MODEL ENGINEER

Vol. 192 No. 4214

6 - 19 February 2004 £2.40

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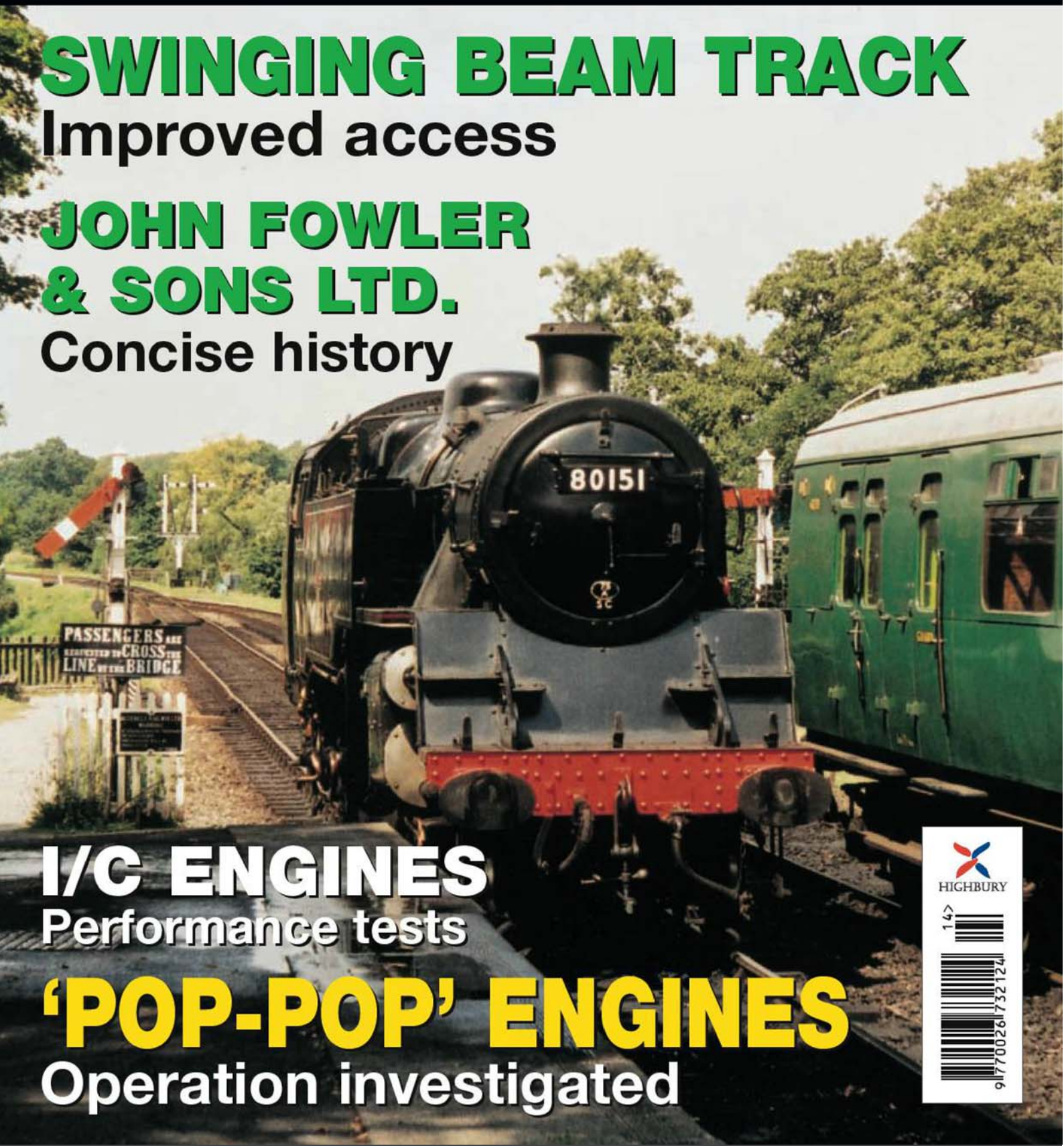

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OPTIONAL FLOOR STAND £99

SPECIFICATION:
- CENTRE HEIGHT 4"
- DISTANCE BETWEEN CENTRES 14"
- SWING OVER CROSS SLIDE 5"
- SPINDLE BORE 3/4" CLEARANCE
- SPINDLE SPEEDS (6) 140/1710 RPM
- HEADSTOCK TAPER 3MT
- TAILSTOCK TAPER 2MT
- RANGE OF IMPERIAL THREADS 8-24 TPI RANGE OF METRIC THREADS 0.4MM – 3MM
- MOTOR 1/2 HP 1 PHASE
- DIMENSIONS 38" LONG x 19"WIDE x 15" HEIGHT
- WEIGHT 230 LBS

ZX-15 MILLING MACHINE

Ideally matched to the BV-20 Lathe

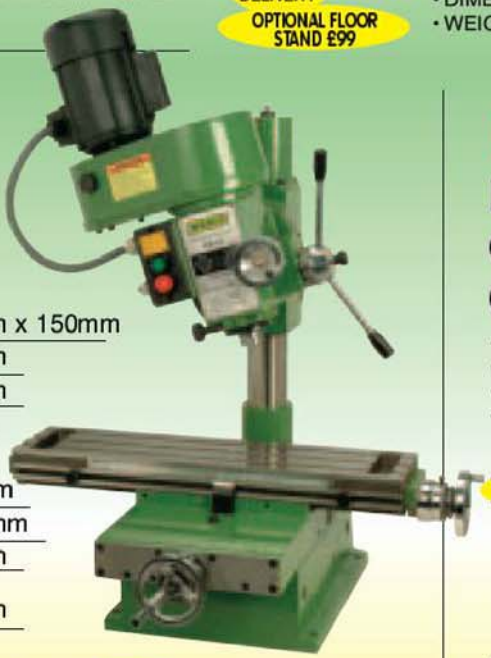

Table size	654mm x 150mm
Longitudinal travel	455mm
Cross Travel	145mm
Spindle Stroke	90mm
Spindle Taper	3MT
Diameter of Spindle	63.5mm
Diameter of Column	66.65mm
Throat	165mm
Max distance spindle to table	320mm
Height with head at top of column	1067mm
Width	775mm
Depth	559mm
Spindle speeds	400-1640
Motor	1 phase 1/2hp with F/R switch
Weight	295lb
Head tilting	90-0-90 worm gear tilt mechanism

General dimensions may be subject to minor variations.

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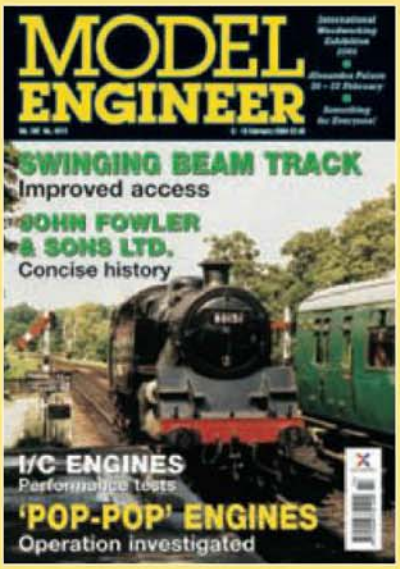

On the cover ...

British Railways Standard Class 4 2-6-4T locomotive No. 80151 runs its train at Sheffield Park on the Bluebell Railway in Sussex. Operating a mid-week service, the engine was used on the line in B.R. days. Built at Brighton Works in 1956, 80151 was acquired from Woodhams Bros. Barry Yard and restored in the Bluebell Railway locomotive works at Sheffield Park.
The Bluebell Railway is located in Sussex and operates steam train services between Sheffield Park, Horsted Keynes and Kingscote. In addition to the above locomotive the line uses two Brighton Terriers and three SECR 'P' Class tanks. Trains operate daily May to September and weekends throughout the year. Further details can be found on the Bluebell Railway website: ***www.bluebellrailway.co.uk*** *or telephone: 01825-722370/720800.*

(Photograph by Gerry F. Collins)

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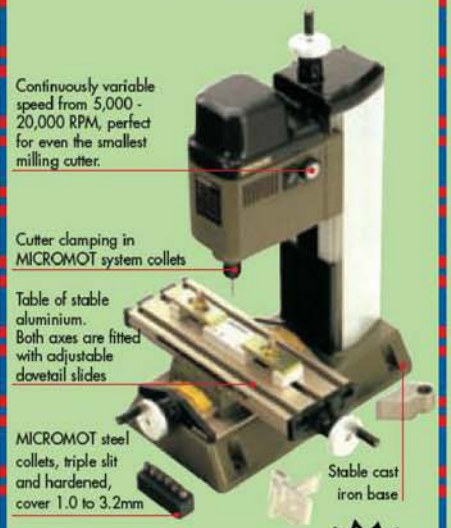

TECHNICAL DATA:
220 - 240 V, 100 W, 50/60 Hz. spindle speeds 5.000 - 20.000 rpm. Table size 200 x 70 mm. Travel is 134 mm (x axis), 46 mm on the y axis, Z (height) 70 mm. Machine base 130 x 225 mm. Total height 340 mm. hardened steel collets cover 1.0, 1.5, 2.0, 2.35 , 3.0 and 3.2 mm.Zero-adjustable hand wheels are calibrated to provide 1,0mm per revolution, one division equals = 0,05 mm.

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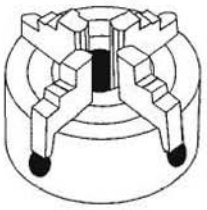

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Boxford 125TCL Computer Op Bench Lathe,QCTP,Manual,1ph £1000.00
Lorch AVIK Lathe,Collets,Comp Slide,Paint stripped off Cabinet for repaint,cheap machine for restoration £ 350.00
Boxford CUD 4 _" x 18" Lathe, Jaw & Toolpost £ 500.00
Boxford CUD 4 _" x 18" Lathe,Tooled,1ph £ 950.00
Myford ML7 3.1/2"X19" Lathe,Industrial Cabinet, Tooling,3ph £1000.00
Myford Super 7,3.1/2"x19",Cabinet mounted lathe,S/C Gearbox,chucks etc £1500.00
Myford Super 7,Bench Lathe,Tooling £1000.00
Myford Super 7,3.1/2"x19" Lathe,Cabinet,Tooling,1ph £1000.00
Myford Super 7 Lathe & Tooling £1250.00
Myford ML7R 3 _" x 19", Bench Lathe,1ph £1250.00
Myford ML7 Bench Lathe £ 400.00
Myford Mystro Wood Lathe,VGC,3ph £ 250.00
Colchester Triumph 2000 Gap bed 7 _" x 50",Tooling,3ph £2750.00
Colchester Student RH,Gap Bed,3 & 4 Jaw, Travelling Steady,Coolant,Collet Chuck,3ph QCTP,Well Looked After,VGC £1500.00
Colchester Bantam 2000, 61/2" x 30", Tooled,3ph £3250.00
Colchester Bantam 1800 5" x 20", Tooled, Coolant, QCTP, 3ph £1450.00
Colchester Bantam 800 5" x 20", Well Tooled,3ph, Lovely Condition £1650.00
Colchester Bantam 800 5" x 20", Basic Gearbox,3 Jaw,Toolpost,Drill Chuck,3ph £ 750.00
Colchester Student RH, 6" x 25", Tooled,3ph £ 950.00
Colchester Master 2500 6 _" x 40", Tooled,3ph £2750.00
Colchester Master 2500 6 _" x 40" Gap Bed, 3 & 4 Jaw,QCTP,FP,3ph £3250.00
Harrison M250 Centre Lathe,5" x 20",Tooled,Light,Coolant, 3000RPM,3ph £1400.00
Harrison M250 5"x20" Lathe & Tooling £2500.00
Harrison M300 6" x 40" Centre Lathe,Tooling,3ph £1500.00
Harrison M300 6" x 25" Centre Lathe,Tooling,3ph £2250.00
Harrison M300 6" x 40" Gap bed Lathe,Copying Att, Tooling,3ph £2750.00
Harrison 140 5 _" x 25" Gap Bed lathe,Tooled,3ph Choice of 3 £1450.00
Harrison 150 5 1/2" x 25" Gap Bed lathe,Taper Turning,Tooled,Variable Speed,1ph £1450.00
Harrison 150 11"x25" Gap Bed Lathe,Tooled £ 850.00
Harrison L5 9" x 25" Lathe,Tooled,Coolant, Manual,3ph £ 750.00
Britan Repetition Lathe,Collets,Bar Feed,3ph £ 500.00
Taylor Capstan Lathe,Cut off Slide, 3ph, 2HP £ 750.00

DRILLING MACHINES

Startrite Mercury MkII Pillar Drill,1ph £ 250.00
Fobco Star Pillar Drill,1ph £ 225.00
Cincinatti Milacron 2 MT Bench Drill,3ph £ 175.00
Aciera Bench Tapping Machine (small) 3ph £ 200.00
David Dowling Model C Bench Tapping Machine,3ph £ 275.00
Meddings Articulated Arm Radial Drill £ 750.00
Essex Bench Tapper,1/4" chuck,1ph £ 250.00
Oldack Tapping Machine,3ph £ 175.00
Pollard 9FX High Speed Bench Drill,3ph £ 200.00
Pollard 3 Spindle Drill (Bench top) £ 250.00
Thoka Arbo No.2 6 Station Turret Drill Head,3MT £ 175.00
Spares available for Fobco Drills £ POA
H & G 23N Bench Tapping Machine,Fitted 1/64" -" Drill Chuck,3ph £ 250.00
Clearance of Meddings,Startrite,Progress,Tauco, Fobco & Union Pillar & Bench Drills, choice of 25 all 3 phase From £35.00

MILLING MACHINES

Deckel FP3 Vertical/Horizontal Mill,DRO,Light,Collets,Chuck,Clamp Kit,3ph £3750.00
KRV 3000 Turret Mill,Variable Speed, Power Long,DRO,40INT Spindle,Vice,Collet Chuck,Light,Coolant,Excellent Condition,48" x 12" Table,5HP,3ph £3250.00
Bridgeport Turret Mill. Power Both Ways, DRO,Coolant, 3ph,Low Line Motor £1850.00
Thiel Toolroom Mill,Vertical Head Only,Fixed Table,Vice,Light,Coolant,3ph £ 750.00
Ajax Turret Mill,PF,Coolant,Light,3HP,40 INT Spindle, Imperial,3ph £1650.00
Hobbymat BFE 65 Milling Head,1 MT, 4 Cutter Holders, 1ph £ 385.00
BCA Jig Borer/Mini Mill,Stand,Collets,3ph,GC £1250.00
BCA Jig Borer/MiniMill,Stand,4 Collets,keyless Drill Chuck,Vice,1ph £1250.00
Boxford VM30 Vertical Mill,Variable Speed,30 INT,Vice, Collet Chuck £1500.00
Elliott OO Onnimill,Vertical/Horizontal,3ph £1750.00
Schaublin 12 Vertical/Horizontal Milling Machine,3ph £1250.00
Tom Senior M1 Vertical/Horizontal Milling Machine, 3ph,VGC £1450.00
Christen S101 Sixis Vertical Mill,Choice,3ph From £1500 - £4500.00
SIP Mill/Drill,NEW,3MT,1ph, £ 799.00
Astra Horizontal Mill,425mmx120mm table,3ph £ 450.00
Lambert No 0, Type 66 Gear Hobbing Machine £ 650.00
Wahli 96 Gear/Pinion Hobber £1000.00
Mikron 79 Gear Hobber £ 650.00
Strausak Gear Hob Sharpener £ 350.00
Gravograph Model ITM, Well Equipped, 1ph, Excellent Condition £1250.00
Alexander 2B 4 Spindle Engraver,3ph £1250.00
Hauser 3BA Jig Borer,3ph £2000.00
Tom Senior Vertical Milling Head,2MT £ 500.00
Tom Senior Slotting Head £ 475.00
Adcock & Shipley TES Vertical/Horizontal Mill,Coolant,Power Feed,Chuck,3ph £1250.00

POWER HACKSAWS/BANDSAWS ETC

Ajax Small Power Hacksaw,3ph £ 225.00
Perris 350 Circular Cut Off Saw,3ph £ 650.00
Qualters and Smith Power Hacksaw,3ph, £ 250.00
Qualters and Smith Power Hacksaw,1ph £ 375.00
Startrite 20RWF Bandsaw,VGC,fitted welder £1450.00
Startrite 18-T-10 Bandsaw,3ph £ 500.00
J. Midhage HS804 Precision Circular Saw (150mm blades),3ph £ 250.00

GRINDERS, LINISHERS, POLISHERS

Deckel SO Engraver Cutter Grinder,Bench Mounting,Collets,3ph,VGC £1250.00
Turner 6" Width X 16" Heavy Duty Belt Linisher, Spare Belts,3ph £ 500.00
Dormer Model 108 Drill Grinder,Bench Mounting, 1/8" – 1/4" Cap.,3ph £ 475.00
Taylor Hobson Model G Engraver Cutter Grinder,1ph £ 450.00
Vanco 1" Bench Vertical Belt Linisher,1ph,240 volt £ 200.00
Hauser Jig Grinder, Well equipped,3ph £3750.00
Clarkson Mk 1 Tool & Cutter Grinder,3ph, No Tooling £ 250.00
Eagle Hand Op Surface Grinder,Mag Chuck,3ph £ 600.00
Jones and Shipman 540 Surface Grinder,Mag Chuck,3ph £1650.00
Jones & Shipman 540 Surface Grinder,No Chuck,3ph £ 850.00
RJH Trim Tool Grinder,3ph £ 200.00
Elliott 8" Pedestal Grinder,3ph £ 75.00
Duplex Toolpost Linisher,3ph £ 125.00
Erzell Rotary Filing Machine,3ph £ 250.00
Canning 2HP Polishing Spindle,3ph £ 350.00
Samand D.E. Tool Grinder/Lapper,Coolant,Light,3ph £ 125.00

SHAPERS

Ajax M8 Toolroon Slotting Machine,3ph,VGC £1800.00
New Wonder Bench Top Die Filer,1ph £ 175.00

BOXFORD SPARES AND TOOLING

Change Gears (Also Fit Southbends) 16T-E10,18T-E11,20T-E11,21T-E11,22t-E11,23T-E11, 24T-E11,26T-E11,27T-E11,28T-E11, 30T-E12,31T-E12,32T-E12, 35T-E12,36T-E12,37T-E12,38T-E14,40T-E14,41T-E14,42T-E14 44T-E14,45T-E14,46T-E14,48T-E14,50T-E15,52T-E15,53T-E15, 54T-E15,56T-E15,59T-E15, 60T-E15,64T-E15,71T-E18,75T-E18, 79T-E18,80T-E20,88T-E22,100T-E25,127T-E30
100/127T Compound Gear £ 55.00
127T/135T Compound Gear £ 95.00
54T/18T Compound Gear £ 30.00
72T/18T Compound Gear £ 35.00
32T Tumbler Reverse Gear £ 12.00
Boxford Manual "Know Your Lathe"New Copies & Drawings & Parts List £ 25.00
Boxford 4" Chuck Backplate,NEW £ 20.00
Boxford 8" Faceplate,NEW £ 45.00
Boxford 5" Catchplate £ 15.00
Pratt Burned 4" 4 Jaw Chuck £ 75.00
Boxford 6" 4 Jaw Chuck,VGC,With Fitted Boxford Backplate £ 100.00
Toolmex 6" 4 Jaw Ind. Chuck fitted Boxford Backplate, NEW £ 155.00
Boxford Lathe Cabinets,Cupboard,Coolant Tank,Tray,Ideal for many small lathes £ 100.00
Headstock Saddle & Apron parts available £ POA
4.1/2" or 5" Tailstock £ 125.00
Boxford Change Gear Cover £ 40.00
Boxford Change Gear Quadrant £ 15.00
Boxford Topslide Assembly £ 45.00
Boxford Vertical Slide,Complete with T Slotted Plate & Vice,Choice of 2 £ 575.00

MYFORD SPARES AND TOOLING

Change Gears: 20TE8.00,21TE8.50,22TE8.75,24TE7.00,25TE7.50,26TE7.50,27TE7.50, 28TE8.00, 29TE8.00,30TE8.00,31TE8.50,32TE8.50,33TE850.00, 34TE8.75, 35TE9.00,36TE9.00, 37TE9.50,38TE9.50,39TE9.50,40TE9.50, 42TE9.75,43TE10.00,44TE10.00,45TE10.5046TE11.00,47TE11.00, 48TE11.00,50TE13.50,51TE13.50,53TE14.50,54TE14.50,55TE14.75 56TE15.00,57TE15.00,58TE15.00,59TE15.50,60TE15.50,61TE16.50, 62TE16.50,63TE17.00 64TE17.00,65TE18.00,66TE18.50,70TE18.50, 75TE19.50,80TE21.50,81TE21.50,85TE24.00, 90TE24.00,91TE25.00, 95TE26.00,100TE27.00,127TE35.00
Metric Conversion Set,Comprises Quadrant,Gears,Spacers and Studs,NEW £ 185.00
Myford 3 Point Steady,New £ 105.00
Myford 2 Point Steady,New £ 45.00
Myford Taper Turning Att, £ 225.00
Myford Screw Op Cut Off Slide, 2 Toolposts £ 225.00
Myford ML7 Long Cross Slide £ 105.00
Myford Super 7 Manual,Inc,Gearbox Info £ 22.00
Toolmex 100mm 3 Jaw,Myford Mount,New £ 125.00
Toolmex 160mm 4 Jaw Ind Chuck, Myford Direct Mount,NEW £ 145.00
Myford 7" Faceplate £ 30.00
Myford 9" Faceplate,NEW £ 40.00
Myford 4.1/2" Catchplate £ 15.00
Myford 4" Backplate £ 18.00
Myford MA73 V Block £ 12.00
Myford Cross Slide Mounted Turret Attachment,VGC £ 225.00
Myford Super 7 Screwcutting Gearbox £ 575.00
Myford Super 7 Tailstock £ 175.00
Myford ML7 Saddle/Apron & Part Topslide Assy £ 175.00
Myford Super 7 Cabinet Stand with Cupboard, Rusty Bottom Edge,Long Bed £ 200.00
Myford Super 7 Saddle, Apron & Cross Slide £ 250.00
Myford ML10 Tailstock £ 100.00
Myford MA74 Vee Blocks £ 15.00

MACHINE ACCESSORIES

Bilz Type 4-1211 Radius Turning Attachment £ 450.00
12"x6" Swivelling Table,T-slotted £ 150.00
Walter R-S 400TG (400mm)Swivel & Tilt Rotary Dividing Table £ 850.00
Coventry Gauges 8" Inclinable Rotary Table,Inspection Quality,VGC £ 350.00
Hofmann 300mm Rotary Table £ 300.00
Alexander Inclinable Rotary Table fitted 4" Chuck £ 250.00
Taylor Hobson 12" Rotary Table £ 350.00
SIP 350mm Rotary Table,Choice of 3 £ 500.00
Hofmann 8" Rotary Table,VGC £ 350.00
Vertex Horizontal/Vertical 6" Rotary Table,(New) £ 135.00
Vertex Horizontal/Vertical 8" Rotary Table (New) £ 250.00
Vertex Horizontal/Vertical 10" Rotary Table (New) £ 300.00
Vertex Horizontal/Vertical 12" Rotary Table (New) £ 350.00
15" Rotary Dividing Table,Table Marked £ 250.00
12" x 9" T-Slotted Swivel & Tilt Plate £ 150.00
Jones and Shipman 4" Sine Vice,immaculate £ 500.00
Gressel Swivel 4" High Precision Machine Vice,4" Opening,Immaculate £ 325.00
Habit Sine Table 10"x15" £ 125.00
Abwood 6" Swivel & Tilt Machine Vice £ 350.00
Abwood 8" Swivel Machine Vice £ 275.00
Abwood 6" Machine Vice £ 150.00
Apex 4" Universal Vice (as new) £ 150.00
SIP Boring Head (L Type) 3-2mm, 4MT £ 75.00
Tom Senior 3 _" Dividing Head & Tailstock, 3 Jaw Chuck,2 Div Plates,GC £ 350.00
Elliott 4" Dividing Head & Tailstock,2 Division Plates, Immaculate £ 325.00
Victoria Universal 4 _" Dividing Head & Tailstock, 3 Jaw Chuck £ 325.00
Toolmex 7-298-160 Indexing Unit £ 325.00
Marlco H/V Indexer Fitted 5" Griptru Chuck £ 350.00
5" Centre Height Dividing Head, No Chuck £ 250.00
4" Centre Height Dividing Head with Chuck & Gears (no tailstock) £ 350.00
BS0 Dividing Head £ 250.00
Burnerd Multisize Collet Chuck & 12 Collets Key op.DI4 Mount £ 350.00
Clarkson 30INT Autolock Chuck (small) with 4 collets £ 85.00
Clarkson 40INT Autolock Chuck (large) with 2 collets £ 100.00
Clarkson 40INT Autolock Chuck (small) with 4 collets £ 80.00
Clarkson 40INT Dedicated 200 Chuck £ 50.00
Clarkson 40INT FC3 Holder £ 25.00
Clarkson Large/Small Adaptor and 4 collets £ 100.00
Clarkson 50INT Autolock Chuck (lge) 2 Imp. collets £ 100.00
Clarkson 50INT Autolock Chuck (small) 4 Imp. Collets £ 85.00
Clarkson 50INT Dedlock 200 Chuck £ 85.00
Clarkson 50INT FC3 Holder £ 45.00
Clarkson Autolock Chuck Collets..... Large.....each £ 15.00
Clarkson Autolock Chuck Collets,Small, Imp £15.00 Metric £ 20.00
30INT-2MT Adaptor £ 35.00
40INT-1 & 2MT,3MT & 4MT Adaptors each £ 25.00
50INT-2,3,4MT Adaptor each £ 30.00
R8-2MT and R8-3MT Adaptors £20.00 - £ 22.00
Precise 63 piece Spacing Collar Set,1" Bore £ 125.00
Bristol Erickson No 10 Tenthset Boring Head £ 100.00
GMT 40INT Boring & Facing Head,Boxed £ 325.00
Elliott Model B Boring Head,3MT Shank £ 100.00
D'andrea TS3 40INT Boring & Facing Head (not boxed) £ 550.00
D'andrea TS3 50INT Boring & Facing Head ,Boxed £ 950.00
D'andrea TS4 Boring & Facing Head 5MT (Boxed) £ 750.00
Narex VHU 2.1/8 Boring & Facing Head £ 850.00
Archer No 1 Reversible Tapping Head,1 MT Shank £ 100.00
Chatwin Polygon Box,1" Shank £ 150.00
Qty. Turret Tooling various types and shank sizes available £ POA
Coventry CHS 1/2" Die Head £ 100.00
Coventry CHS 3/8" Die Head £ 100.00
Coventry 5/16" Type DX Die Head £ 150.00
Herbert 2D DX Die Head £ 200.00
Coventry BDX Die Head,3/4" Shank £ 150.00
Coventry Type CHS 2" Die Head,VGC £ 250.00
Coventry Type CH 1/2" Die Head £ 75.00
Coventry Type CH 1" Die Head £ 75.00
Coventry Type CH 1.1/2" Die Head £ 100.00
Coventry Type CHS 1.1/2" Die Head £ 150.00
Coventry Type CHS 3/4" Die Head £ 100.00
Coventry Type CH 1.1/4" Die Head £ 125.00
Ward 1" Shank Roller Box £ 50.00
Fette F3 Thread Rolling Head with 4 sets Metric Dies £ 400.00
Fette F3 Thread Rolling Head with 3 sets Metric Dies £ 300.00
3/4 Ward 2A Collets,VGC £ 175.00
Herbert Chaser Grinding Attachment,1.1/2" Diehead Chasers £ 150.00
Herbert Chaser Grinding Attachment, 1" Diehead Chasers £ 100.00
Herbert 2D Bar Feed Unit £ 150.00
Archer No 1 Tapping Head,1MT Shank,Reversible £ 125.00
Jones & Shipman UG0060 Grinding Wheel Balancer,VGC £ 350.00
Habit Sine Grinding Wheel Dresser £ 325.00
Pratt 12" 4 Jaw Chuck (Backplate Mount),Boxed,Unused £ 175.00
Burnerd LC10 Multisize Collet Chuck &3 Collets £ 250.00
Acrogrip 5C Collet Fixture & Collets £ 100.00
Burnerd Multisize Collet Chuck and Collets,D13 Mount £ 350.00
Pratt 12" 4 Jaw Chuck L2 fitting £ 150.00
Toolmex 200mm 3 Jaw Chuck, (New) £ 175.00
Toolmex 160mm 3 Jaw Chuck (unused) £ 125.00
Toolmex 160mm 4 Jaw Independent Chuck (New) £ 110.00
Toolmex 160mm 4 Jaw Self Centering Chuck (New) £ 130.00
Toolmex160mm 6 Jaw Chuck £ 250.00
Toolmex 125mm 4 Jaw Self Centering Chuck (New) £ 120.00
Toolmex 125mm 4 Jaw Independent Chuck £ 100.00
Toolmex 125mm 3 Jaw Chuck (New) £ 85.00
Toolmex 100mm 3 Jaw Chuck (New) £ 80.00
Toolmex 100mm 4 Jaw Self Centering Chuck (New) £ 115.00
Toolmex 80mm 3 jaw Chuck (New) £ 70.00
Toolmex 85mm 4 Jaw Independent Chuck,NEW £ 85.00
Jaws for Pratt Burnerd 6 Jaw Chuck,Fit 250mm Chuck Part No.2658-26884 £ 75.00
Burnerd 548BLK Soft Jaws,Fit 10.1/2"-12" 3 Jaw Chuck £ 25.00
30INT Dedlock 150 Chuck £ 75.00
1" Straight Shank Drill chuck £ 20.00
3/4" Straight Shank Drill Chuck £ 15.00
1/2" Straight Shank Drill Chuck £ 15.00
Kawasaki 3/8" Cap. Keyless Drill Chuck,2JT Mount £ 10.00
Kawasaki 5/16" Cap, Keyless Drill Chuck,1JT Mount £ 10.00
1" & 1.1/4" Autolock Collet for Large Chuck £ 15.00
25mm or 32mm Autolock Collet for Large Chuck £ 18.00
Thiel 1/2" x 8" Horizontal Milling Arbor,3MT (unused) £ 65.00
Thiel 5/8"x8" Horizontal Milling Arbor 3MT (unused) £ 70.00
R8 Horizontal Milling Arbor £ 75.00
Thiel Stub Arbor 1/2" or 5/8" (unused) £ 35.00
52 peice 3/8" Clamping Kit,suit Tom Senior,Harrison Mill,etc £ 40.00
52 piece 1/2" Clamping Kit £ 50.00
Pultra 8mm Collets 3 for £25.00 each £ 10.00
Pultra 10mm Collets each £ 15.00
Pultra Vertical Slide £ 180.00
1MT,2MT, or 3MT Tailstock die holder (new) £ 30.00
3-2MT Open ended ejecting adaptor (new) £ 15.00
30INT-2MT Stub Arbor £ 35.00
40INT Stub Arbor (1.1/2" dia),unused £ 35.00
40INT Horizontal Arbor 1" or 1.1/4" (No spacers) £ 20.00
3-4MT Extension Sleeve £ 25.00
4-6MT Extension Sleeve £ 50.00
1MT,2MT or 3MT Revolving Centre (new) £ 20.00
4MT lathe centre (unused) £ 8.00
5MT lathe centre (unused) £ 10.00
6MT Fixed Centre (unused) £ 25.00
1MT 60 Degree Half Point Dead Centre £ 4.00
Viceroy 6" 4 Jaw Independent Chuck £ 100.00
Viceroy 5" Tailstock,3 MT Taper,Complete £ 125.00
Viceroy 5" Catchplate £ 15.00
Viceroy Topslide & 4 Way Toolpost £ 150.00
Viceroy TDS 1 16BL, PF Apron,Feedscrew,Leadscrew and Screw Cutting Gearbox £ 350.00
Raglan 6" 4 Jaw Chuck with Backplate £ 100.00
Raglan 4" Pratt Burnerd 4 Jaw Chuck £ 65.00
Raglan Catchplate £ 25.00
Southbend Tailstock,Complete £ 100.00
Taylor Hobson Engraver Type Tables each £ 85.00
Copies of Machine Manuals,many available SAE for List
7" x 7" Co-Ordinate X & Y Table £ 200.00
Smart & Brown Model A Saddle Assembly £ 75.00
Smart & Brown Model A Screwcutting Gearbox £ 150.00
Smart & Brown Model A Leadscrew & Feedshaft £ 65.00
Smart & Brown Model A 6" 4 Jaw Ind Chuck £ 85.00
Smart & Brown Model A Travelling Steady £ 60.00
Smart & Brown 1024 Topslide/Compound Slide £ 150.00
Smart & Brown Step & Ring Collets,Models A & M £ 25.00
Southbend 4.1/2" PCF Saddle & Apron Assy with topside £ 200.00
Hardinge L6/B Indexing 4 Way Toolpost £ 100.00
Bridgeport R8 Collets, (Not Foreign) each £ 10.00
Deckel FP1 Vertical Head £ 450.00
Victoria No.3 Slotting Head £ 350.00
Schaublin 102 Vertical Slide c/w Simple Dividing Head £ 750.00
BCA 2 Speed Motor,3ph £ 50.00
Dorma 0 Position Multi Drilling Head,5MT £ 650.00
Stuart Turner RG500 Pump 240volt £ 45.00
6" x 12" Co-Ordinate Table £ 150.00
Huntingdon Grinding Wheel Dresser Blades.Size 0/1 £ 2.00
Wako M74/216 Orbital/Cherrying Head £ 300.00
Eclipse 8" x 18" Magnetic Chuck £ 175.00
Acorn Tool Post Grinder,1ph,Suitable Myford/Boxford Size Machine £ 150.00
Jung 6" x 5" Fine Pole Chuck on Slide, Y axis only, with micrometer adjustment £ 150.00
The following machines came from a Watch Manufacturer.
Eboso M32 Automatic Facing Machine (Choice of 3) £1750.00
Elcomatic Twin Head Special Purpose Machine £1500.00
Similar Triple Head Special Purpose Machine £1500.00
Tousdiamants Facing/Milling Machine (Choice of 3) £1500.00
ETS Geveisier Slitting Machine £1500.00
Old Watch Case Lathe £ 250.00
Gudel 8 Station Lathe £1500.00
Swiss Hydraulic Mill S101 £1500.00

WORKSHOP EQUIPMENT

Nikon Measurescope Toolmakers Microscope, X,Y & Rotary Stage,VGC £ 350.00
24" x 24" Black Granite Surface Plate £ 200.00
18" x 24" Black Granite Surface Plate £ 175.00
Mitutoyo 1.5m x 1m Black Granite Surface Table With Stand, As New,Unused £ 975.00
36" x 24" Cast Iron Surface Plate £ 150.00
24" x 24" Cast Iron Surface Plate £ 125.00
18" x 24" Cast Iron Surface Plate £ 35.00
24" x 30" Cast iron Surface Table £ 175.00
48"x72" Cast Iron Welding Table £ 250.00
Honermaster 24/24 DH Shot Blasting Cabinet with Dust Extractor,3ph £ 475.00
Pryor EP34 Pneumatic Letter Marking Press £ 200.00
Chubb Fireproof Safe, 70 " Tall x 30" x 25" £ 500.00
Rosengrens Fireproof Safe 71" Tall x 27" x 34" £ 500.00
4" 1st & 2nd Cut Hand Files,NEW Each £ 1.00
4" 2nd & 3rd Cut Round Files,NEW Each £ 1.00
4" 1st Cut Half Round Files,NEW Each £ 1.00
4" 2nd & 3rd Cut Flat Taper Files,NEW Each £ 1.00
4" 1st & 3rd Cut Triangular Files, NEW Each £ 1.00
6" 3rd Cut Flat Taper Files,NEW Each £ 1.50
6" 1st & 2nd Cut Triangular Files, NEW Each £ 1.50
8" 1st & 2nd Cut Hand Files,NEW Each £ 2.00
8" 3rd Cut Round Files,NEW Each £ 2.00
8" 2nd Cut Flat Taper Files,NEW Each £ 2.00
8" 1st Cut Triangular Files, NEW Each £ 2.00
8" 1st & 3rd Cut Square Files,NEW Each £ 2.00
10" 3rd Cut Hand Files,NEW Each £ 2.50
10" 1st Cut Triangular Files, NEW Each £ 2.50
10" 3rd Cut Square Files, NEW Each £ 2.50
12" 3rd Cut Half Round Files,NEW Each £ 3.00
12" 2nd Cut Flat Taper Files,NEW Each £ 3.00
12" 1st,2nd,3rd Cut Triangular Files, NEW Each £ 3.00
14" 2nd & 3rd Cut Hand Files,NEW Each £ 4.00
14" 3rd Cut Round Files,NEW Each £ 4.00
14" 2nd & 3rd Cut Half Round Files,NEW Each £ 4.00
14"3rd Cut Flat Taper Files,NEW Each £ 4.00
14" 1st,2nd,3rd Cut Triangular Files, NEW Each £ 4.00
14" 2nd & 3rd Cut Square Files, NEW Each £ 4.00
Crown 8" x 12" Compound Sine Table,T Slotted £ 325.00
5.3/4" Dia. Lapping Plate £ 40.00
Windley 12" Dia. Lapping Plate £ 80.00
Eclipse No.323 5"x4.1/2"x3.3/8" Box Cube £ 65.00
9" x 7" x 6" Box Cube £ 75.00
12" x 10" x 9" T Slotted Box Cube £ 85.00
M & W Metric Radius Gauge (new) £ 7.00
Number Drill Gauges 1- 60 £ 5.00
General 255M Screw pitch Gauge 9 - 40 TPI £ 7.00
Craftsman 9 - 4030 Screw Pitch gauge 4 - 84 TPI £ 10.00
M & W Metric Wire Gauge,New £ 6.00
M & W 398M Feeler Gauge £ 15.00
Essex Tool and Gauge Co 10" Sine Bar £ 30.00
9 1/2" x 6 1/2" Compound Sine Table £ 250.00
22" x 8" Sine Table £ 150.00
Swivel Angle Plate 15" x 12" x 12", T Slots One Side Only £ 125.00
Swivel Angle Plate 15" x 12" x 12" £ 125.00
12" x 9" Tilting Table £ 65.00
7 _" x 10" Tilting Table, One Hold Down Foot Damaged £ 45.00
12" x 12" x 12" Angle Plate,With Later Added Stays £ 75.00
12" x 12" x 12" Angle Plate,Corners Machined Off One Web £ 55.00
24" x 12" x 12" Webbed Angle Plate, One Web Radiused End to End £ 75.00
10" x 8" x 6 _" Angle Plate £ 65.00
10" x 8" x 6" Angle Plate £ 65.00
10" x 8" x 6" Angle Plate, Been Drilled £ 45.00
10" x 8" x 6" Webbed Angle Plate,Cut Out On One Web £ 35.00
9" x 9" x 9" Webbed Angle Plate £ 55.00
12" x 12" x 12" Angle Plate £ 65.00
Criterion 9" x 9" x 9" Webbed Angle Plate £ 55.00
12" x 12" x 12" Webbed Angle Plate £ 75.00
6" x 6" x 6" Angle Plate £ 40.00
4" x 3" x 2" Webbed Angle Plate £ 12.00
14" x 8 _" x 6" Webbed Angle Plate, Only One Web Slotted £ 65.00
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26.	***CENTRE DRILL SET (HS)*** 1/8, 3/16, 1/4, 5/16, 7/16		***@ £5 SET***
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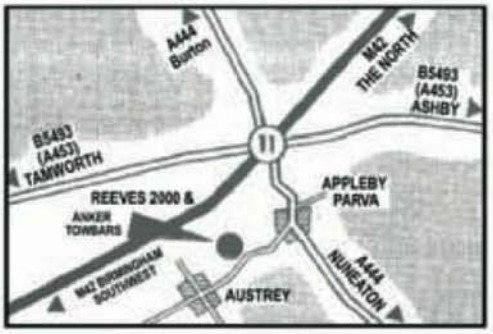

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SMOKE RINGS
With the Editors

Special thanks

We wish to record here our special thanks to all who provided models, either for Competition or for Loan or, indeed to show on the excellent club stands at the recent successful and most enjoyable Model Engineer exhibition held at Sandown Park.

