USEFUL ADDITIONS FOR THE LATHE

For beginners (and experts), a couple of easy to make items which will enhance the operation and enjoyment of your lathe ...

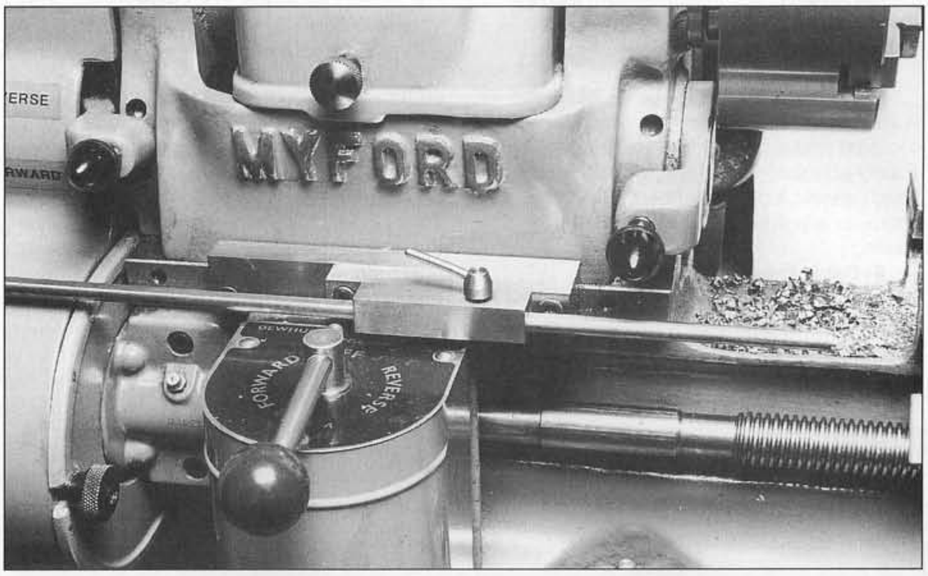
Although most lathes available from the major manufacturers are perfectly adequate for the model engineer's needs, there are many items which can make life easier for the modeller. Some of these items can be supplied as accessories from the lathe manufacturer and, indeed, the larger and more complicated ones are probably best obtained in this way. But there are many smaller accessories which should be well within the scope of the modeller to make for himself.

Two such items are described in this article. Both of these items are quite straightforward and easy to make and, from my own experience, will prove to be very useful additions to the modeller's lathe and make it much easier to perform certain machining operations. With the exception of a few socket cap screws, they are all made from standard mild steel sections which can be bought from the Trade suppliers (or may even be in stock in the modeller's own workshop).

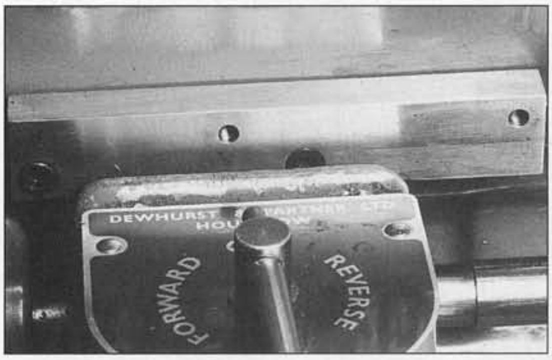
The lathe saddle stop can be used to provide a fixed point at which to end surfacing (or lengthways) cuts, as well as providing a datum for measuring the length of shoulders and positioning undercuts etc. The saddle lock handle just avoids the need to fiddle with spanners and is a much quicker way of working. How often have you "lost" the spanner amongst the usual accumulation of tools and swarf which collects under the lathe during a working session?

The additions described below were made for a Myford ML7 lathe, so the dimensions given are all based on that machine. However, the basic principles can be applied to any make of lathe and the dimensions may be amended to suit.

Here I will ask the more experienced readers to bear with me in the detailed constructional notes which follow. I will make no apologies for describing seemingly easy and basic steps in detail in these notes because many beginners to the hobby just do not know how to go about some of the basic procedures which the experienced modeller will do without thinking. If you already know how to do some of the things just skip on and please do not be offended. If you are a beginner I hope the notes will help you.



The lathe saddle stop shown fitted to the lathe and ready for use.



The raising block fitted in position behind the drum reversing switch.

THE LATHE SADDLE STOP

Design considerations

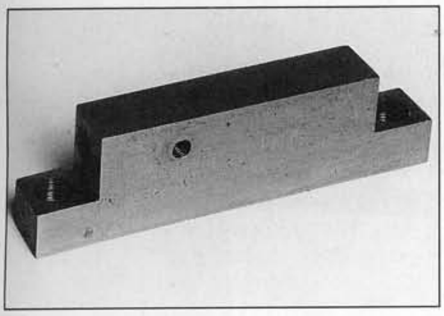
When I decided to make the saddle stop I looked at the edge of the saddle at the headstock end to find a suitable flat area for the stop to come up against.

A machined surface is better for this so I decided to use the outer edge of the saddle top plate rather than the cast surface of the apron. Because the saddle is fitted with a wiper retaining plate it was necessary to come towards the front of the top plate for the contact point and this established the position for the stop rod.

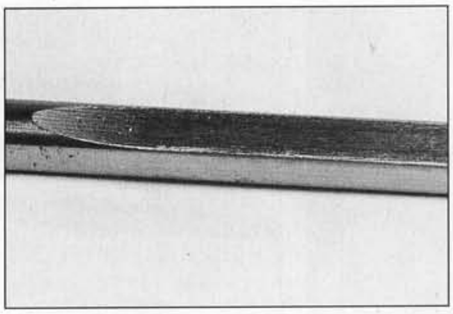
I then examined the headstock area for suitable fixing points for the bracket to hold the stop rod in the right position. On my lathe there were two existing holes in the front edge of the machined lathe bed underneath the headstock, these were already tapped $^1/_4$" BSF to accept a quick change gearbox which was available as an accessory. As I didn't intend to fit a gearbox, I decided to use these tapped holes to attach the bracket for the saddle stop.

Here I ran into a slight problem because I had already fitted a drum reversing switch to the front of the lathe bed below the headstock. As the top of this switch box was just above the tapped holes in the lathe bed it meant that I would have to use a raising piece in order to attach the clamp block for the stop rod. The use of a piece of 1" x $^1/_2$" flat mild steel bar overcame this problem quite neatly. That enabled me to simplify the construction of the clamp block and its design was dictated by the position required for the stop rod.

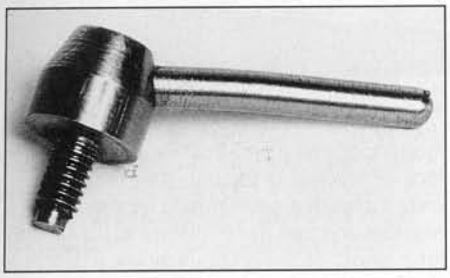
I have described the above in some



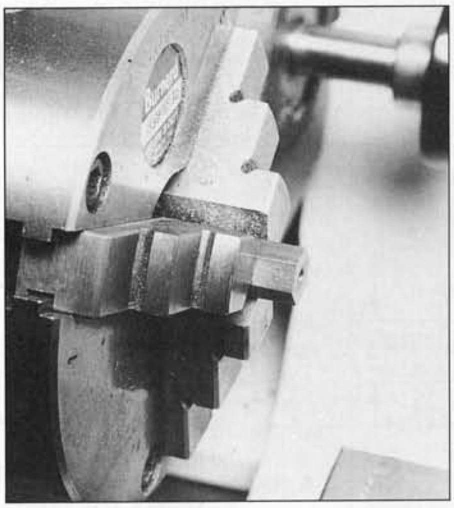
The clamping block.



The stop rod (showing machined flat)



The clamping screw.



Chucking piece to hold clamp screw for turning.

detail in order to show how the design of the saddle stop assembly was arrived at. By using a similar process you should be able to work out how to fit a saddle stop to any other make of lathe.

Construction

First of all make the *Raising Piece* from a 5" length of 1" x $^1/_2$" mild steel bar. Square off the ends by filing (or milling if, like me, you are not keen on filing!). Use marking blue or a thick felt tip pen to paint the approximate areas where the holes will be marked out. Then, using a rule, square and scriber, mark the positions of the hole centres as shown on the drawing. I find it is more accurate to use a small centre punch and a 'tap' with a light hammer first, then have a look with a magnifying glass to see if you have actually put the centre punch mark on the intersection of the scribed lines. If not, it will be fairly easy at this stage to gently tap the small centre punch held at an angle to push the mark into position. Once the mark is in the right place, use a larger centre punch to make the centre deeper to guide the drill.

It is always a good idea to drill all holes initially with a small drill of about $^1/_8$" or 3mm diameter. This will be more accurate than going straight in with a larger drill which can be liable to wander off centre, go in at an angle, or cut a non-round hole. After using the smaller 'pilot' drill, open out the hole with progressively larger drills until the correct size is obtained.

So, for the holes marked 'A' on the drawing, drill through with a $^1/_8$" drill being careful to line up the drill and centre punch mark as accurately as you can. Then open out to $^5/_{32}$" dia. which is the tapping size for $^3/_{16}$" BSF. Use a 'taper' tap first and then follow with a 'second' tap or 'plug' tap to finish the job. Make sure the taps go in square to the face in all directions and it is also a good idea to use a tapping compound when tapping into steel. Don't just screw the tap in, give it one or two turns forward and then unscrew it a turn to break the swarf in the hole before proceeding forward again. File off any burrs that may be thrown up and run the tap through once again to make sure the hole is clear.

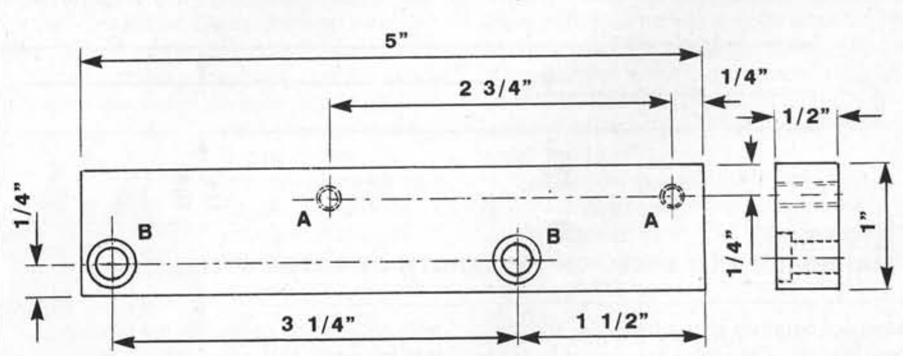
Using a similar procedure, drill the holes marked 'B' and open out to 6.5mm dia. which is clearance for a $^1/_4$" dia. screw. The next stage is optional:- if you are going to use socket cap screws the holes must be counterbored to accept the head of the screw. Counterbores are a type of drill bit with a 'pilot' which will centre them with the smaller hole. They are available from our Trade suppliers (or you can find instructions for making them in some of the model engineering books). If you don't want to use socket cap screws there is no reason why hexagon head or countersunk head screws could not be used.

Having established some basic working routines we can now turn our attention to the *Clamping Block*. For this we need a 3$^1/_4$" length of 1" x $^1/_2$" mild steel bar. Square off the ends and mark out and centre punch the position of the $^1/_4$" dia. hole which passes right through the block from end to end. Mark and centre punch both ends of the block as the hole will be drilled halfway through from each end. Mount the block in a 4-jaw chuck in the lathe and set the centre punch mark to run true.

Don't be too frightened of using the 4-jaw chuck, it may be a bit fiddly to set up but it is a very useful way of holding non-round material in the lathe for accurate machining. The secret is to position the jaws roughly, using the concentric lines on the face of the chuck body as a guide. Then put your material in the jaws and close them each in turn until they just grip the work. By slightly slackening *one jaw* and then gently closing its *opposite* number you will be able to slowly move the material into the right position. Always work on *opposite jaws*, never on adjacent jaws, *when setting up*. Persevere and it will come with practice.

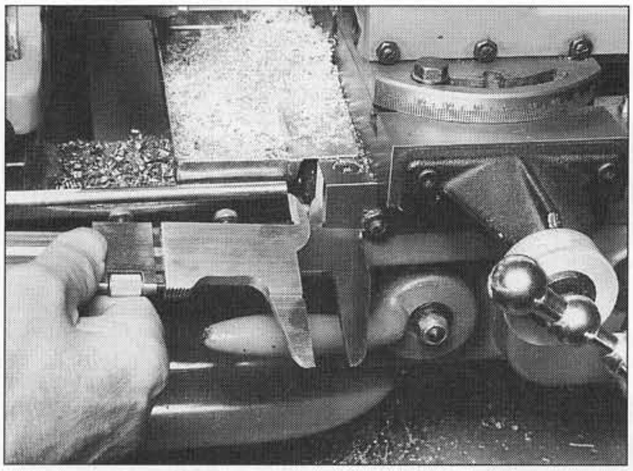
Using a $^1/_8$" dia. drill held in a drill chuck in the tailstock, drill into one end to a depth of about 1$^3/_4$". Withdraw the drill frequently during this operation to clear the chips from the flutes of the drill. Now open out to $^3/_{16}$" dia. and then to 6.3mm dia. This procedure should ensure a parallel hole which runs true. Now reverse the block in the chuck by only slackening *two adjacent jaws* and retightening the *same two jaws*. Check that the job still runs true at the centre punch mark and *adjust using opposite jaws* if necessary. Repeat the drilling procedure as before until the holes join up in the middle of the block and then, running the lathe spindle at slow speed, run a $^1/_4$" dia. reamer through the hole all the way to produce a smooth bore. When using a reamer it is important to keep it moving forwards through the job and then reverse it out without stopping, otherwise it may cut oversize or jam in the hole.

With the block back on the bench, mark out the $^1/_2$" x $^1/_2$" cut-outs at each end. Cut

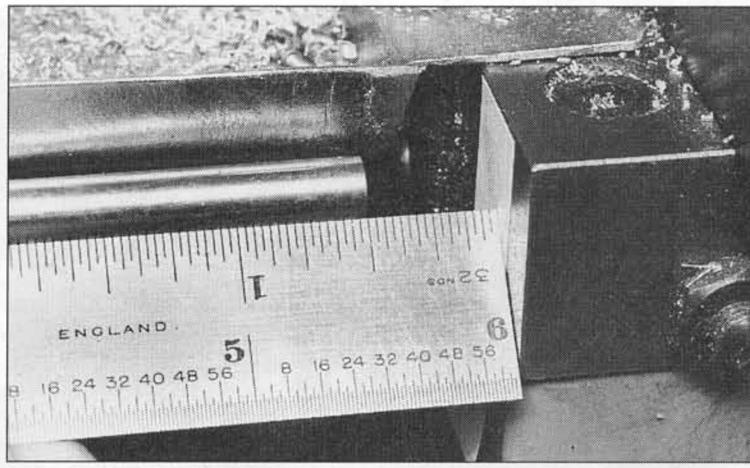


HOLES
A - DRILL THRO' 5/32" AND TAP 3/16" BSF
B - DRILL THRO' 6.5mm DIA COUNTERBORE 9.9mm x 1/4" DIA

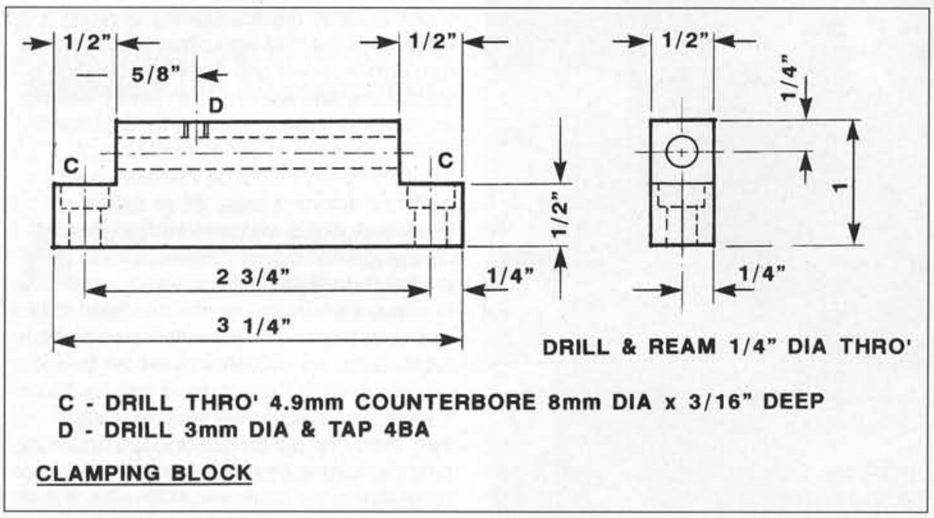
RAISING PIECE
MATERIAL:- MILD STEEL

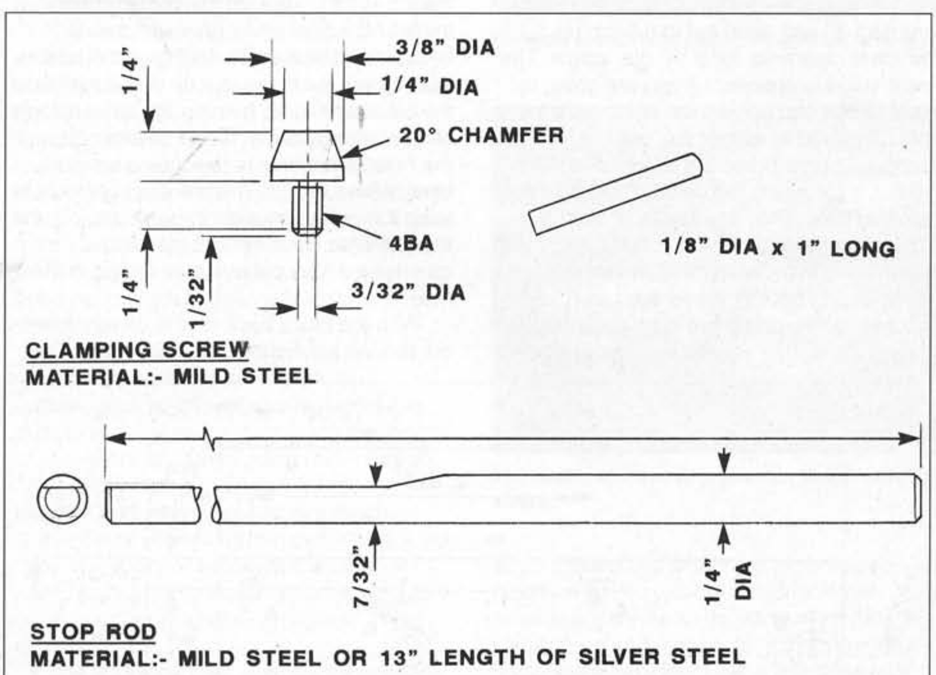


Using a vernier calliper to set the stop rod position.



