MODEL ENGINEER

Vol. 193 No. 4225

9 - 22 July 2004

IMLEC 2004

NEW STYLE EVENT

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25>

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- Huge range of tooling including many new items.
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Sunday 5th 10am to 3pm

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For a limited period we will include a revolving centre, tailstock drill chuck and a set of 16mm index lathe tools FREE of charge!

Optional equipment
- Quick change tool post hardened and ground, supplied with 3 tool holders and parting off holder with blade £170 inc VAT with fitting kit to suit BH-600 fitting
- Coolant system £130 inc VAT
- Tailstock die holder £39 inc VAT

- THE ULTIMATE MODEL ENGINEERS LATHE
- HARDENED AND GROUND BEDWAYS
- TAPER ROLLER BEARING HEADSTOCK SPINDLE
- TEE SLOTTED CROSS SLIDE
- POWER CROSS FEED
- NORTON THREAD CUTTING GEARBOX
- 2HP SINGLE PHASE MOTOR
- BACK GEAR WITH 50 RPM LOW SPEED
- 1 3/8" SPINDLE BORE

SUPPLIED WITH ACCESSORIES AT NO EXTRA CHARGE
- 6" 3 JAW CHUCK
- 8" 4 JAW CHUCK
- 10" FACE PLATE
- FIXED & TRAVELLING STEADIES
- FOUR WAY TOOL POST
- IMP/MET THREADING
- STAND, COOLANT TRAY, REAR SPLASH BACK

VMC Mill
ONLY £1,450
inc VAT & Delivery

SUPPLIED WITH POWER FEED TO X TRAVEL AT NO EXTRA COST

- ILLUSTRATED WITH OPTIONAL D.R.O AND POWER FEEDS
- TABLE SIZE 26" X 6"
- MOTOR 1 1/2 HP
- AVAILABLE 3MT R8 - METRIC - IMPERIAL

BV-20 Lathe
ONLY £585 inc VAT & Delivery
Optional floor stand £99

- FULL ENCLOSED GEARED HEADSTOCK
- SPEED SELECTION BY LEVER
- PRECISION GROUND VEE BEDWAYS
- LARGE BORE SPINDLE RUNNING ON TAPER ROLLER BEARINGS
- COVERED LEADSCREW
- SET OVER TAILSTOCK FACILITY
- INDIVIDUAL ACCURACY TEST REPORT
- SAFE ELECTRICAL INTERLOCKS TO CHUCK GUARD AND GEAR TRAIN COVER

SUPPLIED WITH:
- 4" 3 JAW SELF CENTERING CHUCK
- 4"4 JAW INDEPENDENT CHUCK
- FIXED STEADY
- TRAVELLING STEADY
- FACE PLATE
- FOUR WAY INDEXING TOOL POST
- 3MT AND 2MT DEAD CENTRES
- METRIC & IMPERIAL THREAD CUTTING CHANGE GEARS
- SWARF TRAY
- REAR CHIP GUARD

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" HIGH • WEIGHT 230 LB

WM-20 MILLING MACHINE
NEW

ONLY £3,500
inc VAT & Delivery

- INVERTOR DRIVE - INFINITE SPEED CONTROL
- SPEED RANGE 25 - 1480RPM
- TABLE SIZE 9" X 36"
- R8 SPINDLE
- 1.5HP WILL OPERATE FROM 13AMP SOCKET
- WEIGHT 750KGS

Warco Mini Lathe
ONLY £375 inc VAT & Delivery

- 31/2" CENTRE HEIGHT X 12" BETWEEN CENTRES
- SUPPLIED WITH 3 JAW CHUCK
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- THREADCUTTING
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- VARIABLE SPEED 0-2500RPM WITH BACK GEAR FOR MAXIMUM TORQUE
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Special offer
Tailstock drill chuck and TCT indexable lathe tool set with each machine.

Warco WMT 300/1
ONLY £799 inc VAT & Delivery
Combination Lathe Mill

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- 5" 3 JAW CHUCK
- TEE SLOTTED FACE PLATE
- FIXED AND TRAVELLING STEADIES
- VICE
- DRILL CHUCK
- FACE CUTTER
- LATHE TOOL SET
- IMP/MET THREADCUTTING

Warco WMT 300/2
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SAME CAPACITY AND ACCESSORIES AS THE WMT-300/1 WITH THE ADDED BENEFIT OF A LARGER MILLING TABLE - 17" X 6" COMPARED TO 8" X 6", RACK AND PINION FEED TO SADDLE AND LEFT HAND THREADING FACILITY.

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SIMILAR TO THE SPECIFICATION AND ACCESSORIES TO WMT-300/2. POWER CROSS FEED TO MILLING TABLE/CROSS SLIDE. DEEP THROAT FOR EXTRA MILLING CAPACITY.

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inc VAT & Delivery Optional Stand £89
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

ZX-15 Milling Machine

Warco, Fisher Lane, Chiddingfold, Surrey GU8 4TD Fax: 01428 685812
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IN THIS ISSUE

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On the cover ...

Based on a design developed by Malcolm Beare in Australia, this 25cc internal combustion engine built by T. Pascoe and exhibited at the eleventh National Model Engineering & Modelling Exhibition, has a number of interesting features. Despite being a single-cylinder, four-stroke engine it has opposed pistons. The upper piston/cylinder is similar to an inverted two-stroke engine and runs at half engine speed. It controls the induction and exhaust phases of the lower four-stroke cylinder by way of two disc valves and the cylinder ports.
For further details of this engine and the fabulous range of other models on display at the Harrogate show, readers are directed to page 16 of this issue.

(Photograph by Mike Chrisp)

TURN TO PAGE 52 FOR GREAT OFFERS ON SUBSCRIPTIONS!

INDEX to ADVERTISERS

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205mm Cross Travel
80-1250 rpm
MT3 Spindle
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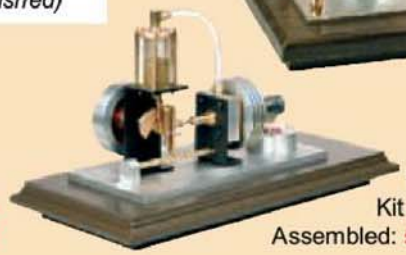

HAE04:
Kit: **£70.00**
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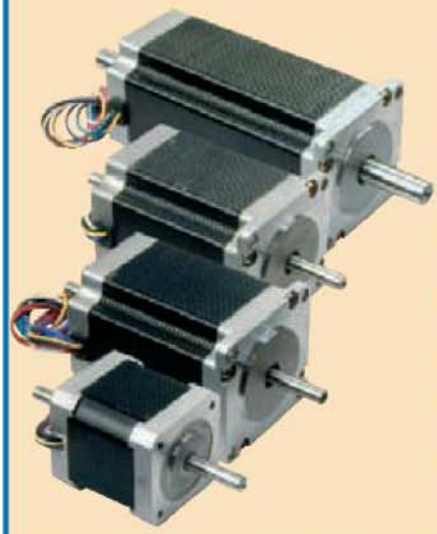
Stepper Motors



Arc Code	AC420484610	AC570764525M	AC570764525I	AC571157525M
Type	Hybrid Stepper	Hybrid Stepper	Hybrid Stepper	Hybrid Stepper
Holding Torque	36N/cm	180N/cm	180N/cm	220N/cm
Step Angle	1.8°	1.8°	1.8°	1.8°
Rated Voltage	4.6V	4.5V	4.5V	7.5V
Rated Current	1A/Phase	2.5A/Phase	2.5A/Phase	2.5A/Phase
No. of Wires	8	8	8	8
Size	42x42x48mm	57x57x76mm	57x57x76mm	57x57x115mm
Shaft Dia.	6mm	6mm	1/4"	10mm
Shaft Length (Front)	25mm	25mm	25mm	30mm
Shaft Length (Rear)	25mm	25mm	25mm	30mm
Net Weight	380g	1.065kg	1.065kg	1.74kg
Price	£15.00	£30.00	£30.00	£39.50

Bi Polar Stepper Motor Controller

Micro step setting 7: 1,2,4,8,16,32,64
which with a 1.8 Deg motor is = to 200,400,800,1600,3200,6400,12800 steps /rev
Motor Current Settings 8: 0.9A to 3A peak current (0.9A,1.2A,1.5A,1.8A,2.1A,2.4A,2.7A,3A)
Input Signal 3.0 to 10 volts
Motor supply voltage input to controller: 10 to 40 volts
There is a facility to turn off the motor current
Arc Code: SMD093064 **Price: £62.50**

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550mm between centres. 6 speed belt driven.
Cuts metric & imperial threads.

Standard machine includes :

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*115mm disc #230mm disc
‡ REDUCED CAG115C was £31.67 inc.VAT

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B=Bench mounted F=Floor standing

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CDP101B	245/5		£54.95	£64.57
CDP151B	300/5	£99.82	£79.95	£93.94
CDP201B	370/12	£135.70	£109.95	£129.19
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REDUCED

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	CTC900	9 dr chest	£70.44	£49.95	£58.69
	CTC500	5 dr cabinet	£105.69	£84.95	£99.82
	CTC700	7 dr cabinet	£140.94	£99.95	£117.44
	CTCI 300	13 dr chest/cab	NEW	£139.95	£164.44
2	CTC800	8dr chest/cab set	£117.44	£84.95	£99.82
	PRO RANGE				
3	CTCI03	3 dr stap up chest	£52.82	£39.95	£46.94
4	CTCI06	6 dr drop front	£76.32	£54.95	£64.57
5	CTCI09	9 dr chest	£82.19	£64.95	£76.32
6	CTCI05	5 dr trolley	£164.44	£129.95	£152.69
7	CTCI07	7 dr trolley	£199.69	£159.95	£187.94

REDUCED

Clarke BENCH GRINDERS

FROM ONLY £18.95 EX VAT £22.27 INC VAT

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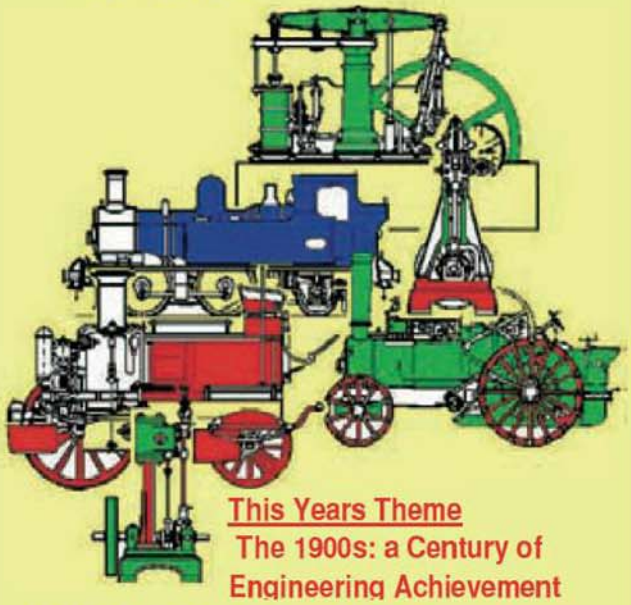

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SMOKE RINGS
With the Editors

Anthony Gerald Chrisp 1973 - 2004

Our tragic loss

It has been my all too frequent duty to record in these columns the passing of respected and eminent members of our model engineering fraternity. It is with unspeakable sadness therefore that I now have to tell you that on Tuesday afternoon 1 June our beloved son Anthony fell to his death from a tower block at Nottingham University where he was working as a Research Fellow with the E-RACE project.

Born in St. Albans on 28 July 1973, Anthony grew up with his two elder sisters Jacqueline and Barbara, and among friends. My model engineering took Anthony to the North London SME track where he soon became a proficient driver of miniature steam locomotives. During a school summer holiday in August 1985 he began work on his 5in. gauge *Rail Motor* to Don Young's design. We used the facilities at St. Albans College where I taught, and in my own home workshop where Anthony learned the craft and techniques of most aspects of workshop practice. We spent many happy and constructive hours together.

We learned about computers together and worked as a team when I had to teach CAD, CNC and DTP at college. We even used Anthony's *Rail Motor* to help us focus on this 'new' technology. Although only in his mid-teens, Anthony became a valuable assistant in my evening classes, helping adults to learn to use AutoCAD.

Sunday mornings during the winter months were spent working at the track and, with his young friend Sam, Anthony hand mixed cement for the top screed of our raised track. Week after week they got the mix just right every time despite the helpful advice proffered by adult club members who were always sure they knew best.

Anthony's success at school extended into both his academic and practical work. He became involved with a Sainsbury Trust project which brought him into contact with the worlds of industry and commerce. He gained good grades in his GCE A-Levels which led him to an apprenticeship with Dowty in Cheltenham and a degree in Mechanical Engineering and Management at Nottingham University.

Anthony became very fond of Nottingham and made good friends there. He began work on his PhD and some readers may recall our Centenary issue (*M.E.* 4058, 1 January 1998) in which he described the work he was doing.

Anthony found a new life in Canada where he made more new friends and enjoyed the exhilarating sport of snowboarding at which his profiency led him to qualify as an instructor. The two photographs above were taken in Canada.

More recently, Anthony returned to Nottingham University as a Research Fellow on the E-RACE project. Project Leader Dr. Svetan Ratchev, Senior Lecturer in the School of Mechanical, Materials, Manufacturing Engineering and Management at Nottingham writes *"As a researcher he offered a rare combination of good knowledge in CAD, programming skills and sound technical understanding of the subject ... Anthony had the opportunity to interact with a number of industrialists and academics in Europe and eveybody was immensely impressed by his technical knowledge and innovative ideas."*

Jean and I will always be intensely proud of our talented and loving son who is dearly loved and desperately missed by the whole family. We take this opportunity to thank all who have have sent kind messages of condolence.

Come to Lionsmeet 2004

A non-profit body concerned with all and everything about the Liverpool & Manchester Railway locomotive *Lion* which, at its last steaming was the oldest working steam locomotive in the world, the Old Locomotive Committee has pleasure in announcing that Lionsmeet will be hosted this year by Northampton SME at Lower Delapre Park, Far Cotton, Northampton on Saturday 7 August 2004.

Lionsmeet is an informal annual gathering of all those with an interest in *Lion* in all its manifestations and gauges, finished or not, and any *Lion* memorabilia they may have to bring to the event for display or demonstration.

There will be a competition, limited to 3½ and 5in. gauge engines, to establish the hardest working *Lion* based on measurement of work done by the engine during a ten minute run.

The track will be open from 10.00am to all wishing to practice, and the competition will start at 2.00pm. Period dress is optional. Prior application is unnecessary, but further information and directions are available by e-mailed request to **alan_pb@yahoo.co.uk** or by telephone: 01254-812049.

Tour the Steam Scene in Australia

We were particularly pleased to hear from Barry Glover in Australia who writes:

"I am calling for 'expressions of interest' regarding an approximate 21 day tour of New South Wales and Victoria, Australia.

"The tour will take in the 'Steam Scene' in both states, the AALS Convention at Easter 2006 (100th Anniversary of Sydney SME) plus, of course, the usual stops to please Mother.

"It is envisaged that the tour will start in Sydney approximately one week before Easter and will depart from Melbourne.

"While Easter 2006 may seem a long way off, there is, of course, a lot of planning to be done.

"Those interested are invited to contact me
by phone: ISD + 61 + 2 + 42840294
by fax: ISD + 61 + 2 + 42832331
*by e-mail: **ame@netspeed.com.au***

CHUCK the MUDDLE ENGINEER — by B. TERRY ASPIN

POST BAG

Cathodic protection of boilers

SIRS, - Mike Casey in his letter (*M.E.* 4223, 11 June 2004) asks whether the use of sacrificial anodes, more properly known as Cathodic Protection, can be used in boilers. Like most things, neither the idea nor the application are new. I know of literature as far back as 1918 advocating sacrificial anodes in boilers. Sothern's Verbal Notes and Sketches is one source. I certainly never came across any in my days at sea with water tube boilers, but I have vague recollection of seeing some in a marine Scotch boiler.

I can certainly confirm Mike's comments about the water level in the gauge glass disappearing out of the top or bottom as the vessel rolled and pitched. This could happen every minute or so for hours on end. One eventually stopped worrying about it. The frequently held belief by model engineers that disappearnce of the water level will lead to instantaneous damage to the boiler causes me some amusement.

Going forward from Mike's comment that he has never had a fusible plug 'do its stuff in anger', this is a comment with which I would agree, given some fifteen years experience of steel boilers in 7¼in. gauge. I wonder if there is a technical basis for this based on the ratio of top firebox flat surface width/length to crown metal thickness. This ratio is much lower in model boilers than full size practice, possibly leading to better conduction conditions in the plate.

Picking up Mike's point about wastage of the firebox crown in a full size roller, I would disagree with his assessment that the corrosion has occurred only while the boiler is hot, and that the bronze plug is the culprit. The so-called electrolysis effect can only occur when the two metals are submerged in water. I would go for the theory that while the boiler is cold and empty, then the flat surface of the crown will retain scale and moisture, as will also the lower parts of the boiler where scale accumulates giving rise to good conditions for corrosion.

Full size boilers in marine/industrial use are in steam for, say 95% of the time, whereas our boilers are cold and damp for 95% of the time. This will give rise to different assessments as to why corrosion is occurring. I am still gathering information as to the best method of preventing corrosion in 'our' steel boilers. The very old tip of keeping a 40W electric lamp alight in the firebox when the boiler is not in use is my current favourite. It raises the dew point and provides somewhere for the mice to keep warm!

Mick McKie, West Midlands.

S.Y. Carola

SIRS, - Prompted by Roger Backhouse's recent feature about the Scottish Maritime Museum (*M.E.* 4221, 14 May 2004), I enclose a photograph of a model I made for the Scott family from the original plans.

I much prefer the original layout to the present one shown in the photo on page 559 of that issue.

I have a very extensive file on the *Carola* from the Scott family, Mark Varvill and G. Tull and, to my sorrow, from Dick Martino who died from injuries caused by escaping steam and scalding water in an incident in the engine room of the *Carola* (see *M.E.* 3926, 7 August 1992).

Dr. A. K. Tulloch, Dundee.

***Dr. Tulloch's model of the Steam Yacht* Carola.**

Man and machine

SIRS, - When recently looking at a past copy of *Model Engineer*, (*M.E.* 2820, 9 June 1955), I was most intrigued by the cover photograph of the late Dan Hollings operating his hand-powered double-column planing machine. It seems that this competent old modeller was a prolific builder of excellent model locomotives and I believe I may have read elsewhere that he was Lord Mayor of Bradford? I would be interested to know if anyone knows anything about him. Was he employed in the engineering industry, and, as he seems to have been at least middle aged when the photograph was taken, when did he pass from this world to glory? He strikes me as having been an interesting and pretty skilled sort of individual. There were lots of similar types of high calibre modellers around in those days who could manufacture lovely work with pretty basic machines and equipment. The same could be said of the chaps in the general engineering factories as well who might be considered as 'model engineering on a bigger scale'.

The ancient hand-operated planing machine shown in the photograph is also of interest. I wonder where it ended up; is it still around and working for someone? I still occasionally use one of these useful and interesting machines although mine is smaller with a 20in. stroke and 7 by 6in. deep capacity, manufactured by the late firm of Tom Senior. It is a little machine capable of giving a lovely accurate finish by, like Adam of old, 'the sweat of your brow'.

Are many other modellers out there using one of these old machine tools? Do let's hear from you if you are lads!

D. M. Mackay. M.B.E.,
North Lanarkshire.

Workshop vacuum cleaner

SIRS, - Every workshop needs a vacuum cleaner to cope with filings and swarf, and even for cleaning out smokeboxes. Over the years I had inherited the cast-offs from the household department as we moved from Electrolux to Hoover and to Dyson. The old Electrolux cylinder vacuum cleaner had done years of service in the workshop when it finally gave up the ghost. At about the same time, the Machine Mart catalogue came through the letterbox with my subscription copy of *Model Engineer.*

A birthday was looming, the choice was easy: for £44 Machine Mart delivered one of their Combi Vac Model WD1000 machines, actually made in Great Britain. It does all that is asked of it in the workshop and has even been known to clean some of the unmentionable corners of the house where the upright Dyson model would have been rather cumbersome. I have no reservation in recommending this product as a good buy for your readers.

D.A.G. Brown, Rutland.

Electrical safety and a plastics supplier

SIRS, - With reference to Ian A. Wright's letter (*M.E.* 4223, 11 June 2004), I too would like to know much more about the induction furnace mentioned by Ernie Henne.

I would however say that to draw 4kWh from a 13A plug is unsafe if not impossible since 4000W ÷ 240V = 16.7A. Tapping into the cooker feed (with permission of the management) will gave access to 30A but should only be tackled by those competent to do so.

Because of its square pins, the standard UK 13A plug only makes point contact in the socket and is unsafe to use at its maximum rating for any length of time. Washing machines and heating appliances frequently cause overheating of the plug and these are running at 'only' 3kW. (3000 ÷ 240 = 12.5A) The situation is not helped by the sometimes poor contact also made by the fuse in its holder.

The old-fashioned 15A plugs with their round pins were safely able to carry 30A; for a demonstration of this statement look at the pin size of a European 16A plug!

On an entirely different matter, concerning the availability of acrylic sheet (ref. letter from Ian Beilby in the same issue), Amari Plastics are a national supplier of all things plastic (normal disclaimer). Visit their informative website or check their Head Office for a branch near you. Amari Plastics Plc., Holmes House, 24-30 Baker Street, Weybridge, Surrey KT13 8AU; tel: 01932-835000; fax: 01932-835001; website: **www.amariplastics.com**

Noel Shelley, Norfolk.

Soft solder alloys

Sirs, - I was very interested in Dick Billington's article about fusible plugs (*M.E.* 4220, 30 April 2004). I shall take his advice and not fit them in the *Conway* on which I have been working for too long.

I was also intrigued by Table 3 in the article which gave a melting temperature of 100 to 110deg. C for 'electronic solder'. The electronic solder most commonly found here is 63% tin and 37% lead, a eutectic alloy with a melting point of 183deg. C. I also found a tin-bismuth eutectic solder with a melting point of 144deg. C, but nothing with a lower melting point. It would be interesting to know what the 100 to 110deg. C melting point solder might be.

It is perhaps also pertinent to point out that non-eutectic alloys, especially when melted and frozen in smaller amounts, may have a re-melt temperature higher than the original

Mr. Taylor would like to learn how new 'tin cans' (right) are manufactured.

alloy. Non-eutectic silver brazing materials would be an example.
John C. Bauer, Ontario, Canada.

Seamless!

SIRS, - I opened a can of baked beans a few days ago and noticed a change in the general construction of the can. The top has the usual rolled joint to provide for opening with a can opener, but the bottom does not seem to have any joint at all. There is also no sign of a side seam. I have to pose the question to those more knowledgeable than I in these matters, how was the new can made? I have no answer.

Shaping the flanged ends of a copper boiler with metal of a reasonable thickness is easy to visualise, but shaping a whole can in steel sheet just 0.008in. thick seems like a miracle.

I enclose the can (sorry, we ate the beans) to see what ideas you and the readers may have.
Frank Taylor, Hampshire.
(The photograph at the head of this page shows an 'old fashioned' can on the left featuring a longitudinal resistance welded seam and ends held in place by means of self-secured or rolled joints. Mr. Taylor's seamless can is shown on the right. It is probably manufactured by deep drawing, but release of the transverse corrugations would require a split mould and/or a collapsible core. We are sure that our readers will tell us how they are made — Eds.)

Sound advice

SIRS, - New entrants to model engineering, and the decline in craft training are recurrent themes in our magazine, and inevitably many who take it up will have great need of help and advice. Joining a club is obviously beneficial in this regard, but as one classically devoid of any technical background I would like to offer some advice based on my own experience.

1: Read every constructional article in *Model Engineer*. I have no great interest in locomotives but by reading articles such as those by Keith Wilson, one picks up all sorts of tips and methods of working. I readily acknowledge that I have gained a lot from such reading.
2: Take your time! Skilled work cannot be hurried, and when you are at the learner stage you have to go slowly. When you go into the workshop, set yourself a limited objective and don't be too ambitious as to what you can do in the session. It is better to end with time to spare than to hurry to finish too much and spoil the work already done. Remember that as one gets older concentration fades, and mistakes tend to creep in at the end of long sessions.
3: The bit we like is machining, but beware! Setting things up is not such fun, but you cannot take it too seriously. Take all the trouble you can in fastening work down so that it is really secure against the forces to be applied.
4: When work has been fastened down, rehearse the traversing movements which will be entailed before you start machining, to be sure the tool will reach where it should. It is infuriating in the process of machining to find that a holding-down bolt on the milling machine prevents the cutter from descending far enough. On a number of occasions when drilling large holes I have drilled a pilot only to find that the chuck was too near the work to permit the longer drill to go in without raising the head and thus disturbing the setting.

I realise the above will seem pathetic to the trained and experienced, but I have learned it the hard way. It is insufficiently technical to get into the books from which we learn and I wish someone had told me!
Dennis Randall,Oxfordshire.

Scales and gauges

SIRS, - On first reading I very much enjoyed Keith Wilson's excellent description of the 7¼ in. gauge Garden and Woodland Railway in *M.E.* 4222, 28 May 2004.

However, on second and more careful reading I'm afraid I got stuck — at the point where he said that semaphore signals would look right on this railway if they were built to a scale of 10¼ inch. I just couldn't understand what he meant by that. So far as I know such a scale does not exist.

I suppose it's fair enough to talk about scales of so many inches to the foot, though I can't help wondering what our (Guildford MES) French and Dutch members make of that, having been brought up all their lives with millimetres and metres. But to my mind, the best, clearest and only correct way of specifying a model's scale is to state just the ratio of the model's size to the size of the thing it represents. For example, up to last year I was building a 1/6 or 1:6 scale model traction engine; I helped my son in law to build a 1/16 or 1:16 scale boiler for his 3½inch gauge 4-8-4 loco; during the war I carved a chunk of pine into a 1/150 or 1:150 scale model of the destroyer I was on; and I have often driven on our club's 3½in, 5 in., and 7¼in. gauge tracks locomotives of 1/16, 1/11, and 1/8 scales respectively.

By the way, I eventually concluded that what Keith was really saying was that semaphores built to the scale appropriate to a 10¼in. gauge layout, i.e. 1/5 scale, would look right on the Garden and Woodland Railway, and better than if they were made to the scale of 1/8 normally associated with a 7¼in. gauge layout.

Could I ask how others feel about this business of scales?
Doug Peddie, Surrey.

Pixels

SIRS, - Derek Brown commented that he was having problems with diagonal lines on his CAD generated drawings. Without more details I cannot be sure, but he may be seeing a fundamental problem with raster devices, such as screens and printers, which create their images from a series of blobs or 'pixels'. These pixels are usually placed in a square matrix with sides of (say) 1 unit.

Consider drawing a straight horizontal line of minimal thickness. The device will place a row of pixels 1 unit apart across the device. Now consider a line at 45 degrees to the horizontal. Each pixel is now displaced both vertically and horizontally from its neighbour making them further apart (actually √2 or about 1.4 units apart). The line will look thinner — probably unacceptably so.

To counter this, the output driver may well try to fill in some of the gaps making it look thicker. The fact is a thin diagonal line cannot be exactly the same thickness as a horizontal or vertical one. A similar but more complicated situation arises at other intermediate angles.

The solution may be to use smaller pixels which will cause the line to be drawn several pixels wide. The problem is still there but much less noticeable. You will probably not be able to do this on a screen but many printers support multiple resolutions.

When a print is requested a dialogue can be displayed so that you can alter the printer settings (look for a 'Properties' button on the print dialogue). It may be worth asking for a higher resolution or improved quality.
Roger Woollett by e-mail.

Acrylic sheet

SIRS, - In *M.E.* 4223, 11 June 2004, Ian Beilby suggested Wickes Ltd as a useful local supplier for acrylic sheet. For those who do not have a local Wickes, or would like something other than 3mm clear sheet, I have discovered a plastics fabricator willing to supply small quantities of acrylic sheet, cut to required sizes and at a very reasonable cost.

Clear is on offer in thicknesses of 2, 3, 4 or 5mm and black at 3mm. The fabricator is A.S.H. Plastics (Wolverhampton), City House, Ettingshall Road, Wolverhampton, WV2 2JP; tel: 01902-450-300. The only problem with small quantities is that the cost of postage and packing is apt to be a significant part of the order cost!
Roger Castle-Smith, Buckinghamshire.

Best in Show was this finely detailed and beautifully finished 5in. gauge model of an LMS rebuilt 'Royal Scot' by Mr. J. Heslop.

Winner of the Raymond McMahon Trophy for the Best Road Vehicle in Steam was this 4in. to the foot Burrell by Mr. M. Roberts.

HARROGATE 2004

THE NATIONAL MODEL ENGINEERING & MODELLING EXHIBITION

Neil Read

reports on the eleventh in the series of these superb events.

●*Part I*

Given the current levels of road traffic in the UK and the terrible state of some of our roads, I am probably not alone in feeling slightly apprehensive about travelling long distances by car. Modern driving conditions seem so hectic that we cannot allow our concentration to relax for an instant and, if a particularly aggressive driver does not 'get' us, then the chances are that a speed camera tucked away in a hedge somewhere will. I know that Mike's four hour journey to Harrogate took him seven hours due to closure of the M1 motorway. Small wonder folk are reluctant to travel! However, as I motored north towards Harrogate to cover this event, I found myself able to settle down more and more and look forward to what I knew would be an exciting and interesting event.

Lou Rex, his family and team set out to make the National Model Engineering & Modelling Exhibition a friendly event that model engineers and their families can enjoy. Comparisons with rival events are discouraged and the emphasis is on taking pleasure in the many facets of model engineering in a relaxed and picturesque setting. Judging by the many happy faces seen walking (and riding) around the Great Yorkshire Showground during the three days of this exhibition I suspect they have arrived at a winning formula.

Trophies and shields

The Barry Jordan Trophy for the Best in Show, the Precision Paints Award for Best Finished Model, the Myford Shield for Best Locomotive and a First Certificate in Section 40 were all awarded to the 5in. gauge LMS rebuilt 'Royal Scot' locomotive built by Mr. J. R. W. Heslop (**photo 1**). One can always tell when a particularly special model is being judged. Hard nosed and steely-eyed judges become more mellow and approachable. They forget to eat their sandwiches or drink their coffee. They call in expert colleagues to discuss a particular feature or perhaps to help them find something to criticise. They even stop counting rivets and poking about with cunning bits of wire to check if the reverse sides of the coupling rods have been fluted. After a time they just stand there and admire the model in awe, pretty much as the newest tyro to the hobby would do. It was like that with this model. Along with all the silverware now adorning his sideboard perhaps the *Model Engineer* team can add their congratulations to Mr. Heslop on a very fine exhibit.

The Raymond McMahon Trophy for the Best Road Vehicle in Steam was awarded to Mr. M. Roberts for his 4in. to the foot Burrell single crank compound agricultural engine (**photo 2**). I gather from the organisers that this engine has seen sixteen years of rally use. This being so, it bears its age remarkably well and is a credit to the owner and his standards of maintenance. Agricultural engines were the work horses of the traction engine world, being built for powering stationary machinery like threshing boxes and stone crushers, and for towing such equipment from place to place. Often they were single-cylinder machines but canny owners would sometimes opt for a compound engine as the higher price could be offset by the reduced running costs. The Burrell single-crank system proved popular for a time and claimed to give the benefits of compounding without the added complexity of a double-throw crank.

This year's winner of the Chester UK Shield for Best Workshop Equipment was the wonderful 1:4 scale model of an Alba 1A shaping machine built by Mr. M. Leafe (**photo 3**). This model was also awarded a First Certificate in Section 42. The opportunity did not arise for me to ask Mr.

The miniature Alba shaping machine, bench and inspection equipment built by Malcolm Leafe and winner of the Chester UK Shield.

Winner of the Eventex UK Shield for the Best Boat was this Sailing Barque by Mr. G. Cutler.

This miniature Benier 1888 Hot Air engine built by Herbert Stumm was awarded the Warco Trophy for the Best Stationary Engine.

An unusual but very photogenic model was this Manx Northern Railway locomotive built by Mr. A. Howarth. It won a First Certificate.

Leafe if he owned a full size version of the machine and was thus able to measure it up. However, for whatever reason, the proportions of this model appear to be just right, and it has all the features remembered on an Alba belonging to an old friend of mine some years ago. Seeing the sturdy construction of this model and knowing of the capacity for hard work of the prototype machine , one is bound to ask why the shaping machine is not more popular in the amateur's workshop. Admittedly, milling is now the accepted method of producing plane surfaces in industry and is without doubt a more efficient way of removing material, but in an amateur's hands, the economics of rapid stock removal are less important and the shaper does avoid the costly outlay on cutters and the means to sharpen them, which is unavoidable with milling.

Mr. T. Collyer's handsome 5in. gauge Jubilee 6P earned its builder a First Certificate and many admirers.

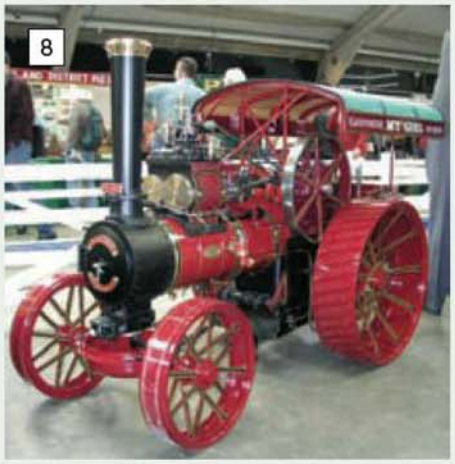
The winner of the Eventex UK Shield for the Best Boat, and a First Certificate in Section 49 was Mr. G. Cutler for his 1:96 scale Sailing Barque (**photo 4**). This model followed the prototype in that no iron or steel was used in its construction. The timber members were joined using copper nails. This gave a durable vessel which had no sources of corrosion from the action of the seawater. Alas, a change of owner and name resulted in a change of fortune and she was lost first time out under her new flag. I believe changing the name of a vessel is considered unlucky by seamen and cases such as this tend to reinforce the superstition.

Still on the subject of boats, it is pleasant to report that the Northern Association of Model Engineer's Shield for the Best Club Stand was won by York Model Boat Club. Every effort had been made by the members to make a colourful and striking display and their award was considered well deserved by other clubs and the public alike.

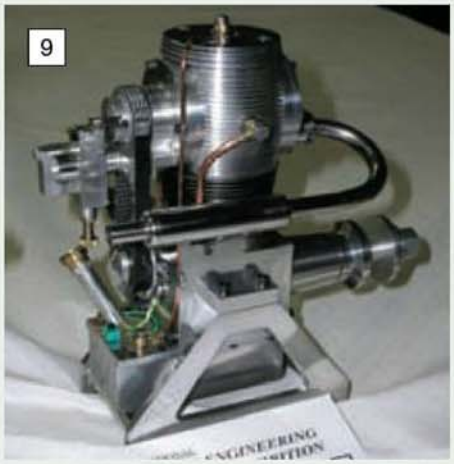
A staunch supporter of several events in the UK is Herbert Stumm of Germany. Herbert's models are often of unusual, well-researched prototypes, and are always well executed and beautifully finished. This year he had entered his Benier 1888 hot air engine (**photo 5**) in competition and was awarded the Warco Trophy for the Best Stationary Engine and a First Certificate in Section 45. Benier was a Parisian who attempted to improve on the engine designed by the Englishman Buckett. On these engines the working cylinder is placed over a closed furnace. The piston is caused to rise when air is pumped through the furnace and becomes hot. A valve then opens and, driven by the inertia of the flywheel, the piston descends and drives out the used gases. The cycle then repeats. Special arrangements are in place to feed the furnace with solid fuel while ensuring that no loss of pressure can occur. On engines of this type dust and cinders from the furnace can cause problems in the cylinder but on the Benier engine a special air feed system helps prevent this.