The quality of craftsmanship on show was quite superb and without your contributions there would have been no such exhibition.

Tributes

It is no surprise that letters have begun to arrive at the Editorial office with expressions of personal regret concerning the recent sad passing of Martin Evans, a very notable contributor to the well-being of the hobby of model engineering in general and of this magazine in particular. Two such letters are published in *Post Bag* in this issue. Let no-one, whatever their specific interest or opinion, be under any illusion that without Martin and before him 'Curly' Lawrence, it is unlikely that this splendid hobby of ours would have the worldwide support of enthusiasts, suppliers, books and magazines that it presently enjoys.

To accompany his tribute, Brian Baker kindly forwarded to us a copy of Martin Evans' book *Workshop Chatter* (ISBN 0 85242 608 9) described as a *Bedside Book for Model Engineers* and rich in Martin's reminiscences concerning the hobby. *"The diversity of models cannot fail to interest even the uncommitted man in the street, anything that works and is copied in miniature has a special kind of appeal, and this book deals very much with working models and purpose-built accessories."*

A slim volume first published by Model & Allied Publications in 1979 and long since out of print, it is well worth the effort of seeking out a copy to borrow from your local library or to purchase from a dealer for your longer term enjoyment.

Nostalgia - not what it used to be

From time to time we receive letters from readers asking for more articles like those *"... we had in the old days."* We wish they would be more specific. Thumbing through the 191 volumes available in the editorial office we are somewhat nonplussed as to what they are referring. Could they be hankering for more features describing experiments with X-rays written up in one of the early volumes by a chap who treated us to photographic prints of the bones in his hand. We are not sure if the experiments resulted in any permanent health problems for the gentleman concerned but those were less safety conscious times and perhaps his early demise caused no comment.

Maybe our correspondents want to construct one of those handy electrical indicators for telling your servants (note the plural) from which room you are summoning them. Moving on through the years we have articles on constructing your own motor tricycle, a refrigerator or how to motorise a manual lawn mower — if that takes your fancy. Interesting enough, though hardly relevant in this day and age.

We suspect that the writers of the letters may be yearning for more from contributors like Edgar Westbury, LBSC and Duplex. All good readable stuff and some of it is still relevant today. However, things do move on and some of the techniques described may no longer be acceptable today. For example, we trust that no one still taps directly into the copper of a boiler shell in order to attach fittings. Some of the workshop articles are also less relevant as the equipment to which they relate has long been out of production.

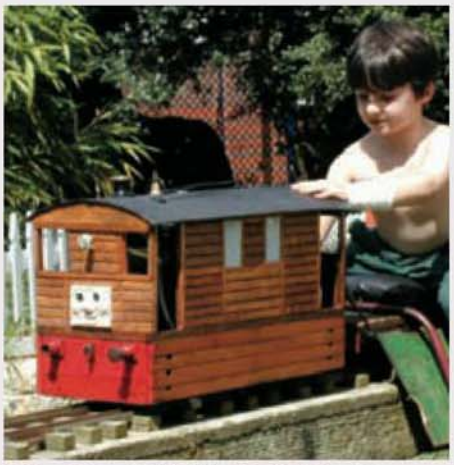
However, please keep your letters coming in. We enjoy reading them and it does keep us in touch with your views and opinions. Just one small request. If you have a favourite topic which you think we should cover please be specific or we are going to be left guessing about what it is you want us to do. Now, where were those articles on driving your lathe through an Austin Seven gearbox and making traction engine wheels out of old boot polish tins ... ?

IMLEC 2004

Plans are progressing concerning arrangements for the forthcoming International Model Locomotive Efficiency Competition for the Martin Evans Challenge Trophy, hosted by Kinver and West Midlands Society of Model Engineers Ltd. on their very fine track at their attractive tracksite over the weekend 10/11 July 2004.

Co-ordinator for this prestigious event is John Hurley, an experienced competitor in his own right, so we are assured that everything which should be, will in place for the competition. Kinver Chairman John Campbell telephoned recently to ask us to draw readers' attention to the new official Kinver and West Midlands Club website at **www.kinvermodelengineering.org.uk** which carries early details of the event.

Prospective competitors and others without internet access who wish to contact Kinver & West Midlands Society of Model Engineers are welcome to call John Campbell on 01384-891244 and/or Mike Harrison on 0121-602-2019. Please note that Official IMLEC 2004 Competition Entry Forms are available from the Model Engineer Editorial Office at PO Box 310, Hemel Hempstead, Hertfordshire HP3 8XL. Please mark the top left hand corner of your envelope IMLEC.



A 5in. gauge electric* Toby the Tram Engine *to the 1989 Rex Nicholls design similar to the locomotive stolen from David Donoyou's garage.

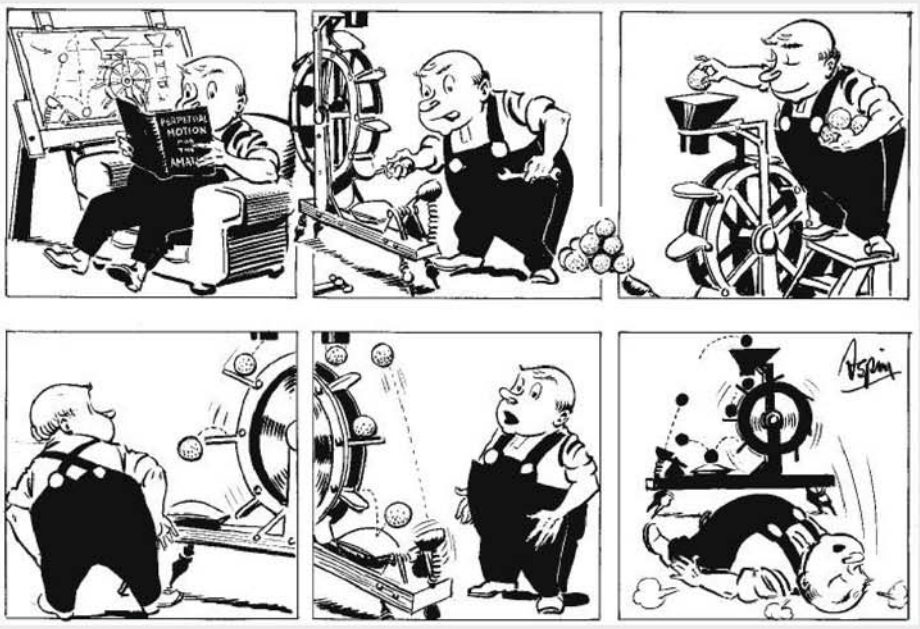
Another stolen locomotive

We regret to have to report the theft of another locomotive, this time with riding car and a 2½in. gauge LMS Black 5 tender chassis. Thieves broke into David Donoyou's Surrey garage to remove the items but took nothing else, not even the tools which were also in the garage. No other garages in the vicinity were raided. Mr. Donoyou's garage is one of several at the remote end of a cul-de-sac on a private estate. The theft took place some time between August and December last year.

The locomotive is a 5in. gauge battery electric model of Rex Nicholls' *Toby the Tram Engine* similar to the one shown above. Fitted with an MDF body clad with varnished horizontal planks, it is powered by a 12 volt Sinclair C5 electric motor and chain drive to the axles is via a pair of bevel gears originally fitted to a hand drill.

Any reader able to help in the recovery of Mr. Donoyou's locomotive, driving car and 2½in. gauge Black Five tender chassis is asked to contact PC A. Ayre of the Crime Management Unit at Reigate Police Station, 79 Reigate Road, Reigate, Surrey RH2 0RY; tel: 01737-765040, quoting Crime Number B/04/548.

CHUCK the MUDDLE ENGINEER — by B. TERRY ASPIN



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Letters may also be sent to **The Editor (*Model Engineer*), Berwick House 8-10 Knoll Rise, Orpington, Kent, BR6 0EL; fax: 01689-899240.**
In the interests of security, correspondents' details are not published unless specific instruction to do so has been given.
Responses to published letters are forwarded via the Editorial Office as appropriate. Publication is at the discretion of the Editor. The content of letters may be edited to suit the magazine style and space available. Correspondents should note that production schedules normally involve a minimum lead time of six weeks for material submitted for publication.

The late Martin Evans

SIRS, - I was much saddened to hear of the death of Martin Evans on 29 December. I have been a correspondent of Martin's for over 25 years and like to count myself as a friend also for that time.

I am sure that the sadness I feel will be reflected throughout the whole model engineering movement upon which his life made a considerable impact. Apart from the multitude of designs for many gauges that he produced, all fine, practical working models, he was also responsible for restarting the Model Engineer Exhibition and for introducing the International Model Locomotive Efficiency Competition which has given so much pleasure and debate to the model engineering world.

Perhaps the best memorial however, will be the number of his designs that are running on club tracks worldwide today.

Brian Baker, Essex.

SIRS, - On learning of Martin Evans' recent sad death, I am reminded that I first met him at the old offices in Noel Street before he became Editor of this magazine.

It is my opinion that we all owe Martin a great deal. When he took over as Editor, he managed to restore a dwindling circulation, perhaps partly by persuading Curly to return as a contributor, neither feats to be considered lightly.

I believe that Martin published more designs than Curly himself, another impressive achievement. When built with care, many of his locomotives have turned out to be competition winners.

His book on the *Model Steam Locomotive* is a much-valued reference work in my library.

Martin was a very mild and modest man with a little smile always on his lips. I last met him a good many years ago; when I called on him we had a good chat and I was shown around his workshop.

I understand that he had recently moved to Sticklepath near Barnstaple, not far from my Devon home of earlier years.

He will be greatly missed.

Keith Wilson, West Midlands.

Indexable tooling

SIRS, - Having read Mr Randall's letter (*M.E.* 4212, 9 January 2004) describing his lack of success with indexable insert tooling, I thought I should add a few comments to the reply from Mike Chrisp.

Sharp cutting edge geometries are essential on small format, lightweight machines, yet are normally undesirable on heavier, industrial quality equipment.

Grades of carbide vary enormously, depending on many varied application situations, and the need to balance toughness with wear resistance.

Coatings can either help or hinder the cutting process, depending on how they are applied to the cutting edge, and on the type of coating for a given application.

Power requirements and rigidity are not major factors in the usefulness of carbide tooling, as these are issues that can be allowed for by the choice of insert.

At Greenwood Tools, we have put much time and effort into selecting a range of inserts in grades, geometries and sizes perfectly suited to the light, low powered machines used by model engineers.

Tool selection information and cutting data are freely available from our website: **www.greenwood-tools.co.uk**

Incidentally, Sandvik's book *Modern Metal Cutting* has been out of print for some years now, and will not be reprinted.

Peter Cook, Managing Director, Greenwood Tools Ltd.

SIRS, - You were not wrong when you wrote that you would get a variety of opinions in response to Dennis Randall's recent letter and your response.

My own experience with indexable carbide tipped lathe tools differs somewhat to that reported by Dennis Randall, and I can only assume that, although he purchased his tools from *"... an impeccable supplier"*, the ones he chose to purchase did not originate from quite such an impeccable manufacturer.

The first indexable carbide tipped tools I used were supplied by Penco (no longer in business), and were fitted with Sumitomo Titanium carbide inserts. Both were designed for use with small machines. One was a conventional right hand turning tool on a 1/4in. shank, using a CCMT 06 insert. These inserts came in a variety of tip radii, from 0.1mm upwards. The second was a tiny boring bar that used an equally tiny triangular tip with a most peculiar tip geometry, that was capable of being used to bore from an initial hole diameter of as little as 1/4 inch.

At the time, the only lathe I possessed was a Peatol (Taig) lathe, which is hardly a 'big league' machine, and inherently not capable of heavy cuts. Despite this, my experience with these tools was very good indeed; they proved to be capable of producing very fine surface finishes on a variety of different metals, giving a near mirror finish on aluminium alloys and brass. Both tools seemed to be equally at home taking light or (for the Peatol) heavy cuts, although the small size of the boring bar inevitably limited the depth of cut of which it was capable. Coupled with the great advantage of never having to re-sharpen the tool, they convinced me that this was the only game in town, and I have been using insert-based tooling ever since.

More recently, I have used similar tools with Sandvik Tungsten carbide inserts, purchased from JB Cutting Tools and from Greenwood Tools; these have been similarly successful in use on the Peatol lathe, although the smallest tip radius of the inserts they supply seems to be 0.2mm, which is less satisfactory for finishing cuts than the smaller tip radius of the Sumitomo inserts.

In addition to the two original Sumitomo tools, I now have a range of larger boring bars, knife tools, and a parting tool. The latter is probably a bit on the heavy side for use on the Peatol, but having said that, I have used it successfully on the this lathe for a number of years now.

At one point, I was tempted to buy a set of five 1/4in. shank indexable tools *from "... an impeccable supplier"* for less than the price of a single tool from the other suppliers mentioned. These turned out to originate somewhere on the Indian subcontinent, and were a total waste of money on a number of counts:

1: The 'Torx' head screws holding the carbide tips in place were of very poor quality, as was the wrench supplied. This made it impossible to properly tighten or remove the fixing screws on some of the tools.

2: The machining of the tip of the shank was very poor. As a result, the insert was not properly 'nipped' against the shoulder on the tool shank, which is necessary to ensure that the tip stays in position when in use. Consequently, coupled with the problems with the screws, the tips were not held rigidly enough to work properly.

3: The inserts themselves were poorly finished, and had a very large tip radius, making them wholly unsuitable for use in a small machine.

The combination of the foregoing factors meant that these tools were totally unusable, and I wrote them off to experience. Yet again, this confirms that 'you get what you pay for'.

More recently, I have acquired a Myford ML7 lathe, and have bought more indexable tools to use on that; needless to say, sourced from the suppliers that I have found to offer satisfactory tools and inserts. My experience with using them on the Myford has continued to confirm my decision to use these tools in preference to HSS. No doubt there will still be occasions when I need to use HSS, but the majority of my work will be done using indexable tooling.

I can therefore only assume that Dennis Randall's poor experience with this type of tooling is a result of being tempted into buying one of the cheap, inferior quality, tool sets, and I would suggest to him that before giving up completely on indexable tooling, he tries out a better quality tool/tip combination.

Tony Jeffree, Cheshire.

Tooling ... and engineers

SIRS, - I refer to Dennis Randall's letter (ME 4212, 9 January 2004) and your challanging comments. I too have experimented with indexable inserts and am a convert. Even with our more lightly built machines they are worthwhile, however I have found that the insert source must be the best brands — not just the supplier, and height setting is more critical than with HSS toolbits. Myford-Dickson interchangeable toolholders make life really easy in this respect.

Care must be taken not to try to rub the metal off! Certainly with cast iron you can take 0.050in. plus cuts at quite fast feed rates, but with steel it is more difficult to take a very light cut. It is better to take a deeper final cut than with HSS. However that is not to say that you cannot take 0.0005in. if your machine is up to it!

I have regularly machined higher grade steels for use on a 12in. scale locomotive with reasonable production rates.

On a separate matter, I now refer to H. D. Turner's letter published under the heading *Engineering and perception* in *M.E.* 4210, 12 December 2003.

Mr. Barry Johnson with his model of Wilson's Farmers Engine, drawings for which are sought by Mr. David Mottram.

To my mind there is no doubt about the 'engineer' bit. The man who worked the engine, was just that: the engineman; the man who works in an engineering environment (e.g. factory, etc.) is an engineering worker. To be an Engineer, you have to have responsibility for design and to lead that design; perhaps our best example is Isambard Kingdom Brunel, now, *he* was an Engineer!

The American use of 'home mechanic' or 'home machinist' is descriptive and possibly arises because of the undesirable use of 'model shop' in our English use of the words (USA = hobby shop).

Regarding the intended slight of our Engineering Institutions and the 'Johnnies Come-Lately' tag, the Institution of Electrical Engineers was founded in 1871 and the Institution of Mechanical Engineers was founded around 1850 by no less a person than George Stephenson who was an Engineer as well!

I am proud to sign myself

K. A. Willson, Chartered Engineer
Hampshire.

SIRS, - I refer to recent letters by Messrs. Turner and Margolis. I hope you have received many letters, including this, resisting the call to rename those who pursue the hobby of model engineering either 'home mechanics' or 'home shop machinists'. In my view both terms denigrate the range of knowledge and skills required to build the complicated and sophisticated models regularly described in your excellent magazine.

Obviously the arguments as to the mixture of the theoretical and practical knowledge required to allow a man or woman to be entitled to the term 'engineer' can be carried on for ever. The important thing is that the status be recognised, and in this respect any association of the words 'engineer' and 'mechanic' must be avoided, even suppressed.

D. R. Richards, by e-mail.

Farmer's Engine

SIRS, - On page 38 of *Model Engineers' Workshop* magazine No. 51 (July 1998) there is a picture of Mr. Barry Johnson driving *St. George,* a model of Wilson's Farmer's Engine.

Are drawings for this older style of undertype traction engine available in the UK? If so, from where can they be obtained? I realise that it is possible that Mr. Johnson prepared his own drawings. Any guidance would be appreciated.

David Mottram,
New South Wales, Australia.

Tractive effort

SIRS, - I thought that the formula for tractive effort (*Edwardian Elegance*, *M.E.* 4212, 9 January 2004) looked wrong. Other things being equal, larger drivers give smaller tractive effort; it's all a matter of moments.

I think the π symbol should have been a solidus. The usually quoted form is:

$T = (d^2 L P) / D$

This formula has the advantage of giving a result of the correct dimensions (the same as for force) whereas the original gives force times area.

I think that the derivation is by considering work done:

$P(\pi d^2 L) / 4$

is the work done by the steam at mean effective pressure P in stroke L.

Equally, the work done in a half-rotation of the driver is $(\pi D T) / 2$.

Equating these gives

$T = (P d^2 L) / 2D$

but what's a factor of two between friends; it is only a theoretical figure after all!

The figure of 85% boiler pressure for P is sometimes rolled up with a figure (c) for friction losses, etc. and the result quoted as:

$T = (c P d^2 L) / D$

where, now, P is full boiler pressure and c is the fiddle factor of somewhere between 0.4 and 0.85 (ie 40%-85%).

A minor point about a fascinating series of articles (even to an avowedly non-steam modeller).

Bob Margolis, Hampshire.

Classic lathe

SIRS, - Mr Ron Etter, in his articles commencing *M.E.* 4209, 28 November concerning the restoration of his classic Drummond 3½in. lathe is to be congratulated on the superb restoration work he has done. I have recently restored the headstock of an identical machine to form the basis of a geometric and medallion lathe.

I wish, however, to correct one or two points in the article relating to this lathe which I believe will be of interest to those readers who have an historical appreciation of early tools used by model engineers and amateur machinists.

Some years ago, I was invited by the then council of SMEE to look after the Drummond small lathe archive, which had been presented to them by the family of the late Richard Bird, who was not only an outstanding draftsman but was also a founding member and inspiration behind the now defunct Drummond Association. This was formed in the 1980s to ensure that like minded individuals with Drummond lathes were able to exchange technical information and obtain drawings of various components which were hard to find.

During the last five years many Drummond owners have, through SMEE, sought technical and other information about their lathes and we have always used our best endeavours to oblige. Most queries, however are mainly concerned with the dating of the early machines which still keep cropping up in the most amazing places!

Drummond Brothers was incorporated in April 1902, by Arthur and Frank Drummond. Arthur was the real innovator and although a portrait painter by profession had a real flair for mechanical design as applied to lathes. He was nevertheless, a keen model maker and amateur mechanic and the firm introduced the classic 3½in. (actually 3 9/16in.) lathe in 1903 The misunderstanding in the article is that this early model which in various guises was in production until around 1912 was not designated the Model B at any time. This appeared in 1912, as a follow on from the round bed Model A which was introduced in 1908.

The 3½in. lathe which Ron Etter has restored so beautifully has the now famous separate split conical gunmetal mandrel bearings which the company retained in modified form up to the end of production. This firmly dates his lathe as post-1906. I have not yet searched any of the early Drummond patent specifications but this feature would have been included and is an excellent and elegant approach to plain bearing adjustment

What is not clear from any of the pictures in Mr Etter's article is the size of the mandrel nose. Up until around 1906/7 the lathes had only a ¾in. Whitworth thread on the mandrel nose, which, with a No. 1 Morse taper did not leave a great deal of metal remaining and complaints were received at the works that with the heavier cuts now possible with the new improved bearings, chucks had become detached following a catastrophic shear failure of the mandrel nose! This was increased to the more sensible 1in. diameter nose.

The exact dating of these early lathes can only be made by reference to certain design features and modifications, and the date of Mr. Etter's lathe does indeed suggest 1907. Unfortunately, there are no known records as to the exact number of 3½in. lathes the company made up until 1912 and my research into those lathes I have inspected indicates that the numbering (if any exists) bears no logical progression. We do know, however, that a total of 9523 round bed model A lathes were made from 1908 until c1943.

The Model B replaced the early 3½in. in 1912 and this was in production until 1921. The anvil type bed appealed to the Admiralty and was supplied as standard workshop equipment on new naval ships in the first war. It was designated the Model BS with power cross-feed and is now extremely rare and very collectable.

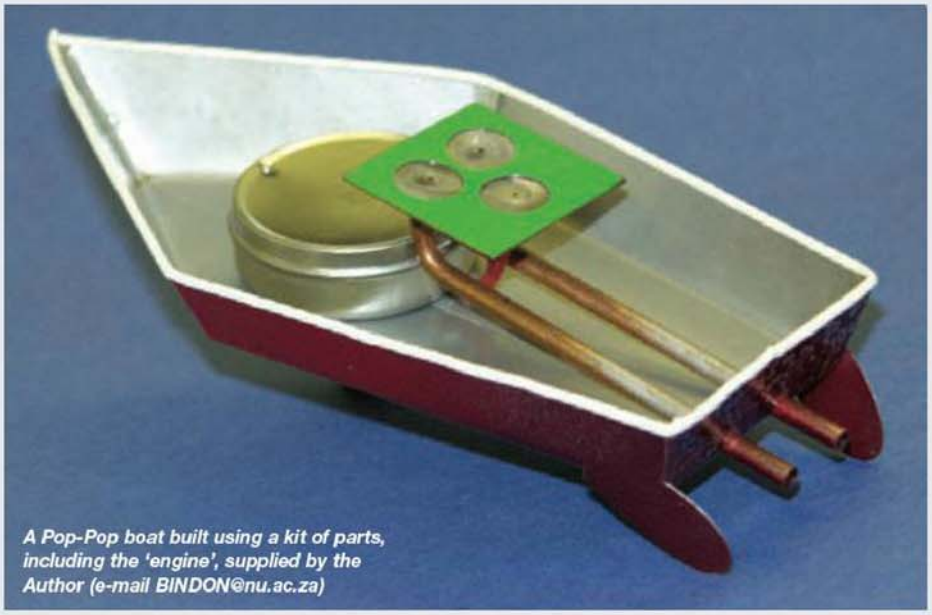
It was mentioned in the first article that Drummond was absorbed by Myford. This needs some qualification and can be misleading. During the 1930s, the Drummond company became a leading UK supplier of specialised automatic multi-tool lathes to industry with their Maximatic and the small lathe division became a less significant part of their overall business. Accordingly, under the pressure of war work and government insistence, the small lathe division was handed to Myford Ltd, and the Drummond Company became part of the Asquith Machine Tool Corporation, but that is another story.

At the time of handover to Myford, the two small lathes were the Myford M and the round bed. It is not known if Myford actually produced any of the round bed lathes but it did form the basis of the Myford ML8 wood turning lathe.

John Anning, Devon.

Jeff Bindon

in South Africa reveals some intriguing aspects of Pop-Pop engine operation and explains how to make a transparent engine with a throb that announces its dynamic internal processes.



A Pop-Pop boat built using a kit of parts, including the 'engine', supplied by the Author (e-mail BINDON@nu.ac.za)

THE SECRET WORKINGS OF A TRANSPARENT POP-POP ENGINE

The water pulse (Pop-Pop, Putt-Putt or Toc-Toc) engine is an exciting and fascinating device. Even when not made from flexible transparent material, you will be kept watching and wondering for hours at its lively antics. Up to now, the explosive internal operating 'life' cycle could only be heard. Now the enhanced throbbing becomes something you can feel and see. Everyone with an interest in things mechanical cannot but appreciate the sheer audacity of such action achieved without moving parts.

Although they have been made for toy boats for over a century (**Ref. 1**), only some aspects of the way they work have been suggested at various times. What follows summarises the ideas and findings of others and presents some new observations and conclusions from simple experiments with transparent engines.

The upper flexible metal plate of an essentially flat boiler was replaced with a piece of overhead projector (OHP) film to permit observation of what was happening inside. The processes in one of the two copper pipes were also observed by replacing it with a silicone rubber tube. A modern video camera system was used to film the action inside the boiler in slow motion. Finally, because OHP film can work up to 250deg. C and is so readily available, some ideas are given for making a transparent engine (**fig 1**).

From 1916 to 1926, McHugh made some very important contributions in two patents (**Ref. 2**). In the second one, he seems to have clearly and correctly understood the way the oscillatory momentum of the water columns causes the pressure fluctuations in the boiler and how steam condensation onto the walls of the cold tube causes the drop in pressure necessary for pulsation to be initiated and maintained.

There have been previous reports of experiments with transparent engines. A rigid transparent upper plate was fitted by Crane (**Ref. 3**) in place of a flexible metal membrane. He concluded from the experiment that the flexibility of the membrane was not essential, a finding that has not been confirmed by the present study. From seeing that the boiler contained only 25% liquid he incorrectly concluded that the remainder was full of *"superheated steam."* He proposed that the water columns are propelled by the steam formed, that the pressure drove the membrane outwards and that the water was sucked back by steam condensing. However, this does not take place *"primarily on cold boiler surfaces"* as stated.

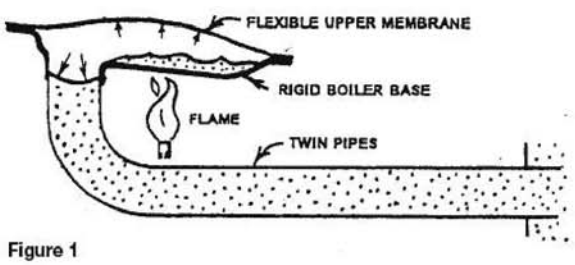
Payne *et al* (**Ref. 4**) gives a good review of previous work and reports the findings from two single tube water pulse jets, one electrically heated and one oil heated. They were considerably larger than the normal Pop-Pop engine. Inclined glass tubes of 25mm diameter and 3100mm long were heated at their upper ends. All their experiments included some air in the hot end and they appreciated that it played an important role in bouncing back the column of water. Pressure fluctuations were measured and although their scale is uncertain, a variation of up to 2 atmospheres may have been reported.

It is often asked if two tubes are essential and many, for example **Ref. 5**, and in the present work, when one tube is blocked by hand, pulsing continues but at a reduced rate. Twin tubes certainly make filling the boiler easier but no-one had made an engine with a single tube that has either the same cross-sectional area or the same internal surface area.

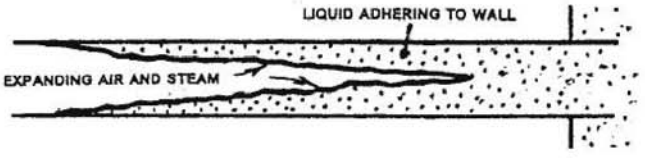
A number of exceptionally well designed engines and boats are available in the streets of India. They have pressed tin 'motor-boat' hulls and a particularly lively 'chinky' noise. Anyone travelling there simply must purchase one although they sometimes filter onto the European street markets. Reference 5 specialises in a range of exquisite hand made hulls powered by a superb deep throated sounding engine that won all the competition categories in **Ref. 6**.

Experiments with transparent engines

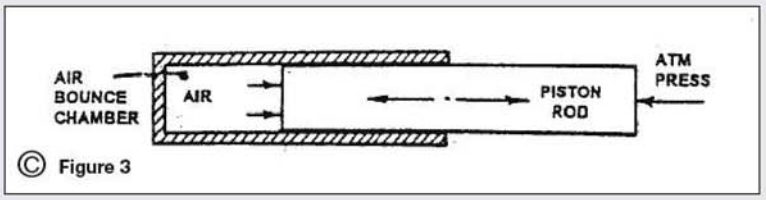
In the present experiments, the first surprising observation was the magnitude of the peak pressure inside the boiler. Although this was not quantified, the upper membrane, being more flexible than metal, was stretched rigid, was distinctly 'hard' to the touch, and could only barely be pressed down onto the lower metal plate. Since the boiler is completely open to the atmosphere via the two pipes, such a pressure can only arise dynamically from the inertia of the water columns. This confirms McHugh's ideas and perhaps the measurements of Crane. Rapid water column motion is crucial in understanding how the engine works. It bears more resemblance to a piston engine with compression and expansion than simply to the idea of steam evaporating, pushing and sucking. Pressure reduction may play a key role in the rapid periodic evaporation of steam that must take place. Conversely, there may also be re-condensation when the pressure rises.



© Figure 1



© Figure 2



© Figure 3

The second finding confirms the 'bounce' role played by air inside the boiler. Without fully understanding the reasons, many Pop-Pop engine designers have found by experience that a better performance results if the tubes are pointed upwards when filling the boiler. See for example Ref 5. This means that the (temporary) upper half of the boiler cavity forms an air lock and only a limited amount of water is allowed to enter. Observations show that when the boiler is filled in this manner, an air bubble fills approximately half the boiler and the pulsing is vigorous and regular with a relatively small amount of liquid being crisply snapped around. In contrast, when all air is purged, pulsing is sluggish and irregular. The cavity is full of water and steam which churns and sloshes with a spongy gurgling sound. This does not continue indefinitely. As will be shown later, dissolved air from the water soon forms a bubble.

It is believed that air stores energy which allows the water columns to oscillate vigorously to effectively form twin 'pistons'. A further possibility is that the air controls the amount of liquid trying to flood back into the boiler.

A third observation through a semi-transparent silicone rubber tube confirmed that the water columns do indeed oscillate back and forth in the tubes over roughly two thirds of the total length. At the far extremity of the 'stroke', the 'meniscus' could not be seen and the liquid steam/air interface may be ragged and well mixed. Since the retreating liquid would tend to stick to the tube wall while the centre is pushed downstream by the expanding air and steam, the water column is likely to bear more resemblance to a pipe full of syrup than to the clean meniscus we see when we use a drinking straw (**fig 2**).

A touch test showed that the first half of the tubes were hot while the last half were only lukewarm. A surprising result was that when observations were attempted with both tubes made of silicone rubber, the engine would not work at all and gave no hint of even incipient pulsation.

The next observation relates to the control of the air bubble size in the boiler. It has been the painful experience of many an engine designer to have the boiler burn out after puttering happily for anything from a few minutes to as long as an hour depending on the design. A burnout is always preceded by a weakening and then cessation of pulsing. The tubes become hot over almost their whole length. An alert operator can prevent damage by blowing the flame out when this happens.

A view via the transparent upper membrane revealed that cessation of pulsing and subsequent burnout were due to a completely dry boiler. Just prior to this, as the pulse rate first begins to weaken, there was no longer any free liquid being disturbed and sloshed around by the upper membrane. Dry patches could be seen on the heated surface. The patch fluctuated in size in sync. with the pulse of the engine and grew until all wetness vanished and pulsing stopped.

When a still intact engine was allowed to cool to condense the steam, it could clearly be seen that the bubble of air was much larger than at the start. Since the boiler is sealed, the additional air must be coming out of solution from the water. As will be mentioned later, a Pop-Pop engine is a heat engine and discharges its waste heat by expelling warm water at each pulse. Cold water must therefore be entering the tubes and when it eventually reaches the boiler, the dissolved air will be released.

Since there is a steady release of air into the boiler it seemed logical to hypothesise that a successful engine that operates indefinitely is one that steadily discharges air. This was confirmed by placing an inverted beaker of water above the two pulse tubes to trap and observe any discharged air. This was seen to take place every few minutes and was as a spurt of two or three tiny bubbles. Additional confirmations came from obtaining the same result for an engine from a completely different source and to deliberately start each one without an air bubble. After a few minutes of sluggish pulsing, the rate gradually increased. When the transparent engine was stopped, the normal complement of air was found in the boiler.

It is suggested that this crucial discharge of excess air takes place when the ragged 'meniscus' of the water column extends beyond the end of the tubes. It is likely that all remaining steam has been condensed into the water which is coldest near the exit.

The resulting tiny bubbles may oscillate for many strokes and be thoroughly scrubbed before finally being discharged. Thus the term meniscus must not be taken literally. It may be a small bubbly zone near the centre of the tube surrounded by slower moving fluid 'stuck' to the surface of the tubes. This zone will oscillate back and forth and will gradually be pushed closer and closer to the outlet as the air volume inside the boiler increases. The length of the tubes and the pulse strength should affect the discharge of air. While a larger flame does not enhance the pulse strength, a very small flame was found to produce a weak pulse that did not result in a discharge of air.

Further observations were made that are interesting without revealing or confirming aspects of engine operation. These are also not to be taken as universal because they depend on engine design and shape. Very small incipient pulsations could often be seen the moment steam bubbles begin to form. As the liquid reaches its boiling point and even the smallest of bubbles emerge, both the flabby transparent membrane and the air bubble begin to flutter. It appears that even when a small volume of steam expands and enters the cold tube, it will immediately condense to reverse the expansion and set up the fundamental unstable mechanism that drives the oscillations. This small incipient flutter will not be noticed with an opaque metal membrane.

An experimental engine with a flat lower boiler surface except for distinct cavities around the pipes and in the centre, did not exhibit this 'flutter'. The boiler simply filled with steam without any pulsations and then boiled dry. It would appear that if the upper membrane touches the lower plate, the surface tension of the resulting thin film of water prevents it from pulsing.

Pulsations are also unreliable with a freshly installed taut OHP membrane. When they do occur, they are sometimes not strong enough to discharge any air. However, after a 24 hour soak in water, the polyester appears to absorb moisture and become flabby. Pulsations are then regularly initiated and strong enough to deliver the air to the ends of the tubes. A similar result has been reported by Ref 5 and stronger pulsations result when the shim brass membrane of a new engine is manually deformed inwards. It is thus concluded that the upper membrane needs to be flexible.

A modern video camera and editing facility enabled the processes through a 40 x 40mm transparent membrane to be seen in slow motion. However, the clamp plate holding down the membrane had only a 25mm dia. viewing hole centred at the front of the boiler over the pipes. No surprising observations were made except to find that the engine has a double pulse, one as the membrane bulges fully outwards and the other at the end of its inward stroke. The two sounds are distinctly different, the loudest being at the end of the implosion. A more appropriate name for the device could be the 'Pip-Pop' engine!

There was no sign of any 'boiling' taking place and in the visible zone, steam does not form as bubbles on the heated surface. There is very little liquid in the boiler and there is a gaseous central region with a meniscus of liquid all around its edges where surface tension seems to keep liquid in contact with both surfaces. The surrounding meniscus expands and contracts as the membrane goes up and down. In the central region, the little liquid there is moves rapidly. Although this region is largely hidden underneath the clamp plate, bubbles of steam appear to emerge from the back of the boiler where the liquid layer is thin. This happens periodically on explosive downwards strokes of the membrane.

An unexpected result was that no liquid was seen to emerge from the pipes. This was because some engines showed a droplet or two of liquid being spewed back on a somewhat irregular basis. These were seen momentarily as they hit the membrane and the engine misses a beat or two as the new liquid is heated. On other engines, this periodic spew back of liquid was much more than a drop and water rushes in with a distinct gurgling choke. The boiler becomes flooded and pulsing can stop for a few seconds. Such engines operate with a continuous gurgling sound that can be heard against the regular pulsing.

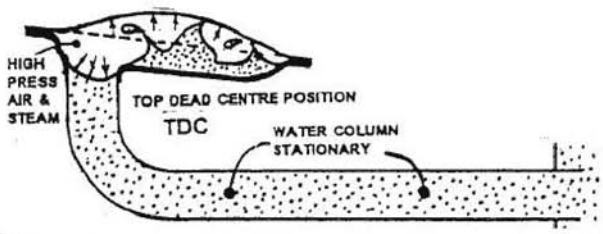
A summary of pop-pop engine operation

For those unfamiliar with the kinetics of a water column and the way air and steam behaves, two preliminary explanations are presented.

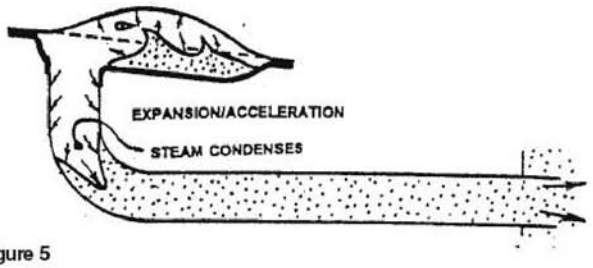
'Air bounce' and column momentum

Consider some air trapped in a cylinder in which there is a heavy, well fitting piston rod (**fig 3**).