Using a rule to set the stop rod.





these out carefully with a hacksaw and file them square. Then mark the positions of the holes marked 'C' on the drawing. It will be easier to mark these on the protruding faces rather than in the cut-outs. Drill the holes to 4.9mm dia. (clearance for $^3/_{16}$" screws) and then counterbore, if required, from within the cut-outs to 8mm dia. by $^3/_{16}$" deep.Now mark out hole 'D' at $^5/_8$" from one cut-out and drill 3mm dia. (tapping size for 4BA) until it breaks into the $^1/_4$" dia. hole below. Tap this hole 4BA, being careful as the tap breaks into the cross hole. It would pay at this stage to run the $^1/_4$" dia. reamer through the long hole by hand to remove any burrs produced by the drilling and tapping of the 4BA hole which runs into it.

The *Clamping Screw* is next on the agenda and this a simple turning job on the lathe. Set up the 3-jaw chuck and grip a $2^1/_2$" length of $^3/_8$" dia. mild steel bar in it with 1" protruding out of the chuck. Using a facing tool with a small radius ground on it, face off the end of the bar. Now mount a knife tool with a small radius on it in the toolpost and turn the bar down to 0.142" dia. for a length of $^9/_{32}$". (This is where a saddle stop would come in handy!). Put a slight chamfer on the end to guide the die.

The 4BA die is best held in a tailstock dieholder but it can be used in an ordinary dieholder which is held against the face of a drill chuck in the tailstock for support. DO NOT attempt to use a die with the lathe spindle running under power - this is a practice which is fraught with danger, if the die jams on the work the dieholder can spin and cause a lot of damage to the operator's hands or the lathe bed. The safest method is make sure the lathe motor is turned off and release the tension of the drive belt. Then, holding the dieholder stationary with the right hand, turn the lathe chuck with the left hand to cut the thread, remembering to cut a couple of threads and then back off the die to break the chips before proceeding.

Once the thread is cut, remove the dieholder and then use the knife tool to turn the end of thread away to $^3/_{32}$" dia. x $^1/_{32}$" from the end of the bar. This serves a double purpose of cleaning up the end of the thread and, more importantly, it will prevent the end of the threaded section from burring over as the clamp is screwed down onto the stop rod. Apart from marking the stop rod, any burrs formed would make it difficult to remove the clamp screw at a later date.

(A useful tip, here, is to put a nut onto the thread and run it clear of the working area before cutting or working on the thread. Once the work is finished, the action of unscrewing the nut will clean up the end of the thread.)

Put a sharp parting tool in the toolpost and set it square across the lathe bed. Make sure that the cutting edge is set exactly at centre height. Now use a slow spindle speed and part off the bar at $^5/_8$" from the threaded end. If you don't like using a parting tool you can use a hacksaw but put a piece of wood on the lathe bed to protect it in case the saw blade goes down too far. You may laugh at this, but it is surprising how often it happens!

If you are very careful you could now hold the threaded section in the chuck jaws for the next operation but I wouldn't recommend it. It would be a pity to spoil all that work by damaging the thread. The best way is to make a chucking piece to hold the job. Put a short length of brass bar (about $^{3}/_{4}$" long by $^{3}/_{8}$" dia.) in the chuck, face off the end square and drill and tap it 4BA to a depth of $^{1}/_{2}$". If you put a centre punch mark on the brass bar adjacent to number one chuck jaw you will be able to use this chucking piece again for other jobs.

Screw the threaded end of the clamp screw into the brass chucking piece until it is finger tight with the shoulder against the brass (the cutting action of the lathe tool will tighten it a bit more). Take light facing cuts across the end of the clamp screw head until the end of the head is $^{1}/_{4}$" from the chucking piece. Now set the topslide over to an angle of 20 deg. with the right hand end of the topslide away from the front of the lathe. Bring the tool up to contact the corner of the clamp screw head and wind in the cross-slide a few thou. Lock the saddle to prevent any accidental movement. Use the topslide feedscrew to take a cut towards the headstock and then retract the topslide until it is clear of the job. Wind in the cross-slide a few more thou and repeat this sequence until you have produced a chamfer about $^{3}/_{16}$" long.

Remove the chucking piece, complete with the clamp screw, from the lathe chuck and prepare to drill the hole for the handle. Hold the chucking piece at an angle in the drill vice so that the chamfer lies horizontal under the drilling machine spindle. Carefully file a small flat on the chamfer to enable the drill to start without wandering down the slope. Make a small centre punch mark on the flat and line it up carefully under the $^{1}/_{8}$" dia. drill which can now be put in the drill chuck. Make sure the drill is lined up with the centre line of the clamp screw. Using a fairly fast speed, drill into the head to a depth of $^{3}/_{16}$".

The Handle is made from a 1" long piece of $^{1}/_{8}$" dia. mild steel with a radius or chamfer formed on one end. This is best done in the lathe.

Remove the clamping screw from the brass chucking piece. If it is too tight to undo the thread, replace it in the lathe chuck and wrap a small strip of emery cloth around the head of the clamp screw (with the abrasive side outwards!). Bring up a drill chuck held in the tailstock to grip the screw head with the emery cloth between the screw head and the drill chuck jaws (this will protect the surface of the screw head). Leave the tailstock free to slide on the lathe bed and turn the lathe chuck by hand to unscrew the clamp screw from the brass chucking piece.

Press the handle into the head of the clamp screw. If you are lucky it will be a fairly close push fit but it might be a bit too loose if the drill has cut oversize. In that case a drop of Loctite on the handle should make things right!

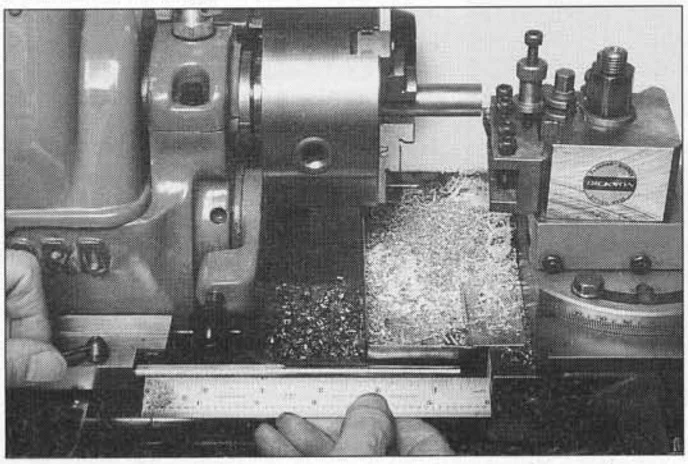
The material for the *Stop Rod* may be either a suitable length of $^{1}/_{4}$" dia. mild steel or you could use silver steel. The advantage of using silver steel is that it will resist the action of the clamping screw better than mild steel which will 'dent' much more easily. File or mill a flat along most of the length, leaving about 3" of full diameter at one end. The flat gives the clamp screw a larger area to 'bite' on and the full diameter at the 'contact' end of the stop rod gives a larger area of contact with the saddle. This makes it much easier when making measurements with a vernier calliper or a drill bit etc.

Assembly

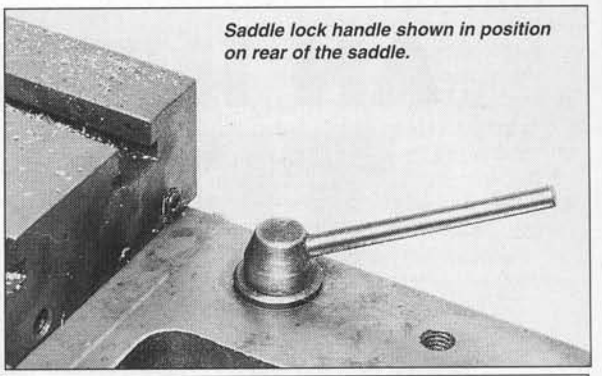
First of all screw the Raising Piece to the lathe bed and then attach the Clamping Block to it. Put the Clamp Screw in position, wind the saddle to the tailstock end of the lathe bed and then insert the Stop Rod into the reamed hole with the flat uppermost. If all is well the clamp screw will now clamp the stop rod in any position along the flat. Job done!

Instructions for Use

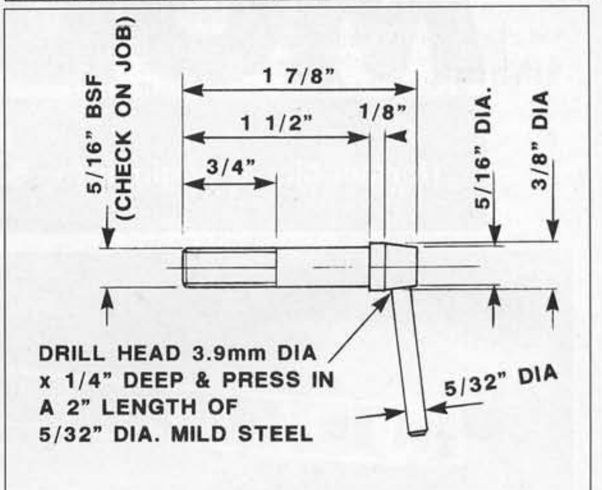
Your completed lathe saddle stop can be set to the desired position by bringing the lathe tool up to touch the end of the work and then adjusting the end of the stop rod by measuring from the saddle face with a rule or vernier calliper. Clamp the stop rod with the clamp screw and then turn the workpiece in the normal way until the saddle contacts the end of the stop rod. Another useful tip is to use a drill bit of the relevant diameter as a gauge between the saddle and the rod. With a little practice you will soon get the feel of using the saddle stop when feeding by hand. When feeding under power the technique is to disengage the power feed just before the saddle gets to the stop rod and feed the last few thou by hand, this will prevent the stop rod being bent by the power feed and also spoiling the workpiece.



Tool touching work and rule used to measure adjustment of stop rod.



Saddle lock handle shown in position on rear of the saddle.



SADDLE LOCK HANDLE FOR MYFORD ML7
MATERIAL:- MILD STEEL

THE SADDLE LOCK HANDLE

Also included in this article is a drawing for a *Saddle Lock Handle*. This will be very useful when used in conjunction with the saddle stop as it provides a much quicker way to lock the saddle in place while setting the saddle stop rod. Used on its own it speeds up many operations which involve the use of the lathe with the saddle in a locked position, for example when carrying out milling operations etc.

If you have followed the instructions for making the saddle stop you should find that the saddle lock handle is quite easy to make. It is a straightforward turning job and is very similar to the clamp screw described above. By now you should be capable of working out how to do it for yourself so I will leave you to it!

The saddle lock handle is designed as a direct replacement for the hexagon head screw supplied by Myford Ltd. Just take out the hexagon screw, being careful to hold the clamp pad in place under the back of the saddle, and pop in the new handle. You may need to alter the thickness of the original washer under the screw head to bring the handle into a convenient working position. Now all you need is a quick hand movement to lock the saddle instead of searching for the spanner!

I hope you will find these additions to your lathe as useful as I have done. Having made and fitted them to my lathe I now wonder how I ever managed without them! ■

AN INTRODUCTION TO TRAMWAY MODELLING

by David Orchard
(former Model Engineering Secretary, Tramway and Light Railway Society)

Comparison between two Liverpool cabin cars built in 7mm and 4mm scales. Both models were made by the Author.

Two extremes of scale! A London E1 tramcar in ³/₄" to 1 foot scale (¹/₁₆) by Brian James and the same prototype in 4mm to 1 foot (¹/₇₀) scale by David Orchard.

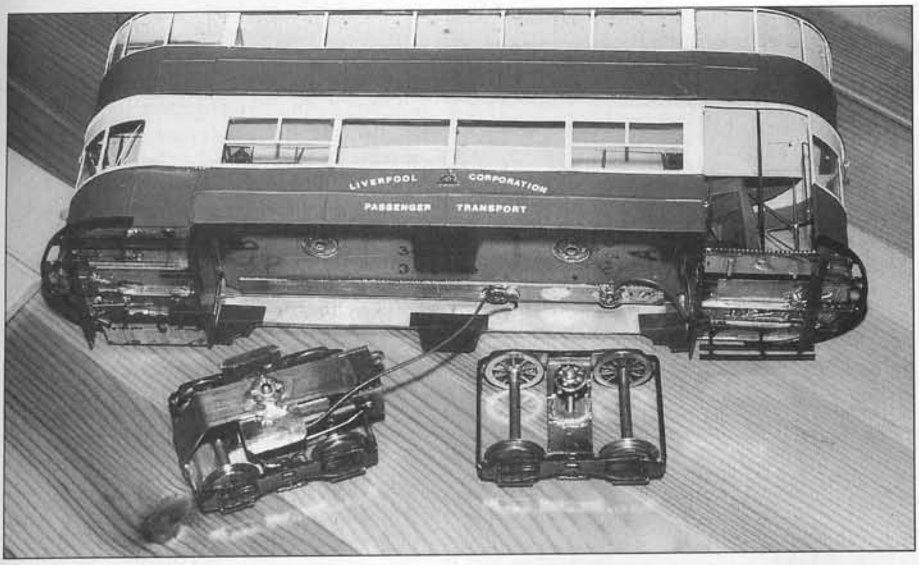
Modelling trams involves a fair amount of engineering combined with other disciplines. This article gives an insight into a fascinating modelling hobby ...

Tramcars are returning now to the streets of British cities, although on the Continent they have always retained their popularity as a fast and efficient way of moving large numbers of people, combining the street level accessibility of the bus with the pollution free mechanical efficiency of electric rail transport. They also differ from conventional railways in that the vehicles will tolerate much steeper gradients and sharper curves, being shorter, better braked, and with a high 'power to weight ratio' resulting from a motor on virtually every axle. Power supply is usually around 750 volts DC, collected by overhead trolley pole or pantograph from wire catenary (usually much simpler than its railway equivalent).

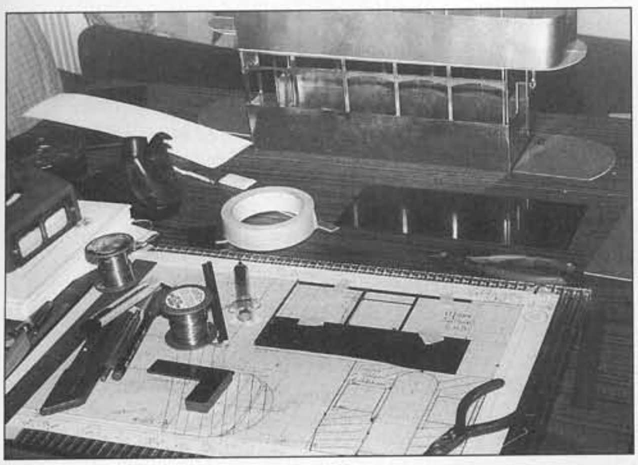
These characteristics make them interesting to model. From a 'layout' viewpoint, one can squeeze in more track and/or working models per square foot in the inevitably limited space one has. From a 'scale model' viewpoint, one can create a completely authentic model that is still of handleable size and can run independently of others. From a purist viewpoint, in the larger scales one can make a tram model that functionally mirrors and replicates the full size prototype in a way difficult to achieve in railway modelling (unless one takes live steam very seriously!): items like suspension and brakes can all be made to work, and the model's electrically powered traction unit fits and functions just like that in full size. The only difference is that 750 volts DC current collection reduces to 12 or 24 volts !