Other awards

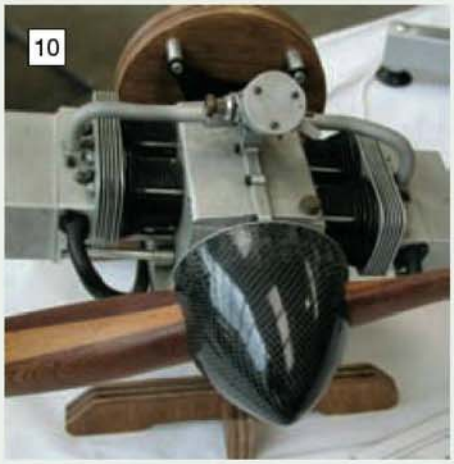
In addition to the principal trophies a number of other certificates were awarded. In Section 40 (Locomotives) First Certificates were awarded to the 7¼in. gauge Manx Northern Railway *Caledonia* of Mr. A. Howarth (**photo 6**), the 5in. gauge Jubilee 6P of Mr. T. Collyer (**photo 7**) and the 5in. gauge *Torquay Manor* 7800 of Mrs. C. Popple. Third Certificates went to Mr. P. McQueen for his 5in. gauge Class VI 2-6-2T locomotive, Mr. J. Cottam for his handsome 5in. gauge unrebuilt Merchant Navy class locomotive and Mr. P. Holroyd for his 3½in. gauge rebuilt Merchant Navy class locomotive. The technically interesting 3½in.



This Fowler agricultural engine built by Mr. C. Ponder was a Second Certificate winner.



This little 25cc engine built by Mr. T. Pasco uses unusual induction and exhaust arrangements.



Brian Perkins' VW inspired flat four aero engine was awarded a Third Certificate.

The well detailed model of a Foden ready mixed concrete lorry built by Mr. P. Lapworth. It was awarded a Third Certificate.

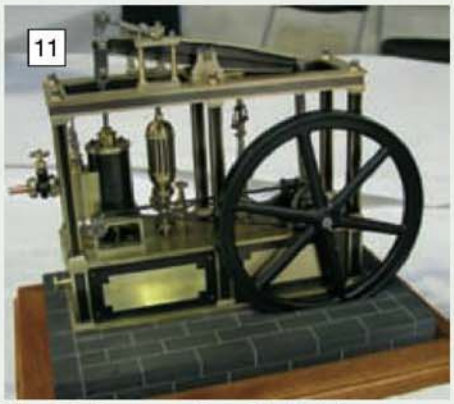
Raymond McMahons splendid Angel Organ was a delight to look at and to listen to throughout the show.

gauge Franco-Crosti boilered BR 9F 2-10-0 of Mr. E. Grinham was Highly Commended.

In Section 42 (Workshop Equipment) both the vertical milling machine of Mr. G. May and the Smart & Brown taper turning attachment by Mr. M. Leafe were Highly Commended.

In Section 43 (Road Vehicles) a Second Certificate was awarded to Mr. C. Ponder for his fine 4in. to the foot scale B6 Fowler agricultural engine (**photo 8**). At first glance this model did not look like an agricultural engine as it carried the half canopy usually associated with road locomotives. However, such items could be ordered as extras on any engines in the Fowler range although I understand that the canopies were not universally popular. Some drivers felt that not being out in the fresh air may cause them to catch diseases! Third Certificates were awarded to Mr. B. Eatock for his 2in. to the foot scale Foden steam lorry and to Mr. J. Elliott for his 1:4 Fowler ploughing engine *Black Beauty*. Alongside his model, Mr. Eatock displayed the patterns for the rear wheels of his Foden and many visitors found these almost as interesting as the finished model itself. Little touches like this really add to the interest of the exhibits.

In Section 45 (Stationary Engines) Mr. T. Pasco had two nicely finished and technically interesting engines on display. His 25cc opposed piston 4-stroke engine (**photo 9**), which was awarded a First Certificate, was based on a design developed by Malcolm Beare in Australia. In essence, this comprises a standard 4-stroke cylinder with a 2-stroke cylinder and piston assembly inverted over the top of it. The top piston/crank assembly runs at half engine speed



The little beam pumping engine built by Mr. J. Cogden and christened **Lady Stephanie.**

and controls the induction and exhaust phases of the cycle by way of a reed valve (inlet) and disc valve (exhaust). In Mr. Pasco's version of the engine two disc valves are used. Both induction and exhaust phases are controlled by a combination of the disc valves and the cylinder ports. The model engine is reported as having good torque and revolves at a comfortable 4500 to 5000 revolutions per minute. The second engine entered by Mr. Pasco was a 42cc 3-cylinder radial engine and this was awarded a Third Certificate.

Regular readers will need no introduction to the work of Brian Perkins whose models have often featured in these pages. Brian had entered his superb 1:4 Bristol *Aquila* aero engine and this was awarded a First Certificate. Alongside was his 0.4:1 semi-scale VW flat four engine (**photo 10**) and this was awarded a Third Certificate. The twin cylinder 4-stroke, horizontally opposed aero engine of Mr. D. Micklethwait and the beam pumping engine *Lady Stephanie* (**photo 11**) by Mr. J. Cogden were both Highly Commended.

The Miscellaneous Section (Section 46) attracts a diverse range of models as befits its 'catch all' status. Mr. N. Wilkinson's 1:50 Bucyrus *Erie* 1150 ton walking dragline was displayed unpainted but in working order and intrigued visitors throughout the exhibition transferring dried peas from one bin to another. Mr. Wilkinson had thoughtfully placed a model man on the inspect gantry to give some idea of the size of the original machine. This model was awarded a Second Certificate though I suspect that a higher award may have been made if it had been painted. Three models were entered by Mr. P. Lapworth, a 1:14 USA Ford lorry, a 1:14 Mercedes lorry and a 1:8 Foden concrete delivery lorry (**photo 12**). All were awarded Third Certificates. Some idea of the attention to detail paid to these models may be gauged from the fact that the lorry cabs were fully fitted out and even included a selection of miniature *Playboy* magazines for the driver to read while off duty.

Section 47 (Fairground Models) was supported by a range of carefully built and well-detailed models. Ray McMahon's miniature fairground Angel Organ (**photo 13**) was not only a stunning sight but also provided visitors with music throughout the exhibition. It was awarded a First Certificate. Mr. R. Whatmore and Mr. M. Slater were both awarded Third Certificates for 1:24 scale models of fairground rides and equipment.

The model boat section is sub-divided into Kit Built (Section 32) and Scratch Built (Section 49) categories. In the kit built section a First Certificate was awarded to Mr. B. Seaman for his model of HMS *Wolfhound,* a Second Certificate was awarded to Mr. C. Behan for his 1:40 WW2 German type U-boat U69 and a Third Certificate was awarded to Mr. B. Southam for his 1:35 Yacht *Scharrhorn*. In the Scratch Built section Mr. C. Johnson was awarded a Second Certificate for his well detailed narrow boat (**photo 14**).

Last but not least, three Second Certificates were awarded in Section 50 (Model Wheelwrights). These were awarded to Mr., J. Cartledge for his 1:8 Ladies Phaeton, Mr. B. Young for his 1:12 Weeks Potato Sprayer and Mr. B. Simpson for his 1:8 Shepherd's Hut (**photo 15**). Next time we will present a full list of the award winners and take a tour the club stands.

●*To be continued.*

The nicely detailed interior of Mr. C. Johnson's narrow boat.

Mr. B. Simpson's Shepherd's Hut even had this rather severe looking shepherd.

MICRO-CULTIVATOR

Frank Taylor

explains how time spent in his workshop took the drudgery out of gardening.

●*Part I*

My wife and I enjoy growing our own organic vegetables in several quite small plots around the garden. The plots have been made very fertile over the years and we enjoy and have become accustomed to the bounty. As the years pass by one's physical abilities decline and digging the ground becomes more difficult. We considered a commercial digging machine but as its length was about half the length of some of the plots it would have been close to useless, particularly as most plots are bounded by walls and fences. I looked at a very small machine purchased by a neighbour. This machine could be got into some of the corners but consisted of a set of power driven tines with no provision for restraining the machine which, like a 'bucking bronco', was always fighting to get away from you. I concluded that the strength needed to control the machine exceeded that needed to dig the ground with a fork, as I had always done.

At this stage my wife came across a book which explained that deep digging was unnecessary and could even be counter productive. We gave the ideas a short try but found it was still necessary to shallow dig to sow seeds, etc. It was at this point that thoughts turned to the actual facilities required and how the workshop could come to the rescue.

Specification

A brief specification was drawn up:

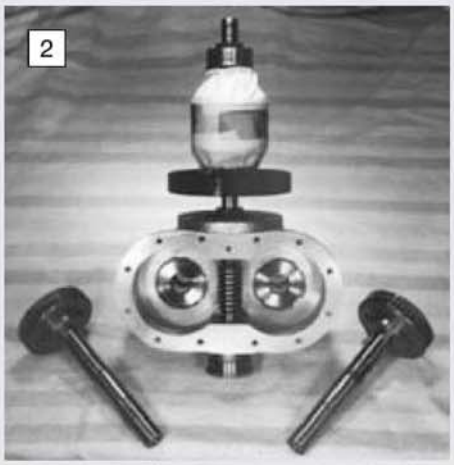
1. The weight of the machine should be such that it could be picked up with one hand (by me) and hung on the wall of the garage.
2. The torque produced by each of the two tines should be balanced, as near as possible, to minimise the effort needed to hold and control the machine.
3. The machine should be capable of dealing with compacted wet ground which has 'over-wintered', and produce a bed ready for sowing seed. The depth of cultivation needed to be approximately 3½ inches.
4. There should be very little noise so that it can be used early in the morning before the neighbours are out of bed.
5. Speed and torque range should be variable to cater for different ground conditions and also to allow for the fact that I was not sure what was actually needed.
6. The machine should be electrically powered with full electrical safety protection and no mains-power switching on the handle. There should be a very fast switch off in the case of mechanical overload caused by digging up large stones, etc.
7. In general use one should be able to walk slowly backwards trailing the machine to avoid walking on the ground just dug. However it should also be able to be used back and forth over a small area, like the lady of the house (and some gentlemen) handle the vacuum cleaner.

The complete micro-cultivator with the electrical cover removed to show some of its construction.

General ideas

The requirement for low weight would mean that the machine would lift off the ground rather than push a tine into it as with a conventional tine arrangement. This problem could be overcome by making the tines screw themselves into the ground. Two sets of tines would be used, one working left-handed and the other working right-handed. Assuming that the work done by each set is equal, this could balance out the torque. If the tines were arranged to interlace with one another, then an action could be obtained where the left hand tine screws up a clod of earth and, while it is being held, the right hand tine goes straight through the middle of it. The left and right swap roles, and so it goes on. I could see this might give a very fine tilth. The screwing action of the tines would try to pull the machine into the ground and keep it firmly on its wheels.

It was all theory and my expectations were not high from two contra-rotating sets of tines. However, from this it was easy to move on to two worm wheels driven by a central wormshaft. This forms the basis of the design and addresses some of the requirements. The others will be dealt with as the detail evolves.



The partially dismantled gear case showing the two main drive shafts and their worm wheels.

General arrangement

This is best seen in **photo 1**, to which I shall return later when discussing detail. The position of the machine is as it would be if its handle (out of the picture) had been lowered to the ground. The machine rests on its handle and its wheels. In the foreground are the tines, which are just clear of the ground. Moving up the two shafts, from the two sets of tines, there is a casing around both of the tine support wheels.

This is a guard to prevent entry of stones, which would otherwise jam the wheels. Next come two black rubber boots which prevent dirt entering the shaft bearings. These are followed by the road wheel assembly clamps which fix to the shaft bearing housings and form part of the gearbox casing. In the upper part of the picture is the motor, crowned by the speed sensor. The motor is surrounded by a structure to provide anchorage for the outer casing and to improve the airflow from the fan (not visible).

At the top of **photo 2** is the armature of the drive motor with the windings carefully wrapped to prevent damage. The motor came from a defunct lawnmower and it was given to me with the comment: *"It don't go but it might come in handy"* — and so it has. With new brushes and a skimmed and undercut commutator it was in good shape, except for the drive end bearing. Fortuitously, the design eliminated this bearing by using the bearing in the gearbox. In the foreground can be seen the two tine drive shafts which have been hardened and ground.

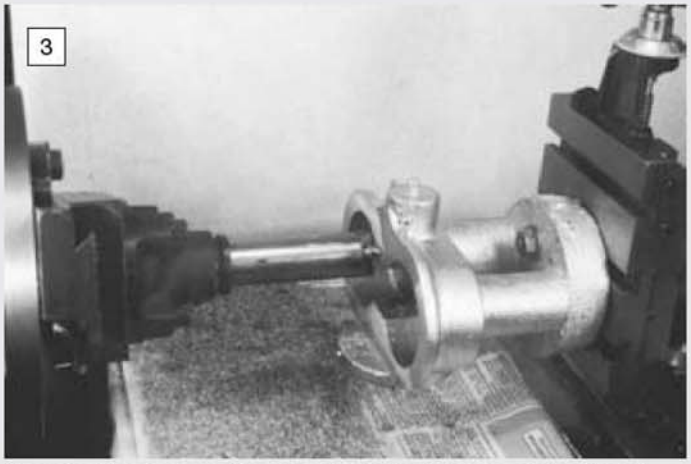
The shafts are topped with worm wheels made from high-grade cast iron. An 'O'-ring is fitted in the face of a boss on the lower part of these wheels. This provides an oil seal in conjunction with polished hardened faces that can be seen in the bottom of the gearbox. The hard tine shafts run in cast iron bearings fitted in the lower part of the gear case.

Construction

Four aluminium alloy castings were made: gearbox, gearbox cover, and two different castings to terminate the tubular part of the handle. The beauty of making your own castings is that it can make your machining operations easy. This can be judged with the following machining sequence for the gear case where an extension to the casting serves as a feeder when casting and an easy, secure method of holding the casting when machining.

Gear case

After setting up as squarely as possible, the gear case was bolted to the vertical slide as shown in **photo 3**. Holes drilled at T-slot centres in the casting feeder were all that was needed for holding. Here the gasket face, which forms a main datum, is being fly-cut. **Photograph 4** shows the motor flange surface being fly-cut ▶



Machining the gear case; here the cover mating face is being machined using the boring and facing head as a fly-cutter.

The motor flange being machined square with respect to the previously finished face. The tine bearing housings are set square to the lathe bed.

after ensuring that the tine bearing housings were as square as possible to the bed. The surface of this flange also forms a datum. Using a surface plate, or a sheet of thick glass as I do, all centre lines were marked out all round the casting by standing it on the datum faces. After machining the face of the casting feeder head true to the machined gasket face (not photographed) the casting was mounted as shown in **photo 5**. Here the gear cavities are being bored out to the gear centre-distance using the cross-slide index.

Boring the wormshaft bearing housings is shown in **photo 6.** Looking at the photo I see a piece of bar fixed to the front T-slot and pressing on the casting. To the best of my recollection this was used to aid setting up the casting to its datum lines prior to boring and is not needed for the machining operation.

Worm and worm wheels

A tool with a pressure angle of 20deg. was carefully ground in order to cut the worm and the hob, the latter to be used to finish the worm wheels to profile.

I do not have the necessary change gears to make the gearing to a standard diametral pitch so the worm was made to 8 turns per inch. Although a single-start worm is not renowned for its power transmission efficiency it had to be used because a two-start worm would have made the wheels much too big for the gear reduction (44 to 1) that I wanted.

Digressing for a moment, I am no gear expert but I do have a wonderful hardback book which deals with all types of gearing in a simplified way and gives worked examples of all formulae used. The book was obtained from a stall at a car boot sale where I successfully suppressed my joy when opening the book, resulting in a price of £3. The book's title is *Gear Design Simplified* by Franklin D. Jones and it contains rules, formulae and examples applying to all types of gears. It was published by The Industrial Press, 148 Lafayette Street, New York. The first edition was published in 1937 and the second edition (which I have) came out in 1940. I expect this book is now out of print but could be obtained on long term loan from library services. Information on cutting worms was gleaned from *Dividing and Graduating* by G. H. Thomas, which helped me to a successful worm that was later hardened and polished.

Coming now to the worm wheels, it was proposed to gash these and allow them to be driven by a hob to achieve the final shape. I have tried this method in the past using a hob with no backing off of the teeth and the hob seems to rub the metal rather than cut it. I have got by with brass and the cutting of one gear with not too many teeth but to cut two identical wheels with 44 teeth might have landed me in trouble. I wanted to put a small amount of clearance on the back of the teeth. This would normally require a piece of kit which would be another project in itself delaying the day when I could get away from the digging fork. There was a slight nagging doubt that a cutter with form relief as proposed might not drive the gear during cutting. How much drive does a clean cutting edge have? There was only one way to find out, so I came up with the following idea which puts a minimum of clearance on the back of the teeth to produce clean cutting. The only effort required was to make a special cam, which once made could be used again in the future.

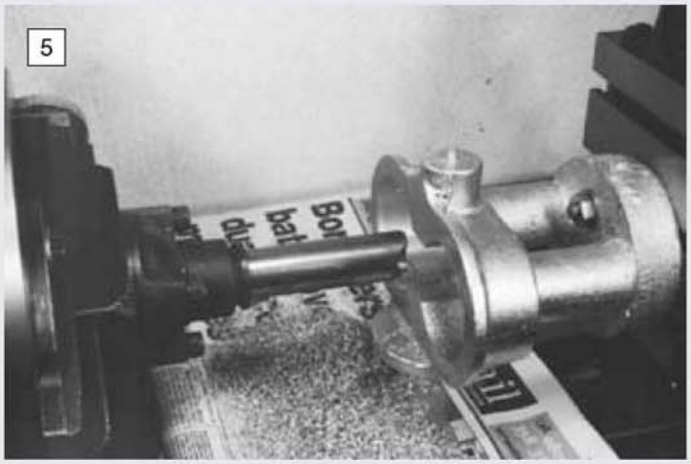
Turning the hob

This was produced on the end of a 6in. length of $^{5}/_{8}$in. dia. silver-steel. I first cut six slots running lengthwise in the hob blank and then cut the thread similar to the worm. Doing it this way round does make the screwcutting uncomfortable due to intermittent cutting, but it does mean that any burrs that are present are in the slots are easily removed with a fine needle file without spoiling the thread.

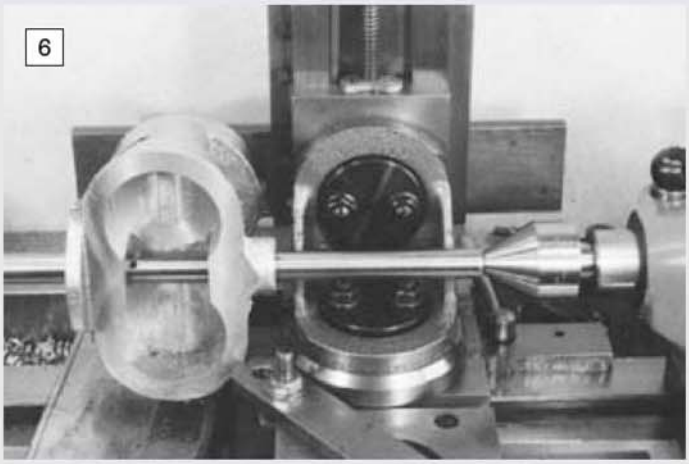
Form relieving hob teeth

To relieve a tooth, the normal screwcutting tool is made to take a progressively deeper cut from the front to the back of tooth. When the tool reaches the gap between the teeth it is made to retract quickly ready for the next tooth. This can be done by utilising a cam to move the cross-slide in the appropriate manner. The set up which I used is shown in **photo 7**, the lathe being set for screwcutting at the pitch of the hob.

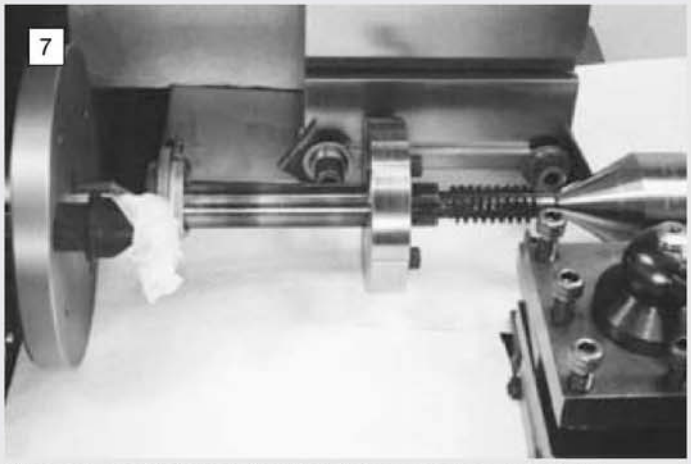
Two separate operations are required. First using a flat tool to back off the tops of the teeth, and secondly using the 20deg. threading tool to cut the sides of the teeth. In the case of the Myford lathe the cross-slide feed screw is removed leaving the slide free to move. A vertical slide is fixed to the back of cross-slide set up square on a Myford raising block. An unused piece of tool steel is placed in a T-slot of the vertical slide (detail **photo 8**) and is pressed hard up against the upper of the



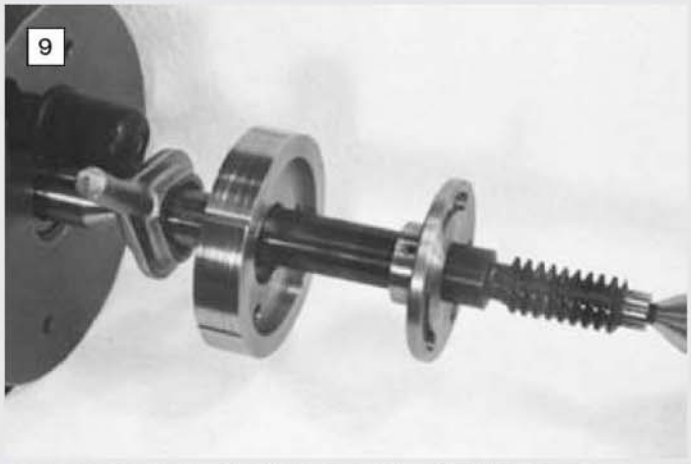
Boring the gear cavities to the correct gear centre-distance; note how the casting design has been arranged to facilitate work holding.



Line boring the wormshaft bearing housing with a between-centres boring bar. The piece of bar in the foreground was for setting up purposes.



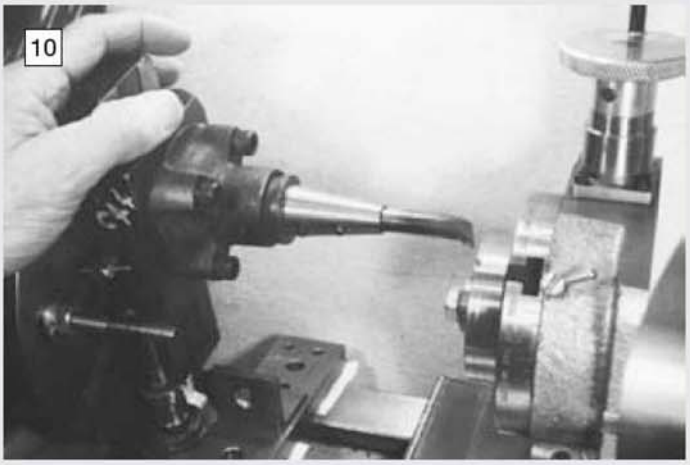
The set up used to form relieve the hob teeth using a cam acting on a spring loaded cross-slide.



The two main components of the cam are shown in this photograph. The flange (right) fits inside the cam body (left).

slot and clamped at each end. Mounted on the hob shaft (photo 7) is a cam, which is arranged to press against the piece of tool steel. This pushes the cross-slide backwards and forwards with the help of a return spring fitted in the cavity made by the removal of the cross-slide feed screw and a plate fixed across the end of the slide using existing holes (sorry no picture).

The spring and plate try to push the slide towards the operator and the slide is restrained and controlled by the cam. As the mandrel rotates, the cam slowly pushes the cross-slide forward against the spring until the piece of tool steel drops off the end of the cam tooth thus making the tool retract ready for cutting the next hob tooth.



The method used to machine the cam. Each of the six segments was machined by laboriously pulling the cutting tool down by hand.

My hob has six slots cut to form the teeth and the cam has a similar number of teeth. The cam is adjustable to make the cutter retract in the space between the hob teeth. It is essential to get the spring pressure right or the slide will not retract properly and a ruined hob will be the result. Very low speed is the order of the day. The mandrel was turned by hand to start with to make sure the full length of the hob could be traversed without anything fouling. The 'bonking' was a bit alarming at first but you get used to it as the lathe takes it in its stride.

When doing the actual cutting, the hob is given a coat of blue and the top-slide adjusted so that a small cut is taken at the back of the teeth. Progressive cuts are taken until the cut extends to the front of the teeth leaving a tiny witness.

The method used to mount the piece of tool steel used as a cam follower.

Cam details

The two component parts of the cam can be seen in **photo 9**. The part on the right closest to the hob is fixed to the shaft with a grub screw. The outside periphery of the part on the left forms the cam. This part has three tapped holes around its inside (only one can be seen) and these correspond with three slots in the first part. The two parts are put together and fixed with three cap screws. As can be seen, this provides a range of adjustment of the cam relative to the shaft. When the desired position is found, the cap screws are locked tight.

Cutting the cam

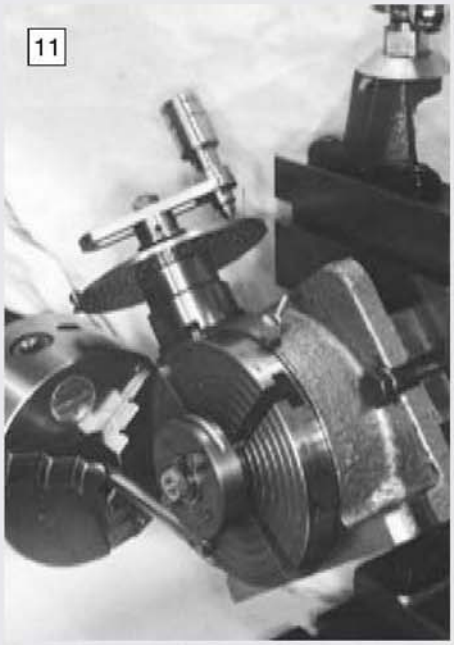
First, six cuts 1/16in. wide were cut across the cam at 60deg. intervals. The cam was then set on a rotary table lined up with the lathe centre line. The table was zeroed and an opposite pair of cuts on the cam set exactly horizontal. This and the remainder of the set up for cutting the cam is shown in **photo 10**. If the cutter is rotated with the rotary table on centre it will just cut around the outside of the blank but if the table is offset it will cut a 60deg. section of cam. Not being good on the necessary maths I found that if the table was moved 0.037in. it gave me a cam movement of about 0.013 inch. The cutting, done by hand, proved very laborious and I kept thinking surely there must be a better way.

Each cut consisted of placing the cutter as in the photo and drawing it down by hand until the bolt in the faceplate hit the stop fixed to the bed, then advancing the saddle a small amount. The stop was positioned, to make the cutter stop in the next slot. On completion of one 60deg. section, turning the rotary table offered up the next. Completion of the cam was accompanied by the seizure of my left arm.

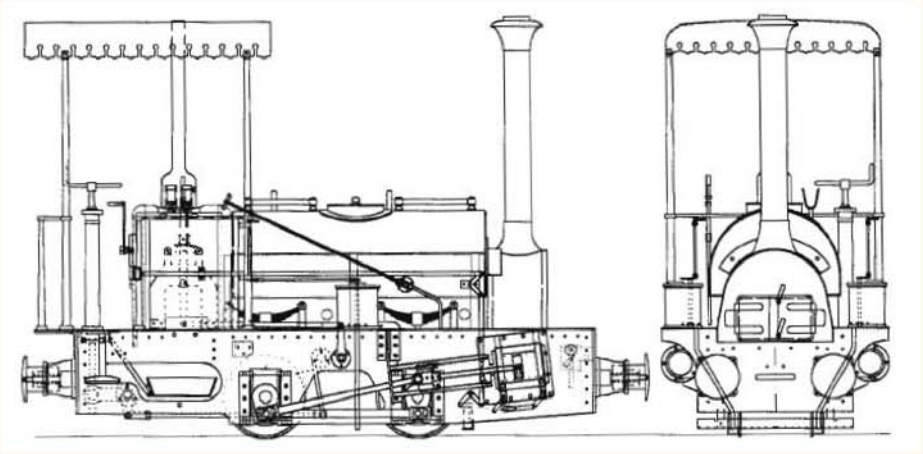
Cutting the worm wheels

I followed the details in the book mentioned previously and cut a depression around the circumference of the blank (**photo 11**). This allows the root of the worm to penetrate into the wheel and gives a large tooth face. For this work the blank was set to the lathe centre line.

●*To be continued.*



Cutting a depression in the periphery of the gear blank prior to gashing the teeth.



ANNA
A MANNING WARDLE LOCOMOTIVE FOR 7 1/4in. GAUGE

D.A.G. Brown and Mark Smithers continue *Anna* - a new design based on an early Manning Wardle locomotive which inspired the 'Quarry Hunslets'.

●*Part IV continued from page 679 (M.E. 4223, 11 June 2004)*

This episode finishes the stretchers and details the axleboxes. In addition, we shall be looking at the wheelsets and associated running gear, including the side rods; I trust that you will forgive a slight illogicality in the order of things; it all boils down to the amount of work that can be put legibly on a page for printing.

Before starting on the description, may I introduce you to our expert pattern maker. In my local model engineering society we are fortunate to have Paul Lingard who earns his living making patterns and has applied his considerable expertise in this project. Having been a lifelong admirer of Terry Aspin and his home foundry-work methods, I have always appreciated the way in which pattern-makers can view the problem, not only adding machining and shrinkage allowances, but taking steps like the formation of oddsides and loose pieces to enable the patterns to be withdrawn from their moulds.

Paul has made a superb job of the patterns and at the time of writing I am waiting for the first set to be delivered from our local foundry. When I originally did my graduate apprenticeship with Peter Brotherhood in Peterborough I spent some time in the pattern shop being taught the rules for the job. I gained a profound respect for the craftsmen who produced the masterpieces in wood, which went into the firm's compressors, turbines and spinning equipment and I was impressed particularly by one of them who used to do the *Times* crossword every day during his tea break.

Things have moved on in the past 45 years and Paul has taken advantage of some of the most up-to-date materials to achieve a good standard.

Axleboxes

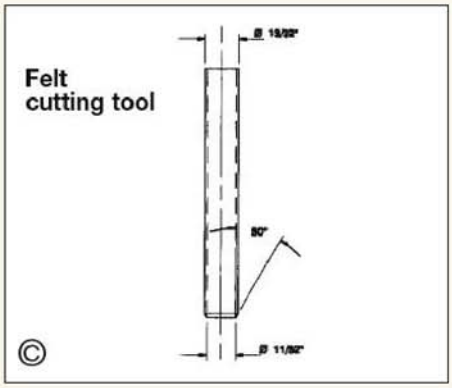
In part 3 we left the horn cheeks 'hanging', so to speak, waiting for the correct spacer to arrive in the form of the axleboxes (see *M.E.* 4223, 11 June 2004). Now here they come, as pairs of castings, nothing more than hefty blocks of iron which are being produced in twos to reduce moulding costs. Each pattern embedded in sand requires its system of runner and risers to enable the metal to reach all the correct places, so it follows that reducing the number of components helps to keep costs down. A contingent benefit is that the two units can be machined almost all over before cutting in two; it was not going to be economical to core out for the axle holes, so here you start with the cast iron stick, from which you must remove the nominal 1/8in. machining allowance all round.

My preferred way of doing this operation is to clamp it down to the table, holding by means of clamps at the ends and middle, with the bottom surface bearing down on a thin strip of MDF to improve adhesion and to protect the machine surface. Move the clamps around to allow the cutter to finish all over the flat surface. As an alternative, if you have a large enough lathe, hold each pair in the 4-jaw chuck and face off each side in turn. Whichever method you use, you should land up with the block measuring 8 1/4 x 2 3/4 x 2in., with both ends machined flat, (a good job for holding in the 4-jaw chuck).

To machine the sliding surfaces to mate with the horncheeks, clamp the piece firmly to the table, clocking it true to the axis of the milling machine. Form the 3/16in. deep groove over the whole length of the piece, using a suitable end mill or slot drill. Before turning over to do the other side, note the precise thickness of the block in order to gauge the final depth of cut on the second side to bring the critical dimension to 2.375in. between horncheeks. It is best now to separate the two axleboxes by means of bandsaw or other means, whatever is to hand!

Again in the 4-jaw chuck, finish the blocks all to the same length of 4 inches. While you have a note of the depth setting of the milling machine and the cutter is still in place, slew each box over by 3deg. and machine the angle cheeks to allow the wheelsets to take up irregularities in the track. Since there are no fewer than 32 cuts to be taken, it is worthwhile erecting a fence on the machine table, with a stop to enable each piece to be planted in the same position, not forgetting that the 3deg. offset needs to be 50% one way and 50% the other.

