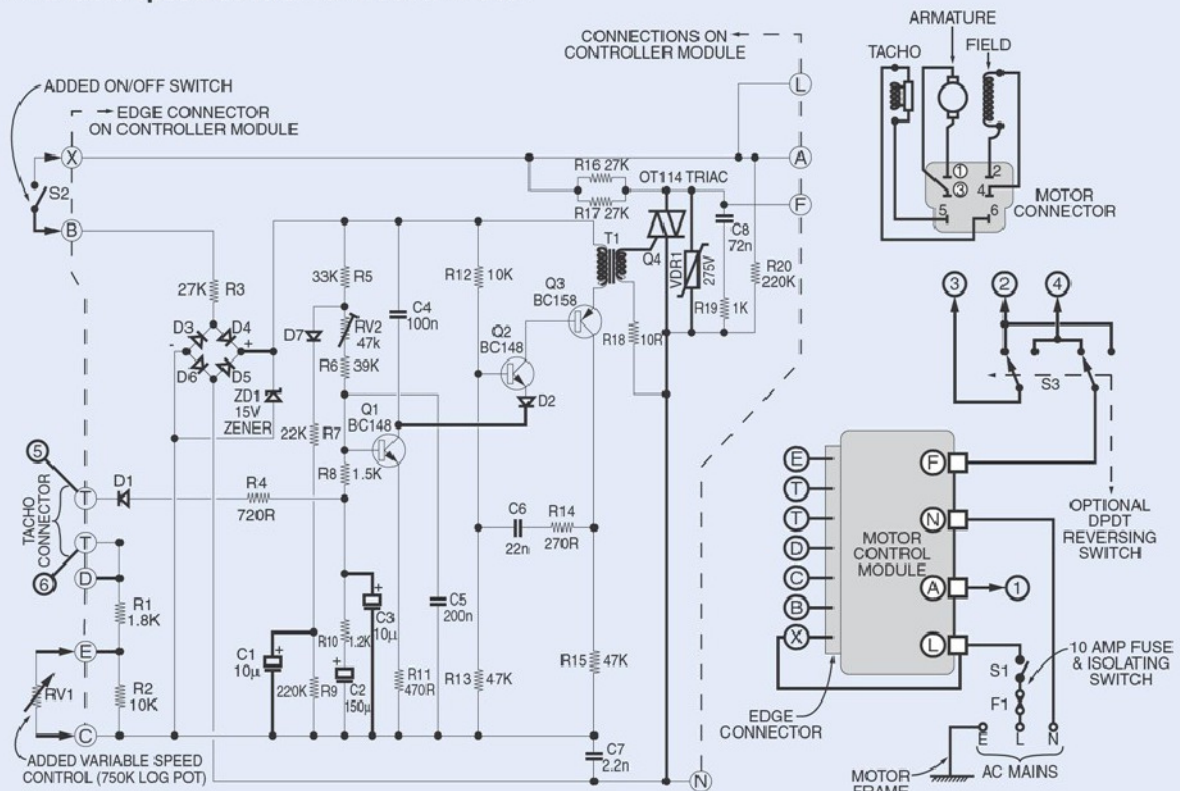
washing machine motor for driving a small lathe or other machinery requiring say 1-2 HP is still an excellent one, because the incorporation in the motor units of a tachometer allows electronic control of speed over a very wide range indeed (without gearing, 100 to 10,000 rpm is typical) with only marginal loss of torque over the whole range, and with tolerably good speed stability for varying loads. Moreover, such motors are usually very inexpensive, or even available at no cost at all, and they run off single-phase AC mains.

In the correspondence of the Aug./Sept. 1997 edition of MEW, the question of speed control of AC motors was discussed, and a particularly helpful suggestion was made to use discarded washing machine motors for the purpose, with an electronic speed

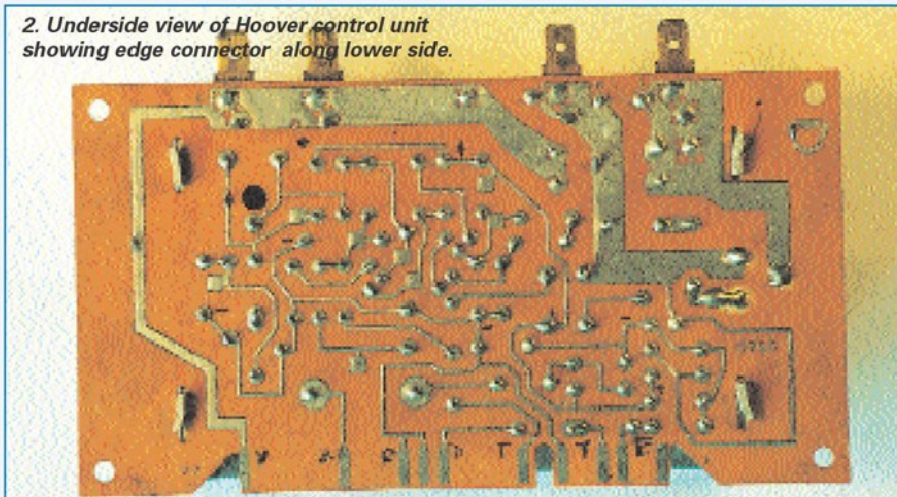
control based on the TDA 2086A phase-control chip. Unfortunately, with the cessation of Plessey semiconductor production (a very sad event indeed) this chip is no longer available at any reasonable price. On the other hand, the basic idea of using a series-wound

The purpose of this brief article is to suggest that a simple, even trivial, solution exists to the problem of electronic control, even less expensive than the original TDA 2086A option. This is to use not only the motor but also the control unit from the washing machine, and then modify it

Fig. 1 Variable speed control for Hoover motor



2. Underside view of Hoover control unit showing edge connector along lower side.



appropriately. The modifications are simply to add a rotary potentiometer with on/off switch, a reversing switch, if needed, housing the electronics and switches in a tough (preferably plastic) box, and making the necessary interconnections.

The author has in fact implemented speed-controlled motor drives based on parts from two different washing machines, Hotpoint and Hoover. It was discovered that the motors, connectors and tachos differed only in minor detail and construction, and so also for the control units; for example, the particular Hotpoint circuit seemed to be marginally superior in having a 'slow-start' feature, while the Hoover motor was the more substantial. The motor mounting arrangement and pulley were also remarkably similar. There is no reason to suppose that other washing machines have anything much different in them by way of motor drive.

Just as an illustration, **Fig. 1** shows the circuit of the (simpler) Hoover control unit, together with the added speed-control potentiometer, on/off switch, and reversing switch. All the letter and numeral symbols at terminal points are as original (e.g. the tacho is connected to terminals (5) and (6) on the motor connector). The reversing switch simply reverses the polarity of the field winding in relation to the armature brushes. It is MOST important that the reversing switch is not operated whilst the motor is powered on, so a mechanical or electronic safety interlock is essential. The

usual warning about reverse running of lathes etc. of course applies. The on/off switch can obviously be quite separate from the speed-control potentiometer, but having a rotary potentiometer with a combined switch does have the added advantage that switching on or off then occurs at minimum speed.

For anyone searching for the control box in such a washing machine, just follow the wiring from the motor connector to the (nearby) control unit. In the author's example, this was a unit with edge connector (convenient!) about 10 x 8 x 3 cm.. Be careful: the metal cooling cover acts as a heat-sink for the Triac switch, and this not only gets hot during operation, but is LIVE to the AC mains. Hence the advice to house the control electronics in a plastic box, and also, incidentally, to leave some holes for ventilation. **Photos 1 and 2** show the control box, from above and below, the edge connector being clearly visible in the latter.

Concerning the tachometer, the Hoover version of which is shown in **Photo 3**, the actual physical construction does vary from one machine to another, as does the number of poles and the magnet arrangement. So, although by no means impossible, it is not advised to use a motor from one machine with a control unit from another. Do not alter the tacho setting unless you know what you are doing!

It is possible in principle to build a control circuit for any of these motors by using ordinary electronic components available from suppliers and copying the circuit I have shown,

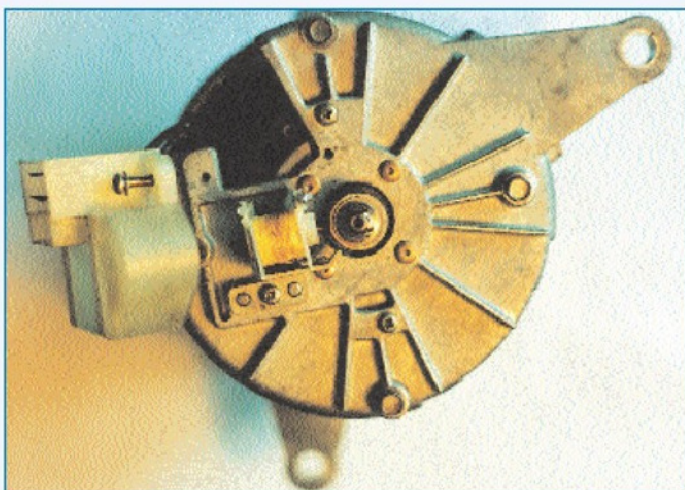
rather than using the washing machine control unit. But care should then be taken to include the various safety features and measures to minimise electrical interference, for example the 'snubber' network. Whatever the control circuit, it is strongly recommended to use an EMC filter between the AC mains and the control unit with motor; this is what the washing-machine makers do anyway. Otherwise there will be electrical interference from the unit to other electrical equipment (such as radios and TV sets) along the mains wiring. Notice that, in addition to the on/off switch on the control unit, I have also shown a separate mains isolating switch and 10 Amp. fuse. This is a standard wall-mounted unit, and is usual practice.

It was not intended here to go into any detail about circuit operation and so forth. Rather the purpose was to describe an easily copied and practical 'black-box' solution to the problem of speed control for readily available motors, and a solution particularly for those who are perhaps not well versed in electronics. For those readers who are interested, I can perhaps mention that the basic scheme used for control is with closed servo feedback loop. The tacho generates a signal proportional to actual motor speed, and this is converted to a voltage which is compared with a reference voltage representing the desired speed. The difference between the two determines the fraction of each half cycle of the AC mains during which the triac is switched on (the so-called firing angle). The circuit operates so as to keep the speed constant regardless of load, although change in speed by changing the setting of the control potentiometer does take a few seconds because of the time-constants of various circuit elements. When first switching on, there is some intentional delay in coming up to speed.

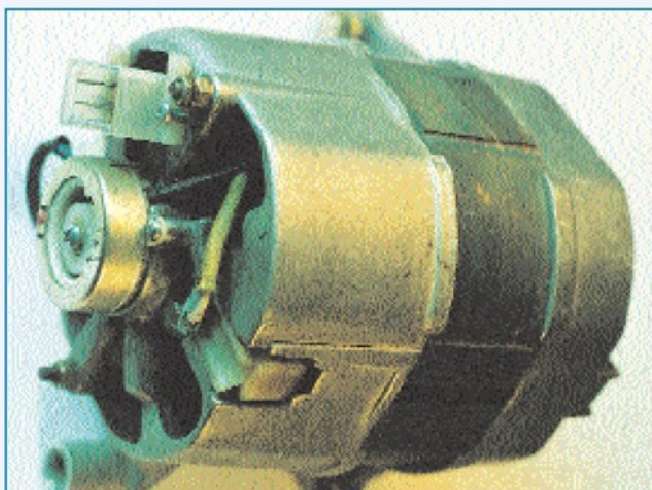
It took some time to go through the tedious work of tracing out the control circuits, and understanding how all the circuit features work. But all this is now done, and the end result has been most rewarding. For no cost at all to the author (except time!) he has several motors whose speed can be controlled from 10 to 1000 rpm (when using 10:1 reduction gearing) at the turn of a single knob. Moreover, the necessity of designing and making a printed circuit board has been entirely avoided. It is to be hoped that other readers will gain the same benefit. After all, there are plenty of scrap washing machines about!



3. End view of Hoover motor showing tachometer. The plastic cover with connecting socket has been moved to reveal the tachometer.



4. Hotpoint motor, clearly showing the tachometer mounted at the end of the spindle, and also the connecting socket.



SIMPLE TOOLS - SIMPLE METHODS

or Hand tools for beginners



1. A selection of small chisels.

Just lately I have had to re-think my model engineering activities, not just re-think but finish. Since moving to a small flat our furnishings and belongings have had to shrink. Having thought long and hard about possibilities, I have decided to stop. It is a question of room: the sitting room and bedroom are non starters for obvious reasons. So is the kitchen, Pauline has hardly enough room to cook. That leaves the bathroom and I toyed with the idea of a board over the bath which I could put the Unimat on. Having thought through all the implications, I abandoned that idea.

During a conversation with our editor,

2. Chiselling the waste off a broad surface



he suggested that I ought to make myself useful by writing something aimed at beginners. I thought that a look at some of the simple hand tools we use would be a good start, as the basic cutting tools are often undervalued and overlooked. If you do not have access to a heavy duty machine shop, then much metal removal can be accomplished quite efficiently by the thoughtful application of hand tools.

Chisels

You cannot get more basic than a chisel. You may choose to think of it as the foundation upon which most metal cutting technology has been built. The shape of the cutting edge and the arrangement of rake and clearance angles are common to most other cutting tools. In a sense, a turning tool is little more than a stationary chisel, presented accurately to a moving workpiece, a flycutter may be thought of as a sort of rotating chisel, and a multi-tooth cutter just a series of chisels. What comes to mind when chisels are mentioned is not always too accurate. The immediate mental picture is of a lump of hardened steel which has to be clouted with a big hammer. This is certainly not always the case, two of my most useful ones are quite small and only need a 4oz. hammer. Consider also the precision work undertaken by master gunsmiths chiselling out fine decoration. **Photo 1.** shows some I use, from left to right, a home-made one from an old file, a very light duty one ground from a $\frac{3}{8}$ in. tool bit, my favourite one, 4in. long with a $\frac{1}{4}$ in. blade width and the last one, bought for me by my son, a Japanese one with a cutting angle rather on the acute side, useful for soft materials and with a lovely comfy handle. **Photos 2,3, and 4** show the favourite one being

Bob Loader describes some very basic techniques, - oft forgotten but nevertheless extremely useful.

used. **Photos 2 and 3** show it at its most useful, where there is an amount of metal to remove which would be very hard work with a file, but too little to saw off, just that awkward size. Making hacksaw cuts to the depth needed, leaving a little for finishing, will let the chisel do all the hard work.

The best metals for chiselling are the brittle ones, like cast iron, cast bronze, cast aluminium alloys and hard brass. Most steels will chisel reasonably well but the tougher ones will need a bigger hammer. Thinner metals can be cut nicely in a vice as in **Photo. 4.** where the flat area of the vice jaw acts as a guide and keeps the cut level. Large jobs in thin materials can be done by putting the work over a piece of wood and following a marked line, leaving a bit for finishing. Keep the edges sharp by grinding them to an angle of about 60 - 70 degrees with a slight radius. Keep the head chamfered, it should never look like a bunch of flowers. There are different shapes of chisel for special jobs but for model engineering, flat ones are the most useful.

Safety considerations when using a chisel

There are three main sources of danger when using chisels. Always wear goggles or safety spectacles. Small chips will fly about and using Vaseline as in **photo.3.** is

3. Chiselling off a narrow surface, a smear of Vaseline helps stop the bits flying about.

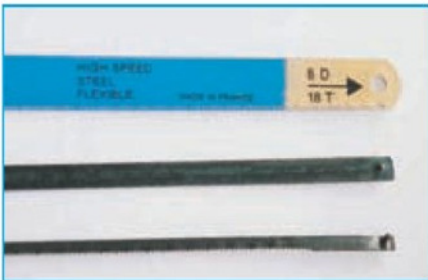




4. Using a chisel against the vice jaw to cut a thin metal.
Photo by Pauline Loader.



5. Preparing the job in photo.3. by hacksawing grooves ready for chiselling.



6. Blades for three different saws.

not always the answer. A much used chisel will gradually develop a mushroom head with split edges. Pieces of these can fracture away at high velocity, so keep the head of the chisel neatly chamfered by filing or grinding when it starts to spread. Use a chisel guard if you have to do a lot. It is a circular piece of hard rubber which can be squeezed on to the chisel shank. When you miss the chisel head, it saves you from clouting your fingers. If there is the slightest chance of anyone else being hit by bits of metal, rig up a guard or curtain to keep them safe.

Saws

Hacksaw

As well as the normal jobs which need sawing, there are some which a hacksaw is specially good at. It can be a very good roughing out tool and also a short cut in

many jobs. For instance, the piece of cast iron being sawn in **photo.5.** is being prepared for the chiselling shown in **photo.3.** It saves time and trouble.

A hacksaw frame with several blades of different pitches will cover most of the cutting you will need to do.

In **photo.6** the top blade is one for a hacksaw and is suitable for most cutting jobs. Look for the magic words, 'high speed steel' or the letters HSS, it may not be flexible but if it is used correctly, that is not too important, I've shown this blade because it shows the number of teeth per inch and also the direction of cut, the big black arrow. What S D means I have no idea. You should have another two blades, one with 24 teeth and one with 32 teeth, then you can follow the rule, - soft and thick materials - coarse blade, - hard and thin ones - fine blade. You will not go far wrong if you remember this. The other blades are one for a junior saw and the bottom one for a coping saw, more about those later.

A useful addition to the hacksawing tackle is a few tension files like those in **photo.7.** The two in the middle fit in the saw frame with the clips shown. The one with the spring clip is the easiest to fit, the other one is a bit of a fiddle. The files are coded, red for coarse, yellow for medium and the coloured bit goes to the handle end. Better still is the one on the left, it is a tungsten carbide one which is uni-directional, no clips, no fiddle and according to the label, will cut anything. It is called a rod saw and I bought it in



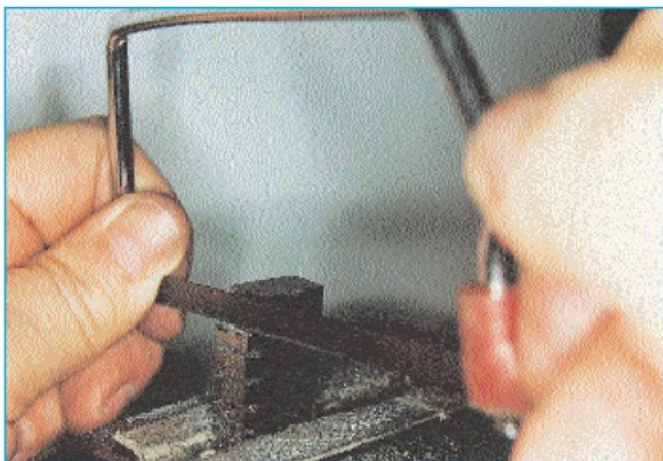
7. A rod saw and two tension files with the clips used in the hacksaw frame.

America, if it is available in this country, buy one, it is excellent.

Junior saw

As the name suggests, it is a smaller version of a hacksaw with a finer pitch blade which is hard only on the teeth, so it is easier to bend and wears out quicker. There is a variety of frames, from the simplest - a piece of 1/4 in. mild steel bent to shape, to some more special ones which are more comfortable to use. **Photos. 8 and 9** show one of each type. They are very good at cutting shallow curves, **photo.8.** because the blade will follow the

8. Using a junior saw to cut out the waste from a curve.



9. A junior saw used for accuracy.





10. A typical use for a coping saw. Photo by Pauline Loader.



11. The thinnest material a coping saw will manage because of the tooth pitch.

curve, especially if the work has been cut down to the marked line first, leaving the bits in between to be cut. Another use, photo.9. is where the cutting must be very carefully done. The job was to rough out

the slots in a four jawed chuck body. The 'feel' is better than a hacksaw and there is less chance of the blade jumping about. So the junior saw is good for accurate work and the smaller jobs.

12. The thin blade of a coping saw will get into awkward places.



14. Hacksawing a large block can be hard work.

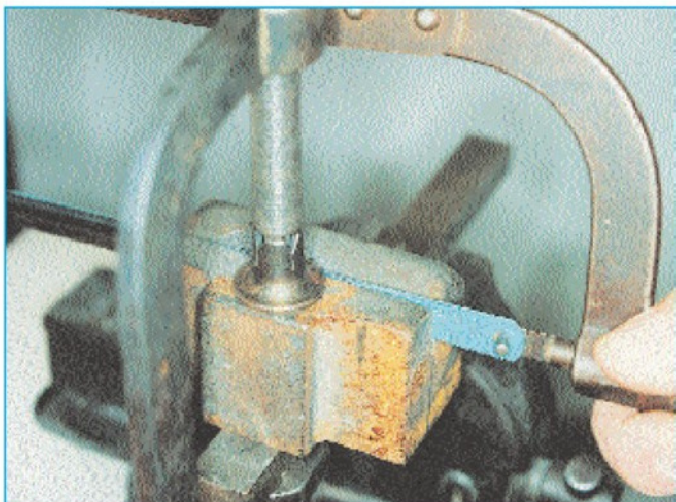


Points to remember when sawing

1. Keep the sawing speed down, for most materials about 60 to 80 strokes per minute is right, the timing of the radio time signal is a guide.
2. The man who made the saw blade put teeth all the way along, use all of them.
3. Cutting pressure should be only enough to make the teeth cut and they cut going forward.
4. If you use the saw like a scrubbing brush, you will break a lot of teeth and the blade will not last and one day it will be the last blade in your box, but you will only find out when you have broken it.
5. When starting a hacksaw cut, file a small nick for the blade to drop in. It will save your fingers and finger nails having lumps cut out of them
6. When sawing to a line, especially on thin materials, cut along the widest side as in **photo.13.** it will let you sight along the line and make sure that there are more than 3 or 4 teeth in contact.
7. Do not cut thin materials vertically, it will encourage the saw to wander and perhaps break teeth.
8. When putting a blade in the saw frame, take up the slack and give the adjusting nut another three full turns, that should be enough tension.
9. The same applies to tension files. Be careful not to saw too quickly with them, they get hot very quickly; for the same reason avoid too much pressure.



13. Sawing along a line instead of vertically is best for thin work.



15. Changing the sawing direction several times will make the job easier, note that when the work is too big for the vice there is a remedy.

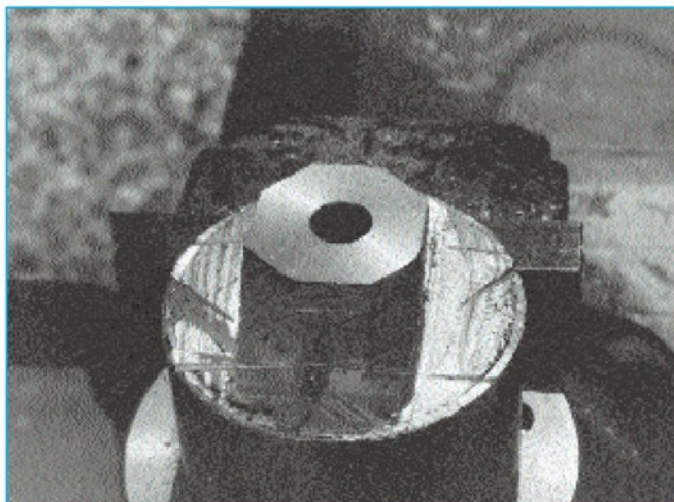
Coping saw

This one has a deep frame and a narrow blade which can be set to any angle. They are very good for jobs like the one in **photo.10** where several discs are being cut from a tufnol blank. They will cut most materials and are better on the thicker ones because of the coarse teeth, the work in **photo.11** is about the limit for thin work. With the blade angled as in **photo.12** it is a good tool for getting into restricted spaces.

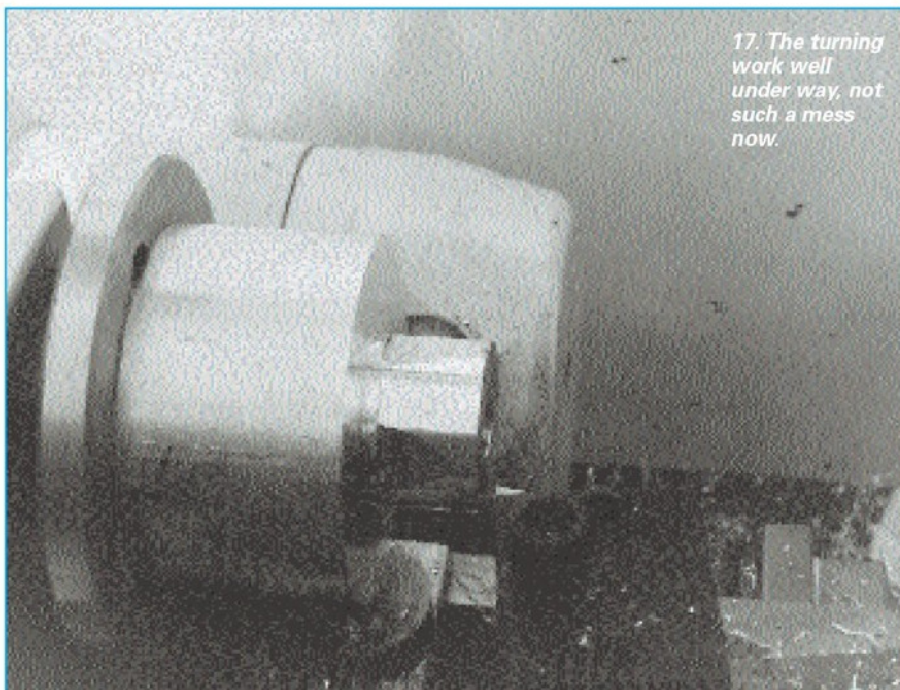
Short cuts

A hacksaw is ideal for shifting a lot of material fairly quickly. If, like me, your machining equipment is limited, a lot of roughing out can be made easier by hacksawing as in **photo. 14** where a cast iron block is being reduced to a manageable size. The technique is to cut down to about the blade depth, then move it 90deg. and do the same again. Keep moving it and you will always be cutting along a manageable length. To use a small vice which will not open enough to hold the block end wise, put a bar into the vice and clamp the block to the bar, **photo.15**. It is a solution I have had to use for larger work.

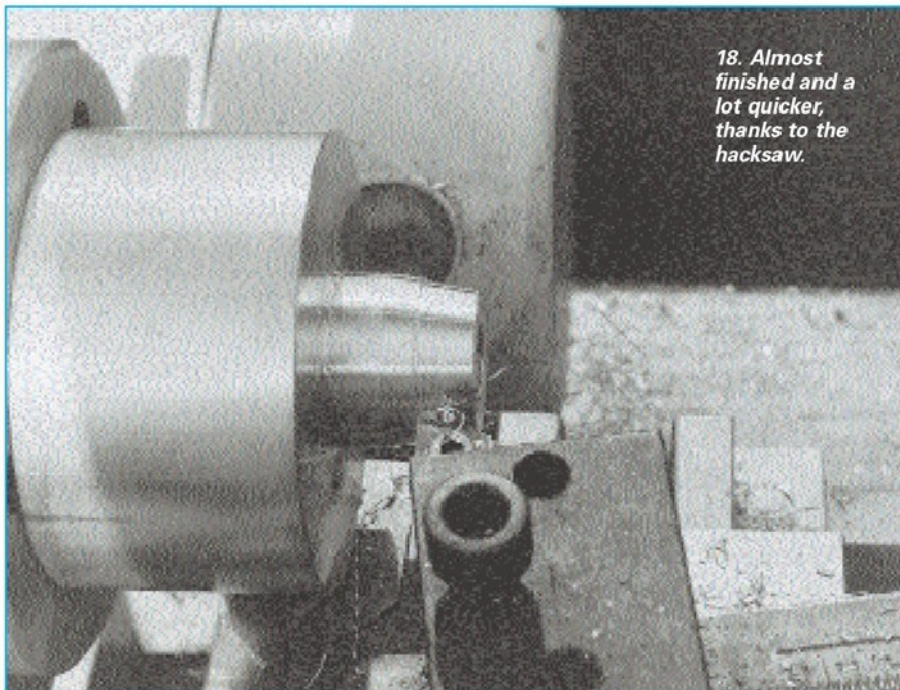
The same sort of roughing out can be used for some turning work where a lot of material must be machined off. Using a hacksaw can be quicker than turning for the roughing out, although it does not look too clever, **photo.16**. But by the time it has been turned a bit, **photo.17** it looks a bit better and when almost finished, **photo. 18**, it has cleaned up a treat and looks as if it could have been turned from the start. In this case the method adopted saved a lot of time and machining, to say nothing of swarf.



16. Roughing out a large turning workpiece with a hacksaw.



17. The turning work well under way, not such a mess now.

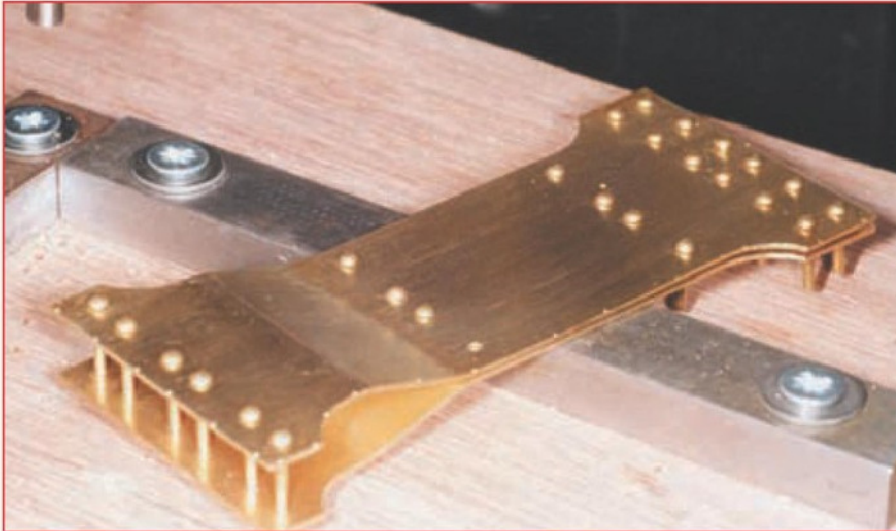


18. Almost finished and a lot quicker, thanks to the hacksaw.

Next issue

In the second part, I shall offer a few words on the subject of files, again simple tools, again frequently undervalued and overlooked.

A TALE OF TWO READ-OUTS (2)



1. Repeatability of positioning is proved by the insertion of rivets in these loco. step parts

Minor Limitations

Although I chose the Newall system as best suited to my requirements, there are many others out there vying for your attention and pocket money, and you might have bigger machines than mine, without the space restrictions. Which would extend your choice of system considerably, of course, and you might well decide on another variety. Whatever the actual system you choose, what it can do remains pretty much the same as long as we stay in the realms of the "professional" equipment. Almost pretty much the same, though you do need to check each one out in some detail before stumping up the monies. As an example, the Newall system that I have has to my mind two limitations – it won't take an input from an electrical edge finder, and it doesn't remember its position when powered down. This hasn't actually caused me any problems, but they may be important to you. The power-off could be a nuisance, as I live in a sort of rural area fed by overhead lines, so power failures are by no means unknown. In fact we had one whilst I was writing this, and the mill DRO's lights went out. It was set up for a part-completed job, but disaster didn't follow since

- it would be relatively simple if a trifle inconvenient to re-locate the reference point on the workpiece, but
- whenever the DRO is aligned for a job I always return the slides to the reference (0,0) position when I pack up – that way I only have to press two zero buttons to set it up again. Anyway, back to the job in hand – how does it perform, and what will it do?

To answer the second question first – nothing that you can't do with the feedscrew dials, and in one particular case a lot of calculation. What it will do is do the same thing but do it more conveniently, more quickly, more accurately and more repeatably. If they don't matter to you, don't waste your money. If they do, then you have my permission to start drooling!

It goes without saying that having got the systems up and running, I was somewhat impatient to cut metal and find out exactly what I'd spent my money on. And if it had been worth it!

Initial Efforts

The mill system was up and running first, so the natural thing was to use that to make the mounting components for the lathe system, eight in total, plus some precision drilling of the cross slide. You'll have to believe me on that for the time being, the drawings are in the next part of the article. Suffice it to say that a lot of holes had to be drilled, some accurate milling was required, and it all had to fit together and on to the lathe. OK, so some of it could have been less accurately done, but I wanted to test out the system. So I went for accuracy, and didn't resort to clamping things together to drill aligning holes, each component was drilled and milled individually. And it all fitted together to perfection. Very impressive indeed, and if that wasn't enough, it was easy to achieve. Yup, it was worth it. Definitely.

Even more impressive was the manufacture of the rear footsteps for my locomotive. These are shown in **photo 1**, and each was drilled individually with 28

Barry Harrison continues by examining the operation and advantages of DRO systems.

- $\frac{1}{16}$ " diameter holes for the rivets – no marking out for the holes, nothing, just location on the mill table against the two bars on the table, each clocked true to the respective mill axis. The DRO was zeroed in using the edge finder visible in the photograph, a George Thomas design most kindly made and given to me by Alan Hopwood of the York Society.

After drilling the first plate the DRO was 'scrambled' and re-aligned with the bars using the edge finder, the second plate then being drilled. When the plates had been drilled and were still in the flat, 27 rivets could be pushed through the back-to-back plates, and the one that couldn't was because I'd become careless and had suffered a wandering drill. Mea culpa, and it serves well to illustrate the point that the performance of these systems cannot exceed that of the operator. There are 20 rivets through the plates in the photograph.

Still on drilling holes, the case mentioned above requiring calculation involves the positioning of any number of holes on a particular and exact pitch circle diameter. Want a prime number division plate way outside the range of the ones you already have? No problem, although some makes of readout place a fairly low limit on the number of holes. Locate the spindle at some convenient point on the job, of known dimension from the centre of the pitch circle. Press a few buttons to tell the DRO where it is and where you want to start drilling, press another to select the bolt hole circle option, and a few more to tell it how many holes you want to drill. Press another button to tell it you're going for hole 1, and the display changes to apparently random numbers. But wind the feedscrews until the both axes read zero and you'll be in position for hole 1. Then press for hole 2, move the slides until both axes again read zero, and you're in position for the second hole. Ad infinitum ad nauseum, until you've drilled all the required holes. It's as simple as that, and accurate and repeatable. So you can confidently drill say the holes in the two ends of each of two cylinders, then drill the four covers, and they'll be totally interchangeable – as long as you didn't let the drill wander when starting, of course, and do the original location relative to the bore accurately enough. No marking out, no drilling two together, no spotting through, just perfectly positioned holes.

A most useful facility is the ability to locate anything relative to anything else. If you want to dimension say a set of holes from an edge of the job, that's ok. If you want them located relative to centre line, that's ok as well, just zero the DRO at the relevant position. Most systems offer several ways of doing this, the most obvious is as described above for the footstep backplates. In fact, they were located from the centre lines of the plates. With the DRO zeroed against one of the bars (it could equally have been against an edge of the work piece) simply measure the width of the job, divide by two and enter this value as an offset into the read out with a few keystrokes, wind to zero and you're there, on centre line. Alternatively, if you don't know, or can't measure, the width of the job, use an edge finder on one side of the job, zero, move to the other side and again use the edge finder to locate that one. Then tell the DRO you want to go mid-way between the two, and it'll take you there, probably to greater accuracy than you could have achieved by measuring the width of the job.

Or the diameter of the job, if you're drilling cross holes through a round bar. No need for drilling jigs and bushes to suit the many work and drill diameters you might want to use, so there's an enormous saving in time if you need to do much of this sort of thing, and every hole will come out on centre line, as long as you exercise a bit of care in starting the drill. And for the rare (!) occasions where you want a hole deliberately off centre by an exact distance, a DRO system can sort that for you as well... as long as you can get the drill to start drilling, of course!

The foregoing examples should serve to illustrate the uses of a DRO on a vertical milling machine, and even though I've only looked at drilling holes it should be apparent how they can be used when milling. Or a combination of milling and drilling, the DRO doesn't care what you're up to, or what tool's in the chuck, it just knows exactly where the spindle centre line is relative to where you zeroed it. So you can cut a slot a precise distance from an edge and an exact depth from the top surface, do any other milling you might need, then drill holes anywhere you like. In the exact centre of the slot, offset to one side, somewhere else. It doesn't matter, the DRO will guide you to the right position, and do it without need for any addition/subtraction on your part.

Absolute or incremental

Which brings us to another useful feature, the ability to work in either absolute or incremental dimensions, or both simultaneously. I suppose that should really be alternately, but you'll see what I mean. The 'normal' operating mode is absolute dimensioning, as shown in the first simple (one axis) drawing (Figure 1) – all dimensions are taken from the left hand edge.