Choice of scale

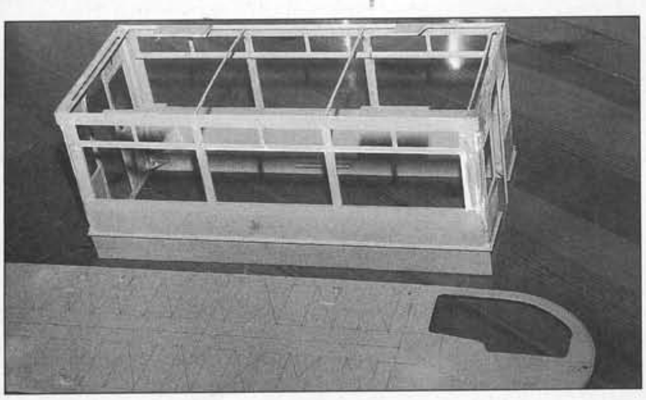
The final factor to take into consideration in selecting which scale to model in, is the question of using kits versus scratchbuilding. Basically, the smaller the scale the greater the availability of kits: there's a great deal in whitemetal or in plastic available in 4mm/00 gauge



This photo shows the traction units (from Terry Russell) removed from the body of the Author's scratchbuilt bogie model tramcar in 7mm scale for '0' gauge track.



Building up brass strip and sheet to form the body sides of a 1/16 scale model tramcar.



The lower saloon for a 1/16 scale model tram.

(list of suppliers at foot of article), as well as US/Continental ready-to-run models off-the-shelf and two ranges of static ready built British models that can easily be motorised (caution: the Corgi range is to '00' track gauge but to a body scale of about 5mm to 1 ft.). In 7mm/0 gauge there are useful card kits from Brumtrams and built-up traction units from Terry Russell (who also does an excellent range of plans for all scales) and others, but not much available off-the-shelf otherwise. In 9mm/1 gauge there is nothing at all, but in 'G' scale (15 mm/foot on gauge '1' track) there are two small ranges of ready-to-run single-deck model trams from Bachmann and LGB, and a range of whitemetal traction unit parts from independent suppliers (details in list below). The really 'big' scale of 1/16th (19mm/foot, 3½ inch standard track gauge) has long been supported by the Tramway and Light Rail Society (TLRS membership details below) who provide a range of traction unit parts, motors, and other aids to scratchbuilding the rest of the tram, also instructions to the novice. Finally, there is also 1/12th scale, bigger still, for the more experienced enthusiast who is able to scratchbuild 100% and has lots of available space.

Useful 'how to do it' books exist for all scales. There is a very good illustrated one for '00 gauge' *(Trams and Tramway Modelling)* by David Voice, SubSeven Secretary of TLRS, and an equally useful handbook for scratchbuilding of tram bodies by Terry Russell to go with the range of ready-built '0' gauge traction units he sells. An excellent book on 1/16th scale by Peter Hammond is about to be reprinted, and there is also E.Jackson-Stevens classic *Scale Model Tramways*, covering all the larger scales, available from transport bookshops.

Materials

Whichever material you use for building/modifying kits or for scratchbuilding is really a matter of personal preference and skill: some people get very good results from plastic and from high quality card such as Bristol Board, while others like myself tend to use metal. In the larger scales the traditional way is to use thin plywood, obechi wood, and other materials whose working techniques are as close to marquetry as to carpentry, although metal can also give good results. There is something of a debate about window glazing; some stick to glass, while others use modern acrylic or plastic transparent material. Similarly on painting: some stick to brushed enamel, others spray enamel or cellulose with an airbrush, others still use acrylic or cellulose car aerosols (my own preference for a really first class finish). The key success factor in all scales is to create a fine-scale model whose materials are durable and which stands up to the rigours of operation.

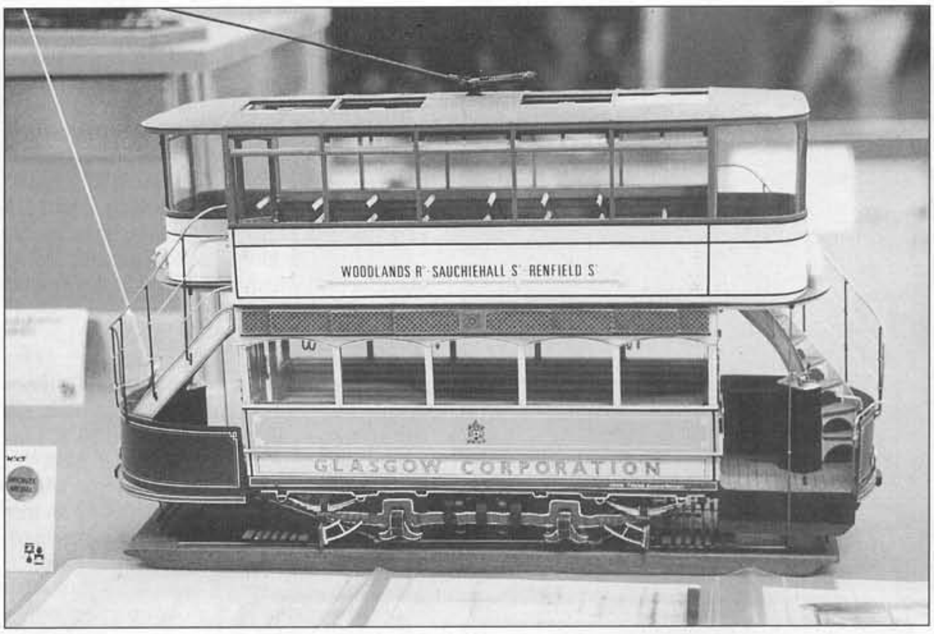
Traction units

Traction units are straightforward. Earlier and shorter trams used 4-wheel trucks with wheelbases varying from 6 ft. to 11 ft. (the latter needed some sort of 'radial' axle which could swivel in sharp curves, which in the UK produced design problems: on the Continent they used a third axle. Both are challenging to model). Longer vehicles, including all present day new designs, used short wheelbase (4 ft. or so) bogies: only two on the longer trams of the 1920's to 1950's, but anything from three upwards on today's articulated trams. Older bogies were outside frame (some had one wheelset smaller than the other so as to swivel under the body), but modern tram bogies tend to use inside frames with magnetic track brakes, resilient wheels, and other advanced features. Compared with a railway bogie, they are notably more compact. This is also true for the model, where very small 12 volt motors are often required in order to fit. The 4-wheel truck with its larger wheels (typically 3 ft. diameter in full size), in contrast, will take a larger 12 volt motor, either mounted transversely driving the axle via a worm, or in line driving via spur gears (larger scales only!) just as in full size.

Track and overhead wiring

Turning to the question of track and overhead wiring, there is a wide range of model railway track available from Peco in '00' gauge, '0' gauge, and '1' gauge/'G' scale, with rail available separately from sleepers if required. Tramway street track is, of course, grooved rail paved flush with the road surface, so a fair amount of infilling with plaster, cork or some such will be needed if the Peco track is used. Proprietary '00' gauge paved tram track tends to be rare and expensive, but can be obtained by the rich and persistent: I have only ever seen the Rivarossi version, which is well made and has usefully sharp 10cm radius/90 degree curves and turnouts which suit a geometric street layout, but which may be too sharp for some off-the-shelf '00' or 'H0' model trams (especially articulated ones).

One useful tip for track construction in 1/16th scale (3½ in. gauge) uses Gauge '1' Peco track cut in half down the sleepers, then glued using PVA woodworkers' glue to a wooden baseboard, setting the track gauge manually. This is much cheaper than using the heavy duty 3½ in. gauge track designed for garden railways, but gives a robust enough trackbed for a tramcar in this scale (and also suits the usual flange profile used, which is shallow - see below). I have built up a portable track this way that has survived four years, six exhibitions, and one dousing by a June thunderstorm, so can vouch for its durability.



David Orchard's $^{3}/_{4}$" to 1ft. ($^{1}/_{16}$ scale) Glasgow Standard Car.

A typical street scene on a 4mm scale '00' gauge model tramway. The low-relief buildings in the background help to 'set the scene' and add realism.

As for the overhead current supply, every modeller has a different method! The main constraint is that the wire itself is only $^{1}/_{2}$ inch in full size cross section, which scales down impossibly thin in most scales. Some overscale thickening of the wire is inevitable, although excusable in so far as the eye 'expects' to see a wire there, and the trend in both '00' and '0' gauge is to use hard-drawn brass wire of 30 or 32 s.w.g. (0.33 mm), with fixings either from lost wax brass or from nifty soldering. In 'G ' and $^{1}/_{16}$ scales the true scale thickness would be $^{1}/_{32}$ to $^{1}/_{40}$ inch (or 1 mm), which is feasible (reels of copperised steel welding wire are ideal here!), but thicker wire is often used for convenience. Current collection by overhead trolley pole is unusual (but possible) in '00' gauge, but is the norm in the larger scales, which also require the trolleys to be scratchbuilt. Modern outline tramways would use a pantograph, which again could need scratchbuilding. It is a very moot point which system is easier to operate; pantographs don't dewire but require very careful alignment of wire to track, while trolley poles are more tolerant of variation in wire height but need a guidance 'frog' to steer the trolleyhead at turnouts and junctions. (Precisely the same considerations apply to full size tramways as to the models, which is, of course, half the particular fun of tramway modelling.)

Wheel standards

I suppose no introductory article these days is complete without a mention of flange depth and wheel back-to-back dimensions. Wheel standards for full size trams stipulate a relatively shallow flange capable of negotiating grooved rail set in a city street, and a narrower tread. The former means that the vital 'back-to-back' dimension differs significantly from that used by British Rail, and this in turn means that unmodified railway type turnouts and crossovers cannot be used by trams without risk of derailment, even though the track gauge is nominally the same. (Similarly, deep flanged railway wheels cannot use grooved tram track unless the track gauge is reduced to 4 ft $7\frac{1}{2}$ in. so that the wheels actually run on their flanges). This is very far from being an academic quibble, a lot of the set-up cost of the new Manchester Metrolink tramway was caused by the need to integrate a street tramway with two suburban BR lines and to create 'compromise' standards for flanges, turnouts etc.

Similarly in the model world: the TLRS wheel standards for $^{1}/_{16}$ scale feature a flange very nearly as 'fine' as in full size, and this tends to apply even in the smaller scales. The de facto standard set by Terry Russell in 7mm/0 gauge uses fine-scale '00' rail wheels from 10 to 18mm diameter (which comes out very close to full size proportions), while in '00' gauge proper the same fine-scale wheels tend to be used by British suppliers, but (obviously) to smaller diameters. In contrast, Continental and US-made 'H0' model trams seem to use a slightly coarser flange that tolerates the clearances in standard model railway turnouts and crossings better. In short, while it is not essential to make your own turnouts and crossings, you may find yourself doing it earlier than you might otherwise have expected!

Controllers and motors

Finally, the question of controllers and motors. Only in $^{1}/_{16}$ scale is there any possible need for a DC voltage above 12 volts, as the ex-Government motors used are rated for 24 volts. However, they only require full volts under arduous traction conditions, and a 12 volt 1 amp supply should be sufficient for indoor operation on level track if the tram(s) are fairly free-running. All smaller scales can use normal 12 volt controllers. Some modellers convert the controller to look like a miniature tram control unit with 'handles', which adds an extra touch of realism and can also improve controllability, especially if a lever type 'reversing handle' (forward/off/reverse) is fitted. The aim in operation should be to achieve 'scale' speed (ie slowish with smooth starts and stops), and obviously the more manageable the controller the better. Some transistorised controllers do this better than others with the small motors in the trams - the 'Doverbeck' range was particularly good - and quality motors like Buhler or Minicraft also pay dividends in smooth responsive running. Some modellers like to 'tune' their trams to emit "realistic" noises of grinding gears etc., but others prefer the quiet sound of well-oiled well-adjusted mechanisms. Which, after all, is what one hears these days whether on the new trams of Manchester or Sheffield or on the heritage museum lines in Birkenhead, Crich, or elsewhere.

Worth a visit

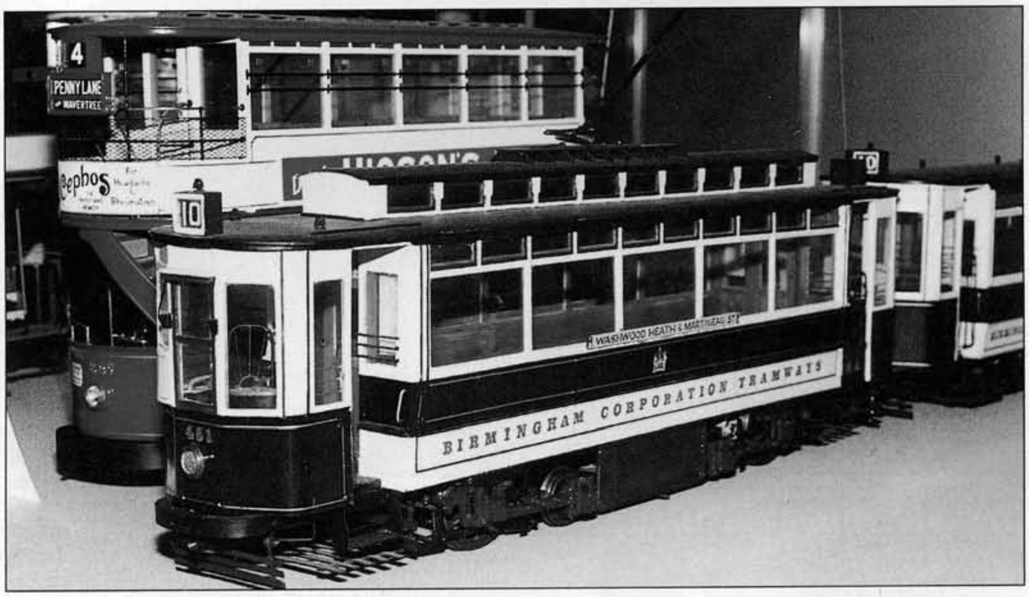
Last but not least - the annual Festival of Model Tramways (open to the public) is always well worth a visit, not only to see dozens of tram layouts in operation in all scales, but also to meet all the suppliers listed below and browse around kits and parts. This year it is at the Kew Bridge Steam Museum on 22/23 April 1995 and the 1996 meeting will be held on the first weekend in July at the National Tramway Museum in Crich, Derbyshire. Newcomers to the hobby are always made warmly welcome. See you there ! ■

David Orchard

A scratchbuilt model of a Liverpool 'radial' Standard tramcar built to $^{1}/_{16}$ scale (or $^{3}/_{4}$" to 1ft.) by the Author. The model is 18" long overall.

NOTE: This list is non-exhaustive and is intended as a guide only. Many model shops stock a surprising range of plastic tram kits in 4mm scale (all of which can be motorised), and there are also fully finished static tram models in 4mm scale (EFE) and 5mm (Corgi) that can be motorised for use on HO/OO gauge track using the well known Tenshodo traction unit. The 5mm range (Heaven knows why they chose that scale!) looks fine on its own but doesn't blend in with other models to 4mm scale for obvious reasons. It looks OK on ordinary 16.5mm gauge '00' track though, as the eye treats it as a slightly narrow gauge tramway of which there were plenty in Britain (and still are abroad). There is also an HO (3.5mm/foot) double-deck British tram to be found here and there (unmotorised but motoriseable) from Models of Yesteryear. This range also includes an N gauge double-deck tram of London E1 outline that some people have successfully motorised, but I don't recommend this as a start in the hobby!

Below: Birmingham Corporation Tramways single-deck tractor car no.451 and trailer car no. 509 seen in front of Liverpool Corporation Tramways double-decker no. 627.



SOME SUPPLIERS OF TRAMWAY MODELLING ITEMS

SMALL SCALE - 4MM / 00 GAUGE

■ ***Tramalan, PO Box 2, Blackpool FY3 8DZ***
Lots of kits, also conversion kits and traction units. Send five first class stamps for catalogue.

■ ***PC Tramway Items, D.Voice, 9 Redwing Court, Kidderminster DY 10 4TR. Kits, etched brass parts. Send SAE for list.***

■ ***ABS Models (see below for stockist Derek Lambelle) Whitemetal motorised kits from BEC and Anbrico ranges.***

■ ***West Midlands Group Shop, Derek Lambelle, 649 Shirley Road, Hall Green, Birmingham B28 9JU***
Full range of kits and parts in 4mm, 7mm, and 'G' scales Send two first class stamps for list.