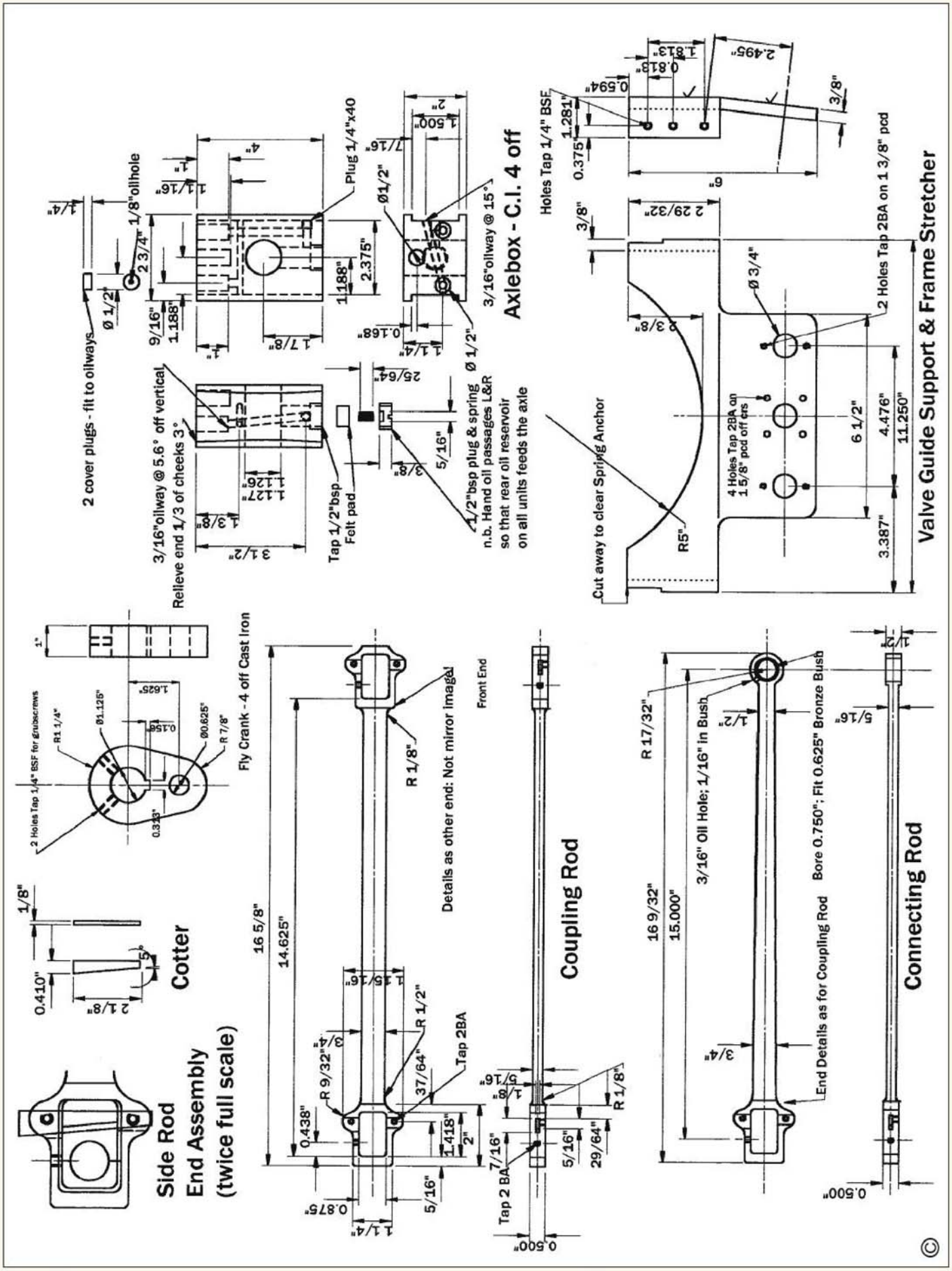
The axle holes are a sure candidate for holding in the 4-jaw chuck, and here the job should be clocked so as to run with the hole in the desired place. In order to achieve this, here is a procedure that works: set the clock gauge at centre-height on the cross-slide and wind in the slide so that it just touches the machined bearing surface which you have just produced. Rock the chuck back and forth to establish the minimum clock-gauge reading and note the cross-slide reading. Withdraw the tool, rotate the chuck 180deg. and repeat the procedure at the same cross-slide reading as before. Adjust the chuck jaws until the clock gauge reading is the same for both sides. This is a very accurate setting procedure for finding centre, since a diametral difference of 0.001in. is halved when it comes to looking at any radial error in the job.



Note that the hole is offset vertically by 1/8in., so that to achieve this there should be a difference in the cross-slide reading of 0.250in., when doing the clock-gauge trick on the top and bottom surfaces. To achieve best results, set this vertical position first, before finally positioning the boxes side-to-side. When boring to finished size, try and get all four to the same value. I do hate selective assembly!

The drilling of holes should now exercise the grey matter, so take it carefully and understand the objective. Of the three 1/2in. dia. holes in the top surface, the middle one is a pocket for the push rod already detailed and the other two are oil reservoirs, feeding horncheeks and axles respectively. I have specified handing so as to ensure that, say the rear oiling point feeds the axle, a small but significant detail when the thing is filthy dirty and has to be serviced under a large umbrella! Using co-ordinates to find the correct positions in all cases, drill 1/2in. dia. and finish to depth with a D-bit or slot-drill fitted with a stop to a depth of 1 inch. Extend the depth of the outside holes with a 3/16in. dia. drill to a further 5/16 inch. In one case this will break into the cross-hole yet to be drilled and in the other, it will provide a reliable pilot for drilling at a funny angle. Now invert the box and drill bang in the middle with a 3/4in. dia. drill into the axle hole, tapping the bottom 3/8in. 1/2in. BSP (which is 14tpi.)

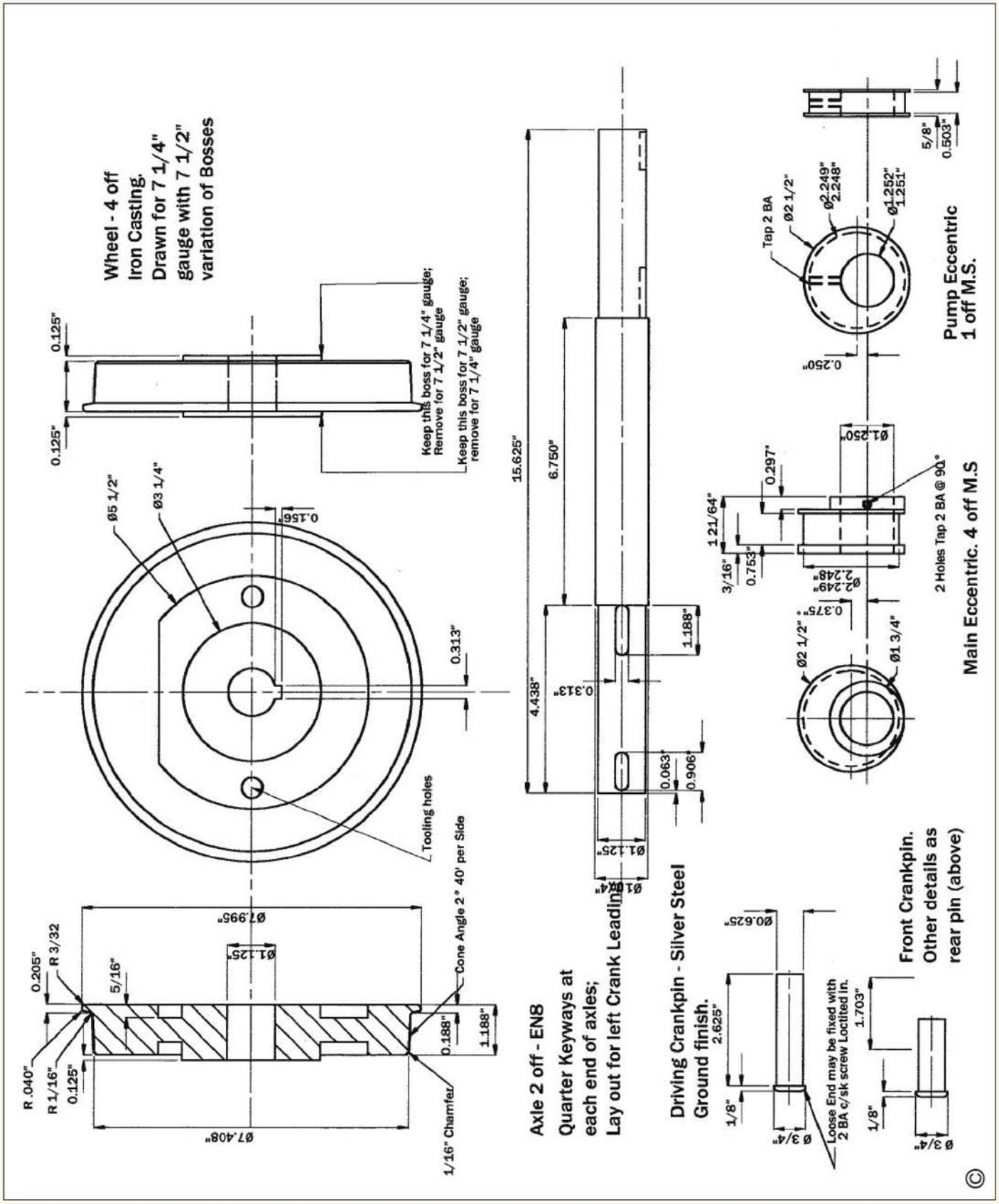
Looking now at the right-hand gallery in the drawing, which feeds the axle with oil, locate the position on the right centre line and 3 1/2in. from the top, where you should drill 3/16in. dia., plugging the end 1/4in. dia. or 7/32in. x 40tpi. The final drilling operation on this side involves inclining the box at 5.6deg. to the vertical



and drilling an extension of the short pilot hole already made, so that oil will flow in a large U-shape into the axle cavity.

Turning to the other side gallery, at 1 3/8in. from the top face, a single horizontal hole is drilled right through from the right-hand face to

miss the axle oil hole and to connect the left vertical oil gallery to both machined bearing faces. Oil fed into the reservoir will soon



percolate to where it is required. I specify plain mineral oil such as a light gear oil, say Shell Vitrea 330 for general lubrication purposes on this machine. Too thin an oil just runs out before it has a chance.

At the bottom of each axlebox the plug restrains a light spring and a felt pad, which feeds oil onto the bottom of the axle. Some years ago I was casting around for suitable felt material, when I had a state visit from our eminent Editor (before his elevation!). He generously presented me with a piece of heavy duty carpet felt, which is absolutely perfect for the job. It can be cut by means of a hollow punch which it is best to rotate slowly in the drilling machine. A mild steel cutter will cope with a small quantity of felt plugs without destroying itself, although silver-steel (unhardened) is better. The property that makes felt the ideal material for this sort of application is its absorbency; a natural material, its fibres are randomly laid down and they adhere weakly to each other. No man-made material that I can find acts quite as well. Each of the 1/2in. dia. holes is fitted with a small collar, which allows an oilcan spout to enter it; I have experimented with worsted twists inside the holes to meter the oil, but all so far to no useful effect. A good source of suitable springs is found by cannibalising some of the small pump mechanisms which operate pump-action hand cleaning dispensers,

window cleaning fluids and other unmentionable items from the domestic armoury.

Having finished the axleboxes, you should now check the fit in the hornblocks which were described in part III (*M.E.* 4223, 11 June 2004) and these may be dowelled to the main frames when you are happy with their positions. Don't forget to mark them in case you disassemble the whole lot again some time.

Stretcher

The next item is from an iron casting, the Valve Guide Support and Frame Stretcher. This is a job for the milling machine, with as little machining as we can get away with. Start by machining a reasonable area of the vertical surface which points to the front of the locomotive, just to clean it up so that it will sit truly on a parallel for the next operation. The back machined surface is really the reference, as indicated by a machining tick on the drawing. After finishing this face with the casting clamped to the table, take a lick over the short top casting surfaces to enable the casting to be set true for the next operation. Upend the casting with the machined face vertical and cut the two bolting flanges one at a time, taking a lick over the flange edge opposite the machined surface and positioning the three tapped holes for 1/4in. BSF screws; do not forget the rebates for the angle iron which will fit behind the casting.

The final set-up for this component requires it to be set accurately with the lower machined surface at 6.5deg. to the horizontal. I favour using a sine bar to position a tilting angle plate at the required angle, but you can do it with a clock gauge if you are careful. With the casting correctly aligned at 6.5deg., machine the lower area to 3/8in. thick, as drawn, pick up the centre line as datum and position the holes, using say a 1/4in. tap as a reference object in order to strike the 3/4in. dia. holes at the correct height below frame level. Location of all of the 2BA tapped holes should be a piece of cake before breaking the set-up. Should you use a tilting angle plate for this or any other operation, do not forget to align the edges of the plate truly parallel with the machine axis before bolting the casting in place; failure so to do would generate a skew plane for the lower part of the casting, rather than a plane which forms an angle of 6.5deg. in geometric agreement with all the other surfaces.

Digressing slightly, let me explain the statement in the previous paragraph about using a 1/4in. tap as a reference device: with the tap in the hole and a short length of 3/8in. dia. silver-steel in the milling machine chuck, move the slide in the Y-axis direction until the silver-steel *just* touches the tap. At this setting the machine centre-line will be 5/16in. from the tapped hole centre-line, so if you move the slide back 2.182in. in the Y-axis direction, the distance between the hole centre and the machine spindle centre will be the desired value of 2.495 inches.

It remains only to do the same with the X-axis to arrive at the correct positions to plant the two 3/4in. dia. holes for the valve guides. You will note that the 2.495in. dimension is indicated at the angle of 6.5deg., this having been worked out by the CAD system to align the valve gear with the cylinders at their positions within laser-cut holes in the frames.

Wheelsets

Castings for the wheels are available in cast iron, making four very hefty lumps. The patterns have allowances on them to cater for the change of gauge from 7 1/4in. to 7 1/2in.; as explained in the drawing, it depends which of the two bosses is retained during the machining operation. The rest of the design, i.e. axleboxes and axles, remains identical for the two gauges. I would recommend starting the machining process by taking the nominal 1/8in. off the back surface and then drilling two 'tooling holes', as drawn, to enable the casting to be bolted to the faceplate. By this means, the whole of the rest of the machining, including the flanges and the boring of the centre hole, can be done without disturbing the set-up, thereby guaranteeing concentricity. Having had a wheel work loose on its axle in the past, I recommend that the wheels be keyed on to the axles, so this requires a keyway in each hole opposite the balance weight.

The axles are best made in EN8, (1 1/4in. dia., which is that bit stronger than mild steel, but is quite easily machineable. The keyways, as drawn, are laid out for the left-hand crank leading; they are best machined while being held in a dividing head on the centre-line of the milling machine, relying on the index system to strike a precise 90deg. between the two pairs. You may wish to consider leaving a short extra spigot on the embryo axles for chucking purposes. Before finishing the mating surfaces, determine what diameter they should be with reference to the wheel bores, to give a very light press fit, secured finally by means of a grub screw; the ideal value can be arrived at by making a short dummy piece as trial gauge and then working to it as an example.

Fly cranks are another set of castings; interestingly, the foundry requested duplicate patterns to enable them to cut the cost of casting four at a time in the one box. Machining is required only on the flat faces and bores, but the two substantial locking screws also reflect my experience with less sturdy ones working loose over time. Try and get the bores the same as those of the wheels, so that gentle press fitting can be achieved.

The best way to get the centre distance correct for the crankpins in the fly cranks is to set them up on a toolmaker's button; here is how: turn up a 1/2in. length of steel to be a good fit in the 1.125in. dia. hole in the crank and drill a 3/8in. dia. clearance hole through its axis; chamfer both of the ends to aid fitting. Bolt the button firmly to the faceplate at the required radius of 1.625 inches. This can be checked by touching against a dial gauge held at centre height as the button passes in the horizontal position nearer the operator; winding the cross-slide forward by 3.250in. should enable the same dial gauge reading to be witnessed as the faceplate assembly is rotated by 180 degrees. As each crank is clamped to the faceplate over the button and aligned so that its small end is symmetrical about the centre-line of the spindle, each crankpin hole will have exactly the same throw.

It remains only to slot the keyways, and here again, circumferential accuracy is paramount. I use a home-made slotter in the Myford, although many methods are possible. With a dummy 5/8in. dia. crankpin in its hole, set the axle hole in the crank to run true in the 4-jaw chuck; arrange a prop beneath the crankpin, precisely 5/16in. short of the lathe centre height. The centre of the crankpin is now precisely at lathe centre height and, provided the slotter is also at centre height, the keyway cut will be truly in line with the hole centres. This is an important item in getting the motion lined up properly.

Crankpins can best be made from 5/8in. dia. silver-steel since, although this material is centreless ground and therefore not truly circular, any error will be very small and the good finish completely acceptable. Loose ends on the crankpins should be fitted with the strongest Loctite available on their screws. The crankpins may be finally retained by means of flush grub screws from the backs of the cranks.

The eccentrics are a straightforward job from 2 1/2in. dia. bar. External grub screws make it easy to set the valves. I have deliberately reduced the stroke of the pump eccentric to avoid the usual diabolical problem of over-feeding by this inefficient means.

Side rods

I am dealing with the coupling and connecting rods now, since they easily fit the drawing space. The original makers' idea behind the design was that rods could be stripped anywhere, without sophisticated equipment; hence the split bearing design which Mark really sorted out from original information; he even produced photographic evidence from Australia to clinch the matter.

We can supply laser-cut profiles for the rods if required and this reduces the iron fighting part of the job to reasonable proportions. Getting an economical price depends upon a number of sets being needed, so don't expect an immediate response on these four items. Study the design and you will see that they are handed to allow the brasses to be placed from the outside surfaces, with the taper wedges always at the front ends. The front and rear assemblies of the coupling rods are identical, not mirror imaged.

The most important dimensions are the centre distances of the rod ends, set to match precisely those already laid down in the frames. Get them right and things will fit; get them wrong and you will be in for some fiddly and avoidable shimming! In the laser cutting operation we are having to leave an allowance for finishing, but all you will need is some final persuasion with a small end-mill to take this out. It remains to drill and tap the various holes and to reduce the thickness of the main lengths of the bars by 3/32in. per side, as shown on the drawing. I have successfully done this job by clamping each end of the rod to an angle plate (one at each end of the table), with a sturdy packing the full length of the rod between rod and angle plate, to take the lateral milling thrust. Since we are starting with metric plate, in order to allow the ends to finish up 0.500in. thick, it is necessary to cut the blanks from 14mm. plate, so there is 0.025in. per side to come off over the end sections. All this is far easier than machining from solid bar!

We shall have to leave the bearing brasses until the next instalment, as I was not happy with the appearance of their drawing at the same scale as the other items in this section.

● *To be continued.*

HOW HARMONIC IS YOUR MOTION?

Ted Wale

continues with his exposition and uncovers some surprises.

●*Part II continued from page 695 (M.E. 4223, 11 June 2004)*

Spreadsheet

The steps taken to prepare the spreadsheet shown in **Table 1**, which covers 0 to 180 degrees of crankshaft rotation, were as follows:

1: Rotation of the crankshaft was listed in convenient increments of 10 degrees.
2: Sines of the angles chosen (step 1) were calculated and listed.
3: Cosines of the angles chosen (step 1) were calculated and listed.

This completed the Yoke arithmetic.

4: Sines of the conrod angles were calculated and listed using the selected conrod length (in this case = 2) and the figures derived from step 2 above.
5: Cosines of the conrod angles were calculated and listed.
6: The effective horizontal conrod lengths were calculated from step 5 above and the actual conrod lengths obtained (in the same units used to make the crank radius equal 1).
7: The figures resulting from step 6 above were deducted from the actual conrod length to provide a list of figures indicating the length lost per degree of crankshaft rotation.
8: The results listed from steps 7 and 3 were combined by addition to give a list of the positions of the piston in the conrod engine.

This completed the Conrod arithmetic.

It isn't necessary to do all this calculation, the spreadsheet does it for us, but an understanding is necessary. Those interested in gaining some familiarity with the calculations may wish to work though a couple of the rows shown in the spreadsheet to get the feel of what is going on when using the arithmetical steps above.

The last two columns of Table 1 are plotted in **fig 8** which represents what happens during one half cycle from bottom dead centre (BDC) to top dead centre (TDC). The red line is the plot of the position of the piston for every 10deg. of crankshaft rotation from BDC to TDC for the Scotch Yoke engine. The green line is the equivalent for the Conrod engine. Just as was shown in fig 5 (see part I) the green line starts at the same place as the red line then lags behind the red line for the first half of the half cycle (i.e. from 0 to 90 degrees). In the second half (i.e. from 90 to 180deg.) it makes up the loss and is again coincident at 180deg. (as it must be; see note 7). It is clear that if the red line represents Simple Harmonic motion then the green line is displaced from that curve. The normal description of this effect is that the motion, or the curve representing the motion, is distorted. This does not mean that there is anything particularly wrong with it but only that it is different from the other, from the Simple Harmonic motion.

If the spreadsheet is extended to cover two complete cycles of the engines, the resultant curves look as in **fig 9** which is obviously that of fig 4 with the green Conrod curve added. Careful study of fig 9 reveals interesting features concerning the leading and lagging of the green curve. It starts coincident with the red curve, then half way down the first half cycle (i.e. at 90deg. crankshaft rotation) it is behind the red curve because the red curve is at zero while the green curve is still at a positive value (actually 0.27); from this point the green curve starts to make up this loss until at 180deg. it is back in coincidence with the red curve.

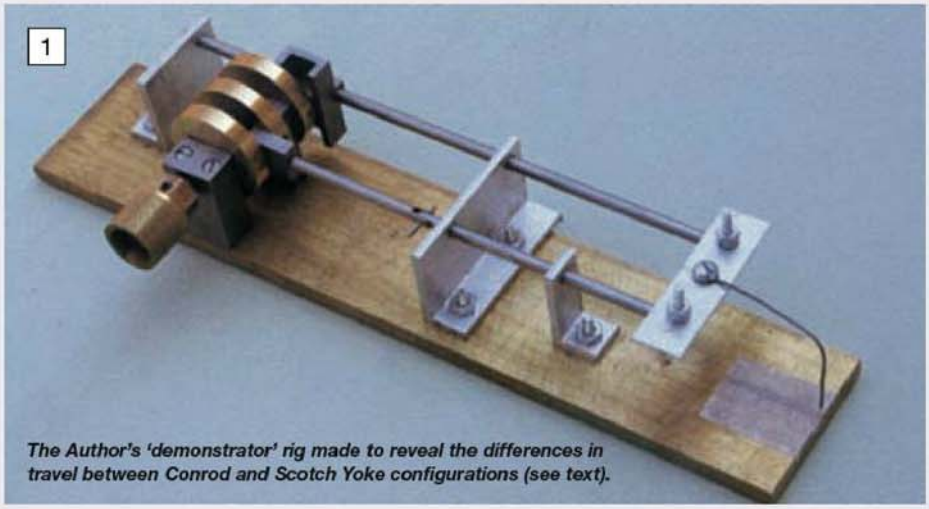
This exactly matches the practical presentation of the piston positions shown in fig 5. The curve is steeper here, the piston of the Conrod engine is moving faster than that of the Yoke engine. Of particular interest is that the Conrod piston continues to move faster than the Yoke piston until half way through the next half cycle. So, at 270deg. it is in advance of the Yoke piston, as it can be seen that the red curve is on zero while the green curve is at a positive number (actually 0.27 again). From there to 360deg. it slows down (it lags) so that at 360deg. it is again coincident with the red Yoke curve (see notes 4 and 5).

This leading and lagging, this faster and slower movement, continues for all succeeding cycles. Unlike the red Yoke curve the green Conrod curve is not symmetrical. Using the same simple test case (as for the Yoke curve in fig 4), the intervals along the zero line are not equal; the intervals for all other points are unequal too. The green curve is asymmetrical. This asymmetry is caused by the shortening and restoring of the effective connecting rod length as seen in fig 6 (see note 6).

In **fig 10** the difference between the two curves, the blue line, is added to the graph. The characteristics of this blue curve introduce another surprise. First it is of course the graph of the figures in column 7. Secondly it moves at twice the frequency of the red and green curves. This is because the green curve departs from and returns to the red curve each half cycle so it does it twice every full cycle. Thirdly it is surprisingly large, being more than 25% of the amplitude of the Yoke curve. This is not immediately obvious from fig 8 but is seen to be true when the *vertical* distance

TABLE 1

Crank angle (degrees)	Sine of crank angle (units)	Cosine of crank angle (units)	Sine of con rod angle (units)	Cosine of con rod angle (units)	Effective con rod length (units)	Piston travel difference (units)	Piston travel of scotch yoke (yoke)	Piston travel of con rod (con rod)
0	0.00	1.00	0.00	1.00	2.00	0.00	1.00	1.00
10	0.17	0.98	0.09	1.00	1.99	0.01	0.98	0.99
20	0.34	0.94	0.17	0.99	1.97	0.03	0.94	0.97
30	0.50	0.87	0.25	0.97	1.94	0.06	0.87	0.93
40	0.64	0.77	0.32	0.95	1.89	0.11	0.77	0.87
50	0.77	0.64	0.38	0.92	1.85	0.15	0.64	0.80
60	0.87	0.50	0.43	0.90	1.80	0.20	0.50	0.70
70	0.94	0.34	0.47	0.88	1.77	0.23	0.34	0.58
80	0.98	0.17	0.49	0.87	1.74	0.26	0.17	0.43
90	1.00	0.00	0.50	0.87	1.73	0.27	0.00	0.27
100	0.98	(0.17)	0.49	0.87	1.74	0.26	(0.17)	0.09
110	0.94	(0.34)	0.47	0.88	1.77	0.23	(0.34)	(0.11)
120	0.87	(0.50)	0.43	0.90	1.80	0.20	(0.50)	(0.30)
130	0.77	(0.64)	0.38	0.92	1.85	0.15	(0.64)	(0.49)
140	0.64	(0.77)	0.32	0.95	1.89	0.11	(0.77)	(0.66)
150	0.50	(0.87)	0.25	0.97	1.94	0.06	(0.87)	(0.80)
160	0.34	(0.94)	0.17	0.99	1.97	0.03	(0.94)	(0.91)
170	0.17	(0.98)	0.09	1.00	1.99	0.01	(0.98)	(0.98)
180	0.00	(1.00)	0.00	1.00	2.00	0.00	(1.00)	(1.00)



The Author's 'demonstrator' rig made to reveal the differences in travel between Conrod and Scotch Yoke configurations (see text).

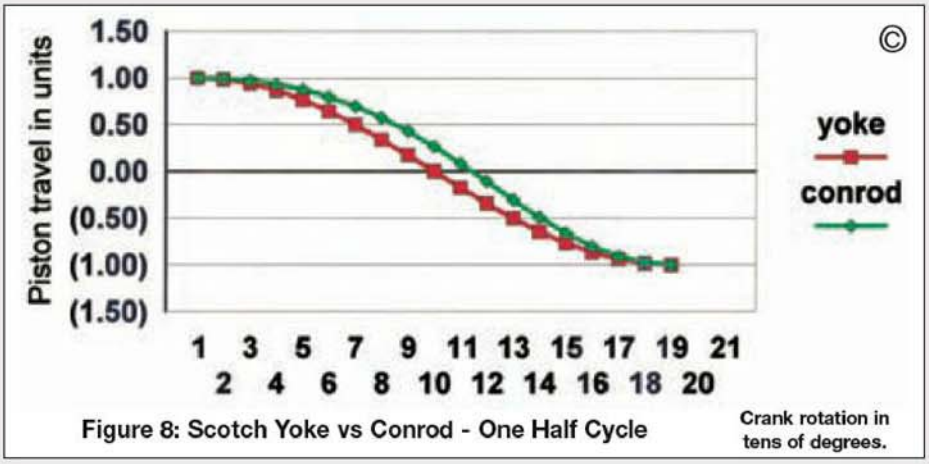


Figure 8: Scotch Yoke vs Conrod - One Half Cycle

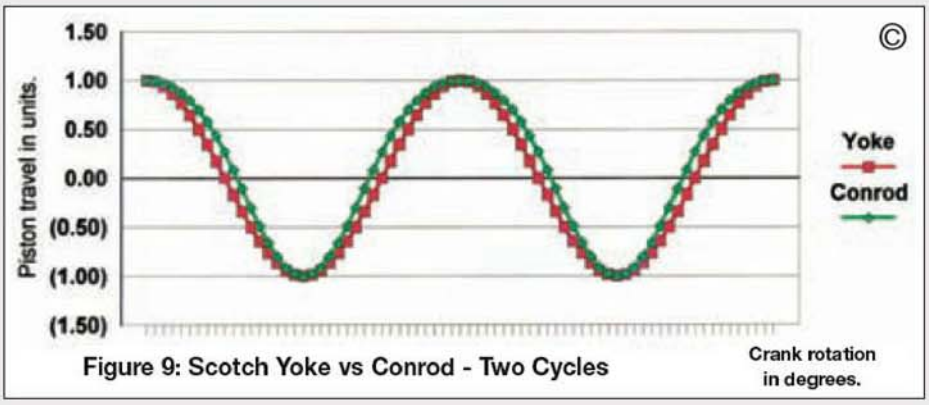


Figure 9: Scotch Yoke vs Conrod - Two Cycles

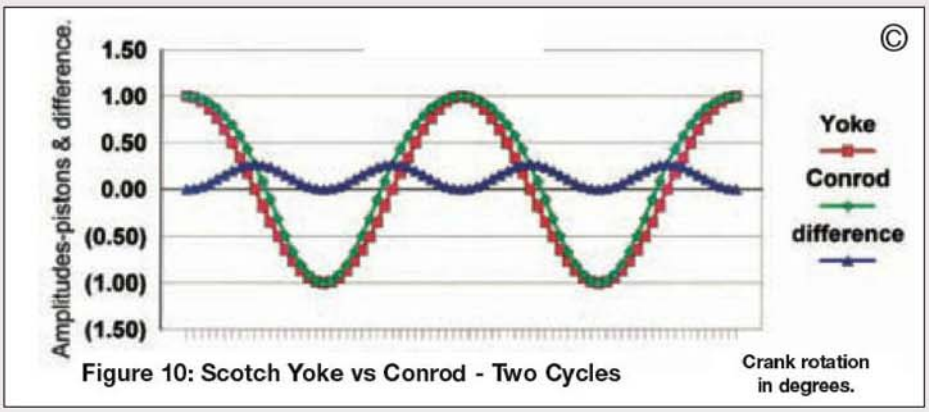


Figure 10: Scotch Yoke vs Conrod - Two Cycles

between the two curves is observed (see note 6).

This blue curve is known as the second harmonic of the fundamental frequency because it is twice the frequency of the red and green curves. This second harmonic is very real, it is not just a nice curve on a piece of paper produced by deducting one set of figures from another. It happens right inside every Conrod engine, is the cause of most of the noise and vibration in an IC engine and is clearly present in a slower revving steam engine. Over the early years designers worked hard to reduce and/or eliminate it, when in fact it is impossible to do so since it is fundamental to the basic design. In the later days the effort has been properly spent on trying to prevent this second harmonic from appearing at the engine mounts from inside the engine.

This is moving into a new field, the field of balancing which won't be touched upon here, except to say that static balancing of the moving parts helped a lot, but it was not until the science of dynamic balancing was understood that real progress was made. Only then were the very high-revving engines of the modern Formula 1 racing cars made possible. In the early days of IC engines it was found that the straight six was the best configuration for the reduction of second harmonic transmitted to the mounts. What was not known was why this configuration had this effect. However, this is the reason why, as soon as engines increased in power, the in-line aero engines were all straight sixes or Vee twelves (which are double sixes) or even 24-cylinder machines with four rows of six cylinders.

Demonstrator

For the club talk I made a little demonstration piece as shown in **photo 1**. Side by side on the same crankshaft with the same throw are the two engine configurations used here. The connecting rod is much longer than the 2 units used above; this is more in line with steam practice. The piston positions are assumed to be at the ends of the two piston rods. As the crank is turned the two rods move together *but not quite*. A hinged bar between the two rods carries a pointer which moves over a piece of masking tape marked with lines. As the crank is turned, the pointer is on one line at TDC and BDC but moves over to the other line at the mid-points so indicating the lead and lag of the conrod piston rod movement.

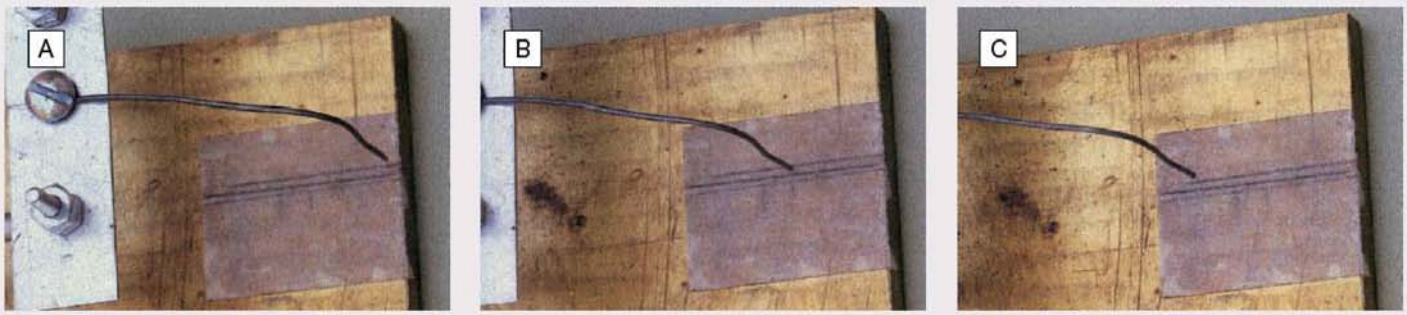
At the club we are all looking forward to our Talks Officer going into the business of balancing, both static and, more particularly, dynamic.

Notes in text

5: The words 'leading' and 'lagging' are used to describe the relative speed of movement of the positions of the pistons and not the positions themselves. Although green can be said to lag, green never falls behind red positionally.

6: At first glance the eye notes the smaller horizontal difference in the positions of the two curves and the impression is obtained that the difference between the curves is small (say only a few percent). It is only when the vertical difference between the same angular points on the two curves is noted that the difference is seen to be large (over 25%).

7: In fig 5, lower view, at 0deg. and at 180deg of crankshaft rotation it is clear that the effective length and the actual length are exactly the same at these points because there is no vertical displacement. The connecting rod is directly in line with the crankshaft centre; there is no difference between the Yoke and Conrod engines at these two special points.



Difference of movement between Scotch Yoke and Conrod — A: Crank at 0 degrees; B: Crank at 90 degrees; C: Crank at 180 degrees. (see text).

RESTORATION PROJECT: A PRECISION CYLINDRICAL GRINDER

Neil Read
rather reluctantly, tells us a little about his latest restoration project.

For some time now, Mike, our Editor, has been pressing me for an article on my latest restoration project and, perhaps to my shame, I have procrastinated. Please do not run away with the idea that I am usually so cavalier about the wishes of our esteemed Editor or, indeed loath to write about the work I have done. It is just that, in this instance, I had come to the conclusion that no one would be interested. This is because the current object of my affections is a precision cylindrical grinding machine and, of all the processes in the armoury of the modern production engineer, it could be argued that the one of least interest to the average model engineer is precision cylindrical grinding. However, my arguments were scuppered to some extent by the recent readership survey, which suggested that more articles on workshop methods would be welcomed by the majority of readers. I bowed to editorial (and readers') will and started typing. No doubt some of you will let us know through *Post Bag* whether or not the results are worthwhile.

Photograph 1 shows the machine in question. It is a Jones and Shipman Fig. 520A (*sic*) Bench Precision Grinding Machine for cylindrical and internal grinding. In view of what has been written above, the curious reader my well ask: *"Why did you buy and rebuild it?"* Well, despite what I said about the process being of little interest to the majority of model or amateur engineers, you do not have to stray very far into the world of full size engineering before coming across the precision grinding process in one of its many forms. Indeed, without the precision grinding machine, it is impossible to imagine how the modern world could exist. One only has to look at items like the components that make up the typical internal combustion engine to see the influence the process has on our lives. How easily we take for granted the availability of high precision, reasonably priced bearings and other finely made components. Certainly in my restoration work on early motor cycles I had often felt the need for a small grinding machine to deal with hardened items such as gudgeon pins, big-end bearings and the like, which have to be made, since stocks no longer exist.