If the rod is pushed hard against the air, the air volume will decrease and the pressure will rise above that of the atmosphere. When the rod is released, air pressure will accelerate the rod. The air volume increases and the pressure decreases. ▶



© Figure 4



© Figure 5

When the pressure falls below that of the atmosphere, which is trying to push the rod back again, the rod will begin to slow down. However, it has momentum and so before it finally stops, the air pressure will have fallen well below atmospheric. The outside air will then accelerate the rod back into the tube and it will only begin to slow down when the air pressure again rises above atmospheric.

Due to momentum, the pressure continues to rise until the rod finally stops. Thus the air acts like a spring or 'bounce volume' and the rod will oscillate in and out until friction eventually stops it. This principle applies to the boat engine because there are moving columns of water in the tubes that have mass and which will bounce back and forth just like metal rods.

Evaporation and condensation

When water at its boiling point is heated it turns into steam at the same temperature. Because vapour has a much larger volume (about 1700 times at atmospheric pressure) it 'pushes' outwards and any restriction of this expansion will tend to increase the pressure. If steam encounters a surface colder than the boiling point, it will begin to condense back into water and the volume and pressure will tend to decrease.

The boiling point of water depends on its pressure. If the pressure of water at 100deg. C and 1 atmosphere is suddenly lowered to say 0.7 atmospheres, the new boiling point will be 90deg. C. The liquid will tend to stay at 100deg. C and will be much hotter than its boiling point. Steam will rapidly 'flash' off until the temperature falls because the energy or latent heat to do this comes from the sensible heat of the liquid. If the pressure is forced back up to 1 atmosphere, the liquid will tend to remain at 90deg. C while the steam temperature will increase due to its compression. It will therefore condense rapidly into the relatively cold liquid until the temperature rises back to 100deg. Celsius.

A 'boiler', consisting of two closely spaced metal plates, is filled with *air and water*. Two metal pipes full of water lead from the bottom of the boiler to the back of the boat below the water-line. The bottom plate is heated by a flame. The upper plate is thin and flexible to produce a change of volume and a sound pulse as it is stretched taught. Some craftsman are able to induce a vigorous over centre 'oil can' snap action that adds considerably to the noise produced.

Two processes are thought to be crucial. The first is that which fundamentally causes the oscillations. As flame driven steam forms, it pushes outwards and displaces water down the tubes. Since this zone is relatively cold and wet, steam immediately condenses and draws the water column back. Those familiar with hot air engine operation may see similarities.

The second relates to the rapid motion of the water columns which become fast moving 'pistons' able to generate pressures well above and well below the atmospheric. Since the pipes are open to shallow water and hence to the atmosphere, it is only the inertia of the liquid in the tubes that can do this. The presence of an air bubble allows energy to be stored during the compression process and return it during the expansion process.

Because of the surprising dynamism that the transparent and more flexible membrane has revealed, it is proposed that the engine actually resembles a piston engine with certain 'strokes' of compression, expansion, etc. Such an approach certainly helps to develop a logical description of the processes. An engine cycle needs to start at a readily identifiable point from which more complex processes can be developed. The point chosen is when the water columns have come to rest at 'top dead centre' (TDC), somewhere near where the tubes join the boiler. The air and steam are fully compressed and the upper membrane is extended with the pressure at its highest and well above that of the atmosphere, **fig 4**.

Since the pressure at the open end of the tubes is atmospheric, the higher pressure in the boiler will now accelerate the water columns down the tubes allowing the volume of air and steam to expand. This is the *'expansion/acceleration stroke'*. The flame will evaporate steam from the liquid but the wet tube surface left exposed by the retreating water columns is relatively cold. Thus steam will start to condense and the air to cool. The combined expansion and condensation process will attempt to decrease the pressure and counteract the effect of the evaporating steam, **fig 5**.

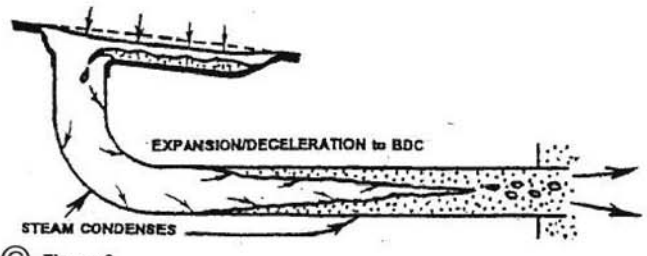
As the water columns retreats, not only is more cold wet surface exposed, but fluid becomes increasingly colder and remains 'stuck' to the walls. Air and steam are increasingly forced to move down the centre of the tubes and become more intimately mixed with the cold water. Thus despite the evaporating steam, condensation and cooling soon dominate and the pressure will decrease. When it falls below atmospheric the upper membrane will be slammed downwards and the water columns will begin to slow down.

A sudden decrease in pressure may lead to a pulse of steam emerging from the boiling water in the boiler.

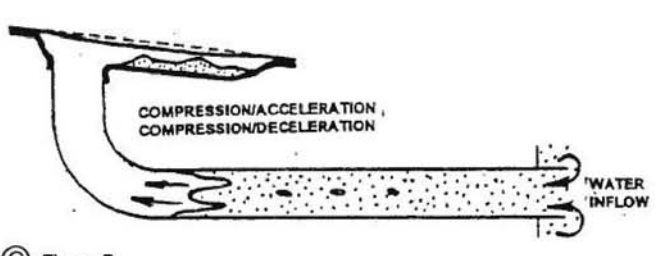
The higher pressure at the end of the tubes will now begin to slow the water columns to form an *'expansion/deceleration stroke'* until the water stops at BDC. The stream of expanding steam and air will become increasingly narrower and the surrounding water colder, and both these factors will ensure that most of the steam will condense to leave only tiny bubbles of air (**fig 6**). Atmospheric pressure will now push the water columns back into the tubes to form a *'compression/acceleration stroke'*. Cooling surfaces are covered, condensation stops, steam continues to form and the pressure begins to rise. When it exceeds atmospheric, the columns begin to slow down, the upper membrane is slammed outwards and the *'compression/deceleration stroke'* starts. The momentum of the columns is such that the pressure rises well above atmospheric. This sudden high pressure may cause steam to actually condense back into the water. Small amounts of liquid may flood back into the boiler to replace that which was evaporated. This may be regular or sporadic. The cycle is now ready to repeat itself (**fig 7**).

As mentioned below, a Pop-Pop engine is a heat engine and discharges its waste heat by expelling pulses of warm water. Cold water therefore enters the tubes to replace the water discharged. Air is less soluble in hot water than in cold (this can be seen in a kettle just before it begins to boil) and when the cold water works its way towards the hot end of the tubes and even enters the boiler, the dissolved air will be released. The steady release of air into the boiler will gradually cause the columns to push further and further down the tubes until a tiny amount is discharged with a pulse of water.

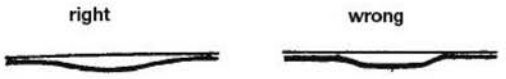
The distance steam and air will push down the tubes depends on the pulse strength which can depend on the flame size. Thus the overall length of the tubes, the flame and the vigour of pulsing could be important factors in the discharge of air.



© Figure 6



© Figure 7



© Figure 8

Pop-Pop engines and the Second Law of Thermodynamics

The Pop-Pop engine is a form of heat engine. It is driven by heat and it produces mechanical work. According to the Second Law of Thermodynamics, the difference between the heat supplied and the work produced must be rejected as waste heat. The work produced is in the form of the kinetic energy of the water ejected from the tubes. There is no way for a significant amount of heat to be rejected other than via these water jets which must be warmer than the water sucked in.

At the hot end of the columns, it is thought that steam condenses into the face (meniscus) of the water and into the film of water in contact with the tubes. As the columns move backwards and forwards, the hot water at one end mixes gradually to warm the cold end which is the part that leaves the engine. A finger test will show that the first half of the tubes are hot to the touch while the last section is only lukewarm.

Making a transparent engine

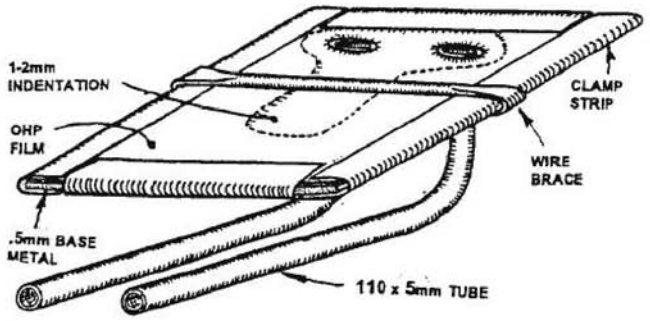
It is not easy to design a Pop-Pop engine that starts reliably and pulses regularly and indefinitely. This is not surprising since the working processes are complex and hidden from view and there is probably still much to learn. On occasion it has been found that when the design of a well performing engine was copied or changed slightly, the new engine would not work at all or at best, it functioned poorly. Design has been intuitive with generous proportions of luck and persistent trial and error. The handful of engine manufacturers should receive great respect and the ownership of a lively boat highly treasured.

Even with the insights gained, the ideas below are presented with trepidation because no guarantee can be provided that they will work. However, it is hoped that many will be lucky and persistent enough to make a transparent engine and experience the sight, sound and feel of your own creation.

The suggested engine has a 40 x 40mm lower boiler plate of 0.5mm thick copper, brass or stainless steel. It should be slightly indented with a ball pein hammer to a depth of from 1 to 2mm roughly over the shape indicated. Allow the metal to slope down to the indentation and do not attempt to form a perfect 'dish' (**fig 8**).

Two holes should be pierced, not drilled, 10mm from the edge at a 15mm pitch. The deformed metal can then provide support and strength for the tubes to be soldered in. First drill a 2mm hole and then drive through the sharpened shank of a drill bit matching the size of the copper tube chosen. This should be between 4.8mm ($^3/_{16}$in.) and 5 millimetres. Two 110mm long copper tubes should be bent around a former and then soldered in. Silver-soldering is not necessary (**fig 9**).

Cut a 40 x 40mm square of OHP film and lightly sandpaper a 5mm wide strip around the edges. Apply a generous layer of contact adhesive to the roughened areas and also around the edges of the boiler base plate. Allow the glue to dry thoroughly and then press the film down onto the boiler. Prepare four 12mm wide clamp strips made of thin tin plate. Bend them in half along the centre line. Squeeze them around the four sides of the boiler first by hand and then tightly with a pair of pliers or a vice. Fill the boiler with water by trickling water down one tube until it emerges from the other. Allow to soak for at least 12 hours before use.



© Figure 9

Mount the engine into the hull of your choice using Prestick (double sided adhesive tape). The enjoyment of the boat will be enhanced by finding a readily available pond. A round plastic tray with the boat tethered with a strip of OHP film is ideal. Light a small stub of a candle or a night light and place it at the centre of the boiler. Alternatively a *vertical* meths wick can be made using the thinnest possible string inside a matching brass tube.

The engine should soon begin to pulse. Unlike shim brass, OHP film is more flexible and the natural pulse rate of the engine will be slow. This can be speeded up by fitting one or more thin (0.9mm) wire braces with flattened ends across the top of the window. This appears to limit the outward bulge. Experiment with the number, shape and position of the braces and you may be lucky enough to find a combination that is rapid and pleasingly noisy. Alternatively, if you are able, make a single full size tin clamp plate with a matrix of holes for viewing. A 3 x 3 pattern of 8mm holes works well, as do three 14mm holes.

Watch your new engine carefully until you are sure that it not only pulses but is an indefinite pulser. Blow the flame out if the boiler simply fills up with steam without pulsing or if pulsing stops after some time because of too much air. There are no certain cures for these problems. If pulsing does not start, the base plate may be too flat near the edges. To promote the discharge of air, try shortening the tubes or adjust the wire braces to enhance the pulse strength.

If these measures do not work, try making another engine. You are as likely to succeed if you change something as you are if you try and make it identical. But once you try, you automatically join the small club of designers finding out by intuition and experiment which parameters and materials work consistently.

It is hoped that the insights provided here could help designers make engines that not only work but also perform better. Knowing some of what is happening has increased the author's enjoyment and wonder of these lively little devices that pulse briskly for as long as they are fed fuel and are given cold water into which to dump their waste heat.

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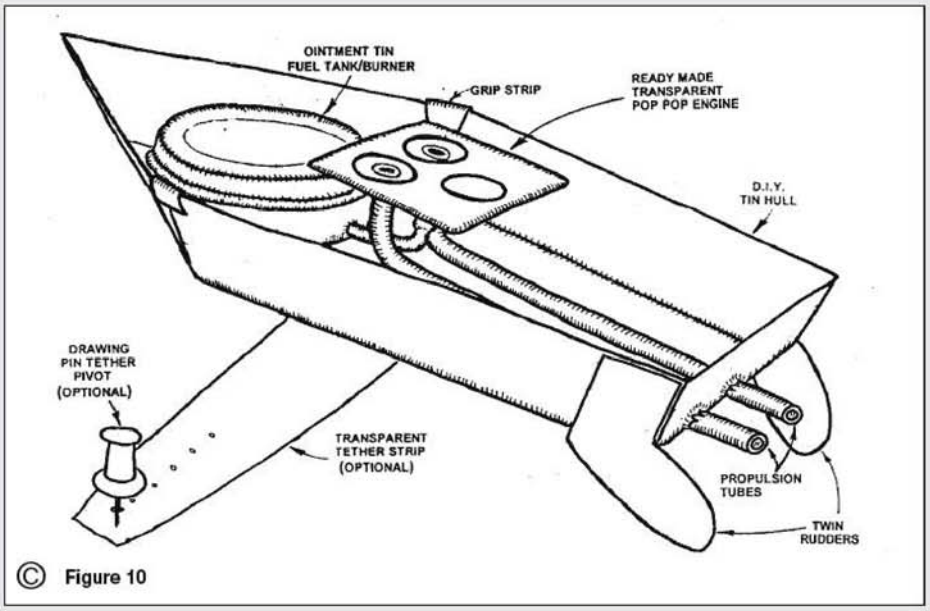


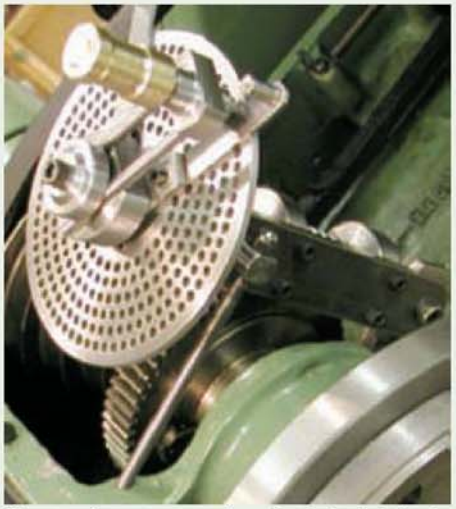
© Figure 10

INDEXING ATTACHMENT FOR THE MYFORD LATHE

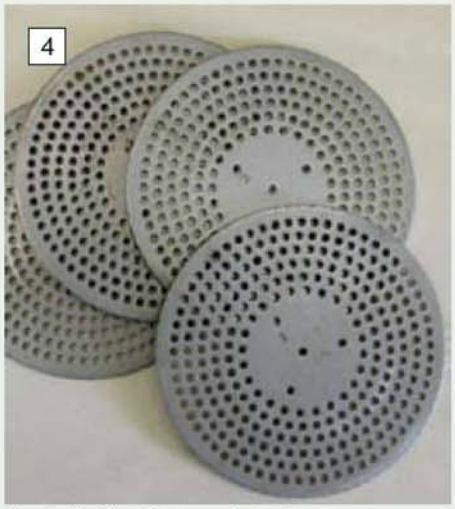
Colin Pape

continues his description of this useful device starting with the indexing assembly.

●*Part II continued from page 25 (M.E. 4212, 9 January 2004)*



The attachment mounted on the Author's lathe is in use here for indexing work on the faceplate.



A set of index plates purchased some years ago from Maidstone Engineering Services.

The indexing assembly consists of the index plunger housed in the index head and the radius arms and their hub. The index head is designed to provide a latch-up position so that the index plunger will be safely held above the plate when the index position is being changed. I used the Radford design and this latch works automatically when the plunger is lifted and the handle turned clockwise.

If the angle between successive operations on the work is greater than 6deg. it will be necessary to turn the handle through more than one revolution so it is necessary for the plunger to have enough travel to allow it to pass over the fingers. The plunger is held inside the housing by means of a small 1/16in. dia. pin. This pin is a light push fit in the plunger shaft. It cannot fall out in use because the brass handle covers it. A small spring is slipped over the thin part of the plunger prior to its insertion in the index head. This provides a light pressure to keep the plunger against the various latch positions.

It is necessary to remove and replace the index head with the radius arms and hub each time an index plate is changed. For this reason I designed these components to form a single sub-assembly attached to the shaft by two 4mm set screws. The set screws drive 3mm steel balls into two dimples drilled in the end of the worm shaft. Location is positive, repeatable and rapid. Choose set screws with dimpled ends rather than points. The set screws only have to be loosened by one or two turns. If you have remembered to put some grease in with the little steel balls there will be no tiny pieces to drop out and get lost. The index head and the associated pieces are shown in **fig 3**.

Finger assembly

This unit consists of the two fingers and a clamp device. The clamp plate is provided to allow the angle between the fingers to be set and maintained. This helps to ensure that, in repetitive operations, the index head moves through the same angle each time it is re-positioned. The clamp plate is tightened using a 3mm socket head screw. The 1/16in. dia. clamp pin prevents the clamp plate from turning. This pin is a force fit in the finger but a sliding fit in the clamp plate.

It is necessary to remove and replace the fingers each time the index disk is changed. I believe that it is important for the operator to be able to remove and replace these parts as easily as possible, so I designed the fingers so that they can be removed and replaced as a single assembly. One finger has a raised boss and the other accepts this in a recess so they will remain concentric and stay together during these operations. The finger pieces are shown in **fig 4**.

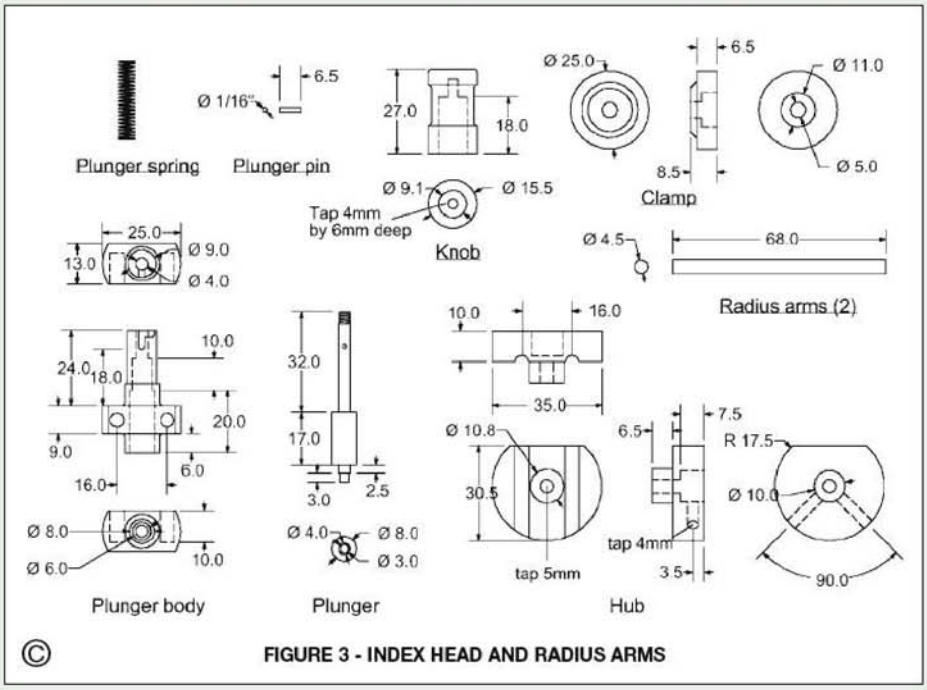
Note that one edge of each finger follows a radius out from the centre. The fingers are mounted so that these edges are towards each other and the fingers are normally set so that these edges provide the stops for the index head.

In this design the maximum angle that can be set between the two index fingers is about 220deg. but this does not mean that bigger angles are unobtainable. The only difference when working with bigger angles is that the angle is set using the outside of the fingers rather than the inside. The small knobs on the end of the fingers are secured by riveting. I used a fibre washer under the radius arms hub to hold the fingers against the disc surface. A wavy washer would be better.

Indexing plates

I believe that these are available from several sources. The set of index discs shown in **photo 4** was bought some years ago from Maidstone Engineering Services, which is now a part of Maxitrak (tel: 01580-893030). I had an idea at the time that I could mount these on an extension of the mandrel and fit some sort of index pin holder, but this idea was not sound so the discs stayed in a drawer for a few years. They needed using!

If you do not want to buy a set, you can make your own. The great thing about an indexing device like the basic Radford design is that you can use it to make its own plates if needed. To make the first plate all you need is a single positively located stop for the handle. With the future index plate held in the chuck, it is possible to drill quite a lot of holes in it with great precision. One revolution of the handle turns the work through 6deg. so, if you want to, you can



© FIGURE 3 - INDEX HEAD AND RADIUS ARMS

drill 60 holes in one circle on the index plate. If all you want to do is to make degree marks round the edges of some rotating devices or dials then this will be the only plate you will ever need.

However, just with this single indexing disc with its single circle of holes you can drill a number of equally spaced holes around a circle provided that the number of holes has prime numbers that are common to the number 60. The prime factors of 60 are 2, 3 and 5, so numbers like 4, 9, 15, 24 and 90 can be produced. It is not possible to produce numbers that have primes greater than 5. Of course there is an upper limit to the number of holes or you will chain drill a circle and the whole lot will drop off!

Once you have a plate with multiple holes around it, the possibilities of producing further plates are greatly extended. The problem with primes disappears for most purposes. For example, the next prime number up from 5 is 7 and we can produce 7 holes equally spaced in a circle using the 60-hole plate and these holes will have a maximum positional error of approximately 0.04 degrees. I am not sure if more precision would be useful for most operations that could be done in the lathe. This is because the necessary tolerances in the lathe slides will lead to positioning discrepancies.

Construction notes

In some cases I think a description of how I made the part could be helpful to others and perhaps allow them to avoid repeating some of my errors.

Backbone

This is a simple piece of 6 x 25mm bright drawn steel. Dimensionally it is very accurate but it may not be perfectly flat. Flatness is very desirable because if you have taken a lot of trouble to ensure that the bearings and sleeve are perfectly aligned you do not want to have a worm shaft that binds because the bearings are not sitting on a flat surface. I had to re-make the backbone because I did not notice that the bar had a very slight curve in it.

I do not know a way to straighten a bar of this resistance so I went through my stock until I found a truly flat piece and used it to make a new piece. Make sure not to remove any material from either side of a flat bar. The angle of the slanting face of the upper part of the post can only be established by measurement when the post has been mounted in the headstock.

The hole for the mounting screw is drilled perpendicular to the backbone. This means that after the angled face has been machined on the upper part of the post, the screw will not be perpendicular to the backbone when the backbone is tightened against the support post. It will have an angle of about 5deg. and so a sloping face of this angle should be machined around the hole (a sort of angled spot face) so that the head does sit flat on the backbone when it is tightened.

Worm

George Thomas wrote his book *Dividing and Graduating* in 1983 and in it he described the Versatile Dividing Head in considerable detail. He had covered the basic information on the VDH in a series of articles in *M.E.* in 1978. In the intervening years he had become aware that quite a lot of people had built his device and its headstock attachment. He mentions this in the book but he adds: *"I gather that very few makers have opted to turn their own worms. Possibly the QC gearbox has something to do with it."*

My lathe has a quick change gearbox but I cut my own worm. I did not really have a choice since I have no idea where I could obtain one ready made. I have never cut a gear of any sort prior to doing this. I was very slow and cautious but there was no problem. I produced a very clean worm that looks very nice and runs smoothly with no tight spots. So, if any reader has any doubts about his ability to cut a worm I hope that my experience will help to remove these doubts. I made my worm shaft with three changes, which are quite significant. The first of these concerns the length of the worm, the second concerns the pitch and the third is to the anti-backlash device.

First, the length; I was nervous about making the worm so I was anxious to make it as simple as possible. I consider the worm in Radford's design to be unnecessarily long and I reduced the length. In my opinion, the result is still a bit long, but I have shown the dimensions that I actually used.

Second, the pitch: I suppose that Mr. Radford's specification gives the optimum pitch for normal use of a worm, which is to transmit power. Mr. Thomas gives two change wheel combinations for cutting the worm. He says that they are close approximations and there is not a change wheel combination that gives an exact result. His combinations are:

60 – 55/65 – idler – 45
or
46 – 50/60 – idler - 35

I was somewhat curious about Mr. Thomas' remarks on builders being reluctant to cut a worm and that maybe this had something to do with the gearbox. In my case I was not sure how to use the change wheel information with my lathe, which has a gearbox, so I looked for an alternative.

My lathe has a metric specification, I have the metric change wheel set, and I usually work in metric dimensions. The metric equivalent of 0.19707in. is 5.0056 millimetres. Inside the end cover of the lathe is a label giving the change wheel combinations for all the usual metric threads. The maximum pitch that is shown is less than 5mm but one of the 'standard' metric pitches that can be cut is 2.5 millimetres. By changing the drive pinion for the metric wheels that cut this pitch from the standard one to another with twice the number of teeth, 2.5mm becomes 5.0mm and this is very close to the specified dimension.

Is it close enough? I think so. All that happens if you have a worm with a pitch slightly bigger than specified is that the worm sits a little higher on the spur gear. This might be important for power transmission but it does not matter for this application where all we want to do is to transmit positional information. The load on the teeth is insignificant. So I used the metric change wheel set and cut the worm with a pitch of 5 millimetres. The result has been entirely satisfactory.

The third change concerns backlash elimination. In the Thomas/Radford design, backlash is eliminated using threaded collars fitted to the worm shaft at each end of the worm. These collars are adjustable and after being set are locked in place. I decided to eliminate these parts and exploit the fact that the worm has a left-hand thread.

Since the bull wheel is being pushed backwards at the top, the worm is being pushed toward the operator and a thrust plate is required on this side. This can be in a fixed position. I designed the centre bearing housing to provide this support. A simple device to stop the worm moving away from the operator is all that is required to eliminate backlash and I used a 4mm steel ball set in the centre hole left in the end of the worm shaft. A setscrew in the end bearing pushes this ball into contact with the shaft and keeps it there.

●*To be continued.*

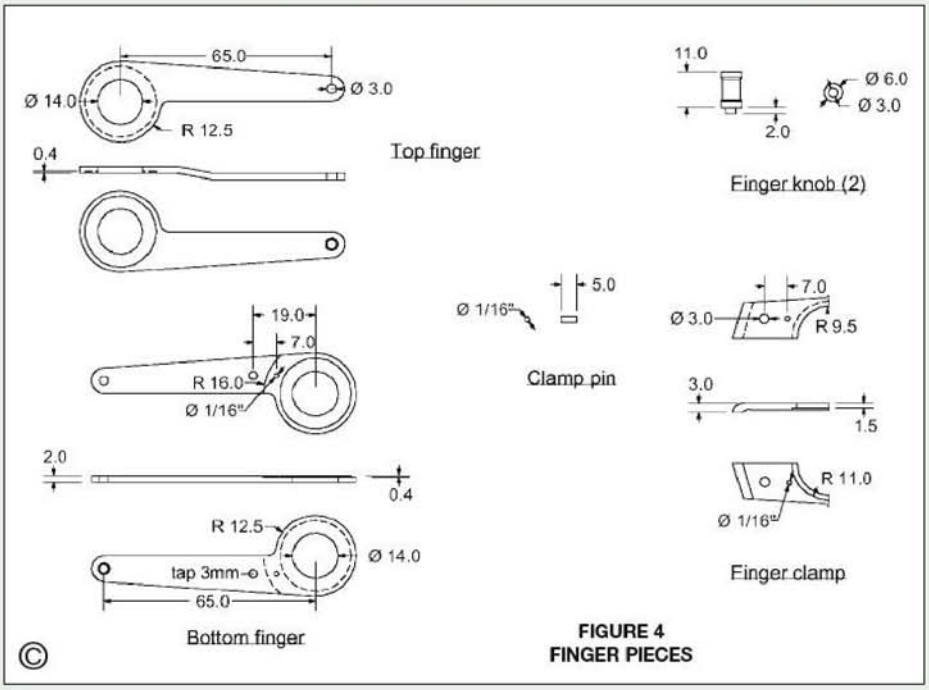


FIGURE 4
FINGER PIECES

PERFORMANCE TESTS FOR A SMALL I.C. ENGINE

Dr. Michael Ackerman

describes his first foray into i.c. engine building as a fascinating, thought provoking and very rewarding exercise, and hopes his words will encourage others to try their hands in this area.

Although quite a selection of constructional and descriptive articles concerning the internal combustion engine have been published over the years, I cannot remember seeing much on performance testing. Admittedly my sampling of *M.E.* has been rather sparse, but I am still hopeful that this article may be of interest in that it presents quantitative test results over a fairly wide range of conditions for a 5cc OHV single of the spark-ignition, 4-stroke persuasion. Of course, most miniature engines are not designed to give a particular power, but to do a job of work, so the question of absolute power output is often academic. It is interesting though to get an idea of how a particular engine performs. The tests reported here have also raised some interesting questions about the effect of scale.

To begin with I must make some acknowledgements. The idea of building miniature engines was sparked off for me by a chance purchase of a set of *Model Engineer* magazines of 1973 vintage which contained L. C. Mason's constructional series on the *Mastiff* flat four engine. The workshop skills to do so were encouraged and developed under the eye of Tim Holt, head of the Engineering Workshop at Reading University.

A focus for the idea of a miniature engine came from my hometown of Bristol, once famed for the Bristol Aircraft Corporation and their radial aero engines. In short, I decided to design and build a five-cylinder radial myself. However, since this would be my first effort at a miniature i.c. engine, I thought it prudent to begin with a single-cylinder prototype on which to make, with luck, most of my mistakes. That prototype is the engine on which the tests described here were carried out.

Design philosophy

The ultimate goal was a five-cylinder, poppet valve, radial, air cooled and spark ignition of course, driving a large air screw at modest rpm, somewhat in the style of the classic Bristol OHV aero engines of the thirties. The original design compression ratio was 6.5:1, which is in line with this philosophy. I did not want to use any special materials, since most of my materials come out of somebody else's scrap bin. My favourite specification is GNC (got for no cost). In order to avoid having to make any very miniature components for this first effort I decided arbitrarily on a swept volume of around 5cc per cylinder.

Another arbitrary decision was to design for a speed of 6,000 rpm. Having been exposed to the Velocette *Venom* 500cc, single cylinder motor cycle at an impressionable age I have always considered 6,000 rpm to be quite recklessly fast. The speed should scale as the inverse of the length scale, but I most definitely did not want an engine that screamed. On the other hand, I had in the back of my mind that the engine, if successful, might, one day, end up in an airframe, so I did not want to limit the power by restricting the rpm too much.

When I lay down the outline design I was not aware of the whole range of Bristol radials, and did not realise that an early one of the series was a five-cylinder engine called the *Titan*. I later discovered that the main dimensions of bore and stroke of my design made it close to a one-eighth scale *Titan*. Since the *Titan* design speed was 2,000rpm that would imply that the model should run at 16,000rpm, way above my self-imposed limit.

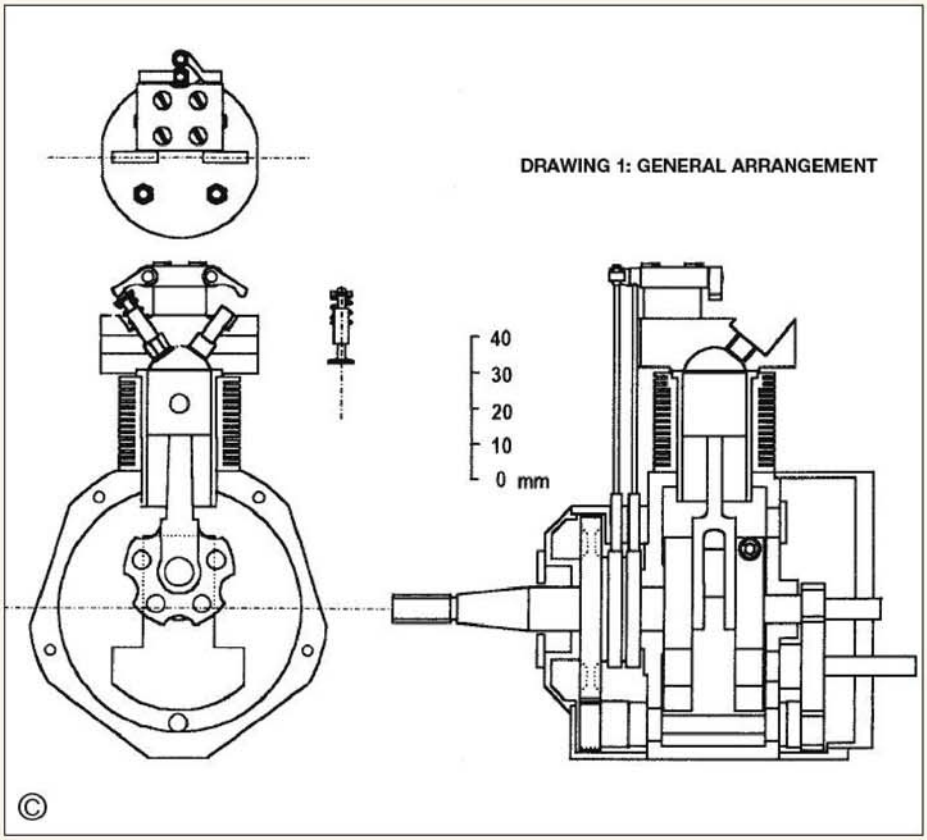
Another good reason for adopting a speed lower than the scale speed is that it does make the designer's life much easier. In general, material stresses should be the same for a scale engine running at scale speed as for the prototype, so the component stresses in my engines should mostly be on the low side. The valve train is also rather easier to deal with below scale speed. I wanted the engine to idle reliably at low rpm, so adopted, originally, very soft valve timing. The somewhat vague idea here was that the model engine would be running well below scale speed and so might be more tractable with a woolly, side-valve kind of valve timing.

Description of test engine

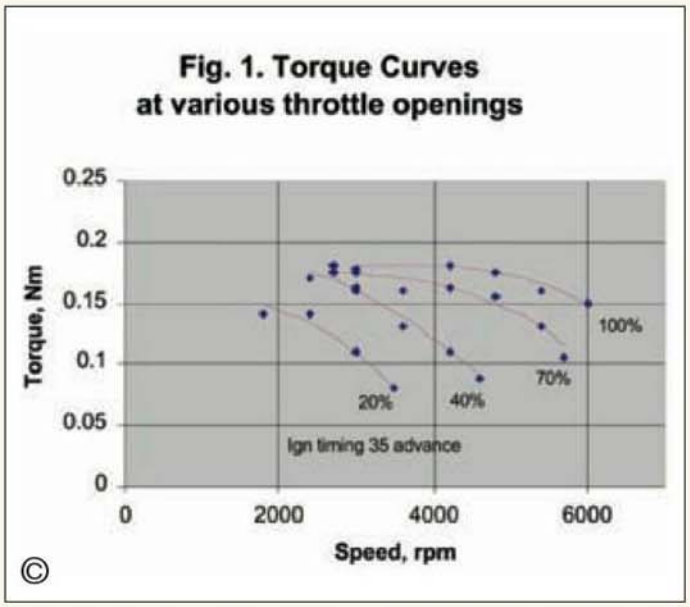
Again, credit where credit is due: the first thing I should do is acknowledge the extent to which I took inspiration from L. C. Mason's methods and ideas. Other influences were a familiarity with the aforementioned Velocette *Venom* and, of course, the Bristol radials. For some details I found Ricardo and Hempson's classic *The High Speed Internal Combustion Engine* very useful.

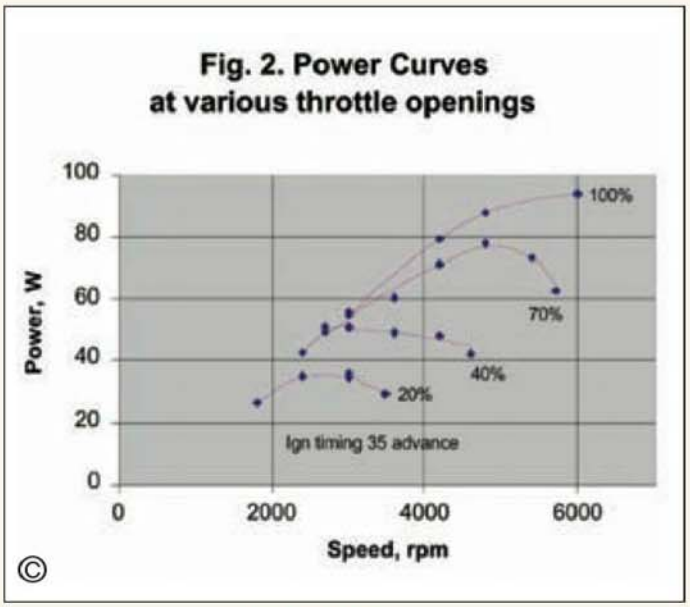
The engine is unusual in that it is really a radial with only one cylinder. That is to say, the major bottom-end components follow radial practice, while the components from the cylinder upwards would be appropriate to a range of engine types. The tests described here thus have relevance beyond this peculiar prototype, with one or two provisos.

The crankshaft is split, with main shaft, front web and crankpin in one lump. The rear web and timing/auxiliary shaft is attached firmly to the crankpin by a split bore and pinch bolt following Bristol practice. The connecting rod was made as a radial master rod, first for the practice and secondly to have about the right amount of metal flailing around. It thus holds four dummy slave big end pins. A pinion on the rear shaft drives a gear



DRAWING 1: GENERAL ARRANGEMENT





on the half-time shaft, which extends to the rear to carry the contact breaker cam. The half-time gear then drives a crossover shaft at engine speed to take the drive to the cam gear at the front of the engine. Traditionally, the cam ring of a radial would be driven by epicylic gearing in the front cover, but the crossover shaft is easier to lay out and suited some gears that I had to hand. Again for the practice, the cam was constructed on the radial pattern, a two-lobed cam ring revolving counter to the crankshaft at one-fourth-engine speed.

The main shaft runs in a long plain bearing bush, on the outside of which runs the cam ring and gear. What with this and the crossover shaft bearings, there is much more plain bearing area in this engine than would be found in a more orthodox 5cc single, so we can expect the power output to be on the low side. Short cam followers with radiused ends slide in the front casing, from which push rods extend up to the valve rocker arms.