INTERMEDIATE SCALE - 7MM / 0 GAUGE

■ ***Terry Russell, 'Chaceside', St Leonards Park, Horsham, W.Sussex RH13 6EG Nearly 500 drawings available in 4mm, 7mm or 9.5mm scales (the last is $^{3}/_{8}$ inch to 1 foot, simply double all dimensions for $^{3}/_{4}$ inch to 1 foot: $^{1}/_{16}$ scale). Also a wide range of whitemetal parts for scratchbuilding and a full range of built-up traction units for 7mm scale/0 gauge. Send SAE for list.***

■ ***Brumtrams Roger Cromblehome, 23 Danis Road, Selly Park, Birmingham B29 7QY***
Wide range of card kits in 7mm/0 gauge (also some in 4mm) which are pre-coloured and make up into effective models that can be motorised with a Tony Russell traction unit (see above).

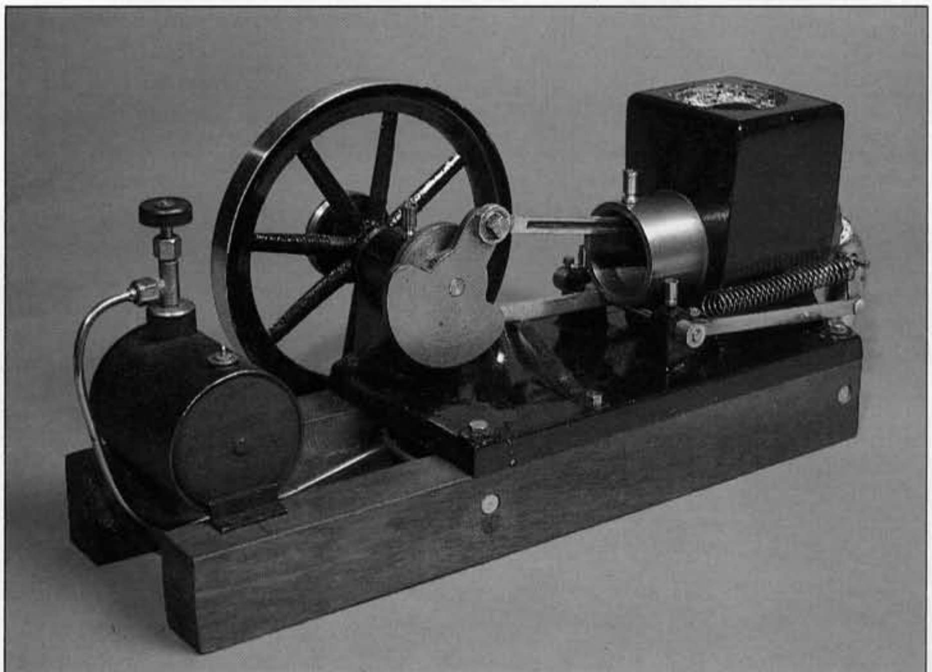
LARGE SCALE - $^{3}/_{4}$ INCH TO FOOT OR $^{1}/_{16}$ SCALE

A range of traction unit parts, wheels, and motors is available to members of the Tramway and Light Rail Society (TLRS). Open to all, the annual subscription is surprisingly modest. Membership details from:
H.J. Leach, Membership Secretary, 6 The Woodlands, Brightlingsea, Colchester, Essex C07 ORY

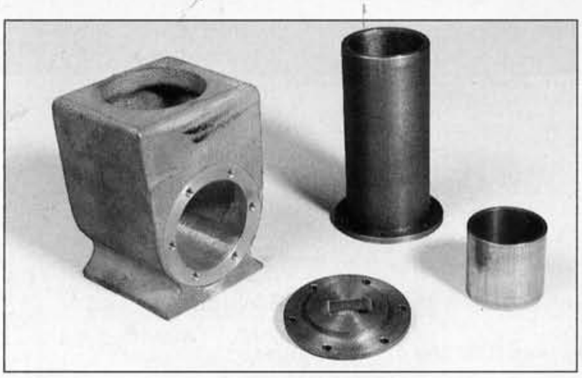
THE SCOTT VACUUM ENGINE

by Bruce Davey

A delightful "flame gulper" engine which is quite straightforward to make and very interesting in operation ...



The Scott Vacuum Engine.



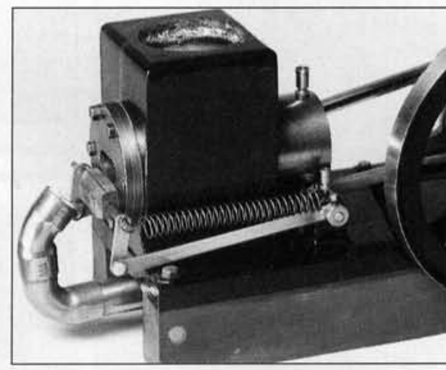
Machined components (clockwise from left) - the hopper, showing cylinder fixing holes; the cylinder; the piston; and the cylinder cover showing the 'inside' face.

The Scott vacuum engine is designed as a project for beginners and experienced model engineers alike, a complete kit is provided except for the burner and gas tank which are available as finished items. Castings are in gunmetal for the cooling hopper, flywheel and baseplate. The engine was designed in the late 1800's and patented by one Mr. Lowne as a competitor to the many hot air engines being produced at the time. The working principle is very simple, suck a flame into a cylinder through a valve, shut the valve and cool the flame; this generates a vacuum, causing atmospheric pressure on the underside of the piston to push it into the cylinder thus causing a power stroke.

Construction is straightforward and requires the use of a small lathe with a centre height of 3 inches or more. A vertical slide or milling machine will make life easier but if neither are available then simple jigs will suffice.

The base (Fig. 1)

Starting with the base, clean up the sides opposite the flywheel and by the hopper with a sharp file, ensuring that they are square to each other. This is to make marking out easier. The underside of the base can be milled flat by mounting it on an angle plate attached to the cross slide (use the corner fixing holes temporarily tapped to 2 B.A. for clamping). A single point fly-cutter with a radius of 2" mounted in the chuck is then traversed across the base, taking cuts of around 10 thou. depending on the particular lathe, until a flat surface is achieved. Minor irregularities can be ignored so long as even fixing can be made to the wooden bearers. Mark out the area at the hopper end of the base where the hopper is mounted, remount on the cross slide angle plate and mill this area flat using a $^{1}/_{2}$" dia. end mill. If a vertical slide is not available, take a cut and progressively move the base up the angle plate to take overlapping cuts until the whole area is machined.



The assembled cylinder end of the engine with the hopper, cylinder, valve and gas burner.

Mark out the position of all the other holes in the base, including the main shaft bearing hole and the cross shaft holes. Drill the holes in the base for the oil cups, hopper and follower spring. Mount the base on an angle plate with the previously prepared edge at the bottom, centre pop the holes for the main shaft and the cross shaft and drill through with $^{1}/_{2}$" and $^{9}/_{64}$" dia. drills respectively. Ream through 13mm and $^{5}/_{32}$" dia. respectively. The base fixing holes may now be drilled out to the clearance holes as shown.

The flywheel (Fig. 2)

The flywheel should be held on the inside of the rim in a four-jaw chuck and set to run truly on the shoulders of the rim. In this way it is possible to turn both sides and the outside of the rim and face off the hub at the one setting. With a small boring bar, bore the centre hole to run true after first drilling $^{7}/_{32}$" dia., this ensures that when reamed the flywheel will be absolutely true to the shaft. It is not necessary to face of the other side of the boss unless so desired.

The hopper (Fig. 3)

Cooling is by hopper and the casting for this is also gunmetal with one side thicker than the other, check carefully which is the thicker. Hold the casting by the top in the four-jaw chuck and face off the base, checking the distance from the centre of the cored cylinder hole to see how much needs removing. Re-chuck the casting with the thicker end outwards, bore through for the cylinder and then face off for the flange of the cylinder. Remove and mark out, drill and tap for the base fixing bolts.

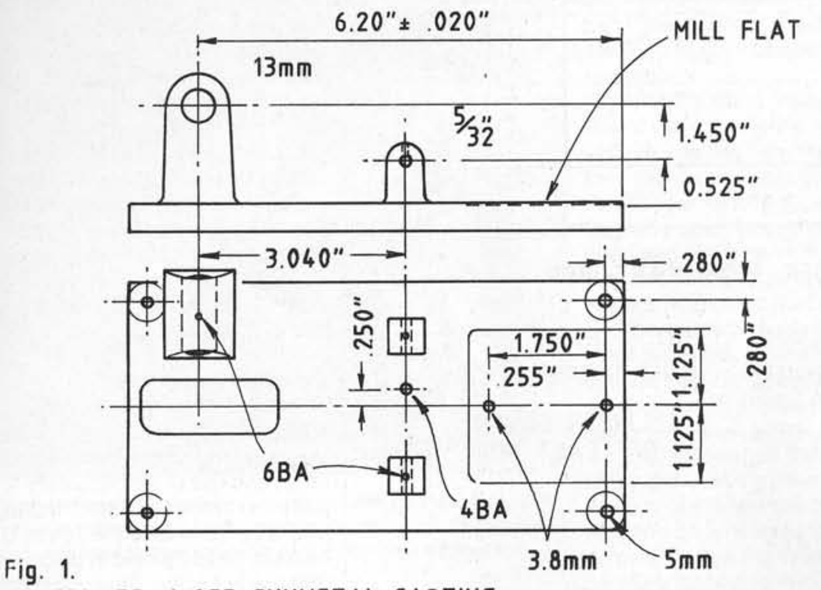


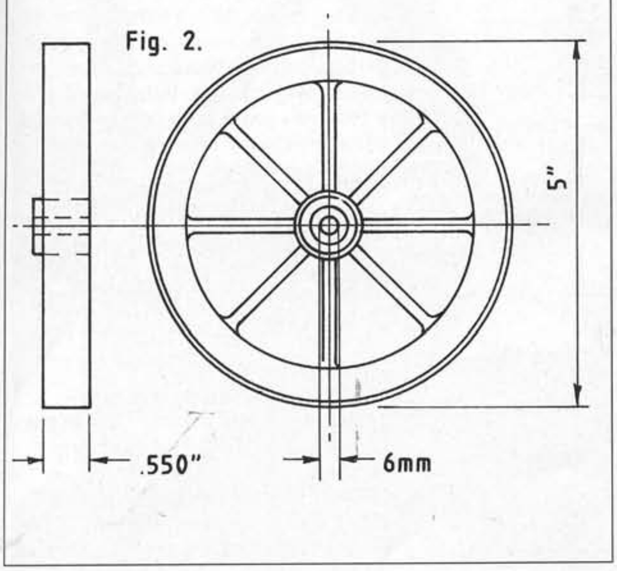
Fig. 1.
BASEPLATE, 1 OFF GUNMETAL CASTING.

The only tricky bit here is to ensure that the centre hole is true to the diameter. Use the same method as for the flywheel by drilling undersize and then boring prior to reaming 6mm. Part off the two discs and, if necessary, reface the parted faces to a fine finish. Mark out the discs to the finished shape as shown on the drawings - as the material used is cast iron it is very easy to file and the final shape is soon achieved.

The cylinder cover can now be finished, drill the fixing holes and then mark out for the flame port. Drill a 3/8" dia. hole at each end of the port and then remove the material between them with a file. If necessary, reface the valve face of the cover as it is essential that it is as smooth as possible. Now place the cover on the cylinder and spot through for the bolt holes, drill the holes through 3.2mm (0.126") dia. Now slide the cylinder into the hopper and, after ensuring the correct position of the holes, spot through into the hopper for the tapping size drill. Tap the hopper holes 5 B.A.

Cast iron is a wonderful material and it is

Fig. 2.



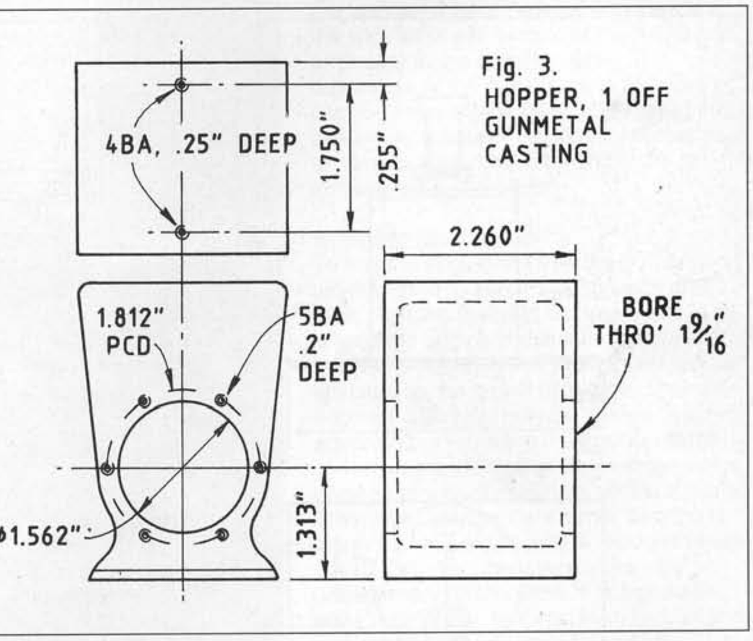
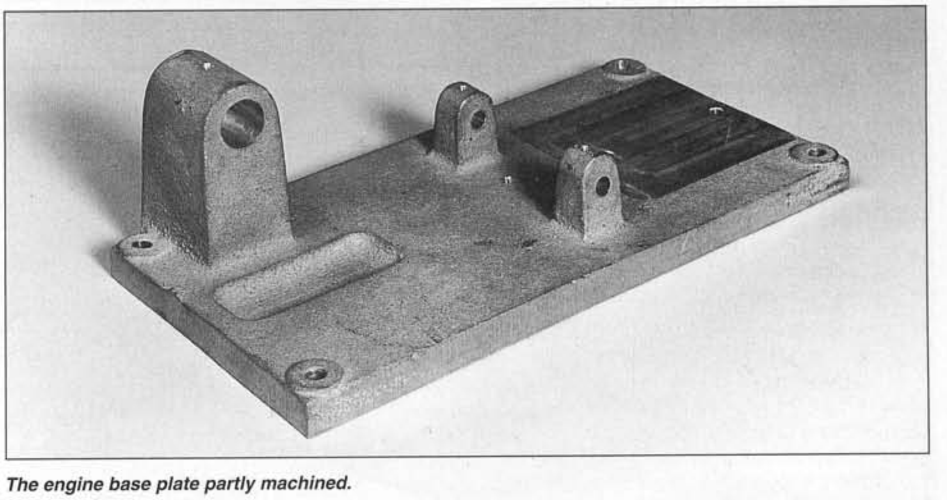


Fig. 3.
HOPPER, 1 OFF GUNMETAL CASTING

Cylinder and cover (Fig. 4)

The cylinder, cylinder cover, crank disc and eccentric are all machined from 60mm peeled cast iron bar and are machined in sequence. Grip the bar in the 3-jaw chuck, face off the end, centre it and support with a tailstock centre. Machine off the outside of the bar to length for the cylinder until it is a sliding fit in the hopper. Next, bore the cylinder to one or two thou undersize by first drilling, as this is the quickest way to remove the metal, and then finishing with a boring bar. Now part off the almost complete cylinder. The screw holes are spotted through from the cover, so leave these until it is made. The cover is now made from the cast iron bar in the chuck, face off the end and turn the register to the cylinder bore diameter. Now, with a sharp pointed tool in the toolpost facing the headstock, scribe a line around the bolting face that will be the centre-line of the fixing screws. If your lathe has back gear it is often possible to use it to mark out the angular position of the fixing holes. If the bull wheel (final drive gear) has 60 teeth, then every 10 teeth gives six divisions.



The engine base plate partly machined.

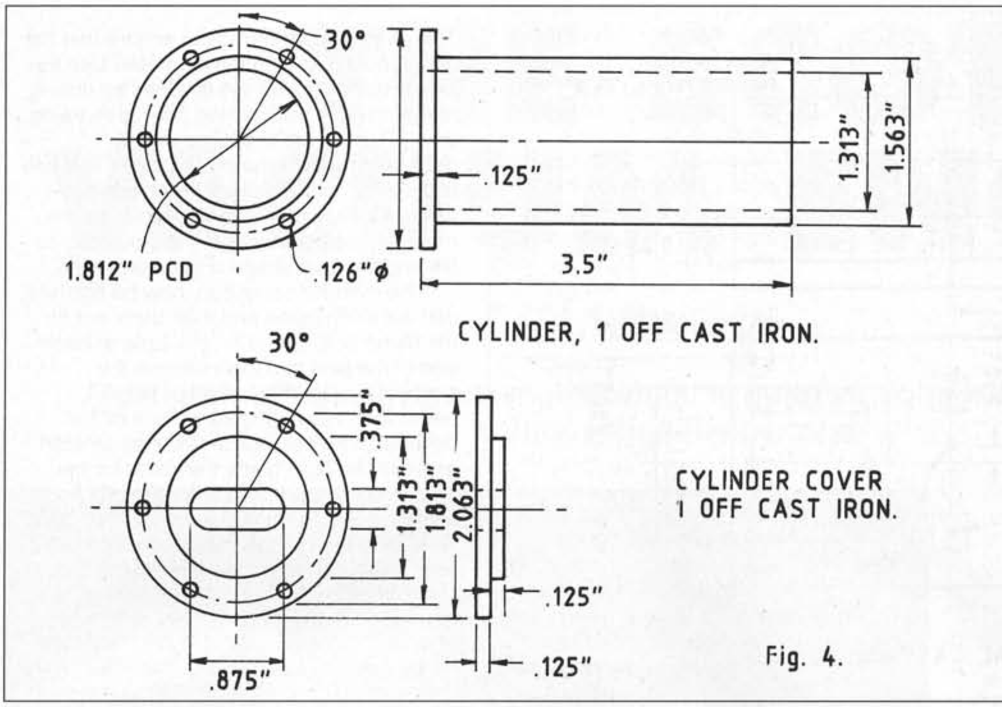
Arrange a simple device to engage in the teeth of the bull wheel to hold it rigid whilst the sharp pointed tool is drawn across the previously scribed line thus producing the six hole centres. Part off the cylinder cover to be finished later.