The Author's Jones and Shipman Fig. 520A Bench Precision Grinding Machine viewed through the workshop door.

I also have a more personal reason for an interest in the grinding process. Looking back over my career, perhaps 70 to 80% of the project work undertaken has involved grinding machines of one sort or another. These ranged from simple tool room machines, bigger brothers of the one I now own, to large, fully automatic production grinders weighing many tons. Therefore, for me, owning a grinding machine is no different to an engine driver wanting a locomotive of his own! Although in the past I have often cursed the process as a product of Bedlam it certainly has the ability to fascinate the curious (or masochistic).

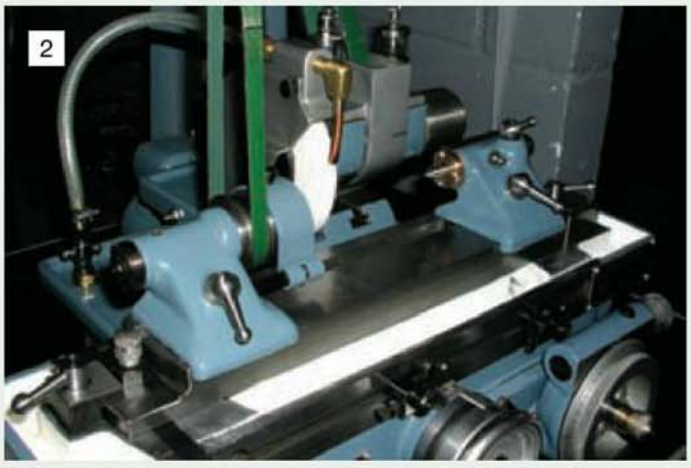
However, wanting a machine and getting one are two different things. What presently passes as a small machine in industry, such as the very fine Myford MG12, would just about fill the typical 8ft. x 6ft. shed used by many amateurs, even if it could be got through the door. Nevertheless, really small grinding machines have been built in the past by companies like Tripet in Switzerland, Overbeck in Germany and Jones and Shipman here in the UK. I deliberately use the past tense, as such machines are not made any more. I believe they were built for the electro-mechanical instrument industries which grew up just prior to World War II and have long since been displaced by solid state electronics with the inevitable result that the need for such machines in industry has evaporated.

Machine details

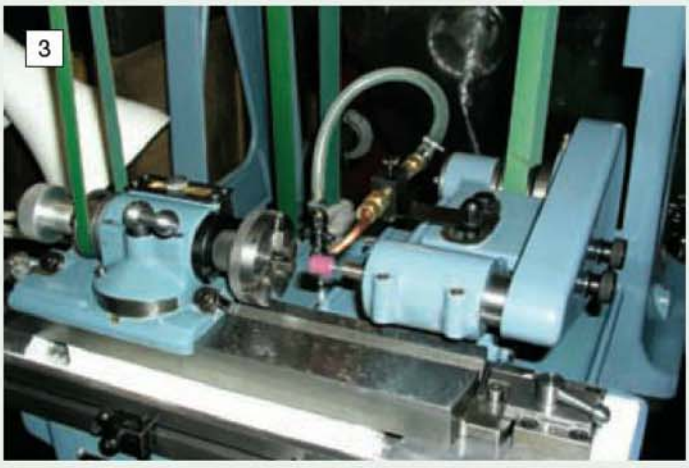
Having set the scene let us move on to see how my grinder is screwed together. It can really be considered as comprising three main sub-assemblies:

1: the grinding machine itself,
2: the countershaft assembly,
3: the base.

The machine itself is really quite small and measures up at approximately 20in. long and 20in. wide. The working surface of the table is



The machine set up for dead centre external grinding. The stout front guard has been removed for this photo but is always in place during grinding.



Here the machine has been converted into an internal grinder using a live spindle work head and bore grinding spindle.

The external grinding wheel undergoing dressing using a diamond mounted in a rigid bracket clamped to the machine's table.

Work table angles can be set directly using a slip stack nipped between a fixed plate (reversible) and a pin attached to the top swivel table.

13 1/4 x 2 3/4in. and the maximum distance between centres is 5 1/4 inch. The centre height is 1 1/2 inch. The external grinding wheel size quoted for the machine is 5 x 3/8 x 1in. bore. This is no longer a standard size so I had to have a batch of wheels made to order. This is not a cheap option but, unless something unusual crops up, I doubt if I shall have to buy another external grinding wheel ever again. For grinding shafts the usual arrangement is to mount the work between dead centres and drive it via a carrier just like turning between centres on the lathe (**photo 2**). Grinding off a live spindle is possible as I have the live spindle work head and this is necessary for grinding items like the points of centres that cannot be easily mounted between centres. The main grinding spindle runs in plain phosphor bronze bearings fitted with spring loaded pads to prevent the development of spindle flutter. Lubrication is via drip feeds.

For internal grinding the external grinding wheel head is removed and an internal grinding wheel head assembly substituted. This comprises an additional countershaft and a spindle with spring loaded angular contact bearings. The live spindle work head is necessary for internal grinding and this can be fitted with a small chuck if required (**photo 3**). The grinding spindle has an integral collet bored for 3mm and this takes mounted grinding points with shanks of that size.

Readers who have a Quorn or similar tool and cutter grinder will know that successful grinding requires a clean, sharp wheel of the correct type. This is also true of cylindrical grinding but here the wheel dressing process cannot be done freehand. The dressing diamond is rigidly held in a purpose made bracket (**photo 4**) and traversed past the wheel using the main table axis. This ensures that the wheel is always running as truly as possible and the diamond in-feed can be adjusted using the normal feed arrangements.

The table is traversed using a hand wheel driving a pinion that engages a rack mounted on the underside of the table. The pinion drive is via a gearbox, which gives a silky feel to the movement. The feed screw moves the slide under the grinding wheel head backwards and forwards and the drive is arranged through a gearbox such that advancing the hand wheel through one of the widely spaced divisions on the index collar removes 0.0001in. from the work. It is therefore relatively easy to grind work to tolerances of a few hundredths of a thousandth of an inch — provided you have a reliable means to measure it.

One pleasing feature of the machine is that the swivelling top table is arranged as an 8in. sine bar so that angles can be set directly with a slip stack (**photo 5**). Tests indicate that it is not far out and it certainly makes life easier than the 'cut and try' methods usually found on machine tools

The countershaft assembly (**photo 6**) sits over the grinding machine and, in comparison with the latter, is a massive affair. The whole assembly is mounted on cast iron legs and the shaft bearings are mounted in cast iron side plates bolted to the top of the legs. All shafts are mounted in self aligning ball races. A motor in the base drives the main input shaft via a long (over 12ft), 1in. wide flat belt. From this shaft the drive is taken forward by way of V-pulleys to the grinding wheel drive shaft and the work head drive shaft. The grinding wheel drive shaft sits in the middle of the assembly (driven from the right hand end as seen from the front) and offers three speeds so that the speed can be increased as the grinding wheel wears. Drive to the grinding wheel spindle is via a further flat belt which in this case is 3/4in. wide.

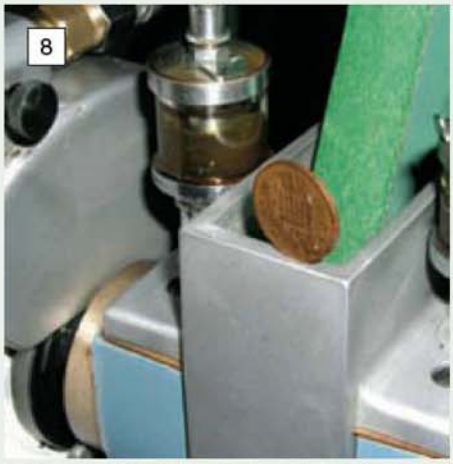
The work head drive shaft is nearest the operator and is driven from the left hand end as seen from the front. It provides speeds of 1,250, 686 and 375rpm to cater for different work diameters. Drive to the work head, which of course moves to and fro during grinding, is via a long drum that allows the flat belt (3/8in. wide) to traverse with the table movement. A clutch is included to permit the work head to be stopped for work changing or measurement purposes (**photo 7**). It is considered bad practice to stop a grinding wheel spindle that has warmed up and attained working temperature for work changing operations unless safety considerations dictate otherwise.

The grinding wheel spindle and work head drive belts are both tensioned by jockey pulleys to maintain drive while the various machine axes are moved about during grinding. All the shafts and pulleys are adequately guarded but the drive belts are exposed. Even so only the work head drive belt is near to the operator and this is relatively slow moving and no more of a risk than the drive belt used on a lathe overhead drive.

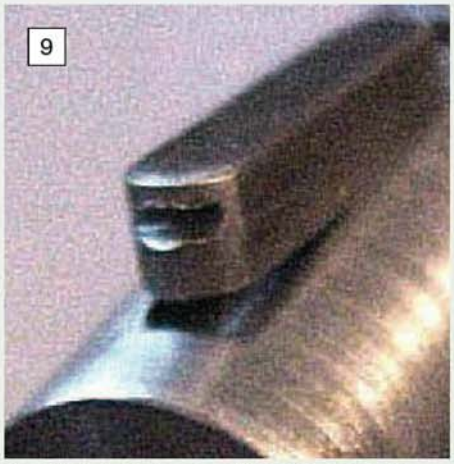
The base is laid out along the lines of an old fashioned writing desk with two pedestals and a kneehole. The drive motor sits in the kneehole on an adjustable platform. The left hand pedestal houses the coolant equipment while that on the right is a cupboard for tools. Two drawers are also provided for storage purposes. It is made from oak faced block board and is heavy, strong ▶

The countershaft assembly as viewed from below. Each shaft is mounted in self aligning ball races.

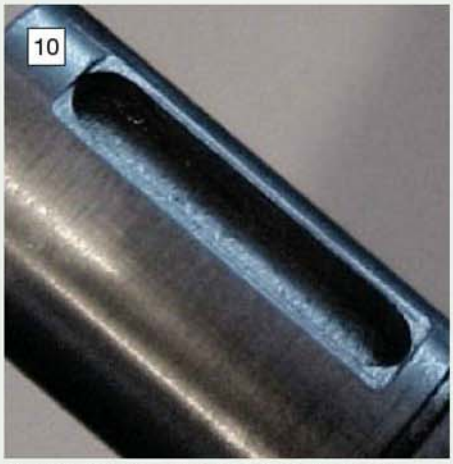
Another view of the countershaft showing the work head driving drum and tensioning pulleys. The clutch can be seen to the right of the photo.



This photo was taken with the spindle running following careful balancing of the grinding wheel.



Good fitting practice: each key was notched to facilitate removal.



The keyways in each of the shafts had been carefully filed up to remove burrs.

and rigid. The size is 36in. high x 44in. wide x 28in. deep. The machine looks quaint to modern eyes as we have become used to seeing integral drive motors and enclosed belts. However, from a grinding point of view, the design is sensible.

During my career I have been in contact with several development grinding machines designed to explore concepts like the dynamic stability of the work piece during grinding and the effects of forced vibrations on the grinding process. All of these machines had their drive motors placed as far away from the grinding area as possible to avoid the heat and vibration from them upsetting the results. By burying the drive motor low down in a wooden base Jones and Shipman achieved a similar result and, with a correctly balanced grinding wheel, the machine runs smoothly and with barely a tremor **(photo 8)**.

Rebuild

I had not originally planned to do much to the machine as, despite being fifty or sixty years old, it was in surprisingly good condition. It was perhaps extra surprising as the machine had been used until quite recently in production and such machines are not usually 'nursed'. During my preliminary examination of the machine, I got the impression that it had perhaps been rebuilt at least once before in its long life, but it is difficult to be sure. What finally convinced me that an overhaul was necessary was the discovery of a large and probably very old crack in one of the countershaft support legs. I thought this may need complex heat treatment after welding to avoid problems with stress cracks but my local expert used a ductile filler rod that avoided all such complications. After cleaning up and repainting no-one would know the repair was there.

The machine was a pleasure to work on as it had been put together by fitters who knew their job. Little things like the way the keys had been notched to facilitate extraction **(photo 9)**, the careful deburring of the keyways **(photo 10)** and the stamping of mating parts helped enormously. The only replacement on the countershaft assembly was the work head clutch actuation collar. The replacement was turned from EN24 steel and heat-treated to 50 to 55 Rockwell C by a local heat treatment firm.

Probably as a result of it standing on damp floors, some delamination of the block board used in the base was starting to occur. This was given what the antique furniture trade might term sympathetic restoration, and carefully levelled. A new one horse power motor was fitted and the base rewired for single phase supply complete with remote controlled starters connected to the front mounted control panel as originally used. The countershaft assembly was then reunited with the base and attention turned to the grinding machine itself.

The main concern here was the condition of the grinding wheel head and live work head spindles. These were made of nitralloy steel and nitrided so that the surfaces were very hard. However some wear was evident and after considerable debate it was decided to have them repaired by hard chrome plating. So far this has proved to be a satisfactory repair. All parts were carefully stripped, cleaned and repainted before assembly. New belts were obtained from Griffiths Engineering **(www.lathes.co.uk)** who also supplied (on loan) the heat press to join them up. Jones and Shipman were very helpful with advice about the specification and colour scheme

Grinding process

It is probably true to say that, despite the use of other types of grit and bonds in certain specialised industries, most grinding is still done using aluminium oxide grit in a vitrified bond. This is probably because steel is still one of the main structural materials and this type of grinding wheel suits it well. Consider **fig 1** for a few moments. In a typical grinding wheel the grits are not packed in shoulder to shoulder as might be expected, but have a finite layer of bond and even air gaps between them. Each grit of aluminium oxide acts as a cutting tool and research has shown that chips are produced during grinding.

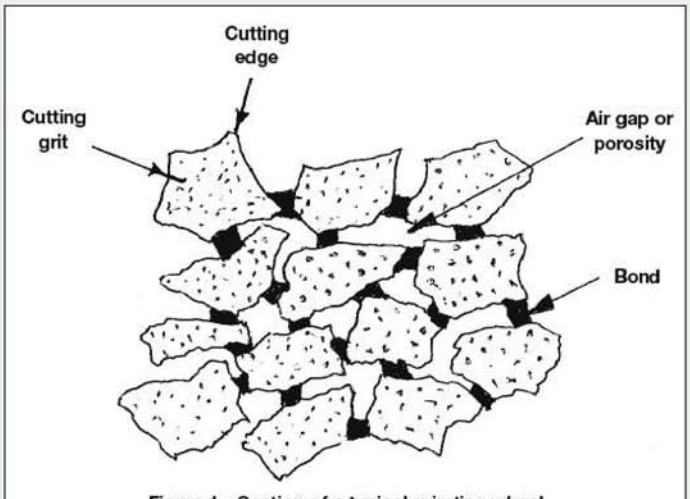


Figure 1 - Section of a typical grinding wheel showing the structure

You may well say that you do not think much to the rake angles on the 'tools' and that they are like something from the Stone Age. Well, of course, you are right and that is why grinding tends to generate a good deal of heat and why the use of a coolant is desirable to avoid metallurgical damage to the work piece. The gaps between the grits allow coolant access and space for the chips, thus promoting more efficient grinding.

The term 'vitrified bond' just means that the grits are held together using what amounts to fused glass. Now, you know what happens if you drop that prized cut glass vase that was a wedding present from your great aunt — it cracks or breaks. For this reason, grinding wheels should be treated with care. If a cracked grinding wheel is used and breaks in service the resultant high speed debris will most likely kill you. I am not being alarmist here and you ignore this warning at your peril.

Take extra care if you choose to buy secondhand grinding wheels. They may be okay but please make sure that they are properly identified and that you test the wheel thoroughly before mounting. This can be done by tapping with a light non-metallic object like a hammer shaft or screwdriver handle. You should hear a clear ringing note. If the note is dull assume the worst and discard the wheel. This procedure goes for new grinding wheels too — never assume that a wheel is safe just because it is new, but satisfy yourself that it is safe to mount. Never stand in line with a grinding wheel when starting it for the first time, just in case it breaks.

So far as identification is concerned, grinding wheels are given a code by the makers and are also marked with their safe maximum cutting speed. The code is universal across most of the industrialised world but makers do put in their own prefixes and suffixes. The important part is usually the bit in the middle and may look something like A60K6V. The letter A signifies that the wheel uses aluminium oxide grit. The 60 gives us a measure of the grit size. Grit is graded using meshes of different spacing and the figure 60 relates to this. A medium wheel will have 46 to 120 grit, a fine wheel 150 grit or above and a coarse

The balancing weights fitted to the external grinding wheel mounting hub.

The J& S knife edge balancing unit seen with a grinding wheel mounted on the test mandrel.

wheel 10 to 36 grit. Sometimes an additional digit is used (e.g. 602) and this indicates a mixture of grits — in this case 60 and 62.

The next letter indicates the grade of the wheel and is a measure of its hardness or ability to break down during cutting. A 'K' wheel is of medium hardness. Softer wheels will have a letter from earlier in the alphabet whereas harder ones will use a later letter. Z is therefore very 'hard' while E is 'soft'. The next digit denotes structure and is concerned with those voids in the structure mentioned at the beginning of this section. The figure '6' is for a regular structure. Lower numbers are used for very close, dense wheels while very open wheels may be numbered '15' or above.

The final letter V just tells us that we have a vitrified bond. All this sounds complicated but it is not really. In any case, the code quoted above will cover most of the grinding applications you are likely to meet on hardened steel. Discard, or better, do not buy any grinding wheel which cannot be identified.

External grinding wheels are usually mounted between steel flanges. Compressible washers (paper or plastic) should always be used to cushion the clamping pressure and spread the load. Failure to use these might crack the wheel. Never over tighten the flanges, just apply enough pressure to clamp the wheel firmly. Over doing the clamping may crack the wheel. Commercial set ups often quote a maximum torque figure and the clamping is done with a torque wrench. When mounting the grinding wheel make sure that the flanges are of a sensible size and free from burrs or other damage.

Although modern grinding wheels are carefully made and are of a remarkably uniform structure, they still require balancing before being used for precision applications. On tool room machines this is usually done by providing the wheel flanges with movable weights (**photo 11**). The balancing procedure involves mounting the wheel and flange assembly on a balancing mandrel and resting the latter on two carefully levelled knife edges. The wheel is first rough-dressed to true it up with the weights removed from the flange. We then need to find the heaviest spot on the wheel. This is done by resting the mandrel carefully on the knife edges and allowing it to roll until it come to rest (**photo 12**). The heaviest point will be at the bottom. This point is marked and the weights placed such that there is one at 90deg. each side of the mark. The weights can then be carefully moved away from the mark until perfect static balance is achieved. Note that a grinding wheel may need re-balancing as it is worn or dressed away in use.

A grinding wheel should always be run at the speed recommended by the makers. Exceeding the safe working speed may cause the wheel to break up with devastating results. You can make a hard wheel think it is softer by running it at a slower rotational speed. Those of you who have tried running a mounted grinding point in an electric pistol drill will know that most such drills are hopelessly slow for this task and, as a consequence, the grinding wheel disappears quicker than the workpiece. Conversely a soft wheel will cut 'harder' the faster it is run but please remember and observe the makers' maximum recommended speed.

After all the above preliminaries the actual grinding process is relatively simple. You just need to bring the grinding wheel very gently up to the work and 'touch on'. It is then just a case of applying a cut and traversing the table until size is reached. On no account force the process; 0.001in. cuts are plenty large enough for roughing and finishing calls for much lower infeed rates. As size is approached allow the grinding wheel to traverse the work without additional infeed. This procedure is termed 'spark out' and allows all the deflections in the work and machine due to the cutting forces to restore themselves. It is this factor which sets grinding apart from other metal cutting processes as the stock removal per pass can be barely measurable whereas a turning tool, for example, would just rub. To be effective the process needs a stable machine and this is usually accomplished by making the structure as heavy as reasonably possible. The net weight of my little Fig. 520 grinder is 750 pounds. Compare that to a typical lathe of similar capacity.

Well, that completes our tour of my little grinding machine. I hope those of you who like workshop articles have found it interesting and that those who hate this sort of thing have not been bored too much. As was mentioned earlier in this article, modern life owes much to the grinding process. In my own small way perhaps I can keep some of the skills and techniques alive and, more importantly, finish some of the jobs that have been waiting patiently for just such a process since time immemorial!

LETTERS TO A GRANDSON

M. J. H. Ellis

completes the construction of his flap valve injector with details of the flap valve itself, and concludes with notes on re-starting devices.

●*Part LXV continued from page 699 (M.E. 4223, 11 June 2004)*

Dear Adrian, I had scarcely sealed up my last letter when I realised that I had not finished the injector story at all, as I had said nothing about the important component which gave it its name, that is to say, the flap-valve. It needs to be made from thin flexible material which is able to withstand the temperature of the steam, and ordinary rubber and plastics are not very suitable.

The author of the original article mentioned 'silicone rubber' but I don't think he made any suggestions as to where a suitable material could be found. I have therefore tried various materials, of which the best I have discovered is that used for the diaphragms of the carburettors of Briggs and Stratton rotary lawn mowers, that is to say, the type with a vertical crank-shaft. I can quote you the part number of the diaphragm from which mine came; the box is printed '496416 Diaphragm Assy.', but a label '391681 Diaphragm Kit' has been stuck over it. I have given you the exact details, but I don't think that the particular type of diaphragm is important, and that all of them probably make use of the same material. The only snag is, that in this country these items cost around £5 ($9), although you can get several valves out of one diaphragm.

If I had not had a couple of them by me, which I had replaced with new ones in our mower, I would have tried the scrapyard first. This material is obviously resistant to petrol (gasoline), and so, too, would be the diaphragm of a petrol pump from a motor car engine, which abound in the scrapyard. In case you don't know, Briggs and Stratton do not, so far as I am aware, make mowers themselves, but their proprietary engines are widely used by mower manufacturers, just as 'J.A.P' (standing for 'J. A. Prestwich') engines were widely used in British motorcycles in the days when the industry still prospered in this country.

Although previously published, this photo of the Author's injector is also appropriate here.

This photograph shows the various items referred to by the Author during his description of the construction of his flap valve injector. A set of brass cones are also shown.

I have one final piece of advice about making the valve. Making a clean small hole for the screw is simple enough. Just cut out a piece of sheet material — brass or mild steel — about 1 1/4in. by a full 1/4in. wide, and drill a 10BA clearance hole close to one end. Now file the sides and end to put the hole in just the right place, and you can use it as a jig for making the valve by clamping the material between the jig and a piece of wood, holding the lot together by means of a strap and a couple of wood-screws. By this means, you can both drill a clear hole and, apart from the rounded end, trim the valve to shape with a sharp chisel. The rounded end you will have to trim with scissors.

Re-starting

I was forgetting that you asked me why a valve is required at all, in view of the fact that I did not mention it in my explanation of how the injector works. At that time I was trying to keep the explanation as simple as I could, but I can see that by now I should have dealt with the valve also. Sorry.

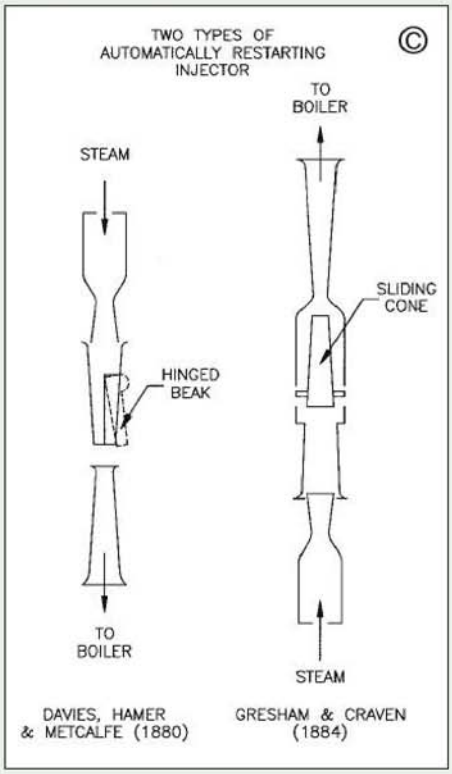
A simple injector without any relief valve is able to start provided that the water will flow into it of its own accord, usually, because the tank is higher up, and that the water is turned on before the steam. (This statement is true in general, but specialised injectors have been designed, capable of raising water from a lower level). If water is present in the injector when the steam is first admitted, it ensures that the steam is condensed, and thereby becomes part of the water-jet.

If there is no water there, or for any reason the supply is interrupted, the steam, not being tamed in this way, seeks to escape, which it can only do through the combining cone. But the outlet from the combining cone is smaller than the nozzle of the steam cone, and in the combining cone the pressure becomes greater than that of the atmosphere. There is now no hope of the injector ever re-starting, because the steam pressure now actually drives the water back and may even force its way as far as the water tank. The injector will only begin to operate once more if the steam is turned off, so allowing the water to flow again, and then turned back on.

In order for the injector to be capable of re-starting automatically, it is therefore necessary for one of two things to happen, either the steam is shut off for long enough for the water to start to flow again, or something happens to permit the rampaging steam to escape so freely that no positive pressure builds up within the combining cone. I dare say that nowadays, by means of some kind of electronic sensor and circuitry the first of these possibilities could be put into effect, but such complication is completely unnecessary, as much simpler mechanical alternatives have long been available.

Two principal methods are used in full size injectors, and both make use of the fact that during normal operation the pressure within the combining cone is below atmospheric, but during a period of 'knocking-off' it exceeds the pressure of the atmosphere. Logically, in fact, there is a parallel with what I told you regarding double-current telegraphy, where the direction of the current signalled either the marking or the spacing condition, whereas in the case of the injector negative or positive pressure signals either the 'operating' or 'knocked-off' state. To carry the analogy a step further, in telegraphy a polarised relay detected the direction of the current, whereas in the injector, some form of valve detects the direction of the pressure difference.

The first of these methods is to turn the combining cone itself into a valve, which is achieved by dividing the combining cone into two parts, one fixed, and the other hinged, so that it resembles the beak of a bird. As the cone is surrounded by a cavity which communicates freely with the overflow, its outside is effectively at atmospheric pressure. During, normal operation, the 'beak' accordingly remains closed, but as soon as the pressure inside the cone is raised by the steam running wild, it opens to provide the free outlet required.



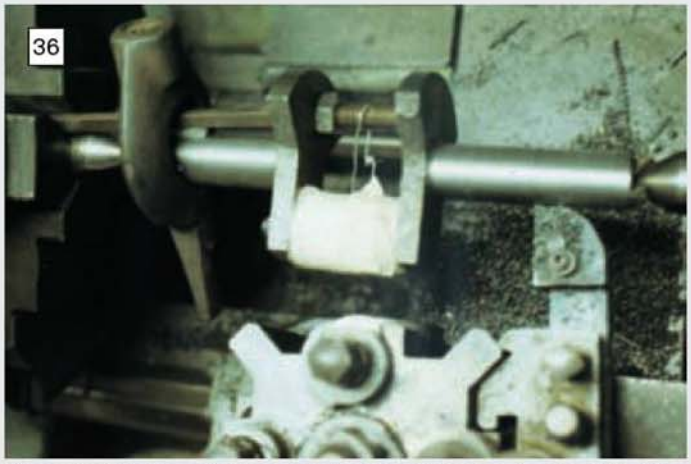
This arrangement is not practicable in the tiny scale of our miniature injectors, so the alternative method is used instead. The combining cone is divided into two parts by an annular gap which gives access to a valve. As with the 'beak' system, the valve is held closed during normal operation, but it opens to release the steam into the overflow if the injector knocks off. When the injector is working, there is no reason for the water to try to escape through the gap; on the contrary, air would like to get in, and in fact does so if the valve is not air-tight. The water-jet simply takes the gap in its stride as if it wasn't there. I have explained the operation of the relief-valve in perhaps laboured detail, but the reason is, that I found it myself more perplexing than the basic principle of the injector itself until I thought it out properly. I have just worked out that the cross-sectional area of the annular gap is eight times greater than that of the small end of the cone, so you can see why it is so effective.

The beak-style combining cone was devised in 1880 by Davies, Hamer & Metcalf. Mr. R. G. Brooke of Holden & Brooke Ltd. contributed the two-part cone plus relief valve, used in their *Sirius* injector. There were other variants of the same basic principle, for example, that employed by Gresham & Craven, in which the second part of the divided cone could move to-and-fro. No relief valve was needed, since the moving part of the cone carried a flange, which served the same purpose. Under starting conditions, the steam pressure drove the flange forward, opened the gap, and released the pressure. When water was drawn in and condensed the steam, atmospheric pressure pushed the flange back and closed the gap again. There have also been two-stage injectors, able to deliver feed-water at a higher pressure.

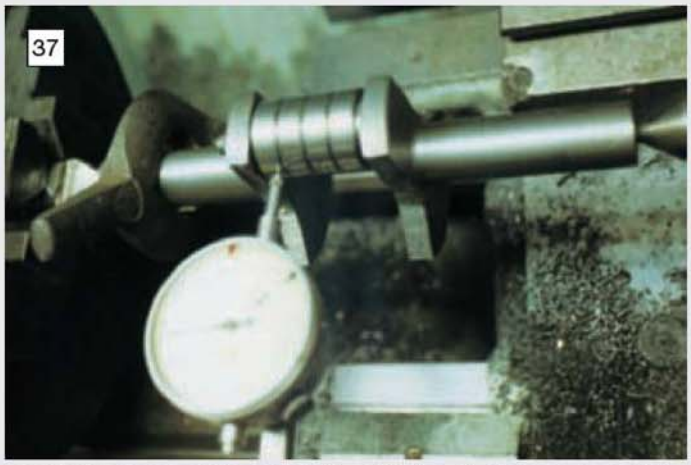
I think, however, that the palm for lateral thinking should be awarded to Alexander Morton of the Glasgow firm Morton & Thomson. He invented the Ejector Condenser by inverting the principle of the normal injector, and using a jet of cold water to draw in steam from the exhaust of an engine, thus avoiding the complication of the usual form of condenser and air-pump. You should go and do likewise.

Your affectionate Grandpa.

●*To be continued.*



The main shafts were finished after the big end bearings had been fitted to the crank pin to ensure concentricity. Note the tape to keep bearings clean.



Checking both ends of the mainshafts and both ends of the crank pin with a dti to ensure everything is in alignment.

FOWLER STEAM WAGON

Tony Webster

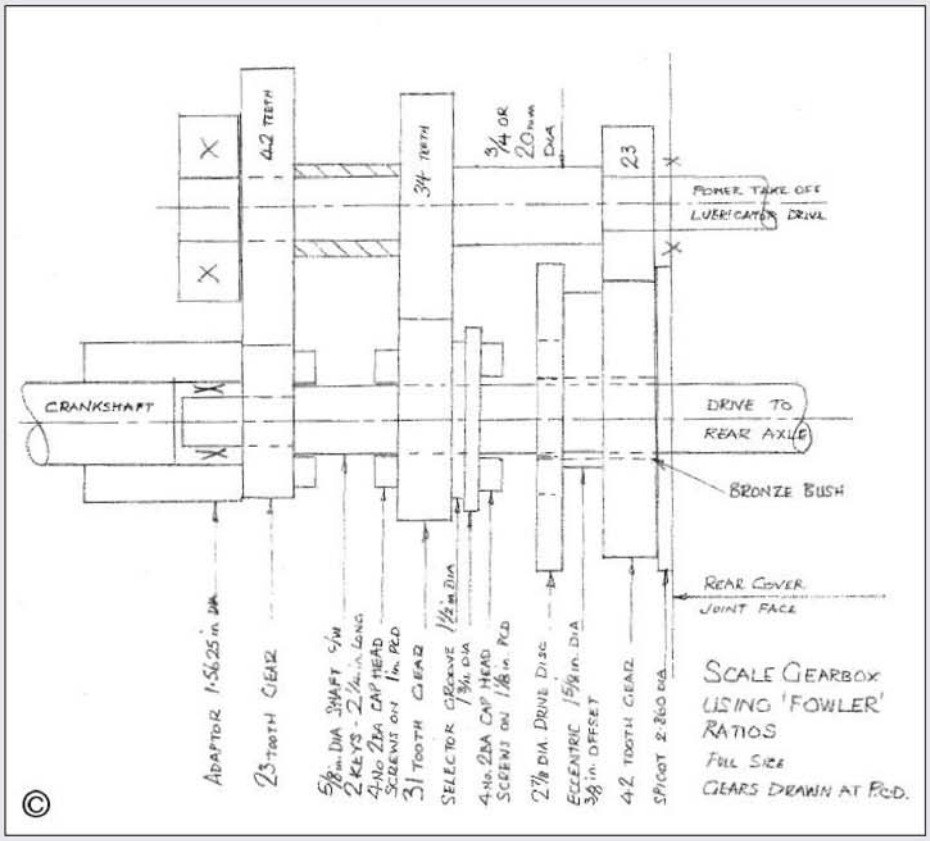
provides an alternative approach to building the gearbox and then begins assembly of the engine.

●*Part VII continued from page 687 (M.E. 4223, 11 June 2003)*

An alternative way of making the gearbox is to use purpose-made or standard gears such as lathe change gears. Two gears of 23 teeth, two of 42 teeth and one each of 31 and 34 teeth are required. This makes the gear cutting much easier. The original gears were of 4DP (diametral pitch), which at 1:4 scale results in a simple multiplication to give 16DP. All gears are 1/2in. wide.

If the gears are made for you, the crankshaft adaptor and the two 23 tooth gears should be made in one piece, 1.563 x 3.25in. long, bored and reamed 20mm diameter (assuming a 20mm dia. crankshaft bearing). The teeth should be cut to full depth for 1.375 inch. This end has 1/2in. parted off to form the low speed drive gear on the layshaft. The next 7/32in. is reduced to the root diameter and milled across the end to form four dog teeth.

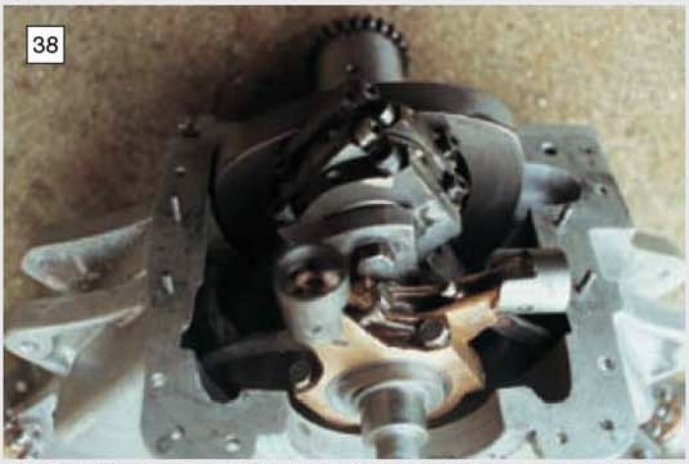
If standard commercial gears are employed, a 23 tooth gear is secured to the adaptor with four 2BA or M5 cap head screws. The screw heads on a 1in. pitch circle diameter will form the dog teeth. These dogs will mesh with similar dogs on the middle gear of 31 teeth. This gear has two keyways cut through the bore which slide on long keys in matching keyways on the output shaft. The drive from all three ratios is transmitted through this gear and its keys to the output shaft. This gear can be made in one piece, with its selector-fork groove and dogs, or have the turned groove screwed on with exposed cap head screws on a 1 1/8in. pitch circle diameter (these screws will be at 45deg. to the other four screws on the other side).