Figure 2 the same component, but

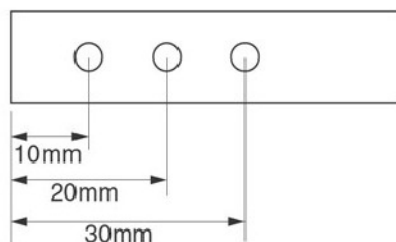


Figure 1

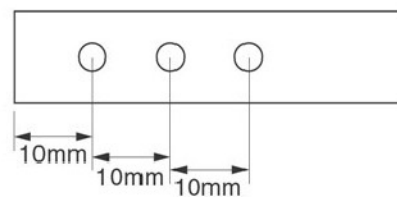


Figure 2

dimensioned incrementally – each hole is dimensioned from the adjacent edge or hole.

As we all know, many engineering drawings that we work to use a mixture of absolute and incremental dimensioning, and we also know that it can be a real pain to convert dimensions on the drawing to dimensions on the job, with much addition and subtraction being needed, each one bringing with it the possibility of mental error – or digit difficulty if you're using one of those new fangled electronic calculator things.

Most DRO systems can work with either system, and you can jump around from one to t'other without any difficulty. Take for example drilling loco frames. The pattern of holes for the horn blocks might be repeated at axle centre spacing. If the holes are dimensioned relative to a pattern reference point, then it becomes very easy to move to the new absolute reference point, switch to incremental, and proceed with the pattern.

So you work alternately in absolute and incremental dimensions, but the DRO does it simultaneously, always remembering where the zero point for the absolute measurement is located. This is most convenient.

And so to the lathe

So here I am, absolutely (or should that be incrementally?) delighted with the mill system, what about the one for the lathe? Would you believe instant disappointment? Naturally the first thing that I checked on the lathe was how well the DRO agreed with the feedscrew dials. Great along the bed, unbelievably out for the cross slide movement. Damned idiot, Harrison, you forget to switch to radius mode! One needs to remember that the feedscrew dials on the Myford (but not necessarily on other machines) effectively read radius; if you move the dial by ten thou, that's ten thou off radius, twenty thou off diameter. The Newall DRO defaults to diameter mode unless you tell it otherwise, so it was reading twice the movement indicated by the dial – for my ten thou dial movement it was telling me that the diameter would reduce by twenty thou. Right, that's sorted, and a lesson learnt: When all else fails, READ INSTRUCTION BOOK!

The second trial was to turn repeatedly to 0.750in. from some 0.875in. round bar. The theory goes like this: take a cut along the bar to some diameter above finished diameter, and

measure the resulting work: say this comes out at 0.781in. You now make a few keystrokes and punch 0.781in. into the read out, so it now knows that the tooltip was at 0.3905in. from the lathe centre line, cutting a diameter of 0.781in.. Don't forget the plus/minus sign, though, or you'll both get confused! Now move the cross slide until the DRO reads 0.750in., take the cut and that's what you'll end up with, 0.750in.. Fat chance, no matter how many times I tried it, the finished size was wrong. Sometimes not much wrong, less than a thou but readily detectable, sometimes by several thou. And to add to the confusion and disappointment, the error could be either way, up or down on diameter. So, instant disappointment, and I packed up to go away and sulk, muttering awful things about Mr. Newall.

Whilst sulking and muttering I began to recall that this wasn't actually the first time I'd had this problem, and I'm sure it must ring a bell with others who have for example zeroed the cross slide dial at finished diameter, then worked to that setting for further components, only to have them come out the wrong size. I also recalled that I'd had an idea as to the cause of the problem, but hadn't been able to confirm it. But now, if I were to assume that the DRO was in fact correct, then I had to look elsewhere for the answer to the diameter problem, and might be able to prove or disprove the idea as to what had caused it in the past.

Now towards the end of the first article I wrote: "The capabilities and performance of these devices are such that you'll only get the full benefit if the machine is rigidly mounted, in good condition, and properly adjusted, set up and aligned. And properly used."

Yes, that nicely described my Myford. Very carefully set up, aligned and adjusted, and mounted on Myford's industrial stand which was firmly bolted to a concrete floor. Carefully used as well, each time I'd done a test the cross slide had been clamped, as was the top slide courtesy of GHT's clamping system. Since the DRO was reading cross slide movement and hadn't recorded any untoward creeping, the error didn't come from that quarter. The top slide was set with it's slides parallel to the work, so even if it had crept along slightly, that couldn't have caused the significant errors that were turning up. Only one suspect left, deflection within the top slide assembly. A few more tests, and Bingo, I'd got it!

Let's say we rough down with 0.020in. depth of cut from 0.875in. to 0.795in. diameter, measure the work and input the dimension to the DRO. Take another 0.020in. cut to 0.755in., followed by a finishing cut of 0.0025in. Normal practice, agreed? Well, that was the cause of the problem. When cutting at 0.020in. deep, the load applied at the tool causes slight deflection via the top slide, allowing the tool tip to move from the dialled position to some other point – the amount of deflection will depend upon the depth of cut, the condition of the mating faces of toolpost and top slide, how well your top slide gib is adjusted, and the condition of the mating faces of top slide and saddle. So we input a diameter cut by a deflected tool, then finish with a light cut that doesn't deflect the tool. Hardly surprising that things go astray. The variation in error is then simply accounted for by the fact that I wasn't cutting consistently to the same depth of cut on either the measurement or finishing cuts, so I was getting variable results.

As soon as I started taking an intermediate finishing cut immediately before taking the initial diameter measurement, and always used that same depth of cut to get to finished diameter, instant disappointment was replaced by the instant happiness of perfect and repeatable results. As long as the depths of cut for the intermediate and final finishing cuts were kept sensibly alike. A bit inconvenient at times.

You might be tempted to think that the tool holding was at least partly to blame, but I can assure you that wasn't the case as I use a Myford-Dickson tool post and holders which are amongst the most rigid of the quick change varieties. And a few days later, I was able to show that wasn't the culprit.

Now why do we want a top slide? So that we can a) turn short tapers, and b)

advance the tool accurately towards the chuck when facing off. That's about it, I think. For me at least, a) is rare, and could be dispensed with for the vast majority of my lathe work. So far as b) is concerned, the machine's now got a DRO scale for movement to and from the chuck, so who needs a top slide for most work? Older readers may remember a tool post design by Tubal Cain that went straight onto the cross slide, no top slide in the way. He called it the 'Gibraltar' toolpost because it was as solid as a rock! So taking TC's toolpost as a hint, and my experiences as encouragement, I made a version to take the Myford-Dickson tool post. The finished item is shown in **photo 2**, and again taking the hint from TC, I call it the Bunker tool post – it'll take a bomb to shift it!

This has made an enormous difference to both the lathe's cutting capability (I'm not a paid up member of the Society for Prevention of Cruelty to Myfords, by the way!) as well as to its accuracy and the repeatability of diameters cut against the DRO. It also indexes the M-D post, as well as my square 4-tool turret, so I can zero a tool in, twist it away to cut at an odd angle where clearance is needed, then index it back and still have the tool point as near as dammit to its original, zeroed, position. I can't quote the accuracy of the tool positioning, but I can't detect any error on finished diameters after moving and re-setting the tool. Of course, since it still uses the same Myford-Dickson tool post and holders, it confirms that my top slide was indeed a source of slight deflection. This may have been inherent in the design, or more likely due to an element of wear, since on anything but a brand new machine, it can be tricky to ensure correct gib adjustment over total topslide travel. Additionally, it is not unknown for wear to occur on the swivel faces such that slightly convex surfaces lead to reduced rigidity.

Other benefits

That tale has served to illustrate both how a lathe DRO is used for basic turning, and how its performance can be negated by deficiencies in the machine and the operator. How else does it benefit one's working?

Well firstly a Myford is often used for drilling holes in a work piece mounted on the cross slide, so its advantages for accurately positioning holes are the same as those described for the mill system, albeit with the obvious limitation that it can only work on a single axis. And you need to remember to switch it from diameter to radius mode!

Anything mounted on the cross slide can be moved towards and away from the headstock by precise distances, so facing castings and such to length becomes a simple matter. Yes you can use the leadscrew handwheel to do the same job, but the backlash can be significant on a worn machine, and tricky to compensate.

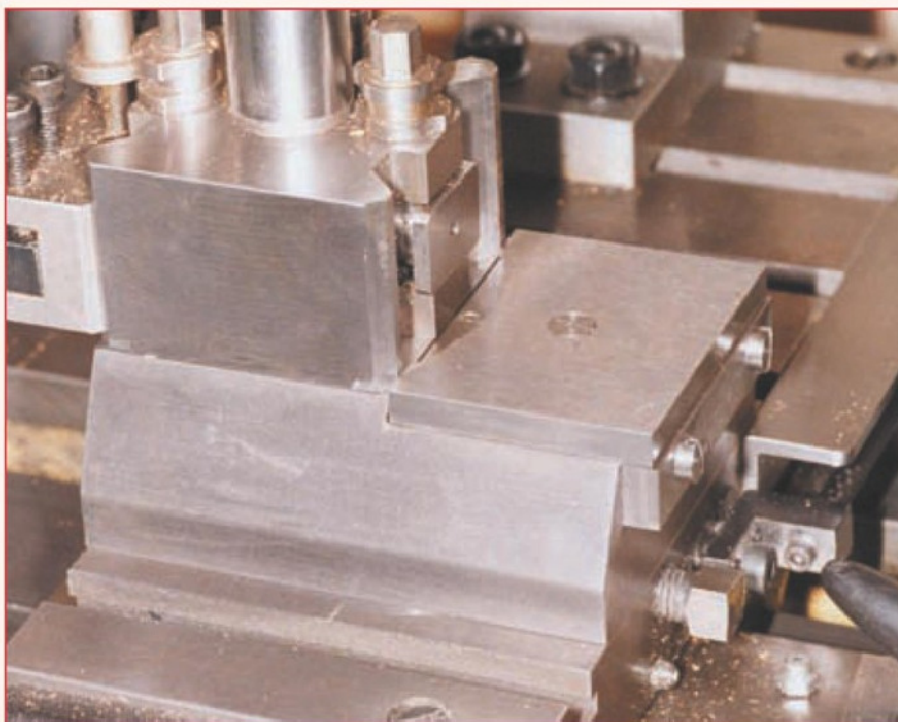
What about setting up to turn a taper? I haven't had occasion to try this as yet, but it should be very easy indeed. Any taper can be expressed as say 0.253" per foot, so with the cross slide connected to the taper turning attachment one would simply zero both axes, then move the saddle along the bed for a distance of 12", adjusting the taper turning slide until the said 12" of lateral movement produces 0.253" of cross slide travel. No DTI needed, no master taper as reference. And if you want to set up for a metric taper, it's only necessary to switch to metric measurements on the read out, no conversion to be done.

That's another huge advantage, you can switch between imperial and metric at will, the DRO does the conversion for you. The lathe (or mill of course) becomes a dual-calibrated machine, equally at home and comfortable in both territories, and quite content to mix them on the same job. Can't think why anyone should want to do that, but if they do, the facility's there.

The next feature worthy of comment isn't available with all types of DRO, and in fact Newall offer a Microsyn/Topaz system without this feature, which reduces the cost significantly. Whether or not you decide to spend the extra will depend upon whether or not you put sufficient value on the facility. And that's the facility to zero-in nine different cutting tools.

Let's assume that you have a toolpost such as the Myford-Dickson, whereby you can interchange tools and each tool tip will re-locate at the same position as it was before it was removed. With a suitably featured DRO, each tool can be programmed into the DRO in the same way as I described above, each one's data (for both axes) stored against a tool number. So you set up each tool, giving it an identity number, and each time that tool is fitted you tell the DRO you're using say Tool 2, and its display changes to indicate either the distance of that tool point from lathe centre line (radius mode) or the diameter it will cut (diameter mode). This works for any

2. The "Bunker" toolpost improves rigidity and accuracy.



tool, whether it's in the front or back toolpost, the only difference is that you need to remember to put the appropriate plus or minus sign before the measured diameter, according to whether the tool's at the front or the back. To date I've only used this capability for up to three tools, (roughing and finishing tools in the front tool post and a parting tool for grooving in the back one), but it's proved it's worth. In conjunction with the use of replaceable carbide tips which amongst their other advantages eliminate the need for tool re-setting (and therefore re-zeroing), the tool offset capability can bring real benefit when multiple components involving the use of a number of cutting tools have to be made. Not just several-off of one component, mind you, making different components also benefits from having the tools and the DRO effectively calibrated for each one. As long as you don't get a power cut that is, when you then have to go through re-calibrating the lot. Easy to cope with though – just spend even more money and buy an un-interruptable power supply to run the DRO!

Oh yes, I've used the offset facility for boring a large diameter blind hole where I had to open it out with a small tool initially, following up with a bigger, stiffer tool as the bore progressed. Each tool was programmed in for both diameter and distance from the face of the job. When I changed tools the DRO compensated for the different lengths of

the boring bars, so by watching the Z-axis read out I could get to the bottom of the bore without the 'orrible graunching noises that result when the tool hits the bottom. I could also accurately position the bottom of the bore, and skim either the bore or the bottom at any time through the progress of the work without fear of 'losing my place' and inadvertently running the tool into either one or t'other.

Which way to look

Now that needed me to watch the display, not the work, and that's taken some getting used to. I was so accustomed, so conditioned, to watching the cut and keeping an eye on the dials, or vice versa, that to turn one's eyes completely away from the work and saddle was initially quite alien. As I said, it takes some getting used to, but eventually I did. Now I find it strange to do anything without the DRO, and look down at the work and saddle! No doubt I'll strike a balance eventually and become equally comfortable working either way.

After those initial problems were sorted, that's the only difficulty that I can think of, the only disadvantage. I'm still learning how to use some of the features nearly a year after I installed the kit, my excuse is that I'm not cutting metal eight hours a day, five days a week, and that naturally extends the learning curve in comparison to someone working in industry. And of

course I'm not using every feature every day, so there's still a need to resort to the instruction book every now and then. But those occasions are getting fewer each time I use the systems.

Each time I use them I marvel at their capabilities, and take pleasure from producing things that fit so nicely together, with such little effort on my part in terms of measurement, marking out, etc. I can assure you that not having to do all that, is not, for me, a down-grading of skill, it's a welcome relief from some of the tedium of peering through loupes and magnifying lenses in order to read scales on rules and vernier height gauges, then trying to locate a drill right atop an intersection of two fine lines. I never did enjoy marking out, and that lack of enjoyment has increased as my close vision has deteriorated. Nor did I enjoy making allowance for backlash when indexing on the mill, that drudgery has gone as well. They have saved me time, precious time, in many ways, time that can now be spent on other aspects of building a locomotive. Nearly a year down the line from that fateful trip to Donington in September 2001, I think I can answer the question 'Were they worth it?' For me the answer is 'Oh yes, they were. Most definitely.' And I'll kill anyone who tries to take them away from me!

In the next and final section of the article, I'll look in detail at the mounting brackets for the Myford.



IN OUR NEXT ISSUE

Coming up in Issue No. 87 will be

Engraver Cutter Grinder

Doug Ball looks at engraver cutter geometry, and presents a device for accurate grinding.



Extension to Mill

Adrian Kruger gets a quart into a pint pot with extra daylight.

Gantry Crane

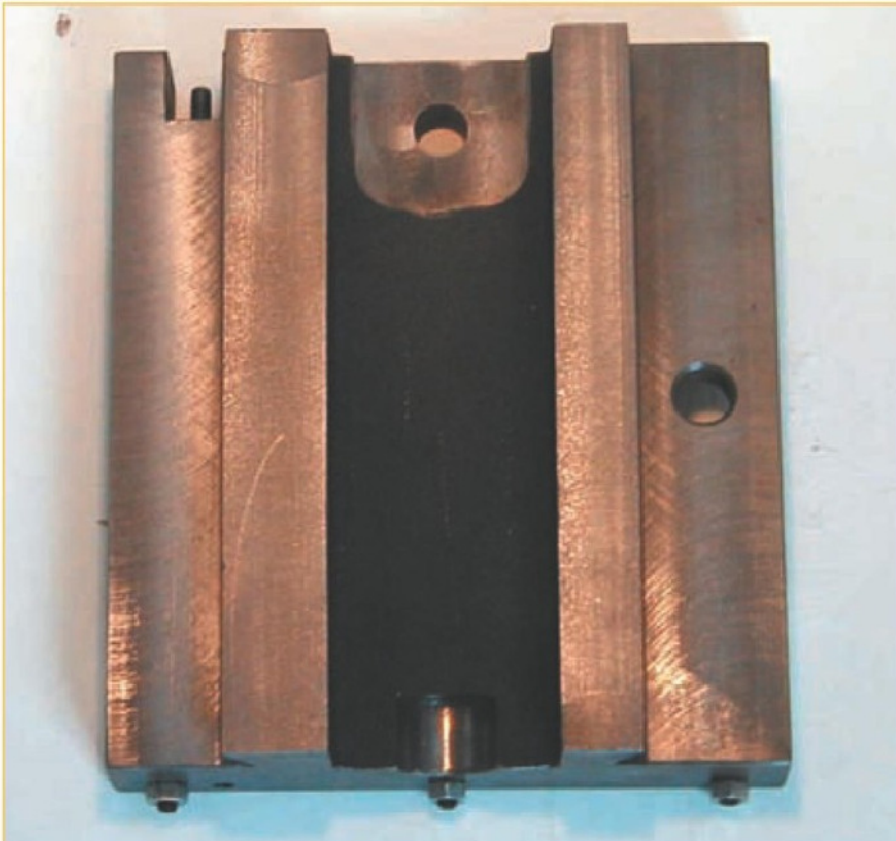
For moving heavy models or workshop machinery, Philip Amos may have the answer.



Issue on sale 13th December 2002

(Contents may be subject to change)

RETROFITTING BALL SCREWS TO A WABECO MILL



1. Y-axis slide showing the two mounting holes for the X- and Y- axes nuts.

Background

I purchased my CNC option Wabeco 1210 mill just over 2 years ago. The original reason for embarking on CNC was that my deteriorating eyesight was making fretting skeleton clock plates and crossing out wheels increasingly more difficult. Now two years on, I wonder how I managed before I had my CNC mill. Everything had been going smoothly and I was delighted with the accuracy obtainable with the machine. Recently however I began to notice that the parts I was making were no longer quite as accurate as they had been. I re-ran the backlash compensation routine that comes with the software only to find that the backlash, which initially had been uniform along the length of the X-axis screw, now varied quite considerably along the length of the screw. The same applied to the Y-axis screw. If I had only been using the mill as a hand operated machine this non-uniform wear would have been of no consequence. But as I use the mill very extensively in CNC mode (the machines in my workshop have to earn their keep!) the degree of non-uniform backlash meant that the screws were now worn to the point of justifying replacement. Either I replaced the old screws with new Acme screws and nuts with the prospect of replacing them again in a further couple of years or I replaced them with ball screws, which would last a lot longer. Before making a decision the cost implications of the two types of screws needed to be considered. Some years ago I looked into replacing the worn screws on a BCA Jigborer. Then the cost of a quality Acme screw and nut was in the region of £100. Not at all cheap! The replacement ball screws from Wabeco were about £200 each. The basic difference between the two types of screw is, the Acme screw involves sliding friction between the threads in the screw and the nut and the consequent wear. With ball screws the friction is rolling friction and the wear is significantly reduced as a consequence.

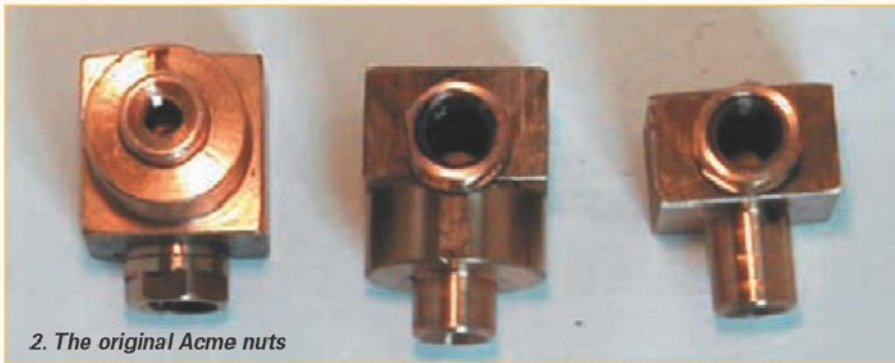
Dick Stephen describes a performance enhancing rework.

The Alternatives and Options

Having reached the decision that replacement with ball screws was the only realistic option, the next problem was how to actually carry out the fitting. There were two possible options. The first was to have Wabeco in Germany do the fitting for me. This would have involved my shipping the mill to Germany and being without it for about 8 weeks. The cost of fitting would be about £500. Together with shipping I was looking at a potential cost somewhere in the region of £1500 with VAT included. This was sufficiently large to prompt me to look for an alternative. After phoning around a bit I finally settled on the firm THK as the best possible source. The principal advantage of THK was they were able to supply 14 mm diameter, 4 mm pitch screws, the same pitch and diameter as the original Acme screws and a platform nut which potentially would make fitting a lot easier. Incidentally THK are the only manufacturer I have found that supplies a platform nut. The other nuts supplied by THK and all those from other manufacturers are cylindrical with mounting flanges on the end. These nuts are also significantly bigger than the THK platform ones and would be a lot more difficult to fit, at least to the Wabeco. The final decision could only be made once the mill had been dismantled and the possible methods of fitting the nuts considered. I had already seen the way Wabeco had fitted ball screws. This clearly involved significant modification to the castings. The screws from THK did have one disadvantage, namely only right hand screws were available. The X- and Z- axis Acme screws originally fitted were both right hand threads only the Y-axis had a left hand thread. THK said they could supply a left hand thread screw at a cost of several hundred pounds. I decided that the slight inconvenience of a right hand thread Y-axis, which would only be a "problem" for hand operation, was not worth spending a lot more money.

Nut Brackets

I set about stripping the mill down and only when I removed the nuts did I realise just how simple fitting the new nuts was



2. The original Acme nuts

going to be. **Photo 1** shows the Y-axis slide to which are attached both the X- and Y-axes nuts. **Photo 2** shows the original Acme nuts. The 15 mm diameter cylindrical stub of the nut inserts into the 15 mm diameter hole in the casting. The axis of the cylindrical section of the nut is lined up with the axis of the thread in the nut. The Z-axis nut is similarly fitted. The only problem in fitting the new nuts was to

make an attachment bracket having similar features to the original nuts. The brackets I made for the new nuts are shown in **Photo 3**, and **Figs 1, 2, and 3**. The only bracket that gave a slight problem was the X-axis one. In Fig 1 the thickness of the rectangular mounting for the X axis nut has not been given. The thickness will depend on precisely how much of the casting is milled off to accommodate the

new nut. The height of the central axis of the original Acme screw above the machined surface of the casting is 10 mm. The distance of the ball nut to the mounting surface is 13 mm. To get the height of the nut correct and to give something to bolt the nut to required the depth of the recess originally machined in the casting to be increased by about 6 mm. This gave the thickness of the rectangular mounting plate after I had machined my casting as 3.24 mm. The only other machining that appeared to be required was to increase the width of the slots in both the Y- and Z- axes slots in which the nuts slide by 4 mm. The original width of these slots was just 34 mm, exactly the width of the ball nuts. I could probably have got away with using a file to increase the width, but preferred to do a neater job so I took the castings round to a friend who has a Theile Mill which made short work of the machining required.

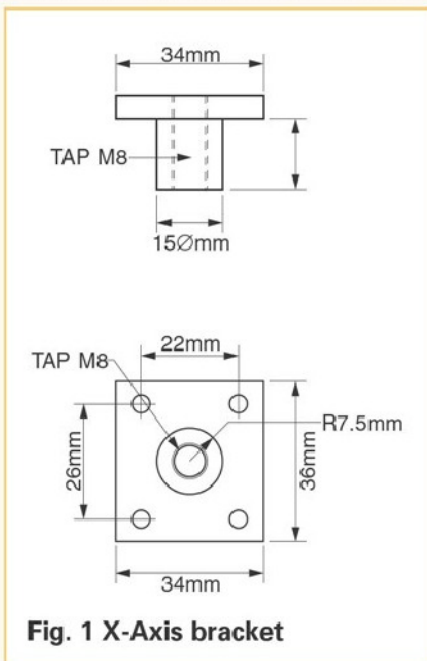


Fig. 1 X-Axis bracket

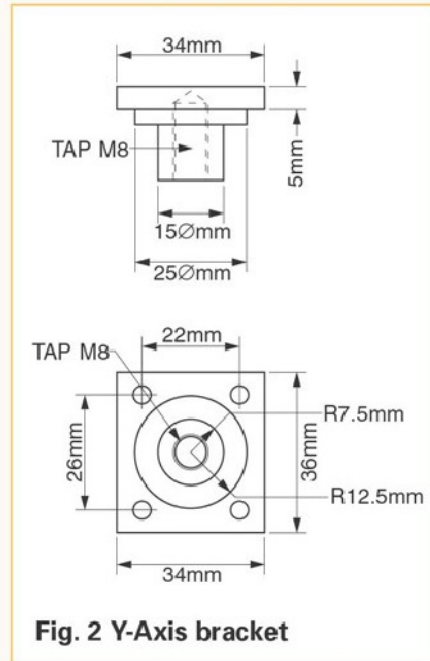


Fig. 2 Y-Axis bracket

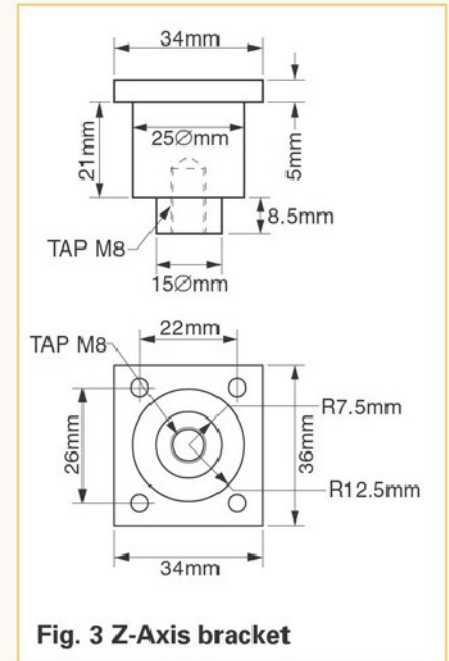
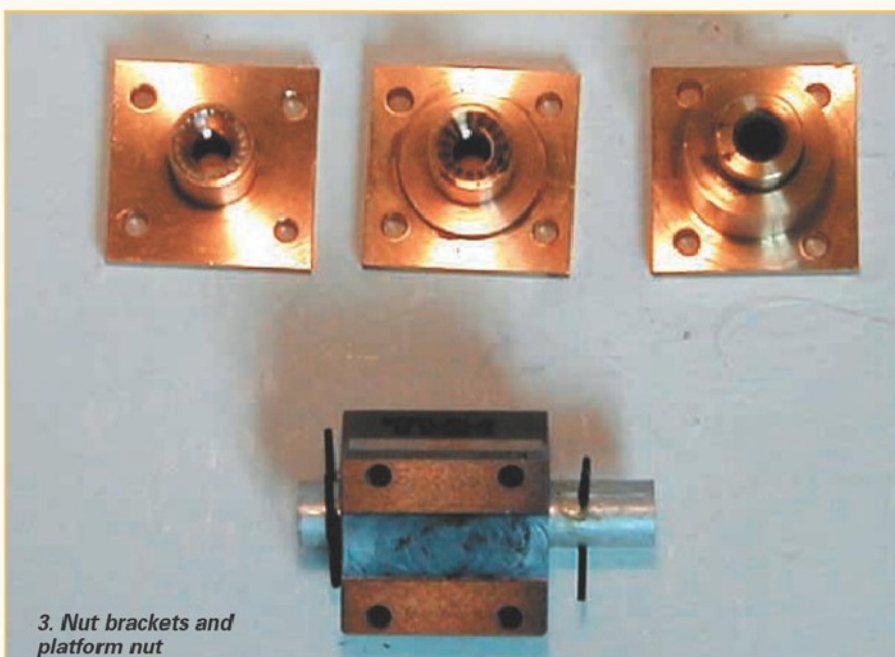


Fig. 3 Z-Axis bracket



3. Nut brackets and platform nut

4. The welded joint of the original Acme screw and extension shaft.





5. The machined ends of the screw shafts and the extension shafts.

Adapting the ball screws

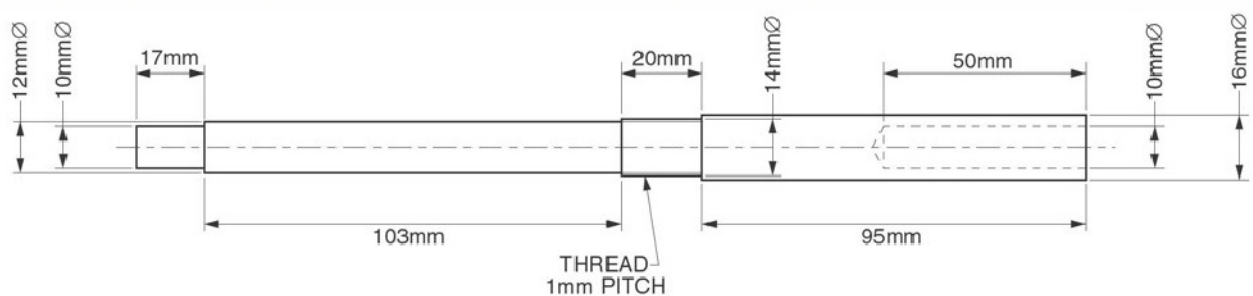
The rolled ball screw shaft supplied by THK comes in either 1000 mm or 1500 mm lengths and is induction hardened. A single 1500 mm length of rod was adequate to make all the three screws for my mill. **Photo 4** shows a close up of one of the original Acme screws illustrating how it was welded to the extension shaft.



6. The Z axis nut and guide peg.

After some deliberation I decided that the best way of attaching the extension shaft was to grind down the ball screw shaft to 10 mm diameter and fit this into a reamed hole in the extension. The dimensions of the extension shafts required for the Wabeco 1210 CNC Mill are given in **Fig 4**. Before the ball screw shaft was delivered I turned up in the lathe the three extension shafts and reamed a 10 mm hole in the end to a depth of 50 mm. At this point I was faced with the problem of getting the ball screw shafts ground down to 10 mm diameter for a length of 50 mm. As soon as the ball shaft was delivered the first thing I tried was a file on one end of the shaft. Though clearly quite hard I was able to make an impression in the shaft with the

file. This gave me hope that I would be able to turn the shaft down with a carbide tool in the lathe. My hopes were confirmed when I was able to cut off a length of shaft with a hacksaw. Clearly the surface of the screw was quite hard, however once through the skin, the steel cut quite easily. With the length of shaft held in a 14 mm collet taking light cuts the end was turned down to 10 mm diameter for a length of 50 mm. Initially I had a bit of difficulty until I arrived at the optimum depth of cut, feed rate and speed. Once I had these parameters worked out it was simply a matter of patience. The diameter of the ends were made approximately 0.02 mm under size as I planned to use Loctite Structural adhesive (320) to secure the



X and Y shaft extensions

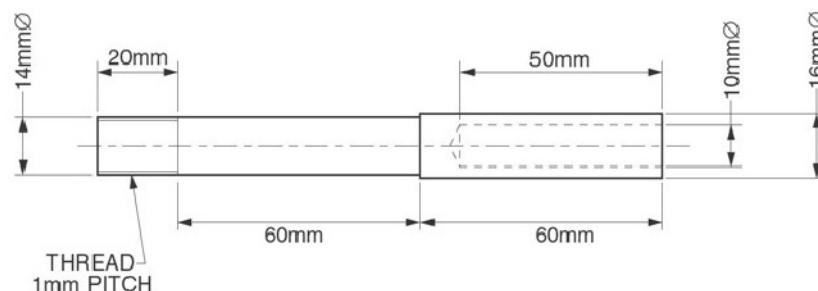


Fig. 4 Z-axis shaft extension



The final job before I could test the system was to invert the direction of rotation of the Y-axis to take care of the change from left hand to right hand pitch. All that was required was to interchange the two wires from one of the windings of the motor. This done it was time to measure the magnitude of the backlash in the screws. The CNC software I use, PCLathe, has a very useful programme called SYNCUTIL for compensating for the backlash in the screws. On running this programme, the measured backlash in both the X and Y screws was a lot more than the figure of 0.05 mm given by THK. The Y-axis did feel a little "odd" when turned by hand so I began adjusting the alignment of the nut/shaft. This turned out to be the root cause of the problem. After a bit of tinkering and appropriately placed pieces of shim stock I was able to reduce the backlash on both the X and Y axes to almost the expected value. The ball nuts may appear initially to be tolerant of the alignment as I had thought. This is not the case alignment is absolutely critical if the screws are to work as designed.

Conclusion

In spite of the alignment problems I encountered, I was surprised how easy and quick the job was to do. Having now worked out exactly how to do the fitting I reckon the whole job, once the required parts had been made, could be done just over a day. If you want to fit ball screws to any other mill, then using the platform nuts supplied by THK should make the job almost as easy as fitting new Acme nuts and screws.

Now that the mill is again in working order I have been able to appreciate just how superior the ball screws are. There is a small amount of backlash, which is very nearly constant along the length of the screws. The only way to avoid all backlash is to use preloaded precision nuts and ground screws. To go down this road you will need to have a very fat wallet.

If the screws on your mill are reaching the end of the road or have already got there I can recommend fitting ball screws. I have not found the change from left to right hand pitch in the Y-axis any problem at all for hand operation. If you do not wish to fit the ball screws yourself Maynard Ltd. are willing to undertake the work of retrofitting.



shafts in the shaft extensions. Photo 5 shows the screw shafts machined down to 10 mm and the three extension shafts. The Loctite will produce a perfectly adequate joint, as the axial forces on the screws under any normal operation are quite small.

If you don't like the idea of using Loctite then a really snug fit and a pin to hold the shaft in place is an alternative method. Any form of joint involving heat is not advisable as this may damage the ball shaft. The final job was to drill a 5 mm hole in the other end for a guide pin in each ball shaft (see below). The ends of the shafts and the holes in the extension shafts were carefully cleaned free of all oil and grease and thoroughly dried. The ball shaft was gripped in the collet, Loctite was smeared on the end and in the hole in the extension. Using a centre in the tailstock the extension was pushed in place, and left until the Loctite had set. The screw was removed from the collet and left overnight for the Loctite to fully cure.

The ball nuts are supplied on a short length of tube, which is used to retain the balls in place in the nut. If the tube is removed in the absence of the screw all the ball bearings in the nut will fall out which will give you two problems. The first is the balls will have all fallen onto the floor of the workshop. There they will either have got intimately combined with all the rubbish on the floor or if your floor is nice and clean rolled into some

inaccessible corner where you cannot find them! Having dropped out all the balls the next problem will be to get them back again. To overcome these problems I made the guide pin illustrated in Fig 5. One end of this guide pin inserts in the 5 mm holes drilled in the ends of the shafts and the other end into the ball retaining tube. Photo 6 shows the guide pin in place in the Z-axis nut. As the shaft is screwed into the nut the tube is forced out. Photo 7 shows the Z-axis shaft successfully fitted to the nut. The retaining tubes should be put carefully away as they will be needed if the shafts ever need to be removed from the nuts. I next fitted the Y and the X screws in place. The Y-axis was no problem however when I tried to slide the table over the X-axis nut I found that the top of the nut failed to clear the underside of the table by about 1 mm! The only remedy was to mill a slot in the underside of the table 3 mm deep and 25 mm wide to give plenty of clearance. Fortunately I had access to a mill with the capacity to cope with this simple job. Having machined the slot the fitting of the screws was completed.

Alignment and backlash

The three screws appeared to work nice and smoothly. I finished reassembling the machine with the stepper motors in place.

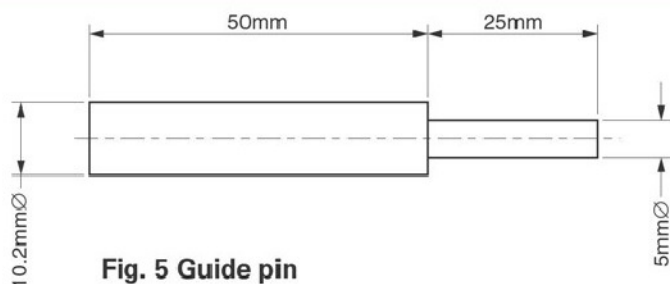


Fig. 5 Guide pin

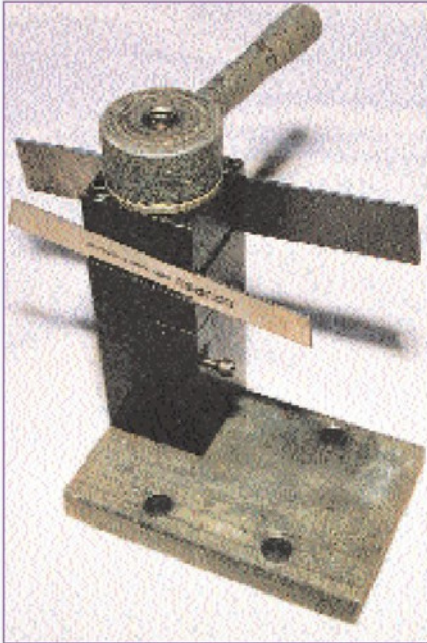
Suppliers

For ballscrews contact:
THK UK
25 Alston Drive,
Bradwell Abbey,
Milton Keynes,
MK13 9HA
Tel 01908 22 21 59

THK are an international Japanese company with branches throughout Europe and the US.