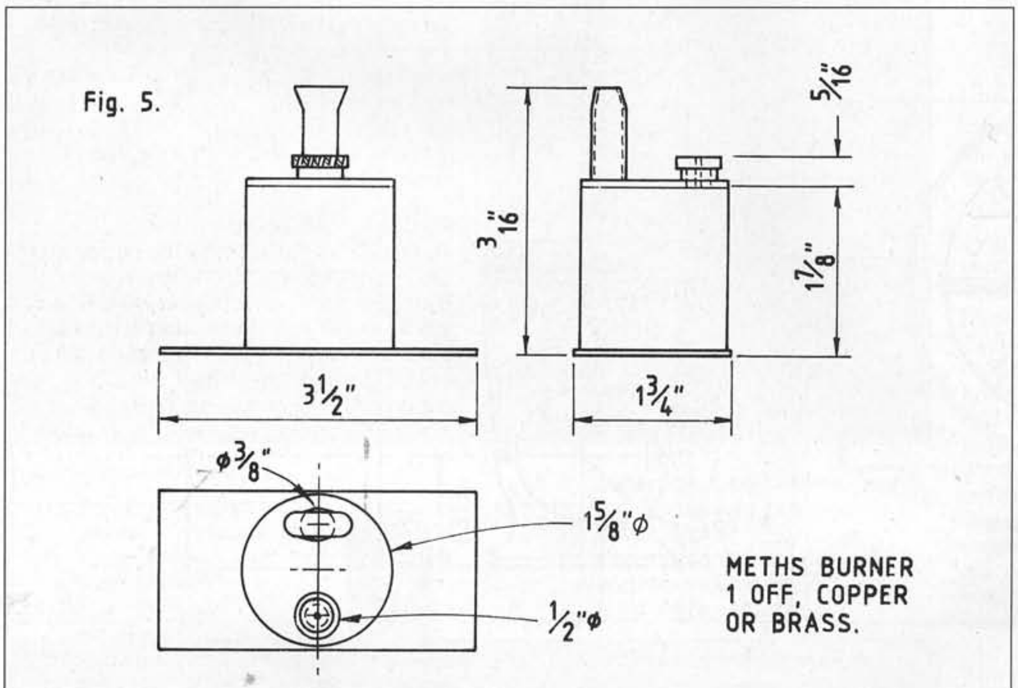
The remaining bar is now used to make blanks for the disc crank and the eccentric.

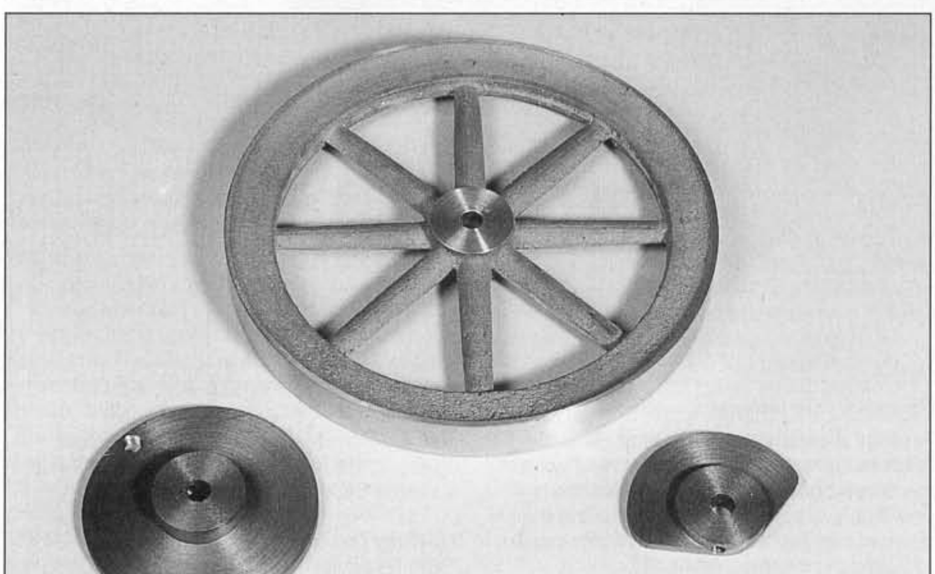
also ideal for the piston. This is supplied, again, in the form of cast bar. The piston is a simple turning and boring job.

Honing the cylinder

First, however, the cylinder bore needs to be honed and suitable hones are available from the casting suppliers. Honing is done






Flywheel, disc crank and cam in various stages of production.

by rotating the hone in the bore at the same time as the hone is moved in and out of the bore. A special oil is used to keep the bore clear of particles and to speed cutting. The process is continued until a cross-hatch pattern of scratches is produced in the bore. In this case exact size is unimportant as the piston is now fine turned to fit the finished bore. Ideally the piston should just be able to slide under its own weight when allowed to drop down the bore with both parts clean and dry.

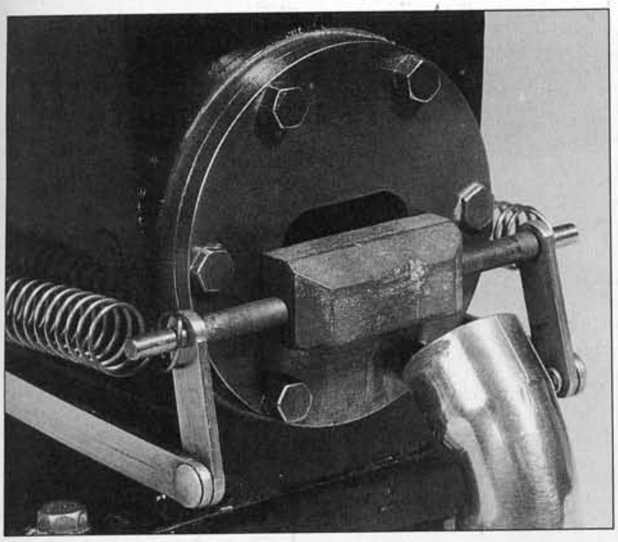
Connecting rod etc.

The connecting rod is a brass fabrication and is decorated with simple fluting machined in with a small end mill or a horizontally mounted Woodruff cutter. The big end is bored to take the 10mm O.D. ballrace which is held in place with 290 grade Loctite. Take great care to apply it only to the rim of the ballrace. Similar techniques are used to make the follower arm, which may be decorated in a personal way.
Other parts such as the small end and big end bolts are simple jobs needing no explanation. The special carbon/graphite valve should be treated with care as, if damaged, it is a relatively expensive part to replace; when drilling the cross-hole, clear the drill frequently and feed in gently. The valve may be machined or filed to shape but it is important to ensure that the working face is perfectly flat. This can be done by rubbing it gently on 600 grade emery paper laid on a piece of glass.

Assembly

When all parts are completed, assembly can be started. First fit the cross shaft into its base mounting pedestals with the assembled follower arm set in position to align with the cam on the mainshaft, fit the outer lifting arms and temporarily lock up their fixing screws. Now drill through the follower arm boss for the taper pin (a parallel pin or a roll pin of $^{3}/_{32}$" diameter may also be used). Fit the main shaft bearings to the main shaft - use Loctite 290 sparingly on the shaft and slide the bearings into place taking care not to get any Loctite in the race shields. Whilst it cures, the cylinder and cover can be assembled into the hopper. Apply Loctite 290 to the flange face on the hopper and the cylinder cover, and fit in place with the six bolts provided: the Loctite used is penetrating and only a few drips need to be applied around the outer cylinder joint to seal it. Slide the main shaft assembly into the boss on the base and again apply the Loctite carefully to the outside of the bearings. Fit the flywheel in the same way and then the cam and disc crank with grub screws. Assemble the hopper on to the base with two 4 B.A. screws.

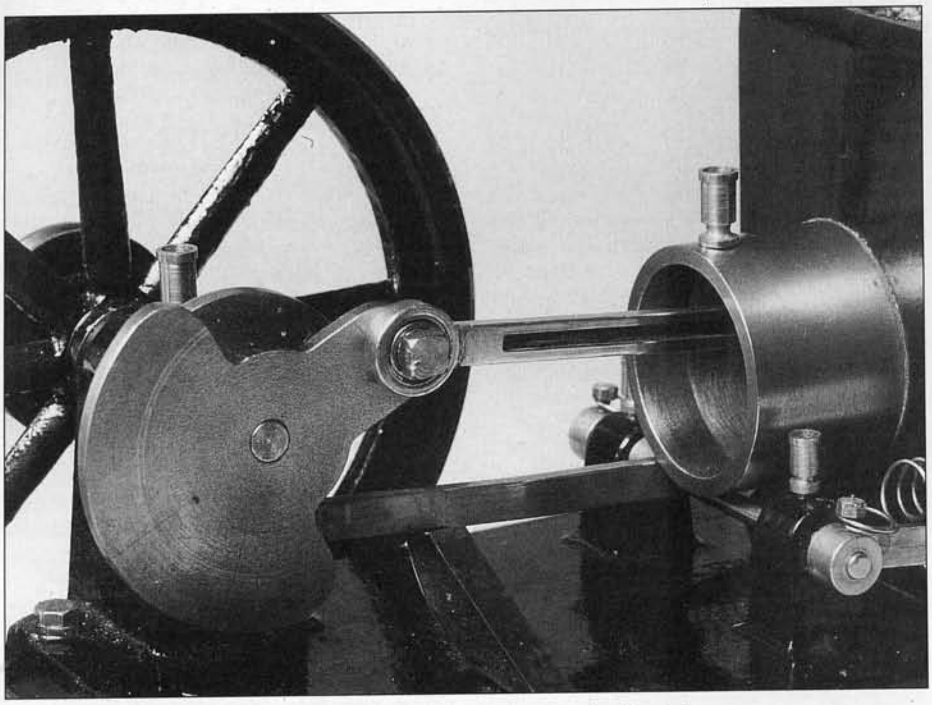
The piston and connecting rod are now assembled with the small end joint which should have a little grease applied to its screw when it is fitted. Slide the piston into the bore and screw the big end bolt into position; rotate the flywheel, checking for



The "business end" - the gas burner can be seen on the right just in front of the carbon/graphite valve and the cylinder port. The spring tension is adjusted to hold the valve on the port face without any undue friction.

alignment and freedom of rotation - when spun by hand, the flywheel should continue to spin for several revolutions.

Remove the lifting links and rivet a valve link to the end of each, making sure that they can move freely. Refit the lifting links loosely, slide the valve shaft through the open end of the valve link, fit a spacer followed by the valve and another spacer and then slide through the other valve link. Fit the two springs between grooves in the valve shaft and each lifting link clamp screw. With the cam follower on the top of the cam, arrange the valve to just cover the flame port and do up the lifting link screws. Rotate the flywheel carefully clockwise and check that all moves freely. If all is well the timing can now be set, rotate the flywheel until the piston is between 30 and 45 degrees before bottom dead centre. Move the cam until the valve just covers the flame port, do up the cam grub screw. Apart from the burner, the engine is now ready for a test run.



This photo shows the piston rod and crank with the cam lever and spring below.

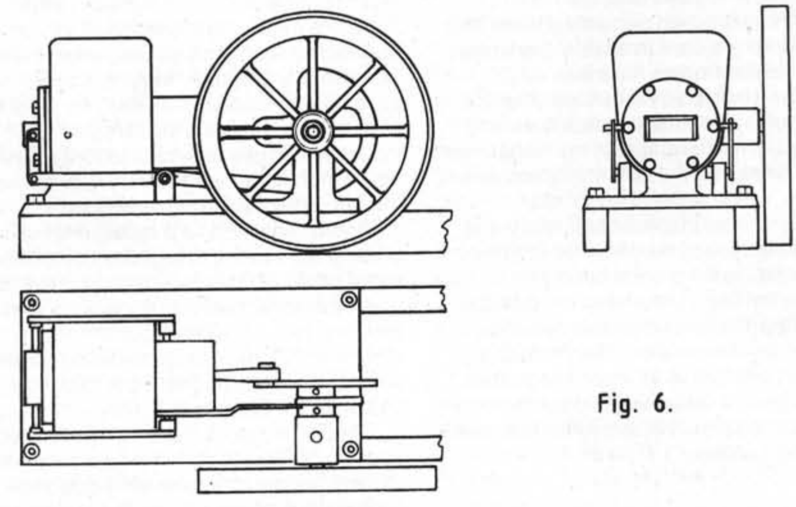


Fig. 6.

Burners

The gas burner (seen in the photographs) is made from brass bar, the proprietary items being the gas jet and two 15mm end feed copper pipe fittings - one 90 degree and one 45 degree. Ceramic may be used for the flame outlet if available but if not make one as per drawing. The gas tank is available as a ready made item and comes with a jet holder and copper fuel line, so there is no need to buy a 4.5mm x 0.5mm pitch tap for the jet. The burner mixer tube may be fixed to the underside of the baseplate with a Terry spring clip.

The alcohol burner (Fig.5) is usually made from brass or copper as shown and requires little explanation other than it must be silver soldered and fitted securely under the wooden engine bearers with the top of the wick level with bottom of the flame port and close to the graphite valve. The advantage of the gas burner is the ease of control of the engine by simply turning the gas valve, whereas the alcohol burner has to have its wick moved up and down to achieve the same effect.

Running the engine

To test the engine, light up the burner and set the flame to about 1" long clean and blue. Spin the flywheel clockwise and, if all is well, the engine should start and settle down to a steady rythm - the speed can be adjusted by the size of the flame. The engine's character may be altered by advancing or retarding the position of the cam. Turning the cam clockwise makes the engine more docile and vice versa. It is also possible to reverse the engine. Starting is made easier if the hopper is filled with warm water. Cylinder lubrication is normally unnecessary as the valve is designed to wear very slowly thus liberating fine graphite particles that become sucked into the cylinder consequently providing sufficient lubrication. Oil must be used sparingly on the moving parts, make sure it is a straight thin oil, such as sewing machine oil or gun oil, and not oils like 3-in-1 which, when the lighter fractions have evaporated, leave a greasy residue which may slow the engine considerably.

I hope you have as much fun as I have had in building and running the engine, so far it has been used to drive a Meccano model, a small dynamo and a water pump. ■

Unfortunately, limitations on space prevent us from including all the detail drawings for the Scott Vacuum Engine in this article. A full set of working drawings (and castings and materials) are available from Bruce Engineering, "Hollow Tree", Riverside, Walton Bridge Road, Shepperton, TW17 8NF
Tel: 0932 245529. - Ed.

BOOKS AND PUBLICATIONS

by Adam Harris

"HOW DO I FIND OUT ... HOW TO DO THAT?"

Adam Harris offers some advice on finding the right source for information on the model engineering hobby ...

As a bookseller specialising in model engineering books, I often receive calls from people seeking help, as they have just bought their first lathe, brought it home and realised they are none too sure what to do next - and who can blame them, as a lathe at first sight is a daunting machine. Luckily help is at hand from a number of sources and, whilst nothing can beat direct instruction via night school or club contacts, the newcomer to the hobby will find that there is an extensive range of "publications" in print to which he can turn for help. These fall into three categories:
(1) Magazines
(2) Books
(3) Videos

Magazines

Dealing with the English language magazines available, these are (in age order):

- ***"Model Engineer"***
  British, published twice-monthly.
- ***"Live Steam"***
  American, published bi-monthly.
- ***"Engineering in Miniature"***
  British, published monthly.
- ***"The Home Shop Machinist"***
  American, published bi-monthly.
- ***"Modeltec" -***
  American, published monthly.
- ***"Projects in Metal" -***
  American, published bi-monthly, alternating with "The Home Shop Machinist" above.
- ***"Model Engineers Workshop"***
  British, published bi-monthly.
- ***"Australian Model Engineering"***
  Australian, published bi-monthly.