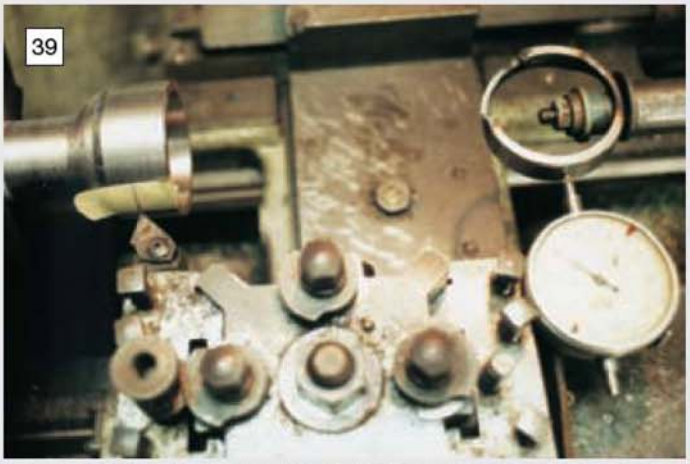
This second set of dogs mesh with four 3/8in. holes in the drive disc and eccentric. If assembly to standard gears is employed, three countersunk screws are used to secure it to the 42 tooth gear (the fourth screw would miss the eccentric and so is not used). Whichever origin of gear is used, the eccentric drive disc must be separate from the gear to enable assembly of the eccentric strap, which is not of the split type. The 42 tooth gear, eccentric and drive disc should all be mounted on a common bronze bush. If the adaptor and 23 tooth gear are made in one piece, the needle roller race for the spigot end of the output shaft should be situated in the gear, not the adaptor.

The layshaft should be made from 20mm dia. steel which could be reduced in size for the 34 and 42 tooth gears (with a spacer between) to a size common to the bearing. It goes without saying that all the gears and bearing seats should be concentric. The layshaft front bearing can be a 12mm/1/2in. up to 5/8in. inside dia. ball race. The rear bearing can be a 12mm ball or needle roller race. This latter bearing fits into a steel bearing housing which is shrunk or 'retained' in the rear cover of the gearbox. An extension to the rear end of the layshaft can be used to drive a cylinder lubricator pump or hydraulic pump on the tipper version of the Fowler wagon.

If this option is used, an oil seal should be fitted to the rear cover. The cylinder lubricator pump is mounted on the front right hand corner of the water belly tank. If the layshaft is extended to facilitate power take-off, a curved 'bite' is removed from the right hand side of the gearbox rear cover extension and torque tube socket to make room for the power take-off. This removes one of the six bolts in the flange. Gears, complete or teeth cut on your blanks together with the worm wheel are obtainable from L.S.M. in Derby (tel: 01332-830811). The gearbox gears are also obtainable from M.J. Engineering (tel: 01425-476234). ▶



The underside of the assembled crankshaft showing the eccentric straps/ rods and their pistons, big ends, joint studs, gear adaptor and first gear.



Setting up to turn the torque tube sphere; Tool set opposite the middle of sphere with dti set to middle (max.reading) of the outer ring of the ball race.

Engine

Assemble the two big end sleeves onto the front half of the crankshaft. Place the four needle roller races onto the sleeves and assemble the rear half crankshaft to the front. Set up the crankshaft between centres in the lathe and check with a dti in the tool-post that both ends are parallel (**photos 36** and **37**). Gently tighten the nut which pulls the two opposing tapers together. Check that all is still parallel. Fit the rear crankshaft race and the primary gearbox adaptor after fitting the flywheel.

Assemble the piston rod to the crosshead with a touch of your favourite anaerobic adhesive on the threads. The crosshead is fitted with an Oilite bush which runs on a hardened steel sleeve which in turn is secured with a 1/4in. dia. bolt trapping the sleeve in the fork of the connecting rod little end.

Rig up some means of supporting the crankcase upper half in an upside-down position on the assembly bench. Push the crossheads down the trunk guide bores, fit the crankshaft in position and offer up the front bearing housing complete with its ball race. Assemble the big ends around their bearings and fit the caps. Check that everything turns freely. You may need to remove some metal from the connecting rods or the trunk-guides. It is best to tackle them one at a time.

Having got it all to rotate freely and perhaps run it in the lathe, disassemble the big ends and remove the con-rods, crossheads, etc. You will be pleased to note that the con-rods, etc. can be assembled or removed without disturbing the crankshaft, even when the lower half of the crankcase is in position.

The two halves of the crankcase are bolted together by a series of 4BA bolts and nuts, not forgetting flat washers under both heads and nuts. There are also four studs, already mentioned, which are actually hexagon head set screws which have been screwed in from above.

Valve gear assembly

Rivet the link bar between the reversing guide levers on the guides. The bar is cranked and fits behind the LP and in front of the HP lever. With the crankcase halves separated, assemble the trunnions into their bushes in the front of the crankcase lower half. The right hand one is the long one which has a lever pinned to it on the outside. Keep this lever close to the engine as the front axle does not allow much clearance. Slide the rear bearings in their angle brackets onto the other trunnions and bolt the brackets to the crankcase. Check that the crankshaft is clear of these brackets. Remove metal from the brackets if and as necessary.

The eccentric is keyed to the crankshaft front half with the maximum throw of the eccentric exactly opposite the crankpin.

Assemble the pistons to the little end of the eccentric rods. The gudgeon pin is 3/16in. dia. silver-steel, hardened but not tempered. It is prevented from moving in the piston by means of a 6BA grub screw inside the piston, which bears in a small recess in the gudgeon pin. It will then oscillate in the gunmetal of the rod casting. The crankshaft can now be located in the lower half of the crankcase, feeding the pistons on the rods into their cylinders. Fit the front bearing housing (**photo 38**).

Check that everything rotates freely and then try moving the cylinders around on the trunnions. They have to tilt to nearly 45 degrees. Note any tight spots and remove metal accordingly.

The valve-operating rod is a piece of flat steel with a cylindrical end silver-soldered onto the lower end. The end is drilled and tapped 4BA for a set screw, which goes into a dimple in the pivot pin (3/16in. dia. silver-steel, hardened), which fits the middle hole in the eccentric rod. The top of the operating rod is forked and another 3/16in. dia. pivot pin connects it to a 5/16in. dia. rod, which passes through a bush in the casing. Before this can be assembled, the lower crankcase half has to be secured to the upper half. Check for full and free movement in the full forward and reverse valve gear positions.

The main connecting rods, complete with crossheads and piston rods, can now be added. Screw the valve spindles into the 5/16in. dia. valve spindle end, which emerge from the crankcase, not forgetting a steel lock nut. Fit both glands to the lower cylinder covers. Fit the cylinder lower covers to the trunk guide flanges with six 2BA or M5 bolts and check that the piston will have equal clearance at each end of the cylinder. If necessary re-machine the 60deg. angled shoulder on the piston rod, or in the piston. The piston has two holes for a special spanner to tighten the piston onto its rod.

On final assembly, spring the piston rings onto the pistons but, for trial assembly, make sure that the bare pistons slide freely in their cylinders. Fit the cylinders to the lower covers, followed by the upper covers.

Torque tube sphere

The front end of the torque-tube has a spherical joint with the rear of the gearbox. Making this sphere needs a detailed description. The sphere is complete with a short tubular socket into which the torque tube enters. The whole is turned from 2 1/2in. dia. steel bar. Choose free-cutting steel as most of it will finish up as swarf. Cut a piece about 2in. longer than necessary.

Chuck the end that will ultimately be the sphere and rough the other end down to about 1 3/4in. diameter. Centre drill, drill and bore to receive the torque tube, not forgetting that the end 2in. is surplus and will eventually be cut off. Finish turn the outside of the socket which should terminate in a thickening rib at the end of the socket. Take a light cut from the 1 3/4 dia. x 2in. long surplus length. Reverse the job end for end and grip in the chuck by this last turned diameter.

Set up the lathe with a small round-nosed tool in the left hand tool holder and a dial test indicator (dti) in the right hand tool holder. Ideally, the radius of the tool tip should be the same as that of the dti tip. Secure the 62mm outside diameter ball bearing outer race in a horizontal situation on the tailstock barrel.

Reduce the large diameter to a parallel 62mm diameter i.e. finished size of the sphere. While the tool is still set for turning this diameter, traverse the lathe carriage until the tool is opposite the point which will become the centre of the sphere (**photo 39**). Advance the tailstock until the dti reads the highest reading and lock the tailstock to the lathe bed, and also the barrel. Zero the dti dial under the needle.

Move the carriage to the right to clear the job. Set the automatic traverse to move the carriage to the left (towards the chuck). Advance the cross-slide to apply a cut and with the lathe running at a moderate speed, engage the auto-feed and watch the dti needle. When the needle reaches 0.02in. (before zero) stop the auto-feed and return the carriage. Apply another cut and auto-feed again to 0.02in. (before zero) stop the auto-feed and return the carriage. Repeat until the whole 'corner' of the cylinder has been rounded off into a series of steps.

Now move the carriage to position the tool to the left of the embryo sphere and set the auto-feed to move the carriage to the right. Apply a cut and auto-feed to the right until minus 0.02in. is reached, and stop (**photo 40**). Return, apply cut, feed to the right to minus 0.02in. and stop. Repeat until the steps created have rounded off the left 'corner' of the sphere. You should now see where all this is leading. While the lathe is set to auto-feed to the right, return the tool to the centre of the sphere, i.e. dti to maximum reading. With the lathe running at a slow speed, engage fine auto-feed and advance the cross-slide to maintain the dti reading at 0.01 inch. This is not as difficult as it might seem and a smooth sphere will result albeit 0.02in. (0.01in. each side) too big.

Roughing out the steps on the left hand side of the sphere. The first step is to auto-traverse to the right to a dti reading of minus 0.02 inch.

Finishing the sphere using auto-traverse to the left leaving 0.01in. stock for a final finishing pass to zero on the dti.

Return the tool to the centre and change the feed to the left and repeat the traverse, this time to the left and at 0.01 inch.

This is the practice run and is now repeated to left and right with the dti reading zero (**photo 41**). It is important to remember that the roughing cuts are traversed towards each other and the finishing cuts are traversed away from each other to ensure that the cut is being applied (or put on) and not backed off.

The depth of roughing cut applied and the speed used is entirely dependent on the size and condition of the lathe you are using. There is no relationship between the 0.01in. and 0.02in. in my description and the depth of cut. Stopping at 0.02in. and taking two finishing cuts means that you have a practice run at 0.01in. before making your final cut at zero. The resulting sphere should move freely but without shake in the gearbox socket with its cover cap in place. Before removing it from the lathe, bore out the sphere to a smooth 1/8in. thickness all over. The last operation is to part off the sphere, complete with its socket (from the 2in. over-length, not forgetting the stiffening rib on the end of the socket).

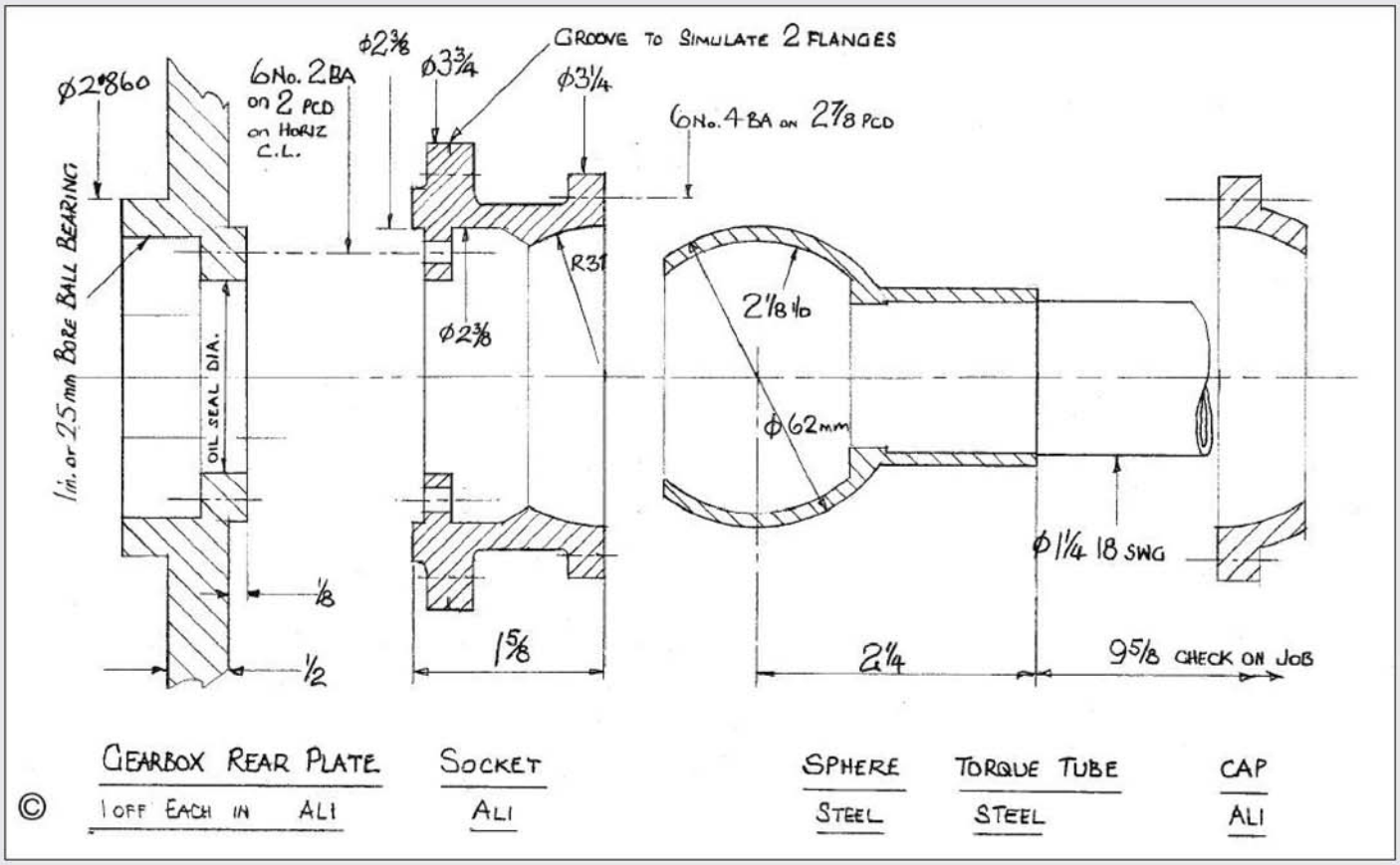
The flange at the front of the gearbox, where it is bolted to the rear flange of the engine crankcase, should have 'ears' around each bolt-hole as shown clearly in the illustrations of the full size engine. The array of holes as drawn by Fowlers starts with one on the left, on the crankshaft centre-line, and spaced equidistant around the pear-shaped flange. This was fine on the original engine design in which the crankcase was not split and the engine rear bearing appeared to be in a pedestal hanging from the top of the crankcase. Incidentally, to keep a reasonable oil level in the gearbox, the engine must have been flooded with oil. A further complication is caused by the larger-than-scale bearing housing which increases the centres between the two long studs (M6) which secure the bottom half of the crankcase each side of the engine rear bearing. The correctly spaced flange bolts get in the-way of the M6 nuts.

Also the left hand bolt on the horizontal centre line has to be assembled into the 'half-holes' on the joint-line and part of the side flange removed to accommodate the bolt head. The 'ears' dictate that the bolts must be in the same place on the re-designed crankcase.

The solution to all this is to space two bolts equidistant above and below the crank centre-line and two bolts between the two M6 nuts. We are using a continuous flange and can rearrange the bolts to better suit our situation. I used 4BA bolts and nuts, not forgetting the flat washers, but I think that the slightly larger size of M4 would look better. I used the Fowler hole array from the drawings.

Final assembly

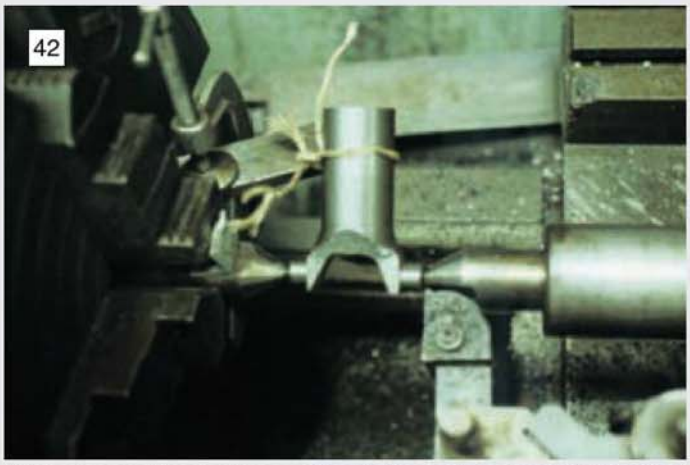
Many of these notes could be added to the appropriate description of the assembly concerned, but as one note could be appropriate to several ▶



situations I thought it best to put them all in one place.

There are two great advantages in enclosing major assemblies in an 'oil bath', i.e. to exclude dirt, abrasive dust and water, and also to provide a continuous supply of oil for lubrication without the daily chore of oiling each component.

An oil-bath or sump, creates its own problems in the need to keep the oil in the sump by fitting gaskets, oil seals and glands where rotating shafts and moving rods have to exit the oil-bath.



Turning the trunnions between centres for the ring type, final drive universal joints. Note the method of driving off one of the 4-jaw chuck jaws.

Gaskets can be made from paper, (photocopier paper) or cornflake packet card if some thickness is required, or proprietary steam gasket material where appropriate. Some people successfully use brown paper smeared on both sides with steam oil, even on steam joints. A tube of your favourite gasket liquid or 'goo' from the local motor accessory shop is also needed. This can be used to secure (I am avoiding the word 'stick') a paper gasket to the component which has the studs protruding from it. Keep the other side dry and on breaking the joint it should come apart where you want it to come apart.

Joints on precision components (ball race housings) must not have paper gaskets but can have liquid gasket material.

Starting at the front of the engine, the crankshaft front bearing housing needs a paper gasket but as the cap needs metal-to-metal contact between the spigot and the bearing, oil tightness should rely on a generous application of 'goo'. The crankcase joint on the crankshaft centre line should rely on 'goo', and also the sump joint. This joint continues across the narrow ledge by the end flange. Top and bottom covers to the cylinders need proprietary steam jointing. This material can often be picked up at rallies and shows in small off-cut quantities. Steam pipe flanged joints also need this material.

The joint between the engine and gearbox needs a paper gasket or 'goo' and the various covers on the gearbox also need paper gaskets. The small square cover on the top is kept dry with a 'gasket' of 20swg aluminium alloy sheet. This small piece of aluminium alloy 'gasket' has a 3/16in. wide slot from its top edge to communicate with a drilling in the main casing. This provides an air vent for the engine and gearbox and makes it possible to get oil into them. I have found no sign of any kind of air-vent in the engine or the gearbox drawings.

The flanged housing around the gearbox output shaft needs 'goo' and perhaps a paper gasket (depending on the smoothness of your joint surfaces) although this is outside the shaft oil seal. The torque tube sphere socket cover could have thicker (or thinner) gaskets to free the socket or take up excess play. The oil seal runs on the outside of the universal joint (**photo 42**) and 'goo' will stop oil penetrating the splines on the shaft. The rear axle casing top cover needs a paper gasket, as will the front and rear flanges of the cover.

The spring mounts incorporate oil seals which run on the inner boss of the road wheels. If oil passes through these oil seals it would drip onto the brake shoes and drums and affect braking. A drain tube diverts this seepage away from the brakes and onto the ground. It is interesting to note that the Fowler drawing shows the drain tube on the oil side of the oil seal.

The half shafts drive the wheels via a drive hub. This should have 'goo' around the shaft and keys (or splines) and between the hub and wheel surface.

●*To be continued.*

MINIATURE de LAVAL & CURTIS TURBINES

R. Pridmore

discusses a topic too long absent from these pages.

Little or no progress has been reported on the development of these tiny machines since the early work of W. H. Elkin, which took place in the 1940s. Difficulty of manufacture and design problems due to the uncertainty of rotor blade loss prediction appear to be the main bottlenecks.

Manufacture

H. H. Harrison's two-plate method of disc manufacture is one possible solution. By a combination of cold forming and machining of 'thick' plates to produce 'profile' blades of required flow angles and height, rotors for low speed (50-60,000rpm) machines are feasible. Brass or German silver will cope with the low stresses. **Sketch 1** shows the basic method.

Rotor blade losses

These are the bugbear of accurate design and accessible details of them appear to be non-existent. In a somewhat confusing article in *M.E.* 2350, 23 May 1946, W. H. E. described a geared turbine, scaled down from a full size machine, and inferred a gearbox efficiency from the power output. The blade losses were assumed to be as for the full size machine. Later in the year (*M.E.* 2378, 5 December 1946) in a letter claiming an improved power output for the larger machine, W. H. E. 'crossed swords' with K. N. Harris. The claimed power could hardly be doubted in view of the chosen adversary. Wisely, W. H. E. did not refer to the gearbox efficiency.

A Mollier diagram for this remarkable machine (**Sketch 2**) shows a likely range of corresponding, discrete input powers/efficiencies, exit losses, blade loss coefficients and gearbox efficiencies, all to match the claimed exit power.

Probably the only ways of approaching the blade loss problem are to measure the turbine shaft power directly (at 50-60,000rpm) and/or to determine the leaving losses by means of an impulse test.

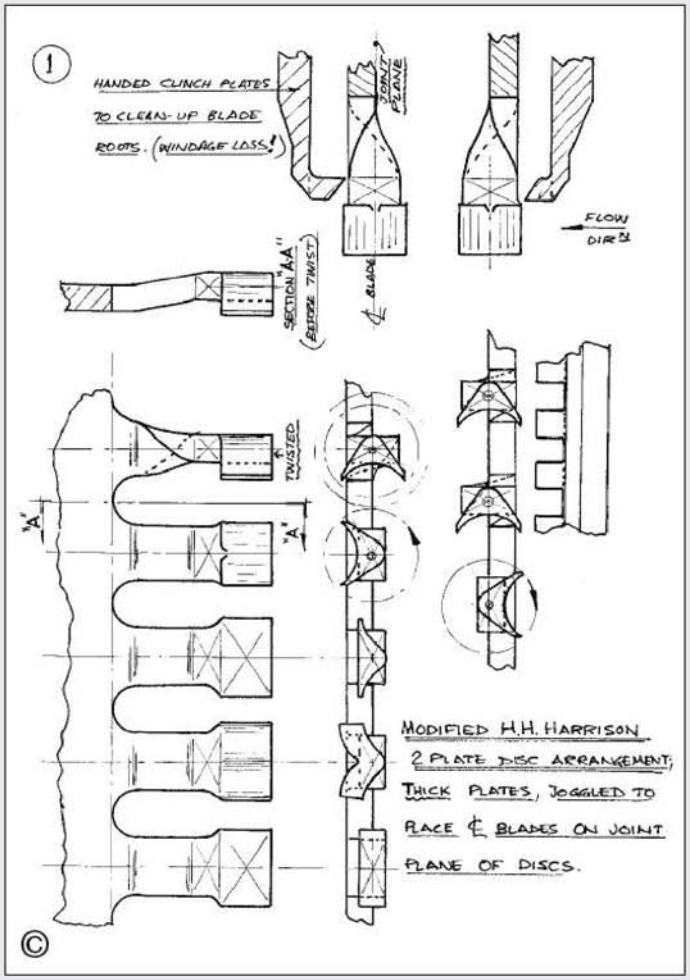
The power obtained from a single row wheel is relatively insensitive to blade losses, but these need to be known if efficient use is to be made of the first stage leaving loss in a second row of blades.

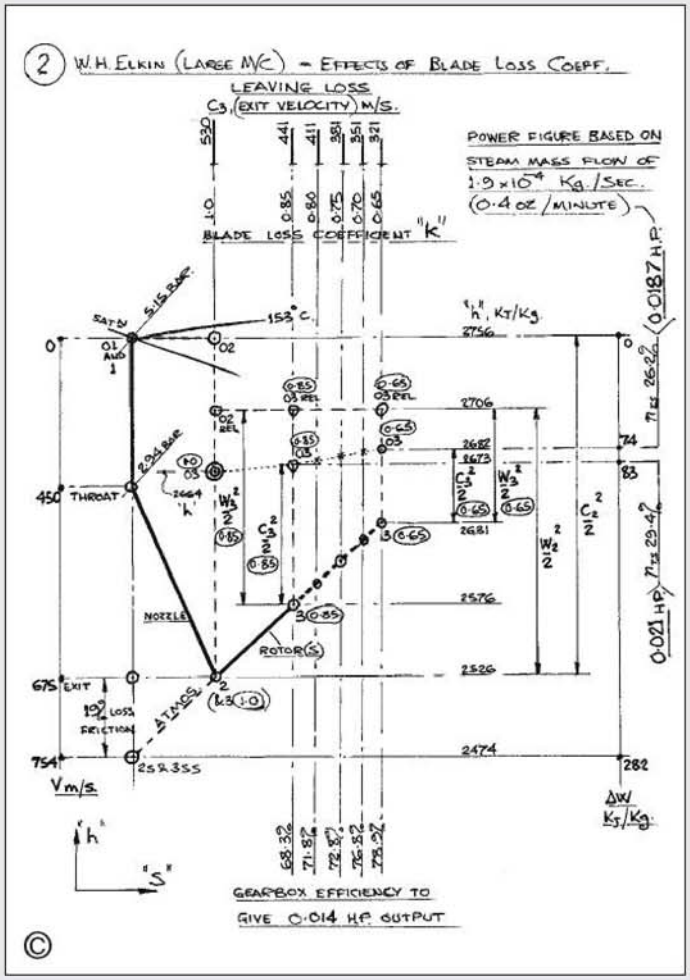
Development

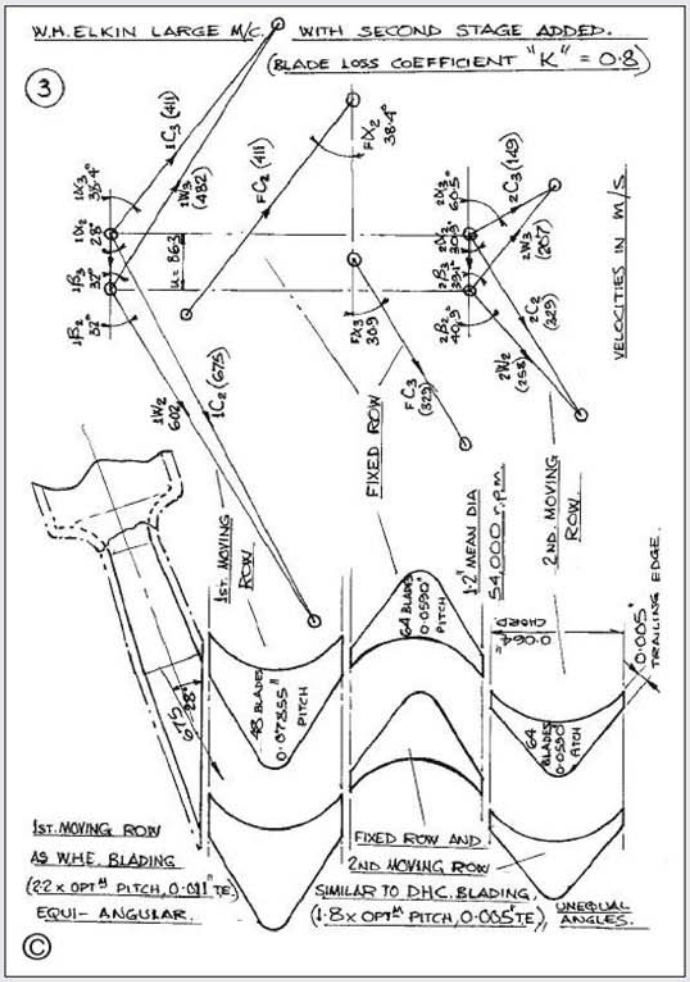
Sketches 3 and **4** show the effect of adding a second row of blades to W. H. E's machine. The apparent crudity, at first sight, of W. H. E's blading contrasts markedly with that employed by Prof. D. H. Chaddock (designed for multi-staging), but the basic machine's performance could not be faulted.

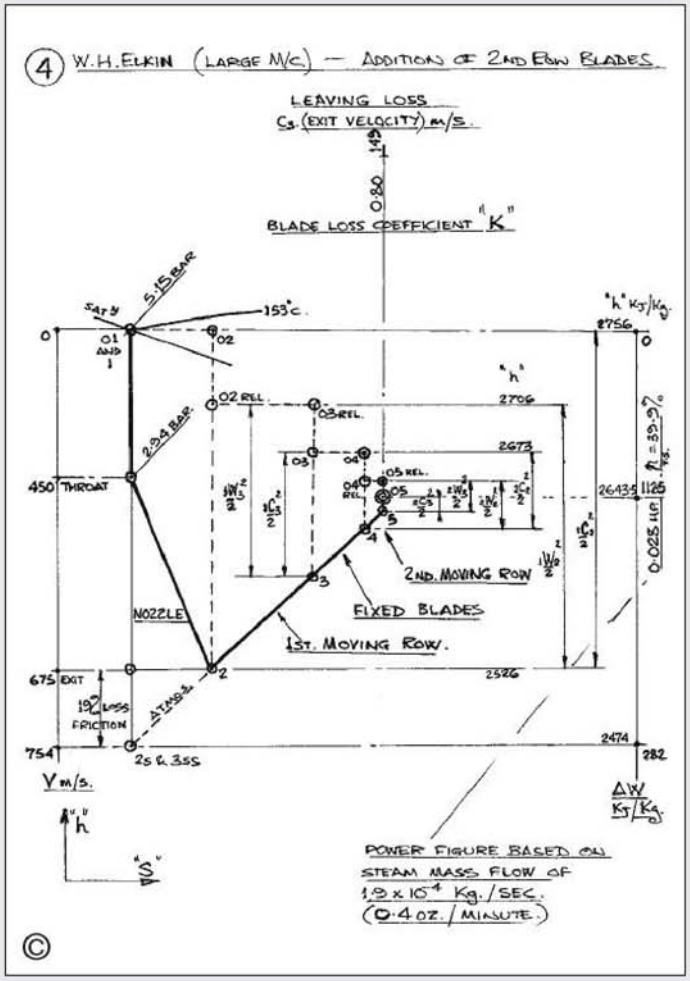
Considering the lamentably poor steam conditions and minute flow there would appear to be real development possibilities. W. H. E's machine employed a 'large' steam entry angle, presumably necessary to coerce the steam to flow through the extreme curvature of the blading (see *Thermodynamics* by Eastop & McConkey), and at the same time lowering the machine's efficiency. The steam entry angle, along with its departure (deviation) from the nozzle angle, needs to be borne in mind at design. Safety must be considered and provision made for over-speed protection.

Provided stable steam conditions prevail, e.g. with gas firing, surely this admittedly challenging job is not of the 'blind man riding a wild stallion' variety. It may even provide the stimulus for the next generation of model engineers offering a change from the P.L.A.N. over 33,000 of my youth.


1
HANDED CLINCH PLATES TO CLEAN-UP BLADE ROOTS. (WINDAGE LOSS!)
JOINT PLANE
FLOW DIR.
SECTION "AA" (BEFORE TWIST)
BLADE
TWISTED
'A'
'A'
MODIFIED H.H. HARRISON 2 PLATE DISC ARRANGEMENT; THICK PLATES, JOGGLED TO PLACE ℄ BLADES ON JOINT PLANE OF DISCS.
©


2 W.H. ELKIN (LARGE M/C) – EFFECTS OF BLADE LOSS COEFF.
LEAVING LOSS
Cs (EXIT VELOCITY) M/S.
BLADE LOSS COEFFICIENT "K"
POWER FIGURE BASED ON STEAM MASS FLOW OF 1·9 x 10⁻⁴ Kg./SEC. (0·4 oz/MINUTE)
0·0187 H.P.
0·021 H.P.
SAT.V
5·15 BAR
153°C.
"h" KJ/Kg.
THROAT
NOZZLE
ROTOR(S)
EXIT
19% LOSS FRICTION
4 TIMES
Vm/s
ΔW KJ/Kg.
GEARBOX EFFICIENCY TO GIVE 0·014 H.P. OUTPUT
©


3
W.H. ELKIN LARGE M/C. WITH SECOND STAGE ADDED.
(BLADE LOSS COEFFICIENT "K" = 0·8)
VELOCITIES IN M/S.
FIXED ROW
2ND. MOVING ROW
1ST. MOVING ROW
1·2" MEAN DIA
54,000 r.p.m.
64 BLADES 0·0590" PITCH
48 BLADES 0·07355" PITCH
0·005" TRAILING EDGE
1ST. MOVING ROW AS W.H.E. BLADING (2·2 x OPTM PITCH, 0·01" TE) EQUI-ANGULAR.
FIXED ROW AND 2ND MOVING ROW SIMILAR TO D.H.C. BLADING, (1·8 x OPTM PITCH, 0·035" TE) UNEQUAL ANGLES.
©


4 W.H. ELKIN (LARGE M/C) – ADDITION OF 2ND ROW BLADES
LEAVING LOSS
Cs (EXIT VELOCITY) M/S.
BLADE LOSS COEFFICIENT "K"
SAT.V
5·15 BAR
153°C.
"h" KJ/Kg.
THROAT
NOZZLE
2ND. MOVING ROW
FIXED BLADES
1ST. MOVING ROW.
EXIT
19% LOSS FRICTION
4 TIMES
Vm/s.
ΔW KJ/Kg.
POWER FIGURE BASED ON STEAM MASS FLOW OF 1·9 x 10⁻⁴ Kg./SEC. (0·4 oz./MINUTE)
©

A SOUTHERN RAILWAY MERCHANT NAVY CLASS LOCOMOTIVE IN GAUGE 1

Roger Thornber
tidies up a few 'loose ends' having had a chance to enjoy running his locomotive.