The cylinder consists of a cast iron liner lapped to a good finish, inside a light aluminium alloy finned sleeve. The piston is machined from the solid in light aluminium alloy, and designs using one or two cast iron rings were tried. The cylinder head is an aluminium alloy unit providing a near-hemispheric combustion chamber, held down by long studs extending through the barrel to the crankcase. Stainless steel valves seat directly in the head and run in bronze guides, with an included angle of 70deg. between them. The valves are operated by steel rocker arms carried in an aluminium alloy bearing block attached to the cylinder head. The valves and rocker gear are not enclosed, in keeping with Bristol practice, and because it is nice to watch it all working.

Ignition was by a coil set-up for all the tests described here, although I did get side-tracked into building a miniature magneto for good measure. Commercial 1/4in. x 32tpi spark plugs were used, and found to be trouble-free despite poor oil control. The ignition timing was made manually variable over a range of about 5 to 45deg. before tdc. The carburettor was a simple affair, basically a plug cock for air control with an independent needle valve control over fuel admission to a central jet, so that a good mixture could always be obtained, though not automatically. Lubrication was by splash, using a wet sump.

Some representative part-sectional sketches of the general arrangement are given in **Drawing 1**, and some salient dimensions are given below:

Bore and stroke: 18 x 20mm
Valve lift: 2mm
Valve head diameter: 7mm
Port diameter: 5mm
Carburettor choke diameter: 4mm

Range of test conditions

Ignition timing: 25 to 45deg. btdc
Throttle opening: 20, 40, 70 and 100%
Valve timing: Two cam designs detailed in table 1 below, and effect of tappet clearances
Compression ratio: 6.5 and 8

Table 1. Valve timings

	Inlet Opens btdc	Inlet Closes abdc	Exhaust Opens bbdc	Exhaust Closes atdc
Cam 1	10	40	60	0
Cam 2	14	48	70	8

The piston-cylinder clearance and piston ring type and number were not rigorously investigated for performance but various observations were made on the different set-ups.

The load in these tests was a permanent magnet, d.c. electric motor extracted from some ancient printer; it was a low speed, high torque design. Driven by the engine as a generator, it proved to match the speed/torque characteristics of the engine quite well, with the loading easily controlled by means of a rheostat. It also worked well as a starter motor. It was mounted in bearings and restrained by a sprung arm, which moved over a calibrated scale to give a direct reading of torque. Engine speed was measured by a magnetic type rev-counter.

Cylinder head temperature was measured with a thermocouple and used to control an auxiliary cooling fan, so that engine temperature could be maintained at a desired value. A temperature limit of 150deg. C was adopted since that was the cylinder head temperature measured on my RS250 Honda under near full load conditions. As a point of interest, air-cooled radial aero engines could operate with cylinder head temperatures as high as 300deg. C, but this is too high for my liking.

Test results

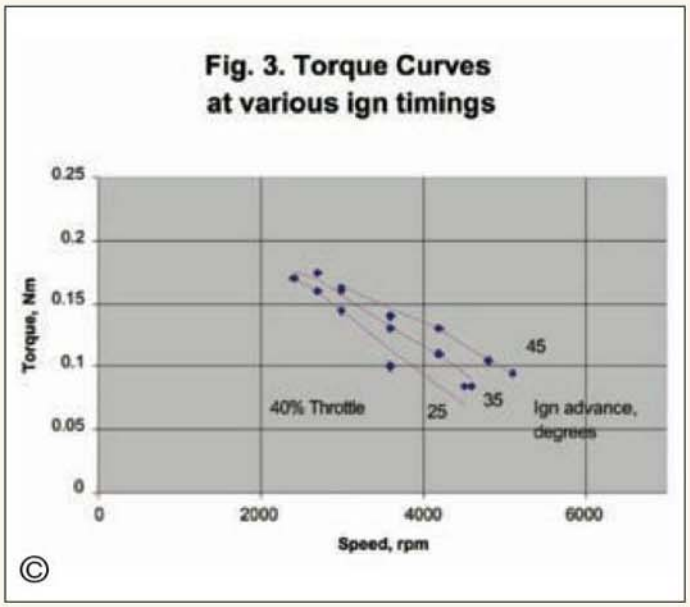
I would not pretend that the test program was very rigorous; with a number of variables and some empirical developments to piston and piston ring arrangements a thorough test matrix would have taken more time than I had to spare. So, not every permutation of ignition and valve timing, throttle opening and piston version have been pursued. Towards the end, in fact, things were degenerating somewhat into a pursuit of power. Over the whole test program the maximum power obtained at the arbitrary rev limit of 6000 rpm rose from 94W (1/8hp) to 146W (1/5hp), an increase of a little more than 50%.

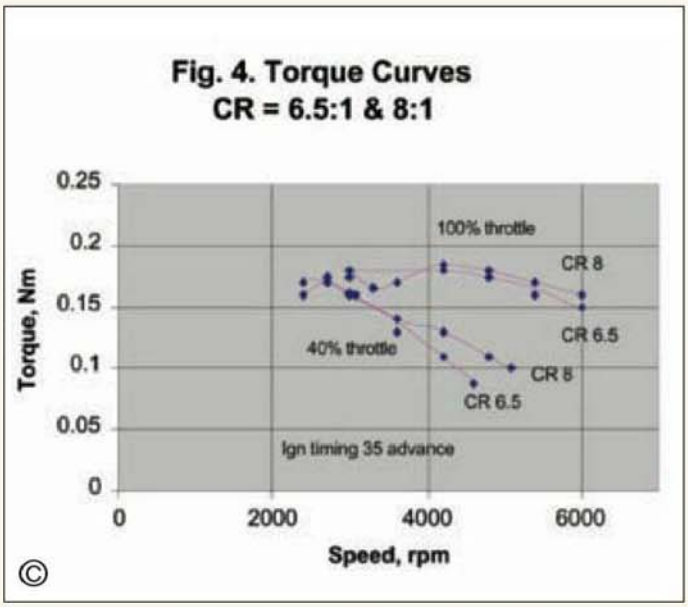
The first two graphs show the torque and power characteristics against engine speed for throttle openings of 20%, 40%, 70% and 100%, all at a fixed ignition timing of 35deg. advance. The compression ratio was 6.5:1 and the first (soft) cam was used. These results were the first consistent set of data taken after a short period of running in. So far as the accuracy of the results is concerned, I would be surprised if the absolute accuracy of torque results were better than about ±0.01Nm due to stiction, vibration and the like, but repeatability within a data set was good. Accuracy of speed measurement is thought to be in the region of ±3%.

As can be seen, the engine is capable of quite flexible operation over a range of speeds and powers. The maximum power recorded represents about 25bhp/litre.

The next investigation concerned the sensitivity to ignition timing.

The graph shown in **fig 3** is probably the best data set but the results were not very consistent. These results are interesting in that even at 45deg. advance, a large angle by normal standards, the output at higher speed is still increasing; there was not enough adjustment to discover the optimum torque setting. Also the engine seems quite insensitive to spark timing at lower speeds. The engine was still tractable at 45deg. advance down to 3000 rpm or a little less. This tolerant behaviour may be a result of the less-than-scale speed, in that the piston speed and hence the charge swirl and turbulence will be less than usual values. A decrease in charge turbulence would result in less rapid combustion, which has a similar effect to a reduced ignition advance. This, incidentally, is hindsight; having a fixed idea that 45deg. advance was an awful lot I did most of the testing at a nominal 35 degrees.





Encouraged by these early results, and particularly by the general flexibility of the engine, I decided to increase the compression ration to a nominal 8:1 by shortening the cylinder barrel a little. Thermodynamic analysis, in the form of the Air Standard Cycle, indicates that a change of c.r. from 6.5:1 to 8:1 ought to increase the thermal efficiency by about 7%, and arguably give the same increase in typical torque and power *to a first approximation*. Well, some of the data does and some of it doesn't, as shown in **fig 4**. There is a torque increase at the higher speed end of the characteristics at both part and full throttle, but it is debatable whether the increase is very significant compared to the uncertainties in the measurements.

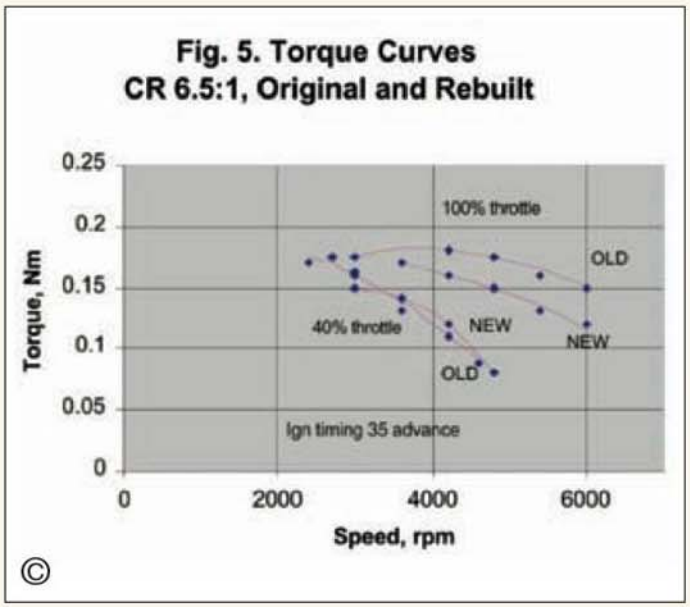
Things took a turn for the worse around this point so far as an orderly test program was concerned. In the testing of a variety of different carburettor set-ups the engine was running with wild mixture variations, and this may have contributed to a gradual falling off in performance. I stripped the barrel and piston for inspection and found the bore to be quite scored. The cylinder was re-lapped, but on re-assembly it became evident that I had enjoyed beginner's luck with the first assembly of barrel, piston and ring, because I did not obtain the earlier levels of performance.

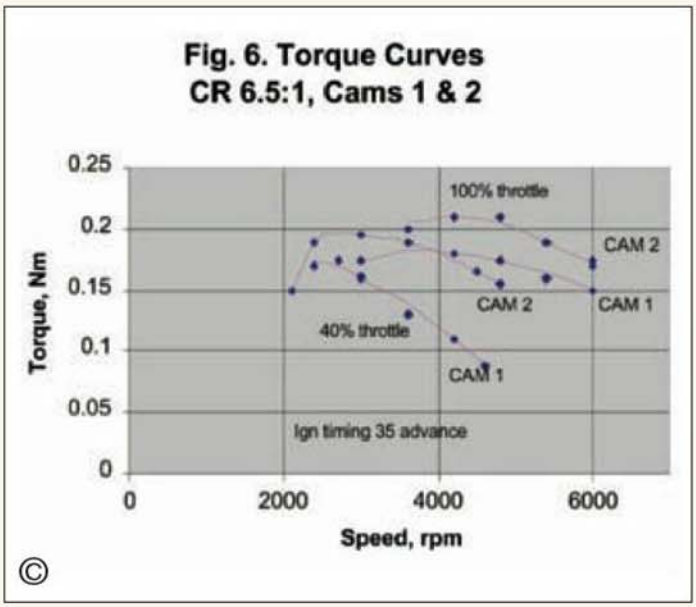
There followed a frustrating sequence of rebuilds, ringing the changes on piston fit and piston ring details. Eventually I decided that I had simply underestimated the original piston clearance, so had been making the fit rather tight in an effort to replicate the original favourable set-up. At least, this is consistent with the observation that the original performance was reasonably well reproduced at part load, but fell off at high load, presumably as the piston expansion increases the frictional losses. The peak performance is obviously quite sensitive to the build details. **Figure 5** gives a typical test result from this period compared with historic data showing the progressive power loss with increasing load.

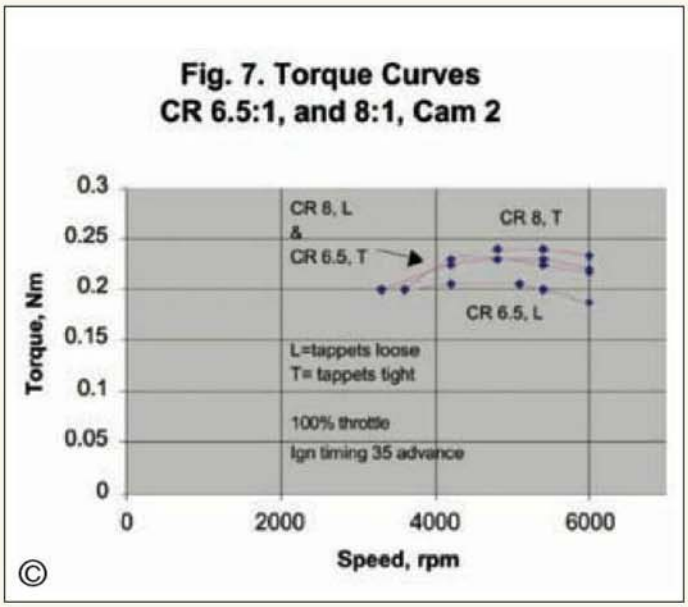
Since the optimum piston fit would depend to some extent on the maximum power, I decided to try to up-rate the engine by fitting new cam rings before continuing to explore this aspect of the design. Accordingly, new cam rings were made having more dwell and overlap, more consistent with OHV practice but still not exactly hot cams. However, the effect was fairly dramatic. The maximum available torque increased by about 15 to 20% more or less across the board from the best previous test results, but only for short periods near full load because of the tight piston clearance when hot. After some more tinkering, a piston fit was found which would allow sustained full load running without tightening up.

The necessary clearance was about 0.03mm on the diameter so far as I could tell; it was actually quite difficult to measure accurately. **Figure 6** compares the performance with the two cams with this piston. The graph appears a little jumbled because the performance at 40% throttle with cam No. 2 overlaps the full throttle performance with cam No. 1. The engine was still quite flexible, as can be seen by the curve for 40% throttle and cam No. 2 extending almost down to 2000 rpm. It is interesting that the part-throttle curve shows the largest performance gain, because I had assumed that the breathing of the engine would be dominated by the throttle restriction in that region. The c.r. was returned to 6.5 on this rebuild.

Having now realised that valve timing was the way to go, I also realised that I could obtain a little more angle of opening by running with tighter tappet clearances. I had previously been setting the tappets to be just free on a cold engine, but perhaps with no very great care. I had also observed that the tappet clearances on the hot engine would increase to about 0.1mm. A little calculation showed that with the cam geometry used, clearance would effectively reduce the opening period by about 10 degrees. So my valve timings would have been rather softer even than I had intended. It is all very obvious in







hindsight, but then this was my first essay into engine building. Anyway, in the light of this, a test was carried out in which the engine was first run up to operating temperature, then the tappets reset to be just free on the hot engine, then a performance check done. Another significant performance gain was seen.

All of this testing was done with a nominal c.r. of 6.5:1, and to round off this series of tests the c.r. was increased to 8:1 again, and the testing repeated with normal and hot-set tappet clearances. The torque curves for the four permutations of c.r. and tappet settings are shown in **fig 7**. These results are intriguing. With the higher c.r., an apparent performance increase of about 15% was found with normal tappet setting, but the performance seemed much less sensitive to the tappet settings. Part of this behaviour I think is simply a reflection of uncertainty about the exact clearances. The highest power recorded in these tests was about 146W, corresponding to about 39bhp/litre. This sounds like a reasonable figure compared to the performance of the classic radial aero engines, but there is much more to be said about this, and humble pie to be eaten, later.

I was fairly happy with the performance by now, but there were still some questions in my mind about a suitable piston fit and ring details. I had by trial and error arrived at a fit that, with a single piston ring, seemed to give satisfactory performance without nipping up when hot. The gas sealing of the piston rings seemed quite reasonable; compression seemed good and no great blow-by could be detected, but the oil control varied between poor and dreadful. What was needed were some tests to investigate some of the variables such as the radial and axial fit of the piston rings, and some testing also of a two-ring piston. Aa a University lecturer, I am sometimes able to farm out interesting pieces of investigation like this in the form of student projects, and this was the case here.

A helpful chap called Fred Rice took on this project and after a fair amount of testing, established that the ordinary rules of thumb for full size engines seemed to work quite well even at this small scale. He was also able to show that the performance of the engine was little affected by the ring details, but that the oil control was, and so a two-ring design for the radial was finalised. Subsequent experience with the radial actually makes me think that oil control is also much more profoundly affected by the exact piston to cylinder fit than we appreciated then.

At this point I decided to stop development of the single and to proceed with the design and construction of the radial engine.

Performance comparisons and scaling

The single-cylinder engine has certainly fulfiled its purpose of informing the design of the radial, but has also raised some interesting questions concerning scaling effects; for instance the results at large ignition advance angles. Also, once the pleasure of simply having an engine that runs wears off, the question arises of how good an engine is it. Before actually looking into the question of scale effect I had always assumed that the specific power (bhp/litre) was a good measure of an engine. Now I realise that the scaling laws indicate that specific power can be expected to be higher by the inverse of the scale factor for smaller cylinders. (The scale factor is the ratio of the linear dimensions as usual.) I had been vaguely aware that multi-cylinder engines tend to out-perform singles or twins, but had not realised that there was a fundamental principle at work. This explains why some fairly extreme engines such as the Moto Guzzi 500cc V-8 were built. Obviously there are practical limitations to how far the philosophy is pursued. When this penny dropped, I was left feeling a little sheepish that I had been under a misapprehension during the whole of my acquaintance with engines. I soon discovered however that everyone else in my circle of engine aficionados was similarly challenged by the idea, so perhaps it bears a little elaboration.

The scaling laws as I have seen them expressed (*Internal Combustion Engines*, Lichty, 1939), assume that for engines to be considered similar, the piston speed and gas velocities must be the same. Thus the engine speed scales as the inverse of the length scale, and pretty much everything else follows from that. In particular, the power output can be expected to scale with the square of the length scale because it is proportional to the product of swept volume and engine speed. Then the specific power, the power per unit volume, should scale as the inverse of the scale factor.

The test of equal performance becomes not whether the specific powers are the same, but whether the brake mean effective pressure (bmep) values are equal. The bmep is that hypothetical pressure which, if acting on the piston over the whole of the power stroke, would result in the brake power developed. It can also be regarded as a measure of the torque per unit volume. Now, bmep depends directly on engine size, power and speed and indirectly on a number of factors including compression ratio and valve timing, so this complicates comparisons between engines which are not exact scale copies of each other.

Within a range of engines designed to a common purpose, the principles are fairly well demonstrated. Because these ideas were unfamiliar to me, and old habits of thought die hard, I looked around for some comparative engine data with which to convince myself. I am grateful to my colleague Neil Larsen for providing me with some useful data for a range of production 500cc motorcycle engines of the late '70s. Comparing a Honda 500-4, the Honda 500-T twin and the Yamaha SR 500 single, the bmep values are within 5% of each other at around 9.2bar, reflecting the similar state of tune of these engines. The specific powers, though not scaling exactly to the inverse of the bore, are about 45% greater for the four-cylinder engine than for the single, being about 94 and 65bhp/l respectively, and the design speeds nearly so at 9000 and 6500rpm.

As might be expected, trying to apply scaling laws across wider ranges of cylinder size and engine type is less clear cut. In particular, departures from scale speed obscure the specific power scaling. Suppose we arbitrarily take, say, the above 500cc single as a datum. Few very small engines work at anything like the scale speed, perhaps chiefly on the grounds of noise abatement. As it happens, the large engines for which I have detailed data are of 1930s vintage, which also ran slower than scale speed, presumably from limitations on materials then available. However, making allowance for non-scale speeds, the performance of a Rolls-Royce *Kestrel* (1770cc cylinder) and an OS FS120 (20cc cylinder) are broadly consistent with the principles outlined above.

Having convinced myself that I should be looking to the bmep as a figure of merit, the results are humbling. Although my little engine ended up with a specific power of around 40bhp/l which sounds reasonable for an engine in a low state of tuning, the corresponding bmep value of a little less than 6 bar is pretty low by any standard. With a bit of development though I might be able to get close to the value of 7.8bar that the Bristol *Titan* was achieving in 1927. Actually, bmeps of about 7.8 bar are also typical of commercially available small four-stroke model aircraft engines.

In my defence it must be said that I had started out with tractability as a high priority and certainly achieved that, but it seems that I may have overdone it a bit. The radial has been treated to a bit more valve opening time and overlap with that in mind, together with an allowance for hot valve clearance. Initial trials of the radial have been encouraging, but accurate performance testing has yet to be done. In addition, the test results show that unusually large angles of ignition advance could probably be used to improve performance further if required.

In conclusion, my first foray into i.c. engine building has proved to be a fascinating and thought provoking exercise, and very rewarding when the thing splutters into life for the first time. Perhaps these words will also encourage others to try their hands in this area.

WORLD TIME DIAL CLOCK

Ian Beilby

continues work on his unusual timepiece with depthing the train.

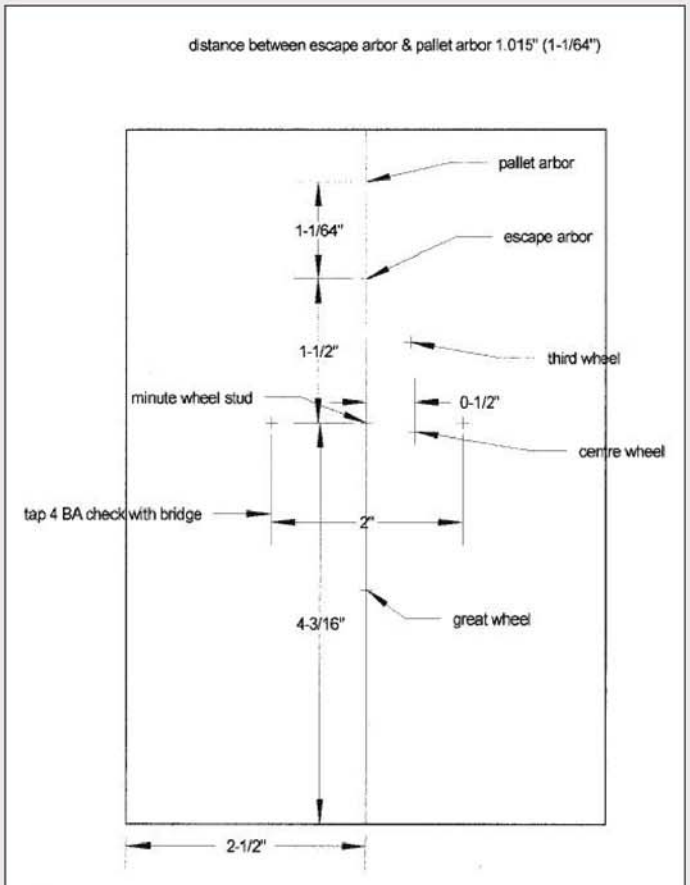
●*Part IV continued from page 27 (M.E. 4212, 9 January 2004)*

WHEEL, PINION AND DISC DATA

WHEELS							
Addendum 2.72	Module	No. off	Thickness (in.)	Blank diameter (in.)	Blank diameter (mm)	No. of teeth	Bore (in.)
Great wheel	0.85	1	3/16	3.305	83.947	96	5/16
Centre wheel	0.85	1	1/16	1.699	43.155	48	3/16
Third wheel	0.85	1	1/16	1.431	36.347	40	3/16
Rev. minute wheel	0.85	1	1/8	3.104	78.842	90	3/16
Rev. hour wheel	0.9	1	1/8	0.806	20.472	20	3/16
Hour wheel	0.9	1	1/16	2.932	74.473	80	1/2
Escape	No. 6 recoil	1	1/16	1.436	36.474	30	3/16

PINIONS							
Addendum 2.72	Module	No. off	Thickness (in.)	Blank diameter (in.)	Blank diameter (mm)	No. of teeth	Bore (in.)
Centre, Third, Escape	0.8	3	5/16	0.325	8.255	8	3/32
Addendum 1.61							
Minute wheel	0.8	1	1/8	0.556	14.122	15	3/16

DISCS							
	Module	No. off	Thickness (in.)	Blank diameter (in.)	Blank diameter (mm)	No. of teeth	Bore (in.)
Moon Disc	-	1	1/16	5	127.000	118	3/16
Country Disc	-	1	1/16	6	152.400	-	11/16



© **WORLD TIME DIAL CLOCK Figure 10: Frontplate**

I am assuming the constructor is conversant with the John Wilding depthing tool whereby the wheels and pinions are depthed before they are fixed to their respective arbors. I intend to describe depthing the wheel train and motion work using this tool rather than the conventional depthing tool. Many amateurs tend to cut their solid pinions as separate pinion heads and secure them to the arbor with Loctite. Also, if the pinions are bought in ready cut, they are usually supplied in this form. Should constructors wish to use a conventional depthing tool, further arbors would have to be made to accommodate the motion work wheels.

When depthing a clock train, it is normal to work from the position of the centre wheel (centre hand) up through the train and down to the great wheel. So here, we are starting from the point of the minute wheel stud, marked on the front plate in **fig 10**. In effect we are depthing the motion work first, and from this determining the position of the great wheel. From there we can then go on to depth the rest of the wheel train. The position of the minute wheel stud should be carefully centre punched on the centre line, as well as the positions of the pallet arbor and the escape arbor.

The 15-tooth minute wheel is meshed with the 90-tooth reverse minute wheel. Without altering the setting of the depthing tool, the 20-tooth reverse hour wheel and 80-tooth hour wheel should be meshed, and should be found to depth correctly at the same setting. If either pair of wheels feels tight or too loose, the depthing will have to be adjusted until both pairs of wheels mesh comfortably at the same setting.

In all cases, when depthing motion work, the depthing should be on the loose side rather than tight. One runner of the tool is positioned in the punch mark locating the minute wheel stud, and the other runner should scribe an arc below this, with the centre line. This is the position of the great wheel arbor. The position of the great wheel should then be centre punched.

Before depthing the great wheel with the centre wheel pinion, a line should be scribed on the front plate 1/2in. to the right of the centre line as shown in fig 10. The great wheel should then be meshed with the centre wheel pinion and an intersecting line scribed with this line from the position of the great wheel. This intersection should be centre punched.

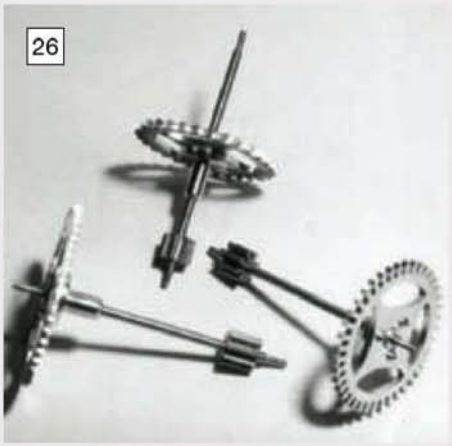
The third wheel should then be meshed with the centre wheel pinion, and an arc struck to the right of the centre line from the position of the centre wheel. Finally, the third wheel should be meshed with the escape wheel pinion, and an intersecting arc struck with the previous arc from the position of the escape wheel. This intersection should also be centre punched.

Drilling the plates

The position of the minute wheel stud on the *front plate* can now be carefully drilled and tapped 5BA. Both plates are then registered together and held with a pair of toolmaker's clamps before being taken to the drilling machine in order to drill the wheel pivot holes. At this stage do not drill the holes for the pallet arbor.

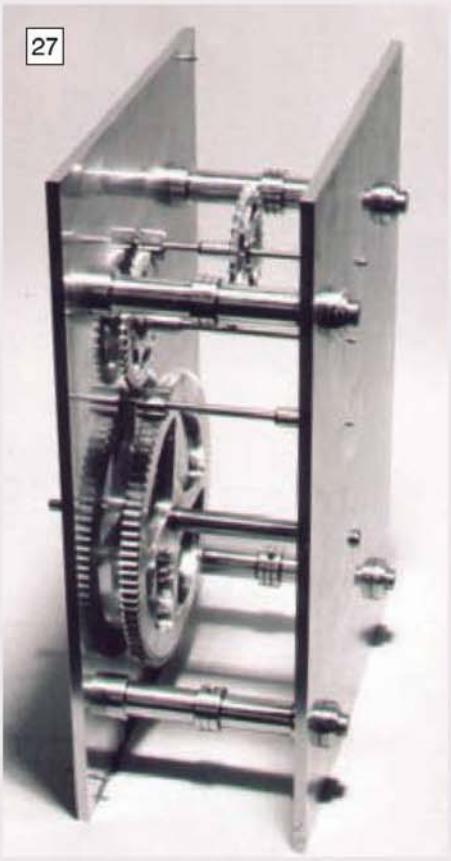
All the holes should be drilled undersize for their respective pivots. I generally use a 1mm drill to initially drill all the holes, which is undersize for all the pivots in this clock. The holes for the great arbor will require further drilling to just under the 3/16in. diameter of the arbor pivots. When drilling large holes, ascending sizes of drill should be used and care should be taken to see that the drill does not wander. It can help to scribe several circles with a pair of compasses prior to drilling, should the drill be found to be wandering it can then be corrected with a round file.

The escape, third, and centre wheels can now be drilled with three equidistant 10BA tapping holes. The third and centre wheels can then be fitted to their respective collets. If the collet wheel seatings have been left oversize, the wheel centres will require broaching slightly, in order to fit the wheels onto the collets. The three holes in



The wheels and pinions assembled and fixed to their arbors with Loctite.

The face angle of the click should be such that its full width bears against the crossing.



After checking individually and in pairs, the entire train wheelwork can be assembled and tested.

the wheel can then be used as a template to drill the tapping holes in the collet. The holes in the collet are then tapped 10BA, and the holes in the wheels opened to 10BA clearance. The wheels are then screwed onto their collets with three 10BA screws. The escape wheel should not be fitted to its collet just yet.

The great wheel should secured to its arbor with Loctite, and again if the wheel seating was turned slightly oversize, the wheel centre will have to be broached until the wheel will *just* fit onto its seating. A suitable hollow brass punch should be made, and used to drive the wheel on to the arbor. The punch should be made from a 2 1/2in. length of 1/2in. brass, drilled 5/16 inch. The end of the punch should be polished in order not to mark the wheel. The 1/2in. diameter arbor collar will have to be supported in a suitable stake, and the wheel can then be driven all the way on to its seating. All the wheels and pinions except the escape wheel can now be fixed in their respective positions on their arbors with Loctite (**photo 26**).

A tapered cutting broach can now be used to open up the holes in the plates to fit the pivots from *inside* the plates. The plates should be screwed up tightly, and each wheel should be tried in turn and should spin freely, coasting to a gradual halt. There should be no sudden stoppage, and the wheels should spin irrespective of the position of the plates, whether face up, or down.

The wheels should then be tried in pairs, and again the wheels should spin quite freely and coast to a gradual halt. There should also be a noticeable amount of endshake between the arbors and the plates. The entire train wheelwork can then be assembled and tested (**photo 27**).

As mentioned in Part I (*M.E.* 4208, 14 November 2003), the great wheel revolves anti-clockwise. The click pulley should be assembled on the great arbor, and a check made to ensure that the face of the click makes positive contact with the wheel crossings. The face angle of the click may require filing relative to the crossings in order that the full width of the click face bears against the crossings (**photo 28**).

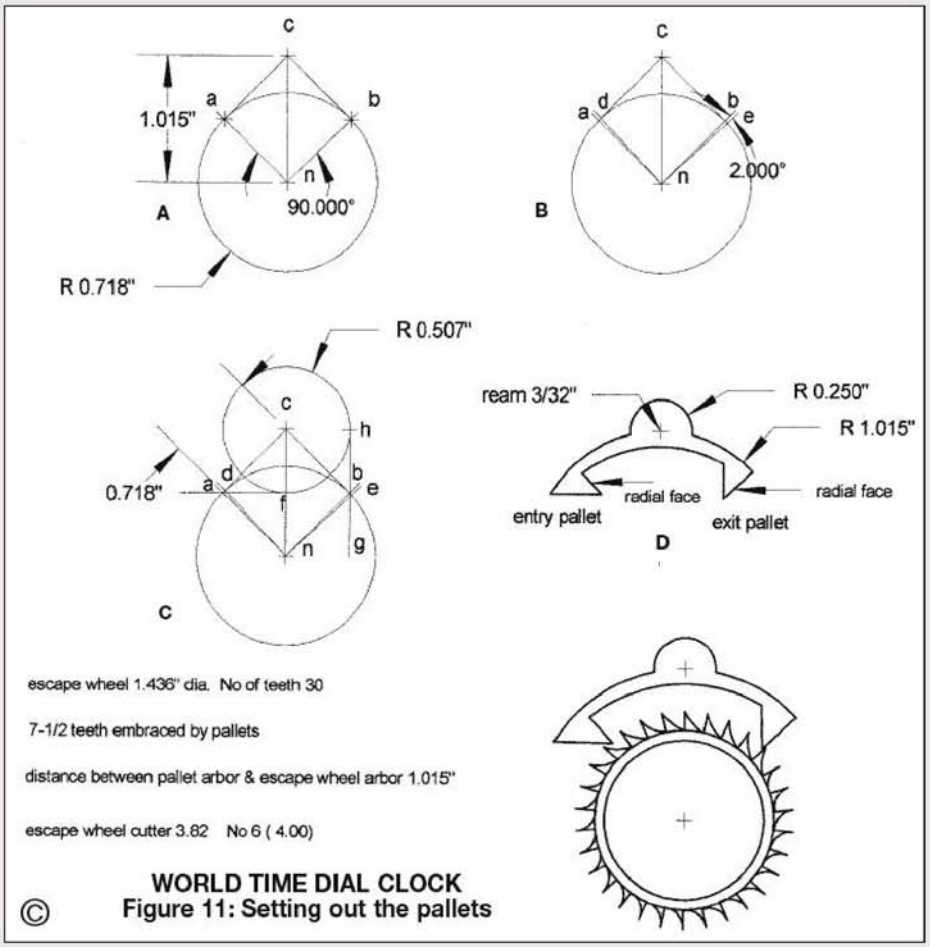
Escapement

Now the train has been planted between the plates we can proceed to make the escapement. The type used in this clock is the standard English recoil escapement which is not difficult to make, and if well made is a perfectly reliable escapement. There are generally two accepted methods of drawing the shape of the pallets, one is where the pallet dimensions are drawn on the actual pallet blank, and the other whereby the pallet dimensions are drawn on paper, which is then cut out and pasted onto the pallet blank. This is also a better method if you intend using a pallet forging.

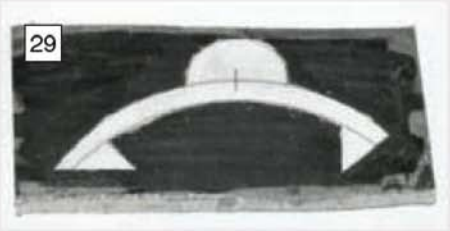
Both methods require the use of the John Wilding depthing tool when it comes to actually making the pallets. The drawings are at very best only an accurate guide, and the pallets must be tried with the actual escape wheel when it comes to filing the pallet nibs, in order to effect a well made, practical escapement.

The method I adopt and intend to describe involves drawing out the pallets on paper or stiff card, cutting them out and pasting them onto the pallet blank prior to filing to shape. I first learned of this method from John Wilding's book *How to Make a Castle Clock.*

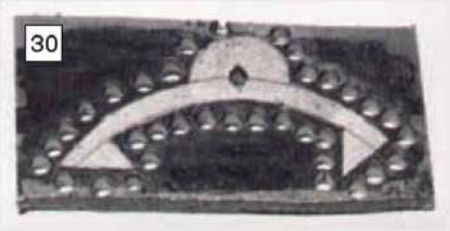
In our clock the escape wheel has 30 teeth, and it is customary for the pallets to embrace a quarter of the wheel i.e. 7 1/2 teeth, at an included angle of 90 degrees. This type of escapement is commonly known as a square escapement. The ▶



WORLD TIME DIAL CLOCK
Figure 11: Setting out the pallets



The pattern is carefully cut out and stuck onto a piece of gauge plate or a pallet blank forging.



The pallet outline can be prepared by chain drilling, sawing and careful filing to the pattern.

The impulse faces are brought to a high level of finish, checked and adjusted as necessary.

escapement must be drawn as follows.

As at diagram A (**fig 11**), first draw a circle 0.718in. radius, which is the radius of our escape wheel, then draw the line vertical line **n-c** for 1.015in., the distance between the centre of the escape wheel and the pallet arbor. Two lines are then drawn at 45deg. to this vertical line (90deg. inclusive), terminating at the radius of the escape wheel **n-a** and **n-b**. At diagram B two further lines are drawn at 2deg. to these lines at **n-d** and **n-e**.

In diagram C we have to draw the radius of the impulse circle. This is found by multiplying the length of the pallet arm tangent **a-c** (0.718in.) by the sine of 45deg. (0.707in.), this gives us a radius of 0.507in., which is drawn as a radius at **c**. The impulse plane of the entry pallet is then drawn through **a-f**, and the impulse plane of the exit pallet drawn as **g-b-h**. The backs or radial faces of the pallets are formed on the lines **n-d** and **n-e** drawn previously.

The arms of the pallets are drawn as a radius of 1.015in. from **n** for the upper curve, and the same radius struck 1/8in. lower, for the lower curve. The centre of the pallets is made as part of a circle with a radius of 1/2 inch. The drawing as at D is then carefully cut out, and pasted onto a suitable piece of 1/8in. gauge plate, or a pallet blank forging (**photo 29**).

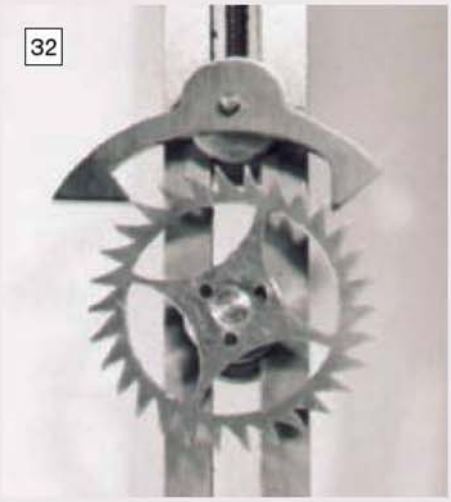
The 3/32in. hole for the pallet arbor is then drilled reamed at the pallet centre. If the pallets are being made from gauge plate, the surplus metal around the drawing is best removed by chain drilling, followed by the use of an Abrafile. The outline of the pallets can then be filed to shape by hand, or with the use of a Linisher, (**photos 30** and **31**).

The impulse faces of the pallets should be brought to a high degree of polish, and then the pallets and escape wheel can be tried for fit in the John Wilding depthing tool. The runners of the tool are set to 1.015in., and the procedure is to remove metal from the *radial* faces of the pallets, until they will just pass the teeth (**photo 32**).