All of these magazines publish a wide range of articles of interest to model engineers, although The Home Shop Machinist, Projects in Metal and Model Engineer's Workshop are mainly concerned with workshop techniques and building tools, rather than modelling per se. There are also a number of more specialist magazines available, including the British The Clockmaker and Turnout, and the American Strictly I.C.. All the British magazines should be available off the shelf at larger branches of the major national newsagents, or to order from your own newsagent. The others are only available on subscription; samples and subscription details are available from Camden Miniature Steam Services (address in list at end of this article).

Magazine choice is very personal, and I would recommend the beginner to sample each of these magazines to see which suits him best. Whilst there are national differences, in reality these are only apparent in the advertisements. British and American lathes work in exactly the same way and whilst British, American and Australian locomotives may look different, identical goings-on happen inside them!

Excellent model engineering magazines are also produced in France, Holland and Germany, which shows that model engineering is an international hobby and, subject to language barriers, the British beginner can learn a great deal from engineers' writings from other countries. The slightly different emphasis can often make the solution to a problem much clearer. In addition to all these magazines, many clubs and societies produce their own magazines and newsletters which can make interesting reading.

Books

As well as being international, model engineering is a very old hobby, having been around as long as man has used machine tools. It also tends to use engineering methods which were the norm many years ago, rather than up-to-the-minute practices. Electronics certainly have a place in model engineering, but are neither neccessary nor common! The beginner of 1995 should bear these facts in mind when considering the wide range of books available to him, as many of the best have been in print for many years, or are reprints of old books. In addition, whilst there are many excellent books written specifically for the model engineer, there are also many equally excellent books (new or reprinted) available which were originally aimed at apprentices, students etc. in industry. Today's high-tech industries might spurn them, but they are very well suited to the low-tech model engineer.

Books written for the model engineer broadly fall into the categories of (1) How to use a particular machine tool, (2) How to use a particular piece of equipment with a machine tool, (3) How to perform a particular operation (e.g. soldering, forming sheet metal etc.) and (4) How to build a particular model or tool.

The first three of these categories also apply to books intended for apprentices or students in industry, with the addition of books which cover all machine tools and techniques in one volume (albeit with less detail than in individual books), and others -

always reprints of old titles - which contain "hints and tips"; these books can be a fascinating source of ideas, any one of which can be worth the cost of the book, but they are probably best left alone by the raw beginner until he has cooked a bit!

Within these categories there are many grey areas - notably anthologies of articles by particular writers, or books of articles which have appeared in particular magazines - but the newcomer to model engineering can rest assured that he is unlikely to come across a model engineering problem which isn't covered in an available book!

The final category of book which the beginner needs to consider, if not buy to begin with, is that which deals with the prototypes of particular models and here one enters the realms of books on full size railways, boats, traction engines etc., a subject too vast for this article. Prototype research really is vital if a good model is to be produced and is another pleasurable aspect of the hobby.

Publishers specialising in books for the model engineer include Argus Specialist Publications* (British - the oldest in the field by a considerable margin), Wildwood Publications (American), TEE Publishing (British) and Lindsay Publications (American), but there are others with smaller ranges.

**(Argus Specialist Publications took over the Model & Allied Publications range of titles in 1984. As of 1st November 1994, Argus Secialist Publications was, itself, taken over by the Nexus group and now trades as Nexus Special Interests - Ed.)*

The two booksellers specialising in model engineering books are Camden Miniature Steam Services and TEE Publishing. Both produce mail order booklists and the beginner should ask each firm for a copy of its latest list. For phone numbers and addresses, see the list at the end of this article.

From my own experience I would suggest that a "core" selection of titles for the beginner might include some of the following:

- ***The Amateurs' Lathe*** *[Sparey] Argus Books*
- ***How to Run a Lathe*** *[South Bend - 1942] Lindsay Publications*
- ***Lathe Operations*** *[Barritt - 1937] Lindsay Publications*
- ***Milling for the Model Engineer*** *[Bray] Lindsay Publications*
- ***Machine Tool Operations*** *[Krar & others] McGraw Hill*
- ***Making Small Workshop Tools*** *[Bray] Argus Books*
- ***Building Simple Model Steam Engines*** *[Tubal Cain] Argus Books*
- ***A Beginner's Guide to Model Steam Locomotives*** *[Cole] TEE Publishing* ***So You Want to Build a Live Steam***
- ***Locomotive*** *[Nelson] Wildwood Publications*
- ***Introducing Model Traction Engine Construction*** *[Haining] Argus Books*

Videos

The final type of "publication" available to the beginner is the video, but whilst training videos are very common in industry, by and large they have not become widely available

to the model engineer. The underlying reason for this must be economic; the cost of producing a truly professional video is astronomic and, whilst industry will pay well into three figures for a single copy of a training video, the model engineer can find better uses for such a sum!

Engineering tuition videos are available to the amateur, but the majority represent a cost compromise. From Britain come a video on lathework featuring Ted Jolliffe, editor of *Model Engineer*, one on gas welding (really aimed at the car restorer) featuring well known car restoration author Lindsay Porter, and two from the Welding Institute on MMA and MIG electric welding. These last two were produced by the Institute's own training department and are noticeably more professional in every sense than the others.

From America (but converted to the British Pall system) come four videos featuring well known writer Rudy Kouhoupt, three involving lathe work and one the milling machine. The quality of information on these is worthwhile, but they were shot using high grade amateur equipment in Rudy Kouhoupt's workshop, and the ultimate picture quality could be better. Two other videos from America, on sand-moulding in the foundry, suffer the same fault although otherwise they are of considerable interest.

Given the economics of video production, what is currently available is probably all there will be in the foreseeable future and the beginner should resign himself to relying on the written word for the majority of his information.

In summary

Whilst some will regret the lack of videos, there is a gold mine of information available in books and magazines and the beginner may well find as much pleasure in reading about ideas, techniques etc. as in putting them into practice. This is a well known syndrome called "Armchair Model Engineering"! Beginners can look forward to many hours of enjoyment learning and perpetuating skills which are becoming obsolescent in industry - if they are not already obsolete; every time they stand at their lathes, model engineers are using one of the most remarkable of man's inventions - the only tool which can replicate itself.

So, go ahead, have fun, become a model engineer - and treat yourself to some books; they should answer the question in the title and you will enjoy learning the secrets they contain! ■

Useful names and addresses to contact when searching for books etc.

Argus Secialist Publications (see Nexus Special Interests)

Brandbright Ltd, The Old School, Cromer Road, Bodham, Holt, Norfolk NR25 6QG, Tel: 0126 370755.

Camden Miniature Steam Services, 13 High Street, Rode, Somerset BA3 6UB Tel: 01373 830151.

Meridian Clocks, Wheelwrights, Hillgrove, Lurgashall, Petworth, Sussex GU28 9EW.

Nexus Special Interests, Nexus House, Boundary Way, Hemel Hempstead, Herts. HP2 7ST, Tel: 01442 66551.

TEE Publishing, The Fosse, Fosse Way, Radford Semele, Leamington Spa, Warwickshire CV31 1XN, Tel: 01926 614101.

H.M.S. WARRIOR

by The Rev. William Mowll

This magnificent 1:48 scale working model of an iron warship, the original of which was built in 1860, started through seeing the work of an illustration student and gradually became an obsession with the Author ...

In 1980, I had an invitation from two college lecturers, from Bournemouth and Poole College of Art, to go and see the work of a student called Stephen Ortega. This young man had been sponsored for an extra year to complete a cut-away illustration of *HMS Warrior 1860*, on which he had been working for the previous eighteen months.

At that time, I had just completed a working model of Brunel's *Great Britain* (1843) and published a book on the subject, in conjunction with Technical Illustration Department of Bournemouth & Poole College, whose students had, under close supervision, provided many of the scale drawings for the book.

Seduction

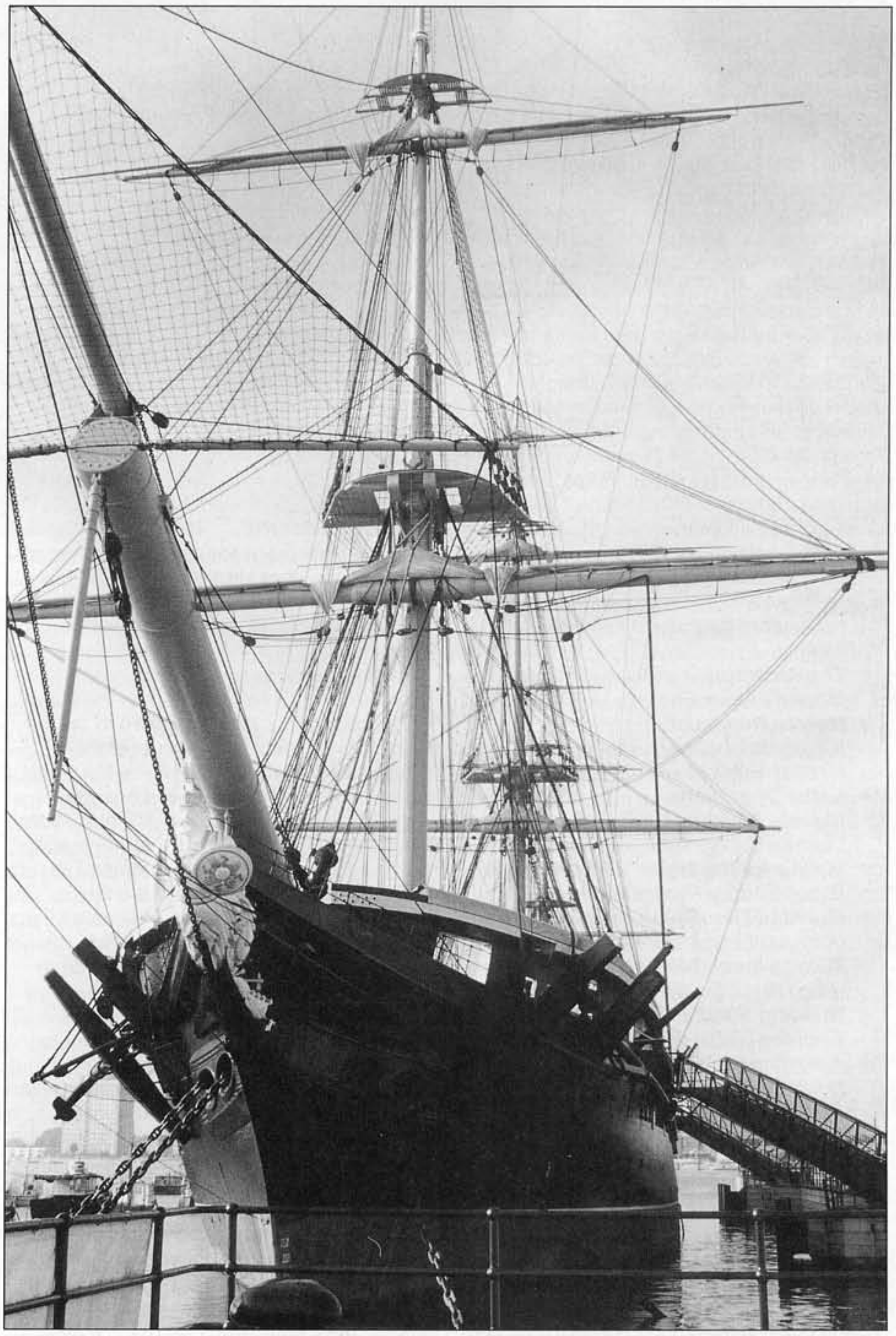
Model engineers are perhaps one of the few groups of people who will fully understand how seductive plans and illustrations can be, and it soon became obvious that I had been totally ensnared by the temptation to convert the magnificent two dimensional illustration into a three dimensional working model.

When people talk about a working model, it can mean almost anything, from something which simply "goes along nicely", to a highly detailed scale replica which is almost indistinguishable from the prototype - a smaller version of what is known as "The real thing."

The prototype

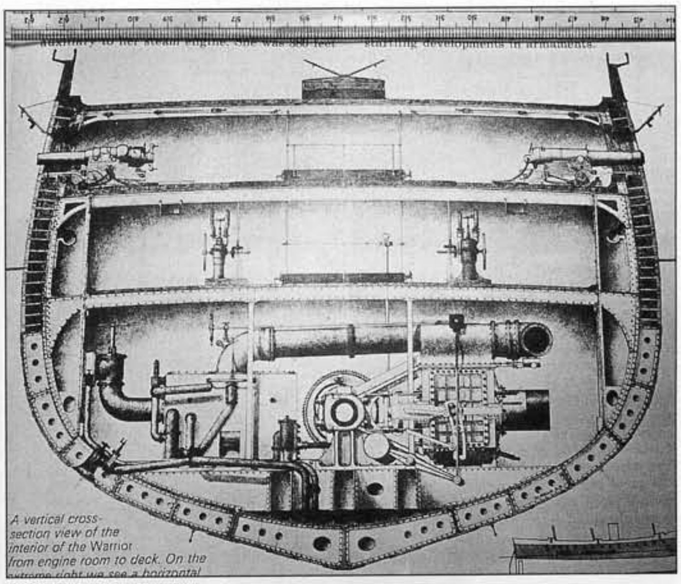
At the time I knew precious little about the major restoration work to the *Warrior* prototype, and only later learned about her full history and significance. In the early part of the 1980's she was berthed at West Hartlepool, having been rescued from ignomy as an oil pontoon in Milford Haven. Later I would discover about the enormously important vessel she was and is but, at that moment, I recognised that she was iron built and that she fell into the period of shipping which saw sail and steam together. That in itself was sufficient to convince me that I would like to try and build a miniature working replica of her, in as much detail as is practicable for a model ship.

One thing more, I wanted her to be coal fired, for I could see that the whole essence of this ship was centred around the bunkers and boilers. Gas would not do!

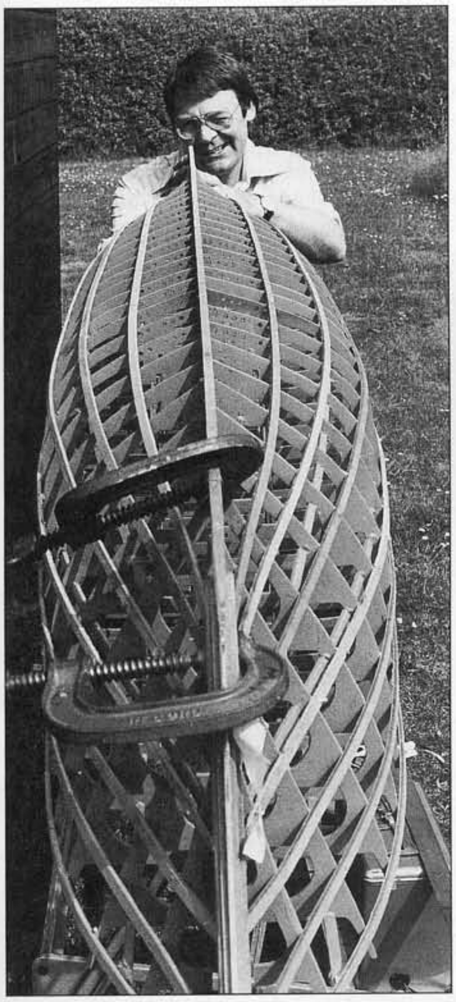


HMS WARRIOR 1860 - "The real thing" - berthed as a totally restored historic ship at Portsmouth.

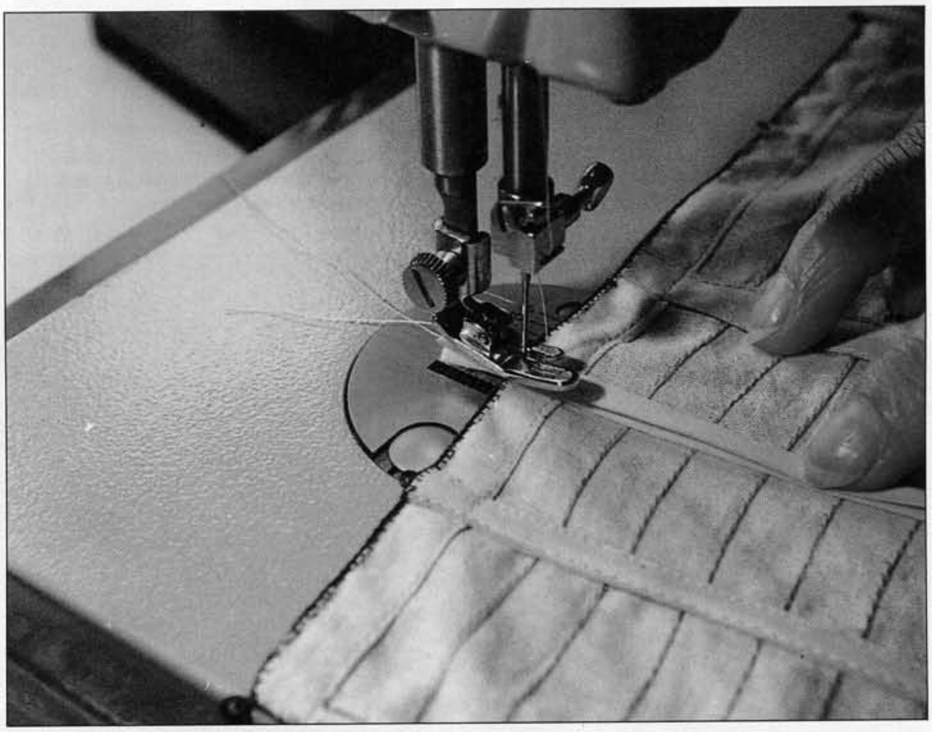
HMS Warrior, the original, under restoration at the Coal Dock Wharf, West Hartlepool in May 1982.