For retrofitting contact:-
Mark Maynard,
Maynard Ltd.
10 Merritts Mill Industrial Estate,
Woolchester,
Glos. GL5 5EX
Tel: - 01453 833185

PARTING OFF WITH THE QUORN



1. Initial attempt at Thomas design.

Background

Parting Off! With the Quorn? Is the man mad? Well amongst other things this article is actually about the use of the Quorn to grind a parting off tool into the shape recommended by George Thomas in reference 1 and also about modifications to his style of rear tool post.

Phil Amos reviews parting off techniques and describes a method for achieving accurate blade geometry.

Like just about every other home workshop lathe operator I have had my share of smashups when parting off - and very unnerving it is too. So when I read in reference 1 about the mechanics of the rear tool post, this made a lot of sense and I decided that I must have one. I followed the Thomas pattern tool post using "Eclipse" style blades, but still had a few smashups and I concluded that my emulation of the Thomas pattern was insufficiently rigid, and would not hold the blade accurately enough. My early attempts at shaping the blade to the Thomas "Ultimate" pattern were poor also. So since that time I have adopted the double side-by-side groove Thomas approach with marked success. Nevertheless it still seemed a worthwhile challenge to attempt to follow the Thomas rear tool post concept. Now read on.

First Considerations

Thomas made a careful analysis of the factors likely to cause problems in parting off and set these out in a series of articles in ME entitled "Matters Arising" (later incorporated in his Model Engineers Workshop Manual). To recapitulate, these problems were:

1. Lathe flimsy or in poor condition.
2. Tools unsuitable or poorly set.
3. Nature of workpiece material.
4. Type and quantity of lubricant.
5. "Gun shy" operator using speeds too low.

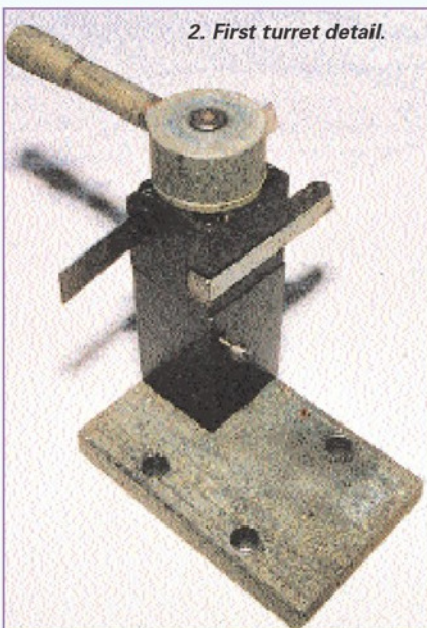
His recommendations for successful parting off were:

- (i) Minimum overhang of workpiece from front of chuck jaws.
- (ii) Less top rake than used for normal turning tool for same material.
- (iii) Tool set slightly below centre (front mounted tool)
- (iv) Tool narrower at back than front.
- (v) Tool exactly square to lathe axis.
- (vi) Saddle locked to bed.
- (vii) Speed about half that for turning same material.
- (viii) Feed in slowly by hand.

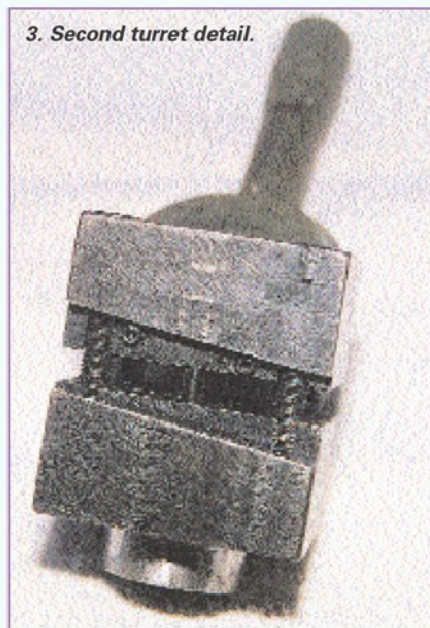
Thomas used these criteria in his development for a rear tool post for parting off, which latter has a geometric advantage against digging in. I first read all this information in 1994 and decided to make myself a Thomas rear tool post with such changes as required by my own lathe configuration. It is a Taiwanese model with 6 inch centre height; the Tee slots in the cross slide run from the back towards the front rather than the side-to-side arrangement for which the Thomas tool post was designed.

My original attempt followed the Thomas design quite closely see **photos 1 and 2**. However this did not work too well. It would seem that it is not possible to simultaneously clamp two parting off blades in the one turret unless all angles and dimensions are quite exact; mine probably were not.

Consideration of this problem led me to another try which had only one parting off blade with its own clamping piece



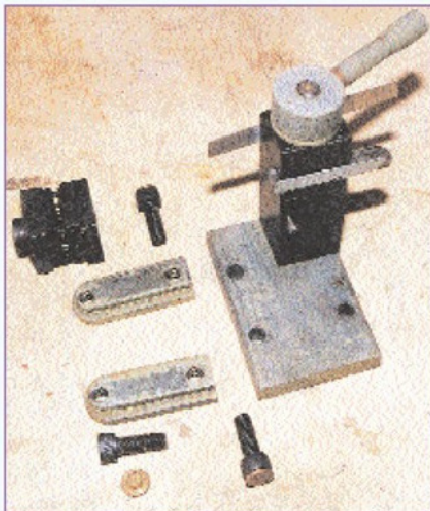
2. First turret detail.



3. Second turret detail.



4. Second turret detail - note clamping separate from turret proper.



5. Kit at conclusion of original attempts.

separate from the turret proper - see photos 3 and 4.

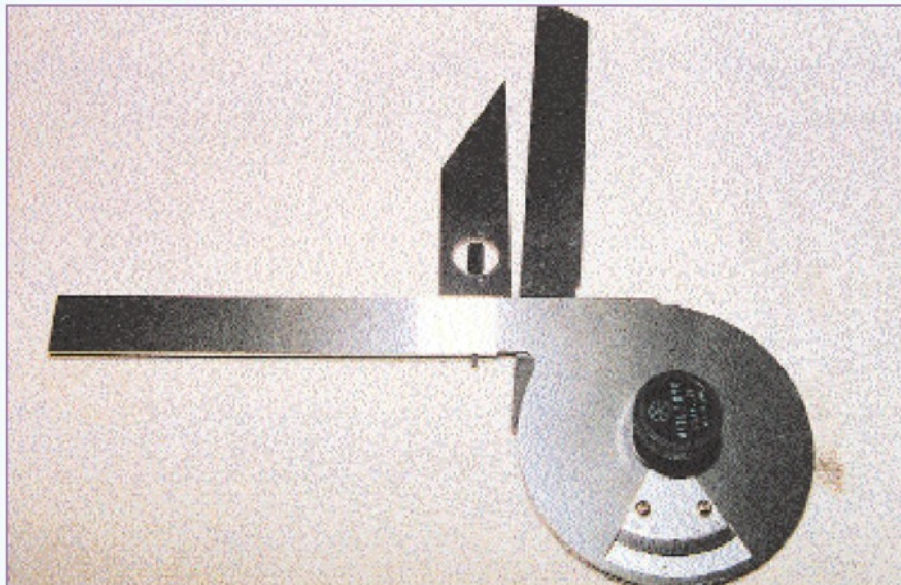
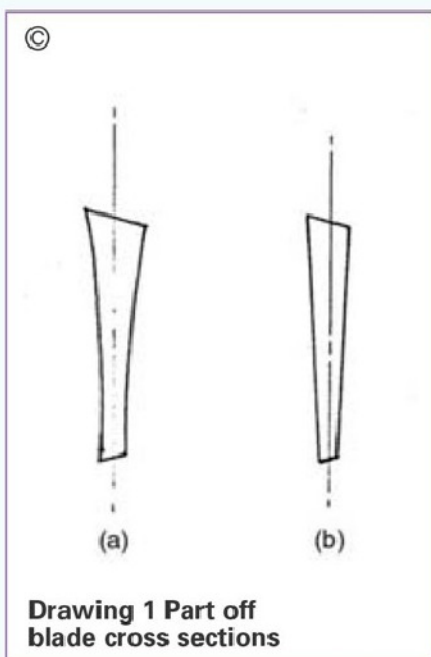
The opposite side of the turret was arranged to hold a chamfering tool secured in the conventional way by screws. This design did not perform much better and resulted also in a conventional smashup.

Photo 5 shows the whole kit at this stage. Turret 2 is in place on the post and turret 1 is on the bench. Two Tee bars for the cross slide slots allow the mounting base to be secured with three socket capscrews, each with a brass plug to keep out the swarf.

The whole project was then set aside for several years, and got under way again with a third try this year. Thinking about the Thomas advice, it seemed most important to be able to accurately shape the parting off blade by grinding, and to accurately position it and hold it securely in place.

Parting Off Tools

Parting off blades are available in two types of cross section as depicted in drawing 1 (as seen from the business end). Version (a) has hollow ground sides



6. Protractor set for measuring angle between blade sides.

whereas in version (b) the tapered cross section is straight sided. The top and bottom of the blade are chamfered at less than a right angle to the sides for gripping/location. Version (b) seems to be much more common these days. The angle between the long sides does not seem to have been standardised between manufacturers. The ones I possess lie between 3° and 5°.

All lathe tools have clearances to allow them to cut. For a parting off tool, the front clearance can readily be ground; it is usually about 5°. Our very experienced toolroom foreman recommended a two stage front clearance - for about the first mm from the edge 2° to 3°, then 5° to 6°. I tried this but could detect no difference one way or the other.

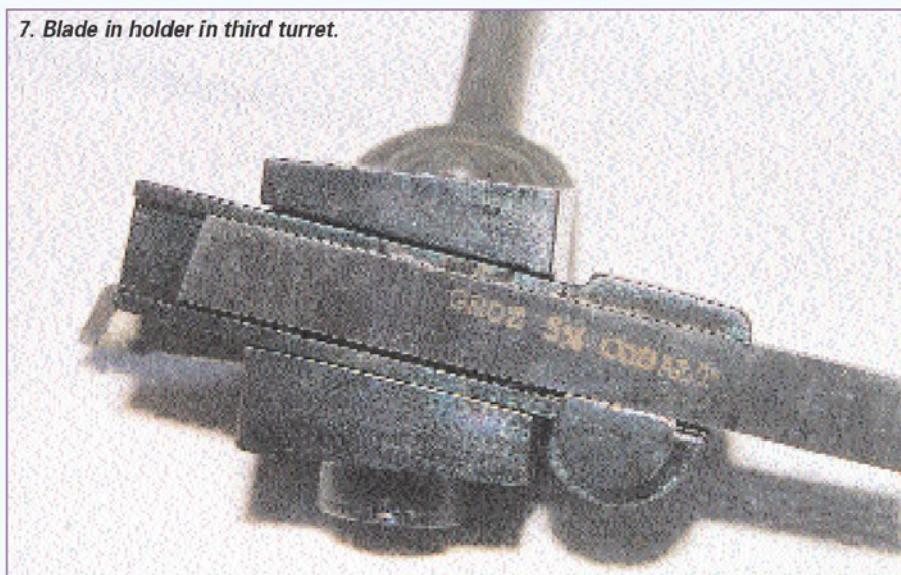
As a parting off tool cuts into a slot it needs side clearance on both sides and this is manufactured into the blade by its cross sectional shape. The blade should be positioned vertically with equal clearances both sides.

Many references suggest that in plan view the blade should taper in back from the edge on both sides at about 1deg. each side. While this may be appropriate for parting off tools of say 6 mm width and

more, for those of 3 mm and less such practice severely weakens the already rather fragile tool. Considered as a cantilever beam in the horizontal plane the strength of the tool varies as the square of the thickness, and its stiffness varies as the cube of the thickness. If the tapering is to be of any use it must be continued back along the tool as far as the tool will penetrate into the workpiece. Thus it would not seem to be desirable to tamper with the plan configuration of thin parting off blades.

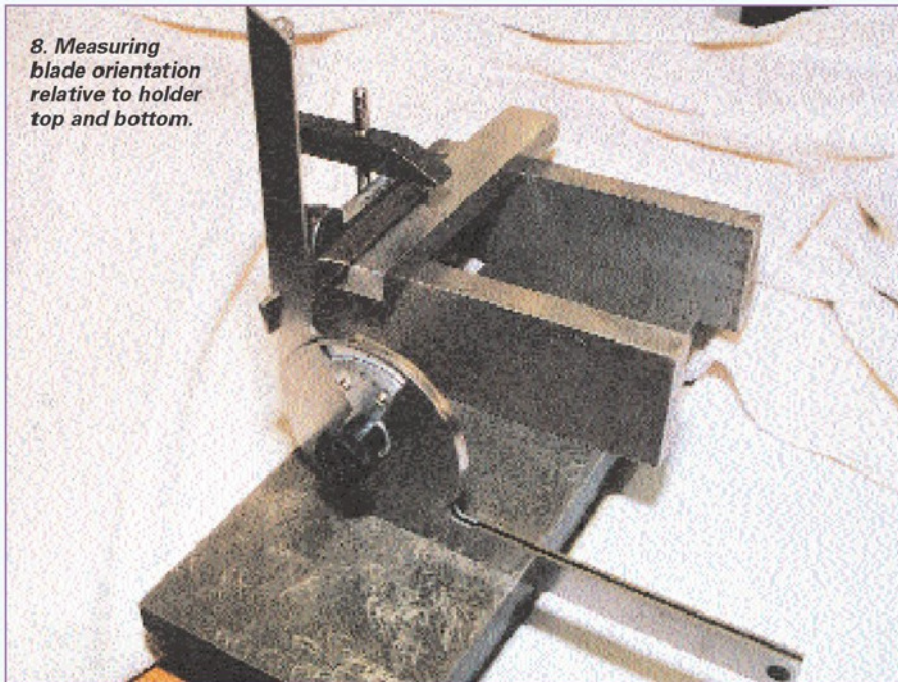
As pointed out by Thomas the often quoted suggestion in many references of slanting the cutting edge of the parting off tool slightly from parallel to the lathe axis, leads to sideways pressure on the tool and hence deflection which may cause jamming in the slot - see drawing 2, or an off square part off cut. Furthermore the chip width generated by the slant edged tool is wider than the slot so may not exit the slot as easily, and a higher tool loading is implied. The purpose (pipless component when cut off) is often not totally achieved and most workers are quite prepared to do a facing operation on the cut off part anyway.

For most materials lathe tools are given



7. Blade in holder in third turret.

8. Measuring blade orientation relative to holder top and bottom.



a top rake angle usually about 5° to 15° . A number of references suggest grinding the top of a parting off tool to achieve this as shown in **drawing 3**, but as Thomas points out, even if the initial sharpening leaves the cutting edge at the full height of the blade, re sharpening will reduce the height - but also the width of the cutting edge from "T" to "t" - hence the width of the groove cut, and the full width left at the top of the blade can jam in the cut. The Thomas design inclining the whole blade to achieve desired top rake angle avoids this problem. Smashups when parting off seem to stem mainly from:

- (a) the tool digging in, or
- (b) chips jamming beside the blade, and Thomas addresses these problems in the following manner:
 - I. A rear mounted tool post is geometrically less likely to cause digging in if the tool is deflected by a chip not breaking from the workpiece - see **drawing 4**.
 - II. If chips can be formed as ribbons rather than short pieces they are more likely to exit the groove in the workpiece. This is assisted by a flood of coolant in the case of a rear mounting tool post mounting.

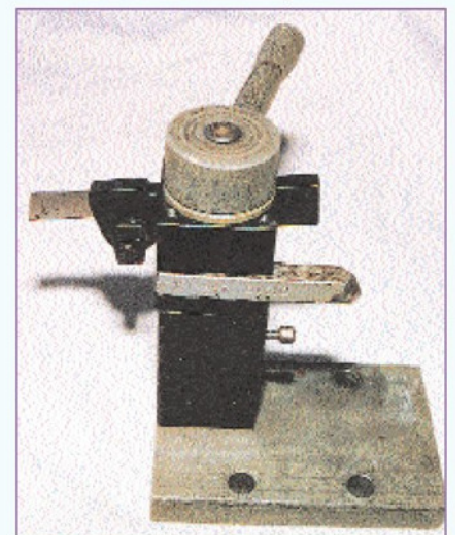
Tool Positioning

It is important to feed the parting off tool into the workpiece exactly at right angles to the lathe axis, as otherwise it will tend to at first bend, then jam and possibly break. It is fairly easy to precisely set the blade against a truly faced block held in the chuck or even against the chuck face or jaw face.

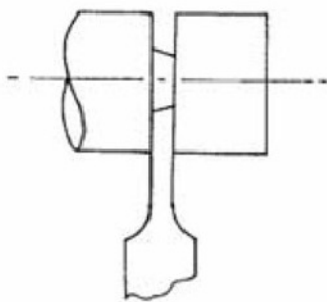
It is very much more difficult to precisely set the vertical centre line axis of the blade vertical so that equal side clearances are obtained on each side.

The exact cross sectional shape of the blade must be measured. The top and bottom chamfer angles can be measured with a vernier protractor, but it is not easy to measure the small angle between the vertical sides with this device as these sides do not come to a point. It is possible to fix the auxiliary arm to one main arm of the protractor so as to leave a small gap

10. Assembled third attempt.

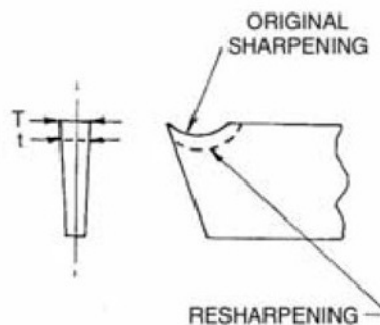


©



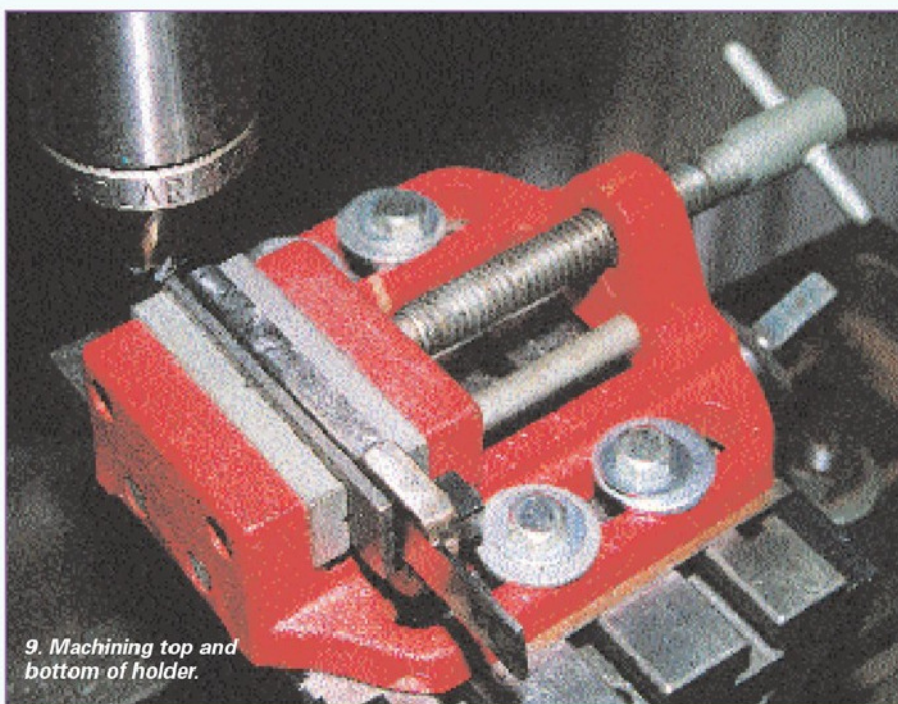
Drawing 2 Slant edge

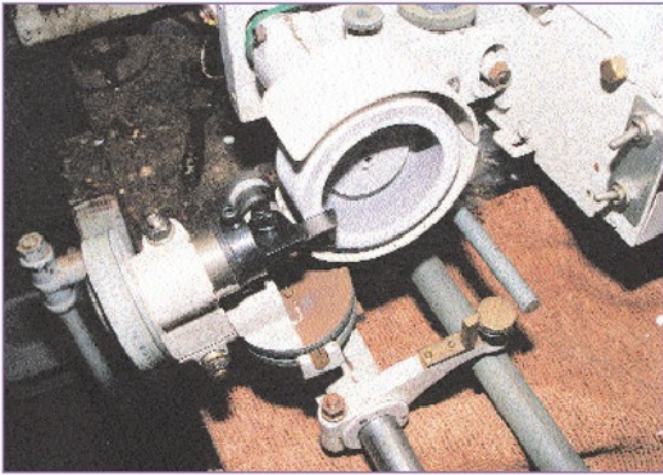
©



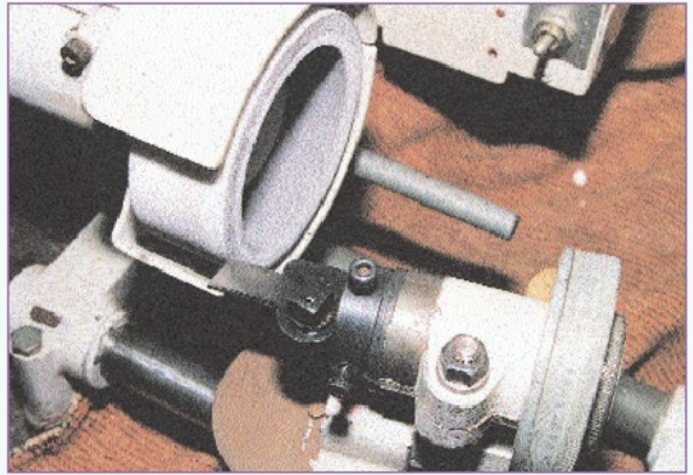
Drawing 3 Rake sharpening

9. Machining top and bottom of holder.

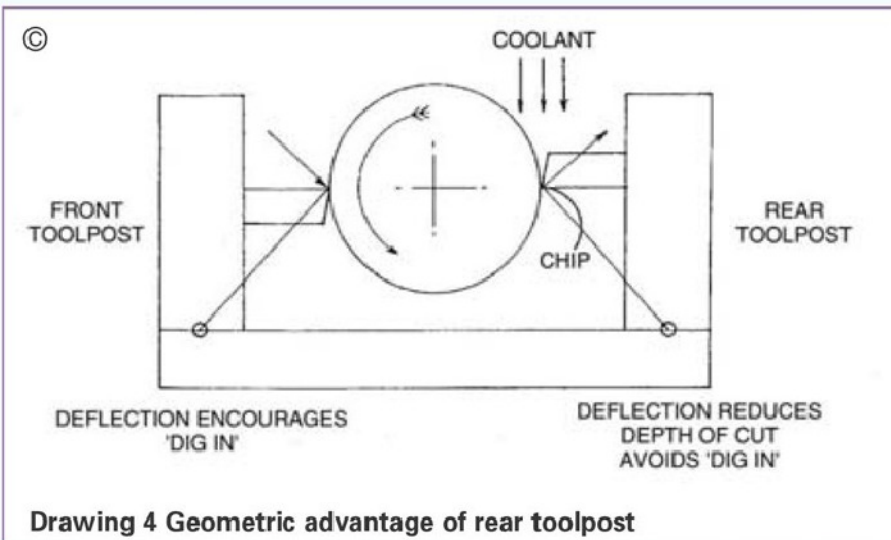




11. Shaping top face of blade.



12. Shaping front face of blade



between it and the other main arm as shown in photo 6. In this way the sides of the blade can be made to contact both arms.

Although the vernier protractor itself can typically read to 5 minutes of arc, getting the two arms adjusted simultaneously is not easy; especially due to the arrangement for clamping the auxiliary arm in position, so that the final measurement can probably not be more precise than about a half degree.

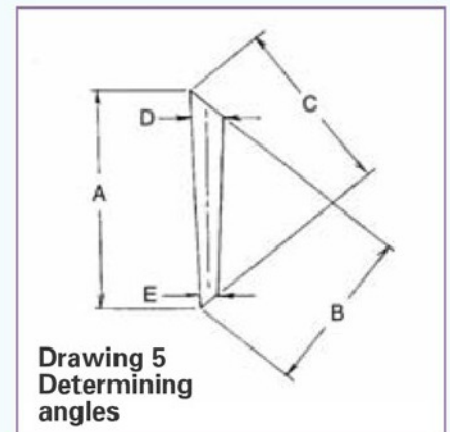
Another approach is to use a micrometer to measure the distances A,B,C,D, as shown in **drawing 5**, then plotting at 10 X scale and measure the angles resulting. This procedure is probably able to measure the angle between the blade sides to about one quarter degree accuracy.

Thomas uses small socket setscrews to bear against one side of the blade to cant it to get the axis vertical - seen in photo 2. It requires great patience and much trial and error (set screws, clamp blade, measure, remove blade, reset screws, etc,etc) and in my manifestation of his design, I felt that the blade was very insecurely held with this arrangement. There is anyway still the problem with the holding of the blade so as to be able to grind its top chamfered surface flat and at right angles to its vertical axis to produce its cutting edge.

From these considerations I elected to hold the blade in a traditional commercial holder, which has a tapered bolt forcing

the blade in against the back of the holder and its lower recessed edge - **see drawing 6 and photo 7**.

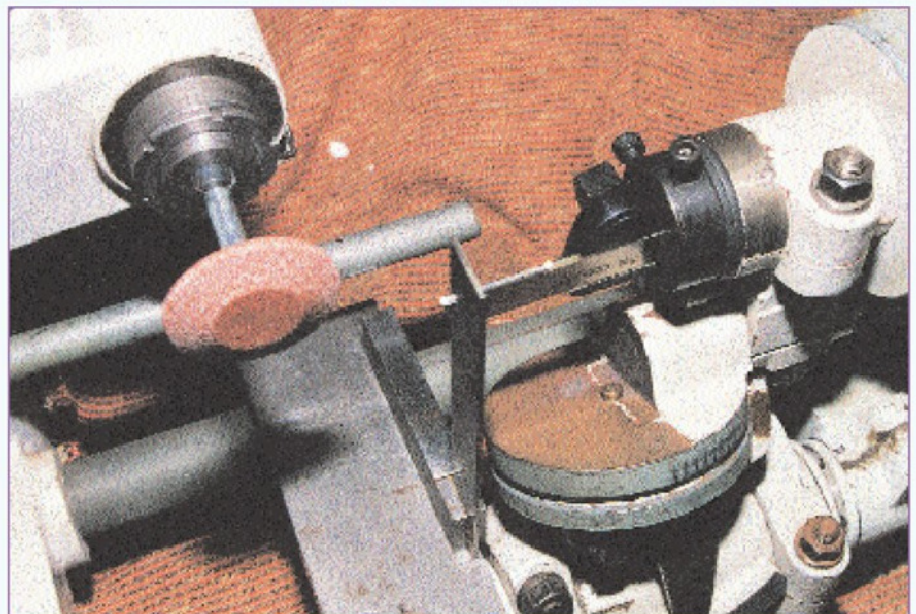
It would seem that the back of the holder slot is often machined perpendicular to the top and bottom of the holder and not so as to make the axis of the blade perpendicular to the top and bottom. By measuring the blade side

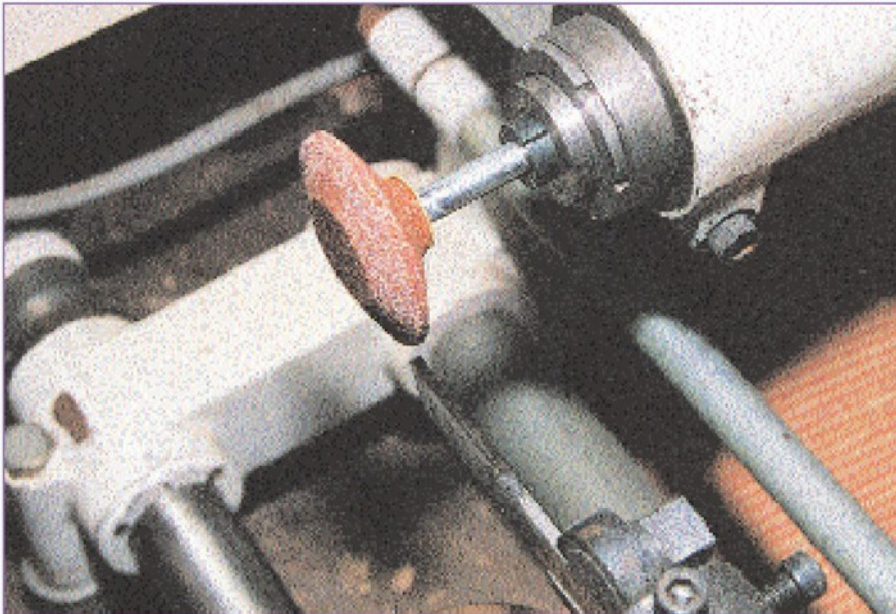


angles relative to the holder top and bottom it was determined that its axis was 2.25deg. out - **see photo 8**. So the top and bottom of the holder were then milled at a 2.25deg. angle to achieve the vertical blade axis. See **photo 9** where a blade holder is clamped in a vice set on an angle table in turn mounted on the mill/drill table.

After machining the blade axis was again checked as in photo 8 and proved correct. The lathe centre height above the cross slide surface was measured with a vernier height gauge and determined to be

13. Setting blade orientation and position before grooving.





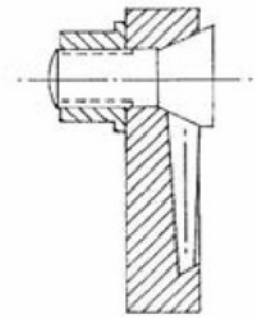
14. Completion of grooving.

87.70 mm. The arrangement was drawn out full scale with the parting off blade at 7deg. slope as recommended by Thomas and with the blade projecting 26 mm from its holder, with an aim of being able to part up to 2 inch diameter bar. Drawing 7 shows the general arrangement arrived at.

Because the blade slopes there exists a means of small height adjustment at its extremity by moving it in or out of its holder. The blade holder measures 18 mm high and 8 mm wide, and the slot to accommodate it was made 19 mm high

and 8 mm deep. It is secured in position with three M6 socket setscrews 6, 8 and 10 mm long. On the opposite side of the turret a slot 13 mm high and 10 mm deep is provided for the chamfering tool which has 10 x 10 mm cross section: the latter is secured with three M6 socket setscrews 20 mm long.

The third turret manifestation was then marked out prior to machining the slots in its sides. The slots were made with the turret clamped in the milling vice on the drill/mill: firstly a slot drill was run through



Drawing 6 Blade holder

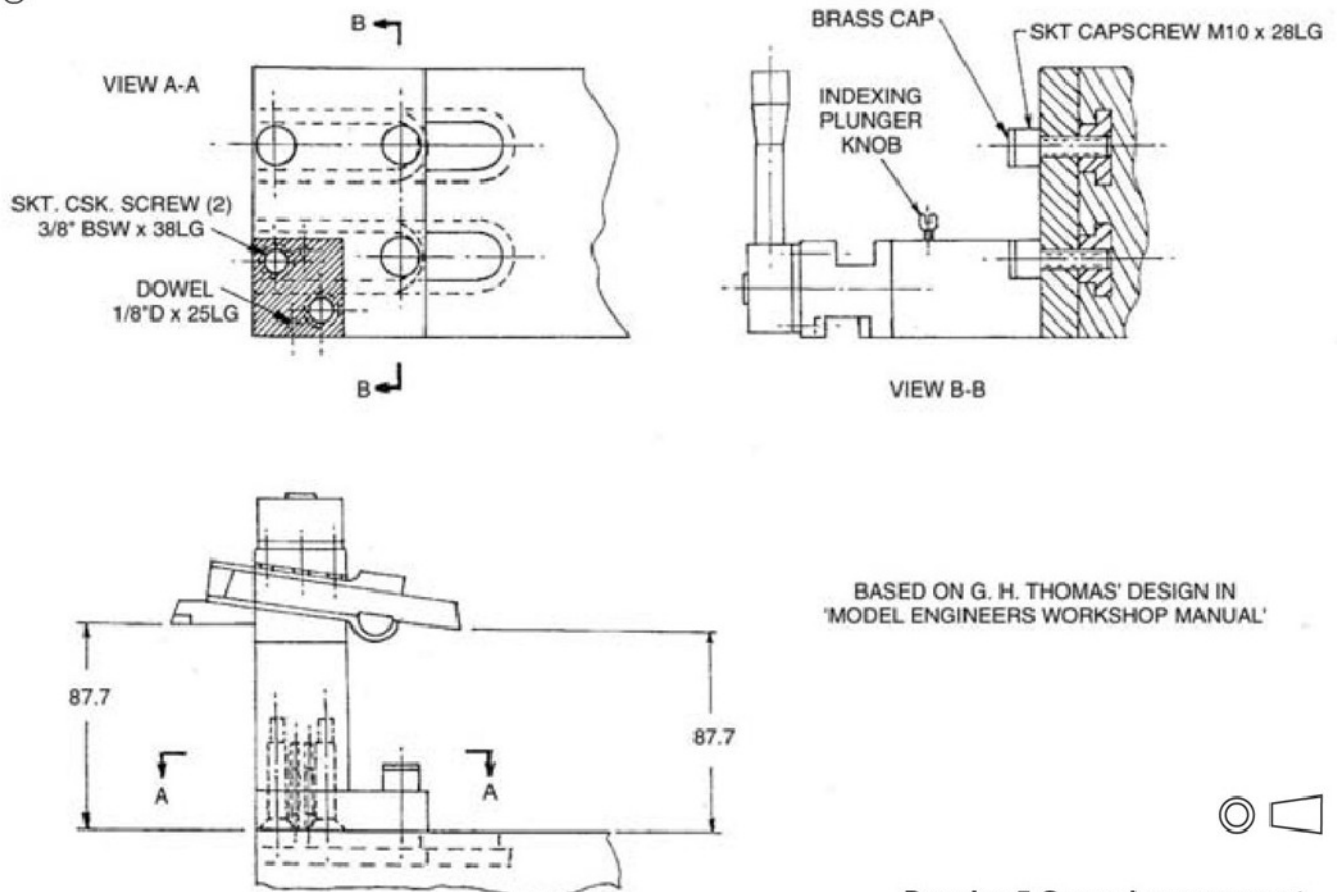
along the centre a line of the slot (0.5in inch diameter for the parting off tool slot and $\frac{3}{8}$ inch diameter for the chamfering tool slot). In each case there were two passes at half slot depth. The slots were then brought to correct width with an end mill ($\frac{1}{2}$ inch and $\frac{3}{8}$ inch diameter respectively) against each slot side in turn.

The finished turret with the tools assembled in place is shown in photo 10.

Tool Shaping

For the tool shape ("Ultimate") shown in reference 1- see drawing 8- having a Vee groove along its top surface, and a shallow ridge running down its front surface Thomas mandates the use of a Tool & Cutter Grinder. He used his "Union" machine but writes "it should be quite easy on a Quorn". Well maybe. However it would seem to require a methodical

©



Drawing 7 General arrangement

approach and some care to effect this shaping with the Quorn. Below follows a step by-step procedure for achieving the required result.

When building my Quorn in addition to a toolholder with a square aperture for normal lathe tool shanks, I also made a similar one with a rectangular hole to accommodate parting off tool holders. For this current shaping exercise this arrangement proved most useful.

The shaping was effected in four stages as follows:

1. To produce a flat surface on the top of the blade perpendicular to the vertical axis. The blade in its tool holder was clamped in the Quorn holder and assembled into the workhead, pointing at right angles to the main bars. Using a small square the side of the blade was set perpendicular to the rotating base upper surface, and then rotated by half the included angle between the blade faces (in my case half 4.5° i.e. 2.25°) using the scale on the division plate. The value was recorded for reference and then the blade rotated 90° so that its axis plane was now horizontal.