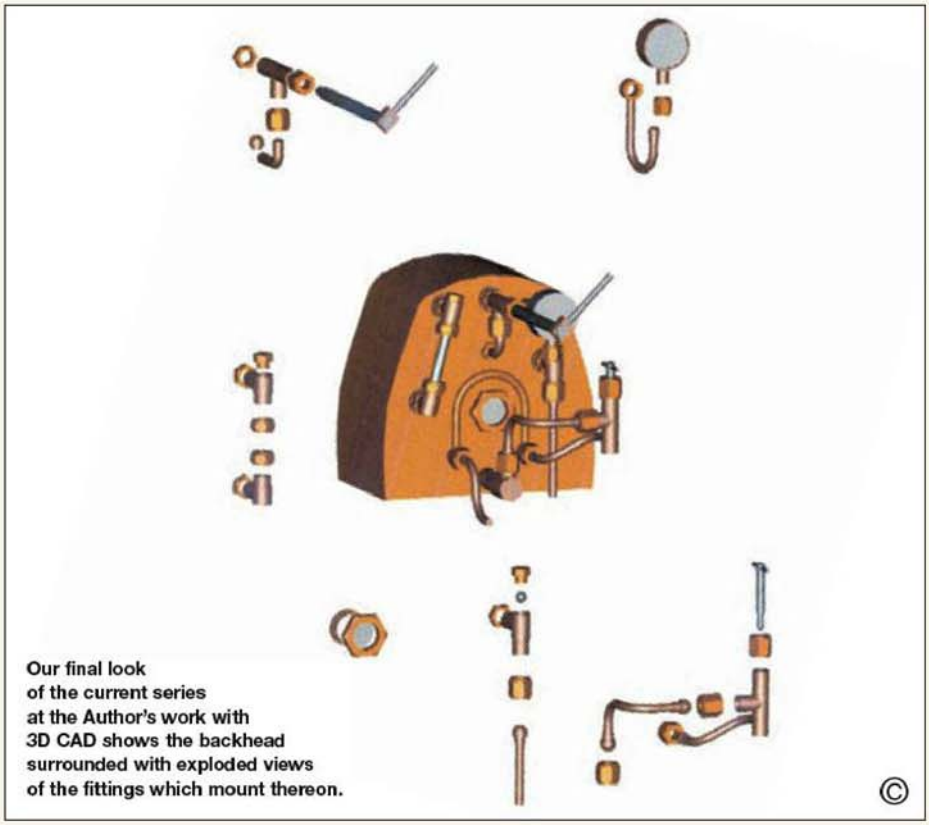
●*Part XVII continued from page 683 (M.E. 4223, 11 June 2004)*

It is about six months since I sent the preceding articles to our editor and I thought that an update might be of interest. During this period the locomotive has performed well with very few problems, the main ones being driver induced! The biggest difficulty was to set the locomotive off in reverse at high speed, which caused quite a spectacular derailment — fortunately no real damage except to paintwork and pride.

Following this I had a close look and found that the connecting tubes from locomotive to tender were lifting the front end of the tender slightly. For some reason this did not affect things when going forward but was not so good in reverse. This problem was cured by bending the plate under the drag beam on which the connector unions are fastened so that they are now angled downward by about 15 degrees.

Looking back, it also seems that I have not mentioned that I have put the pump bypass valve underneath the left-hand footplate rather than in the tender. This was done to reduce the number of pressure connectors.

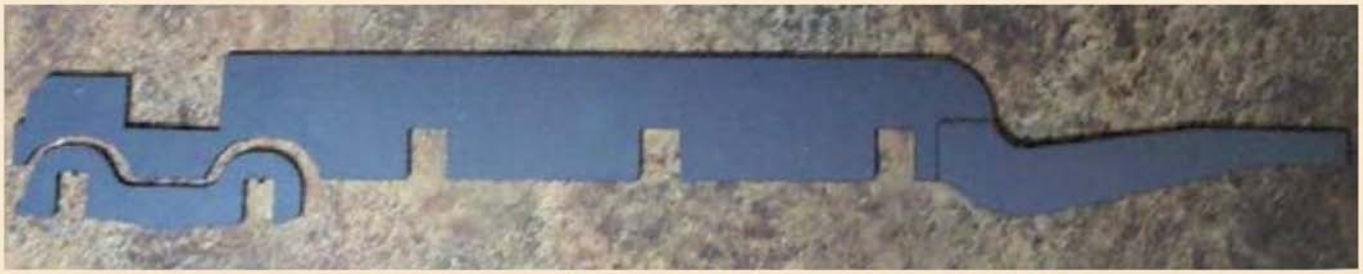
As a result of the derailment I decided to repaint the locomotive. This time I did not line it out myself but used 7mm transfers. Incidentally, Fox Transfers (tel: 01530-242801) are now producing a range of 10mm transfers; it is these which I used for the letters and the tender logo. I believe that they will be adding BR lining to this range shortly. The nameplates are from Guilplates (tel: 01483-565980).



Our final look of the current series at the Author's work with 3D CAD shows the backhead surrounded with exploded views of the fittings which mount thereon.

I was so pleased with the use of two Schraeder valves for gas filling the tender that I have modified most of my other locomotives in this way. While doing this I found that there may be a problem with the valve caps (the chrome plated ones, that is). The latest packet that I got from my local motor dealer were different. These had a central hole in them so that they did not depress the valve stem when screwed on; the sealing washer was also different. My solution was to put a small disc into the cap which had an off-centre hole. An 'O'-ring was used to seal.

Before closing I must add the details below from fellow model engineer Malcolm High who provides a valuable laser cutting service. So, if your current project requires some frames, or other such parts, you know where to look!



Affordable laser cutting

Malcolm High writes

"Laser cutting is getting cheaper!

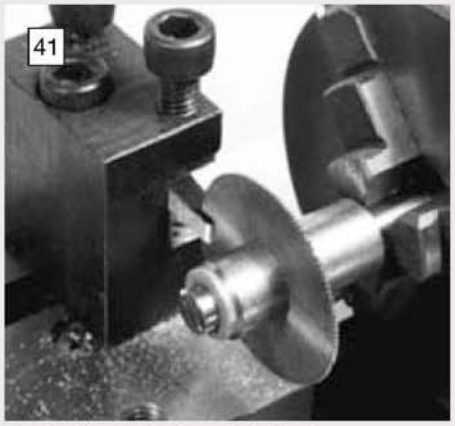
"For a number of years I have been involved in ordering laser cut parts for work. When it came to producing my own frames for Holmside *with a hacksaw and file I decided that there had to be an easier way. Thus I started to look at laser cutting.*

"The late Martin Evans mentioned my service in his Tennent *articles and I have had further mentions in* Model Engineer *since then.*

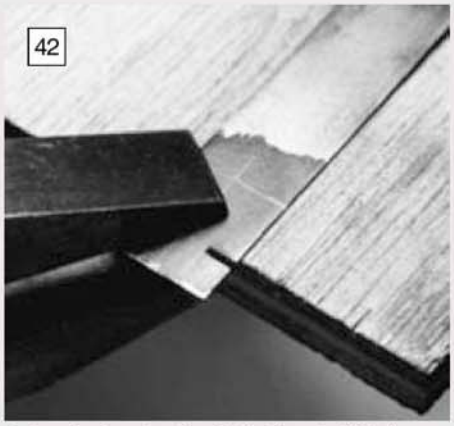
"I am not in the business of making fantastic profits but to provide a service to fellow model engineers. My portfolio is increasing all the time. If you care to send me a drawing (to Miller House, Main Street, Hampole, Doncaster DN6 7ET) I can make the part for you.

"Locomotive builders may consider such items as frames, buffer beams, cabs, stretchers, brake arms, etc. In fact, anything in plate up to 8mm thick. Traction engine builders may consider hornplates, spectacle plates, spokes etc.

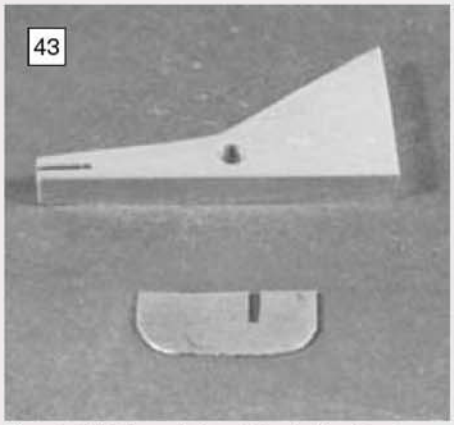
"Visit my website **modelengineerslaser.com**, *e-mail me at* **malcolm.high@btinternet.com** *or give me a call on 01302-721611. You'll find my prices are very competitive."*



Sawing the slot in the gated detent.



Set-up for forming the slot in the steel blade.



The steel blade ready for gluing in the detent.

WOODWARD'S GEARLESS MECHANICAL CLOCK

John Wilding FBHI

describes the backplate fittings and maintaining work before dealing with the weight suspension pulley.

●*Part V continued from page 691 (M.E. 4223, 11 June 2004)*

The backplate fittings are shown in **fig 10** and also in photo 3 published in part II of this series (see *M.E.* 4219, 16 April 2004). They are all straightforward but it will be noticed that there are three line pillars which carry ball races. One of these however is located on a mounting strip and this will be 1/8in. shorter than the other two. In each case the pulley grooves on the ball race housings should be the same distance from the back plate as the drive pulley on the centre arbor.

Gated detent

This important item is shown on **fig 11**. It consists of a triangular piece of 1/8in. brass to which are fitted two steel blades. Dr. Woodward slit the brass and used adhesive to secure both blades in the saw slits. I have done it slightly differently. The upper blade is fitted this way but the lower blade is attached to the underside of the detent with a screw; this gives more scope for adjustment.

Sawing the slot in the end of the detent is best carried out in the lathe using a slitting saw as demonstrated in **photo 41**. In this method the operation is completely under control and you are certain to obtain a straight saw cut.

Concerning the upper blade, a slot is shown on the drawing to allow the pin on the escape wheel to pass through. I cut this slot with the piercing saw as shown in **photo 42**. Here the strip of shim steel is clamped to the sawing board with toolmakers clamps. **Photograph 43** illustrates the blade ready for securing in the detent with Loctite.

The lower blade is drilled No. 50 size and this is illustrated in **photo 44**. Prior to tapping 10BA, the No. 55 size hole in the detent is shown being drilled in **photo 45**. This lower blade should be made oversize and then trimmed by filing so that it is flush with the detent and proud of the end by 1/32in. as depicted on the drawing. The distance between the two blades should be just over 1/32in.; this distance can be adjusted by packing the shelf out or reducing the underside of the detent whichever is necessary.

An illustration of the gated detent together with the back stop pawl and deflector piece is shown in **photo 46**; these other two items are quite straightforward. It will be noticed on the drawing fig 11 that I give the dimension of the steel bearings I used.

These are in the form of sleeves which are mounted on a 10BA screw. The alternative arrangement is to machine a shouldered screw which incorporates the bearing surface. ▶

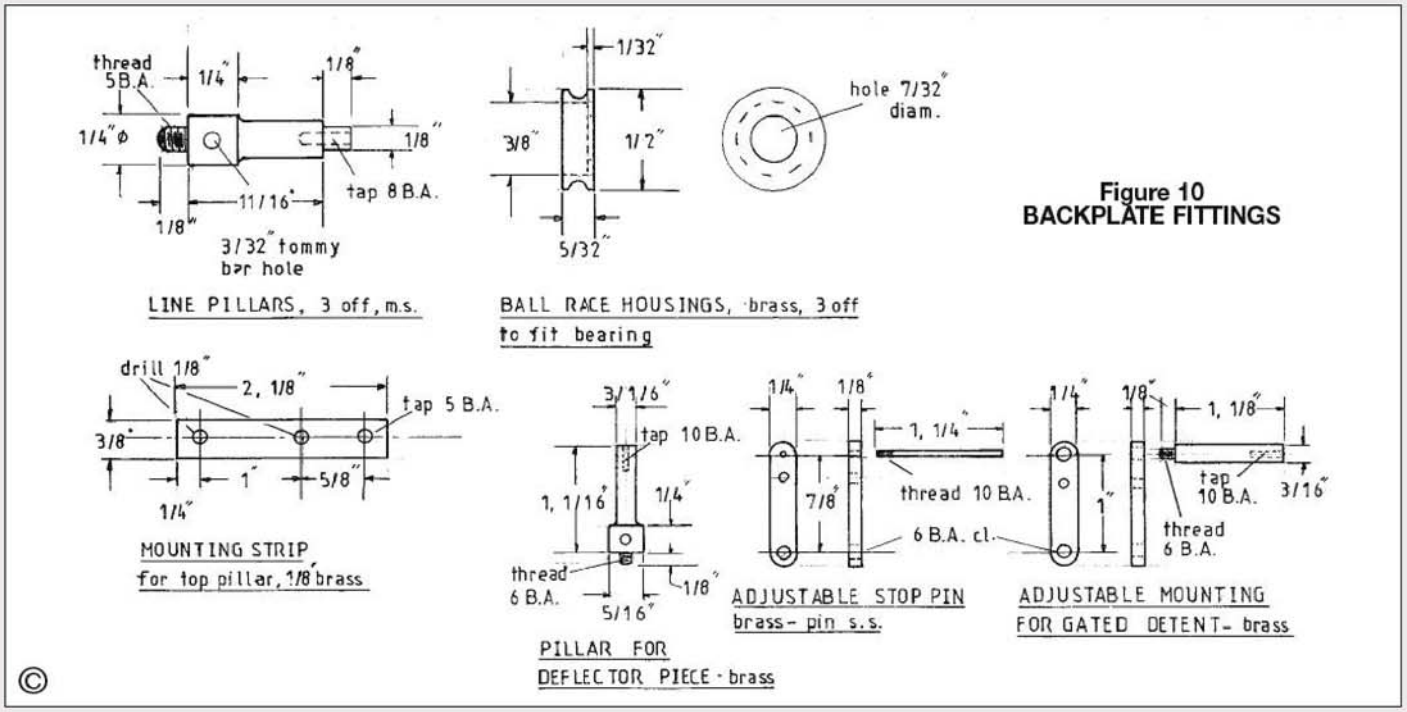
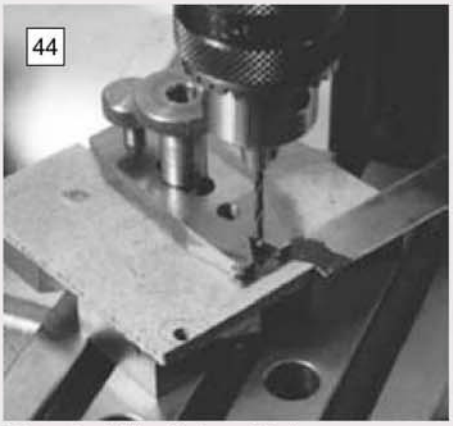
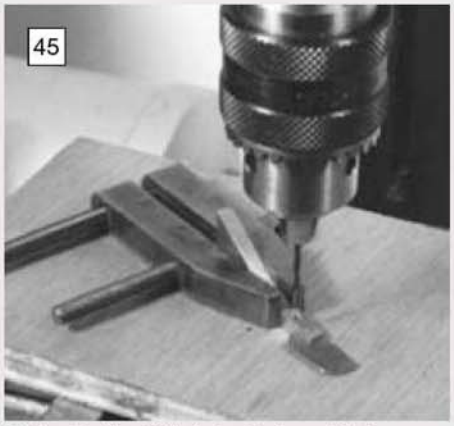


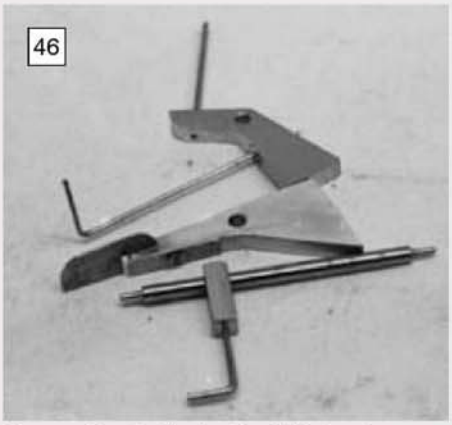
Figure 10
BACKPLATE FITTINGS



Set-up for drilling the lower blade.



Drilling the No. 55 hole for the lower blade.



A group of parts showing the deflector piece, the gated detent and the backstop.

I show a later picture of the backstop pawl or click and you will see that it has a set screw so that the extension of the pawl is adjustable (**photo 47**).

Maintaining work

As previously explained, this is manually operated because I was in such a hurry to get the clock working, but really it should come into operation automatically, as Dr. Woodward has done in his clock. It is essential to have this component, otherwise when the weight is lifted, as during winding, the jockey weight will pull the escape wheel backwards, releasing a pin and advancing the clock by one minute. The parts are shown on **fig 12** and illustrated in **photos 48** and **49**. It consists of a triangular brass plate pivoted at its top so that the engagement of the detent with the pin wheel is adjustable. There should be no trouble with the construction of this item.

The tip of the detent is adjusted so that when the wire on the right is pulled down, the tip will engage a pin on the escape wheel. In this position the auxiliary weight will hold the escape wheel in contact with the gated detent while winding and when the hands are pushed backwards. The detent will automatically release itself the next time the deep tooth comes into operation. The stop pins on the bracket are bent to restrain the movement of the pivoted arm so that only one pin is gathered by the detent.

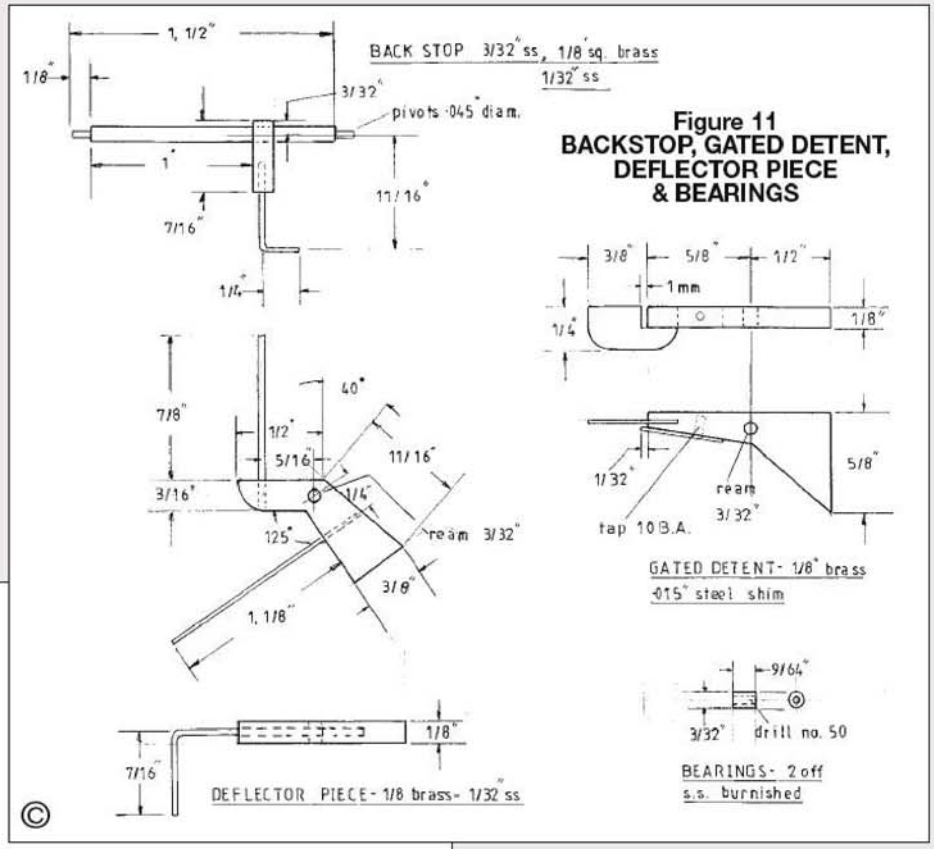


Figure 11
BACKSTOP, GATED DETENT, DEFLECTOR PIECE & BEARINGS

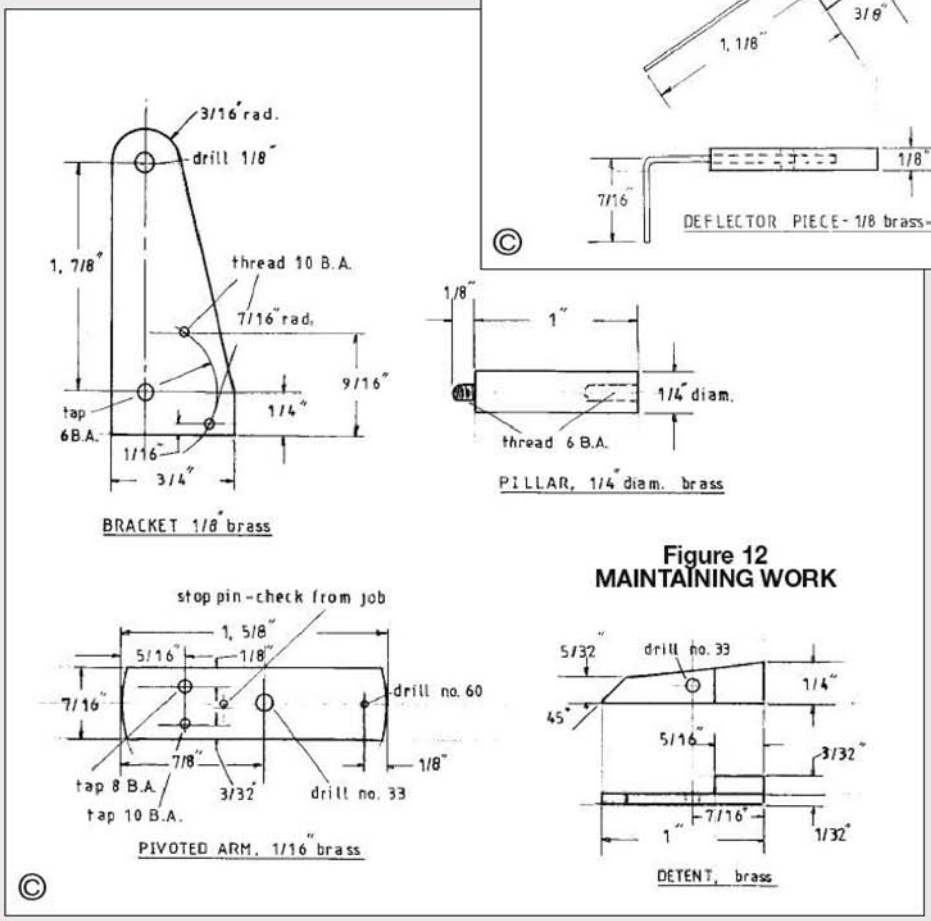
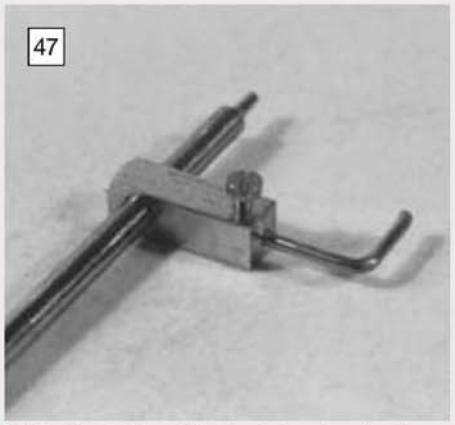


Figure 12
MAINTAINING WORK

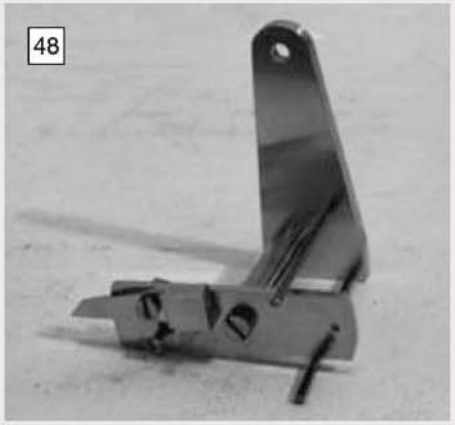
Weight pulley

This is detailed in **fig 13** and shown in **photo 50**. It consists of a block which is secured to the top of the weight. Two triangular side plates are attached to this block and the pulley itself is pivoted in holes at the apex of the plates.

One way of making the assembly is to cut out and file the side plates to shape and drill the pivot holes with the plates clamped together. They can then be separated and clamped either side of the central block as demonstrated in **photo 51**. The drill is used as shown to assist in aligning the assembly. The 6BA holes can then be drilled through the plates into the block. Finally, with the plates secured to



A later illustration of the backstop showing the set screw for adjusting the extension of the pawl.



The maintaining work unit.

the block, the 3/32in. reamer can be passed through the pivot holes to true them up as shown in **photo 52**.

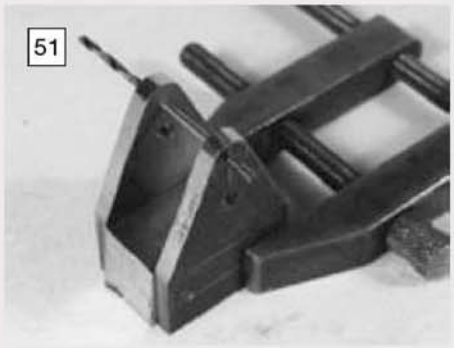
The pulley itself is marked out on a piece of 3/16in. brass and the centre hole drilled and reamed 3/16 inch. The embryo pulley can then be mounted on a threaded mandrel in the lathe for machining the O/D to 1.450in., forming the groove and recessing each side in turn according to the drawing. Finally, the four 5/16in. holes are marked out and drilled in the drilling machine. An illustration of the pulley assembly mounted on the weight is given in **photo 53**.

I believe Dr. Woodward fitted ball races in his pulley and this is easily done if the constructor wishes. The plates will have to be made larger at the upper part to make room for the races.

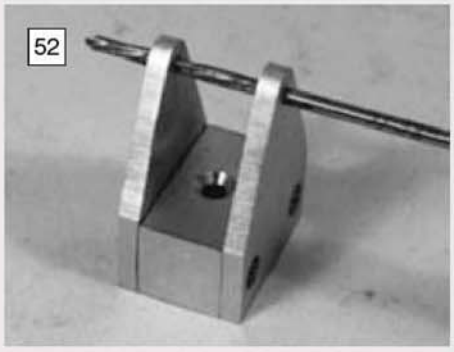
●*To be continued.*

The maintaining work unit fitted on the clock.

The weight pulley assembly.



The assembly clamped ready for drilling the 6BA screw holes.



Truing up the pivot holes with the 3/32in. reamer.

The pulley assembly secured to the driving weight.

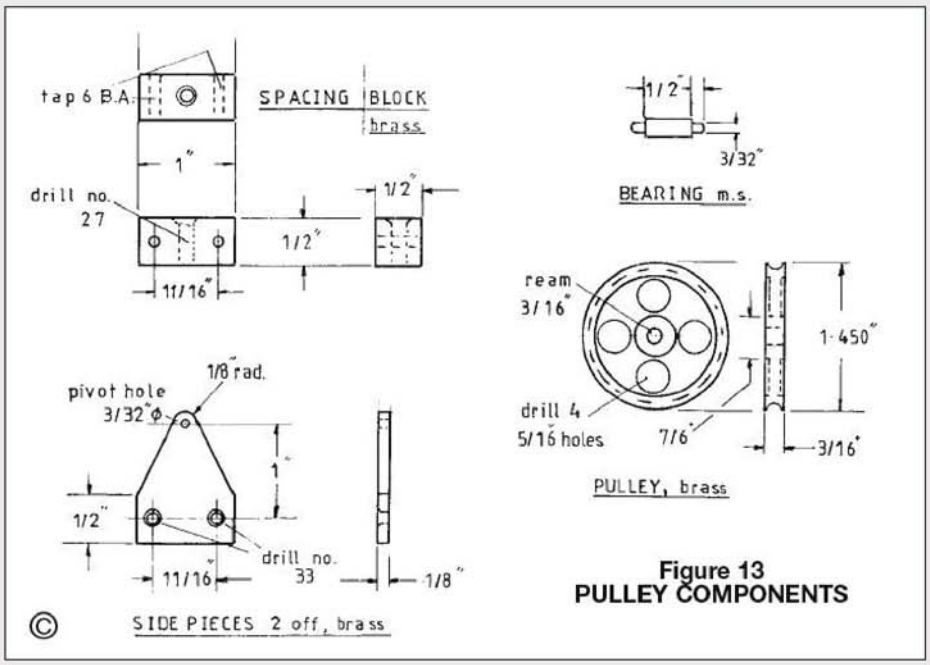


Figure 13
PULLEY COMPONENTS

KEITH'S COLUMN

SAINT CHRISTOPHER

A GWR LOCOMOTIVE for 7¼in. gauge

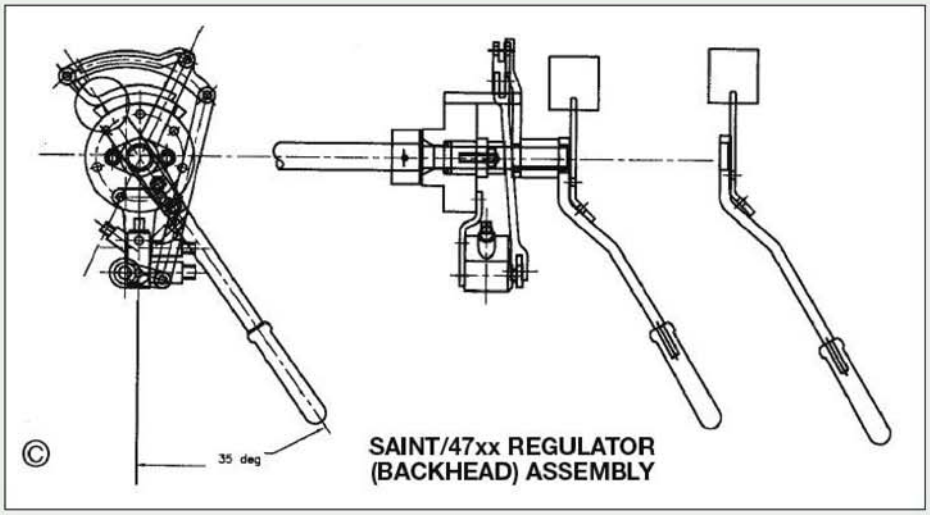
Keith Wilson

describes a suitable regulator for this charismatic locomotive.

●*Part XLIX continued from page 160 (M.E. 4214 6 February 2004)*

Although the description of the Saint and 47 has finished, a well-known and appropriately named law insists that it was not complete. However, this was foreseen and was the main reason for the recent descriptions of railways. I was hoping for some letters pointing out errors and/or omissions, but fortunately (or otherwise) I noted this one myself. How can we start and stop this locomotive? Well, once steam is 'up' you release the brakes and put her in forward gear, followed by opening the regulator — what regulator? Yes, I missed it. 'Twas drawn out and proved, but just got overlooked. *Mea Culpa!*

'Way back when' I tried a 'scale' Swindon regulator in the giant 47s, (10¼in. gauge) and it worked well. However, there is a snag, due mainly to old 'square-cube'. Full-size, there is ample weight in the two valves to keep them steamtight, plus the size of ports. For the down thrust of the steam pressure is determined *not* by the area of the valve, but by the area of the port(s). This means that full size gives a contact pressure such that a special pilot valve is useful. Opening this is not too hard, but of course immediately the pilot opens it reduces the force on the main valve rendering the whole regulator quite easy to use. Also, it was part of the hydrostatic lubrication system, having its own supply of oil. A simple calculation yields intriguing results. If we assume a port area of 6 x 3in. (guesswork on my part) the downward force on a Castle locomotive is a mere 4,050lbf.; a King would be 4,500lbf. — just over 2 tons. Any questions?



SAINT/47xx REGULATOR (BACKHEAD) ASSEMBLY

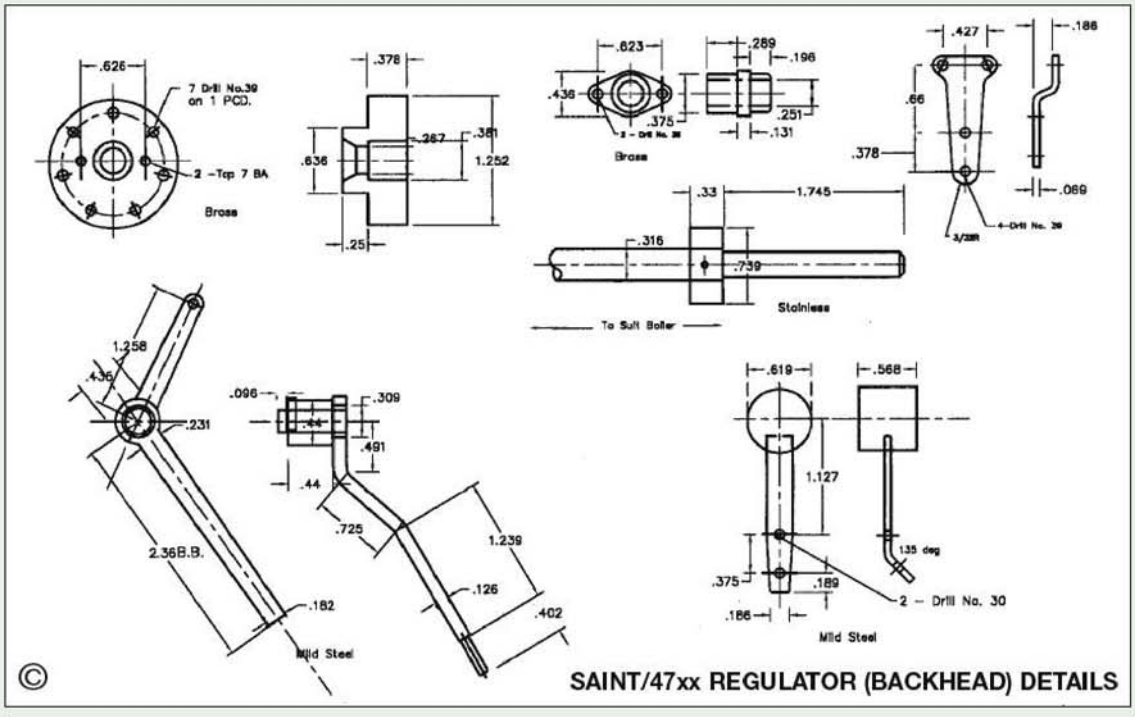
This extra oil might well appear extravagant, but bethink you. All fluid materials passing through the regulator pass also through the cylinders, thus this 'extra' oil is by no means wasted. At the request of the future owner of the first '47', I added a little hand pump lubricator to feed oil into the regulator. To avoid getting oil into the boiler, it fed into the main regulator at the bottom of its tube. In theory therefore, it could not get into the boiler unless it climbed about 3 to 4in. vertically upwards. Against steam flow as well, it could not possibly get into the boiler; the trouble was that the oil hadn't read the instruction book. How it managed it I don't know, but somehow it did and of course instantly migrated to the water gauge glass where it was least desirable. So that idea was not a very good one.

I added a small phosphor bronze leaf spring to aid the contact pressure on the valves when I next used the valve design (on the eight Prairies) and this worked reasonably well, but I later modified it so that the main valve was of PTFE (polytetrafluorethylene). This gave satisfactory service for many miles (I suspect about 3,000) of heavy-duty service.