This photo of a meticulously drawn contemporary illustration by W. Milln RN is a cross-section view of the interior of Warrior showing the engine room armament (110 pounder on portside and 68 pounder on the starboard) and the horizontal engine.



The Author and builder, William Mowll, checking the alignment of the keel on the model in May 1982.



Making the sails to scale. The work of Mrs Phyliss Checkley - the Author's mother-in-law!

How long would it take?

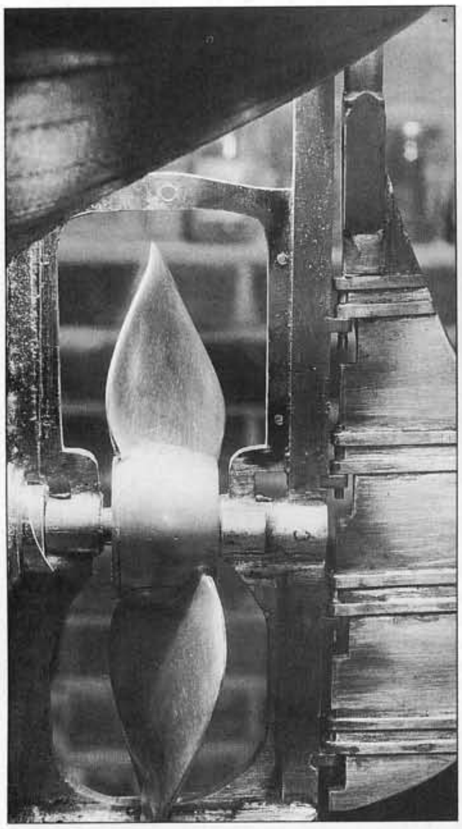
I thought that it might take seven years to do; I reckoned that I ought to be able to keep up with the restorers, even though there were 140 people working on her at the time. This did not include all the little firms and training schemes who, together with the permanent staff, produced the thousands of fittings associated with a major rebuilding programme. The fact that the original ship was built in 18 months astounds me now, as it surprised me then, but I thought 7 years ought to be sufficient time to build the model, on the basis of an amateur who builds for one full day a week.

I readily admit that I am not an engineer. I am, as were the Victorian shipbuilders, a blacksmith, who happens to work at a smaller scale. Unlike many model shipwrights, I love metal and I love working in metal, and it is a well kept secret that it is often easier to produce something in metal than it is in wood, particularly if it's small.

Raw materials

Shipbuilding, of course, demands all the disciplines whether in full scale or miniature. The hull of my model is made from glass-fibre, the beams and decking from timber, as are the masts and yards. The working parts include many different metals; stainless steel for the propeller shaft, bronze for the bearings, antimony (white metal) for the castings of guns and other details, brass for the funnels and two-bladed propeller, aluminium to act as a heat sink for the engine room, copper for the boiler and lead for the ballast - 63lbs of it to trim the vessel out to the load water line.

After the metal and timber, come the soft brigade. All the sails (14) are sewn in cotton voile; the stern decoration is overlaid with goldleaf and all the roping is hand spun on a miniature ropewalk, using a quality of thread associated with the manufacture of boots and shoes. Those parts of the masts which rub and chafe against either rope or timber, are clad with leather (as in the jaws of the gaffs), and the flags are made of fine, permanently dyed, linen. From this list, it's difficult to think of a raw material which is not included and this is one of the



The blacksmith's finest hour - the lifting propeller (Griffith's Patent) set in the banjo frame at the stern of the model ship. All items are fabricated from brass.

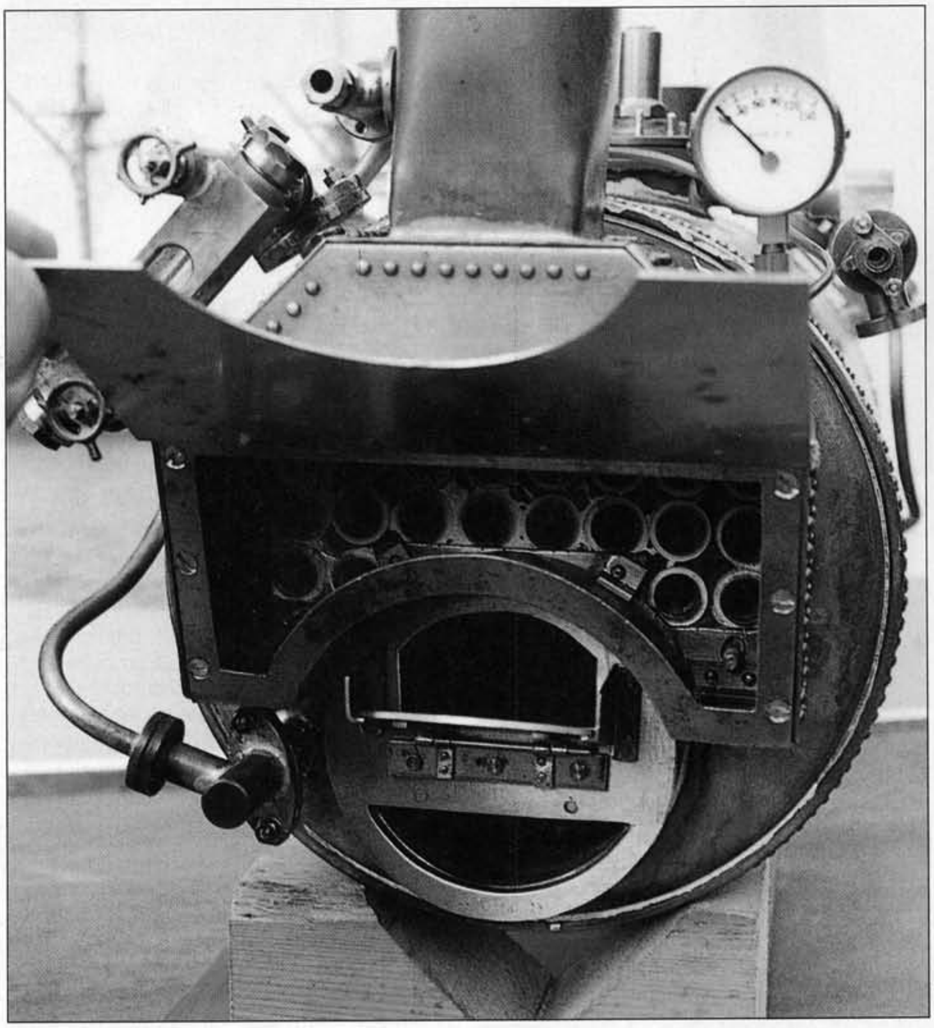
Geoff Sheppard is seen here puzzling out the problems of installation. Geoff is responsible for the design and manufacture of the boiler.

fascinations of boat building, as opposed to any other kind of modelling.

Boiler and engine

Some modelmakers would rather not have anyone else involved in their production. This is a fair point of view which I understand well enough. Nevertheless, when I built my *SS Great Britain*, I enlisted the help of Geoff Sheppard from Bristol to build the boiler, and I never regretted one moment of that decision. His expertise in this specialist area is well known and appreciated by all those who have watched him demonstrate the art of boilermaking at shows and public gatherings. But a coal-fired double-ender! - that is the equivalent in boilermaking terms, of asking someone to consider a trip to the dark side of the moon. It's been done, but it hasn't been done too often.

The engine is a Stuart 'Score', a horizontal version of the 'Double Ten', and markedly close to the original trunk engine as fitted to *Warrior* by John Penn's works, in both size and appearence at 1:48 scale. The miniature 'Score' engine has had a conversion to it, by the addition of the reversing kit normally used with the 'Double Ten'. Extra height is required for this, and the whole unit has been raised from the model ship's floor, partly to facilitate the operation of it, and partly to allow for gearing down the propeller speed, which ought to run at approx 53 r.p.m. to imitate the original.



This photo reveals the the 20 fire tubes at the stern end of the boiler: there is a shared combustion chamber for the double-ended boiler.

Floating out trials - July 1994. By no means finished, but on the water at last! At this time she was still to be boilered, engined and rigged.

Specifications of the model

Built on a scale of 1:48 (1/4" to 1 foot).
Overall length of model to extremes (Flying jib boom to ensign truck) l0ft.2in.

Royal mast to keel 4ft.7in.
Foreyard with booms extended 3ft.
Weight (inclusive of 63lbs. ballast) 146lbs.

Construction of hull is in GRP.
Metalwork is mainly in brass and copper.
Decks individually planked to deck beams.

All masts are timber with metal banding.
Suite of 14 sails, from scale drawings.
Propeller 6in. diameter.
Armament, as per prototype, cast in metal.

Engineering:-
Boiler: Double-ended Scotch wet-back with shared combustion chamber, fired by coal.

Steam Engine: Stuart 'Score' 5/8 in. bore x 5/8 in. stroke, fitted with reversing gear.

Control: Futaba 6 Channel radio transmission on 40Mhz.

Project begun November 1981.
Estimated finish 1997. First floating out trials June 1994.

Specifications of the protoype

These specifications are reproduced by courtesy of Capt. John Wells C.B.E., D.S.C., R.N. and we are grateful for his kind permission to use them in connection with this article.

Warrior was designed by Isaac Watts, Chief Constructor for the Royal Navy, with the assistance of iron shipbuilder John Scott-Russell.

Built by the Thames Ironworks and Shipbuilding Company of Blackwall, London.

Keel laid down on 25th May 1859. Launched on 29th December 1860.

Overall length 418 feet (127.4m). Beam 58 feet (17.6m). Mean draught 26 feet (7.9m).

Original armament of twenty-six 68 pounder smooth-bore muzzle-loaders, ten 110 pounder Armstrong rifled breech-loaders, and four 40 pounder Armstrong rifled breech-loaders plus other, smaller guns.

Main armoured citadel 213 feet (63.9m) long by 22 feet (6.6m) deep with 4$^1/_2$ inches (11.4cm) of wrought iron plating backed by 18 inches (45.7cm) of teak.

Horizontal trunk type steam engine, designed by John Penn, with two cylinders, double acting and jet condensing. Cylinders 9$^1/_2$ feet (2.9m) diameter and stroke of 4 feet (1.2m) producing 1,250 Nominal HP. 10 rectangular fire tube boilers, fed by 40 furnaces, produced steam pressure of 22 lbs per square inch. Coal bunker capacity 850 tons.

24 feet (7.3m) diameter lifting type two-bladed propeller. Funnels, each 31 feet (9.4m) high, could be raised or lowered 15 feet (4.6m).

Three masts, square rigged, with total canvas area available of 48,400 square feet (4495 sq.m).

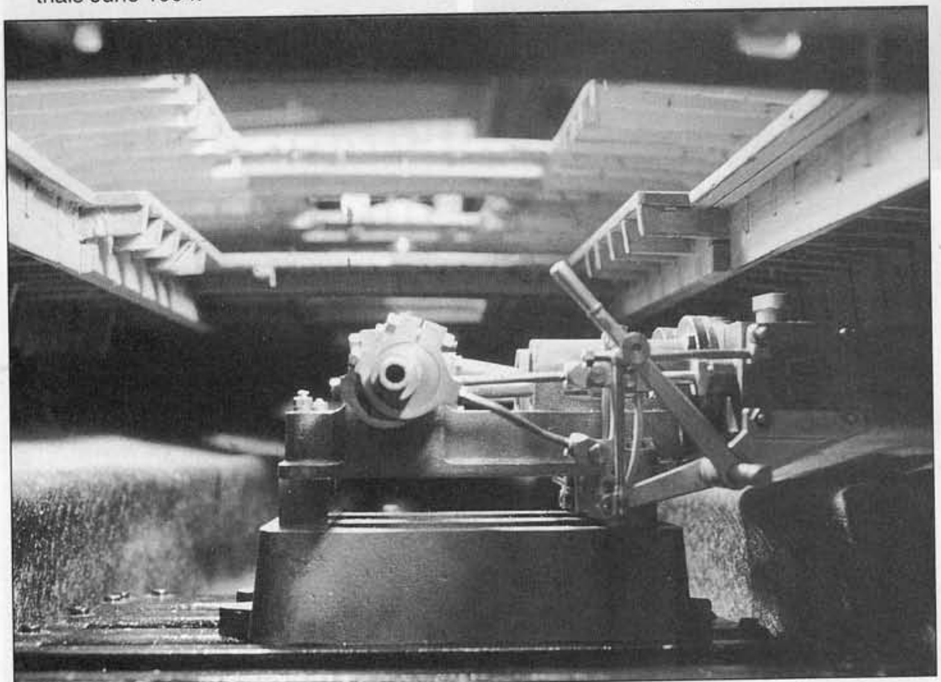
Max. recorded speed under steam 14.3 knots. 13 knots under sail.

Original displacement 9,210 tons.

Complement 705;
42 Officers, 3 Warrant Officers, 455 Seamen; 3 Royal Marine Officers, 6 Royal Marine non-commissioned officers and 118 Royal Marine Artillerymen;
2 Chief engineers, 10 engineers and 66 stokers.

Visit the prototype

HMS Warrior has now been restored to her original condition and is open to visitors every day of the year, except for Christmas Day, from 10.30 to 17.30 (March to October) and from 10.30 to 17.00 (November to February).
Further details may be obtained from HMS Warrior 1860, Victory Gate, HM Naval Base, Portsmouth PO1 3QX. Tel: 01705 291379.



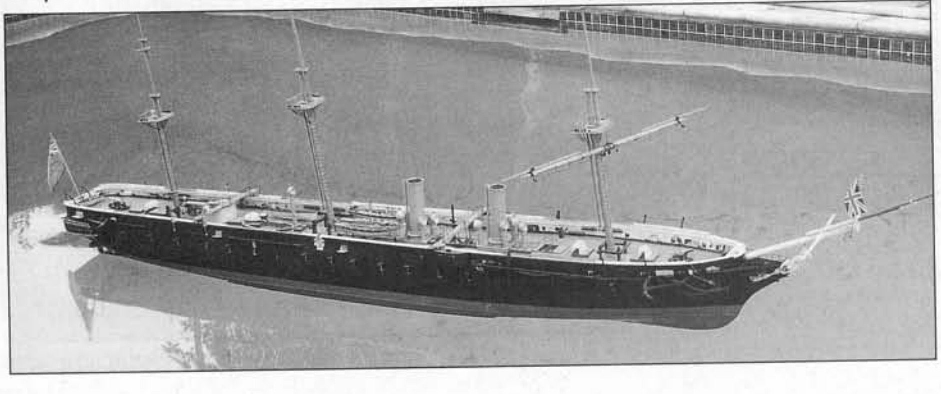
Sited as per the original engine, the Stuart Score engine is placed below decks on the model. Compare this photo with Milln's contemporary drawing in one of the other photos.

Operational nightmare

No-one would pretend that this is going to be an easy vessel to sail. Just finding four people willing to lift it at a ballasted weight of 146lbs is bad enough, to say nothing of its l0ft.2in. length. Nevertheless, it is important to me that she has the ability to sail and steam, and I need hardly mention the fact that to obtain true realism in modelling terms, there has to be steam and smoke, and when they are added to a large model whose sails will catch the wind, then I can puff on the pipe of sweet contentment and dream the secret dream of scratchbuilders, be they sailors or airmen or the elite of locomotive engineers.

About the Author

The Revd. William Mowll has been a member of the Guild of Master Craftsmen since 1979, and was elected as an Honorary Member to the Guild in 1984. He is also a member of the Society for Nautical Research, and a life member of the Warrior Association. He is the Author of the Book *SS Great Britain - The Model Ship*, and the model won a Gold Medal at the 1982 Model Engineer Exhibition at Wembley. ■



A general view of HMS Warrior at 1:48 scale during her floating out trials in July 1994.

STUART TURNER'S MODELS

One of the longest established names in the field of model engineering is that of Stuart Turner, whose designs have been made by model engineers all over the world for the past 95 years ...

The Stuart Turner range of models grew out of an engineer's pastime way back at the turn of the Century. During the late 1800's, Mr S.M. Stuart Turner used to spend some of his spare time making models at his home. One of these models, a vertical steam engine, he designed for himself and made some patterns with which to get some castings made. He then machined the castings and made the rest of the components to finish the model which he then entered in a local industrial exhibition where it was awarded a prize.