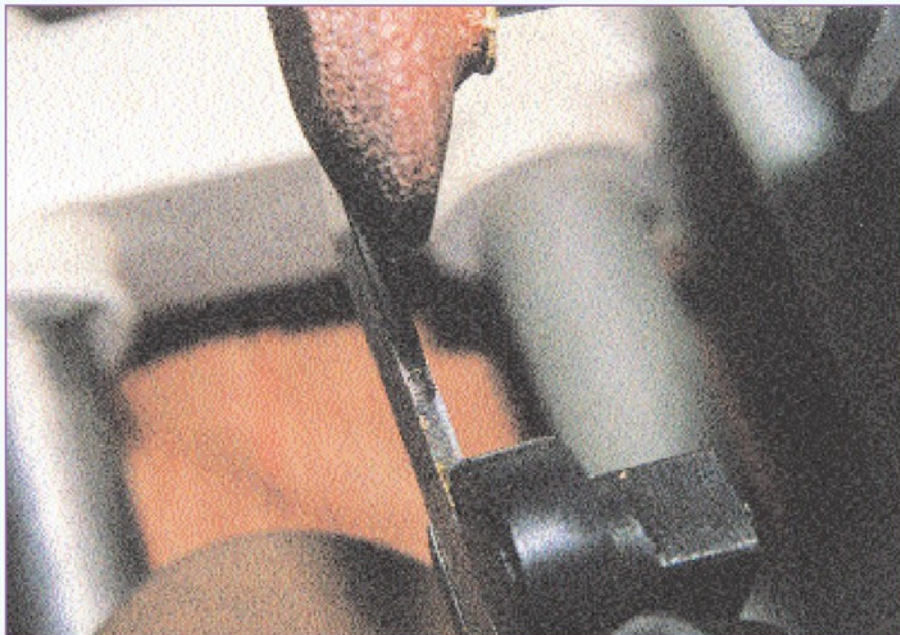
The workhead was moved to close proximity to the side of the grinding wheel, where the cut was put on with the front bar micrometer and taken by rotating the workhead around the front bar, see **photo 11**.

2. To obtain a front face on the blade at 78° to the top flat (when the blade is raked at 7° this leaves a front clearance of 5°) the workhead rotating base was now turned through 102° anticlockwise in plan. The workhead was again moved close to the grinding wheel, the cut put on with the front bar micrometer and taken by rotating the workhead around the front bar - see **photo 12**.

3. To develop the ridge along the front face of the blade having an 140° included angle, the same setup was used as in stage 2 above but with the workhead tilting bracket set at an angle of 20° up or down from the original zero setting. The end of the blade was blackened with a marking pen and a centre line marked along the blade vertical axis. Actually two lines because of the sloping blade sides and a mean was contrived from these to define the blade vertical axis plane. As before the cut was put on with the front bar micrometer and taken by rotating the workhead around the front bar, until the marked axis line was reached - then repeated for the opposite side (after altering the tilting bracket setting).

4. The most exacting task is to cut the 140° included angle groove on the top surface of the blade. The largest available diameter grinding point of roughly disk shape had its edge formed with a diamond to yield a 140° included angle ridge around its periphery.

This point was mounted in a collet in the wheelhead spindle with its axis at right angles to the Quorn main bars, The parting blade had to be held in an extended position from its holder to allow the point to produce a groove back to



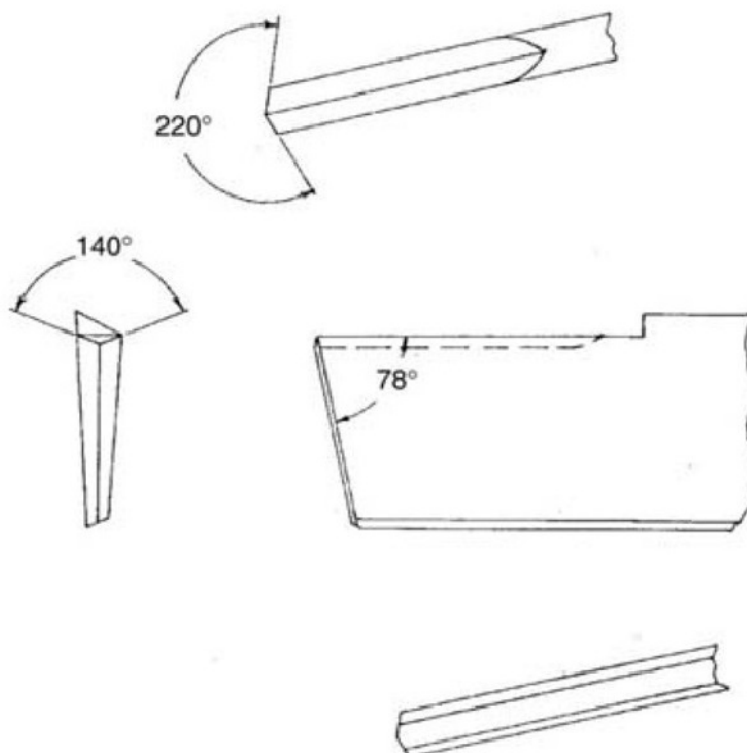
15. Close up of blade groove.

26 mm from the end of the blade.

In order to get the blade in the same vertical plane and below the grinding point it is necessary to tilt the workhead backwards, and the toolholder assembly forward towards the operator. With some judicious juggling it was possible by eye to get the blade fairly well positioned, after which it was checked with a square placed on a parallel across the Quorn main bars, and then turned through the necessary 2.25° (as in stage 1) to get the blade axis vertical - see **photo 13**.

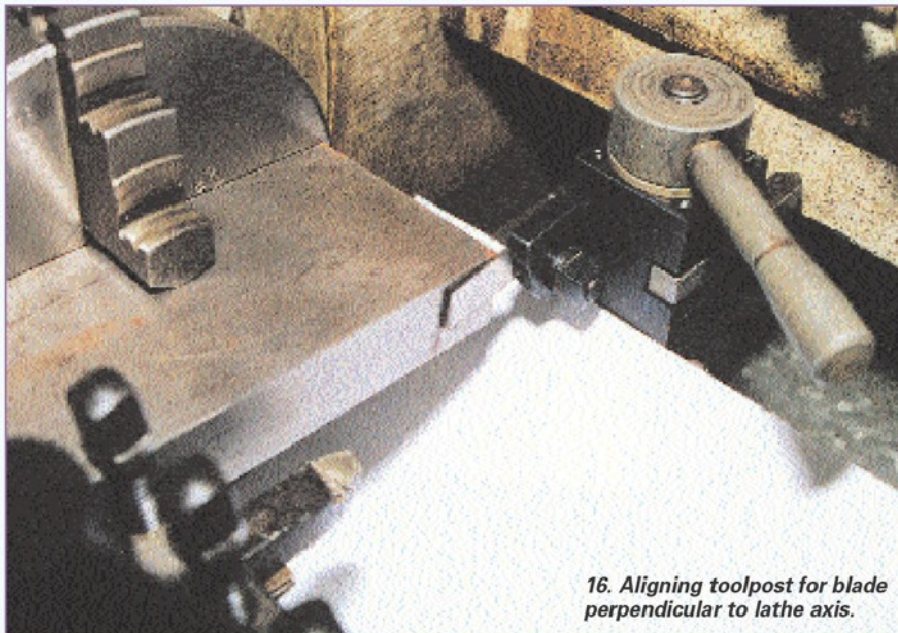
Using the rocking lever adjustment screw, the sideways positioning could be adjusted, but needed further checking of the verticality of the blade axis. The top surface was then blackened with a marking pen and a centre line marked on it with a jenny caliper. The machine was started and the point gradually lowered using the wheelhead adjusting screws until it just touched the blade. This was examined to confirm that the contact was on the marked line. The groove was then ground in a number of passes with the cut being

©

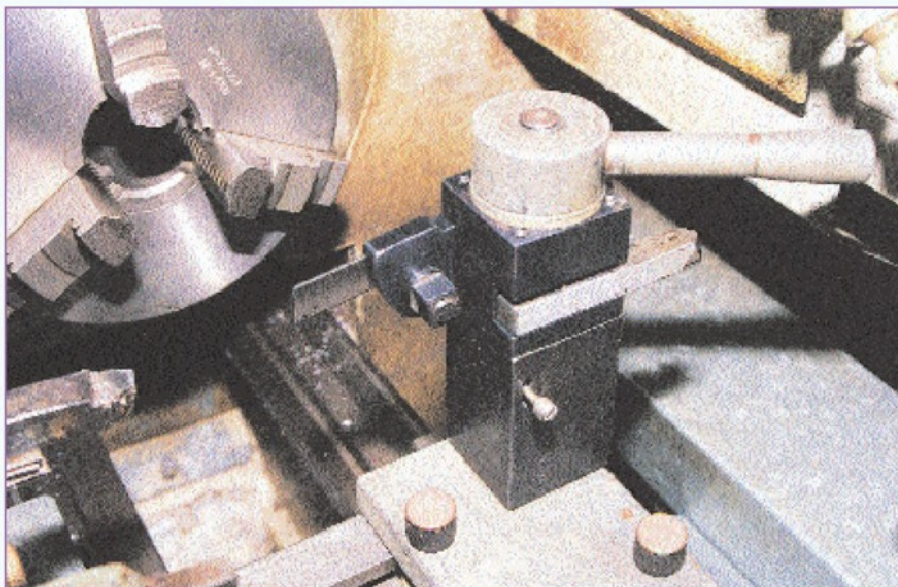


Drawing 8 Thomas blade shape (Shapes exaggerated for clarity)





16. Aligning toolpost for blade perpendicular to lathe axis.



17. Device with height set and ready for work.

set with the wheel head adjusting screws and taken by moving the workhead along the Quorn main bars.

It is of course quite vital that the blade is exactly parallel to the main bars both horizontally and vertically if a uniform

18. Trial result, showing improved surface finish.



groove is to be produced and centrally disposed on the blade: so an examination of the initial cut can show any slight deficiencies in these parallelisms, which can be corrected before proceeding. The production of the groove is thus quite a lengthy business, but can be achieved with care and patience - see **photos 14 and 15**.

Trial

Having the parting off blade shaped it was then clamped securely in its holder with 26mm projecting, and the holder clamped in the rear tool post turret. It was again checked for verticality of the blade axis. The rear tool post was clamped in position on the cross slide with care to ensure that it was at right angles to the lathe axis, and at a position so that it would project forward of the lathe centreline when the cross slide was fully withdrawn - see **photo 16**. The height of the blade was checked and adjusted to be just slightly higher than the lathe axis - see **photo 17**.

A length of 1 inch diameter bright mild steel was chucked and skimmed with a

right hand knife tool. Pieces of the bar were then parted off with the new device. These are shown in **photo 18**. As will be seen the surface finish is excellent, and can be compared with the rather indifferent surface finish of a conventional parting off operation shown for comparison.

Despite this good performance there was still a lot of chatter at some diameters and work overhangs, particularly at each starting point. Possibly this is due to forcing a narrow pointed tool into the workpiece, but see also the appendix discussing chatter. The chips produced were long and curly, consistent with the earlier observations by Thomas, although it is possible that the choice of workpiece material had a bearing on this.

Conclusion

At the third attempt it would seem that a device has been produced which will improve the parting off process in my home workshop.

Appendix - Chattering

Any mechanical system has a natural frequency of vibration, and if suitably excited by some disturbance will vibrate at that frequency. Common examples are organ pipes and violin strings.

In our case here the mechanical system comprises the workpiece, the chuck jaws, the chuck itself, the lathe spindle, its bearings, the lathe frame (that is headstock and bed), the cross slide, the tool post and the tool. Such a complicated system does not easily lend itself to analysis, but certain common principles apply:

- I. Heavy, solid, long objects tend to have low vibration frequencies, whereas light, thin, short objects have high vibration frequencies.
- II. Excitation can come from a single event - e.g. a hammer blow, the breaking off of a chip, etc or a series of repeated events. In the latter case the timing of these events must be such as to match the natural frequency of the system or its overtones (harmonics or sub-harmonics).

If a tool is deflected while cutting a chip and the chip breaks off, the tool can cease deflecting, and this process can repeat. If this deflection and recovery timing meets the criterion II above, then it is likely that chattering will occur. It may be stopped by increasing or decreasing the system frequency by changing the rotational speed, by changing the tool shape to yield continuous chips instead of small broken off pieces, by reducing the tool overhang or workpiece overhang from the chuck jaws or by adding mass to the tool itself.

As a general rule minimum overhang in each case is recommended, and usually the slowest direct lathe speed achieves best results.



References

1. Model Engineers Workshop Manual - G.H.Thomas -1984.
2. Quorn Universal Tool & Cutter Grinder - D.H.Chaddock -1984.

ROTARY GRINDING

1. Dead centre on mag. chuck. Note use of parallels and fence. Guard removed for clarity.



On the front cover of M.E.W for April 2002, I was interested to see a photo of an old friend, the Harig Grind-All. I first used this tool in the US of A in the early 70's and very useful it was too, working as I was, in the electronics industry on press tools, I made many punches using the Harig. A few years later, in England, I missed the old Harig and decided that I would build my own version. Now, the Harig is a fine tool, but it is a bit of a lump, and when you

Alan Booth describes a simple approach suitable for small punches or spindles.

have moved around from shop to shop and flown to and fro across the Atlantic as many times as I have, then portability is a consideration, so I made mine rather smaller and lighter, while retaining the capacity of the Harig. I will get around to my version of the Harig, in a later article, but for now I would like to discuss some simpler means of rotary grinding.

The dead centre

Again, I first came across this method in the United States in the early 70's, and the piece of equipment we are going to talk about I have heard referred to variously as a "Whirlygig - Whirlygig or - Dead Centre". Let's call it by the latter name, Dead Centre, from now on, (See figs. 1 & 2). Being by background, a toolmaker, I have liberally specified "Hardened and ground", on the drawings. For amateur purposes, unhardened components would probably give a reasonable service life, but it should be noted that in order to grind a parallel diameter, the Vees must be formed to accurately support the workpiece, with the axis horizontal. Another piece of equipment which will be needed to complement the Dead Centre is a means of gripping the workpiece for rotation. Let's call it the 'V' centre handle. (See fig. 3), V handle for short.

Method of operation

If you have access to a surface grinder then the Dead centre is placed on the mag. chuck against the fence or rail, with sufficient parallels in between to ensure working room. (See Photos 1 & 2) Safety conscious readers will be reassured to know that all the photos were posed with the machine stationary. The wheelguard was removed to improve visibility of the workpiece, and it was unnecessary to don the safety glasses. For actual operation, these safety measures are, of course, mandatory.

If you are working with a tool and cutter grinder, then the means of setup will depend on the machine design. (I am assuming some basic knowledge at this time. For this method to give accurate results the material that you intend to grind will ideally have a hardened and ground outer diameter, as the accuracy of the ground section is dependant on that of the location section. Broken cutters, centre drills, etc. are ideal for making up little punches, cutters etc. - you can, of course, buy punch blanks in a variety of sizes. Whatever the source of material the precision ground diameter of the blank forms its own bearing.

The punch blank, is gripped with the 'V' handle and placed in the most suitable vee of the Dead Centre to give a small gap between the dead centre body and the

Notes

Material gauge plate or mild steel deep case hardened. Grind all over. Vees 90° inc. angle.

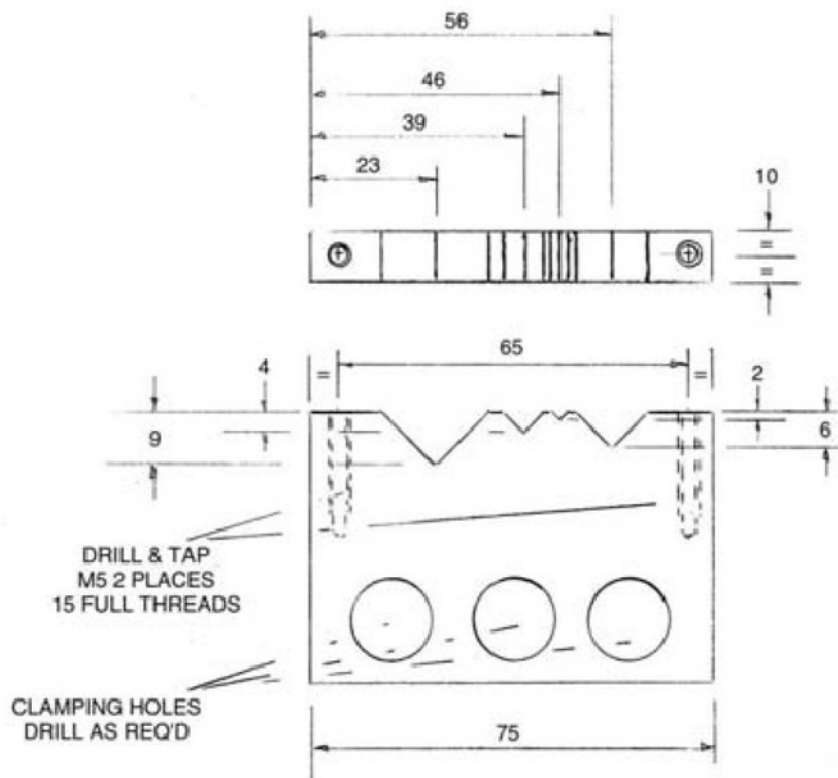
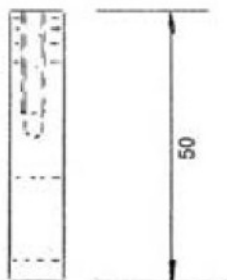
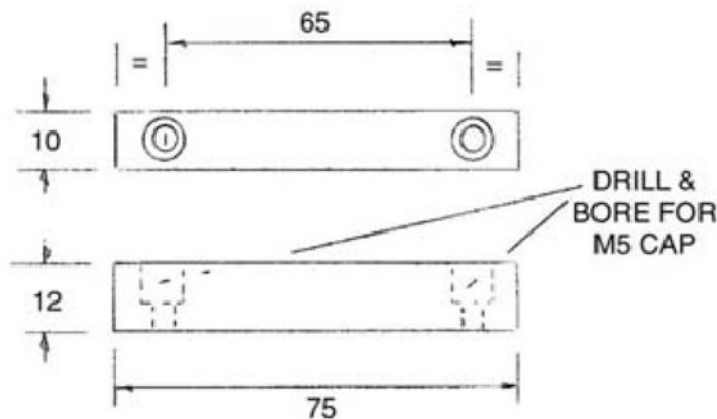


Fig 1 Dead centre - body

©



Notes

Material gauge plate or mild steel deep case hardened. Grind all over.

Use 1 off M5 20 Allen cap screw in one end of clamp plate and 1 off M5 x 25 the other end with a spring about 5-6 mm long under the head.



Fig 2
Dead centre

clamp plate, with the portion that you intend to grind protruding. You will need to place a suitable spacer, (a washer would be fine), on the punch blank, between the 'V' holder and the Dead Centre, so that the handle doesn't rub. The clamp plate is then adjusted so that it is level, and the spring adjusting screw tightened correctly, enough to ensure that the work doesn't tip in the vee but is still able to rotate freely. Now, the wheel having been dressed, the punch blank is positioned under the wheel at the lowest point of the wheel and the wheel moved to within about 0.050" – 0.060" of the dead centre. Commence rotating the 'V' handle with your left hand, you need to develop the facility to maintain a constant rotation speed of somewhere about 70 or 80 rpm. The knack also needs to be acquired of rotating the workpiece in the vee without tipping it.

Now, you have your left hand merrily spinning away, clockwise of course, the direction is important, so that you retain

control of feeding the workpiece against the rotating wheel. Your right hand will be used to operate the wheelhead, (see photo 3) and the cross slide. Bring the wheel down to touch on and note the dial reading. Now, there are two ways of removing material ;

a. **Plunge grinding** – in which the wheel head is fed slowly down, whilst continuing rotation all the time with your left hand, take it steady, this method generates a lot of heat.

b. **Traverse grinding**. Having touched on, wind the workpiece clear sideways, and bring the wheel head down by about 0.001" – 0.0015". Now, this is where the clever bit comes in, it is a bit like the old trick of rubbing your tummy while patting your head! Left hand rotating the work, feed the cross slide slowly into the wheel to your finish position, 0.050in.-0.060in. from the dead centre and feed slowly out again, this will give the best finish and, even if you remove the majority of the

stock by plunge grinding, it would be advisable to finish off with a little traversing cut.

Vibration

When grinding diameters below 5 or 6mm, (you will notice that I switch between metric and imperial measurements with cheerful abandon) then vibration can become a problem. You will feel this vibration through the 'V' centre handle and the grinding finish will deteriorate dramatically. This, unfortunately, tends to damage the wheel surface and you will need to re-dress the wheel.

This vibration can be overcome by introducing a damping mass, in contact with the underside of the rotating workpiece. This damping mass takes the form of a half-inch cube of metal mounted on a spring finger and a swivel mount as shown in fig. 4. feel free to scale the drawing! - this should damp out the vibration successfully.

Lubrication

If you intend to remove more than a few thou then it is helpful to introduce a little lubrication as follows: -

Take a piece of masking tape, sufficient to cover the gap between the top plate and Dead Centre body and to wrap around the ends plus a couple of inches; place on a block of wood, sticky side up, and punch a hole with the punch that you have quickly knocked up, I use my shim die for this kind of thing.

Place the punch blank in the dead centre and **lightly** tighten the spring tension screw. Slip the tape over the punch blank and stick it to the Dead Centre, covering the gap at the front and sides of the dead centre, tear off the excess at the ends. Remove the punch blank, smear a finger end of grease into the 'V', replace the punch blank, tension the spring screw and, hey presto, you have a grease lubricated sealed bearing, works a treat!

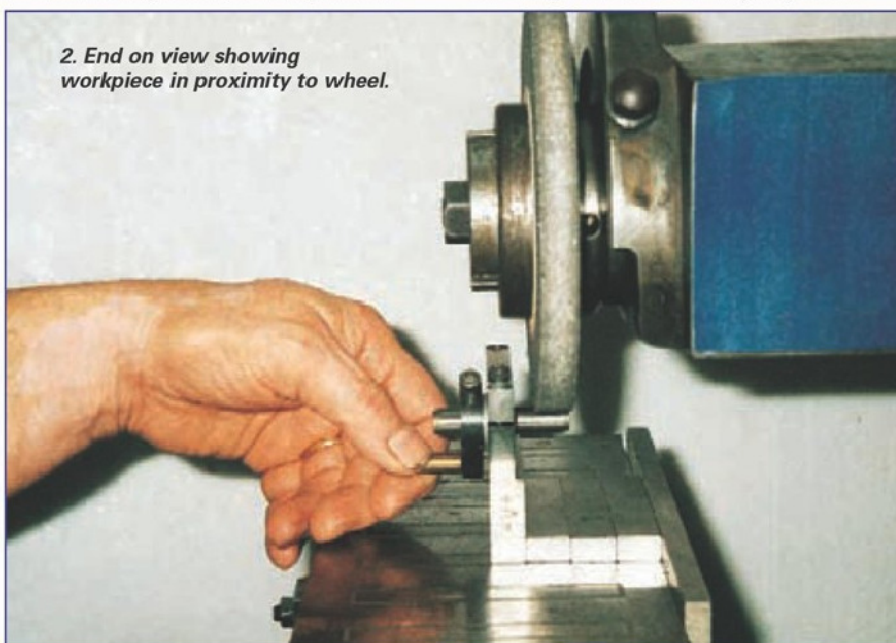
End Plunge Grinding

Some years ago, whilst working in a sub-contract toolroom I had a job making what were known as *pininsert punches*, which had to be reduced from, I think, 0.250in. down to 0.060in. for a length of about half an inch and of course it had to be done very quickly, as well as accurately. The method I used, after some head scratching, was to 'end plunge grind' - details as follows: -

The punch blank is placed in the 'V' centre holder protruding about $\frac{1}{2}$ of an inch, rotated and blued with a marker pen. The wheel is then positioned about 0.050in. away from the dead centre, the working position, and touched on the rotating workpiece. The workpiece is then retracted into the deadcentre, and the wheel head brought down by 0.094in. This is arrived at by subtracting the finish punch diameter of 0.060" from the blank diameter of 0.250in. giving 0.190in. Divide this by 2, giving 0.095in. Prudently we need to bring the wheel head down by, 0.001in. less than this, hence 0.094in.

Now, you are going to need a good supply of coolant for this operation, directed full on the punch, otherwise the workpiece will glow dull red in no time!

2. End on view showing workpiece in proximity to wheel.



Notes

Material - gauge plate or mild steel - deep case hardened.
Grind vee square to face 'A' - grind relief where shown to obviate binding against the dead centre.
Fabricate handle from M4 x 35 long, allen cap screw - cut slot in end to aid assembly.

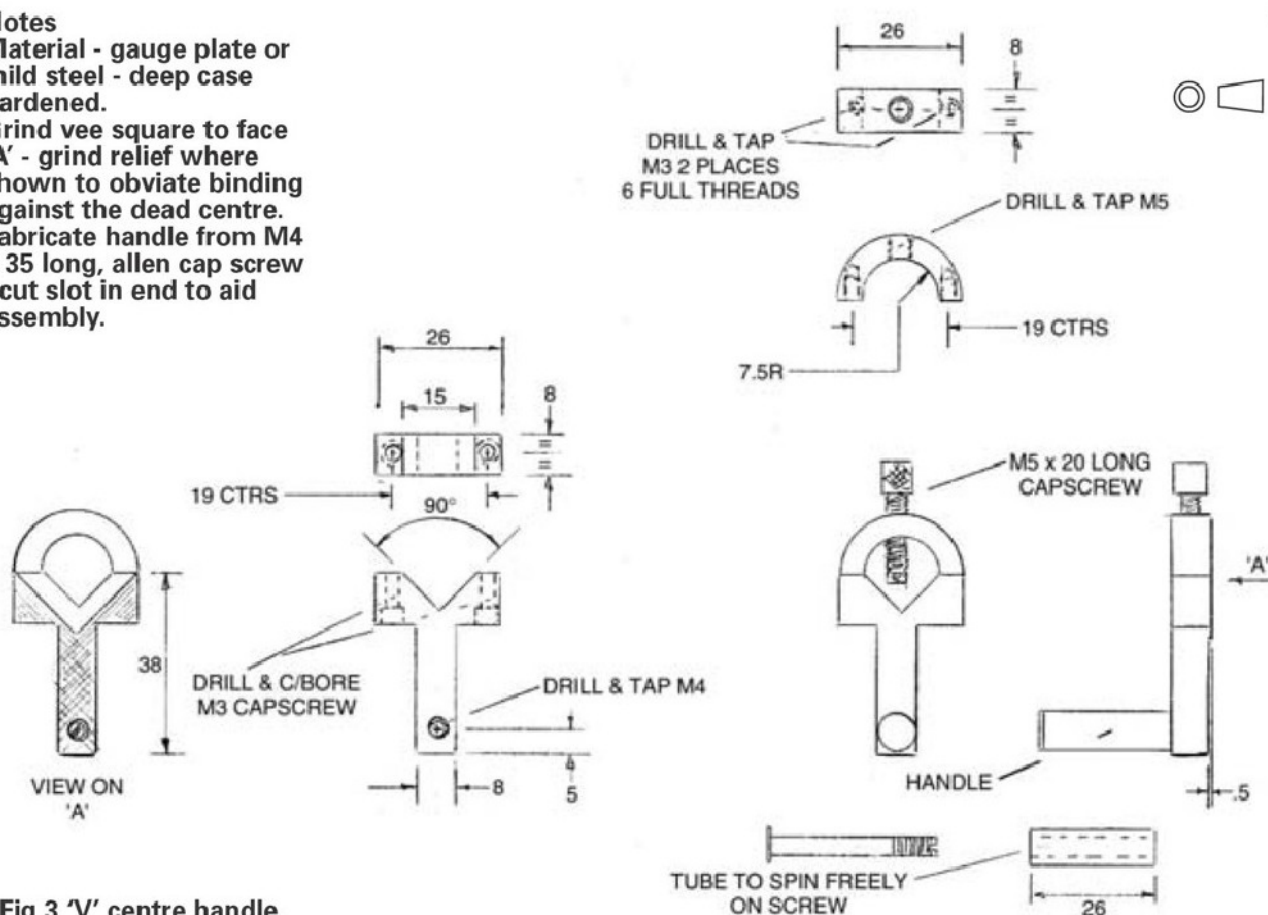


Fig 3 'V' centre handle

(the coolant will act as a lubricant also). Start the coolant, a face mask is advisable, feed the cross slide in to the working position, and, rotating the workpiece, feed in and grind the blank sufficiently to give enough length of diameter to measure. Withdraw the cross slide, measure,

adjust for the final cut and continue grinding by rotating and feeding the punch blank through the dead centre and into the wheel, not as easy as it sounds! This technique works well because the wheel is cutting across its whole face, I used to grind upwards of a dozen punches without

redressing the wheel by this method.

The particular punch I used to grind by this method specified a concave blend radius between the body and the finished diameter and ideally this should be dressed on the wheel, but that is a subject for another day.



3. The author in "spinning left hand pose". Note that when actually grinding, wheelguard and safety glasses are essential items.

Notes

This view is from the wheel head - behind the wheel

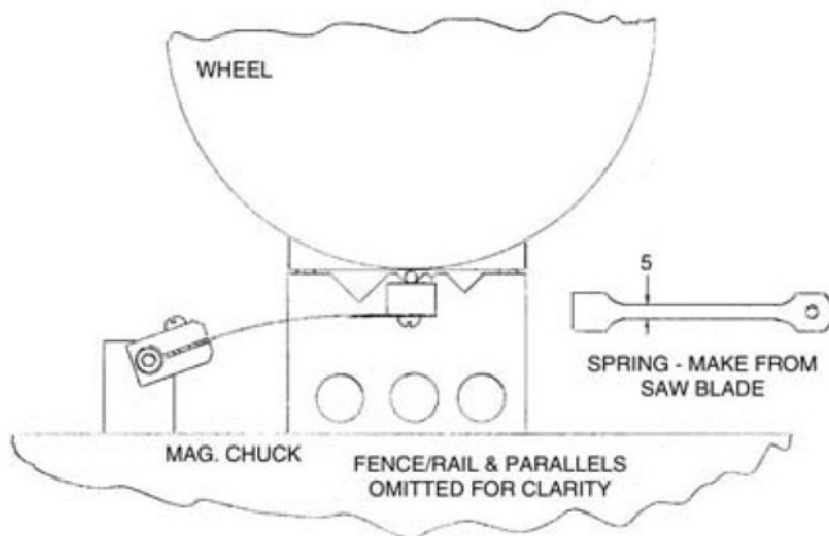
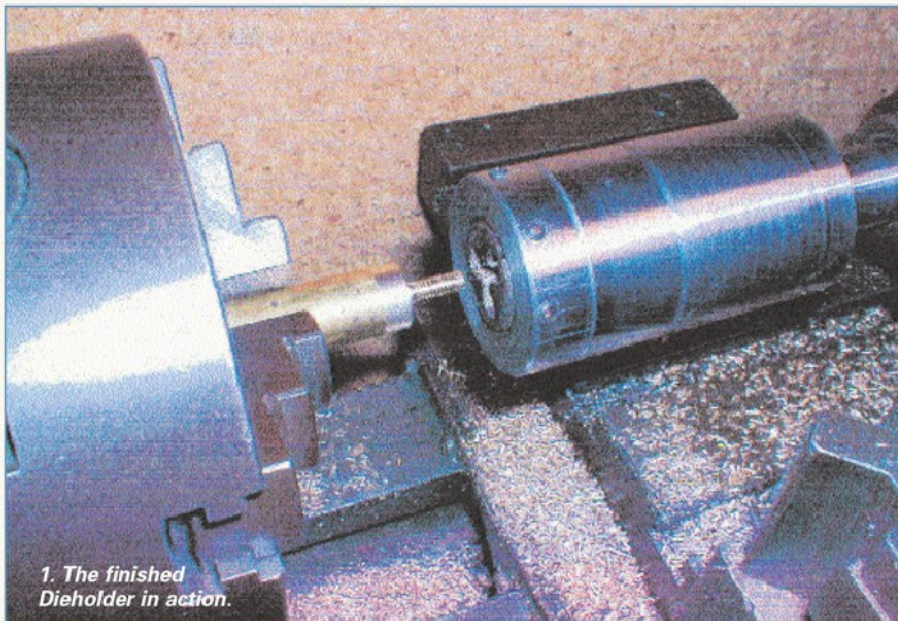


Fig. 4 Vibration damper

TAILSTOCK FLOAT



How many of us has at some time needed to cut a really small diameter thread which needs to be square, and free from the curse of drunken thread syndrome? The problem with using a tailstock die holder is, that should there be a slight misalignment of the tailstock for whatever reason, then the thread carries a risk of being stripped. The die holder to be described does not suffer from this fault. It is intended to faithfully follow the blank being threaded, keeping itself concentric with the centreline of the blank. In use, the floating head is moved manually so that the die runs onto the blank, and is prevented from turning by holding with the fingers. The degree of side float in any direction is a maximum of 0.02in. which I reckon should be more than sufficient to cater for most contingencies. In use the die is centred manually against the end of the

part to be threaded. The lathe can be run at a slow speed and the die will feed itself onto the part. To stop threading, simply release the hand grip. Note that the spring compression forces may need to be adjusted. The pressure is about right when the die head can be easily moved off centre, but still strong enough to prevent loss of parallelism. The die holder recess is bored to suit the die O/D's available to the individual. My small dies measured 0.8125in. dia. I did consider making the bore larger, and making adaptor sleeves to suit the smaller dies, but the main reason for making this tool was to enable the reliable cutting of small threads, and anything larger can be left to the conventional tailstock die holder as most of us will have one already. Construction of the tool is quite straightforward, the thread probably being the most difficult to machine. One other point comes to mind.



Dyson Watkins offers a method for cutting more accurate small threads on well worn lathes

It is as well to mention the apparently excessive length of the head end of the section, which fits into the tailstock. By all means make this shorter if you wish. My reason for making it this length was that I want to run off lengths of studding up to 4in. long. If you don't need this facility, then reduce the length of the overhang, but take care not to allow the reamed hole to break through the side of the Morse taper! So, let's get started and make it!

Die Holder

(Fig 1)

Set up a length of 1.375in. dia. Bar in the three jaw chuck. Square up the end face, and clean up the O/D. Centre drill the end.. Drill and ream to finish at $\frac{1}{16}$ in. This diameter is not fussy, but it gives a clean and concentric datum from which to clock up when reversing to machine the other end. Bore it out lightly if you wish. Turn the diameter to be screw cut back to just short of the shoulder. When the diameter is down to size, finish to length with a squared off parting tool, and turn the undercut at the same time. Next set up the screw cutting tool and set the machine to cut 26 t.p.i. The tool needs an included angle of 55 degrees being Whit form. Do use a screw cutting gauge to set up the tool. It is imperative that the flanks of the thread should end up at the correct angles. **Photo 2.** If you don't happen to have a gauge handy, then make one from a Whitworth form bolt (e.g. _ B. S. F.) with the same t.p.i. turn down the head, and remove half the thickness as shown in the diagram. Hold the "gauge" in the tailstock chuck and offer up the tool to check alignment. Now machine the thread and chamfer the first thread back to clean off the burr. Reverse in the four jaw chuck and clock true. Face the end to a length to suit your particular die thickness. Bore out the recess and apply a small lead-in chamfer to the bore. Remember that if in your case, the die thickness happens to be greater than the recess depth given in the drawing, then increase the overall length of the die holder by the difference, otherwise the depth of the spring plunger holes will have to be reduced, which will affect the spring loading, and possibly the brass plunger lengths.

Mark out, centre punch, drill and tap the grub screw holes, which are M4. I used a home made dividing head to mark out, but because it was too big to set up on the drilling machine table I used a Vee block to support the die holder, the actual set up as in **Photo 3.** I was obliged to hold the part on the Vee block by hand, as I did not possess a suitable clamp.

ING DIE HOLDER

Whichever method you use, just make sure that the holes are true along the radius of the part. Three M4 grub screws will be needed, and the ends should be dressed to suitable points.

Next mark out the three 7mm dia. holes for the brass spring plungers. Drill to depth, (I used a small piece of $\frac{1}{8}$ in. flat strip as a depth setting gauge for the drilling machine) and chamfer all edges lightly.