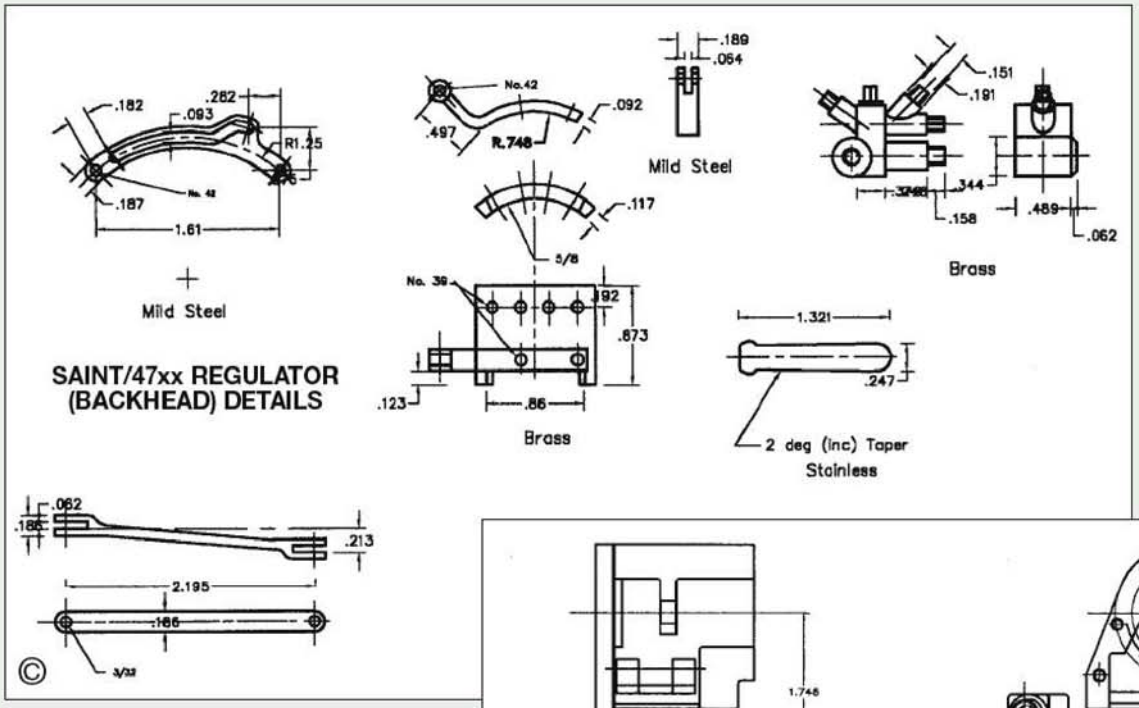
However, there is a nasty snag for us, due mainly to difficulties of working inside a smokebox. The output from the regulator being underneath, not overmuch room is left for connecting pipework to the superheater wet header. In fact 'tis something of a nightmare.

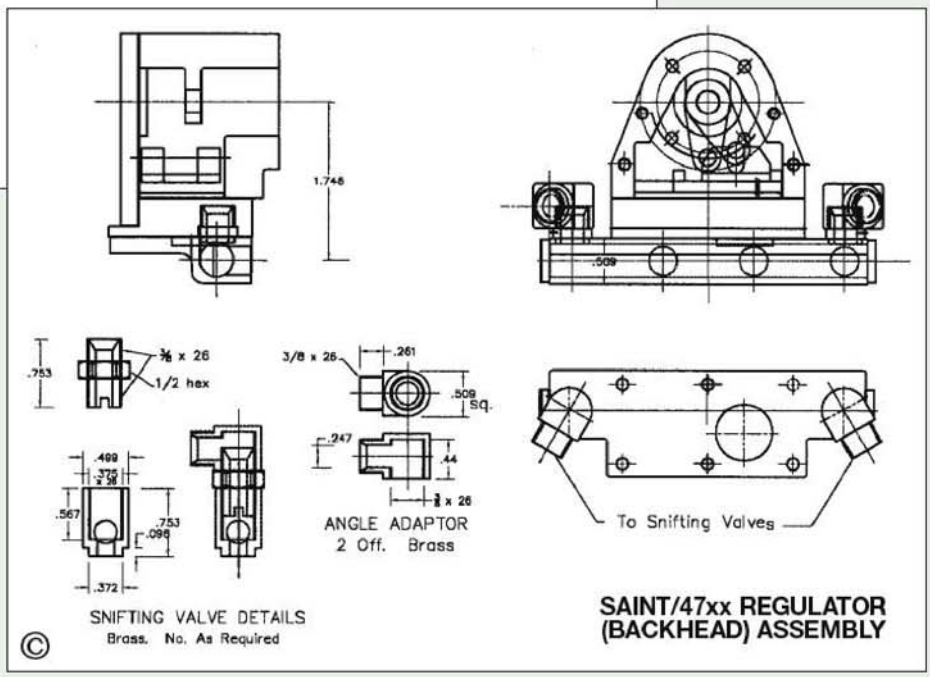
When (alas, not if) a superheater element needs attention, the entire regulator has to be disassembled in order to get it out, followed by re-assembly later. New gaskets are required, and the general kerfuffle is confoundedly annoying.

In fact, if we are to get reasonably good steampipes, applying this design to anything smaller than boilers



SAINT/47xx REGULATOR (BACKHEAD) DETAILS





based on Standards 1, 4, 7, 8 and 12 is just about impossible. It would be possible to use 'the next size down' i.e. a 5in. scale version on a 7¼in. locomotive, but then we have to look at smaller nuts and bolts, and even big ones are a confounded nuisance in sooty corrosive conditions. Full size, it was not worth bothering to undo nuts, etc, inside the smokebox; a hammer, chisel, and some good old Anglo-Saxon words were used. I'm not quite certain which of the three proved most useful.

Much the same applies to us, although not necessarily including hammers and chisels, (perhaps the less said about the words the better!) but seldom have I succeeded in undoing many, even with a good dose of good old WD-40. They almost invariably snap off anyway, so have to be renewed no matter what.

The boiler numbers mentioned above are those of larger diameters, No. 1 being Saints, Halls, Granges, 28s, Stars; No. 4 fitting giant Prairies, Cities, 42s, 72s, 1500s; No. 7 for the 47s only; No. 8 for Castles and No. 12 for Kings. Note that No. 4 uses the same endwise profile as No. 1. As I am just nearly finishing a couple of 7¼in. Bulldogs (No. 2 boiler) space is considerably more limited. I realised this after completing the boilers, for I had used the standard regulator design, done some years ago. Not no how could it be worked in, so some rapid thinking had to take place resulting in a disk-in-tube regulator, of just about equal capacity, logarithmic opening, easier fittings, and generally more convenient.

I have never made a locomotive with any other type than logarithmic (not strictly the correct use of the word but hopefully understandable) but I have handled locomotives with 'all-or-nothing' regulators and do not like them one little bit. My first full size drive was to take a Castle from Stafford Road sheds back to Wolverhampton low-level, cross over all the tracks to the bay platform, and back her onto her train, 135 or so tons, very rigid; imagine that with such a regulator. Include me *out*!

The main portion is fixed to the front regulator bush semi-permanently; it should not need removal. It is necessary to have a collar on the main shaft, for we don't have even the tiny weight of the valve to make sure it remains on the portface. The portface section has been kept as thin as is reasonable; no point in taking the overall dimensions too massive. Said portface must be dead flat, rubbing it on a piece of fine carborundum paper on a flat surface (use a figure-of-eight track) is recommended; the same treatment applies to the business face of the actual valve (PTFE). The relative angle of the portholes and the curved slot is important, but this need not apply to the square hole in the centre.

On no account miss the tiny bevel on the central hole where valve and portface meet, this greatly aids sealing. Note that the valve is only a tiny bit smaller than the bore of the main block; this aids assembly.

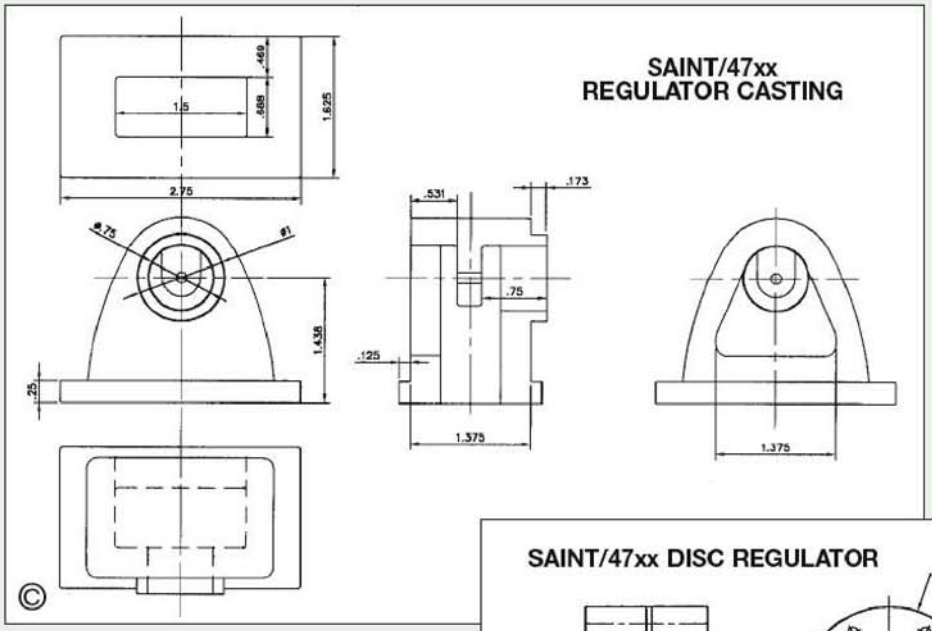
If you would like some extra headroom, note that the angle fitting in the exit need not necessarily be located on the centre-line of the regulator. There is room for it 5/16in. higher, it just means offsetting the output block in the 4-jaw chuck for the drilling and tapping.

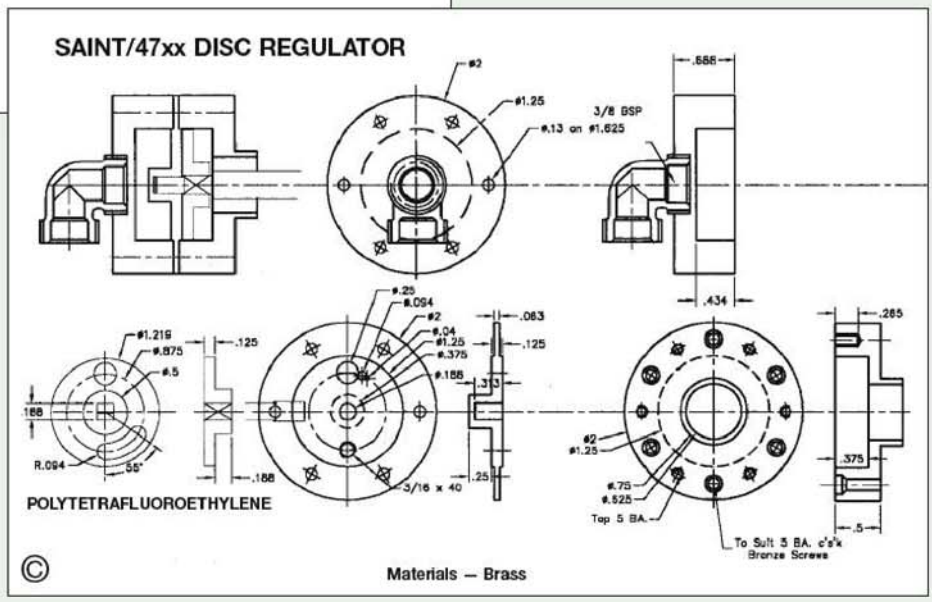
The square hole in the valve is easily done with a square needle file, take it gently until a piece of 3/16in. square bar will pass through smoothly, but *not* tightly. Make certain that the disk resides squarely on such a shaft, for it doesn't aid sealing one little bit if it is cockeyed to start with.

To get a reasonable square on the round shaft it is best to set things up in a vertically mounted rotary table. It is of course possible to file a good square, but it is not one of the lighter matters. Using the 3-jaw chuck in the lathe, set Number 1 jaw at 12 o'clock, file off 1/32in., rotate chuck so that Jaw 1 now points to 3 o'clock (am or pm, it doesn't matter which!) file off another 1/32in., and so on. In case you are wondering how to judge this 1/32in., note that a micrometer across the first and second flats will read 7/32in.; (0.219in.) and for the third and fourth flats will show 3/16in. (0.188in.). Nothing like making accuracy easier! There are such things as filing guides (two little rollers to guide a file flat), but the milling operation is far easier.

To set the ideal length for the regulator rod, the easiest way is on fitting it into the boiler. If it protrudes about 3/4in. at the rear end all will be well. Note that another collar will be needed to prevent the rod popping out, (helping neither man nor beast). When you have made up the regulator handle, it can be pinned to the rod. Make sure that when the regulator is closed, the handle points roughly to 4.30. With an angular travel of about 55deg., this fits GWR practice as near as I can judge. It will be clear that assembly of the rod in the first instance is from the front; if the rear collar is held with a grub screw and the rod pressed rearwards by assembly of the front parts of the regulator, clearly the rear collar will settle in its correct position. If it is then moved forward by about 1/32in. and pinned, it will be set right for normal operation. Don't worry about expansion, for the copper boiler expands more than the stainless rod.

The 1/4in. dia. stainless rod (quite okay above the water level) and the 1/2in. dia. brass collars pinned with 3/32in. copper rivets, all work well





wearing, and the possibility of a slightly heavier-set safety valve, this figure could reach about 45,000lbf.)

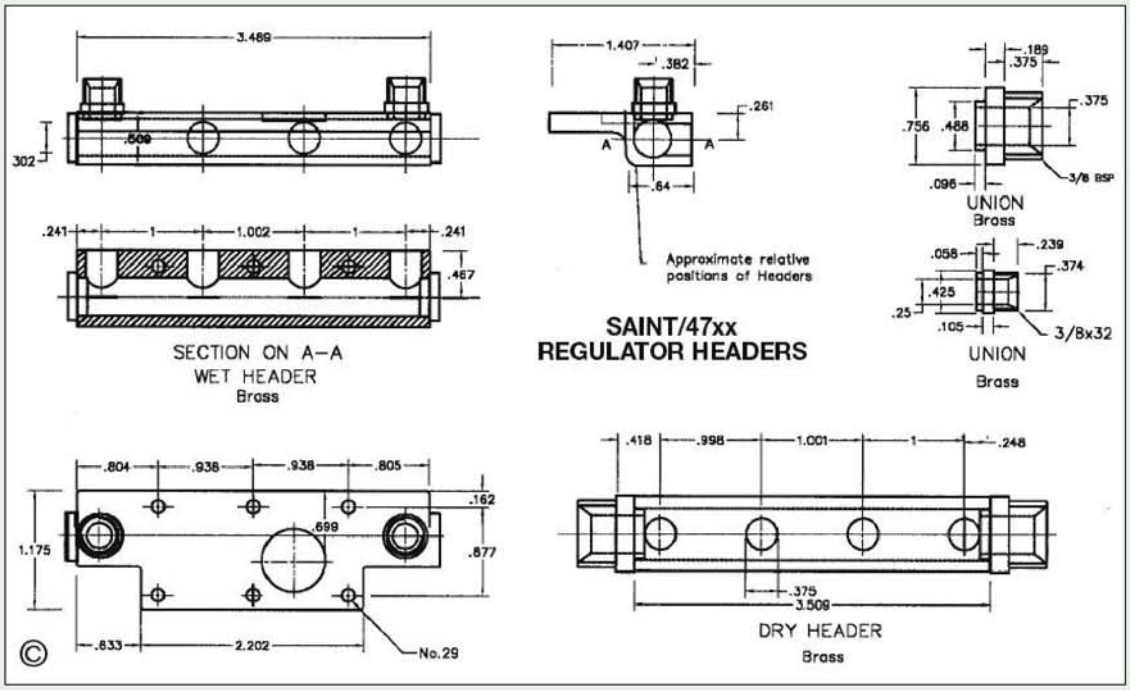
If we scale the proportions exactly, problems immediately arise, for pressure cannot practically be scaled (Note that temperature and pressure are intimately connected) without strange things happening to combustion, efficiency, heat losses (due to the fact that we cannot practically duplicate lagging thickness) and so on. So we are stuck. C. M. Keiller did some interesting work on these matters and using a boiler pressure of 150psi got really good results from $2^1/2$in. gauge cylinders only $^1/2$in. diameter. This pressure puts boiler

together. It does no harm to add a drop or two of Loctite 603 to the collars, although there is no real load tending to shift them.

The actual sealing boss on the backhead is all the better for a reasonably generous countersink, as you will find for yourself when faffling about trying to get the regulator rod threaded through. I've had some.

While dealing with these matters, a steamchest pressure gauge can yield some interesting information, although I do not recall any such on the GWR. On opening the regulator, one of two things will happen. As the steamchest pressure rises, either the wheels will slip or the train will move. The surprising thing is that one or the other will happen but at a much lower pressure than might be expected. There was much argument in the middle 1930s between Curly and others about this phenomenon. There is much to be said efficiency-wise for a high steamchest pressure at speeds, but to get this you must have quite early cut-off. This of course is one of the reasons for the superiority of Walschaerts valve gear at high speeds. Not of course that certain Stephenson locomotives haven't gone well over the ton, but not so much with heavy trains. In our sizes generally, due to old square-cube, things are a bit different, for our locomotives are usually over-powerful compared to the prototypes. A King for example has a tractive effort of about 40,285lbf. (With cylinder re-boring, wheel tyre temperature quite high, getting towards the 'kink in the graph' for oxygen attack on silver-brazed joints. This kink is at about the 170deg. C. mark, or just over 100psi. I may be out by a few degrees here, for I have not been able to check out the exact figures at time of writing.

Be that as it may, a too-high steamchest pressure with our locomotives can lead to a dangerously high speed. If cylinders are carefully kept small, then due to the general fact that pressure tends to vary much more in our sizes than full size it can often happen that one runs out of puff out on the line, not necessarily through any fault of the driver. For in certain cases, trains can be kept running around the main line for a considerable number of laps (my best was eight, in rain). I discovered that even with only about 15-20 'on the clock' the Prairie would get the train home, provided that we did not actually stop on the way. Nerve wracking, not too frequent — fortunately!



TRADE TOPICS

MINIATURE PILLAR DRILL KIT NOW AVAILABLE FROM STUART MODELS, GUERNSEY

Respected suppliers of stationary engines, marine engines, materials, steam fittings, boilers and fixings, Stuart Models in Guernsey has introduced the second in a series of miniature machine tools, the Stuart Pillar Drill which is now available as a set of castings, materials, fixings and pre-cut gears. This delightful little machine is a worthy companion to the miniature Stuart Engineering Lathe released earlier this year.

The Stuart Pillar Drill kit is available for £147.00 and the Stuart Engineering Lathe kit is available for £149.00 both prices being inclusive of postage and VAT. The kits are supplied complete with full drawings and instructions to enable the construction of either miniature machine tool to be completed without difficulty.

The all-new full colour Stuart Models Catalogue is also available for £5.00. Including the range of miniature workshop machinery, it features many new models available as sets of castings, machined kits and ready-to-run models.

Stuart Models (Dept MM) are at **Braye Road, Vale, Guernsey, UK, GY3 5XA; tel: 01481-242041; fax: 01481 247912; website: www.stuartmodels.com**

CORROSION PROTECTION PRODUCTS FROM ENGINEWISE

Specialist manufacturer of products for corrosion protection, Enginewise has re-named and re-packaged its range of proven products offering unsurpassed corrosion protection and is improving accessibility to model engineers via retailers.

VapourSeal (previously known as VCI Emitters) protects all tools in storage, eliminating the risk of rust and corrosion to instruments, and tooling in storage. It provides the ultimate non-contact metal protection, emitting a powerful vapour-phase inhibitor to block the corrosion which occurs when moisture meets bare metals. Since it does not dry the atmosphere, there are no problems for wooden components.

One **VapourSeal** provides two years' protection for the contents of a standard tool box or similar relatively closed environment such as a heavy duty polythene bag containing a spare engine or other components. It begins to work as soon as the re-sealable lid is removed. Two or more may be used for larger enclosures and cabinets. Each **VapourSeal** has a self-adhesive pad for fixing in position and a paper label to record the date of installation.

VapourSeal is available in blister packs. One retails at £3.99; the triple pack is £9.99.

MetalGuard (previously known as XMP) is a spray-on anti-rust coating giving two years' of unbeaten protection from corrosion for bare and plated ferrous, non-ferrous or multi-metal constructions. A defence industry standard product, it forms a soft, clear, thin (2 micron)

film which will not discolour with age and is easy to wipe clean.

Its powerful water-displacing character means it can be applied directly to wet machines and components. It has outstanding penetrating capability. Applications for model engineers include protection of machine tools, particularly relevant if they are kept in damp workshops and when using water-based cutting fluids. **MetalGaurd** is also valuable for the protection of part completed models containing iron, steel and non-ferrous metals.

MetalGuard is available in a 150ml aerosol can retailing at £6.99 which can be sprayed from any angle, even up-side-down, using an advanced spray technology that releases no harmful propellants.

GreasePlus (previously known as CP Grease) seals and protects against rust providing not only lubrication but also exceptional corrosion protection. It contains active corrosion inhibiting ingredients to protect all ferrous and non-ferrous metals. Highly water repellent, it will not emulsify, does not contain silicone and has a high temperature melting point of 200deg. C. Unlike some ordinary greases, **GreasePlus** will not dry out and crack to admit water allowing unseen corrosion to start.

Model engineers find **GreasePlus** especially useful for machine tools and models where grease rather than oil lubrication is preferred. Its high melting point and water repellent characteristics make it suitable for live steam model applications.

GreasePlus is available in a 250g plastic pot retailing at £9.99.

All products are available from **Enginewise** by mail order to **3 Venture Business Park, Gilbey Road, Grimsby, DN31 2UW; tel: 01472-347400; fax: 01472-267647; website: www.enginewise.co.uk** Enginewise welcomes enquiries from retailers.

FOR YOUR BOOKSHELF: CLERGET PATENT AERO ENGINES FROM CAMDEN MINIATURE STEAM SERVICES

Three manufacturers tended to dominate the rotary engine market in the years leading up to and encompassing World War I. They were the French companies of Gnôme, La Rhone and Clerget-Blin & Cie. As demand for their products increased during the World War I period, all these manufacturers entered into licensing agreements with British companies and, in the case of Clerget, an arrangement was made with Gwynnes Ltd. of London. Clerget engines were used in the Sopwith *Camel*, a very successful fighter and scout aircraft. Gwynnes produced a handbook in 1917 to help users of the engine with routine maintenance tasks, and to provide a means of identifying spare parts when required. This book is a reprint of that handbook.

To the internal combustion engine enthusiast the Clerget engine is of some importance as it was arguably one of the best of its type. W. O. Bentley worked for Gwynnes for a time and some of the features of the Clerget design are used on the Bentley BR2 engine. The first 26 pages of the handbook give a general description of the engine followed by instructions on dismantling, re-assembly, adjustment, mounting, precautions before starting and general information on fuel and lubrication.

Thirteen highly detailed and reasonably clear drawings are included to clarify the text. The general arrangement drawing is provided with overall dimensions. The parts list drawings and descriptive tables, which cover a further 17 pages, are very good though since they are not to a fixed scale, it is sometimes difficult to determine the size of the part you are looking at. However, combined with the drawing in the main body of the text, they do give an indication of what would be required to construct a model of one of these engines. Certainly this little book gives a good foundation for further research.

This book provides a glimpse at a once important technology now only extant in museums and the hands of aero engine model enthusiasts.

Clerget Patent Aero Engines – Instructions and Parts List **(ISBN 0-9536523-1-9)** is priced at £8.60 and is published in A5 softback format by **Camden Miniature Steam Services, Barrow Farm, Rode, Frome, Somerset, BA11 6PS; tel: 01373-830151; fax: 01373-830516; email: orders@camdenmin.demon.co.uk website: www.camdenmin.co.uk**

CLUB CHAT
With Malcolm Stride

Dick Ganderton with some Very Important Passengers at Littledown.

UK News

Discussions are continuing within the **National 2½" Gauge Association** membership about the possible recreation of the LBSC design *Ayesha*. One of the problems is that the original design published in *English Mechanics* was different from LBSC's own locomotive. The question for the association to answer is *"Do we provide castings for the 1931 design that purports to be* Ayesha *and is not, or do we provide castings and drawings for an Ivatt Atlantic, with enough detail to enable those who wish to build the Brighton version?"* Several other options have been suggested. Gerald Chandler has already scanned some original drawings and has removed crease marks, etc. The list of castings available for the New Zealand Ab Class 4-6-2 is growing fast and two members are building examples of this locomotive. Steve Eaton has reached the final 'episode' (part 13) of his popular freelance narrow gauge design *Toby*. I expect he breathed a sigh of relief when that was done. He comments *"I am going to have a little rest now and do some building."* I think model engineers owe a great debt of gratitude to those like Steve who put in so much time and effort to produce designs for others to build.

The headline on the front page of the **Bournemouth DMES** News is *"It's Official We Are Open!"* This follows the very successful official opening of their new track at Littledown by the Worshipful Mayor of Bournemouth. The Mayor and other officials arrived in a procession led by Phil Perry and his traction engine. The Mayor congratulated all concerned on their efforts before cutting the tape and was then treated to a ride around the track behind a *Maid of Kent* driven by Dick Ganderton who wore new embroidered overalls and a pair of 'dazzling' white gloves for the occasion. After this the Mayor cut the celebratory cake baked by Jean Brookes and then toured the exhibition. I think all concerned with the new track deserve hearty congratulations on their success. It does not seem many months since the project was started. The **Wessex Model Boat Club** also put on a display of their models at the event which augmented the variety of models on show.

Bradford MES was awarded the 'Best Club Stand' trophy at the recent **Northern Association of MES** exhibition at Risley Conference Centre. This was using their display stand which has been newly fitted with 'down lighters' and aroused considerable interest from other societies because of its ease of assembly. Doug Hewson gave a presentation on 'Lost Wax Casting' to the society in April. Doug had a selection of his castings on display and members were impressed with the level of detail produced by this process. The society's marine section took the new display stand to the Yorkshire Model Marine Expo in April and had a good selection of models on show. In addition to all this, all the rolling stock has been refurbished, the exterior painting of the club house has begun and general tidying has taken place on the site. Ian Collins comments on the display of vintage marine modelling equipment put on by Mark Murray at the **Leeds & Bradford Club** exhibition recently. Ian allowed Mark to display his own Taplin *Twin* engine and also on display were two rare 15cc *Gannet* petrol engines. I remember both these engine designs from my early days with the **Southend Model Power Boat Club** in the 1960s.

David Wainwright from **Brighouse & Halifax ME** reports that the new riding trucks (to the design by David Hudson) are up and running very well. The old trolleys were sold on to other clubs. David mentions that the open days run from Easter to October on the second Sunday of each month and visitors with locomotives (with boiler certificates) are welcome. Contact David (tel: 01484-710672) for more information.

Canterbury DMES (UK) is holding an open day on Sunday 12 September at the track site at Sturry near Canterbury. Further details are available from secretary Mrs. P Barker (tel: 01227-273357).

The **Canvey Railway & MEC** holiday steam up will take place over four days from 22-25 July inclusive and visitors with models are welcome. Those bringing locomotives are asked to book them in advance, especially if the owners wish to store them overnight on site. The club has over 4,000ft. of 7¼in. gauge ground level track (60ft. radius) plus about 75% of 5in. gauge and 1,500ft. of 5in. and 3½in. gauge elevated track. Tea and coffee will be 'on tap' and there will be barbecues on Thursday and Friday evenings and a ploughman's lunch on Saturday. Caravans can be

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.

JULY

9-11 **Vale of Aylesbury MES.** *Thomas Weekend.* Contact Andy Rapley: 01296-420750.
10 **Amnerfield Miniature Railway.** *Steam Open Day (5in. & 7¼in. gauges).* Contact David Jerome: 0118-9700274.
10 **Cardiff MES.** *Lord Mayor's Charity Day.* Contact Trevor Jenkins: 029-2075-5568.
10 **Isle of Wight MES.** *Track & Pond at Broadfields.* Contact Ken Stratton: 01983-531384.
10 **Stockholes Farm MR.** *Birthday Party.* Contact Ivan Smith: 01427-872723.
10 **Talyllyn Railway.** *Victorian Train.* Enquiries: 01654-710472.
10/11 **Birmingham SME.** *Display & Portable Track at Expo 2004, NEC.* Contact John Walker: 01789-266065.
10/11 **British Columbia SME.** *Annual Meet.* Contact Sean Laurence: (604) 931-1547.
10/11 **Kinver & W. Midlands SME Ltd.** ***35th INTERNATION MODEL LOCOMOTIVE EFFICIENCY COMPETITION.*** Everyone welcome. Contact John Hurley: 01902-339275.
10/11 ***Model Expo 2004,*** *National Exhibition Centre, Birmingham. 9.30am-6.30pm (5.30pm Sunday 11th) Information 0121-767-3817 or 0121-767-2439.*
10/11 **North Wiltshire MES.** *Charity Weekend.* Contact Les Stiff: 01249-521658.
11 **Bristol SMEE.** *Public Running Day.* Contact Trevor Chambers: 0145-441-5085.
11 **Cambridge MES.** *Public Running.* Contact Rex Mountfield: 01284-386128.
11 **Canterbury DMES (UK).** *Public Running Day.* Contact Granville Askham: 01227-463295.
11 **Cardiff MES.** *Chernobyl Childrens' Visit.* Contact Trevor Jenkins: 029-2075-5568.
11 **Chichester DSME.** *Driver Training.* Contact Brian Bird: 01243-542266.
11 **East Somerset SMEE.** *Public Running.* Contact Roger Davis: 01749-677195.
11 **Great Western Soc.** (Didcot Railway Centre). *Didcot Steamday.* Contact Jeanette Howse: 01235-817200.
11 **Guildford MES.** *Members' Running Day.* Contact Dave Longhurst: 01428-605424.
11 **Harlington LS.** *Public Open Day.* Contact Peter Tarrant: 01895-851168.
11 **Hereford SME.** *Public Open Day.* Contact Richard Donovan: 01432-760881.
11 **Leeds SMEE.** *Running Day.* Contact Colin Abrey: 01132-649630.
11 **Ottawa Valley Live Steamers.** *Steaming Day.* Contact John Bryant: 761-1109.
11 **Surrey SME.** *Public Running.* Contact John Cook: 020-8397-3932.
11 **Sutton MEC.** *Track Day & Barbecue.* Contact Mike Dean: 0208-657-5401.
11 **Teesside Small Gauge Rly.** *Running.* Contact Mike Aslin: 01642-724255.
12 **Bedford MES.** *Electric Locomotive Running.* Contact Ted Jolliffe: 01234-327791.
12 **Erewash Valley MES.** *Steaming Evening.* Contact Jim Matthews: 01332-705259.
12 **Saffron Walden DSME.** *Club Night.* Contact Jack Setterfield: 01843-596822.
13 **King's Lynn DSME.** *Meeting.* Contact Mike Coote: 01533-673728.
13 **Northampton SME.** *Running Night – Visitors Welcome.* Contact Pete Jarman: 01234-708501 (evenings).
13 **Surrey SME.** *Club Barbecue.* Contact John Cook: 020-8397-3932.
14 **Great Western Soc.** (Didcot Railway Centre). *Didcot Steamday.* Contact Jeanette Howse: 01235-817200.
14 **Norwich DSME.** *AGM.* Contact Paul Reed: 01603-462925.
14 **St. Albans DMES.** *Club Night.* Contact Roy Verden: 01923-220590.
15 **Isle of Wight MES.** *Meeting.* Contact Ken Stratton: 01983-531384.
15 **Sutton MEC.** *Busy Night.* Contact Mike Dean: 0208-657-5401.
15-18 **Talyllyn Railway.** *Have-a-Go Gala.* Enquiries: 01654-710472.
16 **Canvey R&MEC.** *Steam-Up.* Contact Brian Baker: 01702-512752.
16 **Chichester DSME.** *Driver Training.* Contact Brian Bird: 01243-542266.
16 **North London SME.** *Barbecue at Colney Heath.* Contact David Harris: 01707-326518.
16 **Rochdale SMEE.** *Visit to East Lancashire Railway.* Contact Mike Foster: 01706-360849.
16 **Romford MEC.** *Track Maintenance.* Contact Colin Hunt: 01708-709302.
16-18 **Guild of Model Wheelwrights** *at Chiltern Show, Great Missenden, Buckinghamshire.* Contact Biddy Hepper: 01492-623274.
17 **Basingstoke DMES.** *Members' Running Day.* Contact Guy Harding: 01256-844861.
17 **Erewash Valley MES.** *30th Anniversary Barbecue Event.* Contact Jim Matthews: 01332-705259.

Bill Ballan and his K1 at Gilling.

The goods yard at Gilling.

accommodated on site by arrangement, and there is plenty of accommodation in the area. For further information please contact Ron Hill (tel: 01702-558743) or Brian Baker (tel: 01702-512752).

We have received information about the next **Ground Level 5" Gauge** rally which will be held over the 28-30 August Bank Holiday weekend at the Gilling site. Application forms for locomotive entries are via Doug Hewson at **doug@the-hewsons.demon.co.uk** or tel: 01652-688408. The closing date for entries will be 10 August. Doug has also sent information about the recent weekend when 44 locomotives were in attendance and the new goods yard and signal box were opened the night before the event. Doug commented *"We do things on the Just in Time basis!"* The new yard and carriage sheds have involved making and laying 28 new points and building another 30 lever fully interlocked frame for the signal box.

Another society carrying out extensive track maintenance and improvement has been **King's Lynn DSME** where, among other things members have put around 30 tonnes of granite chippings around the outside of their track. Various other tasks have also been carried out including some concreting and correction of 'anti-cambers'. As with many other clubs, insurance costs have raised their head at the society. A smallish society, King's Lynn has been hit to a proportionally greater extent by the recent increases. The 25 April fun run resulted in a greater number of locomotives running than previously with a good mixture of 'diesel' and steam in operation.

The first steaming day at **Leeds SMEE** also saw a good turnout of 14 drivers and locomotives. As Chairman Alf Bamfield comments *"this is not bad since in previous years it has taken a while before the old links and joints have warmed up."* I wonder whether Alf was referring to the locomotives or drivers? Two members whose joints did not need warming up were juniors Josh McHugh and Henry Chapman who *"looked to be having a good time."* Member David Beale has suggested that an appropriate subject for discussion has been prompted by the desire to work out how much power his 30cc petrol electric locomotive needs to develop. The society is holding its rally on 14/15 August this year.

Boiler testing day for the **Maxitrak Owners Club** has now come and gone with a good selection of locomotives and traction engines taking advantage of the facilities available. The annual rally will be held at the **Surrey SME** track at Leatherhead on Saturday 7 August. Further details can be obtained from secretary Eric Penn (tel: 020-8979-4335 or e-mail at **eric.penn@btinternet.com**). The magazine also contains two articles on loading and unloading large locomotives from cars to storage and vice versa. Jeff Dickinson uses a lifting table and 'transfer trolley' while Dave Bayliss uses a lifting table to load his Arthur locomotive *Kate* straight into his van. This reminds me of a question I have discussed with others recently which is *"does normal car insurance cover injuries caused by a heavy locomotive moving about in the back of a family estate car?"* With larger 7¼in. gauge locomotives now being relatively common, the question is probably more important than previously. Readers views on the subject are welcome.