Mr. Percival Marshall, the Editor of a new magazine at the time, called "The Model Engineer", saw the model and was so impressed with it that he suggested it might be put on the market for other model engineers to make. So, Mr Stuart Turner went home and set about producing some good quality drawings and castings. Then, in 1898, he announced in the pages of "The Model Engineer" that supplies were available. The engine proved to be so popular, with sales increasing all the time, that Stuart Turner soon found that it was too much to cope with as a spare time hobby and he took the decision to resign from his job and set up a full time business in a small workshop in Henley-on-Thames. He named the engine the "Stuart No.1" and, as demand for castings and drawings grew rapidly, it was followed by further new designs for steam and gas driven engines. Stuart Turner Ltd. was registered as a Company on April 10th, 1906.

Continued expansion

One thing that has remained constant throughout the range of models produced by the Stuart Turner company is that all of the models are based on original full size engine designs.

As business continued to expand, the original workshop was soon outgrown and new premises were acquired at Market Place, still in Henley-on-Thames, where more space and machinery allowed production to be increased. During the First World War, the company undertook a lot of work for the Ministry of Munitions and the Air Board and this meant that the model engine production had to be curtailed and stocks of models were soon sold out. After the War, however, the factory was re-arranged and model production was soon re-established.

Stuart Turner's policy was to always produce the highest quality available and to supply the modeller with everything needed to construct the particular model chosen, including all necessary materials, nuts & bolts, and fittings like valves etc. To this end he set up a section within the workshop to produce all the fittings using capstan lathes and so on. This was in addition to his own on-site foundry to produce the best quality of castings, which he demanded.

The success of the business was, to a great extent, due Mr. Turner's enthusiasm for the model engineering hobby and his continued desire to produce the best quality of design, manufacture and workmanship that was available. It is reported that he maintained excellent relationships with his staff, from the management right down to the tea boy, and this resulted in great enthusiasm and loyalty within the workforce.

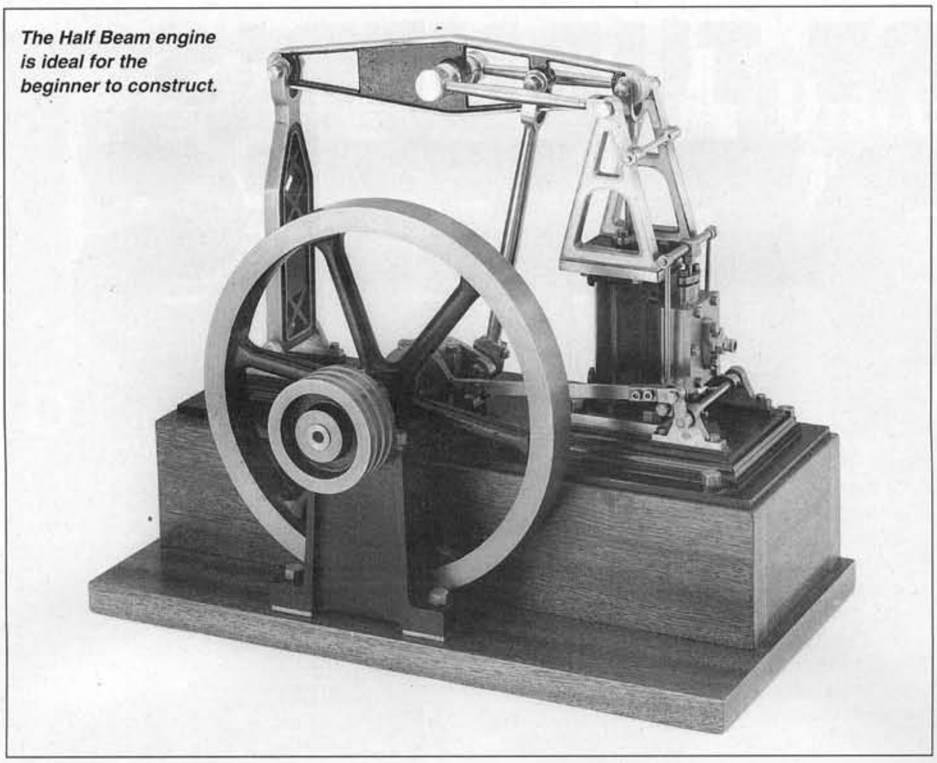
Just prior to his 70th birthday, Mr. S.M. Stuart Turner died on April 8th 1938 after contracting a sudden illness. But the loyalty of his workforce was so great that they determined to keep his name alive and, in fact, continued the success and expansion of the business which had started so many years before as a hobby. The name of Stuart Turner is now famous all over the world and he is recognised as one of the pioneers of the model engineering hobby.

The original Stuart No. 1 engine

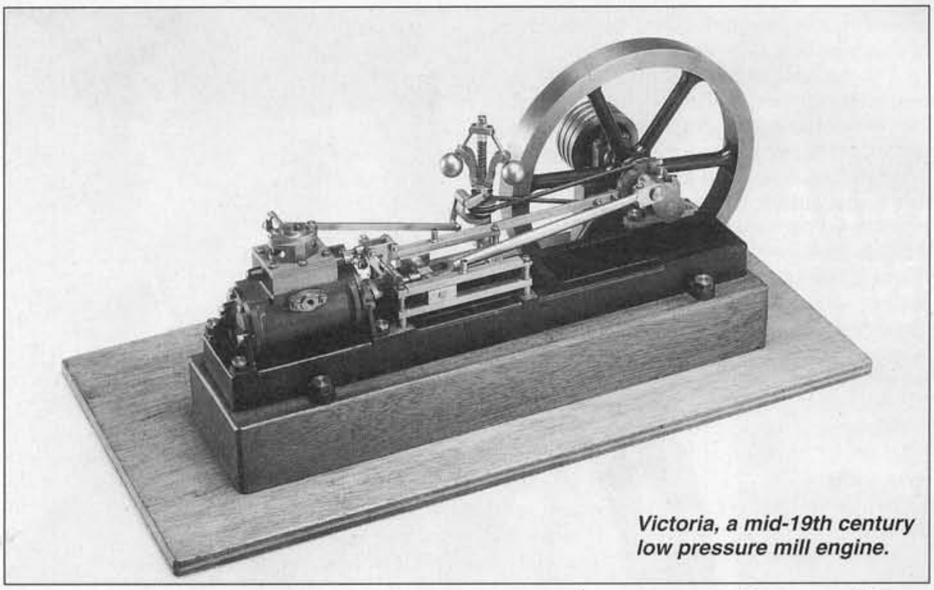
Change of ownership

In the mid 1980's Stuart Turner Ltd. formed a new company called Stuart Models which was based in Cheddar, Somerset. It was set up to handle the model side of the original company which, by now, had diversified into other areas of engineering.

Towards the end of the 1980's, a new company called Cheddar Models purchased the boilermaking side of Stuart Models, along with the design of a new engine which was under development at that time. The new engine became the highly successful



The Half Beam engine is ideal for the beginner to construct.



Victoria, a mid-19th century low pressure mill engine.

"Puffin" and is a two-cylinder double acting in-line oscillating engine.

In 1991, the remainder of the Stuart Models company, which comprised the model engine designs and manufacturing side, was purchased by Jones & Bradburn and moved to Guernsey, in the Channel Islands. Jones & Bradburn, recognising the importance of continuing the excellent standards and quality associated with Stuart Models also purchased the company name and are continuing the long tradition by trading as Stuart Models. This acquisition complements their previous purchase of the Plastow range of traction engine designs.

The models themselves

The current range of models now marketed under the name of Stuart Models still includes Mr. Turner's original design, the Stuart No.1. This is a single cylinder vertical steam engine with slide valve operated by an eccentric on the crankshaft. The model has a 2" bore and a 2" stroke and is 13" high overall. It is a powerful engine capable of driving quite heavy loads.

Other vertical engines in the range include the Stuart No.4 ($1\frac{1}{2}$" bore x $1\frac{1}{4}$" stroke) and the Stuart No.7 (1" bore x 1" stroke), both of which may be fitted with reversing gear. The Stuart 10V is a small single cylinder vertical engine ($\frac{3}{4}$" bore x $\frac{3}{4}$" stroke and eccentric driven slide valve) and is very suitable as a first time project for the beginner in model engineering. The Stuart D10 (known affectionately as the "Double Ten") is essentially two 10V engines mounted side by side on a common base casting. Optional reversing gear may be fitted to either of these engines.

The Stuart 10H is a horizontal version of the 10V and has a single cylinder of $\frac{3}{4}$" bore x $\frac{3}{4}$" stroke with an eccentric driven slide valve. The Stuart Score is a twin cylinder horizontal slide valve engine closely related to the D10. The "Score" is very popular with boat modellers because of its resemblance to the engines used in paddle steamers.

There are three beam engines in the range. The Stuart Beam Engine is a simple engine with Watt's parallel motion. With a 1" bore x 2" stroke, it is ideal for the beginner to construct and only requires a small boiler to run it. Also suitable as an introduction to the hobby is the Half Beam Engine ($\frac{3}{4}$" bore x $\frac{3}{4}$" stroke) with its unusual beam motion. This is also suitable as a beginner's project. The Major Beam Engine is a more complex model which is quite large at $1\frac{3}{4}$" bore x $3\frac{3}{4}$" stroke and a height of $18\frac{1}{4}$".

The Victoria and Twin Victoria engines are models of the type of low pressure horizontal engine which would have been used in the mid 19th century to supply workshop and factory power. The Stuart Mill Engine S50, of $\frac{5}{8}$" bore x 1" stroke, is modelled on a typical North of England mill engine.

One of the more complex engines in the range is the Stuart Triple. This is a triple expansion marine engine with cylinders of $\frac{3}{4}$", $1\frac{1}{4}$" and $1\frac{3}{4}$" bore, all with 1" stroke. It is a fully reversible engine which generates sufficient power to drive scale model steamers and tugs. Many fine examples of this model may be seen at various exhibitions etc. as it also makes a first class display model.

The Stuart Twin Launch engine with its 1" bore x $\frac{3}{4}$" stroke is ideal for use with radio control, especially when fitted with the optional reversing gear, and is another very popular engine. It is also available as the Stuart Compound with $\frac{3}{4}$" and $1\frac{1}{4}$" bore cylinders.

Much larger engines include the vertical Stuart 5A ($2\frac{1}{4}$" bore x 2" stroke), the 6A Compound ($2\frac{1}{4}$" and 4" bore x 3" stroke) and the Cygnet ($2\frac{1}{4}$" bore x 2" stroke). The Swan is a twin vertical cylinder engine similar to the Cygnet.

A very wide range of accessories including both hand and steam driven feed pumps, lubricators, boiler fittings etc. are also available. There are also five steam boilers in the Stuart Models range to complement all of the different engines.

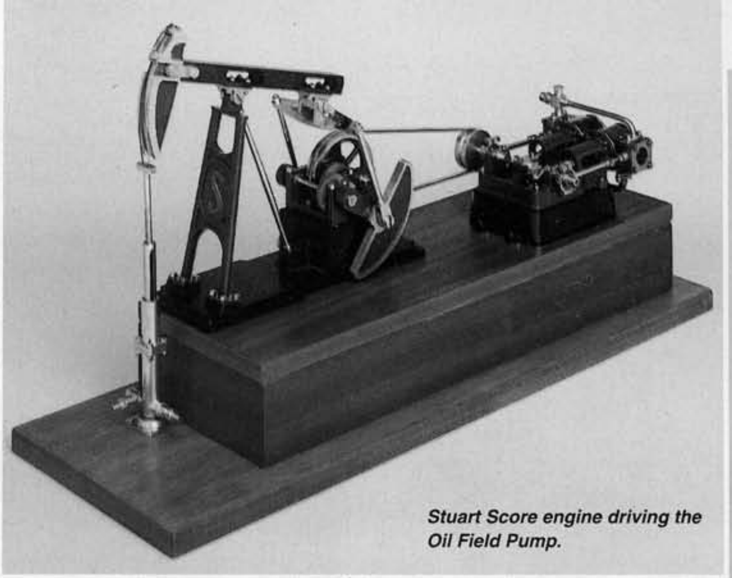
In conclusion

As noted above, many of the Stuart engines are suitable for the beginner to make. Indeed, there must few model engineers who have not, at some stage, constructed one of the Stuart models. Thanks to Mr. S.M. Stuart Turner's excellent design abilities and his understanding of the needs of the model engineer, these model engines are ideal for either the newcomer who is making a start in the hobby or for the experienced modeller who wants to try his hand at making something different to his chosen field of model engineering.

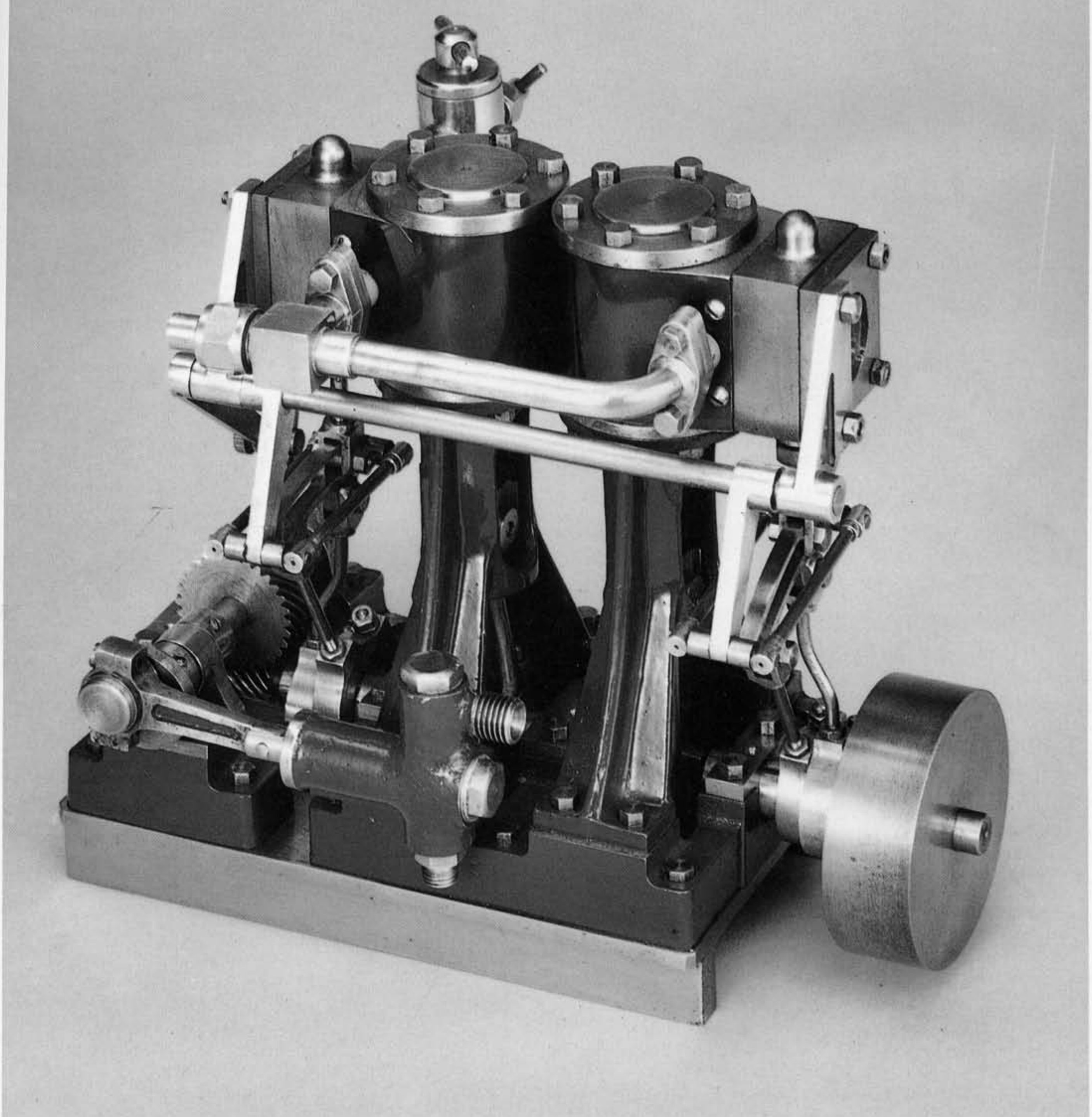
The following is a list of books available on the construction of the Stuart engines

- ***A beginner's guide to building a Stuart No.1 Engine** - by Andrew Smith*
- **Building a 19th century steam engine, *Victoria*** *- by Andrew Smith*
- **Building the Stuart No.9 engine** *- by Tubal Cain*
- ***Building the Vertical Steam Engine** - by Andrew Smith*
- ***Building the James Coombes table engine** - by Andrew Smith*
- ***Building the Stuart beam engine** - by Andrew Smith*
- ***Building a Real vertical steam engine** - by Andrew Smith*

All these books are available from Stuart Models, Braye Road Industrial Estate, Braye Road, Vale, Guernsey, Channel Islands. Tel: 01481 49515 or Fax: 01481 47912. ■



Stuart Score engine driving the Oil Field Pump.



The Stuart D10, shown fitted with reversing gear and boiler feed pump, is ideal for boats up to 34" in length.