Retaining Cap

(Fig 2)

Set up the bar in the three jaw chuck Face and turn the O/D to size. Centre and drill the through hole, and bore in preparation for screw cutting. Back face the end of the bore and turn the undercut. The back face needs to be finished smooth and square with the axis. Proceed with screw cutting the internal thread, (Photo 4) setting up the screw cutting tool accurately as with the male thread. I favour wrapping a piece of plastic insulation tape around the tool shank, and without switching on the machine, advancing the tool into the bore up to the point where it has to be disengaged. I then mark a line on the tape in line with the mouth of the bore. This gives me an indication as to the point where I have to disengage. Carry out trial fitting as the final cuts are approached until a satisfactory fit is achieved. When assembled the two parts should fit with their shoulders butting together. Check the inside gap dimension where the flange of the sliding tube is accommodated. This must be a clearance fit, with not more than 0.005in. of clearance.

Morse Taper Shank

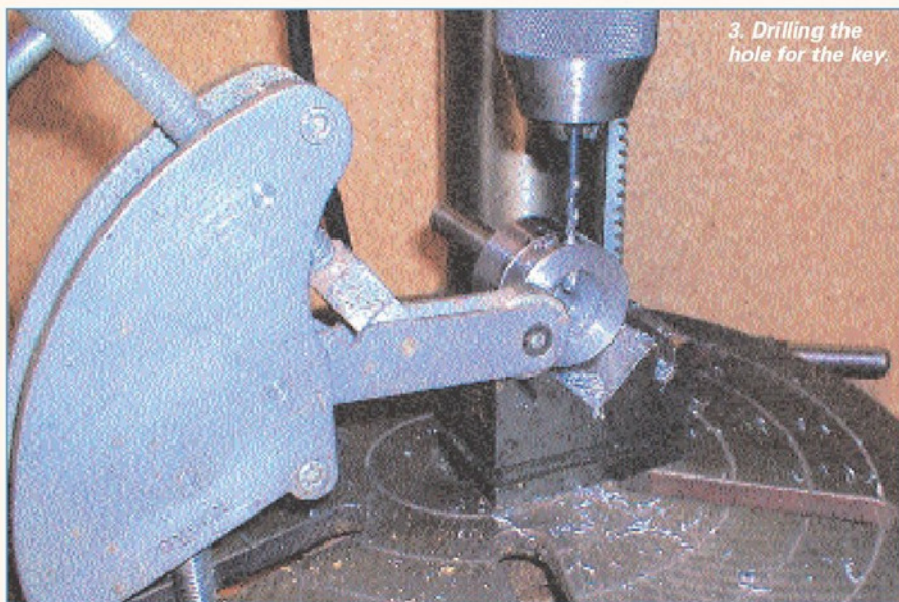
(Fig 3)

Face and centre, leaving enough overhang to machine the Morse taper. My part was made to fit a Myford, so should you have a lathe furnished with a smaller size, then don't forget the danger of the bore breaking through the wall of the shank. You might have to make some modifications if this is the case.

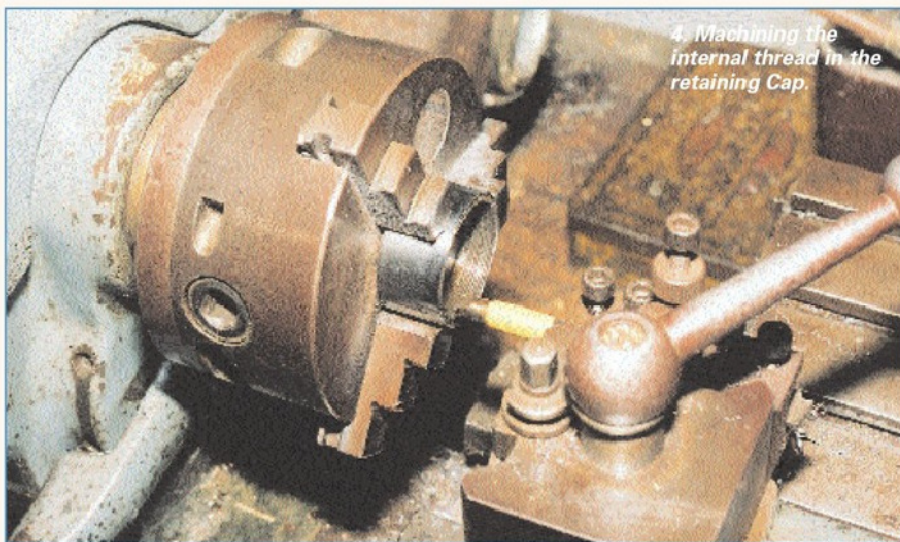
Take a light skim off the outside diameter with the overhanging end supported on the tailstock. Check that the machined surface is parallel over the full length. Adjust the tailstock if required and re-skim until parallel. Set over the top slide to half the required M.T. included angle. In the tables, No 2 M.T has an included taper of 0.5994in. / foot.

Half the included taper will be = $0.5994/24$
= 0.02497in. per inch.

Set up a dial indicator in the tool post and adjust the dial reading to zero when the top slide has been wound back to a convenient starting position, where the tool tip just touches the work. Now advance the top slide forward, a distance of one inch, when the dial indicator should



3. Drilling the hole for the key.



4. Machining the internal thread in the retaining Cap.



5. Turning the No.2 Morse taper. Note for finishing cuts, the tailstock support was not found necessary.



6. Drilling through the sliding tube.



7. Facing the flange on the sliding tube.

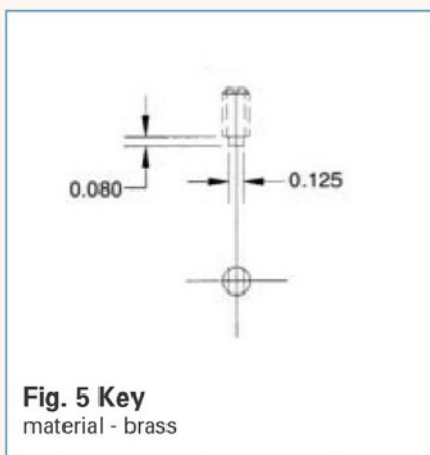


Fig. 5 Key
material - brass

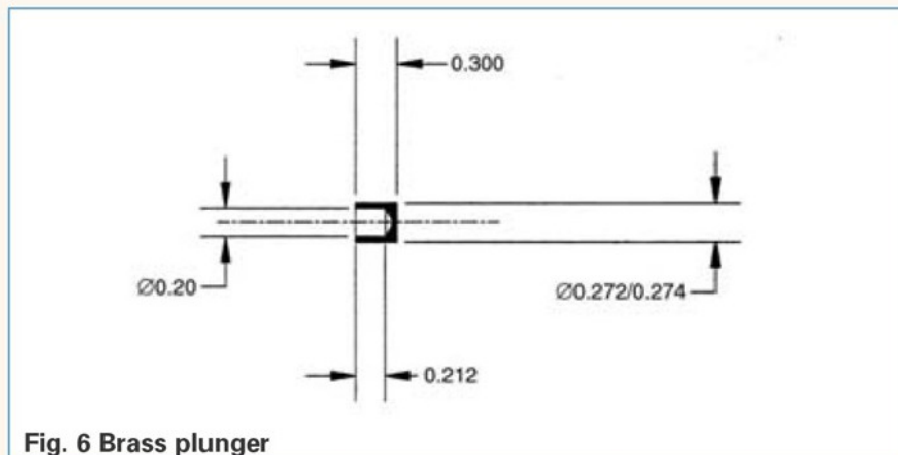


Fig. 6 Brass plunger

Three are required. Again, these need to be a nice sliding fit in their housings.

Assembly and Use

Ideally the faces of the sliding tube should be case hardened and ground, but being without the facility for carrying out these operations, I lapped the end face on a piece of cast iron, with some fine carborundum lapping paste. The ends of the brass plungers were polished up with

some 600 wet or dry paper. All parts were thoroughly cleaned, oiled and assembled. I initially tried the tool without assembling the key, and found no problems without it. I assembled the key and, satisfied with the ease of sliding the tube into and out of the M.T. holder, I cut another thread. This time I released the die holder once the die had engaged, and allowed it to feed on its own up to, and against the end face. I half expected the M2 screw that I was cutting to shear off, but to my delight, it simply

stopped cutting and rotated smoothly. I simply reversed the lathe rotation, and the die head screwed itself off, leaving a nicely cut thread. The finished part can be seen in **Photo 10**. The operation was repeated, with the tailstock deliberately moved off centre by about 0.015in. and another perfect thread was the result. I felt that the project was very worthwhile, and another useful tool joined my collection in the cupboard.



8. Milling the keyway

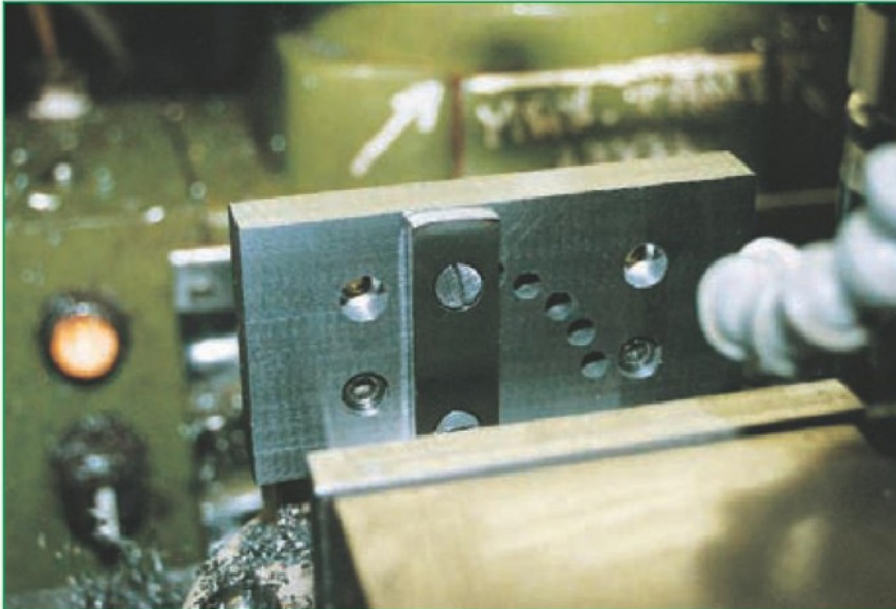


9. Plunger and spring



10. A finished part with M2 thread.

AN ANGLE MILLING FIXTURE



1. Fixture fitted to vice.

The human limitation

This accessory was first dreamed up some years ago as a means of avoiding the frustration of not having three hands. I had for many years, as I believe most Engineers do, machined the ends of bars etc at an angle by holding them in a vice and using either a square or protractor to set the angle.

This method requires:

- A. One hand to hold the workpiece,
- B. A second to hold the square, and
- C. A third hand to tighten the vice.

The two handed solution

To overcome this problem a simple jig was built see **Photo 1** and **Fig 1** which was adjustable from 15 deg. to 90 deg. in 15 deg. Increments. It can be built either as a free standing unit or can be bolted in as a substitute rear jaw of a standard milling vice.

The photographs and drawing relate to a unit made to suit my own vice which is an "ABWOOD". However the dimensions can be simply modified to suit any size or shape of vice which has removable jaws, which I would think is 99.9%. Generally vices are supplied with hardened and ground jaws held in place with two cap head or countersunk screws. However, as soft jaws are used extensively in industry we should not be unduly worried if we don't go the whole hog with hardened and ground finish.

Backplate

My "ABWOOD" vice is a 4in. (102mm),

and has a jaw size of 102mm x 38mm x 12mm as standard, but I decided to use taller jaws to ease the holding of larger pieces. I therefore made my backplate 115mm long x 60mm high x 16mm thick, and made a matching front jaw.

The back plate is drilled clearance size and counterbored to suit the size and spacing of the attachment bolts in the vice, however by drilling the plate such that it may be used either up its correct way or upside down it becomes considerably more versatile (see **Photo 2**). (Use your hardened jaw as a drill jig to drill these holes). Also at this stage drill, ream, and tap the lower pivot hole. I am a great believer in using whatever suitable tools

Peter Rawlinson describes a device to speed angled setups for milling.

are available, and therefore I have used a mixture of metric and imperial as available. The reader may choose to use what he has and modify the drawings accordingly.

Arm

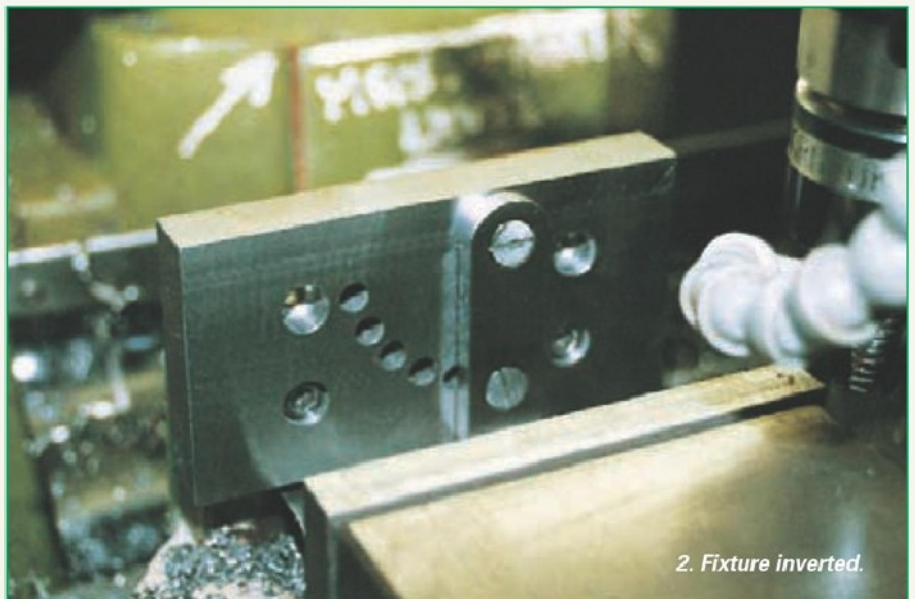
The arm should be made from 20mm x 6mm x 60mm long B.M.S. The holes are marked out, drilled, reamed, and counterbored. To this end I used a 6mm counterbore, pilot drilling the arm 6mm, then counterboring, and finally reaming the holes $\frac{1}{4}$ in. dia.

The ends of the arm should be rounded as shown by which ever method suits your equipment. Note that for accuracy in use, it is IMPERATIVE that the hole positions be accurately aligned with the edge of the arm.

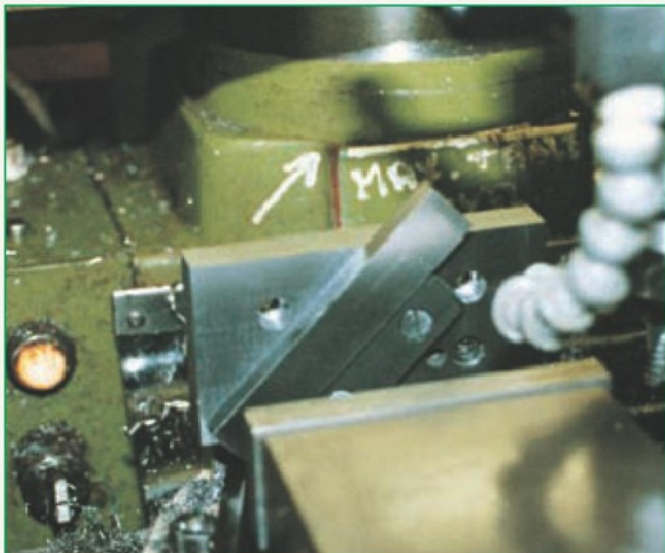
Bolts

Special bolts are required these being cheese headed shouldered bolts. I chose M5 for the thread, but 2BA would be just as suitable. The shank was turned to $\frac{1}{4}$ in. to match the reamed holes mentioned earlier. My 6mm counterbore leaves a hole of 11.33mm dia. so I used 12mm B.M.S. bar turned down to suit. The remainder of the work on the bolts is a straight forward turning job, but the thread must be concentric with the shank.

Ideally the arm and the bolts should now be hardened, especially the arm as it will be used as a reaming jig in the last operation.



2. Fixture inverted.



3. Workpiece in place, to be clamped.



4. A ball ended Allen key screwdriver eases jaw swapping.

Also two small drill bushes will be required. These can be B.M.S. and casehardened, or Silver steel and hardened. Each is turned as a tightish fit in the counterbored hole "B" in the arm, and is drilled, and bored if necessary to guide the tapping drill 4.2mm(M5) or 4mm(2BA). The second is drilled or bored to suit the undersized hole for the Reamer.

Fit the arm to the back plate such that when the pivot bolt is fully tightened there is no slop but the arm moves smoothly.

Machining the angle holes

The holes which set the angles can be tackled in several ways, less precise or more precise depending on the degree of accuracy intended, and the equipment available.

1. Using a universal bevel protractor, set at 15 deg. offer up, clamp arm, fit drill bush, drill tapping size, fit second drill bush, drill undersize for reaming, remove drill bush and ream using arm. Repeat at 30, 45, 60, 75, and 90 degrees.

2. Using a Rotary Table.

A. Clamp to mill table.

B. Centre under mill spindle using "D.T.I."

C. Clamp back plate to rotary table with pivot hole aligned with spindle by use of "D.T.I." on mill table and indicating on a short stub of silver steel in the pivot hole while rotating the table.

D. Line up Base of Back Plate with table axis again using "D.T.I." and zero rotary table.

E. Offset pivot hole by 35mm, or whatever radius has been chosen. This must be accurate.

F. Fit arm. Line up. Fit tapping bush, clamp arm, drill. Change bush, drill, remove bush, ream.

G. Repeat for all angles adjusting rotary table accordingly.

3. Using direct indexing.

If you have a DRO on your mill, then this becomes a doddle. If you don't, all is

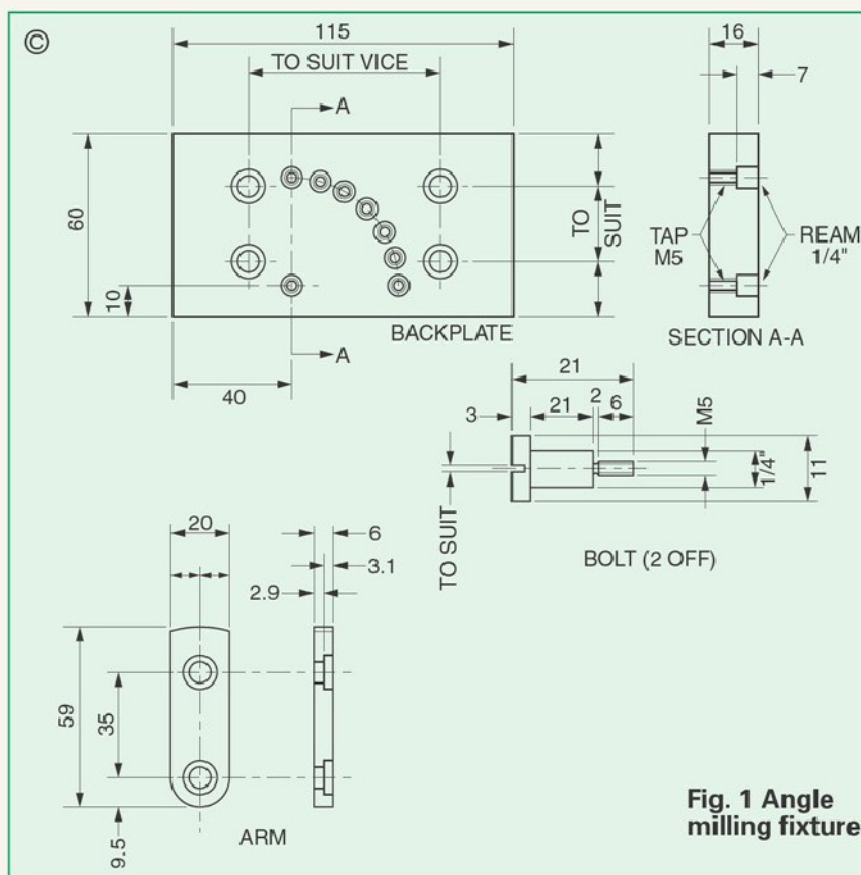


Fig. 1 Angle milling fixture

not lost, but you do have to keep track of the dials, and work one way to take up backlash.

For the 35mm radius suggested, the X-Y coordinates for the various positions can be calculated from basic trigonometry ($X = 35 \cos A$, $Y = 35 \sin A$), and the figures are in Table 1.

The machining process is then very much as described earlier.

Operation

The method of use is, (Photo 3) I believe, self explanatory. It saves a lot of frustration and is quick and simple to use, making life just a little easier for us mere two handed mortals. I would, however

TABLE 1

Angle (A deg)	X(mm)	Y(mm)
0	35	0
15	33.807	9.059
30	30.311	17.500
45	24.749	24.749
60	17.500	30.311
75	9.059	33.807
90	0	35

recommend the purchase and use of a ball ended Alan key Screwdriver (Photo 4), which makes swapping jaws a good deal easier in confined spaces. As always, I am happy to help where I can, but phone only please. Peter Rawlinson, Charing, Kent, 01233 712 158.



CHUCKS - HOW MANY?



T. E. Dominey outlines his collection and their applications



1. The larger commercial chucks and one self built collet chuck.

2. The smaller chucks with heavy drilling fitment to rear, and sensitive drilling attachment in foreground.

I do not class myself as a model engineer but someone who enjoys machining for interest. I make small pieces of equipment for myself and produce or repair things for other people. It keeps the mind active and the fingers supple. Before proceeding, I should note my thanks to Mr. G. Willis for providing the photographs.

The early years of my working career were spent in a workshop where the only lathe chucks were 4 jaw and somewhat larger than we are accustomed to in the amateur context. The smallest was about 12 inches in diameter and the largest several feet bigger. It was rumoured that 3 jaw chucks were only for amateurs!

In my home workshop, I now own a Harrison L5 lathe with the standard

equipment of one 8 inch four jaw and one 6 inch three jaw chuck. Over the years, I have added to these, so that the collection now totals some sixteen chucks as shown in **Photo nos. 1 and 2.**

The collection

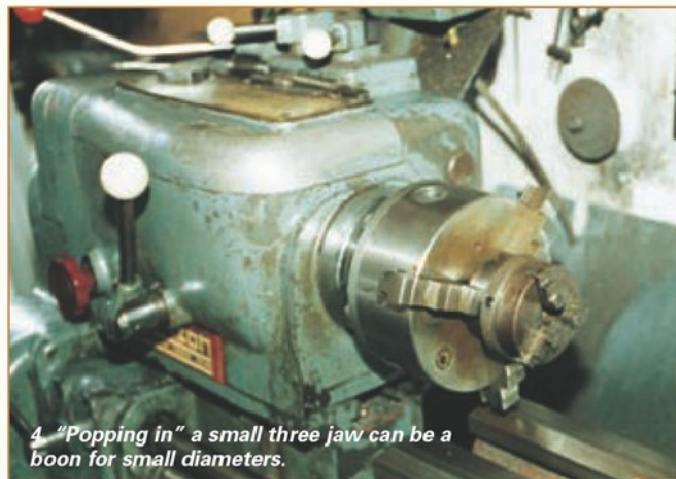
The first photograph shows the Pratt 8 inch and Bison 6 inch, Burnerd 5 inch four jaw, Axminster 4 inch four jaw self centring, Burnerd 3 inch three jaw and a 5 inch magnetic chuck fitted with a backplate for mounting on the boring table; also a small collet chuck I made for use in the lathe spindle Morse taper.

And in the second can be seen, identified by their numbers:

1. A heavy drilling fitment in 4 M. T which after removal of the top slide is fitted to the cross slide.
2. Jacobs Super chuck $\frac{3}{8}$ inch- 1 inch capacity.
3. Westcott 0- $\frac{1}{2}$ inch capacity sliding jaw chuck.
4. Westcott 0- $\frac{1}{2}$ inch sliding jaw chuck with large Slocombe centre drill permanently fitted
5. Keyless 0- $\frac{1}{2}$ inch tailstock chuck.
6. Cardinal 0- $\frac{1}{2}$ inch secondary tailstock chuck.
7. Alfred Herbert Quick chuck with collets.
8. Sensitive drilling attachment for tail stock.
9. No 3 M.T. arbor fitted with No 3 centre drill.



3. Axminster self centring four jaw chuck.



4. "Popping in" a small three jaw can be a boon for small diameters.

Applications

The Axminster four jaw S.C. chuck is particularly useful for machining square stock. It can be seen in **Photo 3**. It also has another backplate to suit my wood turning lathe and a set of Axminster bolt-on jaws.

Having a lathe of fair capacity, it becomes possible to grip a smaller chuck in a larger. In this way, you can get down to smaller diameters as in **photo 4** where the Burnerd 3inch three jaw (which can also be fitted to my wood turning lathe) is mounted in the main three jaw, and also make a quick change to the Bison four jaw independent. As a "Pop in" this saves time on small odd shaped items to be turned (**photo 5**).

Having the facility to mount a four jaw chuck on the toolpost opens up various possibilities for drilling and milling operations on the lathe. The Burnerd 5inch four jaw can be seen set up in this way in **photo 6**.

The Herbert Quick chuck is a super piece of equipment. It has two parts; the main body with M. T shank and a sliding sleeve. A drill is fitted to the parallel collet and entered in the body. The sleeve is then slid forward which locks the collet in the drive position. As soon as a turning force is exerted on the drill the whole chuck locks solid and exceedingly true; the moving and locking parts are all ball bearings working on a cam action. After use slide the sleeve back, remove drill and collet. With several collets fitted with increasing sizes of drill a very rapid work rate is possible.

The Westcott sliding jaw chuck has a grip like a bulldog. This is achieved by using a screw with left and right hand threads operated by a square key, which moves the jaws. I find that keeping a centre drill on its own arbor saves a lot of time and fiddling - likewise the large Slocombe fitted to the small Westcott used for putting a radius in the end of work.

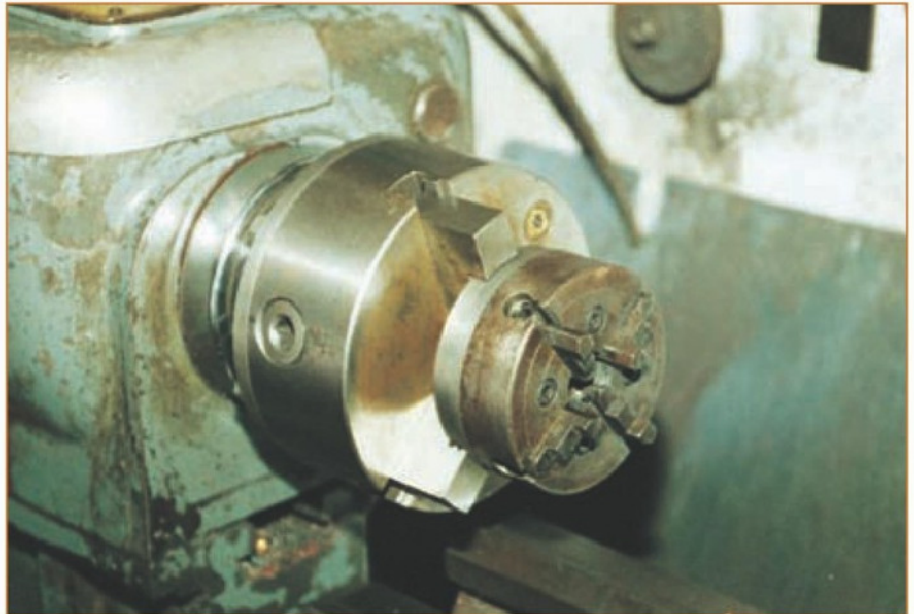
The Jacobs Super Chuck is a massive drill chuck being $\frac{3}{4}$ inch - 1 inch capacity. It is inscribed with the dates:- September 16th 1902, January 26th 1909, June 5th 1915.

Perhaps it is nearly a hundred years old. It certainly does not look it and is in very good condition. I use it in either end of the lathe for holding milling cutters. It may not be best recommended practice, but I find it ideal for bottoming out blind holes etc.

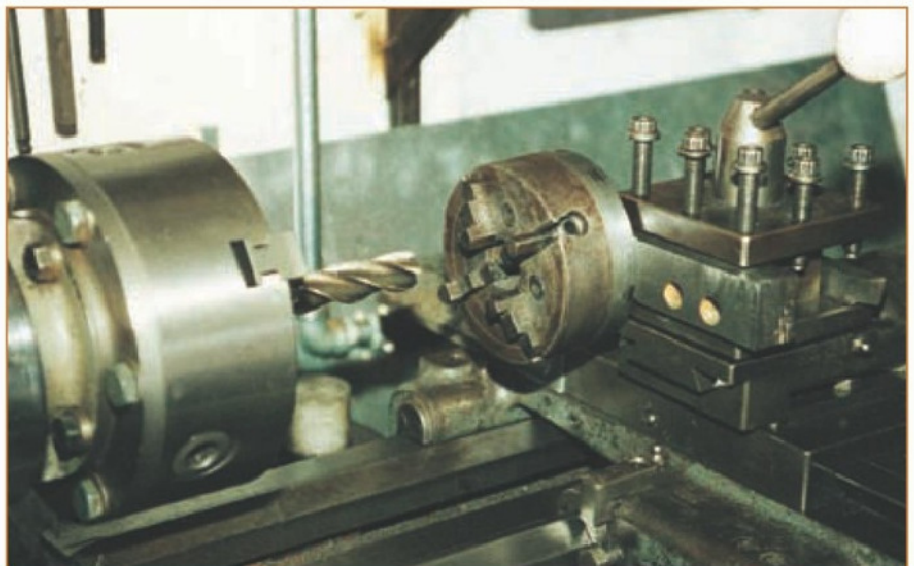
Of all these chucks I bought only the Bison and the Axminster new. All the others have been bought for as little as five, to as much as twenty pounds. Perhaps my collection is a bit O.T.T., but I find when machining repetitive work, it pays to have a row of chucks fitted with a selection of drills or cutters ready for instant use and saves much time.

Not a chuck but still very useful

One piece of somewhat non standard kit is the heavy drilling fitment, shown in **photo 7**, being used with 32 mm drill. I use this when opening the end of a work piece, and employ the power feed to the saddle - it saves much time and effort - Note the hexagon screw fitted in the end (**photo 2**) to eject the drill.



5. A four jaw piggy back gives a quick change for odd shapes.

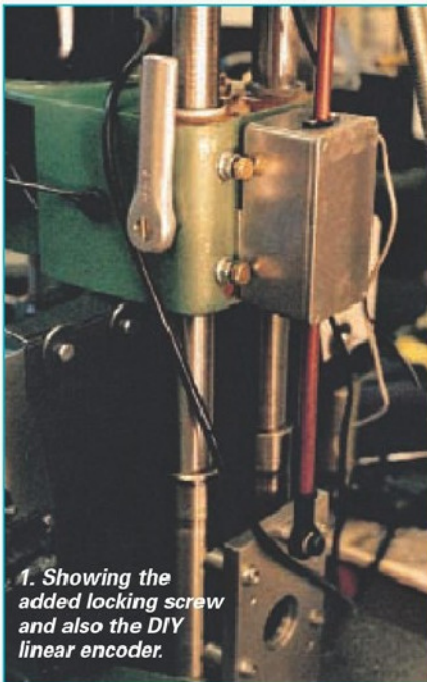


6. Toolpost mounted four jaw allows milling/drilling operations.



7. Saddle mounted heavy drilling device can be used with power feed.

ENHANCEMENTS TO



1. Showing the added locking screw and also the DIY linear encoder.

After building a rigid machine frame, and having worked on the cutter head to give a stiff spindle with minimal end-float, the final step towards accurate sizing of the work requires the user to make precise moves in the Z-axis. In my terminology moving the cutter vertically towards the work is a positive move. This means that a Z+ move on a knee mill is a vertically upward move of the knee, whereas on a mill-drill or sliding head machine such as Compumill a Z+ move entails moving the cutter vertically downwards.

The knee mill configuration works well in keeping the nut consistently located against the working flank of the Z-leadscrew. In contrast to this the sliding cutter head configuration has considerable mass causing the cutter head to fall away

Having covered the basic machine construction, and spindle speed variation, Richard Bartlett turns his attention first to improving Z axis accuracy, and then to ultra low budget DIY DRO's.

Use of the vertical adjuster

The vertical slide adjustment is by four M8 screws on the phos.bronze bushes of the two columns. Adjusting these to increase the friction on the columns to a point where the cutter head will not slide down under its own weight will work for small cutters and/or light cuts. The interrupted cutting loads which are natural to milling can cause this light frictional locking to be overcome allowing the cutter to descend by the full amount of the backlash in the Z-leadscrew. Since careful adjustment of these screws is necessary for a 'good feel' to the slide when wound by hand, it is not practicable to adjust them after each cut.

This 'good feel' factor is a direct result of a small stick-slip characteristic. All machine slides respond to small discrete inputs in this stick-slip way, the first 1/10,000inch will NEVER produce movement of a dovetailed slide controlled by a previously unloaded acme thread. As further small inputs are made the energy is stored in the elasticity of the mechanism, at some point this 'spring energy' will overcome the static friction and the slide will move by an amount approaching the sum of the small inputs.

A high level of friction does reduce any tendency for the head to drop under

cutting, but increases the stick-slip value to a level which eliminates any chance of moving in 0.0005inch increments using the index ring. Conversely, too light a setting of gib or bush adjusters will result in a minimum stick-slip characteristic but inadequate lateral location of the slide.

Adding a separate 'locking' screw to the slide allows the adjustment to be set and maintained with the additional locking force added prior to cutting (see photo 1).

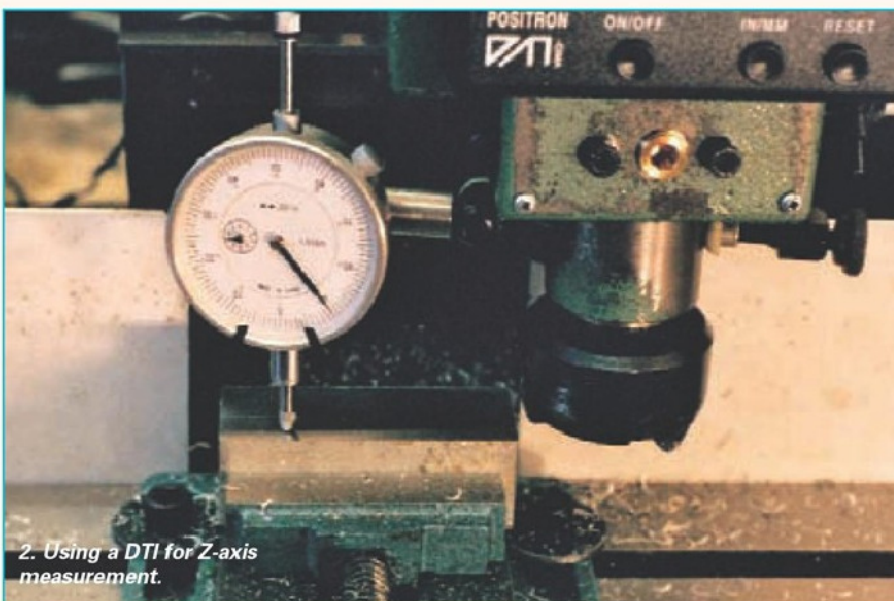
Eliminate Backlash and Endfloat in the Z-axis

This is the first component of the ideal option, construction details were covered in previous articles and although the points were mentioned as mods to do when "CNCing your mill", the above might encourage the builder of a manual machine to incorporate them on the Z-axis at least. Eliminating backlash/end float and counter balancing the cutter head requires some extra work but is well worth the effort and together they provide the ideal solution for the Compumill configuration.

Use of a counterbalance for the vertical head

This has the advantage of reacting the vertical load of the cutter head through a point much nearer the centre of gravity of the head, as well as maintaining reliable contact between the nut and the working flank of the screw. Certainly the simplest way to achieve this counterbalance is to tap the top surface of the head casting M8 to give an attachment for a Bowden (bicycle brake) cable. Run this up to a cable 'splitter' attached to the front of the column top plate and run the outer cable over the machine well clear of the vertical feed handle to a second 'splitter' mounted on the rear of the column top plate. The wire then passes through the base and is fixed into an M8 tapping in 15Kgs of 3inch dia. steel bar or whatever sash/clock weights etc. you have to hand. Set the cable length to allow the counter balance weight to sit on a 1cm thick piece of scrap chipboard when the cutter head is at its highest. This allows easy fixing/adjusting of the weight.