The action of the escapement should produce minimal drop, that is the movement of the escape wheel between the release of one tooth and the arrest of another. When forming the shape of the impulse face of the entry pallet, the action of the escapement on recoil will be improved if this face is made slightly convex. Although I have seen some antique clocks with a convex exit impulse face, the face of the exit pallet should be left flat, as the action of the escapement here is different.

Only the pallet nibs require hardening, and they should be held in the flame of a gas torch. When they are at red heat, plunge them into water, and leave them dead hard.

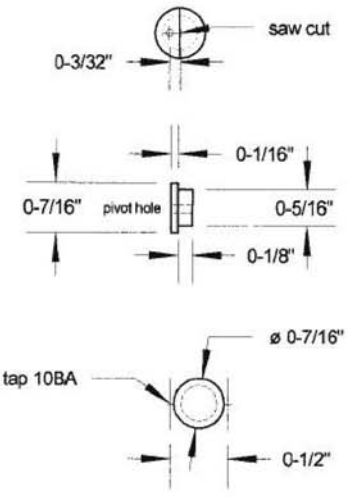
The whole of the pallets are then brought to a high degree of polish, especially their acting faces. The pallets and escape wheel are then tried again in the depthing tool, and the action checked. As the centre of the pallets have not been hardened it should be possible to make any necessary small adjustments as required.



The operation of the escapement is checked in the versatile John Wilding depthing tool and when correct, the pallet nibs are hardened and polished.

The 10BA tapping drill can then be used to drill two equidistant holes in the boss of the pallets to enable the pallets to be fastened to the pallet collet made previously. The pallets can be fitted onto a spare 3/32in. arbor and used as a jig to drill the collet. After which the collet can be tapped 10BA and the holes in the pallets opened up to 10BA clearance.

The escape wheel can now be fixed to its collet in the same way, utilising the three previously drilled holes. The wheel centre will require broaching slightly if the collet seating was left oversize. The escape wheel and collet should then be secured centrally on the escape wheel arbor with Loctite.



WORLD TIME DIAL CLOCK
Figure 12:
Eccentric bush (top) and securing eccentric bush (bottom)

Eccentric bush

In order to provide simple but effective adjustment to the entry pallet of the escapement, I am including an eccentric bush, which is fitted to the frontplate of the clock. John Wilding, and other amateur clockmakers, have used this design of eccentric bush in many of their clockmaking projects. It is simple to make and adjust, and cannot be improved upon by me. The bush is detailed in **fig 12** and is made from 7/16in. brass bar. The 5/16in. dimension must be carefully machined, and reduced to a length of no more than 1/8in. (the thickness of the plates). The bush is then parted off, leaving a 1/16in. flange.

A point for the pallet arbor has been marked on the clock frontplate; a parallel mark should be scribed 3/32in. to the right of this mark, and then centre punched. The bush is held in place in the frontplate, with the heads of two 10BA screws. The heads of these screws sandwich the flange to the frontplate and hold the bush firmly in place when adjusted. The holes for these screws should be drilled as close as possible to the 7/16in. rim of the bush as shown in fig 12. A 1/2in. circle should be scribed from the second point just made, to mark the radius position of the two screws.

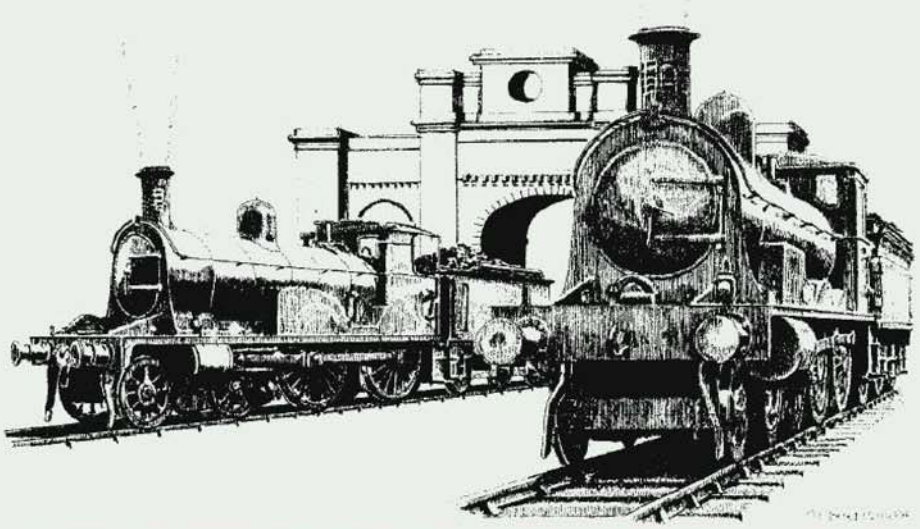
The clock plates should then be registered together and held with the toolmakers clamps. A 1.3mm drill is then put through the *first* original point. The plates are then separated, and the second point on the frontplate is then drilled 5/16in. to accommodate the 5/16in. bush.

The two holes for the retaining screws should then be drilled and tapped 10BA. The bush is then fitted into the frontplate, and held in place with the two screws. The plates are then again registered together, and held with the toolmakers clamps. The 1.3mm drill is then put through the bush from the previously drilled hole in the backplate; the plates can then be separated, and a slot filed in the front of the bush with a screwhead-slotting file to facilitate adjustment of the bush (**photo 33**).

In the next issue we will make the back cock, the pallet arbor, and the pendulum crutch. The clock can then be set going.

●*To be continued.*

The eccentric bush is adjusted using a screwdriver and secured with two 10BA screws.



THE HIGHLAND RAILWAY JONES 'BIG GOODS' & LOCH 4-4-0

LOCOMOTIVES IN 5in. GAUGE

Neville Evans

describes the construction of the tender tank and platework before discussing soft-soldering techniques which will guarantee sound joints.

●*Part XXXIV continued from page 32 (M.E. 4212, 9 January 2004)*

Tender tank

The Jones tender tank poses a few slight problems in the making, as the corners are rounded at 3/8in. inside diameter. I think that to make the sides as two halves, left and right, joined front and rear is probably the best answer. Before we start, however, we should think about the material that we are going to use and its thickness. The obvious alternatives are brass, nickel silver, and tinplate. The best of these is probably nickel silver. This possesses all the advantages of being ductile and strong, which means that thinner sections can be used, it doesn't corrode, it solders easily and takes paint very well. The big snag is of course, that it is very expensive in 24 gauge sheet. It may be worth thinking about though for superstructure generally, if you can get hold of some at the right price. In fact, given the opportunity, I would never use anything else.

Tin plate has most of the above advantages, and is of course very cheap. I don't know that it is readily available in sheets of more than about 0.023in. thickness, which may mean that a tank side would need vertical bracing for added stiffness. The obvious snag is that it is only too easy to scratch through or otherwise degrade the protective coating of tin. This allows the underlying steel to corrode. As I mentioned a few months ago, this corrosion can largely be inhibited by coating the inside of the tank with a resin called 'Petseal'. This can be obtained from any Classic Motorcycle shop. Look in your local *Yellow Pages*.

Brass, the obvious alternative, has all the virtues but doesn't accept paint very readily. It is therefore necessary either to use a self etching primer or to bead blast the surface to give a key before the first undercoat of paint. Brass can be readily obtained in sheets from 16 to 24 gauge and 1/16in. sheet brass is beautifully rigid and so therefore no cross bracing is necessary in the tank. Furthermore as the tank top and bottom edges are invisible after assembly, you can use any thickness of plate that you prefer.

Sole plate

This is the foundation of the whole tank, made from 16 gauge brass, so make sure that it is flat. As the Jones tenders were made of pretty substantial material, I don't think that we need worry about thinning the edges to improve their appearance. Start by drilling the necessary holes for mounting the various blobs and gadgets that go in the tender and on the sole plate. Then we can decide whether to start by screwing 1/4in. angle brass to the soleplate itself, in the appropriate places and drilling through from the sides, or we can assemble the sides complete with the angles and drop them onto the sole plate, having drilled the holes in the angles so that we can mark through onto the sole plate, prior to the final sweating up of the joints with soft solder.

An alternative to assembling the whole thing with small brass countersunk screws is to use 1/16in. copper rivets. There is always the possibility however of distorting the brass plates when hammering the rivets over. Incidentally, ▶

Left: left side plate and stanchion.
Above: Front left hand corner with side plate.
Right: Tool box and rear of tender.

when using brass screws in holding plate work together, try not to countersink deeper than the level of the slots in the screw head, you never need to take them out again, and when the screw heads are Linished or filed off, the joint becomes practically invisible.

The vexed question of the tender handbrake wheel has at last resolved itself. I have just received a supply of small bevel gears, made from Delrin, a hard white plastic substance, which are eminently suitable for the innards of the stand. Mike has the drawings and photos, which means that pattern making is proceeding apace.

I have been exercising the grey matter over the last few weeks, on the question of tender pumps. I shall not be fitting one myself, though many people will expect a suitable pump to be detailed. What are hand pumps for? Certainly not to be used in an emergency. The last thing you need to do is to pump cold water into an overheated boiler. Far better to drop the fire smartly and shut everything down. As to filling the boiler John Hill has a gadget which consists of a water container and a length of piping which connects up to the blow down valve. Place the container on the cab roof, fill it with water and let Mother Nature take her course.

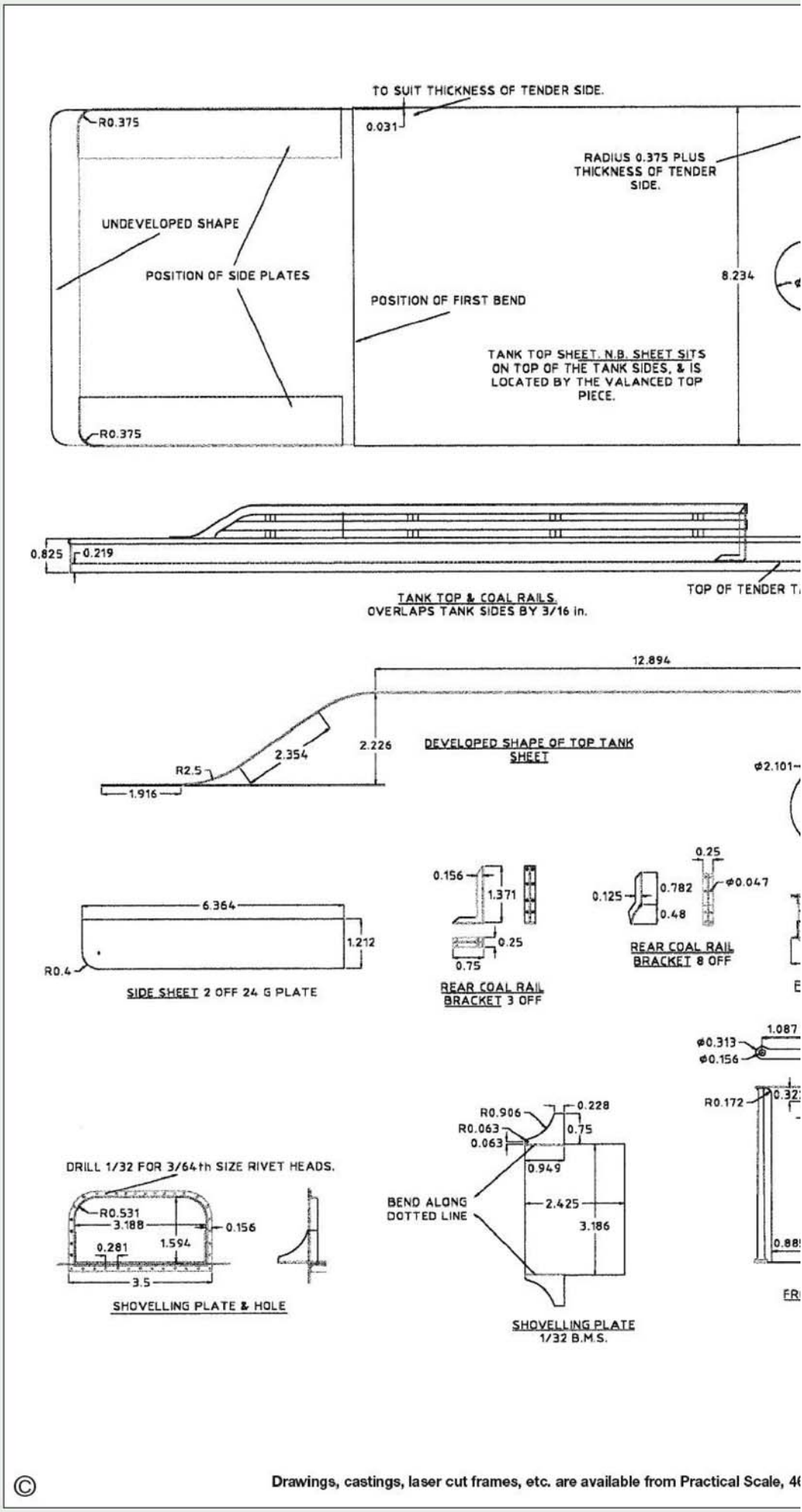
Having said all that, we are rather constrained by the shape of the tender, in that it is difficult to fit an accessible lengthways pump. Fitting one across the tender is much easier, though I once upset the whole applecart through overvigorous pumping. So, Dave Noble is sending me a drawing of his vertical pump. Don't worry about the extra holes, as we can drill up from underneath.

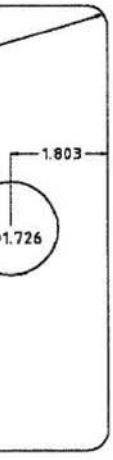
Tank sides and top

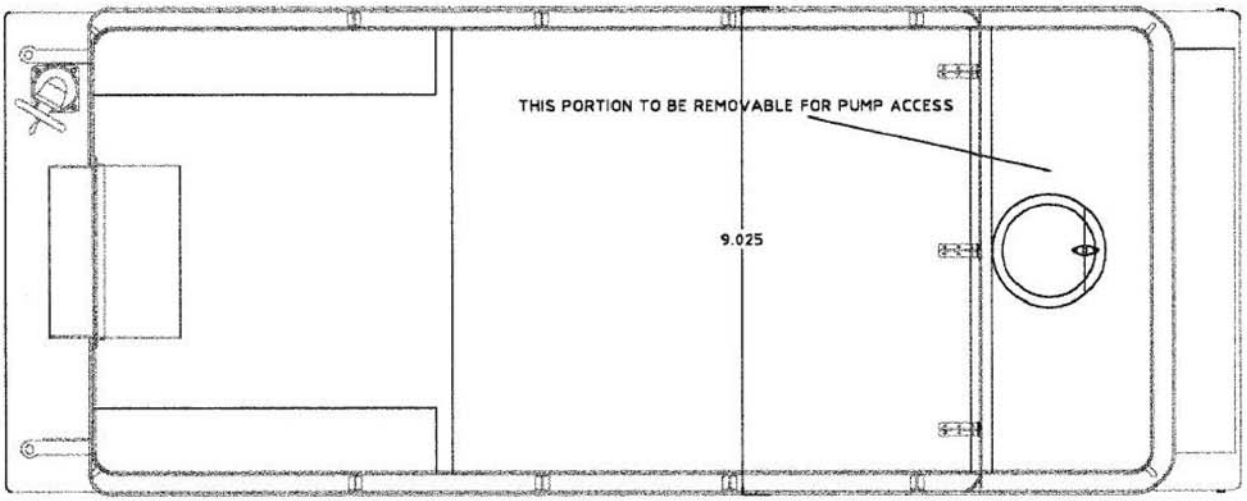
As previously mentioned, the tank sides may be made from 16 gauge brass, which is too tough to be bent through 90deg. over a 3/4in. diameter round bar until it has been annealed thoroughly. Brass is annealed by bringing it up to a temperature of 600deg. C, in other words to a dull red, just visible in daylight. Leave to cool slowly in air, so as to minimise distortion. Take great pains to ensure that the bends are precisely at 90deg. otherwise the sides will take on a drunken aspect that would not be in accordance with the mores and morals of the directors of the Highland Railway.

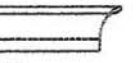
If you decide to make the tank in two halves, left and right, with the joins fore and aft, trim one half at exactly 90deg., assemble the other half to it at the correct distance apart, cramp up, mark out and cut. Assemble the two sides with a soldered strap on the inside. Note however that on the front of the tank we have the coal hole, and in the short piece of metal above that, we are unable to put any bracing straps, so we have to be content with a soft-soldered butt joint.

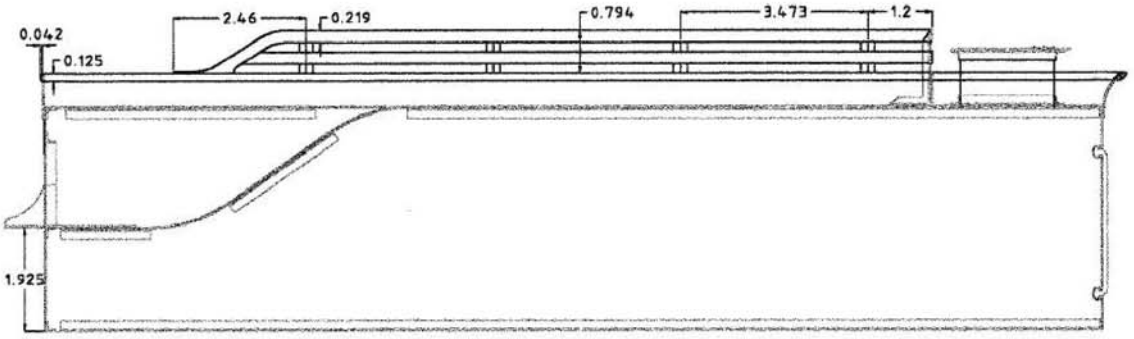
The tank top sits on top of the tank itself, and is reduced in width where it sweeps down to the shovelling plate on the inside of the side sheets. There are two plates, one each side at the front of the tank as can be seen from the drawing and photographs, which presumably gave a walkway from front to rear of the tender. These plates will have to be made of a thinnish gauge metal as they are very obtrusive.

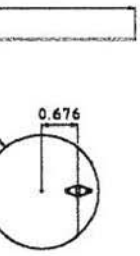


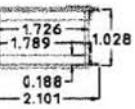






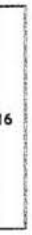


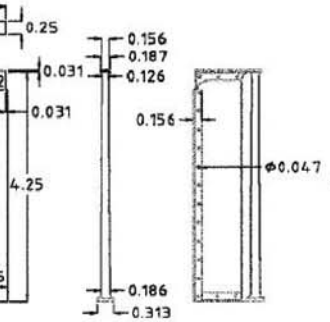




ILLER & LID

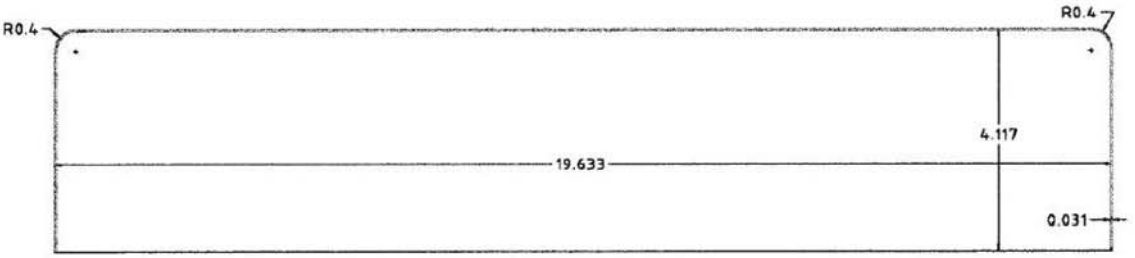
TANK TOP SHEET SITS ON TOP OF THE TANK SIDES & IS LOCATED BY THE FLARED TANK TOP.





ONT PLATE & STANCHION
2 OFF 24 G PLATE

TENDER TANK SIDES LEFT & RIGHT.
SOLDER TOGETHER & AND FILL
JOINT.



TENDER TANK

SUPPLIER

Pentyla, Port Talbot, West Glamorgan SA12 8AA; tel/fax 01639-883741. Please send a stamped self-addressed envelope for details.

Front of tank; note shovelling plate hole and side plate.

Filler cap.

Detail of coal rails at rear of tank.

Shovelling plate and coal space.

Top of tank from front end.

Coal rails

The coal capacity of the tender is considerably enlarged by flaring out the extreme top and providing rails around the coal space. Note that the flared portion must be of a thin material as it sits outside the tank and is again held on prior to soldering by a few brass screws. The flared part is capped by a semi-elliptic beading which is probably best made from brass strip which has the two corners rounded off with a file. An alternative is to use 1/8in. wide half round beading, which is commercially available, and to reduce the thickness somewhat with a smooth file. This strip, in full size, was held on by small rivets, as can be seen from the photographs and drawing detail. We can either rivet it on as in full size practice, (quite a job), emboss the valanced part with a riveting embossing tool that I will show next time, or just forget about it.

The coal rails themselves are made up from steel strip, 0.219in. wide and 0.032in. thick. The rails may be beefed up a little to 1/4 x 1/16in which is of course a commercially available section. Please yourselves, but remember that the rails are a bit vulnerable perched up there on top of the tender, so it may be better to err on the side of strength. Whatever you do, remember to leave no sharp corners that will remove pieces of flesh in a most painful manner.

Soft-soldering.

To close this particular episode, a word or two on soft-soldering may not come amiss. Soft-solders are basically alloys of lead and tin. They have melting points below 200deg. C, dependant on the proportion of tin and lead in the alloy. Within certain limits the higher the tin content the higher the melting point and *vice versa*. Solder makes a joint by alloying with a thin layer of the surface of the metal to be joined. The remainder of the joint is a sandwich of solder before the alloying to the next piece of metal. It can be seen therefore, that as solder is not very strong, the thinner the layer of solder, the stronger will be the joint.

Front of coal rails; note recessed coal plate.

The essentials of making a good joint are having sufficient heat available and clean surfaces to be joined. The latter is achieved by using a degreasing agent provided of course that there is no rust or other obstruction on the surface. The joint is then fluxed to prevent oxidisation. Make sure that you have enough heat in the form of a small nozzled torch, or even a large soldering iron. With insufficient heat, simply heating a joint until the solder melts results in a part that is too hot to handle and a joint that may still be imperfect. With sufficient localised heat the solder melts and flows before the heat travels into the model, and material an inch or so away will only feel warm. Distortion is also kept to a minimum. A liquid acid flux will run along by capillary action, as will paste flux when heated. A good joint will show by the solder obviously wetting the metal and there should be a thin concave fillet.

As we are concerned largely with the fixing together of the various bits of the tender tank and the sealing thereof, I shall confine my remarks to that aspect of the art. The basic technique is similar to that used in soldering up a footplate valance under a footplate (and where else?) The problem lies in the fact that we are joining two bits of metal with dissimilar coefficients of expansion. We can start by mechanically fixing the valance to the footplate by small screws or cramps. A good, stiff, small wire brush is a great asset in spreading flux and solder so, beginning at one end, heat the valance quickly and apply a small tack of solder, allowing the hot metal to melt the solder and not the naked flame. When that end has hardened, go to the other end and apply a tack, then do the same in the niddle and then tack between each of these tacks. Finally run the flame along with a little more solder to give a continuous joint.

●*To be continued.*

ROAD STEAM

JOHN FOWLER & SONS LTD.

NOTES ON THE COMPANY AND SOME OF ITS PRODUCTS

Martin Wallis

continues his review of some of the great names associated with road and agricultural steam, looking this time at the early days of a very highly respected company.

●*Part I*

The legend of John Fowler & Sons Ltd. is widespread on modern day rally fields, primarily in the area of steam ploughing, but also in heavy road haulage with representations usually present in most classes of steam vehicle. The John Fowler of the 'Steam Plough Works' fame was born in 1826, was known as John Fowler Junior and was the third son of John and Rebecca Fowler, a relatively wealthy family of strong Quaker persuasion. At the age of 16 John Junior was apprenticed to a corn merchant, but a career in engineering appealed much more. So, in 1847, by arrangement with another Quaker family, his father allowed John Junior to serve an apprenticeship with a large company primarily manufacturing railway engines and rolling stock in Middlesbrough.

Agricultural interests

John Fowler Junior was a man with strong religious beliefs. His agricultural interests were probably the result of a Quaker trip to Ireland where, with other friends, John Fowler went to see what practical relief might be made to appease the terrible suffering during the potato famine. His religious principles, combined with his considerable practical ability, were the foundation of, and inspiration for, his ploughing, cultivating and land drainage business eventually to become John Fowler & Sons Ltd. of Leathley Road, Leeds.

The company may be traced back to 1850 when John Fowler went into partnership with Albert Fry (of Fry's chocolate), another Quaker, and exhibited several pieces of land drainage equipment in the Great Exhibition of 1851 held in Hyde Park. In a relatively short period of time he had a whole repertoire of patents and a host of land anchors and winding drums, some steam driven, for land drainage purposes. As was usual at the time John Fowler took his merchandise to agricultural and county shows and was rewarded with several medals. Much of the hardware, for example boilers, wheels and cylinders, were purchased from other manufacturers including Clayton & Shuttleworth, Ransomes & Sims and Robert Stephenson & Co., for he did not have the wherewithal to make his own at that time.

Steam Plough Royalty Company founded

By the late 1850s John Fowler was finding that the agricultural engines supplied by Clayton & Shuttleworth and Ransomes were not as sturdy as he wished in view of the very heavy duty required of them when ploughing or undertaking drainage work. In consequence, in 1859 he went into negotiations with Kitson & Hewitson in Leeds to design and build a new revised series of steam ploughing engines. In April of that year he formed the Steam Plough Royalty Company to which friends and relatives subscribed. The Kitson & Hewitson engines had the cylinder fixed over the firebox and the crank was over the boiler barrel, an arrangement which was convenient in driving the drum underneath the boiler but less so for driving the back wheels to make the engine self-propelling. Earlier engines achieved self-propulsion by using a long chain, and later designs employed a slanting shaft driven by bevel gears. The flywheels were distinctive with their decidedly curved spokes.

Slanting shaft ploughing engines

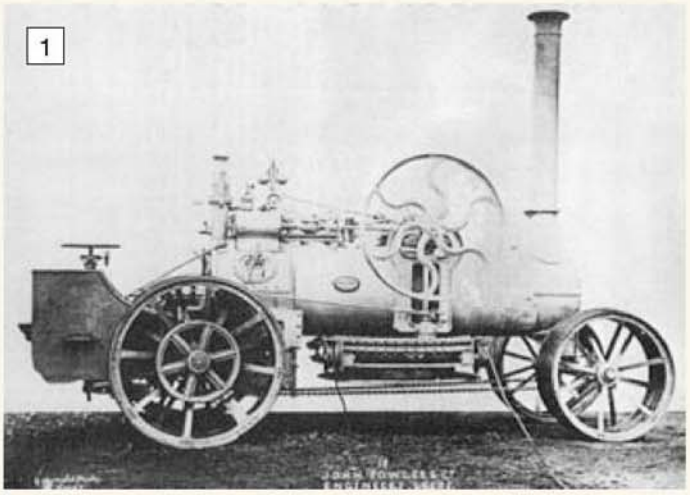
Photograph 1 shows a Kitson & Hewitson 'slanting shaft' ploughing engine, although unfortunately on this illustration the slanting shaft is on the far side. However, the top of the bevel wheel on the slanting shaft which takes the drive to the back axle may be just seen above the engine's connecting rod. This engine has the earlier design of steerage operated by the handwheel above the tender which gear drives a pulley underneath the manstand with long steerage chains on it to the front axle.

The drum is a 'clip drum' which gripped the cable that was effectively a continuous loop with one part of it around the engine's clip drum and another around a pulley on an anchor some distance away. With the clip drum the engine could either pull the plough towards the engine, with a direct pull, or away from the engine with the rope running across the field around the anchor pulley and back to the plough.

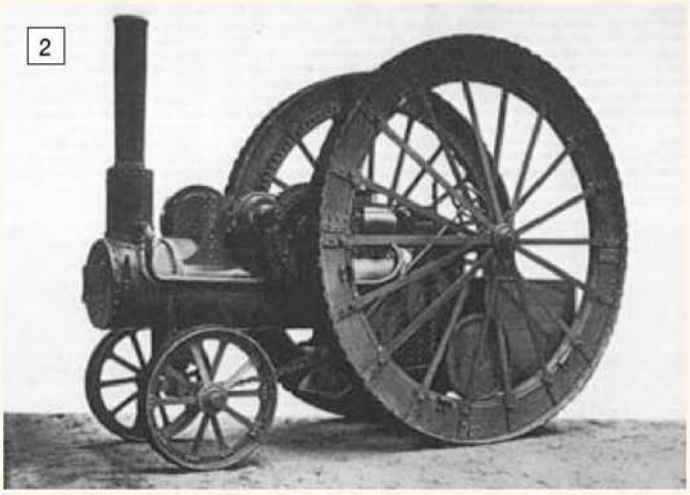
Steam Plough Works established

The success of these ploughing engines was such that Kitson & Hewitson suggested that a company dedicated to steam ploughing tackle was warranted under the auspices of Fowler and Hewitson. Called the Steam Plough Works, the premises chosen were the old Spanish Leather Works, and the first engine was completed at the new works in 1862. Expansion was rapid and with the purchase of several other adjacent premises amounted to nearly 8 acres by 1877. In July 1863 Fowler won the Gold Medal at the RASE Worcester meeting with one of his 10nhp slanting shaft engines. His 10nhp ploughing engines developed 45ihp, three quarters of which was available at the plough giving a tractive effort of 1½ tons. The Worcester RASE judges recorded some interesting statistics which are worthy of reproduction here:

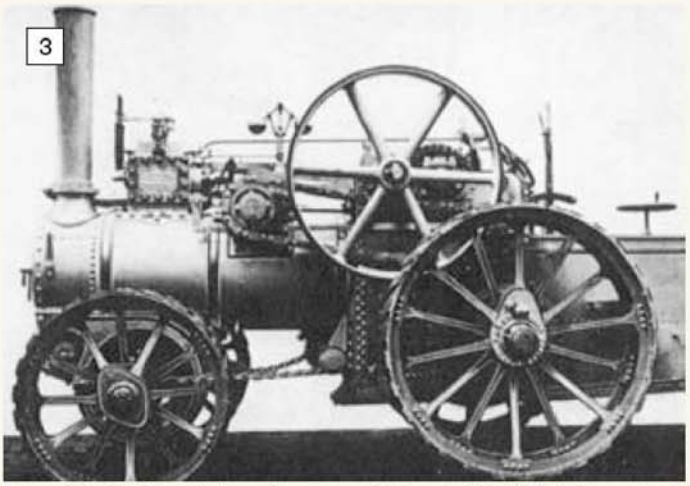
Engine: John Fowler 10nhp
working at 70psi and costing £540
Ground ploughed: 1 acre 3 rods 34 perches
to a depth of 7in. *(about 2 acres)*
Coal used: 3 cwt 1 quarter 2 lb

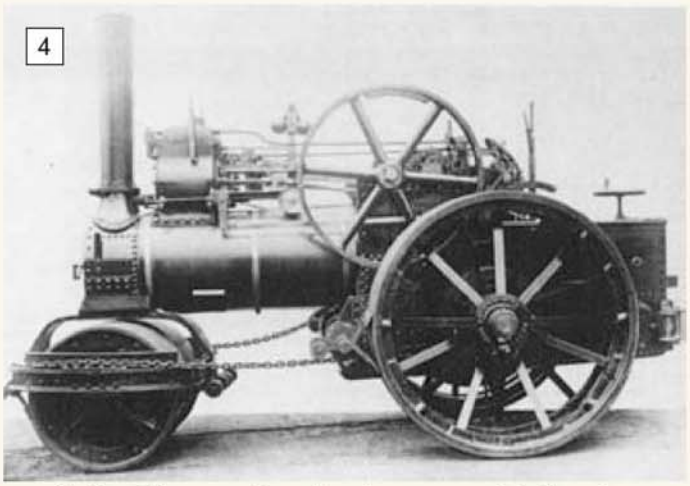


An 1862 Kitson & Hewitson clip drum ploughing engine. Note the heavy Watt type governor to enable the engine to undertake threshing and other duties.



The 1877 'Steeplechaser' fitted with 12ft. diameter back wheels. Note the large drive gear visible on the inside of the far back wheel rim.





Above left: the 'Steeplechaser' was completely rebuilt in 1885 to four-wheel drive specification. Not many parts can have been common to both engines. Above right: engine No. 4839 was the first roller built by John Fowler. The rear rolls are large enough to lift the engine to create extra room under the smokebox. The front roll was as large in diameter as possible, consistent with it fitting under the smokebox.

Time taken: 1hr 57 min
Cost of coal at 1s 0d *(5p)* per cwt: 3s 3d *(16p)*
Cost of coal per acre: 1s 8d *(8p)*
Number of acres per 10 hour day: 9.5
Cost of labour per day: 15s 1d *(75p)*
Wear/tear and interest on capital: 4s 9d *(24p)*

What is not recorded is the cost of equivalent ploughing by horse, but it can be safely assumed that steam ploughing was very much cheaper, hence the rapid expansion and popularity of the steam ploughing industry.

Expansion and exhaustion

Overseeing the very rapid expansion of the Steam Plough Works, and the preparation of so many new designs, the manufacture and evaluation of prototypes, together with the multitude of patents to protect the business left John Fowler exhausted. By the summer of 1864, on his doctor's advice, he sold his house and moved to Achworth near Pontefract where he had many Quaker connections and friends. Sadly, while out horse riding shortly after the move, his mount lost its footing and fell, throwing John Fowler to the ground. The initial injury was only a broken arm but tetanus (lockjaw) unfortunately ensued from which he died.

John Fowler certainly touched the souls of a great many people, both friends, customers and employees. In his excellent book on the *Steam Plough Works* ISBN-0-85298-4146 (source and/or clarification of many of these notes) Michael Lane lists a number of tributes of which perhaps the most poignant is a comment made by the Chairman at a public meeting to raise funds for a suitable memorial to him:

"It had been thought most consonant with the feelings of the family of Mr. Fowler not to entertain the question of a statue but to establish some kind of charitable institution for the assistance of those who shall by accident become disabled by the working of agricultural machinery, preference being given to those injured by Steam Ploughing or Cultivating Machinery ... and to build a school to educate the children of the deceased out of the funds of the charity."

One thousand employees

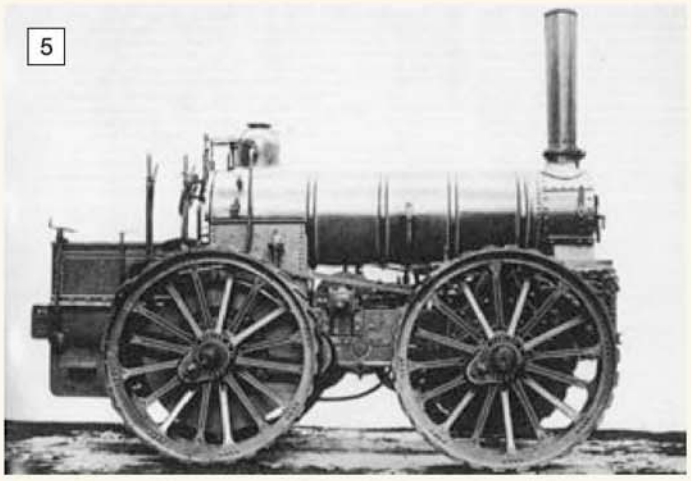
John Fowler left a well organised and prosperous business with some 1,000 employees in the capable hands of Robert Fowler (his brother) and partners. Their machinery continued to be considered with the highest regard and a large portion of the Fowler product was exported. Certainly the 'Steam Plough Works' fortunes did ebb and flow, for example the end of the Egyptian cotton boom lost them a great deal of trade, but fortunately as one market declined others opened up.

Due to the great weight of the steam engine, the system of the cable ploughing remained in the forefront throughout the steam cultivation era and Fowlers reigned supreme. Although there were exceptions, Fowlers almost always sited the cable drum underneath the boiler barrel. By the end of steam ploughing the implements were invariably hauled across the field and back by two engines, one each side of the field. The earlier system of one engine using an anchor on the opposite side of the field to return the wire rope proved too cumbersome. The two engine system was easier and more convenient; while the very much higher capital outlay was a definite deterrent, increased productivity made it worthwhile.

David Greig and Max Eyth

We must also acknowledge the contributions of two notable partners in the Fowler company: David Greig and Max Eyth. Both were very clever, indeed one of Greig's patents was for pouring molten metal into metal rather than sand moulds, the forerunner of gravity diecasting a process used extensively today. Many of the 'John Fowler' prototypes, patents, and products were the work of one or other of these gentlemen.

Regrettably Eyth offered his resignation to Robert Fowler in 1882 and departed after 21 years of unstinting service. Reputedly frustrated by the inappropriate promotion of Grieg's sons, too often he found himself left trying to unscramble inappropriate business and design arrangements. Another loss to the company was that of John Fowler's only son, John Ernest Fowler, who it was hoped would succeed Robert Fowler, but who died on a business trip to Algiers aged only 21.



Above left: works photograph of Fowler's undertype four-wheel drive traction engine of 1886. Above right: A very fine 3in. scale model of the undertype engine in photo 5 built by Les Vince. Note for safety reasons the gauge frame on the model has a protector but other than that it is very close scale indeed.

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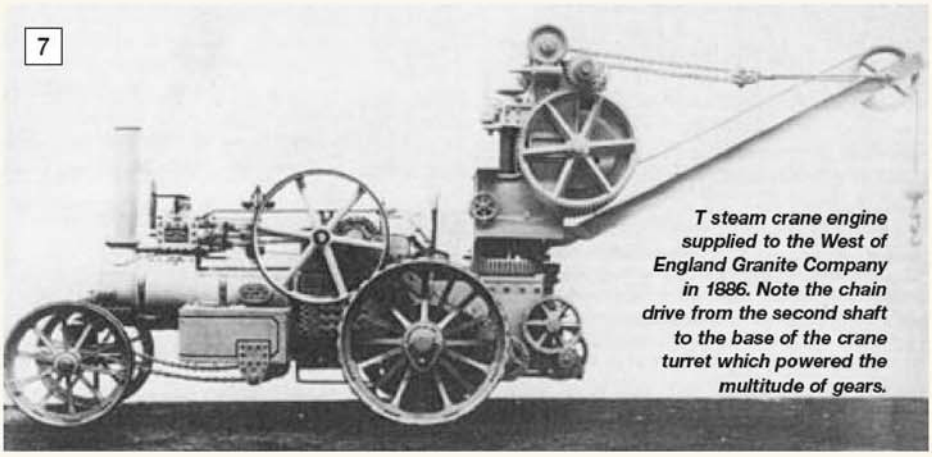


T steam crane engine supplied to the West of England Granite Company in 1886. Note the chain drive from the second shaft to the base of the crane turret which powered the multitude of gears.