We have received information on the dates of the **Northern Mill Engine Society** museum (near Bolton, Lancashire) opening days this year. The dates remaining after publication of this issue are 29/30 August and 11/12 September. Further details can be obtained from the excellent web site at **www.nmes.org**

North London SME had an interesting 'Work in Progress' meeting recently with several items 'on the table' including Grahame Ainge's B1 tender which is of the Great Eastern pattern rather than the LNER standard pattern. Grahame obtained drawings for this tender from Glasgow University and had to carry out some adjustments to locomotive and tender to align the footplate heights. Adam Gorski had part of an 'N' gauge diorama based on a greeting card scene. It includes thatch made from plumbers hemp and applied using the correct thatching techniques. Bert Mead had a gauge 1 South Western D15 locomotive based on the *Project* design. Peter Badger had his hot air engine which among other things uses two Coca-Cola cans and a baked bean can for the displacer. A 3½in. gauge Peppercorn A1 rolling chassis was brought along by Ron Price. Derek Perham has been working on the backhead cleading for his 5in. gauge Black Five which is being done to a high level of detail. Dave Lawrence has been experimenting with a propane fired furnace for melting steel for lost

17	**Fareham DSME.** *Fareham Gala Day.* Contact Trevor Fry: 01329-285779.
17	**North Norfolk MEC.** *Barbecue at Track.* Contact Gordon Ford: 01263-512350.
17	**Romford MEC.** *Track Afternoon.* Contact Colin Hunt: 01708-709302.
17	**Steam LS of Victoria.** *Club Running.* Contact Graham Plaskett: (03) 9750-5022.
17/18	**Brede Steam Engine Society.** *Centenary Celebrations.* Contact John Foxley: 01323-897310.
17/18	**Guildford MES.** *Rally & Exhibition Weekend.* Contact Dave Longhurst: 01428-605424.
17/18	**Guild of Model Wheelwrights** *at Much Marcle Steam Rally, Herefordshire.* Contact Biddy Hepper: 01492-623274.
17/18	**National 2½in. Gauge Ass'n (Southern Region).** *Guildford Weekend.* Contact John Cook: 0208-397-3932.
17/18	**Peterborough SME.** *Sacrewell Rally.* Contact Tony Meek: 01778-345142.
17/18	**Southport Model Engineering Club.** *Open Weekend.* Contact Craig Skelland: 07867-973443.
18	**Bedford MES.** *Public Running.* Contact Ted Jolliffe: 01234-327791.
18	**Great Western Soc.** (Didcot Railway Centre). *Didcot Steam & Railcar Day.* Contact Jeanette Howse: 01235-817200.
18	**Keighley DMES.** *Open Day.* Contact K. Parkin: 01274-564866.
18	**Oxford (City of) SME.** *Public Running.* Contact Chris Kelland: 01235-770836.
18	**Pinewood MRS.** *Public Running.* Contact Ivan Hurst: 01276-28803.
18	**Plymouth MSLS.** *Running.* Contact John Brooker: 01752-671722.
18	**Rugby MES.** *Public Running.* Contact David Eadon: 01788-576956.
18	**Saffron Walden DSME.** *Running Day (public pm).* Contact Jack Setterfield: 01843-596822.
18	**Taunton ME.** *Public Running Day.* Contact Don Martin: 01460-63162.
18	**Teesside Small Gauge Rly.** *Running.* Contact Mike Aslin: 01642-724255.
18	**Wimborne DSME.** *Running Day.* Contact Eric Basire: 01202-897158.
18	**Woking MRS.** *Teddy Bears' Picnic.* Contact Ronald Dewar: 01932-343331.
18	**York City &DSME.** *Running Day.* Contact Pat Martindale: 01262-676291.
19	**Chesterfield MES.** *Running Day.* Contact Mike Rhodes: 01623-648676.
19	**Lancaster & Morecambe MES.** *Chris Oxborrow: Lancaster Canal Trust.* Contact Harry Carr: 01524-411956.
19	**Peterborough SME.** *Bits & Pieces.* Contact Tony Meek: 01778-345142.
19	**Salisbury DMES.** *Summer Meeting.* Contact Pete Parrish: 01980-610346.
19	**Steam LS of Victoria.** *Club Run.* Contact Graham Plaskett: (03) 9750-5022.
20	**Basingstoke DMES.** *Meeting Night.* Contact Guy Harding: 01256-844861.
20	**Chesterfield MES.** *Mike Eggington: G.C. Talk.* Contact Mike Rhodes: 01623-648676.
20	**South Durham SME.** *Evening Steam-Up.* Contact B. Owens: 01325-721503.
21	**Bournemouth DSME.** *AGM & Geoff Wright: The Joys of Building a Rocket.* Contact Mike Baker: 01202-383653.
21	**Great Western Soc.** (Didcot Railway Centre). *Didcot Steamday.* Contact Jeanette Howse: 01235-817200.
21	**Hull DSME.** *Shep, Watson & Wilson Trophy Competition at West Park.* Contact Tony Finn: 01482-898434.
21	**Maidstone MES (UK).** *Members' Afternoon Playtime Run.* Contact Martin Parham: 01622-630298.
21	**West Wiltshire SME.** *Steam-Up.* Contact R. Nev. Boulton: 01380-828101.
22	**Leyland SME.** *Pipework/Platework Night.* Contact Mark Entwistle: 01772-422411.
22	**Sutton MEC.** *Evening Steam-Up.* Contact Mike Dean: 0208-657-5401.
22	**Worthing DSME.** *Michael Wheelwright: Brakes, Large and Small.* Contact Bob Phillips: 01903-243018.
22-25	**Canvey R&MEC.** *Modellers' Days including Open Days for Visiting Clubs.* Contact Brian Baker: 01702-512752.
23-26	**Isle of Wight MES.** *Thomas at Havenstreet.* Contact Ken Stratton: 01983-531384.
24	**Leyland SME.** *Junior Members & Guests Afternoon Driving Session.* Contact Mark Entwistle: 01772-422411.
24/25	**Claymills Pumping Engines.** *Steaming.* Claymills Pumping Engine Trust., Meadow Lane, Stretton, Burton on Trent, Staffordshire. Contact B. Eastough: 01283-812501.
24/25	**Fareham DSME.** *Open Weekend.* Contact Trevor Fry: 01329-285779.

In Memoriam

It is with the deepest regret that we record the passing of the following members of model engineering societies. The sympathy of staff at *Model Engineer* is extended to the family and friends they leave behind.

Jack Boothman	*Northern Mill Engine Society*
Peter Davis	*North Norfolk MEC*
David Halsey	*National 2½" Gauge Association*
Stuart Robinson	*Rugby MES*
John G. Shaw (of Gloucestershire)	*North London SME*
Trevor Summerfield	*North Norfolk MEC*

wax casting. So far Dave has reached the 'bronze age' with his furnace. Grahame Ainge is also stepping down as Newsletter Editor in October after five years to give someone else a chance. As an 'outside recipient' of Grahame's efforts I would like to congratulate him on the excellent journal that he produces.

The **North Wiltshire MES** 'Tuesday Club' have been busy carrying out maintenance and other tasks round the Coate Water site. Despite comments that *"the work rate is not very high (too much talking and drinking tea)"* the backlog of jobs is diminishing. Areas worthy of particular mention are the station area and the installation of a ticket office. The club has a new website at **www.communigate.co.uk/wilts/northwiltsmes**

Cosme Link, journal of the **City of Oxford SME**, has reached a major milestone with its 200th issue. Over the winter season work has taken place on re-aligning some sections of track with the workers having *"to put up with the freezing cold, biting winds, rain, hail and snow"* but *"they have continued on regardless."* We model engineers are a hardy lot, aren't we? The club has also replaced some Halon fire extinguishers which have been illegal to use since 2002. Other clubs may care to check as this has not been publicised at all widely. The annual COSME 'Dreaming Spires' rally will be held on 24/25 July this year.

The 35th anniversary dinner of **Romney Marsh MES** was a well attended affair with 65 members and wives plus others attending. They all sat down to an excellent meal and everyone present enjoyed the evening. The club has a very busy programme of events for the year with what seems to be something on most weekends including several 'Saturday Track Meetings' The garden railway extension is taking shape and the Wednesday Gang have *"all but finished"* the club house extension.

The second new 7¼in. gauge carriage was 'rolled out' on 15 February at **Rugby MES** and work is now progressing on the third. As with most other clubs, lots of work has been carried out over the winter including re-laying of track, improving the second track crossing and general tidying up. I think all clubs owe a big vote of thanks to all those stalwarts who turn out in all weathers to perform these 'non-engineering' tasks for the benefit of others. The club magazine *Roundhouse* has a new Editor in the person of Simon Rolfe. We all wish Simon well in his new role. Member Ian Clipston recounts his adventures with building a 7¼in. petrol 0-4-0 locomotive, including the engine destroying itself with a collapsed piston. Luckily Ian had another engine available which he has adapted to fit.

Salisbury DMES have sent details of their programme of talks for the year. On August 16 Ivan Perryman will be talking about 'Model Boiler Making' and on 20 September Adam Harris will be talking on 'The Future of Model Engineering'. All meetings start at 7:30pm at the St. Nicholas Church Hall, Winterslow Road, Porton, near Salisbury and further information can be obtained by telephone from 01980-610346 or 01264-781607.

World News

Australia

Members of the **Steam Locomotive Society of Victoria** are making good progress with the upgrade of their elevated track. The front oval track was used as a trial and President Fino Faccenda comments *"Oh boy! Was that a fast learning curve!"* I am sure many readers will have sympathy with that comment. I find it amazing what we model engineers tackle on a 'find out as you go along basis.'

New Zealand

Mike Coghlan shared more of his bush tramway knowledge with members of **Hutt Valley MES** recently with information on 'the contraptions used on various trams.' This included such well-known names as Heisler and Climax, but also many lesser names. One of these lesser locomotives was the *"Johnson 16-wheeler which had too much of everything and the bushman coming home behind the log train had a sack to gather all the bits that fell off the locomotive."*

Maidstone MES (NZ) report that they opened their railway in conjunction with the Rimutaka Trust sponsored 'Blues, Brews and Barbecues Festival' in Maidstone Park. Peter Carr ran his 7¼in. *Owain Glyndwr*, Trevor Watt his 5in. gauge *Diana* and Barry O'Callaghan his 7¼in. gauge petrol Hunslet. The day was reported as successful.

South Africa

The **Durban SME** steaming bay now has a roof, although it is still to be fully completed. Other tasks carried out are repairs to the traverser and turntable and bush clearing. Member Neal Roberts had the first steam up of his new *Rob Roy* and is reported as *"having made a very good job of it."* The society suffered a break-in at the club house recently with entry being made via the kitchen roof and ceiling. The miscreants came prepared with bolt cutters and equipment to disable the burglar alarm. Some damage was inflicted to doors and locks in the process. I am sure many readers will sympathise having experienced similar frustrating situations resulting in more work for those who really just want to enjoy their hobby of model engineering.

United States of America

A recent visit to the Mazda R&D convention reported in the journal of the **Bay Area Engine Modellers** was much appreciated, particularly by Mrs. Hurst whose husband Ken is reported as to be buying her a new Mazda car. Member Pat O'Connor is building an engine described as a *"twin crankshaft, two stroke, opposed piston, spark ignition, uniflow engine."* Unusual indeed!

24/25	**Oxford (City of) SME.** *Dreaming Spires Rally 2004.* Contact Chris Kelland: 01235-770836.
25	**Amnerfield Miniature Railway.** *Public Running.* Contact David Jerome: 0118-9700274.
25	**Bristol SMEE.** *Public Running Day.* Contact Trevor Chambers: 0145-441-5085.
25	**Cardiff MES.** *Public Running Day.* Contact Trevor Jenkins: 029-2075-5568.
25	**Chichester DSME.** *Steam on Sunday.* Contact Brian Bird: 01243-542266.
25	**Elmdon MES.** *Public Running.* Contact Chris Giles: 0121-458-1291.
25	**Frimley & Ascot LC.** *Club Running.* Contact Bob Dowman: 01252-835042.
25	**Great Western Soc.** (Didcot Railway Centre). *Family Activity Steamday.* Contact Jeanette Howse: 01235-817200.
25	**Guildford MES.** *Driver Training Day.* Contact Dave Longhurst: 01428-605424.
25	**Harlington LS.** *Public Open Day.* Contact Peter Tarrant: 01895-851168.
25	**Hereford SME.** *Public Open Day & Charity Event.* Contact Richard Donovan: 01432-760881.
25	**High Wycombe MEC.** *Public Running.* Contact David Savage: 01494-527402.
25	**Otago MES.** *Public Running.* Contact John Clover, 221 Ravensbourne Road, Ravenbourne 9002, New Zealand.
25	**Ottawa Valley Live Steamers.** *Steaming Day.* Contact John Bryant: 761-1109.
25	**Staines SME.** *Passenger Day.* Contact Stan Bishop: 01784-241891.
25	**Teesside Small Gauge Rly.** *Running.* Contact Mike Aslin: 01642-724255.
25	**Wigan DMES.** *Open Day.* Contact John Chamberlain: 01744-882255.
25-31	**Talyllyn Railway.** *Victorian Week.* Enquiries: 01654-710472.
26	**Bedford MES.** *Toyshop Steam.* Contact Ted Jolliffe: 01234-327791.
28	**Great Western Soc.** (Didcot Railway Centre). *Didcot Steam & Railcar Day.* Contact Jeanette Howse: 01235-817200.
29	**Sutton Coldfield MES.** *Visit by Sutton Coldfield RS.* Contact Neal Harrison: 0121-378-3992.
29	**Wimborne DSME.** *Annual Barbecue.* Contact Eric Basire: 01202-897158.
30	**Chichester DSME.** *OGM.* Contact Brian Bird: 01243-542266.
31	**Hereford SME.** *GL5 Society AGM.* Contact Richard Donovan: 01432-760881.

AUGUST

1	**Bristol SMEE.** *Public Running Day.* Contact Trevor Chambers: 0145-441-5085.
1	**Ellenroad Engine House**, Elizabethan Way, Milnrow, Rochdale, Lancashire OL16 4LE. *In Steam plus Demonstration of Woodturning.* Enquiries: 01706-881952.
1	**Frimley & Ascot LC.** *Public Running.* Contact Bob Dowman: 01252-835042.
1	**Great Western Soc.** (Didcot Railway Centre). *Didcot Steam & Railcar Day.* Contact Jeanette Howse: 01235-817200.
1	**Guildford MES.** *Members' Running Day.* Contact Dave Longhurst: 01428-605424.
1	**Hull DSME.** *Dove House Hospice Charity Running Day at West Park.* Contact Tony Finn: 01482-898434.
1	**Leyland SME.** *Scale Running Day.* Contact Mark Entwistle: 01772-422411.
1	**Malden DSME.** *Public Open Day.* Contact John Mottram: 01483-473786.
1	**National 2½in. Gauge Ass'n.** *Midlands Area Summer Rally at Little Hay.* Contact Clive Young: 01233-626455.
1	**North London SME.** *Toy Boat Regatta.* Contact David Harris: 01707-326518.
1	**Oxford (City of) SME.** *Public Running.* Contact Chris Kelland: 01235-770836.
1	**Peterborough SME.** *Visit by Erewash Valley MES.* Contact Tony Meek: 01778-345142.
1	**Plymouth MSLS.** *Running.* Contact John Brooker: 01752-671722.
1	**Reading SME.** *Public Running.* Contact Graham Bustin: 0118-9615450.
1	**Royston DMES.** *Running Day.* Contact Jeff Dickinson: 01763-261670.
1	**South Durham SME.** *Running Day.* Contact B. Owens: 01325-721503.
1	**Steam LS of Victoria.** *Public Running.* Contact Graham Plaskett: (03) 9750-5022.
1	**Sutton Coldfield MES.** *National 2½in Gauge Ass'n Rally.* Contact Neal Harrison: 0121-378-3992.
1	**Taunton ME.** *Public Running Day.* Contact Don Martin: 01460-63162.
1	**Teesside Small Gauge Rly.** *Running.* Contact Mike Aslin: 01642-724255.
1	**Wimborne & District SME.** *Running Day.* Contact Eric Basire: 01202-897158.
1	**York City & DSME.** *75th Anniversary Invitation Running Day.* Contact Pat Martindale: 01262-676291.

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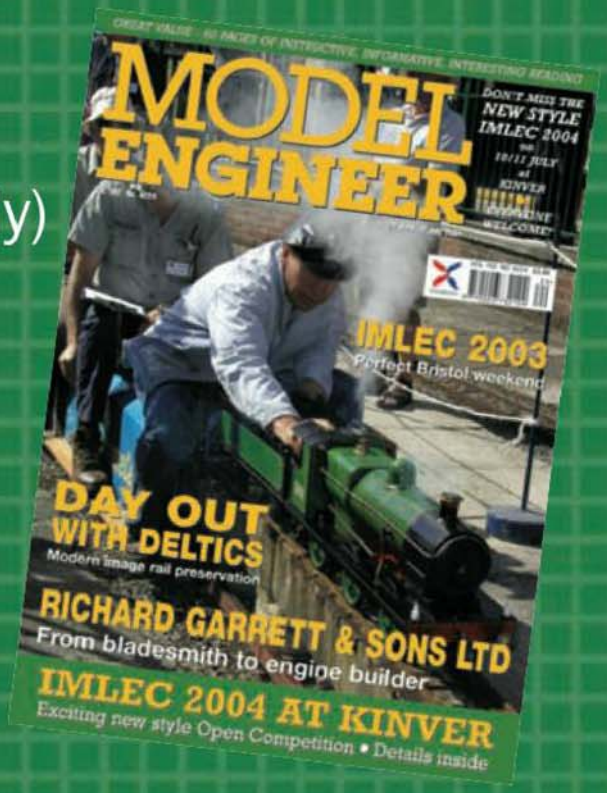

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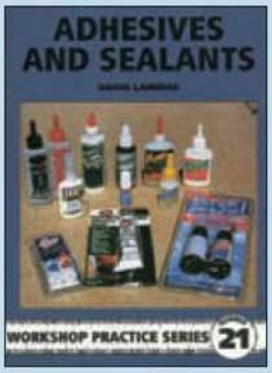

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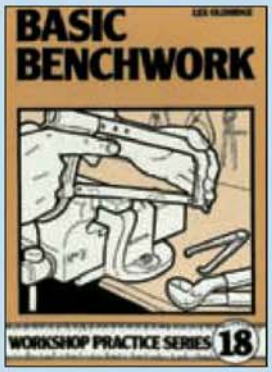

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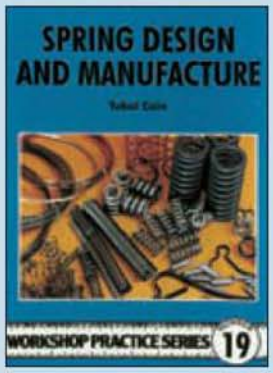

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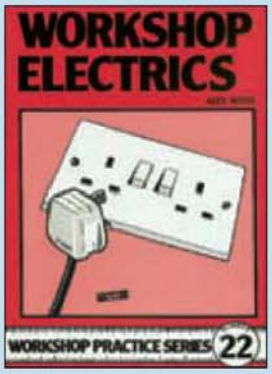

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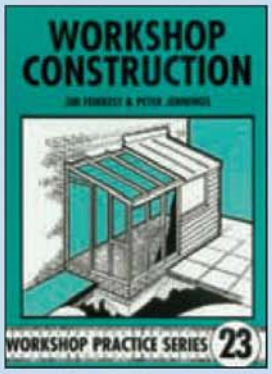

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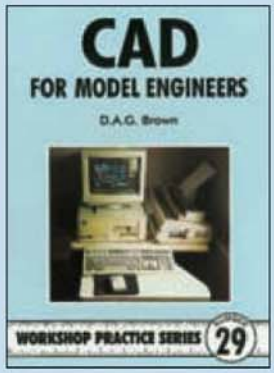

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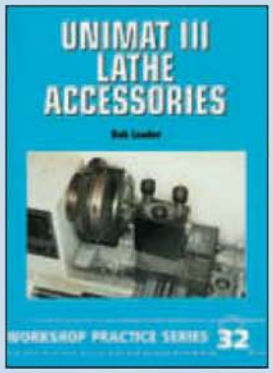

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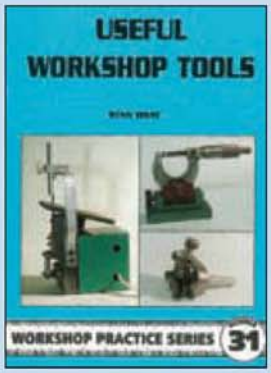

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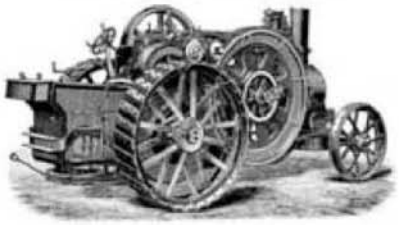

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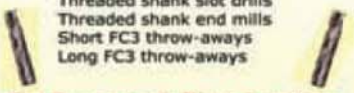

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HOME AND WORKSHOP MACHINERY

QUALITY USED MACHINE TOOLS

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£345
RJH BT125 variable speed fretsaw / tilt


£425
Hare 51T press complete with index table


£3950
Colchester Triumph 2000 + gap bed


£345
Abwood precision grinder


£345
Tom Senior slotting head


£345
Rishton quality buffer


Asquith 14 54, 5 Morse Taper radial drill
£3950


£1400
Raglan 5" x 24" full screwcutting lathe


£675
Myford ML7 capstan lathe


£375
Harrison L5/L5A/140 capstan attachment


£625
RJH 4" linisher + built in extractor


£345
Q & S 6" hacksaw





£1375
We have just had 5 of these 'Colchester Bantam' lathes in all the same in extremely good condition and at a very good price of £1375 each.



£3950
We have just received this 'as new' flagship 'Myford 280' lathe complete with 3 and 4 jaw chucks never used from new £3950


£425
Meddings Imet ideal 250 cut off saw


£2950
Harrison M250, 5" x 20", rare 3000rpm model


£2950
Colchester 1800 lathe 6" x 24" + gap bed


Selection of granite surface plates from £70


£425
Meritus spot welder


Selection of stakes from £5 to £65

LATHES

BOXFORD TUD 41/2" x 20" **MK11** 3 jaw chuck, cabinet stand, hand feeds ..... ***Choice*** £395
BOXFORD CUD 41/2" x 20", changewheels, 3 jaw chuck, cabinet stand ..... ***still only*** £750
BOXFORD AUD 41/2" x 20", gearbox, power cross-feed, 3 jaw chuck, coolant, cabinet stand ..... ***240 volts and in really nice condition*** £1525
BOXFORD CUD 5" x 22" **MKIII**, c/wheels, 3 jaw chuck, 4 way toolpost £1250
BOXFORD BUD 5" x 22" **MKIII**, c/wheels, power cross feed, T-slotted cross slide £1400
BOXFORD AUD 5" x 22" **MK111**, gearbox, power cross feed, T. slotted cross slide, cabinet stand ..... ***very nice*** £1625
BOXFORD 1130 INDUSTRIAL 51/2" X 30", geared head, gearbox, power feeds, 3 & 4 jaw chucks, splash tray and light £2450
COLCHESTER BANTAM 5" x 20", full gearbox, geared head, power feeds ..... ***exceptional condition*** £1350
COLCHESTER BANTAM1600 model, 5" x 20", geared head, power feeds, gearbox £1400
COLCHESTER BANTAM 2000, 51/2" centre height x 30" between centres, 1 3/8" bore, 9 speeds (52-2000rpm), D13 camlock fitting, 3 and 4 jaw chucks, Dickson tool post, bed stop ..... ***In very nice condition and LATEST MODEL MADE*** £3750
COLCHESTER STUDENT Square head, 1500 revs / 2 speed motor model, geared head, gearbox, imperial / metric, power cross feed and gap bed, dual dials, 3 Jaw chuck, taper turning, coolant, etc. £2,950
COLCHESTER MASTER 61/2" X 36", gap bed, gearbox, power feeds, coolant ..... ***nice*** £1750
COLCHESTER MASTER SQUARE HEAD 61/2" X 36" precision lathe, gearbox, power feeds, chucks, Dickson Tool post ..... ***In nice condition*** £2250
COLCHESTER MASTER 2500; Short and long bed lathes well equipped £2950
COLCHESTER TRIUMPH 71/2" x 25", 3 jaw chuck, Dickson tool post ..... ***very nice ex. college Each*** £3950
HARRISON L5, 41/2" x 24", fully tooled, complete with clutch ..... ***one of the best start up deals*** £950
HARRISON 140, 51/2" x 24", geared head, semi gearbox, 3 jaw chuck, gap bed, power feeds, clutch £1400
HARRISON 140, 51/2" x 24", geared head, gearbox, gap bed, power feeds, tooling, coolant £1725
HARRISON M250, 5" x 20", gearbox, power feeds, 3 & 4 chucks ..... ***nice condition*** £2950
HARRISON M250, 5" x 20", gearbox, power feeds, 3 and 4 chucks complete with DRO £3250
HARRISON M250, 5" x 30", long bed, gearbox, power feeds, chucks. Acurite III DRO on cross-slide, dual dials ..... ***In very nice condition*** £3250
HARRISON M300 6" x 24" precision lathe, geared head, gearbox, power feeds, 3 jaw & 4 jaw chucks ..... ***Choice*** £3250
MYFORD ML7 31/2" x 19" lathe, 3 jaw chuck ..***we have a large selection of this popular model from*** £600
MYFORD SUPER 7 31/2" x 19" changewheels, 3 jaw chuck and tooling ..... ***Choice*** £950 - £1150
MYFORD SUPER 7, 31/2" x 19" 3 jaw chuck, power cross-feed ..... ***Late model Choice***
MYFORD SUPER 7 31/2" x 31" changewheels, 3 jaw chuck and tooling ..... ***Choice*** £1400
MYFORD SUPER 7B 31/2" x 19" gearbox, 3 jaw chuck and tooling £1650
MYFORD SUPER 7B 31/2" x 19" gearbox, Power Cross Feed, cabinet stand, tooling £2750
MYFORD C7 CAPSTAN LATHE £1200
MYFORD 280 11" x 23 5/8", As new and never used, Myfords flagship lathe only discontinued because it was **so expensive for its time; completely metric, enclosed screwcutting, enclosed apron with oil bath, Apron protected by torque limiter, hardened and precision V bedways, Gamet precision machine tool bearings, hardened feed box gears, hardened and Reishauer-ground-head – stock spindle drive gears; the list goes on with D13 fitting complete with 3 and 4 jaw chucks at only** £3950
VICEROY TDS 1 GBL 5" x 24", gearbox, power slides, 3MT tailstock complete with fixed steady £1250
TOO MANY LATHES TO LIST!!

MILLING MACHINES

V - VERTICAL, H - HORIZONTAL

ACIERA F3 Universal Milling Machine Complete with Collets 1/16" - 5/8" & 2MM - 20MM, Suds and Light in all round good condition £3250
BOXFORD VM30 vertical variable speed / 30 INT head, table 211/2" x 6" + Abwood vice and chuck £1500
BRIDGEPORT vertical belt head 2 speed (short motor) head, R8 powered head complete with 71/2" raising block,42" x 9" table £1950
CENTEC 2A Vertical / Horizontal, swivel 2MT head, 16" x 41/4" table, pedestal model ..... 'as is' £750
CENTEC 2B Horizontal, 1" arbor, table powered, 3 ph motor, single phase main motor £725
CENTEC 2B Vertical / Horizontal, quill 2MT head, 25" x 5' table, pedestal model £1400
ELLIOT MINIBORER (Jig borer) collet fixture head with good selection of collets, ... £1200
ELLIOT '00' OMNIMILL V/H 3 Morse taper quill universal head, 28" x 71/2" powered table £1250
HARRISON Vertical 30 INT swivel head & clutch, 30" x 8" table / powered £1650
HARRISON horizontal, 31" x 8" powered table ..... still good value £625
HARRISON H/V 30 INT swivel head & clutch, 30" x 8" table/powered £1650
HOBBYMAT milling heads ..... Various
MARLOW VERTICAL TURRET TYPE MILL, 3 MT, 28 x 7" ..A favorite mill for its height under the head ..£950
SIP RF30, vertical milling/drilling machine complete with accessories ..... Still only and New £799
TOM SENIOR M1 horizontal, 25" x 6" powered table, 1" arbor £575
TOM SENIOR M1 V/H, 25" x 6", 2 MT, 1" arbor. ..... Selection £1200 - £1950
TOM SENIOR ELT MAJOR, 2 MT quill feed head, powered 37" x 81/2" table in £2,750
VICEROY AEW vertical mill, 30 INT swivel head, powered table 34"x 8", ... choice £1250 - £1625

DRILLS

ASQUITH 14-54 001 Mk2, 5MT radial drill £3950
BOXFORD 2MT pedestal drill £295
FOBCO 1/2" bench, tilting table £325
FOBCO 1/2" pedestal drill tilting table £345
MEDDINGS 1/2" pedestal drill £245
MEDDINGS 2MT pedestal drills £275
POLLARD CORONA pedestal 1/2"/1MT ..... From £100
SIP HDP 600B 5/8" / 2MT bench drill, table operated by rack, speeds; (16) 162 - 3000 rpm ..... New £175
STARTRITE Mercury 1/2" 4 speed bench drill £225

GRINDING / BUFFING

ABWOOD tool and cutter grinder £425
CLARKSON MKI Tool and cutter grinder complete with universal head and centres £550
EAGLE 4W wet surface grinder + magnetic chuck £725
HERBERT drill grinder + followers is £245
MILFORD 12" Pedestal Grinder £325
VICEROY Grinder, pedestal model £145
VICEROY Buffers, pedestal models ..... each £250

MISCELLANEOUS / FABRICATION MACHINERY

Deals on some machinery needing an overhaul or good clean and paint !!
BOXFORD 4 1/2" / 5" steadies in ..... £45 / £85
BOXFORD vertical slide £445
RECORD 3" / 4"drilling vices ..... NEW £10 / £15
HUNTON BOLSTER No.2 base + rings £245
BESSBORO 8" rotary table £245
ECLIPSE DE-MAGNETISER £70
ROTATING CENTRES 2MT & 3MT for tube work ..... NEW £40
MECA dividing head + tailstock, gears, banjo ..... very nice £425
LXL indexing attachment complete with 8" jaw £125
SWIVEL ANGLE PLATE 12" x 9" £65
PNEUGRIP air vice / machine vice 3 "" £75
EQUI-SPACER (Midland Machine Tool Co.) indexing head complete with 6" 3 jaw chuck £245
NAREX 40INT universal boring head ..... Boxed ..£345
A. HURST / ALCON set; jacking dogs £45
BARBER COLMAN CO. bench centres £45
MYFORD 4" & BOXFORD 5" back-plates ..... special £22
RAGLAN / LITTLEJOHN lathe set of collets and draw bar, all metric and as new (at least 20) £345
MYFORD dividing head (boxed) suit ML10, ML7, Super 7 lathes £450
HPC TWO STAGE twin large compressor £675
GABRO 24" box and pan folder £325
BATY digital vernier 6" with metric / imperial, origin and absolute buttons ..... NEW £35
EDWARDS 39-1/2" x 16g treadle guillotine with all its stops in very nice order £625
ALCOSA hearth ..... Just in £245
WELLSAW 4" hacksaw £325
RJH horizontal 4" linisher complete with built in dust extractor £625
RJH vertical 4" linisher complete with built in dust extractor ..... very nice machine £750
OMT Optical Measuring Tools universal boring head, 40 INT, boxed + tooling £345
CLARKE strip heater, 110 amps in very good order £75
MITUTOYO 7-8", 9-10", 10-11", 11-12" micrometers just in ..... EACH just £45
ABWOOD SWIVEL/TILT 4" vice in all round good condition £245
ABWOOD SWIVEL/TILT 6" vice in all round good condition £375
CLARKSON RADIUS MK1 radius grinding attachment in nice condition ..... BOXED £345
NEW FROM NEW ZEALAND:- Machine vice, 55mm. Jaws precision miniature type ideal for vertical slides and smaller milling machines such as BCA now with the swivel base £134
Vice on own £85
Swivel base on own £49
CROMPTON PARKINSON 1/4 HP, resilient mount, Boxford / Myford Super 7 Type motor ..... New £140
MYFORD RODNEY HEAD MILLING HEAD FOR THE MYFORD ML10 ..... £550
MYFORD CAPSTAN ATTACHMENT (LARGE BED TYPE) £550
HOFFMAN DIVIDING HEAD Complete with tailstock £425
ARCHER Tapping Heads ..... FROM £70

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- 2-Axis DRO from £615 inc vat
- Made in the UK
- 5 year No-Fault Warranty
- 10 micron Accuracy

£380

Complete with a USA Built PCB

Conquest Lathe

- Centre Height: 90mm • Distance Between Centres: 325mm
- Large MT3 Spindle Taper • Spindle Bore: 19mm
- Now C/W Quick Change Toolpost • Variable Speed Range 100-2500rpm • Metric or Imperial Leadscrews

CHESTER U.K. LIMITED
MACHINE AND TOOLING SPECIALISTS

Cobra Lathe

£275

- Centre height: 70mm
- Distance Between Centres: 250mm
- Speed Range: 100-200rpm
- Metric or Imperial Leadscrews
- Variable Speed Control

NOW INCLUDES A FREE 80mm 4 JAW CHUCK

920 Lathe

£599

- Centre Height: 120mm
- Distance Between Centres 500mm
- Complete with 3 & 4 Jaw Chucks
- Fixed & Travelling Steadies
- Face Plate
- Machine Tray & Splash Guard

DB8 Lathe

£699

- Centre Height: 105mm • Distance Between Centres: 400mm • Complete with 3 & 4 Jaw Chucks, Fixed & Travelling Steadies & Face Plate
- Hardened & Ground Bedways

DB10G Lathe

£850

- Centre Height: 125mm • Distance Between Centres: 550mm • Thread Cutting Gearbox • Complete with 3 & 4 Jaw Chucks, Fixed & Travelling Steadies & Face Plate • Vee Bedway

Model B Super

£670

- Maximum Swing: 420mm
- Distance Between Centres: 520mm
- Cast Iron Construction
- Metric or Imperial
- All Tapers MT3
- Supplied with 3-Jaw Chuck, Drill Chuck & Arbor and more!

Centurion

£1100

- Distance Between Centres: 520mm
- Centre Height: 210mm • Spindle Bore: 28mm
- Powered Crossfeed • Separate Motor for Lathe/Mill
- Complete with 5" 3-Jaw Chuck, Lathe Tools, Change Gear and more!

Craftsman Lathe

£1499

- Centre Height: 150mm
- Distance Between Centres: 570mm
- Swing in Gap: 450mm
- Powered Crossfeed
- Spindle Bore: 36mm
- Complete with 3 & 4 Jaw Chucks, Fixed & Travelling Steadies, Face Plate, Machine Stand, Accuracy Report & much more!

Crusader Lathe

£1950

- Centre Height: 150mm • Distance Between Centres: 860mm • Complete with 3 & 4 Jaw Chucks
- Fixed & Travelling Steadies • Face Plate
- Machine Tray • Splash Guard • Machine Stand

CUB Geared Head Lathe

£2460

- Centre Height: 150mm • Distance Between Centres: 500/750mm • Complete with 3 & 4 Jaw Chucks
- Fixed & Travelling Steadies • Face Plate
- Machine Tray • Splash Guard • Machine Stand

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