The prospect of drilling another hole through my 50mm pressed granite slab base for the above 'dangler' option did not appeal, so a pneumatic cylinder is used as a constant rate spring in a similar way to the gas struts used on the rear hatch of an estate car. Note, if the pneumatic cylinder is not backed up by a relatively large

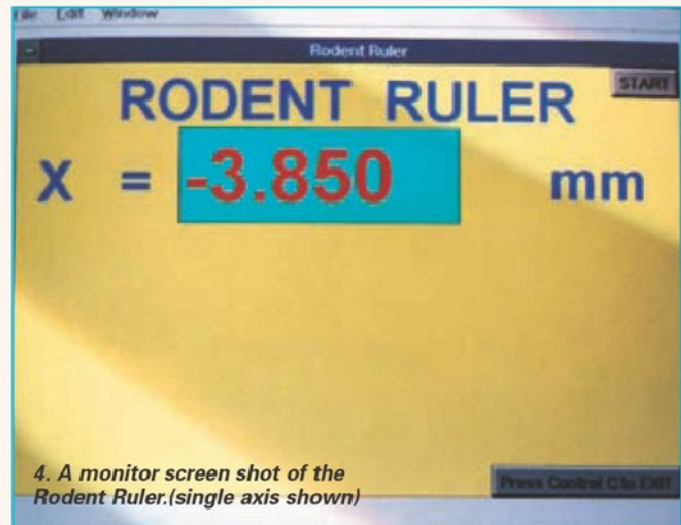


2. Using a DTI for Z-axis measurement.

COMPUMILL - Part 3



3. A digital scale mounted on the Z-axis.



4. A monitor screen shot of the Rodent Ruler.(single axis shown)

volume pressure tank then the counterbalance effort will not be consistent throughout the vertical travel of the head. The reservoir will need to be at least twenty times the volume of the air cylinder. The spare wheel for our camping trailer provides this, otherwise the small receiver from a commercial vehicle air-brake system is available at low cost from a breaker, a CO2 'pub-gas' cylinder would also do the job. The attachment of the wire on the vertical head is similar to the 'dangler' option with the added design luxury of being able to run the cable in any direction to the conveniently mounted cylinder. My cylinder runs down parallel to the backstay and shares the stay's mounting in the base.

The vertical head weighs approximately 12Kgs which suggested a counter weight of approx 15Kgs, this balancing force is easily adjustable using a footpump. A relatively inexpensive range of air cylinders from RS are double acting with 25mm diameter pistons and have a range of accessories to allow the fixing of either end to any anchorage. They are available in a range of lengths, mine is 250mm max stroke from which I require 220mm actual movement. Pressures are still pounds per square inch for me so for an effective piston area of 1 x Pi/4 sq.ins to exert an effort of approx 33lbs. in 'push' mode needs (33/0.785) or 42lbs/sq.inch. From a safety point of view this is well within the capacity of standard airline fittings. Do remember that if you choose to apply the cylinder in "pull" mode the piston area has to be reduced by the piston rod area to give the effective area. This will need a slightly higher air pressure to give the same effort, but the pressures will still be fairly modest.

The valve core is removed from the spare wheel and a connection made at the valve by either tapping a brass tube fitting or using a spare "push&lock" fitting bought as a spare for a footpump. A 3-way fitting is used at the cylinder to give connection to the reservoir and an inflation point which can be a Schrader valve to

allow pressurising using a footpump. The air line between reservoir and cylinder can be any length to allow neat storage of the spare wheel. Rubber solution provides a long term seal if using a "push&lock" type of quick connector.

Fit a linear positional indicator to the Z-axis.

This is very much the "soft option" as the machine can be used straight from the box and the sizing cuts put on while viewing the actual vertical movements, including any biasing needed to allow for the vertical component of the locking force.

a. Using a D.T.I.

The indicator can be as simple as a Dial Test Indicator (see Photo 2) firmly clamped to the cutter head casting and referenced to the table, fixture or work. It is used in incremental mode, which means the datum is re-established for each cut, the dti being removed whilst cutting. Since sizing cuts are likely to be less than 1mm the accuracy of a "straight spindle" clock will suffice. A "lever" type dti can be used with feeler gauges built up and checked by micrometer or vernier to equal the cut required. This is fundamentally accurate as the dti only has to repeat at its zero reading. As a dial test indicator is so useful for setting fixtures or setting the work true to the machine slides that it is almost essential equipment for milling, so this method of positional indication can almost be regarded as a zero cost option.

b) Linear Scales

As with most items produced in volume for world markets the cost of Inductive or Capacitive based linear scales with digital LCD readout has fallen to a level which makes them attractive for amateur use. Indeed, the latest crop of Chinese capacitive scales are aimed at this market. The scales are accurate and have a typical

resolution of 0.01mm (0.0005inch). (See Photo 3) At a cost of approximately 50 pounds per 12inch axis they are very good value. Siting them on the machine needs some planning, as the display is an integral part of the measuring head. To keep them swarf free and still readable can involve quite a lot of work/imagination. Suppliers of these scales also offer remote display units with larger digits which help solve the mounting/viewing problem, this sets the cost at approx. 100 pounds per axis. In my experience the remote display is very susceptible to interference generated by switching the main spindle motor ON/OFF or driving the dc feed motors when powered from the mains adaptor, this is much better when powered from the internal 3.6v battery. All motors should be suppressed for use with these remote displays.

c) DIY linear or angular position indicator

Being a DIY modification of something



5. Deepening slots with fret saw and Taig topslide. A spring tooth rest might be added to aid repeat positioning.

intended for another function puts this indicator very much in tune with the rest of the Compumill project. The 'borrowed' part of this unit is the complete circuit of a serial mouse used as a pointing device with a PC computer. These are currently being offered brand new by Farnell (No. 889-1968) and CPC (No. SB0186304) for NINETY NINE pence each. The supplied lead plugs straight into the 9-pin serial COM port of a PC.

Running the 'Rodent Rules' program on any PC allows up to three position measuring devices to display linear or angular positions in LARGE clear format on the screen. This program has been written by Allan Good, a Compucutter who uses CNC woodworking machines at hobby level, and is available as a free download in 3axis form from the Compucut Users Forum. The simplest way to access the forum is to log on to the Compucut Website at www.compucutters.com and then click the link at top left called Compucutters users forum. The program is in the Software

section under "Rodent" and includes a DOS mouse driver. Anyone wishing to play with the 'Rodent Rules' but having no internet access for the download can send five pounds to COMPUCUT for the Rodent programs on CD. The address is elsewhere in this magazine. Further information will be given on the use of the software and hardware requirements in the follow up article.

Photo 4 shows the display which allows the screen to be mounted well away from the suds/swarf environment of the machine.

Photo 1 also shows a linear encoder with a simple frictional linear to angular translator which uses a Tufnol rod and silver steel axle attached to the Z-axis of Compumill. This device has a resolution of 0.001inch and in incremental mode has an accuracy of ± 0.001 inch in the range needed for this Z-axis application.

Adding a push button to the lid of the die-cast housing to actuate the right hand mouse switch on the PCB allows the display to be zeroed prior to putting on the

cut when running the Rodent Rules program. This stops any errors accumulating.

That's it, using your selection from the methods suggested above will allow accurate work to be produced on your Compumill.

The rest of this article and one which will follow in a future issue are devoted to building and testing different forms of DIY digital readouts using the serial mouse PCB. These are cheap enough to allow their dedicated use on any linear or rotary machine slides including digitising heads for the logging of CNC machining data.

Suppliers

HPC Gears 01246268080 for gears, racks and pinions.
RS Components <http://rswwww.com> for bushes, bearings, die cast boxes
Farnell Electronics 08701 22 77 22 for A4Tech Serial Mice
CPC Electronics 08701 20 25 30 for A4Tech Serial Mice

Rodent rules

It is most important to look at the construction of a PC mouse pointer if you have not already succumbed to curiosity and done so. Remove the mouse ball as though for cleaning and it will be seen that when the mouse is moved the silicon rubber covered ball rolls along the mouse mat surface with little or no slip. The ball is spring loaded against two axles which are set at 90 degrees to each other. This sprung loaded ball mechanism translates the linear movements in X and Y into proportional rotation of the two axles.

Removing the screw which holds the two mouldings of the outer shell together and carefully separating reveals that each axle carries a radially slotted disk. The slots are arranged to pass between an optical source (LED) and a pair of detectors (Photo transistors).

The mice from the suppliers mentioned are badged A4TECH 'fast mouse' and have a relatively high resolution at 520 lines per inch. They have 45 slots in the periphery of each encoding wheel. Other resolutions can be used by scaling the following examples to suit your serial mouse.

Before removing the plugged lead from the mouse PCB, note which way round it is connected. The four way connector is not keyed. On mine the green wire is adjacent to the opto switches.

The mouse PCB

The good news is that there are NO electrical modifications required to this circuitry, we use it straight out of the box! Looking at the components either side the slotted wheel, on one side a Light Emitting Diode emits a beam which is collimated by a tiny lens moulded in the end of the led, this beam will, if not cut off by one of the teeth of the slotted disk, fall upon the face of the detector which has dual sensors (A & B) that are spaced within the moulding by one quarter of the circular pitch of the slotted wheel. This spacing gives a

sequence of logic signals at A and B that are called quadrature outputs.

The optical switches

If we assume a tooth on the slotted wheel is cutting off the beam from the detectors resulting in both outputs A and B being OFF, then by turning the slotted wheel first clockwise by TWO slots then anti-clockwise by two slots the following pattern would be detected by the electronic counting circuit. (Take 0 for OFF and 1 for ON)

	START	clockwise	anticlockwise
A	0	11001100	01100110
B	0	01100110	11001100

From the position where one tooth is completely blocking the beam, shown by A=0 B=0 to the position where the next tooth completely blocks the beam there are FOUR unique equally spaced outputs 00, 01, 11, 10, and the sequence will depend on the direction of movement of the slotted wheel. The mouse circuitry counts each change of state in A and B.

This sets the ANGULAR resolution of the mouse as:

$$1 \text{ COUNT} = \frac{1}{\text{No. SLOTS in wheel} * 4}$$

and the LINEAR resolution as:

$$1 \text{ COUNT} = \frac{\text{Effective circumference of measuring axle}}{\text{No. SLOTS in wheel} * 4}$$

Note, the above is independent of diameter of the ball. The ball simply translated linear movement into movement around the circumference of the measuring axle. From this it follows that:

1) The basic components of: PC plus Program plus Mouse PCB plus Slotted

wheel make up an ANGULAR measuring device, and
2) By adding a linear to angular translator the system can be used for LINEAR measurement. The translator divides the CIRCUMFERENCE of the measuring axle into: (Number of slots * 4) counts.

Example as an angular encoder

The mouse axle/slotted wheel is set in the end of the worm of a dividing head which is fitted with a 90T wheel.

Using the 'as bought' slotted disk (45 slots) the resolution will be:
 $1/(45 * 4 * 90)$ of a turn of the work spindle = $1/45$ degree or 1.333' minutes or $1/16200$ th of a work spindle turn. This is accurate but not wildly convenient. If we used a dividing wheel of 40 teeth we would get: $1/(45 * 4 * 40) = 1/7200$ or 0.05 degrees of work rotation.

With a 90T dividing wheel, let's aim for a resolution of 1 minute of arc. This equates to $90/(360*60)$ of a spindle turn. So, $90 * (\text{SLOTS} * 4) = 360 * 60$

SLOTS needed = 60

I prefer to work in decimal fractions of a degree, so for a resolution of 0.01 degrees and 90T the slots required are:

$$(360 * 100) / (90 * 4)$$

slots needed = 100

It would require a very good mechanism to support such high resolution and a more practical choice would be 0.02 degrees resolution provided by 50 slots.

Making slotted disks

Checking the recommended mice will show that their standard slotted disk has a circular pitch closely equivalent to a 0.4MOD gear. This circular pitch must be maintained to preserve the quadrature relationship of the outputs. Buying a standard gear with teeth equal to the number of slots required is a good start towards making an encoder if

one has no dividing equipment. Due to the difficulty in placing the PCD of a standard gear exactly on the invisible beam of the optical path to preserve the quadrature relationship, the tooth space should be deepened with a radial slot of width nominally equal to the circular pitch/2 to give a total depth of 1.5 times the original depth (1.5mm or 0.06inch).

Making the new slotted encoder disk could be as simple as sawing down the tooth space of a 0.4Module gear with a piercing saw of CP/2 blade width. A junior hacksaw blade can be stoned down to width which will remove the secondary (wavy edge) clearance to give a fine finish. Remember to fit the blade to cut on the downward 'pull' stroke. Half the circular pitch of 0.4 module is 0.63mm however the actual slot width of the standard wheels is 0.5mm (20thou) which I assume is cut to obtain quadrature phase outputs allowing for hysteresis in the opto switches, so use a saw blade of 0.5mm width unless you intend to check the phase outputs against known rotation of your specific circuit.

Producing a 90 slot encoder by hand sawing needs good light, a depth stop and some patience. The depth stop is easily made by tapping a piece of 1/2inch steel plate M5 (the bore of my gear was 5mm) at a distance from the edge to allow the saw to touch the edge of the thick plate at full depth.

Example for 90 slots: The gear has an OD of 36.8mm giving a radius 18.4, the tapping is centred $18.4 - 1.5 = 16.9\text{mm}$ from the edge.

Using a mechanical saw

See photo 5 I found this method of producing slotted encoder wheels to be fairly bearable. The Taig top slide is spotted on to the table of the scroll saw with a blob of Super glue with the pivot point for the gear in line with the blade when viewed down the slide, and the angular alignment of each tooth space was done by eye with a little help from a fairly strong glass. A similar setup could be done quickly using a slitting saw in the lathe with the gear pivot mounted in the toolpost and the work fed in on the cross slide.

Obviously the accuracy of this hand slotting process will depend on the care taken, but remember that: ONE COUNT is generated by a rotation equivalent to a quarter of a circular pitch of the encoder (0.31mm) so a rotation through ONE complete tooth space is equivalent to TWO COUNTS. Any error in sawing down the centre of the tooth space is unlikely to exceed 10% of the space when bearing in mind that the gear locates the saw precisely at the start of each cut. 10% off centre would give rise to a cyclic error of $(2 * \text{RESOLUTION}/0.1)$ With a resolution of 0.001inch this equates to 0.0002inch, which should provide some encouragement for this quick and easy approach.

Once the slots are formed the disk will need to be thinned to 0.04inch. If using Polyacetyl for the disk it is important to cut

this width using a sharp HSS tool with plenty of top rake. This avoids making burrs which take forever to remove.

A light spray with matt black paint and the slotted disk is complete.

If the gears are being made from scratch then black Delrin is a good choice.

The opto assembly of slotted wheel and PCB is mounted to the machine and needs to be covered to stop extraneous light from fooling the detectors. Small diecast boxes make good housings and as the photo 1, shows, are easy to mount.

A prime application for a 'Rodent Rule' is to fix a slotted wheel into the end of the shaft carrying a worm which meshes in the Bull wheel of the lathe. This allows a very accurate and cheap method of dividing around work held 'as true as it was turned' when making gears, cams or dividing plates etc. Using the Myford bull wheel of 60T as an example and aiming for a resolution of 0.02 degrees of the lathe spindle, the slots required in the encoder would be:

$$\begin{aligned} (\text{slots} * 4) &= (360 / 0.02) / (60) \\ \text{slots} &= 75 \end{aligned}$$

Returning to the application in hand, which is to display the sizing cut on the Z-axis of Compumill. This is a linear application and will require some form of 'LINEAR TO ANGULAR TRANSLATION' as performed by the ball in the original mouse pointer.

In the next article we will address various solutions to this "Translation" question, and the use of Rodent Rules.

A brief note on steel specifications

For readers involved professionally in engineering, the following notes may be "Old Hat", however from the telephone queries received to the editorial office, it seems that an outline explanation may be in order. Back in the 1950's, The British Standards Institution published B.S.970 : 1955 which presented a standardised range of steels – the En series. This was then rewritten in 1983 as the British six character system which in theory has already been replaced, although just about everyone in the UK still uses one or other of the B.S.970 systems.

The 1983 System

This system uses six characters, grouped as three numbers, one letter, and two numbers.

The first three numbers denote the general type of steel :

- 000 – 199 Carbon and Carbon Manganese steels where the figures indicate the manganese content.
- 200 – 400 Free cutting steels where the second and third figures indicate sulphur content.
- 250 Silicon – manganese spring steels.
- 300 – 499 Stainless and heat resisting steels
- 500 – 999 Alloy steels

The fourth character is a letter which for stainless steels will be "S", and for others

will be either "M, A, or H". For non stainless steels this relates to the condition of supply.

M indicates specified mechanical properties, e.g. tensile strength, yield strength, % elongation, etc.

A that the metal has been supplied to a closely controlled chemical composition.

H that the steel conforms to hardenability requirements.

The fifth and sixth characters are numbers and for non stainless steels, show the mean carbon content.

Thus as an example, 070M20 is a non alloy steel having a manganese content around 0.7%, a carbon content around 0.2%, and having specific mechanical properties rather than chemical composition.

Suffix letters may be added in certain cases either to indicate chemical additions (e.g. lead Pb) or that the material has been heat treated to a particular condition (typically T)

Steels for the Amateur Workshop

While there is a great multiplicity of steel specifications, a relatively small number will satisfy the majority of needs. For machining work, the following are readily available in bright bar form, some also in hex, square, and flat.

For low stressed parts it is sensible to

make the machining process as easy as possible and use a free machining steel. One very popular and readily commercially available is EN 1A or 230M07 also available with a slight addition of lead or lead and tellurium in which case the suffix Pb or PbTe is added to the specification. The freecutting steels are not generally recommended for welding.

Moving up the strength range a little, En 8 (080M40) or its free machining variant En 8 DM (212A42) have a higher strength than En 1A, and may be further heat treated.

For even higher stressed components, En 19 (708M40) is a chrome-moly steel, and En 24 (817M40) is a nickel-chrome-moly steel. Both of these are available hardened and tempered to the "T" condition, having a tensile strength of 55-65 tons/sq.in. eg En 24T (817M40T) For those wishing to delve further into the many varieties of steels, Macreadys, (phone 01788542 191) are one of the largest UK steel stockholders/distributors, and publish the "Orange Book" price £15-00 which has gained a reputation as a steel users bible, extending to over three hundred pages, covering carbon, alloy, stainless, tool, silver and spring steels as well as bronze bars and cast iron. In addition, their wall charts, produced in conjunction with Castrol and Kennametal Hertel give excellent summary information on properties, machinability, and choice of tooltips and coolants.

SCRIBE A LINE

Hardness Tester

Mr W. T. Glenn from Dundee writes:

The "novel hardness tester" mentioned in the *Scribe a Line* section in MEW issue No 84 by Prof. R. F. Cane, had me make a bee line to the box my seventy-six year old mind told me I should find it. My tester, like his, has a range of Rockwell "C" scale 46 – 62 in 2 unit intervals. I write this letter for a number of reasons. First to mention that moulded into the gauge housing on the same side as the scale numbers is "Pats. Pending Prov. No 26443". Such information may help one of our current small firms looking for a new product. The accompanying **photo 1** shows the "spoked device" and the two parts of the Bakelite case.

Second, to thank Philip Amos and his like for helping to give us a wonderful magazine.

Finally, other readers may be interested in a small modification to my Myford 7. As a firm believer in regular oiling, I found that surplus oil found its way from the rear headstock bearing on to the pulley and thence to the belt, eventually causing degradation and slip. A new belt was fitted, and a "flinger ring" made in two halves and attached to the pulley. **Photo 2** shows the general arrangement. Now, even if I get a little over enthusiastic with the oil gun, the belt drive stays dry.



What was it? – The Answers

Mr A. Rowland from Formby writes:

Under *Scribe a Line* (issue 84) Mr K. P. Kleiser is puzzled as to the purpose of the small gauge illustrated.

The instrument is similar to devices used in military target rifle shooting some years ago. These were used to adjust the simple military rifle sights in steps of one minute of angle, so giving the rise or fall of the bullet on the target as one inch per 100 yards of range. Several designs were used, but typically the instrument was hooked under the sliding part of the sight and moved up or down with the adjusting screw. The presence of the vernier

graduations would give an accurate reading irrespective of screw backlash.

Various models by manufacturers such as O'Hare, and Lyman Gun Sight Corp. are illustrated and described in the book "Military and Sporting Rifle Shooting" by Edward Crossman, and published in the U.S.A. in 1932.

Modern rifle sights have the micrometer principle built into the sight, with clicks indicating elevation changes of one quarter minute of arc.

Mr C. A. Currie from Bath writes:

The item in SAL iss 84 is nothing to do with clock and watchmaking. It is in fact a vernier adjustment for ladder type rear sights on rifles used for target shooting. This type of rear sight was universal on most military and many civilian rifles both before and after 1900.

The rifle sight was coarsely graduated in steps of 50yds from 50 to 1000, and the vernier gauge was used to fine tune the sight to a particular rifles characteristics. By recording the vernier readings for actual ranges, the sights could be adjusted and repeated for any setting.

In use the screw controlled the elevation, and the slotted link controlled windage. These adjusters were made with slight variations by most of the large gunmakers.

I hope Mr Kleiser looks after his adjustor as it is a nice reminder of a golden age before the sport became the victim of philosophically bankrupt politically correct politicians.

Mr Arthur Chankin of Hartsdale, N.Y. wrote with details of a similar tool made by O'Hare, and asking "What is it". The above would seem to provide the answer. **Mr Peter Jackson of Knaresborough** also wrote offering the "rifle sight vernier" identification.

Milling Advice

Mr. M. A. Delaney from Oakville, Ontario, writes:

Having had similar experiences to those of Mr. Hall "Milling machine projects for beginners (1)", Model Engineers Workshop No.84. August September 2002. I find myself not so much at odds with the author as wishing to amplify some of his information. Much of this additional material is based on bitter experience, some of it costly, but fortunately not irreparable.

First; one must never try to mill using a drill chuck no matter how much it is tightened. The reason is not only will the mill be pulled out of the chuck, but the chuck will come loose from the mandrel. The "Jacobs" series tapers used for drill chucks are short and relatively steep. The rotating vibratory load applied by a milling cutter will soon work it loose.

Second: All milling cutter holders, set screw, collet or "Clarkson", that are attached to the spindle with "Morse" tapers, must be retained by suitable draw bars. Even these slow tapers will work free

over time. Murphy says they will hang on until during the last finishing cut.

Third: Never climb mill! Mr. Hall explains the reason; it is backlash. You can adjust as much as you like, but with a worn lead screw, you will still not be able to avoid a crash when hand feeding. My technique to get the improved finish that the production people get on their C.N.C. machines is to wind the work back slowly with the cutter running but no change in the cutter position. On my small home machines there is always just that tiny bit of spring that takes the lightest possible amount off on the way back.

Fourth: Have the quill and the non feeding slide locked during every cut. Vibration will move any unlocked feature at some time. Ball handles are seldom truly balanced.

Regarding cutters and holders, I accept that I can only speak for my part of North America, but I have measured the $\frac{1}{16}$ in. shanks of all my cutters; some 20plus, that come from all parts of the world, and carry cutting diameters from $\frac{1}{16}$ in. to $\frac{1}{8}$ in. in two and four flute types. The beautifully ground shanks are all the same size as near as I can tell with my tenths micrometer. Also, how much run out is acceptable? All it does is make a very small difference to the feed rate from tooth to tooth. I mostly use set screw type plain holders, being careful to engage the set screw in the flat on the shank and checking it after the first cut. My $\frac{1}{16}$ in. holder was purchased finished for very little money (the equivalent of about £5-00) courtesy of the fine factories in India. The $\frac{1}{16}$ in. dia. I made from a Morse taper blank with a one inch dia. by one inch long end, by mounting it in the lathe spindle and drilling and reaming the hole. Both have the small end of the taper tapered $\frac{1}{16}$ in. U.N.C. for the draw bar. For the smaller shanks on the mills below $\frac{1}{16}$ in. dia, I have made a series of bushes all $\frac{1}{16}$ in. O.D. and reamed inside $\frac{1}{16}$ in. $\frac{1}{32}$ in. $\frac{1}{64}$ in. and $\frac{1}{128}$ in. Each is fitted with a set screw. I also have a series of collets, bought when on sale, sized from $\frac{1}{16}$ in. to $\frac{1}{8}$ in. by $\frac{1}{16}$ in. steps, that fit into a No. 3 Morse taper. They are operated by a draw bar and are fine for milling cutters and drills.

I hope Mr. Hall will mention coolant/lubricant in a future article. I have particular problems in this field, as my workspace is indoors, so that smell and smoke is not acceptable.

And continuing on coolant

Dyson Watkins from Swansea writes:

Mr. Sylvester mentioned in M.E.W. issue 81a blue cutting coolant. It could possibly be a type that I used about eight years ago in trials that I conducted in continuous production of gearbox parts. The coolant was greatly superior to the common sulphurised water soluble coolant we called "suds". Sulphurised cutting oil has an unpleasant smell, and over a period of time attacks components such as rubber seals, and paint used on many machine tools except stoved finishes. The blue cutting coolant called "Metosol 506" had a pleasant smell, gave an increased tool

life and therefore an improved productivity. The downside was a higher initial cost. It was diluted with water to a strength of approximately 5%, always adding Metosol to water - Never water to Metosol, otherwise an emulsion would not form. More details can be found on the internet by looking up the name "Metosol" or www.petrokimiagresig.com or Metolube. It does not attack machine paints to the same degree as "suds". Like suds however it will break down if lubricating oil is allowed to leak into it. This forms an air seal over the emulsion, and bacterial breakdown will occur due to the anaerobic conditions which are then formed. Other than that it is good stuff.

Hope this info will be of help.

Retirement complexes and workshops

Mr. W.A. Brading, of Auckland, New Zealand, writes:

I read with interest your editorial comment on the demand for workshop facilities within retirement complexes and offer my experiences on retiring to such a location in New Zealand.

I am a retired professional electrical engineer and have enjoyed model engineering, in particular 5-inch gauge steam locomotive and rolling stock construction for very many years even before retirement. When the time eventually, and long put off, came to retire, my wife and I were faced with the dilemma that you describe in your editorial column of August 2002. I certainly did not want to give up my main hobby nor dispose of the tools acquired over half a lifetime.

Happily, in New Zealand, the demand for the pursuance of hobbies of all types is very strong among potential retirees and the need has been met over the last decade in many retirement complexes by generous provision of working space among the central facilities of such schemes. Here I must add that I prefer the word "complex" to "home" in such context. A brief description of the facilities offered in our "village" is offered below and this is by no means unusual in this country.

Our village comprises 100 houses of 1, 2, or 3 bedrooms, many with single or double garages and a separate central block with administrative office with lounges and restaurant. We have a library, gymnasium and heated indoor swimming pool with snooker and games rooms. But, best of all, there are three "craft rooms", each of about 150 square metres in extent. One is for art (there is a non-resident teacher), another is for pottery, weaving and the like, and the third is for wood and metal work. In there we have two enthusiasts, namely myself and another equally keen with his woodworking lathe and tools. I have my Myford Super Seven and other machines installed with perfect confidence that that they are for my exclusive use and the room is secured after hours by the Management. I shall shortly be augmenting this with a Myford VMB milling machine. Since moving into this superb environment five years ago my hobby activity has blossomed. In there I have completed the

John Wilding's second clock and several other smaller projects in metal and wood including a case for the clock, which has now been running for over two years. Interest in the "goings-on" in this hive of activity is such that among both the other residents and the Management the enterprise is known as the "Engineering Department" so that we do receive requests for the odd repair job. We let it be known that miracles can take a bit longer.

I should add that all this may sound expensive but having just returned from a visit to the UK where we were both born I can assure you that this sort of thing is available for just about the UK average house price. Our monthly levy, which includes local rates and taxes and water as well as lawn maintenance and use of all the central facilities amounts to about £100 per month.

Incidentally I am aged 81.

Mr. L.I. Varty of Pickering, North Yorkshire writes:

I was surprised to read your item on Retirements Homes and Workshops in the Editorial of the August/September edition, as my own thoughts have mirrored yours for the last 18 months. My own mental ramblings have possibly gone a little further.

My own ideas envisage a large residence with a reasonable amount of mature land, preferably rural, but near to a larger conurbation. Such a home would need to be managed by one of the recognised care organisations, but it would be the additional facilities of workshops that would be of interest to the craftsman. I say craftsman, for it may be reasonable to include wood workers in the scheme of things! Also should there be craft rooms for any resident wives? No doubt a large house of the right character would have stables blocks or similar suitable for conversion. The possibility of small bungalows in the grounds for married couples would be attractive.

Machinery is unlikely to be a problem as prospective residents would no doubt donate their own equipment. So too with models, but this implies somewhere to operate them. Should there be a dual 7 $\frac{1}{2}$ /5inch track? Would one cater for smaller gauges? Would there be a model railway room? Out in the grounds there may need to be some form of road system for model steam road vehicles and possibly a model boat pond!

The question of funding of this side of the accommodation would need attention as it would be unfair to place all of the cost on the operation of the Home itself, but with suitable attention to layout of the grounds, public access may be viable for (say) Sunday public running. If the facilities could be made available to a local club, this would provide a core of younger people to assist in this way. They may even appreciate the experience of some of the older residents! Additional support funding may be possible through raffles at the major exhibitions.

Finally, where do we place this Home? May I suggest that the aim would be ultimately to have possibly five regional Homes to give reasonable accessibility to people and their relatives.

I am sure that other people will have different thoughts, but don't hang about - time is ticking by!

TO HELP YOU GET THE BEST FROM THE MODEL ENGINEER EXHIBITION

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

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

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

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

Club exhibits

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

Additional forms

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

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

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

COMPETITION CLASSES

Engineering Section

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

Railway Section

- B1 Working steam locomotives 1in scale and over.
- B2 Working steam locomotives under 1in scale.
- B3 Locomotives of any scale, experimental, freelance or based on any published design and not necessarily replicas of full size

prototypes, intended for track duties.

- B4 Scratchbuilt model locomotives of any scale, not covered by classes B1, B2, B3, including working models of non-steam, electrically or clockwork powered steam prototypes.
- B5 Scratchbuilt model locomotives gauge 1 (10mm scale) and under.
- B6 Kitbuilt model locomotives gauge 1 (10mm scale) and under.
- B7 Scratchbuilt rolling stock, gauge 1 (10mm scale) and under.
- B8 Kitbuilt rolling stock, gauge 1 (10mm scale) and under.
- B9 Passenger or goods rolling stock, above 1in scale.
- B10 Passenger or goods rolling stock, under 1in scale.
- B11 Railway buildings and lineside accessories to any recognised model railway scale.
- B12 Tramway vehicles.

Marine Models

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

Model Horse Drawn Vehicle Section

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

Junior Section

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

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

gold, silver or bronze medals

Model Vehicle Section

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

DUKE OF EDINBURGH CHALLENGE TROPHY

Rules and Particulars

1. The Duke of Edinburgh Challenge Trophy is awarded to the winner of the Championship Award at the Model Engineer Exhibition.
2. The trophy remains at all times the property of Nexus Special Interests.
3. The name of the winner and the date of the year in which the award is made will be engraved on the trophy, which may remain, at the discretion of Nexus Special Interests Ltd, in his/her possession until required for renovation and display at the following Model Engineer Exhibition.
4. Any piece of model engineering work will be eligible for this Championship Award after it has been awarded, at The Model Engineer Exhibition, a Gold or Silver medal by Nexus Special Interests Ltd.
5. No model may be entered more than once.
6. Entry shall be free. Competitors must state on the entry form:
 - (a) That exhibits are their own bona-fide work.
 - (b) Any parts or kits that were purchased or were not the outcome of their own work.
 - (c) That the model has not been structurally altered since winning the qualifying award.
7. Nexus Special Interests Ltd. may at their sole discretion vary the conditions of entry without notice.

COMPETITION RULES

1. Each entry shall be made separately on the official form and every question must be answered.
 2. Competition Application Forms must be received by the stated closing date.
- LATE ENTRIES WILL ONLY BE ACCEPTED AT

THE DISCRETION OF THE ORGANISERS.

3. Competitors must state on their form the following:
 - (a) Insured value of their model.
 - (b) The exhibit is their own work and property.
 - (c) Parts or kits purchased.
 - (d) Parts not the outcome of their own work.
 - (e) The origin of the design, in the case of a model that has been made by more than one person.

NOTE: Entry in the competition can only be made by one of the parties and only their work will be eligible for judging.

4. Models will be insured for the period during which they are in the custody of Nexus Special Interests Ltd.
5. A junior shall mean a person under 18 years of age on December 31st in the year of entry.
6. Past Gold and Silver medal award winners at any of the exhibitions promoted by Nexus Special Interests Ltd. are eligible to re-enter their model for the 'Duke of Edinburgh Challenge Trophy.'

Past winners at any of the exhibitions promoted by Nexus Special Interests Ltd. will not be eligible for re-entry into the competition unless it has been substantially altered in any way.

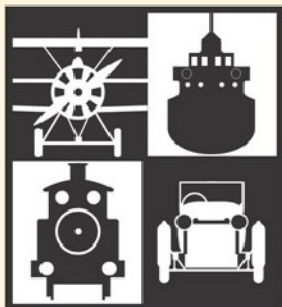
7. Nexus Special Interests Ltd. reserve the right to:
 - (a) Transfer an entry to a more appropriate class.
 - (b) Describe and photograph any models entered for competition or display and to make use of any such photographs or descriptions in any way they may think fit.
 - (c) Refuse any entry or model on arrival at the exhibition and shall not be required to furnish a reason for doing so.
8. Entry into the competition sections is not permitted by:
 - (a) Professional model makers.
 - (b) Anyone who has a financial interest in the direct supply of materials and designs to the public.

NOTE: If unsure, please contact the Competition organisers, prior to the show.

9. The judges' decision is final. All awards are at the discretion of the judges and no correspondence regarding the awards will be entered into.
10. Exhibitors must present their model receipt for all models collected at the end of the exhibition and sign as retrieved.
11. The signed release for each model must be presented to security staff when leaving the exhibition complex with display model(s) after the close of the exhibition.

IMPORTANT NOTE PLEASE MAKE COPIES, INCLUDING PHOTOGRAPHS, OF ALL INFORMATION RELATING TO YOUR MODEL, AS NEXUS WILL NOT ACCEPT LIABILITY FOR ANY LOSS.

CLOSING DATE 16TH DECEMBER 2002



THE MODEL ENGINEER EXHIBITION

Please return completed form to:
Model Engineer Competition, The Leys,
Church St., Twyford, Bucks. MK18 4EU

ENTRY FORM - COMPETITION & LOAN MODELS

ENTRY NO.

OFFICE USE ONLY

CLASS	ENTRY NO.

PERSONAL DETAILS (Please print)

Surname Forename(s) Age

Address
.....
.....

Post Code Home Tel: Daytime Tel:

Model Club or Association

Have you entered before? (Y/N) Do you purchase or subscribe to a Nexus magazine? (Y/N)

How many years have you been a modeller?

Mail Order Protection - please tick this box if you would prefer not to receive mail from other companies which may be of interest to you ☐

MODEL DETAILS - PLEASE TICK BOX IF MODEL IS FOR LOAN

Entry Class (competition entries only)

Model Title (to be used for catalogue and display card)
.....

Model Description
.....
.....

Model Scale Length Width Height Weight

Type of construction
.....

Parts not made by you and commercial items.....
.....