The designs and inventions from the Steam Plough Works are far too numerous for a chronological dissertation on them all to be practical here. The accompanying illustrations have been chosen to reflect the breadth of their work together with a few of the 'oddities' they produced from time to time, presumably for evaluation purposes.

The Steeplechaser

A memorable engine was Barnard Fowler and Max Eyth's 'Steeplechaser' with its 12ft. dia. wheels; it was built in 1877, Works No. 3271. It was well-known then, as now, that the rolling resistance of a large wheel is less than that of a small one, the more so as the quality of the road surfaces deteriorates. The 'Steeplechaser' was built to test this notion. In order not to greatly increase the weight of the engine, and invalidate the test, the arrangement in **photo 2** was devised.

The back wheels were made of lighter construction than was usual and the weight of the engine was applied directly to the wheel rim by two flanged wheels, each running on the inside edge of a back wheel. These flanged wheels were sprung for a smoother ride and the axle on which the 12ft. back wheels ran was located in a vertical slot in the top of the hornplates so they could move vertically, and did not take any of the weight of the engine. The cylinder was above the firebox and the crankshaft was situated behind the chimney driving a large gear on the inside of the wheel rim. The duplex cylinders were of $5^3/4$in. bore by 10in. stroke.

Steeplechaser rebuilt

The 'Steeplechaser' was evaluated by the military at the Woolwich Arsenal but failed to attract any orders. Max Eyth's recorded opinion was:

"It steers as well as any, it pulls rather more and runs very much better, but only a fool would buy it."

However, a buyer was forthcoming, but the engine presumably did not live up to the purchaser's expectations as it was returned to the works and extensively re-built to reappear as another experimental engine, Works No. 4920 and illustrated here in **photo 3**. Number 4920 was essentially a standard engine with a compound cylinder of $5^1/4$in. and $9^1/4$in bores.

The front wheel drive was taken from the third shaft by chain to shaft running across the engine underneath the crosshead guides. On the other side another chain took the drive diagonally down to a shaft beneath the smokebox and thence to the steerable front wheels via a reduction gear and a system of gimbal joints.

Second four-wheel drive engine

Presumably building on the experience gained from No. 4920 Fowlers built another four-wheel drive engine, Works No. 5042, which was exhibited at the RASE show in Norwich in 1886, (**photo 5**). To avoid the complicated gear and chain arrangements from a cylinder mounted on top of the boiler, the cylinder was mounted underneath the smokebox and the crankshaft held in plate frames running beneath the boiler.

All four wheels were 5ft. 6in. dia. and were driven by gearing, the front axle using a similar arrangement of gimbals to that on No. 4920. The anticipated improvement in adhesion with four-wheel drive must have been limited as No. 5042 never sold and remained at the Steam Plough Works until it was scrapped in 1895. Happily a very fine model has been built of it which is illustrated in **photo 6** attending rallies in the Eastern region a few years ago.

A review of Fowler's curiosities must surely include the crane engine built in 1885 (**photo 7**), and sold in 1886 to a granite company in Penryn, Cornwall. The virtues of the design are the power operated jib elevation and power rotation of the whole turret, but quite how the dynamics worked with a decent sized block of granite hanging from the hook is a matter for pure conjecture!

Railway engines

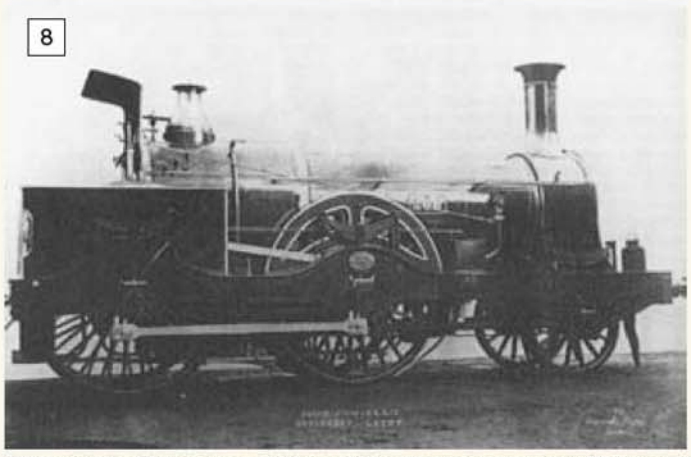
John Fowlers also built a host of railway engines from 18in. gauge, through standard gauge, to 5ft. 6in. gauge. In standard gauge they built engines for the Great Northern Railway, including three express passenger engines to Archibald Sturrock's design (**photo 8**). A year later Patrick Stirling asked Fowlers built a further twenty 2-4-0 express engines and twenty 0-6-0 goods engines for the GNR, which they completed during 1867 and 1868. Such large orders were fairly routine, examples of larger production runs including a batch of forty 0-6-0 5ft. 6in. gauge goods engines for the Great Indian Peninsular Railway and twenty-eight 2-4-0 standard gauge side tank locomotives for the Egyptian Daira-Sanich railway.

In common with most road steam manufacturers Fowlers built what is essentially a hybrid of a road engine and a railway locomotive (**photo 9**). The 0-4-0 wheel arrangement is less common than the 2-2-0 arrangement where a pair of large back wheels are driven and a smaller pair of front wheels left free exactly as mirrored on a road engine. This engines were called 'traction tram engines' and were used in quarries, large engineering works and collieries. The geared reduction drive presumably gave a superior tractive effort at, of course, the expense of speed.

Considering the railway engines alone, it takes little imagination to realize the size and capacity of the John Fowler works. Other projects included steam generating plants, 1000hp air compressors, and colliery winding engines. A larger example of a colliery winding engine had cylinders 54in. dia. by 84in. stroke with a winding drum weighing some 90 tons. However, road steam, and in particular steam ploughing, is our brief, and next time we will look at a few more typical examples of Fowler's engines.

●*To be continued.*

8



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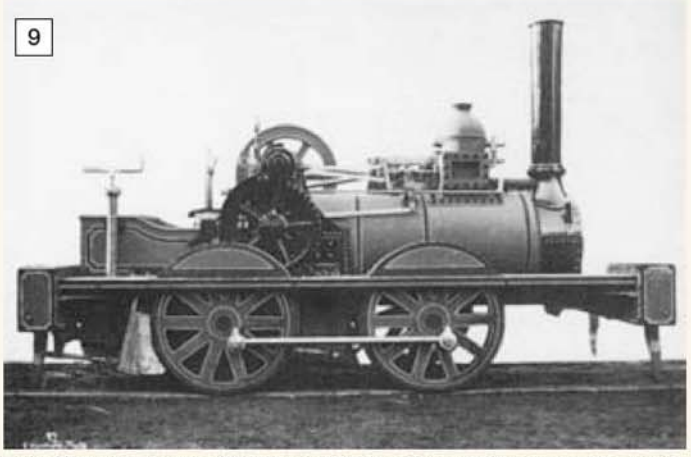


Above left: Archibald Sturrock's 2-4-0 GNR express locomotive built at the Steam Plough works. Above Right: a John Fowler 0-4-0 traction tram engine built in 1866. Note the single large wood brake block behind the back wheel.

PETE'S PAGE

COMBINATION ANGLE GAUGES

Peter Spenlove-Spenlove
explains some of the secrets of the making and use of these gauges.

A set of inexpensive but serviceable imported angle gauges ideal for home workshop use.

Angular measurement and circular divison form an important part of engineering metrology. They are concerned respectively with the measurement of individual angles and the continuous measurement of angles in the division of a circle. In a previous instalment of these notes (*M.E.* 4210, 12 December 2003, page 699) we have seen how a length standard in the form of slip blocks can be used with a sine bar for the accurate measurement of angles. Some readers may also be aware that the same principle is employed for sine centres, sine vices and sine tables.

Other methods of angular measurement involve the use of precision rollers and balls, the clinometer, precision spirit levels and optical instruments including the auto-collimator, alignment telescope and angle dekkor. Not all these equipments are necessarily appropriate for the model engineer's workshop but a very convenient workshop angle standard which is suitable is a set of angle blocks.

Angle blocks are similar in many ways to the more familiar slip gauges or 'Joey' blocks. Like slip gauges they have two opposite faces which are lapped flat to very close limits and can be wrung together. However, instead of the faces being parallel they are at various specific angles. By using these angles blocks individually or in combination various angles can be made up for inspection purposes.

Professional sets are available, which can be combined to make up any angle to 100deg. in increments of 1/4 of a second of arc. A lesser set will work to one minute of arc. Such sets are very costly and are unlikely to be seen outside of large standards rooms.

Nominal sizes of Combination Angle Gauges

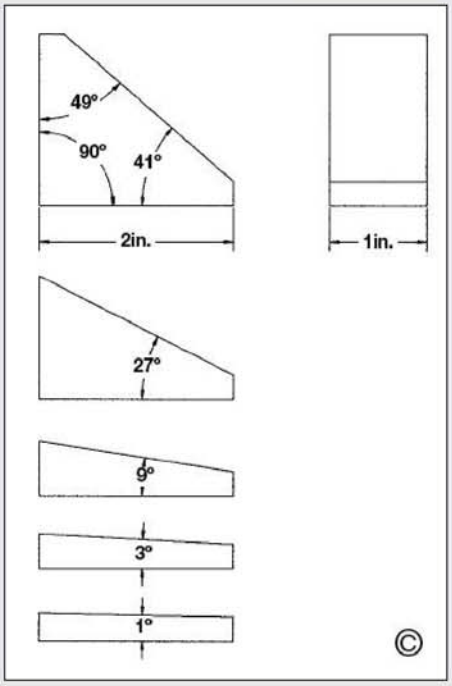
Degrees of arc (°)	Minutes of arc (')	Seconds of arc (")
1	1	0.05
3	3	0.1
9	9	0.3
27	27	0.5
41		

These values are arranged in a modified geometric progression with a common ratio of 3.
A standard set contains 13 calibrated, hardened and lapped combination angle gauges plus a square block. The blocks can be 'wrung' together to produce any angle between 0° and 90° to a resolution of 0.05 seconds of arc.
Readers are reminded that a complete circle of rotation is divided into 360 degrees, each degree can be further subdivided into 60 minutes and each minute into 60 seconds of arc.
0.05 seconds of arc is therefore 0.0000139 degree.

Years ago, as an exercise, I had to make a very simple set designed to resolve whole degrees only. They were made from 1in. thick bright mild steel, case hardened and lapped. Each piece is roughly a triangle whose base and hypotenuse subtend a specific angle. There are five pieces each with a 2in. long base. As specified by the shop foreman, the angles are 1, 3, 9, 27 and 41 degrees. By combining two or more it is possible to make up any angle to 45deg. plus a few more up to 89 degrees. Unlike regular linear slip blocks, these angle blocks can be combined so that their angles either add or subtract. So, for example, the 1 and 3deg. blocks will combine to give 2 and 4deg depending upon how they are assembled. The 41deg. block has a 90deg. base angle so its 49deg. angle can be used as well.

Proper blocks will 'wring' i.e. stick together. Mine do not so I use sticky grease if necessary.

The most frequent use is for checking that a part is tilted correctly in the milling machine vice, usually with the help of a parallel or two. Since making the above set to my tutor's instructions I have looked at the Starrett catalogue. Their simple set consists of six blocks: 1, 3, 5, 15, 30, and 45deg., and is said to be able to make up all angles up to 99 degrees.



Three grades are available: 'Toolroom' accurate to one second of arc; 'Inspection' accurate to 1/2 of a second of arc and 'Master' accurate to 1/4 of a second of arc. I doubt if we can achieve better than 1/4 to 1/2 a degree in our workshops.

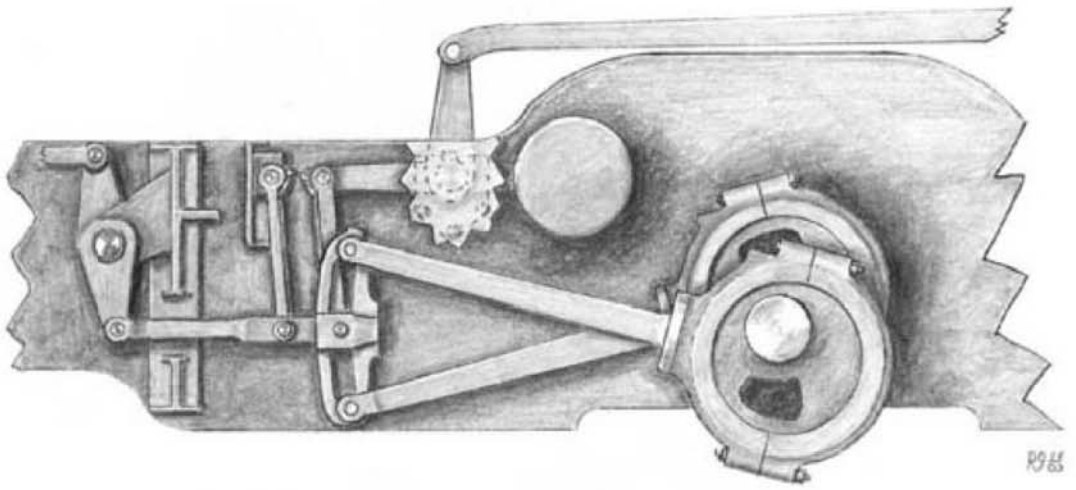
If you make a set of angle blocks remember that they will be prone to distort during hardening making the correction of errors by lapping difficult. The use of a good surface grinder and sine bar is helpful to correct the angle before lapping the measuring faces. Although I used pieces of material 1in. thick and with a base approximately 2in. long, readers could use any size of material to suit available stocks or the expected range of work. If the pieces are hardened, stacks of angle blocks can be built up using one of the low strength anaerobic adhesives. It should be easy to scrape the glue off later without damaging the surfaces. If preferred a 'de-bonding' agent could be used for the purpose.

Note that only two faces on either side of the marked angle are used although three faces are available on the biggest block. The unmarked angles are not accurate. However, if readers care to make, say, the corner of the 27deg. block exactly 90deg. then the third corner will be an accurate 63 degrees.

If your angle blocks are surface ground be sure to check that they have been demagnetised correctly. Magnetised blocks are a menace as they attract swarf but may well repel each other. Most workshops with a surface grinder having a magnetic chuck will have the necessary demagnetising unit so make sure you use it before taking the blocks home.

The set of angle blocks made by the Author and housed in a smart beize lined wooden case.

Figure 6



EDWARDIAN ELEGANCE

Ron Isted

continues with his account of the Caledonian Railway and 4-6-0 locomotives Nos. 49 and 50.

●*Part VI continued from page 22 (M.E. 4212, 9 January 2004)*

Another theoretical deficiency in John McIntosh's magnificent machines, which in practice appears to have had no effect on performance, lay in the steam distribution arrangements. The cylinders drove on to the leading coupled axle, restricting the length of the connecting rod to 6ft. 8in., thereby accentuating the effects of the so-called 'angularity'. In his excellent book on Caledonian locomotives, **(ref 7)**, H. J. Campbell-Cornwell quotes a port opening of 17/16in. for the front at the maximum cut-off of 85%, but only 1 1/4in. for the back, maximum cut-off 79%. Even more uneven at this setting were the leads: zero for the front and 3/16in. for the back. As the engine was notched up, the lead of course increased, as did the discrepancy in both cut-off and lead between front and back ports. Reversing was by steam-assisted lever, which could apparently be lethal if the driver let go of the 'pole' at the wrong moment! This may perhaps at least partially explain why many Caledonian men tended to drive on the regulator, leaving the reverser in one position as far as possible.

As originally turned out, the two 4-6-0s were equipped with ordinary plain slide valves above the cylinders, driven through vertical rocking shafts from Stephenson gear with locomotive type links, the eccentric rods being 4ft. 6in. long, **(fig 6)**. Incidentally, before friends and relations of Inspector Meticulous put pen to paper, let me say that my drawing is slightly illogical in that it shows the right-hand motion, but with the reversing arrangements (which were on the left) inserted in the foreground. In a way, it would have made better sense to have drawn the left-hand motion, but other similar drawings in this series have all depicted the right and I am trying to retain some semblance of consistency — anyway, that's my excuse.

The steam ports measured 18in. x 1 3/4in., the exhaust 18in. x 3 1/2in. and the bridges between them, 1 1/4in., with a maximum valve travel in full gear of 4 23/32in. I have so far failed to unearth details of the lap, but it was probably 1 inch. In September 1904, the plain slide valves were replaced by the Richardson balanced variety, and apart from minor changes in 1905 to reduce clearance volumes, the engines settled down to several years of excellent work until 1911, when the boilers were again modified; No. 49 in March and No. 50 in April, this time by the addition of a superheater giving no less than 515sq. ft. of heating surface. This makes an interesting comparison with the 262sq. ft. of the Swindon superheater fitted 12 years later to the Great Western Castles, although Churchward's pacific of 1908 carried 545sq. ft.

As was common practice at the time, the boiler pressure of the Caley twins was reduced to 175psi, and the balanced slide valves were again replaced, this time by 8in. piston valves, while lubrication was dealt with by a Wakefield mechanical lubricator. Finally, the cylinder diameter was now officially quoted as 20 3/4in., an abnormally 'unround' figure for the Caledonian. The net result of these alterations was that the theoretical tractive effort went down to 21,349lbf., a decrease of nearly 15% from the figure trumpeted by the Caley publicity just eight years earlier.

Numbers 49 and 50, along with the Cardeans, which were also superheated, continued on top link duties until well after the 1923 Grouping of the railways, and obviously remained popular with their crews, as O. S. Nock recorded his first sight of No. 50 in August of that year at Glasgow Central, in charge of the 3.50pm express to Liverpool and Manchester *"... so immaculately clean against the drab background as to be a positive apparition."* Both locomotives received new frames and cylinders in 1924, at which time they were given smokebox number plates bearing their new LMS numbers of 14750 (No. 49) and 14751 (No. 50). Rather more controversial was the removal of the elegant smokebox wingplates and a repaint in the new owner's colour scheme of crimson.

At this point, I imagine all true Scots will react in similar fashion to my friend quoted in the opening paragraph of this article, but putting aside one's personal emotions and prejudices, along with any nasty suspicions of a take-over by the sassenach Midland Railway, I would have thought that these two noble locomotives would actually look rather splendid in red. Unfortunately, as a result of one of the many changes in policy on the LMS in the 1920s, both engines finished their careers clad in a funereal unlined black, before being withdrawn in 1933, No. 50 in March and No. 49 in December, after 30 years of faithful service.

They outlived the last of their more famous and younger cousins, the 903 Cardean class by three years; one reason for their greater longevity may well have been the main frames, which on Nos. 49 and 50 were a substantial 1 1/8in. thick, compared to the 1 1/16in. of the Cardeans, with generous metal allowances around the cut-outs for the driving and coupled wheels, as can be seen in fig 6. The frames were also very well braced and all bearing surfaces were obviously intended for sustained hard work, despite which No. 49 apparently gained an unenviable reputation for running hot in later years.

Miniature version

When it comes to building a miniature version intended for live passenger hauling, scale thickness frames would be too flimsy, (about 3/32in. in 5in. gauge), and life is not made easier by the fact that those on the full size engine were joggled twice: the first opposite the back rim of the rear bogie wheels, from 4ft. 1 1/2in. between frames to 4ft. 0 1/4in., and the second just forward of the cylinder block, so that the distance between the frames tapered to 3ft. 10 1/4in. at the front buffer beam. On the full size locomotive, this complicated manoeuvre avoided full cut-outs round the bogie wheels, which would have left about 4in. depth of frame above the front wheel. With our sharper curves and bumpy tracks, a scale joggle would give totally inadequate clearance for the bogie movement, and if a full cut-out is made, depth of the main frame is down to about 1/8in. in 3 1/2in. gauge.

One possible way round this, which avoids ruining the appearance, is to fit a substantial 1/8in. thick horizontal stretcher between buffer beam and cylinder block, but lifting this heavy locomotive would put a great strain on the front end. Making the cylinder/valve front cover a solid block might help, but the shallowest section of main frame is unfortunately just forward of this, so all in all, it would appear that a little judicious shrinking of the bogie wheel diameter is called for. Incidentally, I omitted to mention ▶

Figure 7

Figure 8

that the bogie pivot is one inch in front of the centre line, as is the case with several Stirling and Drummond derived locomotives, and has been discussed in a previous article in this series.

The diameter of the bogie wheels on the full size engine was 3ft. 6in., with the usual 10 spokes, which scales to $2^5/8$in. for $3^1/2$in. gauge, $3^{21}/32$in. for 5in. gauge, and $5^1/4$in. for $7^1/4$in. gauge, but a reduction of around 10% on the tread diameter as suggested above, is probably necessary to help clearances.

The driving and coupled wheels have 22 spokes and are 6ft. 6in. dia. ($4^7/8$in., $6^{29}/32$in., and $9^3/4$in. in the three main gauges), a fairly easily obtainable commercial size, and on Nos. 49 and 50, the driving wheels fortunately were not 'dished' outwards as they were on the later Cardeans in order to squeeze another inch of bearing surface. But beware a potential problem that has reared its ugly head in a previous article: the throw of the crankpins is only 10in., rather than the 13in. you might expect from the piston stroke. One detail which affects the appearance quite noticeably is that the radius for the curve of the splashers over the driving and coupled wheels is struck from a point one inch above the axle centre, which accentuates the general curvaceousness of these elegant locomotives.

The valves were always above the cylinder bores, but depending on which period you wish to model, or perhaps where your particular interests and skills lie, you have the unusual choice of plain slide valves (1903-04), Richardson balanced valves (1904-11), or piston valves (1911-33). Strictly speaking, piston valves are only correct in conjunction with a superheated boiler, balanced valves with the shortened tube length and no superheater, and plain valves with the original long-tube boiler, i.e. the equivalent of 17ft. 3in. between tube plates. My personal preference if building this engine, although it would probably cause Curly's old friend Inspector M. some anguish, would be to use a radiant superheater and recess the front tube plate even further into the barrel, more or less as suggested by J. D. in *The Engineer* a century ago, combined with balanced slide valves.

If you wish to use scale diameter cylinders, you again have the unaccustomed luxury of three choices: 20in. (1903 or 1904-11); $20^3/4$in. (1911-33); or if you believe the original Caley publicity, 21in. (1903-4). Personally, I think I would risk a thunderbolt from LBSC's *Astral Belle* and go for the equivalent of 19in. or even 18in. diameter: not only would the engine be less likely to 'dance' when getting away, but clearances would be much easier. The standard width between frames in $3^1/2$in. gauge, for instance, is $2^7/8$in., and two cylinder bores of a scale 21in. dia. would fill all but $^1/4$in. of that space, which is pushing one's luck. I would try to retain the 26in. stroke, although as is obvious in fig 6, the space between the rear bogie wheel and driving wheel is very cramped. In full size, the distance is 7ft. 2in. centre to centre, which particularly in $3^1/2$in. gauge ($5^3/8$in.), does not leave much room for eccentric rods (4ft. 6in./$3^3/8$in.,), plus expansion link, plus intermediate valve spindle with suspension lever, plus vertical rocking shaft, plus main valve spindle.

Commercially available castings for cylinders with valves above were discussed in the second article in this series on the North Staffordshire Railway 4-4-2Ts (*M.E.* 4194, 2 May 2003), so I will not go over the same ground again, except to say that if you wish to retain the equivalent of the 26in. stroke of the prototype, beware the short cylinder blocks of designs like LBSC's *Mabel*, the stroke of which is equal to only $22^1/2$ inches. The most hopeful possibilities in $3^1/2$in. gauge appear to be LBSC's *Molly* and *Mona*, and in 5in. gauge, the same designer's *Maid of Kent*, Martin Evans' *Super Claud*, both slide valve, and Martin's *Crewe Alexandra* or J39, if using piston valves.

The boiler, though large, is about as straightforward as it could be, with a round-topped firebox, but I certainly would not go for the so-called Crewe type firebox backplate; it causes a loss of grate area, which however slight, is not a good idea with this tube length, even allowing for a substantial 'recessing' of the front tubeplate.

A tiny detail worth noting is the coupling at the front end of the locomotive, which consisted of a single long link, and J. N. Maskelyne recorded that it was an absolute ritual with Caledonian crews that before the start of every trip, it should be placed in its upper position, leaning against the front buffer beam. Another Caley feature, a version of which became a standard fitting on the LMS, was that wonderful deep hooter, which must have sounded absolutely fantastic, in the old sense of the word, echoing round some remote Scottish glen. Our old friend LBSC gives instructions in the *Live Steam Book* for making the LMS version, using a resonator box, but of course, as he pointed out, the small one will under no circumstances have the carrying power of its full-sized relation, due to basic laws of acoustics.

Colour schemes

I have already expressed my opinion that 'Caledonian Blue' was one of the finest colour schemes used on a railway locomotive, but what exactly is 'Caledonian Blue'? When first turned out, Nos. 49 and 50 are reported to have been painted the official Prussian Blue, which was standard at least from the 1890s, but they were soon repainted in the lighter shade introduced in the early years of the 20th century, possibly at the time of the 1904 boiler modification. Apart from the oil painting already mentioned, a colour lithograph of No. 50 in the original colour was issued with Volume 13 of the *Railway Magazine*.

A major complication in identifying the Caley blue, or for that matter any other railway's version of that colour, is the sensitivity (or lack of it), to the different colour wavelengths possessed by the black and white photographic emulsions of the day. The early photographic processes were, to all intents and purposes, capable of reproducing only the blue end of the colour spectrum, and while the introduction of what was later called 'orthochromatic' emulsion extended the sensitivity into the green area, the material was still extremely blue sensitive — or to put it another way, both the older 'ordinary' and the new 'ortho' reproduced pure blue as a much lighter grey than it appeared to the human eye. In 1906, three years after the Caledonian twins first saw the light of day, the first panchromatic plates (literally 'sensitive to all colours' — back to Greek again) were put on the market, which not only reproduced reds much more accurately, but were relatively less blue-sensitive; the latter colour therefore appeared slightly darker than on the orthochromatic emulsion, which continued to be commercially available for many years.

As in most cases we have no means of knowing which was being used on any given photograph, it is impossible to compare the various renditions of the blue with any accuracy. Contemporary observers have reported that Caledonian Blue varied over the years, but whether this was due to photographic variations, variation in the paint itself, or because of fading, is difficult to tell at this distance in time. Blue, especially the lighter variants, has always been notorious for impermanence and inconsistency, as British Railways discovered to their cost in the 1950s, and it seems likely that the Caledonian suffered similar problems 30 years earlier. From around 1920, many engines once again left St. Rollox clad in a much deeper and presumably more stable shade, while yet another variant appeared on the Pickersgill 4-4-0s built by outside contractors. Fortunately, the 4-6-0s were always overhauled and repainted 'in house', so that does not concern us.

Other details of the Caledonian colour schemes are as follow: the wheels were blue with black tyres and axle-ends on most engines; one photograph of No. 50, however, shows the driving axle-end only as being left bright, a slightly bizarre effect. Lining was black, edged each side by a white line, while the springs for engine and tender and the frames of the engine were black. Running boards and steps on the engine along with the frames of the tender were deep lake, edged with black, with a white line between the lake and black.

The initials C R and the engine number appeared on the front buffer beam, and the initials also appeared on the side of the tender, normally in 10in. high letters, but half as large again on No. 49 and 50, while the engine number was also displayed on the back of the tender. Numbers and letters, including names where carried were gilt,

shaded to the left in red with white highlights and blocked in black to the right, while the armorial device, (**fig 7**), appeared twice on each side, on the leading splashers of the locomotive, and again between the C and R on the tender. The one on the tender was normally flanked on each side by a scroll, but on Nos. 49 and 50 only, (although not on the Cardeans), it was surrounded by an ornate design of gilt leaves and thistles, (see fig 1, *M.E.* 4212, 9 January 2004).

The buffer beam was unusual, in that the vermilion used by most other railways was on the Caledonian confined to a central panel between the buffers, the shanks of which, together with the outer segments of the beam itself, were painted the same deep lake used for the running boards, the vermilion panel separated from the lake by a black and a white line. The background to the brass number plates on the cabside, (**fig 8**), was originally red, but at some time during the first decade of the 20th century, blue was substituted.

John McIntosh

When John McIntosh retired in May 1914, at the age of 72, he bequeathed a fine fleet of locomotives to his successor, William Pickersgill, but sadly, he enjoyed only four years of well-earned retirement before his death in 1918. Perhaps because he had well and truly worked his way up through the ranks, he had a gift for getting on with people from all strata of society, in an age when lines of demarcation were much more rigid than they are today.

One of his responsibilities from his initial appointment in 1895, was the running of the Royal Train on its frequent journeys to and from Balmoral, when, apart from official duties, he apparently kept H. M. King Edward VII highly entertained with an inexhaustible fund of blue jokes. Three years before he retired, the same Royal Train, but now of course with King George V on board, made a special stop on its way back from Balmoral to invest the Caledonian Locomotive Superintendent as a Member of the Royal Victorian Order (M.V.O.), a high honour. Obviously, I would not dream of suggesting that this had anything to do with the unofficial entertainment John McIntosh had provided over the years for the previous monarch.

In conclusion, I would once again like to thank Keith Moore at the I. Mech. E library for digging into century old archives and Laurie Marshall for the loan of extra photographs.

Caledonian Railway Nos. 49 and 50
Useful Dimensions

Note: these are intended specifically for use in producing a miniature version of No. 89, so 'internal' measurements such as heating surface and diameter of boiler barrel sections are omitted. The figures for 3½in. and 5in. gauges have been calculated to the nearest 1/64in., using ¾in. to the foot and 1 1/16in. to the foot respectively. For gauge 1, halve the 3½in. gauge figures, for 2½in. gauge, halve the 5in. gauge figures, for 7¼in. gauge, double the 3½in. gauge figures. Figures prefixed by ≈ are approximate only

Description	Full Size	¾in. scale (3½in. gauge)	1 1/16in. scale (5in. gauge)
Length over buffers, engine and tender	65ft. 6in.	49 1/8in.	69 19/32in.
Overall length of engine	≈38ft. 9½in.	29 3/32in	41 7/32in.
Length of engine main frame	37ft.	27 3/4in.	39 5/16in.
Overall length of tender	≈26ft. 2in.	19 5/8in.	27 51/64in.
Height to top of chimney	12ft. 11in.	9 11/16in.	13 23/32in.
Height to top of dome	≈12ft. 11½in.	9 23/32in.	1 49/64in.
Height to top of cab	≈11ft. 10½in.	8 29/32in.	11 39/64in.
Width over footsteps (maximum width)	8ft. 11½in.	6 23/32in.	9 33/64in.
Width over footplate	8ft.	6in.	8½in.
Width over cab	7ft.	5¼in.	7 7/16in.
Height of footplate above rail level	4ft. 0 3/8in.	3 1/32in.	4 9/32in.
Distance between frames at buffer beam	3ft. 10¼in.	2 57/64in.	4 3/32in.
Locomotive wheelbase, total	28ft. 8in.	21½in.	30 29/64in.
Divided into: Bogie wheelbase	6ft. 6in.	4 7/8in.	6 29/32in.
Rear bogie to driving wheel	7ft. 2in.	5 3/8in.	7 39/64in.
Driving wheel to mid-coupled	7ft. 6in.	5 5/8in.	7 31/32in.
Mid-coupled to rear coupled	7ft. 6in.	5 5/8in.	7 31/32in.
Tender wheelbase. total	16ft. 6in.	12 3/8in.	17 17/32in.
Divided into:	3 x 5ft. 6in.	3 x 4 1/8in.	3 x 5 27/32in.
Diameter of driving and coupled wheels (22 spokes)	6ft. 6in.	4 7/8in.	6 29/32in.
Throw of crankpins	10in.	5/8in.	7/8in.
Diameter of bogie wheels (10 spokes)	3ft. 6in.	2 5/8in.	3 23/32in.
Diameter of tender wheels (10 spokes)	3ft. 6in.	2 5/8in.	3 21/32in.
Pitch of boiler above rail level	8ft. 6in.	6 3/8in.	9 1/32in.
External diameter of boiler (over cladding)	5ft. 3½in.	3 31/32in.	5 5/8in.
Visible length of smokebox	≈3ft. 4in.	2½in.	3 35/64in.
Diameter of smokebox door	4ft. 3¾in.	3 15/64in.	4 37/64in.
Height of chimney above cladding	1ft. 7 11/16in.	1 15/64in.	1¾in.
Height of dome above cladding	1ft. 10 5/8in.	1 13/32in.	2in.
Distance C/L chimney to C/L dome	10ft. 6in.	7 7/8in.	11 5/32in.
Cylinder bore (see text)	(20in.	1¼in.	1 49/64in.
	(20 3/4in.	1 19/64	1 27/32in.
	(21in.	1 5/16in.	1 55/64in.
Piston stroke	26in.	1 5/8in.	2 19/64in.
Distance C/L cylinders to C/L driving axle	10ft. 6in.	7 7/8in.	10 27/32in.
Distance between C/L cylinder bores	2ft. 1½in.	1 19/32in.	2 17/64in.
Length of connecting rod	6ft. 8in.	5in.	7 5/64in.
Length of eccentric rod	4ft. 6in.	3 3/8in.	4 25/32in.

Dimensions indicated thus ≈ have been scaled from a drawing or photograph.

References

1: *The Engineer*: 3 April 1903; 10 April 1903; 21 August 1903; 5 January 1906 (Courtesy I. Mech. E. Library) This includes photographs, dimensions and Rous-Marten's reports, but no drawings.

2: *The Railway Engineer*: July 1903 (courtesy I. Mech. E. Library): Photograph and not always accurate dimensions, no drawings.

3: *Engineering*: 18 September 1903: (courtesy I. Mech. E. Library): Photograph and dimensions, no drawings.

4: F. Moore Photographs Nos. 5566 and 5567: (courtesy L. Marshall) Two very good views of left-hand side of No. 50.

5: Works drawings, NRM ref. Nos. 3/GW/12511/E (Caledonian No. 11600); 3/GW/12512/E (Caledonian No. 11600); 3/GW/12513/E (Caledonian No. 11631). The first two are General Arrangement diagrams of No. 49/50 as originally built and after alteration (yes, the Caledonian Railway *did* allocate the same number to two different drawings), the third is a G/A of the tender. These are available from The National Railway Museum, Copy Drawings Service, Leeman Road, York, Y026 4XJ.

6: *Locomotives Illustrated No. 51: The Scottish 4-6-0s*. Jan-Feb 1987. Published by Ian Allan. Contains very good photograph of Cardean class 904 and less good ones of Nos. 49 and 50.

7: *Forty Years of Caledonian Locomotives 1882-1922*. H. J. Campbell-Cornwell, published by David and Charles 1974: An excellent information-packed book with many reproductions of G/As and detail drawings.

8: *Scottish Locomotive History 1831-1923*. Campbell Highet, published by Allen and Unwin 1970. More anecdotal than ref 7, but contains useful supplementary information.

9: *British Locomotives of the 20th Century Vol. 1: 1900-1930*. by O. S. Nock, published by P. Stephens 1983. Contains General Arrangement diagram of *Cardean*.

10: *Caledonian Cavalcade*. A. E. Glen, I. A. Glen and A. G. Dunbar, published by Ian Allan 1979. Very good collection of historical photographs, including No. 49 and 50.

11: *Scottish Railways* by O. S. Nock, pubished by T. Nelson 1950. Contains fine colour plate of No. 50.

12: Official photographs, NRM Nos. SRX 39/41/42. Side views of Nos. 49 and 50, obtainable from The National Railway Museum, address as ref 5.

The most useful for builders of a miniature version are references 5 and 7, while the best photographs appear in references 1, 2 and 6, and, of course, 12.

●*To be continued.*

The double pivot design involves a transfer link and radius rod between the fixed structure of the branch line (right) and the swing beam unit (left).

A necessary design criterion was the ability of the mechanism to open to 90deg. to provide 'ride-on' lawnmower access inside the area.

THREE INTO ONE
SWINGING BEAM SIDINGS ACCESS AT BRISTOL

P. W. Davis
describes an ingenious and innovative design for use on the Society's 5in. gauge raised track.

Bristol SMEE has occupied its present site at Ashton Park for 30 years, during which the 5in./3½in. gauge raised track layout has remained unchanged. Hitherto, the 5in. gauge passenger cars have had to be carried from the present storage room at the station and lifted bodily onto the track every running day. They seemed to become heavier with the passage of time.

In 2000, a Lottery Grant was obtained, to help pay for the construction of a dedicated carriage shed to house the Society's 7¼in. ground level and 5in. raised track passenger cars. A 5in. gauge raised track branch line 150 yards in length was constructed with a traverser to connect to the main line. Three parallel tracks are provided inside the new carriage shed to house the 5in. gauge cars, and a 3-way swing beam was designed and constructed to connect any of the three tracks to the branch line.

One of the design requirements was that the swinging beam had to be capable of being fully opened (through 90deg.) to allow access for the Society's 'ride-on' lawnmower. The problem was how to maintain a connection between the beam and the branch line in the three positions of the beam, and yet allow the beam to be opened through 90 degrees. It was considered that a length of flexible track would not have been sufficiently flexible to achieve this, and a swinging beam with a single pivot would not align itself to the branch line in all three positions.