Have you supplied a photograph? (Y/N)

Are you supplying Judges Notes? (Y/N)

Value of model (Highbury Nexus will not insure the model unless a value is entered) £

Name and address of local newspaper
.....

emco Unimat 4 Lathe Machining Centre



- Swing 92mm
- Centre 200mm
- Speeds 130 - 4000rpm (Milling head optional)
- Extensive range of accessories

£299

emco Easycut Portable Bandsaw



- Variable Speed 30-90m/min
- 1kw Motor
- Cutting Capacity 85mm dia x 105mm long
- No need for coolant

£293

emco Compact 5 Machining Centre

Special Offer
Millennium
Limited Edition
Available



- Swing 130mm
- Centre 350mm
- Motor 500w (Milling head optional)
- Made in Austria

£599

emco Unimat Basic



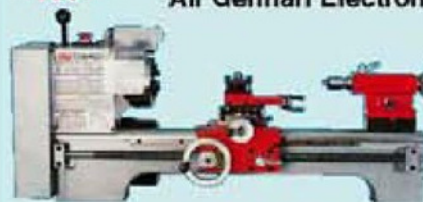
- Swing 110mm
- Centre 200mm
- Varispeed 20 - 2200rpm
- Made in Austria

£499

emco Compact 8E Bench Lathe

NEW

Emco Compact V8
Electronic Varispeed Lathe
All German Electronics



- Swing 210mm
- Centre 450mm
- Motor 650w
- Compact V8 Lathe
- Motor 1.4 kw
- Speeds 45-2300

£1615

emco Maximat F1-P Milling Machine

NEW



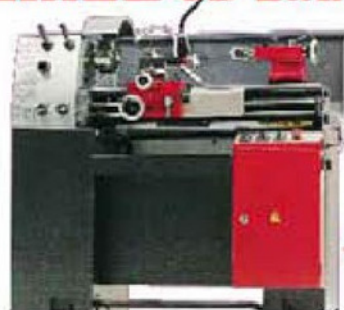
- Table 630x150mm
- 2ml Spindle
- Universal Head
- 120 kgs
- Speed 180-2300rpm
- Made in Austria

Varispeed
version
100-4000 rpm

£1468

Ask about
our CNC
option

emco Maximat Super II CD Lathe



- Swing 280mm
- Centre 650mm
- Geared Head
- 25m or 35m Bore
- Price from £5200.00
- Made in Austria

NEW

230V version
now available

emco Emcomat 17/20 Series Toolroom Lathe



- Swing 340-400mm
- Centres 700-1000mm
- Toolroom spec.
- Advanced features, eg. constant surface speed
- Price from £11,500
- Made in Austria

Machines shown with optional accessories – Prices include VAT

emco

**EXCLUSIVE IMPORTER FOR
EMCO AND WABECO
PRO Machine Tools Ltd**

17 Station Road Business Park
Barnack, Stamford, Lincolnshire PE9 3DW

Tel: (01780) 740956 - Fax: (01780) 740957

E-mail: ProMachUK@aol.com

Internet: <http://www.emcomachinetools.co.uk>



Milling Machine F1100E

- Long Travel 260mm
- Cross Travel 150mm
- Vertical Travel 330mm
- Motor 1.4kw
- Varispeed 180-3000rpm
- Drilling Capacity in steel 16mm
- Price £1489.00



Milling Machine F1200E

- Long Travel 260mm
- Cross Travel 150mm
- Vertical Travel 280mm
- Motor 1.4kw
- Varispeed 180-3000rpm
- Drilling Capacity in steel 23mm
- Price £1757.00



Milling Machine F1210E

- Long Travel 500mm
- Cross Travel 150mm
- Vertical Travel 280mm
- Motor 1.4kw
- Varispeed 180-3000rpm
- Drilling Capacity in steel 23mm
- Price £2069.00



NEW option

Ballscrews instead of standard leadscrews



CNC Milling Machine CC-F1200

- 3 axis CNC Mill with toolmaker's accuracy certificate
- Price £3610.00

NEW

High speed spindle option
100 - 7500 rpm



D2000 Series Lathes

- Swing 220mm
- Centre 350mm
- Choice of motors
- Price from £1621.00
- Stock removal 8mm in one pass



CNC option available



D3000E Lathe

- Swing 220mm
- Centres 500mm
- Motor 1.4kw
- Varispeed 45-2300rpm
- Price £2399.00

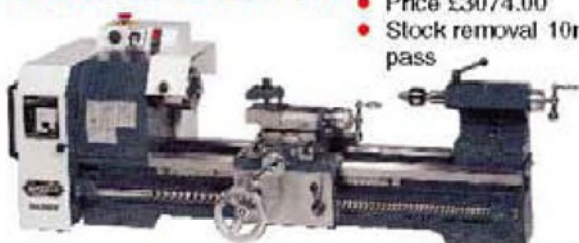


Infinitely variable automatic feed rates



D6000E Lathe

- Swing 270mm
- Centre 600mm
- Motor 1.4kw
- Varispeed 45-2300rpm
- Weight 150kg
- Price £3074.00
- Stock removal 10mm in one pass



CNC Lathe CC-D6000

- D6000E lathe with 2 axis CNC control with toolmaker's accuracy test certificate
- Price £4832.00



Prices include VAT - Machines shown with basic equipment

- Metric machines - true inch machines also available
- 5 Years Manufacturer's Warranty on all Wabeco Machines
- Manual Machines can be retrofitted with CNC add-on package
- Wide range of optional accessories
- Made in Germany



Single to Three phase speed controllers for your lathe or Miller

Are you still changing belts and pulleys? Need to run 3PH machinery from a domestic supply?
Is your miller too fast even in bottom speed? If your answer to any of the above is yes....
Then you need to treat your machine to smooth and quiet variable speed operation.



Complete ready built speed control systems with new a 3PH motor are available to suit all Myford ML7, Super 7, and Super 7 Plus machines. Systems also available for Tom Senior, Raglan, & Colchester etc. Available in sizes 1/2HP, 3/4HP and 1HP. Prices start from £395 + Carriage & VAT for the 1/2HP. Designed and manufactured in the UK, with FULL 12 months warranty and after sales support.

With a Mitsubishi Electric variable frequency inverter, and a three phase motor, the full potential of your lathe or machine tool can finally be unleashed..!



Mitsubishi Electric single to three phase inverters drives available from £113 + VAT. Available in sizes ranging from 1/3HP to 3HP (2.2kW), and with a full range of options including Pushbutton control stations, Programming keypads, and RFI filters.

Here's what some of our satisfied customers say....

"I was very impressed with the service I received from Newton Tesla. In particular George Newton took considerable time and trouble in explaining how the Mitsubishi E520 AC drive system operated and worked out the connection details for my Colchester Student Lathe. Fitting was straightforward and once I had mastered the programming unit the system worked right first time. It was very good value for money!"

Derek Toller, Colchester 'Student' Lathe

"The fitment of the new inverter and the three phase motor has completely changed the use of my 90+ year old Drummond Round bed lathe. Using the original pulleys to change the speeds at the chuck also entailed changing the flat belts, which was tedious to say the least! The speeds I could obtain were 90 rpm, 258rpm and 275rpm. As my lathe is not back geared these speeds did not fit my requirements. With the inverter and the three phase motor I can now obtain speeds from 90rpm to 800rpm without any steps and with much smoother running. I do not now have the problem of "chatter" during machining and the lathe now runs a lot quieter at 'all' speeds. It has also now become a much more useful and pleasant machine tool to use."

Mr A.D. Jones, Drummond Round Bed lathe.

"I have been meaning to write to you for over a year now, to say how pleased I was with the ML750 Speed Control System and motor you supplied for my Raglan Little-John Mk5 lathe. I can do screw cutting without using the back gear, and the smoother 3-phase motor has eliminated the noise produced by torsional oscillation of the single phase motor. A 20p piece can be balanced on the headstock casing and hardly moves at any speed"

Mr B. Harding, Raglan Mk5 Lathe.

Call us now for more information and friendly advice, or visit our new website



Newton Tesla

• ELECTRIC • DRIVES • LIMITED •

Units G15 & G18, Warrington Business Park
Long Lane, Warrington, Cheshire WA2 8TX

Tel. 01925 444773 Fax. 01925 241477 Email. info@Newton-Tesla.com

www.newton-tesla.com



Major credit cards accepted

WARCO

The widest choice...

ONLY
£998.00

...the best prices!



ONLY
£625.00

Mini Mill Drill

- Variable speed control
- 100-2500 rpm
- Tilting head for inclined machining
- 3 mt spindle
- Table 15" x 3 1/2"
- Imperial or metric lead-screws



ZX-16 Mill Drill

- Compact gear head machine
- Tilting head
- Speeds 100/1600 rpm
- Table 23" x 6"
- 1/2 hp motor
- 2 mt spindle
- Imperial or metric lead-screws

Optional
stand £149

Major GH Mill Drill

- Gearhead, tilting head
- 1 1/2 hp motor
- Table size 28" x 8"
- Available 3mt - R8 - Imperial - Metric



ONLY
£1,250.00

All three models are available 3mt - R8 - Imperial - metric



ONLY
£799.00

Economy

- Table size 23" x 7 1/2"
- 3/4 hp motor



ONLY
£985.00

Minor Mill Drill

- 1 hp motor
- Table size 26" x 7 1/2"



ONLY
£1,150.00

Major Mill Drill

- 2 hp motor
- Table size 29" x 8"



ONLY
£1,600.00

VMC Mill

- Illustrated with optional d.t.o. and power feed.
- Table size 26" x 6"
- Motor 1 1/2 hp
- Available 3mt - R8 - Metric - Imperial



ONLY
£899.00

1016 Lathe

- 5" centre height x 18" between centres
- Supplied with 3 and 4 jaw chucks, fixed and travelling steadies, face plate,
- 4 way tool post.

- Also available 22" between centres with Norton thread cutting gear box £1,099

1224 Lathe

ONLY
£1,850.00

- Gear Head lathe
- 6" centre height x 24" between centres
- Supplied with Camlock 3 and 4 jaw chucks, face plate, fixed and travelling steadies.
- Speeds 7.5/1400
- 2 hp motor
- Gap bed
- Hardened bedways

- Also available 32" between centres £1,950



Ask for our latest
Colour brochures!

PRICES INCLUDE
VAT AND DELIVERY
TO UK MAINLAND

www.warco.co.uk



ONLY
£2,250.00

GH-1322 Lathe

- Superb, compact gear head lathe.
- 6 1/2" centre height x 22" between centres.
- Speeds 70/2000
- Supplied with Camlock 3 and 4 jaw chucks, fixed and travelling steadies, face plate, four way tool post, coolant system, halogen lighting, telescopic lead screw covers and foot operated spindle brake.
- Gap bed. Hardened bedways.
- Also available 30" between centres £2,990

WARCO

ONLY
£1,600

Warco BH-600



- 6" Centre height
- 20" between centres
- Power cross feed
- 1 1/2 HP single phase
- Supplied with 3 and 4 jaw chucks
- Fixed and travelling steadies
- Face plate
- Two slotted cross slide
- Rear splash guard
- Cabinet stand & coolant tray
- Hardened bedways
- Speed range 50/1200 rpm
- Also available 37" between centres £1,900



Warco, Fisher Lane, Chiddingfold, Surrey GU8 4TD

Tel: 01428-682929 Fax: 01428-685870/686812

e-mail: warco@warco.co.uk web: www.warco.co.uk



READERS' OFFER

SAVE £6 ON RETAIL PRICES

THREE NEW TITLES IN THE WORKSHOP PRACTICE SERIES
from NEXUS SPECIAL INTERESTS BOOKS

USEFUL WORKSHOP TOOLS

Stan Bray

210 X 148 MM; 104 PAGES;
30 B+W PHOTOS; 70 LINE DRAWINGS;
1-85486-194-8; PAPERBACK £ 6.95

Workshop Practice Series No. 31. A collection of fifteen invaluable additions to the model engineer's armoury of tools and equipment from the former editor of Model Engineer's Workshop magazine. This practical collection covers benchwork, the lathe and milling operations.



MAKING CLOCKS

Stan Bray

210 X 148 MM; 128 PAGES;
100 B+W ILLUSTRATIONS;
1-85486-214-6;
PAPERBACK £ 6.95

Workshop Practice Series No. 33. An introduction to the fascinating world of horology for the complete beginner. This book explains the terminology of the clockmaker and provides general details of clock construction including layout of wheels and escapements, all of which are fully described and illustrated.

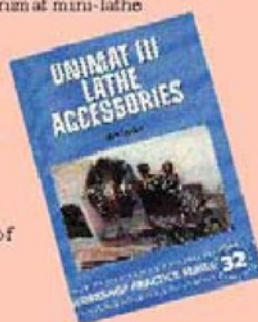


UNIMAT III LATHE ACCESSORIES

Bob Loader

210 X 148 MM; 160 PAGES;
160 B+W PHOTOS; 70 LINE DRAWINGS;
1-85486-213-8; PAPERBACK £ 6.95

Workshop Practice Series No. 32. An acknowledged authority on the popular Unimat mini-lathe has developed numerous accessories and techniques to assist the model engineer in getting the best from the machine. The projects in this book increase the scope of the machine & advise on the performance of a number of tricky operations.



**SPECIAL OFFER THIS MONTH - BUY ALL THREE BOOKS FOR £15.00
SAVE £6.00 ON CURRENT RETAIL PRICES**

To order please call the credit card hotline on 01322 616300 or send a cheque made payable to Nexus Media Ltd.
Customer Services, Nexus House, Azalea Drive, Swanley, Kent, BR8 5HU.
Online ordering www.nexusonline.com

FOR INDIVIDUAL PURCHASES PLEASE ADD £1 FOR P&P

The publisher of *The Woodturner*
brings you a one-off publication *Grimming*
with information for beginners...

BASICS of Woodturning

www.getwoodworking.com

Inspiration, advice and tips for woodturners everywhere

- Techniques and Turning
- Workshop set up and machinery
- Choosing and using timber
- On course for learning

PLUS

all round advice
on design,
chucking and
much, much
more

On sale from September 27th
at leading stockists

Order your copy in
advance by calling

**01322
616300**

THE ESSENTIAL WORKSHOP LIBRARY

from NEXUS SPECIAL INTERESTS BOOKS

MODEL ENGINEERING BOOKS

Building Simple Model Steam Engines

Isid Goin
This book is written for both the model steam engineer and the experienced practical one. It gives a full guide to the theory.

192 1-2000-1002 2000 hours
100 pages Illustrated paperback £ 6

Building Simple Model Steam Engines II

Isid Goin
Now progressing from a delightful little boiler to a larger engine in the style of the original 'Simple Engine' and the 'High Pressure' model by the author. Fully detailed methods of construction with the beginner in mind.

197 1-2000-1003 2000 hours
100 pages Illustrated paperback £ 6

Model Engineering - A Foundation Course

Peter Wright
Written by an experienced model engineer covering all the basic techniques of workshop engineering drawings, layout, marking out, turning, filing, grinding and forming metals.

197 1-2000-1004 2000 hours
400 pages Illustrated paperback £ 6

Model Engineers Handbook

Isid Goin
This third edition completes completion of filling gaps, producing a book that the author has found invaluable in his model engineering activities. It provides a mass of information to which you will return again and again.

196 1-2000-1005 2000 hours
200 pages Illustrated paperback £ 6

The Model Lathe: The First Series

Isid Goin
Based on a series of articles by Isid Goin, the publisher and the author for a number of years published in Model Engineer. All the text and illustrations have been specially prepared by the author for this book.

196 1-2000-1006 2000 hours
80 pages Illustrated paperback £ 6

Introducing Model Traction Engine Construction

John Haining
This book is written in a brief history, choice of model, making processes and the tools needed for every stage of construction. Fully illustrated and full of interesting and useful information.

193 1-2000-1007 2000 hours
100 pages Illustrated paperback £ 6

The Gunbyman's Steam Manual

John Haining
First published in 1922, this second enlarged edition covers the design, construction and care of steel boiler, pressure, with formulae and data and by force of engine. Design of three model lathe are included - the 10 inch, the 12 inch and a 14 inch size version.

196 1-2000-1008 2000 hours
80 pages Illustrated paperback £ 6

An Introduction to Robotics

Harriet Sandhu
This introduction for the beginner to the world of concepts of robotics, design and the use of a variety of tools, the way we work. The first part explains the theory and the way we work and the second part shows you how to make a simple technological model that can be programmed to work from a personal computer.

197 1-2000-1009 2000 hours
200 pages Illustrated paperback £ 6

The Amateur's Workshop

Ken Brodsky
All model engineers are occasionally faced with a specific problem that can only be solved with a little help and photographic illustration. This book is a comprehensive reference book providing information on setting up a workshop and the use of various materials and tools.

195 1-2000-1010 2000 hours
200 pages Illustrated paperback £ 6

The Amateur's Lathe

L.H. Spence
This is the standard work on all 8-12 inch lathe and is the original publication in 1945.

197 1-2000-1011 2000 hours
200 pages Illustrated paperback £ 6

WORKSHOP PRACTICE SERIES

Hardening, Tempering & Heat Treatment

Isid Goin WPS 1
A comprehensive explanation of the structure of steel and the effects of different heat treatments particularly in regard to tools with wear and tear temperature changes.

194 1-2000-1012 2000 hours
80 pages Illustrated paperback + 4 pages of colour plates £ 6

Vertical Milling in the Home Workshop

Arnold Kemp WPS 3
Small workshop including those of model engineers are making increasing use of small vertical milling machines. This book explains how to use them (and how to mill) effectively in the home.

194 1-2000-1013 2000 hours
80 pages Illustrated paperback £ 6

Grinding in the Lathe

Martin Oliver WPS 2
A fully comprehensive survey of the use of a lathe for all forms of grinding in all lathe forms, imperial and metric.

194 1-2000-1014 2000 hours
80 pages Illustrated paperback £ 6

Handywork for the Amateur

Isid Goin WPS 4
This book is written as a practical introduction to using tools in common metal. It covers all the basic things you need to know to get up to date.

196 1-2000-1015 2000 hours
100 pages Illustrated paperback £ 6

Milling Operations in the Lathe

Isid Goin WPS 5
This book by Isid Goin, who makes a contribution to Model Engineer, explains in a thorough and practical manner how to use the lathe for all types of milling work.

194 1-2000-1016 2000 hours
80 pages Illustrated paperback £ 6

Measuring & Marking Metals

Ken Low WPS 6
Model engineers need many small workshops and need, or have, many tools of the workshop. This book explains the use of measuring tools and instruments by means of basic concepts of all stages of work are comprehensively described.

193 1-2000-1017 2000 hours
100 pages Illustrated paperback £ 6

The Art of Welding

Ken Low WPS 7
This book is one of the basic techniques for welding. It covers all the basic techniques for welding with mild steel, cast iron, stainless steel, copper, brass and in sheet, plate or cast form.

193 1-2000-1018 2000 hours
80 pages Illustrated paperback £ 6

Sheet Metal Work

R.E. Welford WPS 8
The author is an instructor in metal work and sheet metal and describes clearly all the processes likely to be encountered by the hobbyist in a model or light engineering workshop.

193 1-2000-1019 2000 hours
80 pages Illustrated paperback £ 6

Soldering & Brazing

Isid Goin WPS 9
Joining metal by one form or another of soft and hard soldering or brazing with various alloys are one of the most basic model and light engineering workshops.

193 1-2000-1020 2000 hours
80 pages Illustrated paperback £ 6

Saws & Sawing

Ken Brodsky WPS 10
This book contains all the information on the use of saws, maintenance and useful information on various applications.

193 1-2000-1021 2000 hours
80 pages Illustrated paperback £ 6

Heat-treating

Isid Goin WPS 11
This book is one of the most important and useful books for the hobbyist to get up to date with all the necessary tools and simple equipment.

197 1-2000-1022 2000 hours
80 pages Illustrated paperback £ 6

Drills, Taps & Dies

Isid Goin WPS 12
In this book, Isid Goin discusses the use of drills, taps and dies in the workshop. It covers all the basic techniques for drilling, tapping and dieing, with a full range of practical information and advice.

197 1-2000-1023 2000 hours
80 pages Illustrated paperback £ 6

Making Small Workshop Tools

Ken Brodsky WPS 14
Making 14 simple but useful tools for the workshop. For both the hobbyist and the professional, this book is a must. It includes a full range of practical information and advice on the use of tools and the use of materials.

197 1-2000-1024 2000 hours
80 pages Illustrated paperback £ 6

Welding in the Lathe

Isid Goin WPS 13
This book discusses all the practical aspects of the subject, with many photographs and diagrams to illustrate the points.

193 1-2000-1025 2000 hours
80 pages Illustrated paperback £ 6

Best's Notes

Isid Goin WPS 16
This book is a collection of notes, tips, tricks, and advice on the use of tools and materials in the workshop. It is a must for every model engineer.

197 1-2000-1026 2000 hours
80 pages Illustrated paperback £ 6

Gears & Gear Cutting

Ken Low WPS 17
Explains and describes all the conventional types of gears and their use in the workshop. It includes a full range of practical information and advice on the use of tools and materials.

197 1-2000-1027 2000 hours
80 pages Illustrated paperback £ 6

Best's Benchwork

Isid Goin WPS 18
This book is a collection of notes, tips, tricks, and advice on the use of tools and materials in the workshop. It is a must for every model engineer.

197 1-2000-1028 2000 hours
80 pages Illustrated paperback £ 6

Spring Design & Manufacture

Isid Goin WPS 19
This book is a collection of notes, tips, tricks, and advice on the use of tools and materials in the workshop. It is a must for every model engineer.

197 1-2000-1029 2000 hours
80 pages Illustrated paperback £ 6

Workshop & Machining Notes & Tips

Ken Brodsky WPS 20
This book is a collection of notes, tips, tricks, and advice on the use of tools and materials in the workshop. It is a must for every model engineer.

197 1-2000-1030 2000 hours
80 pages Illustrated paperback £ 6

Adhesives & Sealants

David Lawrence WPS 21
This book is a collection of notes, tips, tricks, and advice on the use of tools and materials in the workshop. It is a must for every model engineer.

197 1-2000-1031 2000 hours
80 pages Illustrated paperback £ 6

Workshop Materials

Isid Goin WPS 22
This book is a collection of notes, tips, tricks, and advice on the use of tools and materials in the workshop. It is a must for every model engineer.

197 1-2000-1032 2000 hours
80 pages Illustrated paperback £ 6

Workshop Construction

Isid Goin WPS 23
This book is a collection of notes, tips, tricks, and advice on the use of tools and materials in the workshop. It is a must for every model engineer.

197 1-2000-1033 2000 hours
80 pages Illustrated paperback £ 6

Best's Notes in the Home Workshop

Isid Goin WPS 15
This book is a collection of notes, tips, tricks, and advice on the use of tools and materials in the workshop. It is a must for every model engineer.

197 1-2000-1034 2000 hours
80 pages Illustrated paperback £ 6

The Handywork Minder

Isid Goin WPS 14
This book is a collection of notes, tips, tricks, and advice on the use of tools and materials in the workshop. It is a must for every model engineer.

197 1-2000-1035 2000 hours
80 pages Illustrated paperback £ 6

Home Workshop Hints & Tips

Isid Goin WPS 13
This book is a collection of notes, tips, tricks, and advice on the use of tools and materials in the workshop. It is a must for every model engineer.

197 1-2000-1036 2000 hours
80 pages Illustrated paperback £ 6

Spindles

Isid Goin WPS 12
This book is a collection of notes, tips, tricks, and advice on the use of tools and materials in the workshop. It is a must for every model engineer.

197 1-2000-1037 2000 hours
80 pages Illustrated paperback £ 6

Simple Workshop Devices

Isid Goin WPS 11
This book is a collection of notes, tips, tricks, and advice on the use of tools and materials in the workshop. It is a must for every model engineer.

197 1-2000-1038 2000 hours
80 pages Illustrated paperback £ 6

Old for Model Engineers

Isid Goin WPS 10
This book is a collection of notes, tips, tricks, and advice on the use of tools and materials in the workshop. It is a must for every model engineer.

197 1-2000-1039 2000 hours
80 pages Illustrated paperback £ 6

Workshop Materials

Isid Goin WPS 9
This book is a collection of notes, tips, tricks, and advice on the use of tools and materials in the workshop. It is a must for every model engineer.

197 1-2000-1040 2000 hours
80 pages Illustrated paperback £ 6

Useful Workshop Tools

Isid Goin WPS 8
This book is a collection of notes, tips, tricks, and advice on the use of tools and materials in the workshop. It is a must for every model engineer.

197 1-2000-1041 2000 hours
80 pages Illustrated paperback £ 6

Workshop Materials

Isid Goin WPS 7
This book is a collection of notes, tips, tricks, and advice on the use of tools and materials in the workshop. It is a must for every model engineer.

197 1-2000-1042 2000 hours
80 pages Illustrated paperback £ 6

Workshop Materials

Isid Goin WPS 6
This book is a collection of notes, tips, tricks, and advice on the use of tools and materials in the workshop. It is a must for every model engineer.

197 1-2000-1043 2000 hours
80 pages Illustrated paperback £ 6

Workshop Materials

Isid Goin WPS 5
This book is a collection of notes, tips, tricks, and advice on the use of tools and materials in the workshop. It is a must for every model engineer.

197 1-2000-1044 2000 hours
80 pages Illustrated paperback £ 6

Please add £1.00 per single book order and 50p for each additional book ordered.

Send payment with your name, address and telephone number to:
Nexus Customer Services, Nexus House, Appleton Drive, Stevenage SG8 8HU.
Cheques made payable to Nexus Media Ltd. or phone 01322 616300.

MODEL ENGINEERS' WORKSHOP



CLASSIFIED Advertisements



Send to Model Engineers' Workshop Classified Department, News & Special Interest, Model House, Azalea Drive, Swanley, Kent BR88 8HU. Tel: 01322 260000. Fax: 01322 263919.
All Advertisements will be inserted in the first available issue. There are no free insertions for local installations.
All advertisements must be pre-paid.
The Business Advertisements (Disclosure) Order 1977 - Requires all advertisements by people who sell goods in the course of business to make that fact clear. Consequently all trade ads in Model Engineers' Workshop carry this 'T' symbol

WORKSHOP EQUIPMENT

www.eternaltools.com
secure ordering online

DIAMOND WHEELS

All Shapes for all machines:
Quorn, Worden, Stent, Bench Grinders

Prices from: £34.95 inc VAT



"Bring life to old carbide tools"

Eternal

tel: 020 7291 4436 fax: 020 7291 4437
1 - 7 Harley St - London W1G 9QD

HI-TEC 3-PHASE CONVERTERS

Speed Controls, Forward & Reverse Switches, Static and Rotary Phase Converters 0.8kW to 45kW to run 3 phase 415 volt machinery from a Single Phase. We can also supply Transformers and Components.
Website: www.phaseconverters.co.uk

BOOST ELECTRICAL ENGINEERING
Tel: 01959 534073 Fax: 01959 532726

WE BUY, SELL & EXCHANGE

TOOLS, MACHINERY, MATERIALS, PART BUILT LOCOS, MODELS ETC.

WORKSHOP TOOLS, MACHINES, MODELS WANTED - WE COLLECT & PAY CASH

M.E. SALE & EXCHANGE

Compass House, High St., Rotherfield, Sussex.
Phone (01892-85) 2968
Long S.A.E. for List

TRUE PHASE CONVERTERS

ESTABLISHED FOR 60 YEARS

- RUN THREE PHASE MACHINES FROM A SINGLE PHASE SUPPLY
- REVOLUTIONARY DESIGN
- OUT PERFORMS OTHER CONVERTORS
- MONEY BACK GUARANTEE



DANEbury ELECTRIC LTD

PHONE, FAX OR EMAIL FOR COLOUR BROCHURE
email: truephasesales@daneburyelectric.co.uk
Web: www.danebury.co.uk

Tel: 01202 524888 or
Fax: 01202 530940

PHASE CONVERTERS 2HP TO 50HP

A Top Quality Range of Static and Rotary Converters to run 3-phase 415v machinery from 240v single-phase supply.

For further details contact:

Motorun Phase Converters

23 Waldegrave Road, Teddington, TW11 8LA
Middx. Tel: 020 8977 0242 Fax: 020 8943 3326
Ansaphone Service After Hours

MODEL ENGINEERING SUPPLIES (BEXHILL)

Stockists of all your modelling requirements. Good used machines, part exchanges, used tooling, new machine tooling and ancillary equipment. Mail order catalogue £1 inc. postage. All major credit cards accepted.

Phone/fax 01424 223702

17 Sea Road, Bexhill-on-Sea,

E. Sussex, TN40 1EE (opp. railway station)

GENERAL

THINKING OF SELLING YOUR LATHE, MILL OR COMPLETE WORKSHOP

and want it handled in a quick, professional no fuss manner? Contact David Anchell, Quillstar (UK) Ltd (Nottingham).

Tel 0115 9255944 Fax 0115 9430858

R.A. ATKINS

MYFORD SUPER 7B LATHES, from	£1,450
MYFORD SUPER 7 LATHES, from	£850
MYFORD ML7, clutch makers rebuild	£950
MYFORD ML10 LATHES, choice	£500
JUBILEE 30" WOOD LATHE, tooling	£300
HARRISON HORIZ MILL, vert head	£700
UNION TOOL CUTTER GRINDER, tooling	£450
WARCO MINOR MILL DRILL	£475
PROGRESS NO.1 1/2" PILLAR DRILLS	£100
WARCO VERT BENCH MILL	£425
MYFORD RODNEY MILL ATTACH, suit ML10	£375
MYFORD PLAIN VERT MILL SLIDE	£100
Q&S BULLDOG 6" HACKSAW	£425
MYFORD METRIC CONVERSION SET	£175

100'S MODEL ENGINEER TOOLS & EQUIPMENT
WE URGENTLY REQUIRE TO BUY WORKSHOPS

HUNTS HILL HOUSE, HUNTS HILL, NORMANDY,
GUILDFORD, SURREY GU3 2AH
Tel: (01483) 811146 Fax (01483) 811243

EVENSON ENGINEERING

Quality Machines
and Tooling

Machine Sales

EX BRADFORD UNIVERSITY MACHINES

Colchester Master 6" x 36" Late fully Tooling	£1500
Arbogast Maskiner geared Head Pillar Drill 3MT	£875
Raglan 5" x 20" Lathe Gear Box P/F Single Phase Fully Tooling	£1400
Thommen Chip-Breaker Tool + Cutter Grinder	£870
Colchester Chipmaster, taper Turning Rear Tool Post, Bed Stops Fully Tooling	£1200
Arbogast Geared Head Drill 3MT	£850
Edwards 4ft X 16G Guillotine	£550
Elliott 00 Mill 27" X 8" Table	£1800
J+S 12-12 Hand opp cylindrical Grinder Single Phase	£1800
J+S 540 Surface Grinder (Like New Condition)	£3500
Elliott 4E Pedestal Drill 4 Morse Power Feeds	£850
3 of Harrison L5 Lathes (All Good Condition)	£1100-£1750
Harrison Vert Mill 30" x 8" Table (Superb Conditions)	£1800

All machines are of outstanding condition & come completely tooled
Too many machines to list, please phone for details

MILLING MACHINES

A.E. Jones Vert/Hort Swivel Head-Table Power Feed (Tom Senior Size)	£1350
Bridgeport 42" 9" Variable Speedhead Digital Readout	£2800
A & S horizontal mills	from £500
Harrison horizontal mills	from £700

LATHES

Boxford Cud Metric Cab/Stand PCF	£875
2 Colchester Masters 6" 36" One with Clutch	£1400
Harrison L6 Gearbox PCF Gap Piece Missing (Vertly Tidy)	£800
Colchester Banham 2000 6" 30" Gap Bed Dual Dials	£1850
Harrison M250 Fully Tooling	£2300
Colchester Chipmaster Tooling Taper Turning Rear Tool Post (Vertly Nice)	£1450

MISCELLANEOUS

Jones & Shipman dig. form model AT new boxed	£550
Bridgeport Slotting Head, excellent condition	£800
Viceroy pedestal grinders, 2 off, ex cond (small & compact)	£180
Leytool slotting machine, 3" stroke, small footprint, swivel head, rebuilt & painted	£1175
Bridgeport milling head, 2 speed motor R8 power quill (fits most mills, ie Adcock & Shipley 1E5)	£850
Eclipse magnetic chuck 19" x 12"	£300
Flypresses	from £50
Colchester Chipmaster lathe (breaking)	£350
Harrison spares	please phone
Swivel vertical head 4MT, make unknown but will fit Senior, A&S etc with modification	£300
Collet chucks, box blocks, vices, angle plates, surface plates etc	please phone
Union Bench Drill	£280
Student/Master Collet Chuck 2 of	each £100
Student 18" Faceplate	£95
Boxford 2MT Pillar Drill (Untidy)	£80
Hort Pedestal Sander 15 Disc Ex Uni	£350
Hydraulic Stackler Truck Ideal for Lifting Vices and Chucks 800 kg	£350
Jones Shipman Bench Centre	POA

WE ALSO PURCHASE QUALITY MACHINES & TOOLING • DELIVERY SERVICE AVAILABLE
PLEASE TELEPHONE BEFORE TRAVELLING - WEEKEND & EVENING VIEWING AND DELIVERY SERVICE

More machines always in stock.

Tel: 01274 544409 & 780040 Mobile 07050 272169
4 Duchy Crescent, Bradford, BD9 5NJ

ENGINEERS TOOL ROOM

The tool supplier for Professional & Model Engineers

CUTTING TOOLS: HSS — COBALT — COATED

Drills: Metric, Fractional, Jobbers, Long Series, Boxed Sets

Reaming: Metric, Fractional Hand and Machine.

Threading: Taps, Straight Flute, Spiral Flute, Boxed Sets, Metric, Imperial, Unified, BA.

Dies: Split Dies, Solid Dies, Die Nuts, Metric, Imperial, Unified, BA.

Milling: End Mills, Slot Drills Plain and Screw Shank, Horizontal Cutters, Slitting Saws, Collets.

Turning: HSS Tool Bits, Tungsten Carbide Tipped Turning Tools, Insert Tools, Collets.

Measuring: Micrometers, Verniers, Dividers, Callipers, Setting up Tools

Workshop Machinery: Lathes, Milling Machines, Pillar Drills, Band Saws

Machining Services: full machining service available, turning, milling, grinding, wire and spark eroding, tool and mould making

"New" Tool Catalogue available **FREE** — Send for one today

CHECK OUT OUR SPECIFICATIONS & PRICES BEFORE ORDERING YOUR MACHINES — Contact us for a Quotation

Part Exchange on some machine tools welcomed

Tel: 01443 777167 Fax: 01443 773347

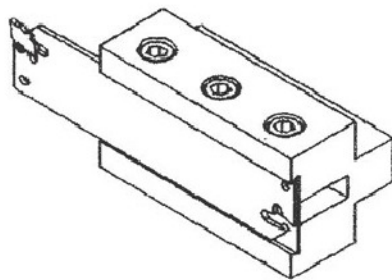
Mobile 07770 988840

Web Site: www.engineerstoolroom.co.uk

Email: regpugh@aol.com

262 PARK ROAD, CWMPPARC, TREORCHY, MID GLAMORGAN CF42 6LE

MEDIUM DUTY PART-OFF SYSTEM



**£89.50
incl. VAT &
P & P**

System comprises of:-

Five 2mm wide carbide inserts
Double-ended insert blade
Blade holder & Allen key
Max. Part-off diameter 130mm

Spare inserts available @ £4.80 incl. VAT and P & P

CLARKE ENGINEERING

Tel: 01603 722023, 01603 426522

FULL MONEY BACK GUARANTEE

TOOLCO

The home of good quality used tools and machinery

www.toolco.co.uk

or send for full itemised stocklist.

Unit 4, Ebley Ind Park, Ebley, Stroud, Glos GL5 4SP

Important: Phone for opening times before travelling.

(Just 4 miles J13 M5 Motorway)

Tel: 01452 770550

E-Mail: sales@toolco.co.uk

Fax: 01452 770771

Operate three phase machinery from your single phase supply system.

Transwave
CONVERTERS

www.powercapacitors.co.uk

Power Capacitors Limited

30 Redfern Road, Tyseley, Birmingham B11 2BH

Tel: 0121 708 2811/0121 708 4522 — Fax: 0121 765 4054

E-Mail: transwave@powercapacitors.co.uk

THE PEATOL LATHE



£160 including 3 or 4 jaw chuck. Milling attachment and other accessories available.

Centre height 2 1/4" distance between centres 9 1/2".

Full details send 2 x 2nd class stamps. Price inc. VAT

Peatol Machine Tools, M.E.W., 19 Knightlow Road, Harborne, Birmingham B17 8PS **Tel: 0121 429 1015**

www.peatol.com

Churchill-Redman Cub Lathe

24" B/C 6" from B/ToC — 6 speed gear box, power feed in forward and reverse. **£150 ono**

Tel: 01642 323685

TOOLS PURCHASED — hand tools & machinery whole or part collections — old and modern. Will call. Tel: Alan Bryson, Taunton (01823) 288135.

ALFRED HERBERT

Nos. 4 turret lathes senior, junior

£195 each. Also 1920/30 made

flat belt lathe 8in. swing, 36in.

centre, screw cutting,

independent chuck. £295.

Details: 01778 412798 (evenings)

BRIDGEPORT BELT DRIVE

turret mill, Dro, power feed x axis, coolant, 42" x 9" table, machine vice, Tidy machine. **£1,950 + VAT ono**

Tel: 01488 685060 (Hungerford)

CHESTER U.K. LTD

Craftsman belt drive lathe swing 300mm crs 570mm with all accessories & cooling system, 2 years old. **£1,100.**

Tel: 0247639 8647

HARRISON M250 CENTRE LATHE

6" swing, 3 & 4 Jaw chucks, quick change tool post, coolant, light, 2 point steady, tidy machine. **£1,950 + VAT ono**

Tel: 01488 685060 (Hungerford)

MYFORD ML7 LATHE

on original stand with coolant, splash guard, drip tray, change wheels, chucks, single phase, in vgc. **£575 ono.**

Tel: 01455 286759 (Leics)

(24 hr update) www.tradesalesdirect.co.uk (Trade Prices)

Don't wait for the next issue! Check out the Internet Web Site above. It contains a stocklist of used lathes, millers, grinders, drills, saws, miscellaneous machinery, accessories, items of interest, etc. A stocklist is also available 'FREE' by post.