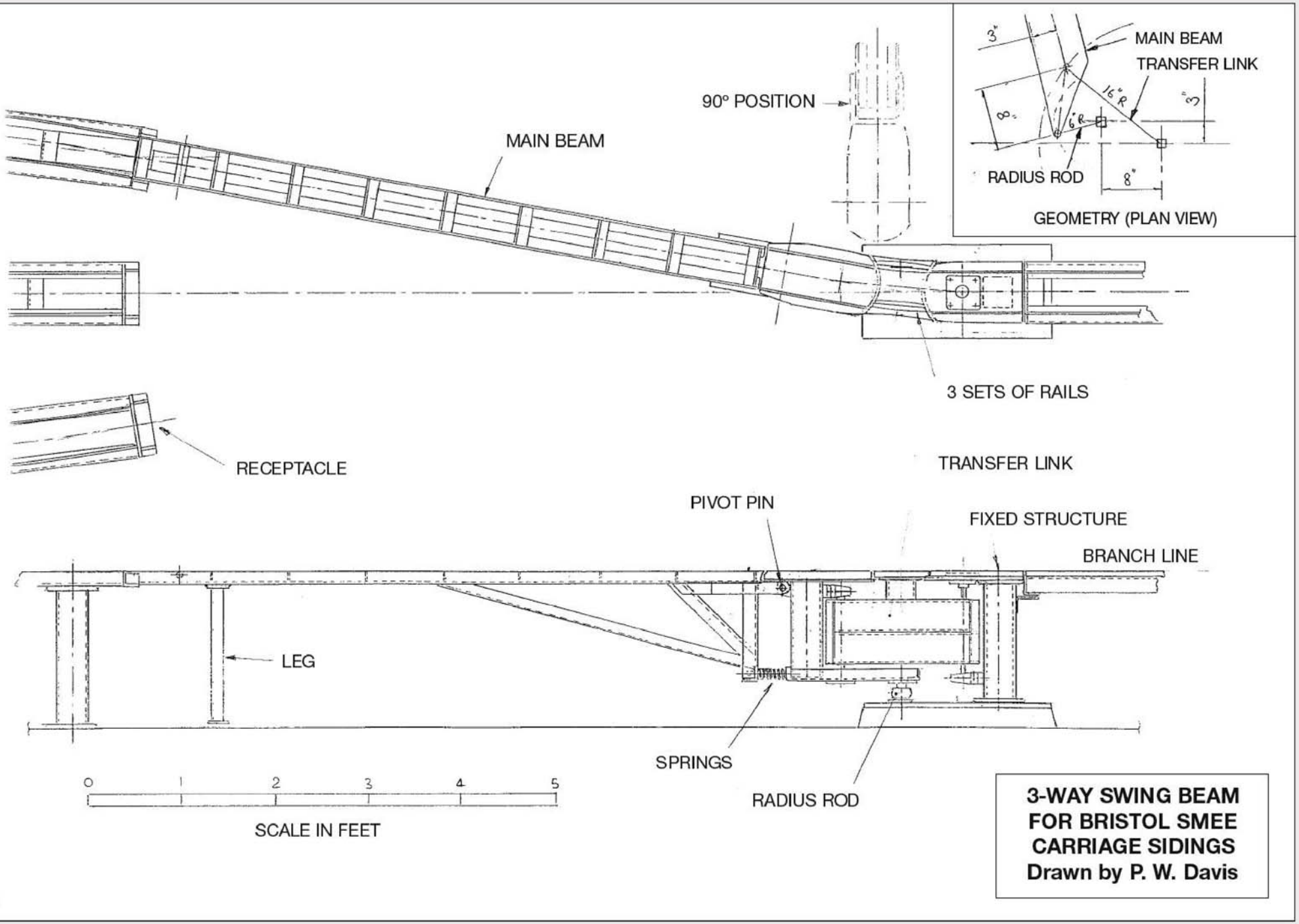
The configuration of the swing beam track is evident from this general view.

A 'double pivot' design was finally adopted in which an 8ft. long main beam is attached at one end to a 16in. long transfer link which is pivoted at its other end to the fixed structure at the end of the branch line. A further guiding link, in the form of a 6in. long radius rod, connects the main beam to the fixed structure to achieve the required motion. The geometry is arranged so that the transfer link swings through half the angle of the main beam. The top surface of the transfer link carries three sets of rails, one set or another of which align with the main beam and fixed branch line in each position of the beam.

The major portion of the main beam is supported on a horizontal pin so that it can be lifted, carried round by hand, and lowered into the appropriate receptacle provided at the end of each of the three carriage shed tracks. Much of the weight of the beam is counteracted by a pair of compression springs so that it can be lifted and carried round with minimal effort. A leg is provided on the beam to support it in the fully open (90deg.) position. The bearings are mainly fully sealed and self-aligning. The entire beam has been galvanised to provide a maintenance-free installation.

The transfer link features three pre-formed rail sections, one or the other of which aligns with the track in each of the three swing beam positions.

Construction is substantial; springs are used to counterbalance the weight of the swing beam and the assembly has been galvanised for longevity.



3-WAY SWING BEAM FOR BRISTOL SMEE CARRIAGE SIDINGS
Drawn by P. W. Davis

KEITH'S COLUMN

SAINT CHRISTOPHER
A GWR LOCOMOTIVE for 7¼in. gauge

Keith Wilson

brings his description to a close with notes on the grate and ashpan before offering a blower design and advice on raising steam and preparing the locomotive for a run.

●*Part XLVIII continued from page 42 (M.E. 4212 9 January 2004)*

I think we are fairly near the end, but if anybody notices something missing, then "ye are to confess it."

The grate and ashpan always present problems, the grate is fairly easy but the ashpan is often very tricky, because it has to be fitted into place avoiding many bits that are definitely in the way.

Grates can be made from black iron, rather better than mild steel because the former has rounded edges. Stainless is better, but by far the best I have yet come across are the stainless grates sold by Norman Spink (01246-277010). They may not be cheap but they are very good value for money, lasting very well indeed. Tough as old boots, they need trimming to final size. I discovered many years ago that my big bandsaw was virtually useless even at very slow speeds. A hacksaw, high-speed blade, and slow steady strokes are *de rigeur*. Now, I know perfectly well that carbon steel is actually harder than high-speed steel; the beauty of the latter being that it takes a far higher temperature to blunt or burn it; however for some reason it is best for this task. At least, that is what I have found.

The grates (fore and aft sections) each rest on a pair of 3/16in. stainless pins threaded through holes in the inner firebox, below the foundation ring. This seems crude, but in practice it has great advantages. It will be clear that dumping the fire at the end of a run is a must. I recall overhauling a *George the Fifth* which had the steel ashpan riveted to the foundation ring. Choked up to the proverbial 'nines' with non-dumped fire, it had a spare heavy-duty grate in the ash collection … any questions?

This method works well. Because of the presence of the axle, it is not possible to just release one end of the grate and let the pivoted end suspend the whole thing. I suppose it might be possible to do this process in two sections, but frankly I cannot see how. The brake gear has a habit of being very much in the way too.

Over an ashpit, the two bottom doors in the grate can be opened, prodding upwards with the poker will then dislodge the grates, permitting the ash and fire remains (often plus a good sheet of clinker) to fall down. It is best to do this only for the forward portion, when the firedoors can be opened and judicious pokery with poker (what else?) will propel the remains forward so that they fall out. In case it isn't obvious — and if you don't believe me you will try it only once — the boiler must cool off rather a lot before you can replace the grate.

In the case of smaller boilers, such as No. 2 or No. 4, where the axle is not quite so invasive, it is quite easy to pivot the grate at rear end and have the front end resting on a little stand fixed to the door — the one at the bottom of the ashpan — so that on pulling the pin, the lot dumps itself and the door can be put back almost immediately. This can be a great boon if your fire clinkers up during a long session; I write from experience!

It is a matter of choice what material is used for the ashpan; mild, stainless, or brass are all suitable. If mild, at least 1/16in. is recommended, for ashpan conditions are probably the worst on the entire locomotive with lots of corrosive substances present. Hot water from condensation as the boiler cools off also takes its toll.

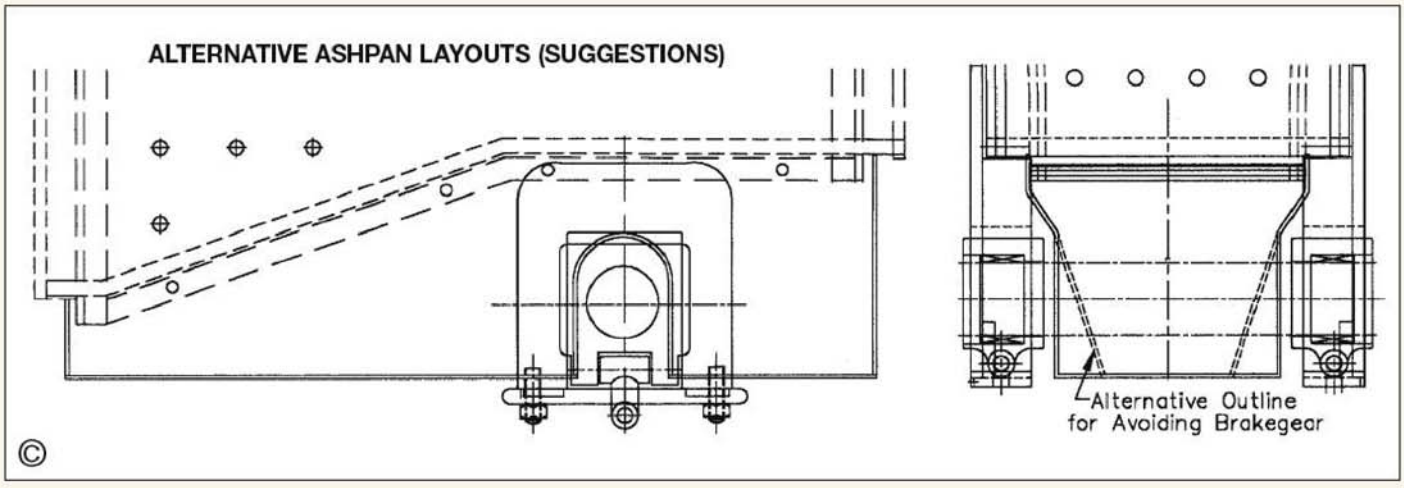
I have not shewn much detail or dimensions with grate or ashpan, for they are easier to make 'fitted' to the locomotive, but the doors at the bottom can be pivoted by silver-brazing a piece of 1/4in. square material across one end of each door to aid in forming a hinge if drilled at each end. A couple of holes about 1in. diameter at the ends of the pan will permit enough air in to achieve combustion, possibly aided by some holes along the sides; this is a matter for some experiment. Try to get the doors of such a width that they will fall clear of the brake rigging. A crafty wangle here is to reverse the precise location of the compensation levers and links; i.e. the two long pull-rods can be moved quite a long way outwards without affecting the efficiency of the braking system. I hope that's clear.

It is perfectly possible to build in proper air-vent doors or dampers, but due to the conditions in ashpans, as mentioned above, they might well have a short life so 'tis a matter for personal choice.

I have made two Saints in my time, broadly on this design, however these were made (like the two 47s in 7¼in. gauge) rather early in my list of workings and were not quite so close to Swindon design internally. I remember that for some reason the two Saint boilers turned out to be 1in. short in the firebox, so I had to graft on a new rear end. One of these boilers lasted 14 years in a hard-water area with never a washout or blowdown; I am quite proud of that boiler! The other one has been steamed twice as far as I know, but not since the early 70s. The engine was dismantled so that it could have better detail made, I believe that it is only within the last year that it has been re-assembled! But it looks a lot better!

Raising steam

I have seen some weird and wonderful contraptions for carrying out this rather important task. The fire will not burn of its own accord; a forced draught is required. One possibility is a long extension chimney. The trouble with this is that it needs to be *very* long for the draught effect to be effective. I do not know just how long, for I have never used this system. However, many long years ago I used to assist in driving on the Littlehampton Miniature Railway; the boilers were steel and raising steam therefore had to be a slow process. With steel, the boiler is made up of several distinct pieces, and



Essentially simple, this blower is constructed around a suitable ex-automotive 12V dc motor.

The body is furnished with a tapered inlet to suit a range of chimney diameters.

heat conductivity is low, so you can easily get one end cold and the other end very hot; not good for sealing joints. Once steam is raised, then forcing the fire with a strong draught from the locomotive's own blower is okay.

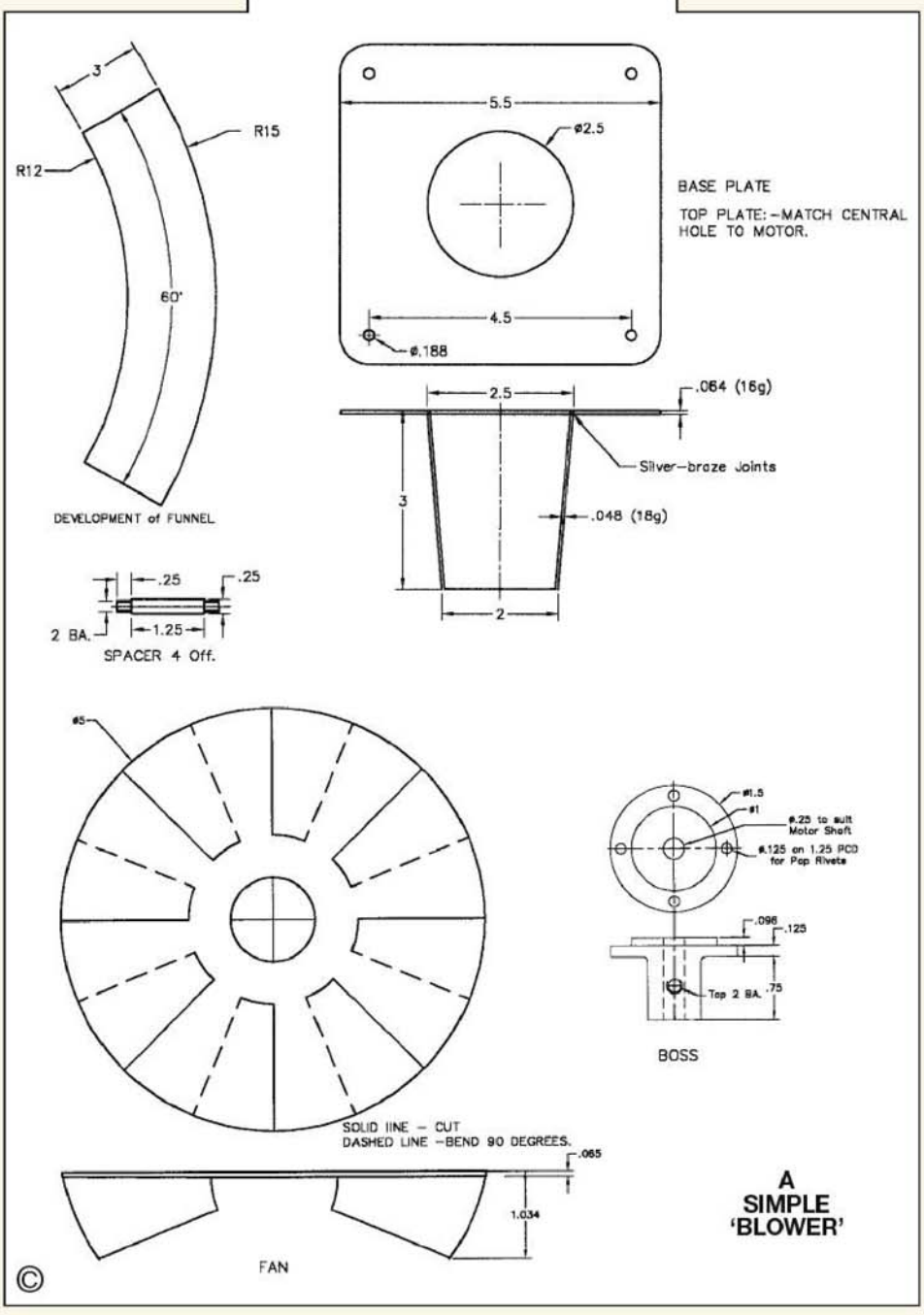
In the case of copper, not only is it usually smaller, but also the boiler is one solid mass of highly conductive material, and due to old square-cube has lots less water, so it is rather more difficult to get vast temperature differences. So a forced draught right from the word go is acceptable. However, there are forced draughts, and forced draughts. I recall on one 10 1/4in. gauge railway where the operator thought that direct use of a fan would result in choking of the fan. So he used a low-pressure fan to shove air into a large jet inserted into a wide tube hoping to get a good draught from the venturi effect. Result: just over 1 1/2 hours to get steam up. The engine was a small one with a boiler smaller than our Saint's … any questions? This system requires much higher pressures and fairly small jets and if so used is a good way of draughting. However, it requires a compressor of reasonable capacity — something like 2 cubic feet per minute is advised. With a jet about 3/64in. diameter, or even 1/16in., it will probably need throttling back a bit to avoid pulling the flames off the fire.

For occasional use, or where a compressor is not available, an electric blower (so called, no doubt, because it is an electric sucker) powered from the car battery, is probably the easiest bet. While for 5in. or smaller, dry cell batteries are usually okay, with a smaller device but we need a bit of 'oomph' for a big 7 1/4in. gauge job.

The design offered here is easy to make, and serves well. Several have been made to this design, and they work well. My record for raising steam fast was on my giant GWR Prairie: 7 minutes from striking the match to opening the locomotive's own blower. This was using barbecue charcoal soaked in paraffin. Firelighters are another quick way, or wood sticks soaked in paraffin overnight; any less time is next to useless. With charcoal, the absorption of paraffin is very fast and overnight soaking is not needed. I keep an ex-1 gallon ice-cream plastic container holding charcoal and paraffin; immediately after lighting the fire the charcoal is replaced from the dry sack. Hence soaked charcoal is always to hand.

Blower (Sucker!)

There is little need for descriptive notes here, the motor can be



purchased new or 'rescued' from a scrapyard car. Make the boss to suit the motor shaft and fit the top plate to the motor. Best to use aluminium for the fan, for if you don't manage to get the fan balanced it can shake like ******* when you switch on.

Operation

Check that water is visible in the gauge glass. There is no need for it to be other than just visible, for the co-efficient of fluid expansion is something around 100 times that of solid; gaseous expansion is roughly 100 times again. So as boiler temperature rises, the water level will creep up the glass and at full pressure you may expect just under half a glass. Put a couple of shovels full (shovelfulls?) of soaked charcoal into the box, then add one more with the stuff already lit with a match or a lighter.

As an alternative, some cheap stores sell piezo-electric gas lighters, usually for about £1. However, I suggest that you do not ask for such an item, but just ask for a gas lighter or you might well be favoured with a rather blank look. Set to give a flame two to three inches long this device is dead easy to poke through the firebox door, followed by pulling the trigger. Very useful, especially if there is a good breeze blowing!

Do not start the blower immediately; let the fire burn by itself for a few moments until smoke and flames issue forth from the door. Then start the blower, add a bit more charcoal, close the door for a while and then start adding coal.

With the fire lit and heating in progress, now is the time to check the lubricator and oil-up the works. It won't be long before some vestiges of steam appear, usually from the snifting valve(s); few regulators are absolutely tight! If you can hear it when the locomotive blower is opened, there is probably enough steam pressure to use that instead of the electric 'sucker'.

It is a strange phenomenon that I do not understand, but every engine I have made exhibits a sort of 'dead zone'. If for any reason the pressure drops below 40psi, it takes quite a long time for it to get back; above 40psi the rise in pressure is quite rapid. Once you have about 40psi on the clock, give each injector a quick test, then you can top up the tanks if necessary and back onto your train. By the time you are coupled up and piped up for vacuum brakes, the boiler will be up to working pressure. There is no need to faffle about until the boiler is full and pressure is up, it is time wasted (probably only after your first run!) Many's the time have I witnessed this.

If this is your first locomotive, keep an eye on the water gauge and occasionally check the lubricator. Warning. Do *not* use 'ordinary' oil in the lubricator; it becomes very fluid when hot and it will lose most of its lubricating properties. One of my eight Prairies was being operated — I certainly will not tell you where or by whom — and the operator claimed that it was always squeaking. I checked the lubricator and the answer was obvious: thin oil. Under such conditions it is about as much use as white spirit.

Now, there is an oil that has been developed for steam locomotives. It is called GP 1000, is reasonably priced, and can be used anywhere on a steam engine. Probably silicone based, it is very good stuff indeed. However do not use it on high-speed operations; when I had my first supply it looked really good so I topped up the oilboxes on my Myford. Result: on switching on at top speed, as the oil got into the bearings the lathe slowed down and stalled even with power on. So thinnish oil for high speeds, GP 1000 for steam engines (other than turbines!) The thick green vegetable oil sold for superheated applications is quite okay, so it is a matter once more for personal choice. Incidentally, this thick green oil is edible … best of luck.

I do not see much point in telling you how to drive, experience is a very quick teacher. But do not be afraid to notch up by using the reversing 'pole' to reduce the valve travel. It will reduce steam consumption without much reduction in output power. In theory, the best way to drive is by having the regulator full open ('up in the corner') and controlling speed by means of said pole. However, while this is perfectly true for Walschaerts valve gear, it is not quite so good for Stephenson's, for due to the fact that notching up advances the valve motion, it also advances the exhaust side, producing choking, so the normal position for Stephenson gear is only about the 20% mark. Walschaerts can easily run up to 12% cut-off. So, if you try to run one of my locomotives in this way, be prepared to partially close the regulator as speed mounts.

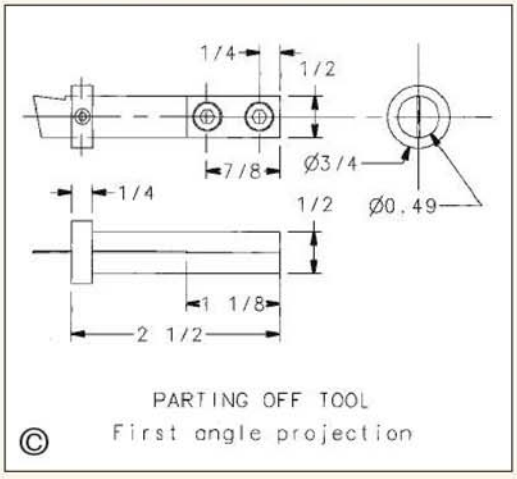
I am often asked, by small boys *"How fast will it go, mister?"* and my invariable reply is *"I don't know, and I am certainly not going to find out!"* More than once I have had my hat blown off in the slipstream (no passengers of course) and I have witnessed (from a safe distance!) a *Highlander* doing a fraction over 31 mph. Bearing in mind that a full-size Saint once cleared the 120 mark beyond doubt; I reckon our 7¼in. version could show a clean pair of heels, as the saying goes!

A PARTING OFF TOOL

Dr. R. Cutler
describes an old design for which he has much admiration.

One of the early tasks the beginner has to master on the lathe is parting off. This is often embarked upon with some dread even thought the current availability of rear tool posts, with the tool in the upside down position, has robbed it of most of its terrors. Normally the cutting part of a parting tool is relatively wide with tapering sides to give clearance. However, where conservation of material is important a thin tool is helpful and the ultimate in minimal width blades is a suitably housed piece of broken hacksaw blade. Such an arrangement can be used to advantage in, say, parting off rings from brass tubing or small diameter round stock.

Years ago, details of a suitable assembly were described in *M.E.* and mine, made to this design, was recently brought out of its oil papered seclusion for the tasks outlined above. The design is ingenious and, much as I would like to take credit for it, this must surely go to some past contributor who, perhaps, some more senior reader can identify.



Construction is simple and dimensions are not critical but those shown have proved to be suitable. The tool consists of two pieces of 2½in. long mild steel having a section of ½ x ¼ inch. These are cleaned up and aligned with preferably two 2BA screws although one would probably do. With the two pieces aligned and bolted together the opposite end face is centred in the 4-jaw chuck and turned down for ¼in. to just clean up on the diameter. A mild steel collar, not less than ¾in. dia., is bored to suit this diameter and then parted off ¼in. long. This collar is then drilled and tapped for a 2BA grub screw.

The two strips used for the body can now be separated and a step machined in each to receive the hacksaw blade cutter. Hacksaw blades are usually 0.025in. thick so relieve each side by 0.0125in. or enough to allow the collar to be fitted correctly when the blade is inserted between the two halves of the tool's body. Most hacksaw blades have a wavy toothed edge to provide cutting clearance so this will need to be allowed for.

When making the cutting blade from a piece of broken hacksaw blade, place the teeth of the blade uppermost as some blades are differentially hardened across their width. The tool can now be assembled and tested. It is probably best to restrict its use to small light work but the thin blade is well suited to use on light lathes. The tool is simple to make and would be a good project for a beginner who would have a useful addition to his workshop at the end of the exercise.

A busy scene in the steaming bays. (Photo: Malcolm Ford)

Brian Remnant crosses the road with a small load behind Lady Margaret.

SWEET PEAS AT CINDERBARROW

Malcolm Ford
describes the 11th *Sweet Pea* Rally, hosted this year by Lancaster and Morecambe MES.

The society agreed in 2001 to host this year's *Sweet Pea* Rally and a small sub-group was set up to work out the requirements for the weekend. Easy really, all we needed were … *Sweet Peas*, coal, water, a track, food, camping facilities, fine weather, The Red Arrows both days, *Duchess of Sutherland* twice on the Saturday — nothing to it! (We really did have the Red Arrows fly over each day and the *Duchess* ran past twice on the adjacent West Coast Main line — but unfortunately we cannot take the credit for organising these events!)

I was rather doubtful about visitors coming so far north to our track, but at Cambridge last year I asked everyone I could about the possibility of coming to Cinderbarrow and I was completely reassured when the majority said *"Of course we will — it's the* Sweet Pea *Rally!"* Invitations were sent out in December 2002 to 80 *Sweet Pea* owners (a list has been drawn up by previous organising clubs) and the replies came flooding in by return.

We eventually had 30 *Sweet Pea* derivatives and 5 *Sweet Williams* (including the original 7¼in. version not seen at the rally before) plus 78 associated visitors to feed. We have found over the past three years at our new site that planning the catering for visitors is a 'black art' but for this rally we knew beforehand how many to cater for. It makes life so much easier for the people involved (and for the Chairman fielding all the problems!)

During the winter of 2002/3 we lifted our outer track (laid only two years previously) removed all the granite chip ballast, replaced it with limestone and welded tie rods across at each sleeper. Well, that was the plan, but we only got halfway round before the running season started again. Coal was sourced in large quantities, the track weeded and levelled, paintbrushes wielded in fact everything we could think of was in place and ready for the big weekend. Or was it? One week before the event someone thought that the Chairman ought to look at our drainage (we have a 5,000 litre cess pit); when I did, I found it full! Panic, our usual disposal contractor was unavailable, making silage 24 hours a day, and we only managed to rectify the problem with a couple of days to go!

It is usual for visitors to arrive on the Friday before the actual rally and some even have several runs that day as well; it is almost becoming a three day event. Our members were on site by 10am on the Friday and our first visitor arrived at 1pm — Bob Short from Exmouth who had set off in the (very, very) early hours and enjoyed a clear run up through the motorway system. From then on visitors arrived thick and fast!

The entire weekend was full of incident, enjoyment, chat, renewal of old friendships, making of new ones, running locomotives, making the occasional repair, enjoying the superb weather and the catering. On Saturday evening we had the customary barbecue, with the difference that we employed a commercial outfit so that all our members could enjoy the evening as well. The evening was so warm and balmy that a small group (they know who they were!) were still sitting out chatting and quaffing until the early hours of Sunday!

After further enjoyable hours on the Sunday the time came for presentations. It is usual on these occasions to make one or two awards and to say thank you. The *June Drake Award* for the best locomotive was won by Jim Harrop from Mansfield with *Toby* and the best 7¼in. by Roger Jackson with *Sweet William* No. 1. The furthest travelled was Brian Remnant from Dymchurch on the south coast, beating Bob Short by some 15 miles! Ron Drake drew the raffle tickets; the amount produced was in the region of £250 some £100 up on previous events, which was marvellous for Cancer Research.

Too soon it was time to bid our farewells with promises to meet up again next year 12-13 June when the rally is to be hosted by Fareham Model Engineers at their Titchfield site; further details from Pete Reynolds (02392-268351) or Blackgates (01132-853652). During the weekend Martyn Chidlow was videoing proceedings and copies of the resulting tape can be obtained from him at M. C. Video, Wrexham, (01978-350122).

Brian Holland and Fair Rosamund II *pass the distant signal.*

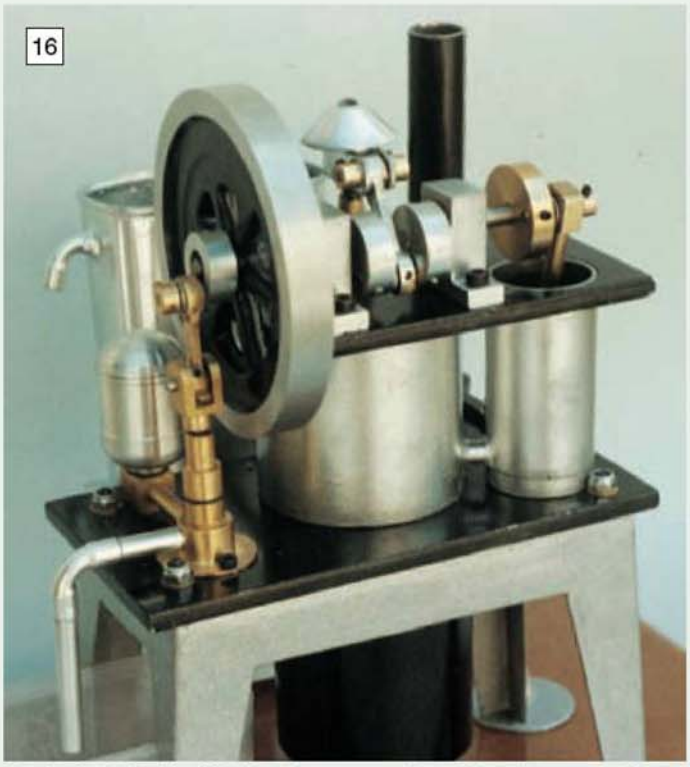
Derek Craig with Irene *on the traverser/turntable. (Photos, unless otherwise credited: Alan Green)*

A serious-looking Brian Remnant with Janet and Rex Mountfield among his passengers.

'HOPKINS' HOT AIR ENGINES

James G. Rizzo
in Malta, completes the construction of his interesting Mk. II engine and finds it a lively and exciting power plant when running.

●*Part V continued from page 39 (M.E. 4212, 9 January 2004)*



The Author's Hopkins Mk. II engine starts easily and by adjustment of the phase angle can be fine tuned to maximise efficiency.

The crankshaft is cut from a 4 23/32in. (120mm) length of 1/4in. (6mm) silver-steel. Two discs (webs) are then cut from 1 11/32in. (34mm) brass rod, each 5/16in. (8mm) thick and drilled 1/4in. (6mm). Each disc (**fig 44**) is marked 1/2in. (12mm) off centre and drilled to take a 3/16in. (5mm) crank pin. A roller or needle bearing with a 3/16in. (5mm) I/D is fitted on the crankpin.

The displacer con-rod is machined from 1/4 x 1/2in. (6 x 12mm) brass flat shaped as shown in **fig 45**. The big end is drilled to fit precisely on the roller bearing while the small end is drilled 1/8in. (3mm). The distance between the centres is 1 3/16in. (30mm).

The crankshaft is now partly assembled. The con-rod and crankpin are mounted on the crank webs with spacer washers, and the crankshaft is also inserted through the webs with space for the con-rod/needle bearing and spacer washers. The webs are held securely in a machine vice and drilled vertically through to take a 1/8in. (3mm) hardened steel pin. The secured crankshaft is then cut off between the webs and the ends filed off.

The crankshaft brackets (**fig 46**) are cut and shaped from 1/2in. (12mm) aluminium alloy flat bar, 1 1/4in. (32mm) high, 1 1/2in. wide and bored at a height of 25/32in. (20mm) to take ball bearings for the crankshaft, either 1/4 x 5/8in. or 6 x 15mm. The brackets are drilled to take 2BA or 5mm bolts.

The crankshaft assembly (**fig 47**) is placed close to the displacer rod guide parallel to the long edge of the top plate, the critical distance being 15/16in. (24mm) between the centre of the guide bush (or displacer rod) and the centre of the crankshaft at top dead centre. A spot of Superglue is put under each bracket once the position has been properly ascertained. The position for the securing bolts is marked, drilled and tapped.

With the crankshaft in place it is now possible to locate the position of the power cylinder with its centre in line with the crankshaft and within short distance (3/8in. or 10mm) from the cylinder block to reduce dead space in the pressure transfer pipe. Once the position of the power cylinder has been determined, a pilot hole is drilled for the centre of the power cylinder.

The top cylinder plate is now cleared of all assembled parts and then bored on a face plate to take the power cylinder in a precision fit.

The components, now including the power unit, are once again assembled on the top cylinder plate and the position of the pressure transfer pipe from the power cylinder plug end to the side of the cylinder block is marked. The cylinder block is drilled to take a 5/16in. (8mm) pressure brass pipe. Builders should note that this pressure transfer pipe will also have to go into the displacer cylinder, but at later point in the assembly process.

A crank disc (**fig 48**) is prepared for the power piston. This is cut from 1 11/32in. (34mm) brass, 5/16in. (8mm) thick, drilled 1/4in. or 6mm according to the crankshaft. The crank web is drilled 1/2in. (12mm) off centre to take a 1/8in. (3mm) hardened steel pin. The web is cross drilled and tapped to take a grub screw. A 1/8 x 3/8in. (3 x 10mm) ball bearing is mounted on the crankpin, and the power con-rod, clevis, power piston assembled at this end. Any surplus length of the crankshaft is marked for cutting off at a later stage. The power unit is tested for smooth running, any adjustments being made at this stage.

A 1 7/64in. (28mm) length of 1/2in. (12mm) square brass bar is prepared and machined to provide a connection between the displacer con-rod on the crankshaft assembly and the displacer rod (**fig 49**). Two holes are drilled, 19/32in. (15mm) between centres, one at 3/16in. (5mm) to fit to the displacer rod, and the other crosswise to take a 1/8in. (3mm) for the con-rod. The bar is cross drilled at the displacer rod end to provide for a 6BA (3mm) grub screw. The connection is now tested and the displacer rod should be able to move freely upwards when the crankshaft is turned clockwise when looking at it from the side opposite the power unit end, i.e. the flywheel end.

We are now approaching the final stages of assembly of the Hopkins Mk. II engine. The first step is to insert the displacer cylinder into the cylinder block. As explained, the displacer enters 25/32in. (20mm) into the cylinder block and a mark

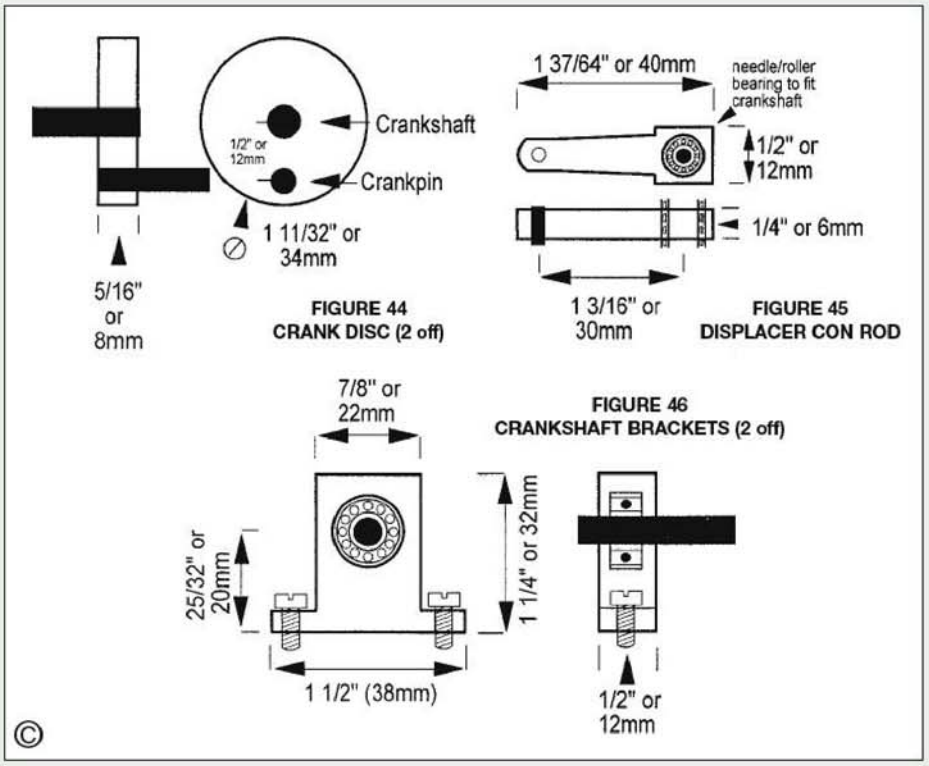


FIGURE 44 CRANK DISC (2 off)

FIGURE 45 DISPLACER CON ROD

FIGURE 46 CRANKSHAFT BRACKETS (2 off)

to this effect made on the displacer cylinder. A mark has already been made in the cylinder block where the transfer pressure pipe joins this component. Before inserting the displacer cylinder, since this is an almost permanent joint, it is advisable to drill the cylinder block; this should be at approximately 3/8in. (9.5mm) from the bottom end; however this distance should be confirmed by aligning a piece of brass tube from the power cylinder to the cylinder block. The displacer cylinder is also drilled to take the pressure transfer pipe.

Once the appropriate size and position of hole is drilled and cleaned, the second step in this process is to secure the displacer cylinder in the cylinder block using epoxy resin adhesive, of course with the displacer in place and running free. When cured, the cylinder block and the power cylinder are joined together by the pressure transfer pipe, also epoxied in place and both components are quickly mounted on to the top cylinder plate, the power cylinder through the bore already prepared while the cylinder block is bolted from below. With these two main components in place, it is possible to give the Hopkins Mk. II a trial run under power.

Displacer and power cylinders are mounted on a base plate, the crankshaft bearings are mounted on the top plate.

The flywheel (**photo 16**) is a 4 x 1/2in. (100 x 12mm) straight spoke aluminium alloy wheel with an integral bob weight from some previous engine. Any size of flywheel from 3 1/2in. to 5in. (90-125mm) will do, always bearing in mind that the larger flywheel has to clear the pump fittings below the top cylinder.

Engine base

An aluminium alloy base, 6 45/64 x 3 35/64in. (170 x 90mm) and 1/4in (6mm) thick (**fig 50**) is now prepared for the Hopkins Mk. II engine. It is aligned against the power cylinder edge, leaving the excess length on the flywheel side, and a distance of 3/16in. (5mm) on either side of the top plate. The displacer and power cylinders are placed on the base (**photo 17**) and their positions and the position of the four studs are marked. If studs are not used, four holes are marked and drilled in the base plate which will take bolts for securing the cylinder block. The plate (fig 50) is then bored (on a faceplate) to take the displacer cylinder with a slight annular gap (approximately 1 13/32in. - 36mm), the four holes that secure the cylinder block are drilled to take an 0BA or 6mm bolt in the centre of the circle scribed around the plugged end of the power cylinder.

The four legs shown in fig 26 are cut, fabricated and bolted to the bottom base which in turn is secured to the cylinder block and the power cylinder. The furnace cover for the gas burner (as in the Hopkins Mk. I) is also prepared and fitted to the base.