Contact: David Anchell, Quillstar Ltd, Lower Regent Street, Beeston, Notts. NG9 2DJ

Tel 0115 9255944 Fax. 0115 9430858 or you can send an e-mail david@tradesalesdirect.co.uk.

WORLDWIDE SHIPPING. TRADE SALES DIRECT IS A SUBSIDIARY OF QUILLSTAR LTD.

TOOL & CUTTER GRINDER Harrison, single phase, mint condition, all accessories will cylindrical grind. £475. Tel: 01283 703368 (Derby).

COWELLS 90ME LATHE, as new, rarely used, accessories, £600. Tel: 045 864032 (Dublin).

ATLAS LATHE 5"x30", 4 chucks, change wheels, boring table, auto traverse, etc. £325. Tel: 01732 842386 (Kent).

LATHE PARTS AND ACCESSORIES + gears for Boxford & Raglan Little John Lathes. T00 Q.C. Tool Post + 2 holders £90. Tel: 077208 70891 or see www.latheparts.co.uk.

SALE HERMINGHAMWAY KNURLING TOOL KIT £25. Crown 4" 4JIND chuck Myford backplate £45. Dremel 210 drill stand (928 screen tool) £10. Tel: 01373 832681.

SALE MYFORD NO. 20/40 Rodney milling/drill attachment. Buyer to collect, Bath area, offers. Tel: 01373 832681.

WINFIELD 41/4"x20" B.G.S.C. LATHE on C.I. stand with chucks and accessories, buyer collects. £175 o.n.o. Tel: 01724 720419 (Scunthorpe).

SHAPING MACHINE very small hand operated £100. Myford vertical milling slide £50. Lathe chucks burnerd £50. Tel: 0115 9266245 (Notts).

MODELS & MATERIALS

INTERNAL COMBUSTION ENGINES

DRAWINGS, CASTINGS, MATERIALS, SPARK PLUGS, TIMING GEARS, ETC AVAILABLE FOR A RANGE OF DESIGNS INCLUDING:



15cc Chenery Aero Twin

- 0.8CC & 5CC DIESEL
- 6CC TWO STROKE
- 10CC GLOW PLUG
- 2 CYL. 30CC O.H.V.
- 4 CYL. 30CC O.H.C

WORKSHOP EQUIPMENT

DRAWINGS AND CASTINGS FOR MILLING ATTACHMENTS, BORING HEADS VERTICAL MILLING MACHINE ETC

RADIAL & STATIONARY STEAM ENGINES

ILLUSTRATED CATALOGUE AND PRICE LIST £1.50

WOKING PRECISION MODELS

27 Petts Crescent, Littleborough, Lancashire, OL15 8ED

Tel: 0780 8446915 (day) 01706 377508 (evening)

e-mail: graham@wokingprecisionmodels.f9.co.uk

www.wokingprecisionmodels.co.uk

FOR SALE - CLEAN MEW with inserts. No. 1 to 40 ie 33 early issues (7 missing). 40 to 74 ie 14 late issues (20 missing). Also Model Engineering 5 volumes 137-138-143-145-146 ie 230 issues. Offers please will split. Tel Devon 01395 225580.

WANTED

**MEW 80
ME 4161**

CALL TONY AT
THE OFFICE

5" GAUGE 0-4-2 LION

50M SCALE, BLACK ANODISED BULLHEAD TRACK, BUFFERS, CROMAR BOGIES, ALL UNUSED

TEL: 01208 812121

SOCKET SCREWS

Cap. Csk. Button. Set (Grub). Shoulder METRIC. BA. BSF. BSW. UNF. UNC

Hexagonal & Slotted Screws Nuts & Washers.

Dowel & Spring Pins. Dormer HSS Taps & Drills. Draper Tools.

NO MINIMUM ORDER PROMPT SERVICE

Send 4 x 1st class stamps for our latest catalogue (refundable)

Special offer *** Workshop Discount Pack *******

36 packets of socket, hexagonal and slotted screws up to a max. size of 2BA - 5/16" - M8. Various threads / lengths. Catalogue value of pack is over £35.00

Send for this offer and benefit from a very useful stock of screws in your workshop.

You will not be disappointed. Refund guaranteed.

Emkay Screw Supplies (MEW) 74 Pepsys Way

Strood Rochester Kent ME2 3LL

Tel: 01634 717256 www.emkaysupplies.co.uk Mail Order Only

Email: emkaysupplies@onetel.net.uk

BA FASTENERS IN BRASS STEEL & STAINLESS

SPLIT PINS, TAPER PINS,
ROLL PINS, TAPS, DIES, DRILLS,
NUTS WASHERS,
RIVETS, MATERIALS

Send Stamped addressed envelope plus two first class stamps for 28 Page List (Overseas £1.50) Quote MEW.

"ITEMS" MAIL ORDER LTD,

46, ST. MARTINS ROAD, NORTH LEVERTON,
RET FORD NOTTINGHAMSHIRE DN22 0AU
Telephone 01427 884319 Fax 01427 884319

BLACK-IT!

Easy to use Chemical Blacking for Iron and Steel

Produces a professional satin black finish in less than 15 minutes

Standard kit (4 X 500ml) ideal for modelmakers £27.99

Large kit (4 x 2 Litres) £64.99

Black-It! kit for Brass £18.99

All prices include VAT & next day delivery

Pixel-Plus, Bryncreos, Pwllheli, Gwynedd LL53 8EH

Tel/Fax 01758 730356 Access, Visa & Switch accepted

For more details, visit our web site at www.black-it.co.uk

PRECISION MACHINING FOR MODEL ENGINEERS

Trade enquiries welcome. Est. 36 years.

Write G. Plume

137a Erith Road, Bexleyheath,
Kent DA7 6BT

or Tel: 01322 554516 anytime

**METRIC STUDENT 3X4 JAW
LARGE FACE PLATE, CATCH
PLATE, STEADIES
TAPERTURN GAP BED, FULL
RANGE THREAD GEARS, £795**

TEL: 01672 563552 (WILTS)

3D CAD ENGINEERING DRAWINGS

For your project. Email: chris@practicalplastics.co.uk.

Tel: 01452 849051 (Gloucester)

MODEL ENGINEERS' WORKSHOP

LINEAGE/SEMI DISPLAY COUPON(Model Engineer) Advertisement Dept.
Nexus Special Interests, Nexus Media, Azalea Drive, Swanley, Kent, BR8 8HU.
No reimbursements for cancellations.

PLEASE TICK ONE BOX ONLY

☐ WORKSHOP
EQUIPMENT

☐ MODELS &
MATERIALS

☐ BOOKS &
PUBLICATIONS

☐ SERVICES

☐ GENERAL

PRIVATE SALE/TRADE SALE (DELETE NON-APPLICABLE)



ALL ADVERTISEMENTS MUST BE PRE-PAID. NO REIMBURSEMENTS FOR CANCELLATIONS.

I enclose my Cheque/Postal Order* for £forinsertions,
made payable to Nexus Media Ltd.

(*Delete as necessary) or Please debit my Mastercard/Barclaycard No.

Expiry Date

Name

Address

.....Post Code

Daytimes Tel. No

email@

SignatureDate

£ for insertions.

PRICE GUIDE - Tick one box

18 words or less

FREE!! (private sales only)

18-25 words, in colour

only £10

26 words +

in colour £15

Private ad, in box, full colour, endless

word count-

2.5 x 1

£25

3 x 1

£30

3.5 x 1

£35

web: www.gandmtools.co.uk



THE QUICK-STEP MILL



A tool post mounted milling spindle for the centre lathe. Fitted to a quick-change tool holder, it can be at work in seconds eliminating second set-ups in the milling machine, mandrel making etc.

Milling operations are rapidly and accurately carried out while work is still held true in the lathe chuck.

- Weight 9 lbs
- 9 speeds 110 - 4000 rpm
- Reversible motor 110 or 230V a.c.
- Collet chuck for ER20 collets, 1 - 13mm x 1mm
- Quick change from axial to radial and vice-versa
- Vertical slide with 1 1/2" travel, calibrated 0.001", with additional steps at 1/4"
- Centre finders provided for quick setting to centre height
- Headstock dividing by means of division rings and detent
- Suitable for light grinding e.g. turning chuck jaws
- Quadrant plate available to enable the machine to be inclined for helical milling

For full colour brochure contact:

J C Payne Engineering Limited
Polgraines, Faringdon Road, Cumnor, Oxford, OX2 9QY
Tel/Fax 01865 865223

progress through simplicity

PROJECT MACHINERY

A sample of our current stock includes:

LATHES

- Colchester Bantam 1600, 5" x 20", equipped, single axis digital readout.....£800
- Colchester Student MK1, 6 1/2" x 25", gap bed, equipped.....£900
- Colchester Student MK2, 6 1/2" x 25", gap bed, equipped inc. collets.....£950
- Colchester Triumph 2000, 7 1/2" x 50", equipped inc. taper turning.....£275
- Harrison 15A, 5 1/2" x 24", gap bed, equipped inc. taper turning.....£1750
- Harrison 140, 5 1/2" x 24", gap bed, equipped inc. taper turning.....£1275
- Harrison M250 5 1/2" x 30", (long bed) equipped, almost as new condition.....£2950
- Harrison M300 6" x 25", equipped, excellent example.....£2650
- Boxford 'A' 4 1/2" x 22", feeds & gearbox, cabinet stand, equipped.....£700
- Emcomat 8.6, 4" x 24", geared head, cabinet stand, 1 phase, equipped, as new.....£1275

MILLS

- Viceroy AEW vert, 34" x 8" T, power feed, swivel head, superb condition.....£975
- Marlow vertical, 28" x 7" T, swivel 3 Morse taper head, excellent value.....£695
- Bridgeport, 42" x 9" T, vari speed head, power feeds, digital readout.....£1450
- KRV 2000, (Bridgeport copy) vari head, P. feeds, digital readout, mint.....£2500
- Adcock & Shipley 1ES, vert/hori, 30" x 8" T, power feed etc.....£950
- Elliott '00' omnimill vert/hori, 28" x 7 1/2" T, power feed.....£975
- Warco A3P, (small Bridgeport) 36" x 9" T, power feed.....£1500
- Arboga, German mill/drill, geared head, 22" x 10" T, digital dials, outstanding.....£1350

VARIOUS

- Qualters & Smith 6" power hacksaw, choice.....£295
- Eagle hand opp surface grinder, 1 Pl.....£495
- Optical dividing head, superb.....£295
- Meddings MB4 bench drill, 10 speed, as new.....£495
- Jones & Shipman 540 surface grinder c/w coolant & mag chuck.....£950
- Fobco 7/8" industrial pillar drill, excellent example.....£700

All prices + V.A.T. Part exchanges always welcome, other machines available, can deliver nationwide (High Wycombe)

Telephone 01494 481 682 (day & eve)
Mobile 0775 2659904

TRACY TOOLS LTD.

2 MAYOR'S AVENUE, DARTMOUTH, SOUTH DEVON TQ6 9NF

Telephone: (01803) 833134 • Fax: (01803) 834588 Credit Card Hotline: 01803 839500 (minimum £10)

Telephone: (01800) 833134 • Fax: (01800) 834588 Credit Card Hotline: 01800 839500 (minimum £10)			
1.	MODEL ENG TAPS & DIES SET (2 Taps, & Dia each size) 1/4"x40, 1/2"x40, 3/4"x40, 1"x40, 1 1/4"x32, 1 1/2"x32, 1 3/4"x32	(TAPPING DRILL SET £6)	TAPS £10 DIES £18
2.	"SPECIAL" MODEL ENG TAPS & DIES (2 Taps each size) 1/4"x32, 1/2"x40, 3/4"x40, 1"x40, 1 1/4"x32, 1 1/2"x40, 1 3/4"x32, 1 1/2"x40	(TAPPING DRILL SET £8	TAPS £22 DIES £22
3.	BA TAP SET (2 Taps each size), & B A Die Set 0-1-2-3-4-5-6-7-8-9-10 BA	(TAPPING DRILL SET £5	TAPS £10 DIES £20
4.	26 TPI TAP SET (2 Taps each size), 26 TPI Die Set, (BSB or CEI) 1/4"x26, 1/2"x26, 3/4"x26, 1"x26, 1 1/4"x26	TAPPING DRILL SET £5	TAPS £10 DIES £10
5.	BSF TAP SET (2 Taps each size), & BSF Die Set 1/4", 1/2", 3/4", 1", 1 1/4", 1 1/2", 1 3/4", 2" BSF	(TAPPING DRILL SET £5)	TAPS £10 DIES £10
6.	BSW TAP SET (2 Taps each size), & BSW Die Set 1/4", 1/2", 3/4", 1", 1 1/4", 1 1/2", 1 3/4", 2" BSW	(TAPPING DRILL SET £5)	TAPS £10 DIES £20
7.	METRIC COARSE TAP SET (2 Taps each size) & Metric Die Set 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 12.0mm	(TAPPING DRILL SET £8)	TAPS £20 DIES £20
8.	UNF (OR UNC) SET 1/4", 1/2", 3/4", 1", 1 1/4", 1 1/2", 1 3/4", 2" (TAPPING DRILL SET £5)		TAPS £15 / DIES £18
9.	METRIC FINE TAPS 14 Taps from 3.0 to 18mm Taps £20 set/Dies £30		DIGITAL VERNIER 6" imp/mm EACH £25
10.	REAMER SET 1/4", 1/2", 3/4", 1", 1 1/4", 1 1/2", 1 3/4", 2" (Or Metric) £30		TAPER PIN REAMER SET (1/4" to 1/2") 10 sizes SET £30
12.	COLLET CHUCK complete (to take threaded endmills up to 1" dia)	2MT, R8 Shanks 3 MT	SET £70
13.	MORSE TAPER SOCKET REAMERS (HS) No. 1 MT @ £15 No. 2 MT @ £18, No. 3 MT @ £20, No. 4 & 5 MT @ £30		SET £70
14.	Extra Long HS DRILLS (Heavy Duty), 10 sizes from 1/4" to 1/2" £6 set	STUB DRILL SET (12 pcs 1/4" to 1/2")	LOT £5
15.	REAMER SET, No. 1M/Taper Shank 1/4", 1/2", 3/4", 1", 1 1/4", 1 1/2", 1 3/4", 2" (or) 1/4", 1/2", 3/4", 1", 1 1/4", 1 1/2", 1 3/4", 2" HSS EACH £30		
16.	REVOLVING LATHE CENTRES with Thrust Bearings (No. 1 MT @ £15, No. 2 MT @ £18, No. 3 MT @ £18 each		
17.	SLITTING SAWS (set of 3, up to 1/4" wide, 2" or 3" o/dia) £6 set	END MILL SET, 1/4", 1/2", 3/4", 1" (with 1/4" shank)	SET £25
18.	COUNTERBORE SETS, 3, 4, 6, 8mm £30 set	IMPERIAL, 1/4", 1/2", 3/4", 1", 1 1/4", 1 1/2", 1 3/4", 2"	SET £30
19.	DRILL CHUCKS (Rohm Precision) 1/4" @ £6 1/2" @ £7 3/4" @ £8 1" @ £10		(with free Arbor 1 or 2 M/T)
20.	ENDMILL SET (HS) SCREWED 1/4", 1/2", 3/4", 1", 1 1/4", 1 1/2", 1 3/4", 2" (also Slot Drills) (also Metric)		SET £20
21.	BALL-NOSE SLOT DRILL SETS 1/4", 1/2", 3/4", 1" (THREADED) £12	T-SLOT CUTTER SET, 1/4", 1/2", 3/4", 1" (THREADED SHANK)	SET £18
22.	BOXED DRILL SETS (1/4" - 1/2") 1-13mm HSS £16 Set (1-6mm x 0.1mm @ £10) (6-10mm x 0.1mm @ £25)		No. 1-60 A-Z SET £18
23.	INVOLUTE GEAR CUTTERS (DP, CP, MOD) all sizes £10 each		also RENOLDS CHAIN CUTTERS
24.	INDEX RH LATHE TOOL 1/4" sq shank, c/w tip & key £8 each		Spare Tips EACH £2
25.	BOXED SET 0-10 BA TAPS & DIES with holders £40		High Speed Steel SET £80
26.	D-BIT SET (8 sizes) 1/4", 1/2", 3/4", 1", 1 1/4", 1 1/2", 1 3/4", 2" (High Speed) £25		CARBIDE TIPPED TOOLS 1/4" sq. (8 pcs) SET £10

FOR UNTHREADED
TAPS & INSERTS
Call 01803 568565

Also Selection of Dovetail, Woodruff, Ballnose, Concave, Spotbores, Broaches, Knurls, Carbide Centers, Cycle Taps & Dies, Boring Bars, Left Hand Tap & Dies, Milling Cutters, Reamers, Countersinks, Gear Cutters, Slitting Saws, Acme Taps, Diehead Chasers, Socket Reamers. These are available between 50% & 75% off list price. Open: Monday to Friday 8am to 4pm - Sat to Noon Despatch by return. Overseas P&P R.O.A. Send for new complete Catalogue (Stamp Please)

BRITISH
WARRIOR
BRAND



BOXFORD TUD 4 1/2" x 20"	3 jaw chuck, cabinet stand, and feeds.	\$290
BOXFORD CUD 4 1/2" x 20"	change feeds, 3 jaw chuck, cabinet stand	\$750
BOXFORD CUD 5" x 20"	Mill, 4 wheels, 4 way tool post.	As new \$1,250
BOXFORD AUM 4 1/2" x 20"	Mill gear box, power cross feed, 3 jaw chuck, tools	\$1,500
BOXFORD BUD 5" x 20"	Mill, 4 wheels, power cross feed, T-slotted cross slide	\$1,400
BOXFORD 10-20 5" x 20"	geared head, power feeds, very late machine	\$1,900
BOXFORD 1130 5 1/2" x 30"	geared head, gearbox, power feeds, cabinet stand, machine	\$2,400
COLCHESTER CHARTER 5" x 20"	gearbox, variable speed, 3 jaw chuck, face plate, 4 way tool post	\$900
COLCHESTER BANTAM 1600 model, 5" x 20"	geared head, power feeds, gearbox	\$1,400
COLCHESTER BANTAM 2000, 6 1/2" centre height	30", between centres, 1 1/4" bore, 16 speeds, D13 camlock fitting, 3 & 4 jaw chucks in very nice condition	\$3,200
COLCHESTER STUDENT 5 1/2" x 24"	geared head, metric / imperial gearbox, coolant	\$1,600
COLCHESTER STUDENT Square head, 1600 rev/2 speed motor	geared head, gearbox, imperial, power cross feed & gap bed, dual dial, 3 jaw chuck, taper turning, coolant etc	\$2,000
COLCHESTER STUDENT 1800 5 1/2" x 40"	gap bed, 700 rev/2, 3 & 4 jaw chucks, Dickson boring, taper turning, dial indicator, coolant, splash back, very nice, metric dial	\$3,700
COLCHESTER MASTER 6 1/2" x 30"	square geared head, power feeds, gap bed	Nice order \$1,400
COLCHESTER TRUMPH 2000 7 1/2" x 30"	full screwcutting, 3 & 4 jaw chucks, steady, taper turning	

cold coolant. \$4,250
 COLCHESTER TRUMPH 2000 7 1/2" x 60" full screw cutting gearbox and power feeds, gap bed, 3 & 4 Jaw
 chucks, Dickson boring, faceplate etc. now \$4,850
 DENFORD 250 5" x 20", 3 jaw chuck, two way tool post, dual dial. \$500
 HARDINGE capstan lathe. \$895
 HARRISON LE 4 1/2" x 24", fully mtd, complete with clutch. \$950
 HARRISON 140, 5 1/2" x 24", geared head, semi gearbox, 3 jaw chuck, gap bed, power feeds, clutch. \$1,400
 HARRISON 140, 5 1/2" x 24", geared head, gearbox, gap bed, power feeds, boring, coolant. \$1,725
 HARRISON M250, 5" x 30", screw cutting, 3 jaw bed, gearbox, power feeds, chucks. Acute lat GPO on stress slide, feed drive. In very nice condition. \$2,950
 HOBBSYAT 600 2 1/2" x 12" Screw cutting lathe with changeheels and some tools. \$425
 LITTLE JOHN 5" x 24" gearbox, power cross feed, 3 jaw chuck, 4 way tool post, cabinet stand. \$750
 MYFORD M18 3 1/2" x 13", changeheels, 3 jaw chuck, rotating centers and cutting slide. \$725
 MYFORD M17 3 1/2" x 19", changeheels, 3 jaw chuck, we have a large selection of this popular model. \$750
 MYFORD M17B 3 1/2" x 19", gearbox, 3 jaw chuck and tooling. \$1,250
 MYFORD M17 3 1/2" x 21", changeheels, 3 jaw chuck and boring. \$1,125
 MYFORD SUPER 7 3 1/2" x 19", changeheels, 3 jaw chuck and tooling. Choice \$950 - \$1,150
 MYFORD SUPER 7B 3 1/2" x 19", gearbox, 3 jaw chuck and tooling. \$1,250
 MYFORD SUPER 7 3 1/2" x 31", changeheels, 3 jaw chuck and tooling. Choice \$1,400
 MYFORD SUPER 7B 3 1/2" x 31", 3 jaw chuck, power cross feed. Late model Choice
 MYFORD SUPER 7B 3 1/2" x 19", gearbox, Power Cross Feed, cabinet stand, tooling. \$2,750
 MYFORD SUPER 7B 3 1/2" x 31", (long bed) power cross feed, induction hardened bed, industrial stand and doors, gear H machine. \$2,950
 RAGLAN CAPSTAN 30" x 24" 6 Station Turner, out of slide, collet chuck (lever) & collets, bar feed, variable speed, coolant. \$1,400
 SMART AND BROWN lathe, full screw cutting gearbox and power feeds, complete with 3 & 4 jaw chucks, collet set, slides and equipment. In very good condition. \$2,950
 TAYLOR SPINNING Lath 7" x 20", two speed mor. A rare machine in New Order. \$750
 VICEROY TDS 1 GBL 5" x 20", gearbox, power slides, 3 MT tailstock complete with feed ready. \$1,400
 TOO MANY LATHES TO LIST

BOXDOCK AND SHIPLEY 8" Horizontal Vertical Head, 30" x 11" powered table and feed grps, coolant	\$1,525
BOXDOCK VMSD variable speed / 30 IN/Tail head, table 21 1/2" x 6" above and coil chuck	\$1,950
BRIDGEPORT Series 1 : 2 HP Variable speed RS head, powered (gearbox) table, 42" x 9"	\$2,250
BRIDGEPORT Belt head 2 speed (short motor) head, RS powered head, variable speed 42" x 9" table	Very nice \$2,500
CENTEC 28 Horizontal, 1" arbor, table powered, 3 ph motor, single phase main motor	\$735
CENTEC 28 Vertical, 1" arbor, table 28 1/2" head, 25" x 6" table, pedestal stand	\$1,140
ELLIOTT 10" POWERHAM 10" vertical head, 20" x 6" table, 3 ph chuck powered table	\$1,100
ELLIOTT 9" GMINMILL 3 Morse taper quill universal head, 28" x 7 1/2" powered table	Just in \$1,850
ELLIOTT TURRILL M.L. RS-10 speed 70-3000 rpm, table 45" x 10" (powered)	\$1,500
EMCO F82 Vertical 6 speed quill feed head 2 MT, powered 24" x 6" table, full coolant tray and cabinet stand	\$2,950
3 phase and does not like a converter so only	Now \$2,950
HARRISON H horizontal, 31" x 6" powered table	\$525
HARRISON H/HV 30 IN/1" arbor head & clutch, 30" x 6" table/powered	\$1,950
HARRISON H/HV 30 IN/1" arbor head & clutch, 30" x 6" table/powered	\$1,950
HOBBS THAT HEAD ONLY 10" x 10" vertical table, 20" x 6" table, 3 ph chuck	\$425
RAGLAN VERTICAL MILL 2 Morse taper 2 speed motor, variable selector 175-2200 rpm, cabinet stand	\$950
SIP RF30, milling/drilling machine complete with accessories	New \$950
TOM SENIOR M1 horizontal, 25" x 6" powered table, 1" arbor	\$575
TOM SENIOR M1 V/R, 25" x 6", 2 motor taper 1" arbor	\$1,450
TOM SENIOR S1 TYPE 2 motor taper quill feed motorized head, 28" x 6 1/2" table / r/w and lat, coolants	Selection \$1,200 - \$1,450
TOM SENIOR S1T MAJOR, 2 motor taper quill feed head, powered 37" x 6 1/2" table in externally	\$2,950
see addendum	
VECO 40" vertical turret mill, 40 IN/1" arbor, 10" table, power all ways	\$3,000
VECO 40" vertical turret mill, 40 IN/1" arbor, 10" table, power all ways	Please ring to view \$2,950
VECO 40" vertical turret mill, 40 IN/1" arbor, 10" table, power all ways	Very nice \$2,950

ASTRUM CR 25 / 25° Radial Drill speeds (R) 100-2500 RPM	Just in \$1,425
INTEGRAL 14-64 001 M60 (5mm) Radial Drill	Immediate saving in \$3,590
FOGCO 1/2" Bench, tilting table	\$325
FOGCO 1/2" Pedestal drill tilting table	\$345
MEDONGS 1/2" pedestal drill	\$245
MEDONGS 2" Morse taper pedestal drills	Choice \$275
MEDONGS MP2 10 Speed 2MT Bench 240 volts drill	\$350
MEDONGS MP5 10 speed 2MT pedestal drill, table rack	\$575
POLLARD-CORONA Pedestal 1/2" Morse	From \$100
SP HDP 600 1/2" 2MT Bench drill, table operated by rack, speeds, (16) 10E - 3000 rpm	New \$175
STAR TRIT 1/2" 1/2" speed bench drill	\$225
STAR TRIT MERCURY 1/2" pedestal drill, 240 volts	As New \$200
WABCO 3MT Bench 9 speed drill, speeds, 150-2500rpm, table operated by rack	\$340

CLARKSON MKI Tool and cutter grinder	as is	\$400
JONES AND SHIPMAN 5610 Surface Grinder	Ex Collage/Seen no work	\$1800
MILFORD 12" Pedestal Grinder		\$236
J.R.H. Buffer Machine, pedestal model	Buffalo	\$205
VICEROY Grinder, pedestal model		\$145
VICEROY Buffers, pedestal models		Each \$25

OXFORD ARC welders	Choice
DUNMORE toolpost grinder / Bonford size or similar	£325
CARL ZEISS p3 projection dividing head	In excellent condition £625
BCA 12" horizontal / vertical rotary table	Very Nice £125

Milori and Masellious measuring tools	Just in
FLAMEFAST DS 100 ceramic chip forge	£24
FLAMEFAST DS 100 hearth	£54
Bridgeport slotting head	£75
MARLCO broaching press	£42
KEMPMAT 230 tig welder	£42
TRANSARC 150 + Transig 150H	£42
STARTRITE 18-y-10 vertical bandsaw complete with welder attachment	£165
JONES AND SHIPMAN 4" x 24" bench centres	£45
TOM SENIOR turning head	£25
STARTRITE 18-y-5 Woodworking / 400 1/2 inch bandsaw	£24
DIAMOND fret saw variable speed	£34
RUIH BT 125 Fawass, variable speed	£24
SMART AND BROWN / CLARKSON H3-H6 toggle presses	Each £195 / £27
ARRAND 2MT long milling spindle	As new £7
MYFORD TRI-LEVER Attachment	£24
VERDICT Clocks, Long/ShortMetric and Imperial models	As new £4
FLAMEFAST LD300 Soldering Iron Stand	£7
GRANITE 18" x 12" Surface Plate	£54
VIBROSHEAR Hobler	Just in
TRIUMPH Burnard 4 Jaw Chuck	£24
TRIUMPH FACE PLATE DM	£7
VANGU LUBRIE	Very Nice £24
ESSEXWAY hardness Tester Type R	£45
JONES AND SHIPMAN Broaching Press + Stand	£37
CLARKSON M6 i Radius Grinder Attachment	£42
ABB Inverter 5 1/2 hp motor, wired up	£25
FLAMEFAST moulding bench	£24

7" x 7" band saw, horizontal coolant	New 1375
WELLSAW Hack Saw	Choice £240 / £24
BRIDGEPORT CHEERIT high speed drilling head	£75
MTFORD diving head	£39
STARTRITE 3/16" cut-off saw	£75
DUPLEX d29 toolpost grinder	£34
EDWARDS cast iron set of six	£35
BOXFORD (imperial only) thread dial indicator	85
HOFFMAN ROTARY TABLES	Selection
ASWOOD 6" swivel machine vice	Under £24
BURNERD, D13 6 jaw grip chuck	£24
VANCO, 1" knurled / vertical + extractor	149
BURNERD, D14 laser collet chuck + collets	149
BURNERD, LD laser collet chuck + collets	149
VERTX Diving head	New £24
VERTX 6" - 8" - 10" rotary tables	New From £13
BOXFORD Turret attachment 4 1/2" + quantity of drill chucks	150
MTFORD M2 / Super 7 rear tool post	54
MTFORD D245 rear tool post	New 54
MTFORD Vertical slide / fixed type (copy)	89
OLIVER - ADRIAN FILER	Now 84
LOCKWOOD quad headed 2int Dr Holder	New 84
LOCKWOOD quad headed 3int Dr Holder	New 84
LOCKWOOD Test Bar / 2mm Bored	New 83
LOCKWOOD Test Bar / 3mm Bored	New 84
MAGNETIC chuck - 16" x 6" fine pole	Never used £25
TOM SENIOR Model E pedestal stand	£15
UNION tool and cutter grinder stand	£13
HARDINGE Capstan type toolpost	£17
50 INT Tooling, Selection	Just in
STARTRITE 232 woodworking band saw	£97
STARTRITE 14-3-5 woodworking band saw	£77
ALCOA OF OROFI Rapid Milling Furnace	£20
GABRI 8" 600-2, 24" Bore and Pan general use folder	£20
MTFORD Burnard / Gripp 3 Jaw Chucks	Bored £25
COLCHESTER HARRISON D15 Burnard 4 Jaw 8" light body independent chucks	Bored £17
RJH 4" Linisher / Vertical (Build in Extraction)	£62
KILNS variator	£200/420
MICROMETERS and associated measuring tools	Still packaged as new
POTTERY WHEELS, kilns and associated equipment	Just in China
SPECAC Powder type press	£25
HARRISON LG Metric Gearbox	As is £25
HARRISON LG Tailstock	£24
NEW FROM NEW ZEALAND - Machine vice, 55mm. Jaws precision miniature type ideal for vertical slides and smaller milling machines	£6
3P 1 TON MOBISLECRANE, Manufactured 2000	As new £27
MITUTOYO grade A set of slips	£24
MARLCO KNURLERS (clamp type)	£7
F/L EDWARDS 24" hole cutter	£5
Large bench vice	£67
LINKS 5 ton vehicle crane + top hat	£65
MITUTOYO 103-912 metric set micrometers	£27
NORTON / EDWARDS arbor press	£75 / 54
AJAX 6" hack saw	£42
SURFACE plates from 12" x 12" to 36" x 36"	Very nice from £3
WEBER 1 1/2 ton mobile garage crane, late blue colour	£69
ELLIOT 1250 STURDMILL vertical head	One off (rare) £52
RJH knurled 4" wide belt pedestal	£24
STEEL STOCK Just arrived	to call on
ELLIOT U1 / U2 Sliding Head	£47
SWAGE BLOCKS	£125 / £34
J & S Universal grinding vice	Choice £275 / £32
BOX TABLES - Grade A and II, many sizes	£40 - £15
SLIPS / GAUGES Metric / Imperial, New Sets; 67 / 61 piece	£125 / £14
HORIZONTAL METAL BANDSAW 6" x 4 1/2" capacity	New £17
COLCHESTER STUDENT / MASTER Round head, faceplate, small / large	£50 / £8
QUALTERS AND SMITH 6" Hack Saw	£24
Boring Heads 2 / 3 Morse, R8 Taper, Max. Capacity 4 1/2" round bar	New, as new
ODONI Machine Bed Clamps (pair)	Special £24 5
HEIGHT GAUGES by Chessman, Shardow, Moore and Wright	From £9
ELLIOT 10M Shaper, 10" stroke	£20
DE Brosses	From 64
TRIANGWAVE 3HP Converter	New £25
TRIANGWAVE 5.5HP Converter	New £30
TRIANGWAVE 12K, RT rotary converter	From £40
CROMPTON PARKINSON 1/4 HP, resilient mount, floodcut / Myford Super 7 Type motor	New £1

PLEASE PHONE 020 8300 9070 TO CHECK AVAILABILITY OR TO OBTAIN OUR LIST
DISTANCE NO PROBLEM!!! DEFINITELY WORTH A VISIT ALL PRICES EXCLUSIVE OF V.A.T.

SEE US AT
SANDOWN
29-31 DECEMBER
Stand B1

fully loaded



Buy the latest **Chester Machines** fitted with a **Newall Digipac DRO** or **Digital Readout 2 Axis System**, complete with the machine at the service & guarantee package and the reputation of **Newall & Chester** name and get it all for the great new price of.

£615
inc vat

Digipac DRO

- Display in 2 axes
- Selectable resolution for each axis
- Absolute/Incremental operation
- Zero re-set/Data pre-set
- Linear error compensation
- Inch/Metric conversion
- Digifind*/Reference
- Datahold
- Centre Find
- Continuous Data Memory
- Radius/Diameter
- 5 Year Warranty

Microsyn 10 Encoders

- Switchable resolutions of 5, 10, 20 and 50 µm per metre
- Maintenance Free – Fit and Forget
- Completely Sealed (IP67 Rating) – impervious to workshop contaminants including dust, dirt, oil, coolant, swarf
- 5 year Reader Head warranty, and a lifetime Scale warranty



CHESTER UK LTD
Clwyd Close

Hawarden Ind. Estate, Hawarden
Nr. Chester, Flintshire CH5 3PZ



£615
Including VAT
& UK Delivery

DIGIMATE DRO SYSTEM

BENEFITS: HEAD UNITS

- Very solid counter with easy to read green LED display
- Models available for Lathes and Milling Machines
- 2 & 3 – Axis systems available
- Auxiliary display for direct information on all settings
- Resolution 0.005mm

BENEFITS: SCALES

- Standard scale units with high accuracy

- Scale reference points at 50mm pitch to determine datum point
- Most models available for Lathes and Milling Machines
- Enhanced vibration resistance
- Top quality rubber lips to avoid contamination
- Reading head with robust 5-sided bearing slide way
- Armoured signal cable (3m standard length)



£725
Including VAT
& UK Delivery

MODEL B-SUPER

- Swing over bed: 420mm
- Distance between centres: 500mm
- Mill drill spindle taper: MT3
- Tailstock barrel travel: 80mm
- 7 speeds – 60 - 1300 RPM
- Swing over slide: 160mm
- Spindle taper: MT3
- Draw bar: M12
- Cross slide travel: 180mm
- Motor: 3/4 HP
- Net weight: 155kg

STANDARD EQUIPMENT

- 4" 3 jaw chuck
- 2 dead centres
- 1/2 drill chuck
- Change gears
- MT3 chuck arbor



£850
Including VAT
& UK Delivery

DB8 Precision Belt Lathe

- Centre height: 105mm
- Maximum swing: 210mm
- Distance between centres: 435mm
- Spindle bore: 20mm
- Spindle taper: MT3
- Spindle speeds – 125 - 2000 RPM
- Range of metric threads: 0.4-3mm
- Range of imperial threads: 10-44 tpi
- Tailstock taper: MT2
- Topslide travel: 75mm
- Crossslide travel: 110mm
- Tailstock travel: 70mm
- Motor: 3/4 HP
- Weight: 125kg

STANDARD ACCESSORIES

- 3 Jaw chuck
- 4-Way toolpost
- Lathe tools
- MT3 and MT2 steel centres
- Hardened and ground bedways
- Vee bedway
- 4 Jaw chuck
- Steady rest
- Follow rest
- Tray and splashguard



£1155
Including VAT
& UK Delivery

COMET LATHE

- Swing over bed: 250mm
- Swing over cross slide: 133mm
- Distance between centres: 550mm
- Spindle bore: 19mm
- Taper in spindle nose: MT3
- Motor: 1/2 HP
- 6 speeds – 125 - 2000 RPM
- Speed range variable: 100-2500 RPM
- Net weight: 130kg

MILL ATTACHMENT

- Spindle taper MT3
- Head travel: 215mm
- Speed variable
- Range: 0-3,000 RPM
- Motor: 1/2 HP
- Net weight: 45kg

Call today for our latest
Tool Catalogue
01244 - 531631

Visit our website
for more information
www.chesteruk.net

Email us at
Sales@chesteruk.net