The water pump described and shown in figs 27-30 can now be fitted to the Mk. II. First a 13/16in. (20mm) O/D crank web with a 1/8in. (3mm) crankpin 3/16in. (5mm) off centre is mounted on the crankshaft next to the flywheel. The positions of the pump and pump con-rod are marked on the base plate. In this engine the centre of the pump bore is 1 7/64in. (28mm) from the right edge and 1in. (25mm) from the front edge when viewing the engine from the front. ▶

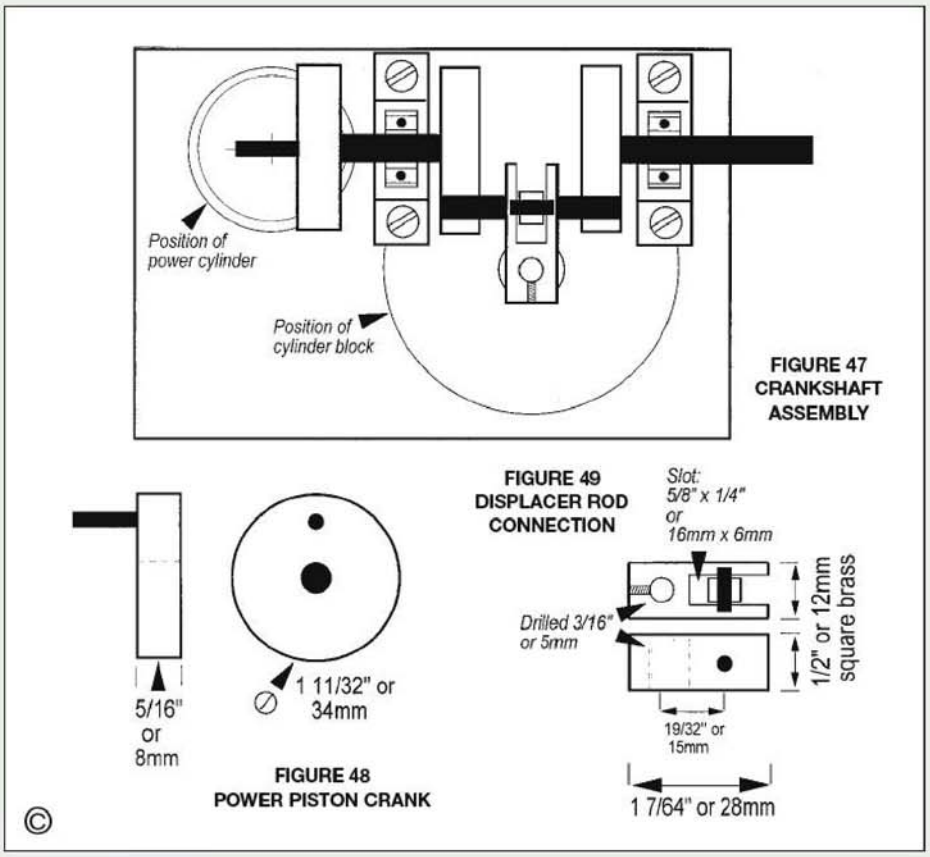


FIGURE 47 CRANKSHAFT ASSEMBLY

FIGURE 48 POWER PISTON CRANK

FIGURE 49 DISPLACER ROD CONNECTION

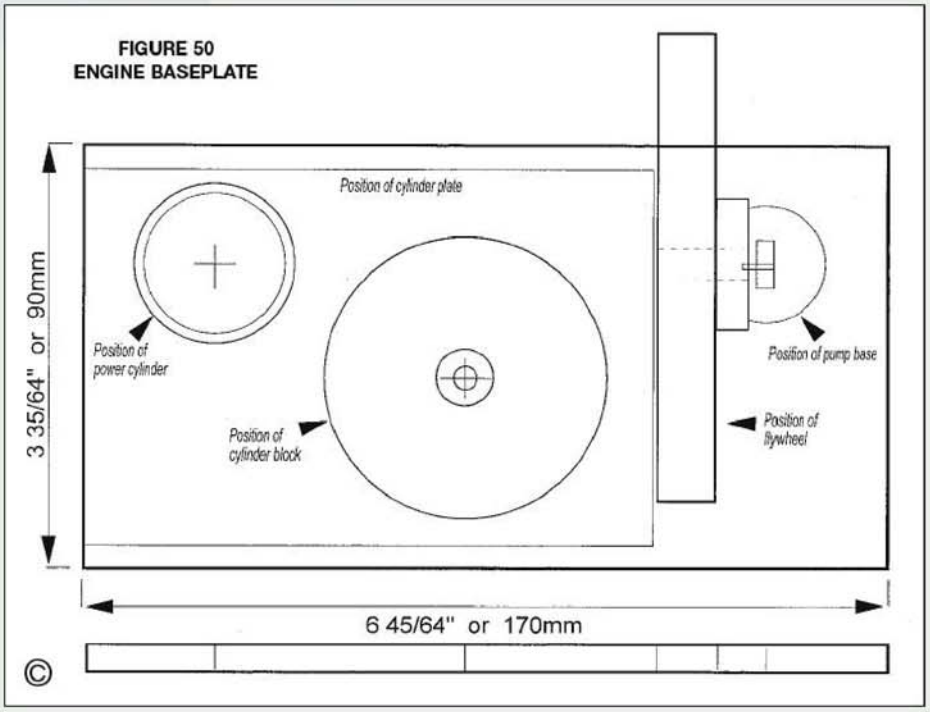


FIGURE 50 ENGINE BASEPLATE

The pump is mounted on the engine base and connected to the flywheel crank pin. The priming cup described in fig 31 is then added to the pump.

The cooling system is similar to that of the Mark I, i.e. a water tank with inlet and exit pipes at different levels to obtain circulation by convection. Readers may use the pump to circulate water from the bottom tank to cooling tank. In this case water from the exit pipe from the pump is routed to the top of the cooling tank. An outlet pipe high up in the upper tank slightly above the inlet pipe maintains a constant water level, allowing the right amount of water to flow to the lower tank to keep the pump working smoothly. This is a case for careful adjustment to water levels.

The burner is similar to that of the Mark I, with an identical furnace and an exhaust chimney pipe.

Running the Hopkins Mk. II

The 90deg. phase angle is set by placing the piston at bottom dead centre when the displacer con-rod is half-way up the stroke. When viewing the engine from the flywheel end, the flywheel turns in a clockwise direction. The Mk. II has an advantage over the Mk. I in that the phase angle may be altered to maximise efficiency. This angle may vary from 85deg. to 95deg., and is a matter for fine tuning the engine.

This engine is a lively and exciting engine to see running. It is an easy starter and will run after a few seconds of heating up. With the pump off, the engine will run very fast, but will slow down appreciably when the pump starts working, making the drive and pump mechanisms a delight to watch.

TRADE TOPICS

PRECISION MANUAL PRESSES FROM WEBER AUTOMATIC SYSTEMS

The Mader range of high performance manual presses have been added to the workshop equipment available from Weber Automatic Assembly Systems Ltd. These are economically priced presses designed for precision operations with the initial capital outlay usually recouped in a very short time for most work contracts.

Toggle presses with either round or square rams can be supplied together with rack and pinion options, which offer a constant pressing force over the entire stroke length. A large throat version is also available to accommodate oversized components. Typical workshop operations include assembling/stamping, riveting, caulking, punching, cutting and gluing.

These presses require relatively low operator effort (typically 150N), and are available in a range of capacities from 5 up to 30kN (kilo-Newtons). They can all be supplied with precision ram adjustment (within 0.02mm) to ensure accurate positioning of the bottom dead centre or point of maximum force. They all feature as standard an Ergopress, laterally offset operating lever, which is adjustable over 360deg. and can be set for either left or right handed operation. This versatility ensures that the machine can be quickly set up to suit individual operators or jobs in hand. This provides the optimum working conditions with an unobstructed view and leads to maximum production potential.

All models also have simple threaded spindle height adjustment of the press head, and feature a hardened and ground ram operating in a long, honed high-precision ram guide. The extra rigid press bases incorporate worktables that are also ground for accuracy.

The square ram toggle presses cover the same capacities and enjoy the same features, with the additional benefits of absolute torsional resistance with play-free movement and large tool support surface minimising the need for tool guides

They can also be fitted with a return travel lock, preventing partial stroke movement which increases work piece quality, together with stroke counter and a table bore to facilitate rapid tool changing.

Rack and pinion presses can be supplied with 1kN and 1.5kN press capacities and are suitable for extreme precision work, pressing in longer components or other long stroke operations. Long throat presses, with 250mm throat capacity, can be supplied for 15kN operation.

All presses are manufactured for long trouble-free operation and designed to be virtually maintenance free. Both pneumatic and hydro-pneumatically operated presses can also be supplied for semi or fully automated production.

Further information is available from:
Weber Automatic Assembly Systems Ltd., 3 Landscape Close, Weston Business Park, Weston-on-the-Green, Oxford 0X25 3SX; tel: 01869-343688; fax: 01869-343699; email: weber@btconnect.com; website: www.weberautomatic.com

NEW ROTACRAFT 12 VOLT ROTARY TOOL KITS FROM SHESTO LTD.

Two excellent, ready-to-use, precision minitool starter kits in attractive aluminium alloy storage and carry cases are now available. These two new 12V RotaCraft, rotary tool kits are ideal starter kits and are suitable for a variety of hobby, craft, electronics, renovation and small precision DIY tasks around the home.

Both kits include a 12V mini rotary tool, which is low voltage powered for extra precision and greater safety. A plug-in mini-transformer and an ample selection of accessories for drilling, grinding, routing, shaping and engraving are also included. The kits are packed in attractive, strong, aluminium alloy carrying and storage cases with clear Perspex fronts and would make excellent gifts.

The RotaCraft 12V Rotary Tool Kits come in two versions:

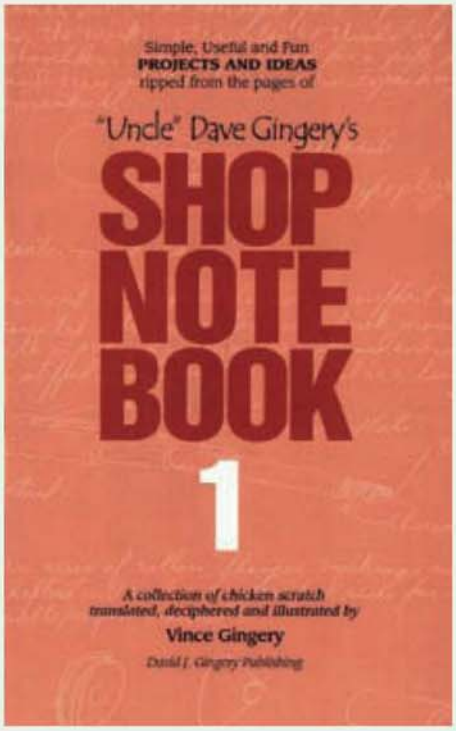
1: The RC12 is a single speed kit comprising of a 12V single speed rotary tool, a mini-transformer and a selection of 44 accessories. Recommended retail price is £19.99.
2: The RC18 is a variable speed kit comprising of a 12-18V rotary tool, variable speed transformer with speed control of 8,000-18,000rpm, and a selection of 60 accessories. Recommended retail price is £29.99.

The RotaCraft Kits are available at Maplin Electronics, Hobbycraft, RS Components and other leading Hobby and Tool stores.

For more details please contact **Shesto Ltd., Unit 2, Sapcote Trading Centre, 374 High Road, Willesden, London, NW10 2DH; tel:020-8451-6188; fax:020-8451-5450; email: sales@shesto.co.uk; website: www.shesto.com**

'UNCLE' DAVE GINGERY'S SHOP NOTE BOOK 1

by Dave & Vince Gingery
Published by David J. Gingery Publishing LLC
ISBN 1 878087 25 8
Price £6.70
Available from Camden Miniature Steam Services



Readers may already be aware of the books written and published by Dave Gingery. He is particularly well known for his series: 'Build your own metal working shop from scrap'. This series of seven books sets out to explain how the amateur can build a complete set of machine tools for very little cost, using as a basis a home made aluminium alloy foundry. Each new addition to the workshop is used to help produce the next. Opinion on the value of these books is divided. Some regard the designs, methods and materials used to be contrary to accepted engineering practice while others applaud the author's initiative in putting the methods he has developed into the hands of a wider audience.

My view is that if they help promote the hobby then they are to be welcomed though the novice needs to be aware that some aspects of the books would raise the odd eyebrow in 'pukka' engineering circles. However, many must have found the books of value, as it is reported that over 100,000 sets have been sold worldwide. That said, how many workshops have been built using the methods described is not recorded.

The work by this author currently under review is called *'Uncle' Dave Gingery's Shop Note Book 1* and is presumably the first of a series. It contains a *"collection of chicken scratch translated, deciphered and illustrated by Vince Gingery."* A slim volume, it contains 59 pages of text and presents a series of projects, techniques and advice all designed to help the home workshop enthusiast. The style is light and unpretentious and would be of particular value to the beginner who has just bought an old, ill-equipped lathe.

The design of the bench in the opening pages would be of interest even to experienced workers. The range of topics covered is diverse and deals, among others, with aspects of lathe work, bench work, tool grinding, dividing and work planning. The book is not just about the workshop; special techniques for specific model engineering related tasks are described. I found it an interesting read but, in my view some of the techniques outlined are not as sound as those described by other authors. For example, the rotary table design may be based on sound principles and a handy tool but could hardly be recommended for gear and sprocket cutting as suggested in the text. Far more reliable methods have been described in these pages and other sources over the years which may involve a little extra work but would give more consistent results.

If you rate the work of Dave Gingery then this book should be on your bookshelf. Read it, enjoy it and learn from it but temper what you read with study of other established authors of books on workshop technique.

'Uncle' Dave Gingery's Shop Note Book 1 (ISBN 1 878087 25 8) is written by Dave and Vince Gingery and costs £6.70 in softback. Published by **David J. Gingery Publishing LLC, P.O. Box 318, Rogersville, MO 65742, USA**, it is available from **Camden Miniature Steam Services, Barrow Farm, Rode, Nr. Frome, Somerset BA11 6PS; tel: 01373-830151; fax: 01373-830516; email: orders@camdenmin.demon.co.uk; website: www.camdenmin.co.uk** *Neil Read*

CLUB CHAT
With Malcolm Stride

UK News

Bedford MES reports a very good year from the commercial point of view, enabling the club to keep subscriptions down to a low level. (*Their words for any members who disagree!)* Chairman Alan Gildersleve notes that some may not like the commercial aspect of club activities, but it keeps funds at a level which enables necessary projects to proceed. I think those comments are true of many societies. Several developments are ongoing, including the raised track building and development and new storage building. The structural steelwork for the new raised track station building nears completion and the footings are part done. Some changes to the ground level track are to be carried out to enable operation of 5in. gauge locomotives during public running if required. The club currently runs only 7¼in. gauge during public running. The club will include a traction engine rally in the 2004 exhibition over the end of May Bank Holiday weekend. The club *'Challenge for the Festive Season'* was for members to make a woodscrew, as large or as small as desired and with either a cross head or a slotted head. We look forward to reporting the results when they are to hand. The 9 February meeting will be a showing of a collection of local archive films, followed on 23 February by a talk by Peter Haycock, Chairman of SMEE, on making taps and dies, an activity with which he was once professionally involved.

At a recent auction held by **Bradford MES** a 'vast array' of items went under the hammer including tools and equipment, a radio controlled yacht and a box of old Dinky toys. The sale of a set of panel beating hammers elicited the comment *"He's teaching his wife to drive!"* while the vacuum cleaner raised *"That's his wife's Christmas present sorted!"* Perhaps wisely, the names of those responsible were not recorded. One lot which remained unsold was a large carrier bag full of 'Gaviscon' tablets some two years past their sell by date! This caused me to wonder whether they have some unusual model engineering use besides their normal function! The society is seeking storage accommodation for its portable ground level track and trailer. Anyone who can help may wish to contact David Brimacombe on 01943-831557. The club recently enjoyed a flying visit from Australian member Richard Young who is also a member of **Bankstown Model Engineers** in Sydney. Perhaps they might like to send a newsletter to this column for more of a mention?

Bristol SMEE recently hosted a visit by a group of 25 young people and helpers from the 'Princess Royal Trust for Carers' who devote their time to caring for disabled parents or siblings. The day included a picnic and some cricket practice followed by a visit to the track for rides behind some of the club locomotives. The day was very successful and one of the helpers enquired whether the event could be repeated on an annual basis. A good selection of items was presented at the September 'On the Table' evening including traction engine lamps, wheels and trolley, various tooling items, a full size motor home (just the photo!), two locomotives, a rotary steam engine and an i/c engine — a good variety indeed. The society hosted a visit by model engineers staying at Brean Sands for the week. The visitors arrived with a wide variety of locomotives, enjoyed a good time running round and particularly appreciated the lunch. The Brean Sands brigade represented Erewash Valley, Harrow & Wembley, Northolt and Bournemouth societies. While all this was going on Bristol members continued with their usual Friday maintenance work. The September ▶

In Memoriam

It is with the deepest regret that we record the passing of the following model engineering society member. The sympathy of staff at *Model Engineer* is extended to the family and friends he leaves behind.

Bob Moody *Stamford MES*

public running day was eventful due to the seizure of a rear axle box on a 7¼in. gauge narrow gauge 0-6-0 locomotive causing it to come to a sudden and unexpected stop and refuse to move any further. The problems were resolved within about ten minutes but only after the resulting crowd of onlookers had watched the locomotive *"... being pushed along like a sledge by four panting and red-faced elderly gentlemen, who should have known better at their age!"* One member of the public was heard to ask *"What fun, does this happen every time?"* She was assured that it did not. There are welcomes for four new members in the club newsletter which also carries an internet address giving access to the valve gear computer programs created by Charles Dockstader in America. The site address is **www.tcsn.net/charlied** During the 22 running days available last season, the club has carried 22,225 members of the public between the hours 12:00 - 17:30 when the railway is open. This gives an average of 1,010 passengers per 5½ hour day or about 184 passengers per hour. Can anybody out there do even better?

Another club soon to be holding an auction is **Colchester SMEE** who which has a sale scheduled for 13 February followed by part two, if required, on 27 February. We wish them success with their efforts. Details of all events can be obtained from Secretary Les Hammond on 01376-511686. The club has a budding young driver by the name of Tarran Macmillan. Tarran joined the club with his father and quickly showed great interest in driving. After a spell driving the club electric locomotive Tarran moved on to various steam locomotives culminating in driving Brian Upson's A4 Pacific with great success. We are not told how old Tarran is but congratulations to him for his efforts; the club obviously has at least one driver for the future. Les Hammond reports a successful year which included outings to Tonbridge and Nottingham clubs, and visits to Colchester by Chelmsford, Peterborough, Chingford and Reading socities. During the trip to the Donington Exhibition, one member was seen buying a small tinplate clockwork chicken. It appears that he is now paying *"monthly silence money"* to the person with sharp eyes who spotted the purchase. Member Malcolm Bradford has carried out experiments on the amount of power the axle pump uses on his *Simplex* locomotive. He concludes that the increase in power without the pump is about 30%. His engine now boasts two injectors and no pump! Member Alf Marshall is to make a new boiler for the club *Butch* after the existing boiler was deemed 'life expired'.

Track renovations at Goffs Park Light Railway, run by **Crawley Model Engineers**, has been completed after a minor hiccup with the last section ending up 3in. short. The track has been tested and was reported as being *"in fine shape and fit for running."* The club had a talk on the *Firefly* project being built at Didcot by the Broad Gauge Society. Sam Bee of the society gave a very interesting illustrated talk, and explained that the locomotive now has its boiler fitted and tested and has been run on compressed air. A newsletter article described as *"A Bit of Light Reading for Christmas"* is *"The Mugwumps Guide to Injectors."* The article was also described as an *"expert free zone"* and warned that experts entering the area may seriously damage their health. Symptoms were described as *"starting with a tightening of the jaw muscles, the face goes red and the hands start to twitch leading to wild waving of limbs, frothing at the mouth and finally total apoplectic collapse."* Since I was able to read the article without experiencing any of the symptoms, I am obviously not an expert!

Coincidentally, a definition of an 'Expert' appeared in the **Guildford MES** newsletter. Said expert (or specialist) is defined as *"Someone who knows more and more about less and less until he (or she) knows all there is to know about nothing at all."* The latest news on the Surrey Young Modellers Competition is that although it will not take place in 2004, the society is trying to find a volunteer to ensure that it or something similar can take place in future years. The club is in the process of replacing the riding cars for use on the raised track. Among others, the reason is to reduce maintenance and ensure safe passenger carrying. A prototype has been in use for the last season and has proved a great success. Parts are now in process of manufacture for nine new trolleys. A total of 1,778 individual wood or metal parts will be needed. About half of these will be 'bought out' with the rest being produced by about 16 GMES 'outworkers'. The intention is to have the trolleys in use for the 2004 season. The club web site at **www.gmes.org.uk** has proved a great success and this is due to the single-handed efforts of member Tom Ralston. Member David Longhurst has made a Keats Angle plate following correspondence in this journal. The only snag is that so far all the jobs he has wanted to use it for have been too big or too small to fit. As David comments *"... but one day ...!"* Myke Baigent comments on the dangers of boilers scaling up with potential for blocked water gauges and scaling of the firebox wall water spaces. He is to return to the subject in future so we will report any advice. My comments in a previous issue related to the maintenance of the club locomotive *Stoke* were described as *"almost tempting providence"*, and so it apparently proved. A leak was discovered in the centre of the tube stack so the boiler was lifted and, after investigation, member Len Steel replaced the tubes. The boiler fittings are currently being replaced ready for the hydraulic test. I promise to be more careful in future when making comments about successful maintenance of locomotives! As the club was founded on 1 January 1954, this year is its 'Golden Anniversary' and a celebration weekend will be held on 5/6 July. I wish to record here and now that my mention of this in *Club Chat* will in no way affect the weather (good or bad) on either of those days.

Members of **Leeds SMEE** had an interesting talk on East African Railways by Keith Collins. This included details of an incident when a locomotive left the track and ended up on its side without damaging the adjacent track. The train it was pulling still ended up in the station even though it apparently made its own way up a 3% incline without the locomotive. The club is seeking members' views concerning the possible change to a limited company, one of the possible measures being taken to minimise the exposure of members to the 'litigious society'.

We have received notice of the annual model exhibition to be held by **Liskeard Model Society** on 6/7 March 2004 at the Liskeard Community College. The exhibition will cater for all types of modelling interests.

Melton Mowbray DMES were entertained to *"the best talk we have ever had"* by Captain Douglas Davidson recently. The topic was tales of the sea in oil tankers but also included stories from oil rigs in Nigeria. The club locomotive *Lilla* is to have an extensive overhaul this winter with the aim of having her back in service in the spring. Brian Jones and Ken Harrison are taking on this task and from the initial examination have produced quite a long list of items requiring attention.

The useful three-wheeler dumper truck owned by **North London SME** was stolen recently and was eventually found dumped in a nearby stream down a 12ft. embankment. The truck was rescued, apparently none the worse for the experience and has now been locked away. Our esteemed Editor and North London member Mike Chrisp has *"grasped the general meetings by the scruff of their neck"* and produced a programme to encourage more members to attend. These include evenings for outside speakers and also evenings involving club members. The club held a successful Halloween night but were blessed with *"some unwanted intruders"* at the end and members are reminded to check the site when they are at Colney Heath. The more positive aspect is that one four year-old was so impressed that he wants to see all the special effects again next year, preferably from the 'inside' as a junior helper. The club celebrates its 60th anniversary this year and is organising a major event for the weekend of 4/5 September at Colney Heath. North London is another society looking carefully at the rule book in order to avoid exposure to litigation. One proposal involved a reduction in the number of public running days. Will this mean less to amuse the youngsters who may then drift into the sort of vandalism described above? This seems to be a good illustration of the 'law of unintended consequences'. I wonder how much time is spent in clubs across the country on this ever intrusive aspect of modern life?

Another club locomotive being overhauled during the winter is *Hernia* operated by **Plymouth Miniature Steam**. It is reported that at the end of the season, a number of members descended on the unsuspecting locomotive with great haste to remove the parts that were going for overhaul. Plymouth is yet another society reporting an attack of vandalism, this time some 60 slates were removed from the club house roof.

The newsletter carries a picture and description of David Newell's 3½in. gauge Nigerian Rivers Class 2-8-2 on which work started in 1960 when he was working in the Nigerian bush. The locomotive was machined on a Myford Super 7 to which power was supplied by a small generator as no mains electricity was available closer than 80 miles away. As the prototype is 3ft. 6in. gauge, at approximately 5ft. 6in. long, the model is large for its 3½in. gauge.

The Chairman of **Reading SME**, Gary Williams, reports a good year for the club including more visits to other clubs, more exhibitions, a visit to the Black Country Museum and the hosting of SEQLEC this year. These activities have raised the profile of the club resulting in an overall increase in membership. Great progress has been made on the club site through the year by the 'Wednesday Warriors' who are reported as *"continuing to work hard drinking Harold Eadie's tea."* Two birthday specials held over the weekend of 22/23 November were a complete success despite 2in. of rain and everybody, including the children, getting a good soaking.

Following the recent AGM, **Rochdale SMEE** has a new Chairman and President. The new President is Jack Kelly who replaces Ted Bennett who becomes Chairman. Richard Readyhaugh remains Publicity Officer and can be reached on 01706-846499.

St Albans DMES now has a staff of two editors producing the *Gazette* with Alan Harmer responsible for the material and Tony Mason responsible for the printing. We wish them both good luck with their new responsibilities.

Saffron Walden DSME 'Pinkies' report a strange problem with one of their signals occasionally showing both 'red' and 'green' which is causing great amusement to the 'Clankies'. No doubt the 'Pinkies' will sort this out before next season.

CLUB DIARY

A minimum of 6 weeks notice is required for diary entries. Clubs and Societies are asked to include a telephone number for the assistance of would-be visitors.

FEBRUARY

6 **Kinver & West Midlands SME.** *John Moxham: Railways of the World.* Contact John Campbell: 01384-891244.
6 **Maidstone MES.** *Quiz night.* Contact Martin Parham: 01622-630298.
6 **North London SME.** *John Beesley: Restoration of a Hunslet 0-6-0ST Locomotive.* Contact David Harris: 01707-326518.
6 **North Norfolk MEC.** *Mr Wood: Lotus Part 2.* Contact Gordon Ford: 01263-512350.
6 **Portsmouth MES.** *AGM.* Contact John Warren: 023-9259-5354.
6 **Rochdale SMEE.** *Meeting.* Contact Mike Foster: 01706-360849.
7/8 ***Festival of British Railway Modelling*** at Doncaster Exhibition Centre, Doncaster Racecourse. Advance booking (to 26 January 2004). Adults: £5, Children: £3, OAP: £4, Family (2+3): £16. Information and Ticket Hotline: 01778-391134.
8 **Cheshire Live Steamers.** *Bits & Pieces.* Contact Tricia Sturgeon: 01606-48586.
8 **Hornsby ME.** *Running Day.* Contact Ted Gray: 9484-7583.
8 **Sutton MEC.** *Track Day.* Contact Mike Dean: 0208-657-5401.
9 **Bedford MES.** *East Anglian Film Archive.* Contact Ted Jolliffe: 01234-327791.
9 **Erewash Valley MES.** *Evening Meeting.* Contact Jim Matthews: 01332-705259.
9 **Melton Mowbray DMES.** *Doug Hewson: Lost Wax Casting & Laser Cutting.* Contact Phil Tansley: 0116-2673646.
9 **Saffron Walden DSME.** *Club Night.* Contact Jack Setterfield: 01843-596822.
10 **Crawley ME.** *Talk.* Goffs Park Light Railway. Contact Allan Sinclair: 01293-888203.
10 **Historical MRS (North West Area).** *Phil Taylor: Historic Modelling in Photographs.* Contact David Goodwin: 01224-880018.
10 **Surrey SME.** *Professor Bryan Woodriff: Tramways of Kingston.* Contact John Cook: 020-8397-3932.
10 **Sutton Coldfield MES.** *Barry Hares: Rolls-Royce in Miniature (Model 'Merlin' engine)* Contact Neal Harrison: 0121-378-3992.
11 **Bradford MES.** *Committee Meeting.* Contact John Mills: 01943-467844.
11 **Harrow & Wembley SME.** *Simon Cole: Bells and Bell Ringing.* Contact Dr. Roger Greenwood: 020-8427-2755.
12 **High Wycombe MEC.** *Bits & Pieces.* Contact David Savage: 01494-527402.
12 **N. W. Leicester SME.** *AGM.* Contact John Elliott: 01455-847040.
12 **Sutton MEC.** *Pressure Gauges Testing.* Contact Mike Dean: 0208-657-5401.
12 **Worthing DSME.** *Natter Night or Video Up2U.* Contact Bob Phillips: 01903-700642.
13 **Colchester SMEE.** *Club Auction, Part 1.* Contact L. G. Hammond: 01376-511686.
13 **Dockland & E. London MES.** *Meeting (Bring & Buy Auction).* Contact P. M. Jonas: 01708-228510.
13 **Hereford SME.** *Ladies Night.* Contact Richard Donovan: 01432-760881.
13 **Toronto SME.** *Meeting.* Contact Art Gordon: (905) 820-1988.
13-15 **Brighton *ModelWorld*** at the Brighton Centre. 10am-5.30pm; Adult: £6, Child/Senior Citizen: £3, Family: £16. Contact Tim Steven: 01444-254057.
17 **Basingstoke DMES.** *Stationary Engines.* Contact Ian Shanks: 01420-561741.
17 **West Wiltshire SME.** *16mm Evening.* Contact R. Nev. Boulton: 01380-828101.
18 **Birmingham SME.** *Auction Night.* Contact John Walker: 01789-266065.
18 **Bristol SMEE.** *On the Table Evening.* Contact Trevor Chambers: 01454-415085.
18 **Guildford MES.** *Bits & Pieces.* Contact Dave Longhurst: 01428-605424.
18 **Hornsby ME.** *Board Meeting.* Contact Ted Gray: 9484-7583.
18 **Leeds SMEE.** *Roger Spence: Film Show.* Contact Colin Abrey: 01132-649630.
19 **East Somerset SMEE.** *Roger Davis: Inland Waterways of the UK.* Contact Roger Davis: 01749-677195.
19 **Historical MRS (Sussex Area).** *Geoff Roberson: West Croydon, Its Significance.* Contact Terry Cole, 17 Coombe Drive, Steyning, West Sussex BN44 3PW.
19 **Rugby MES.** *Alan Willmott: Silver Screen Show.* Contact David Eadon: 01788-576956.
19 **Sutton MEC.** *Kevin Whitticase: Caring for Mr. Bassett.* Contact Mike Dean: 0208-657-5401.
20 **Kinver & West Midlands SME.** *Roger Bryan: Electricity Made Simple.* Contact John Campbell: 01384-891244.
20 **MELSA.** *AGM.* Contact Graham Chadbone: 07-4121-4341.
20 **Rochdale SMEE.** *Rob Wardale: Model Jet Engines.* Contact Mike Foster: 01706-360849.
20 **Steam LS of Victoria.** *AGM.* Contact Graham Plaskett: (03) 9750-5022.
20 **Worcester DME.** *Roger Hennessey: The Atlantic Enigma.* Contact M. Lane: 01905-425972.
21 **Historical MRS (Scottish Area).** *Chris Pendleton: North East Modelling.* Contact Richard Crockett: 01896-750730.
21 **Hornsby ME.** *Family Day/Boiler Inspection.* Contact Ted Gray: 9484-7583.
21 **MELSA.** *Social Dinner.* Contact Graham Chadbone: 07-4121-4341.
21 **N. W. Leicester SME.** *Running Sunday.* Contact John Elliott: 01455-847040.
21 **Steam LS of Victoria.** *Club Run.* Contact Graham Plaskett: (03) 9750-5022.
23 **Bedford MES.** *Peter Haycock: Making Taps & Dies.* Contact Ted Jolliffe: 01234-327791.
24 **Historical MRS (East Lancashire/North Manchester Area).** *Derek Evans: Etched Kit Construction.* Contact John Sykes: 01706-823989.
24 **Stafford DMES.** *Terry McMenamin: Rail Vehicle Engineering.* Contact Chris Dobbs: 01889-270533.
24 **Sutton Coldfield MES.** *Geoff Cowmeadow: Railway Films UK 1937-1962.* Contact Neal Harrison: 0121-378-3992.
25 **Birmingham SME.** *2004 Cup Competition.* Contact John Walker: 01789-266065.
25 **Harrow & Wembley SME.** *Marine Bits & Pieces.* Contact Dr. Roger Greenwood: 020-8427-2755.
25 **Historical MRS (Bedford Area).** *Robin Cullup: Railways in the Kettering and Cambridge Areas.* Contact John Chamney: 01442-851214.
26 **Sutton MEC.** *Non-Steam Night.* Contact Mike Dean: 0208-657-5401.
26 **Worthing DSME.** *AGM.* Contact Bob Phillips: 01903-700642.
27 **Brighton & Hove SMLE.** *Peter Jones & John Burling: The Southwold Collection.* Contact Mick Funnell: 01323-892042.
27 **Colchester SMEE.** *Club Auction, Part 2.* Contact L. G. Hammond: 01376-511686.
27 **Hereford SME.** *Meeting.* Contact Richard Donovan: 01432-760881.
27 **Historical MRS (Essex Area).** *Dave Goodyear: Diesels, a Brush with Colour.* Contact Jem Harrison, 27 Colne Place, Basildon, Essex SS16 5UZ.
27 **Kinver & West Midlands SME.** *John Swingwood: Film Show.* Contact John Campbell: 01384-891244.
27-29 **Hornsby ME.** *LMLS Birthday Run.* Contact Ted Gray: 9484-7583.
28 **Historical MRS (Bristol Area).** *Ian Pope: Forest of Dean Railways.* Contact Gerry Nichols: 0117-973-1862.
28 **The Society of Ornamental Turners.** *Meeting.* Contact N. S. Edwards: 01234-359392.
29 **MELSA.** *Sunday in the Park.* Contact Graham Chadbone: 07-4121-4341.
29 **Steam LS of Victoria.** *Working Bee & Barbecue Lunch.* Contact Graham Plaskett: (03) 9750-5022.

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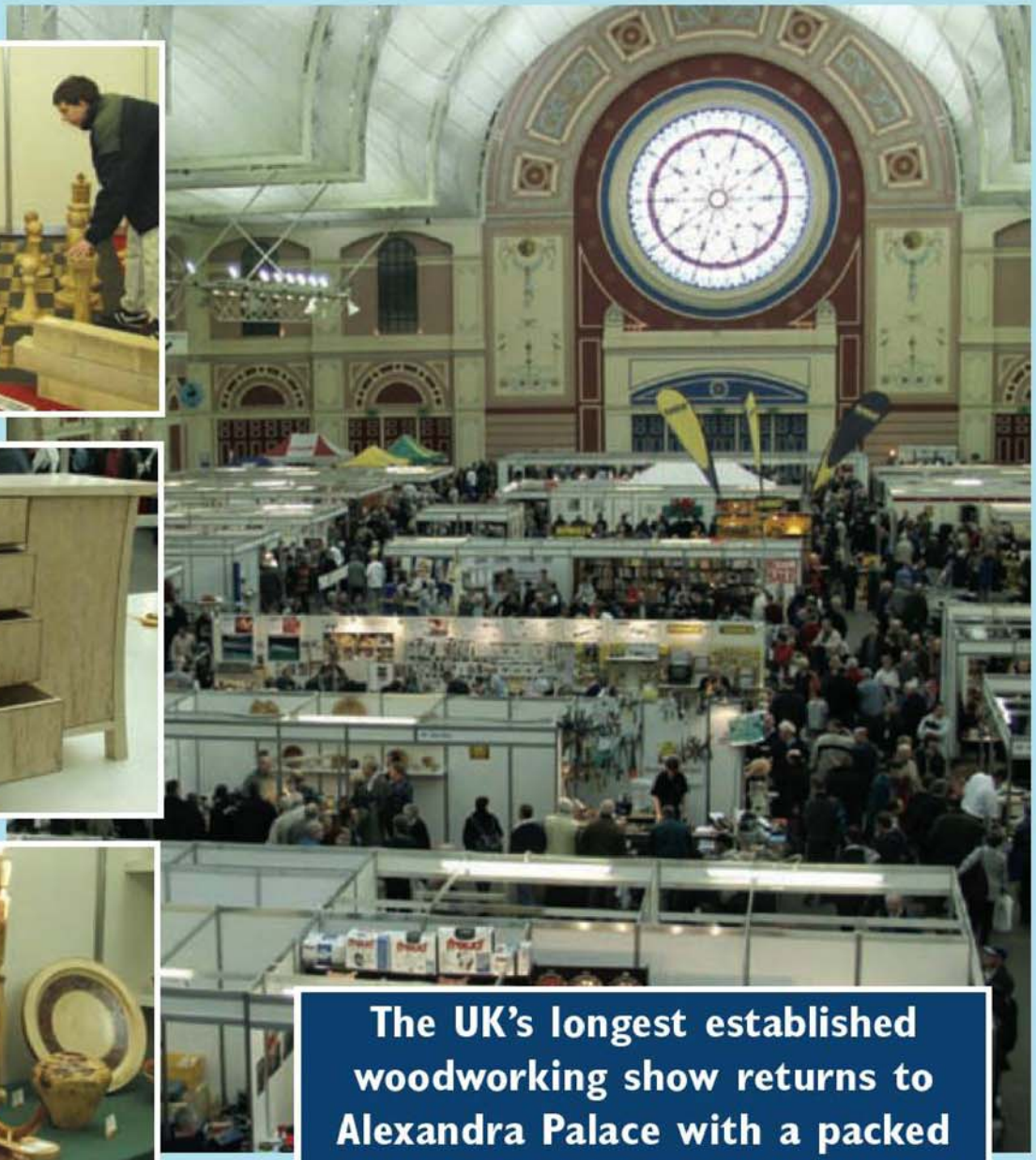

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Harprit Sandhu
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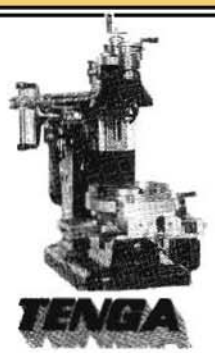

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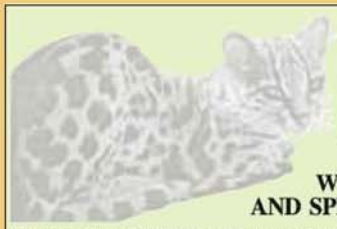

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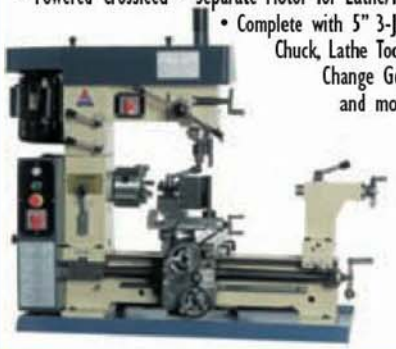

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