Model Mechanics

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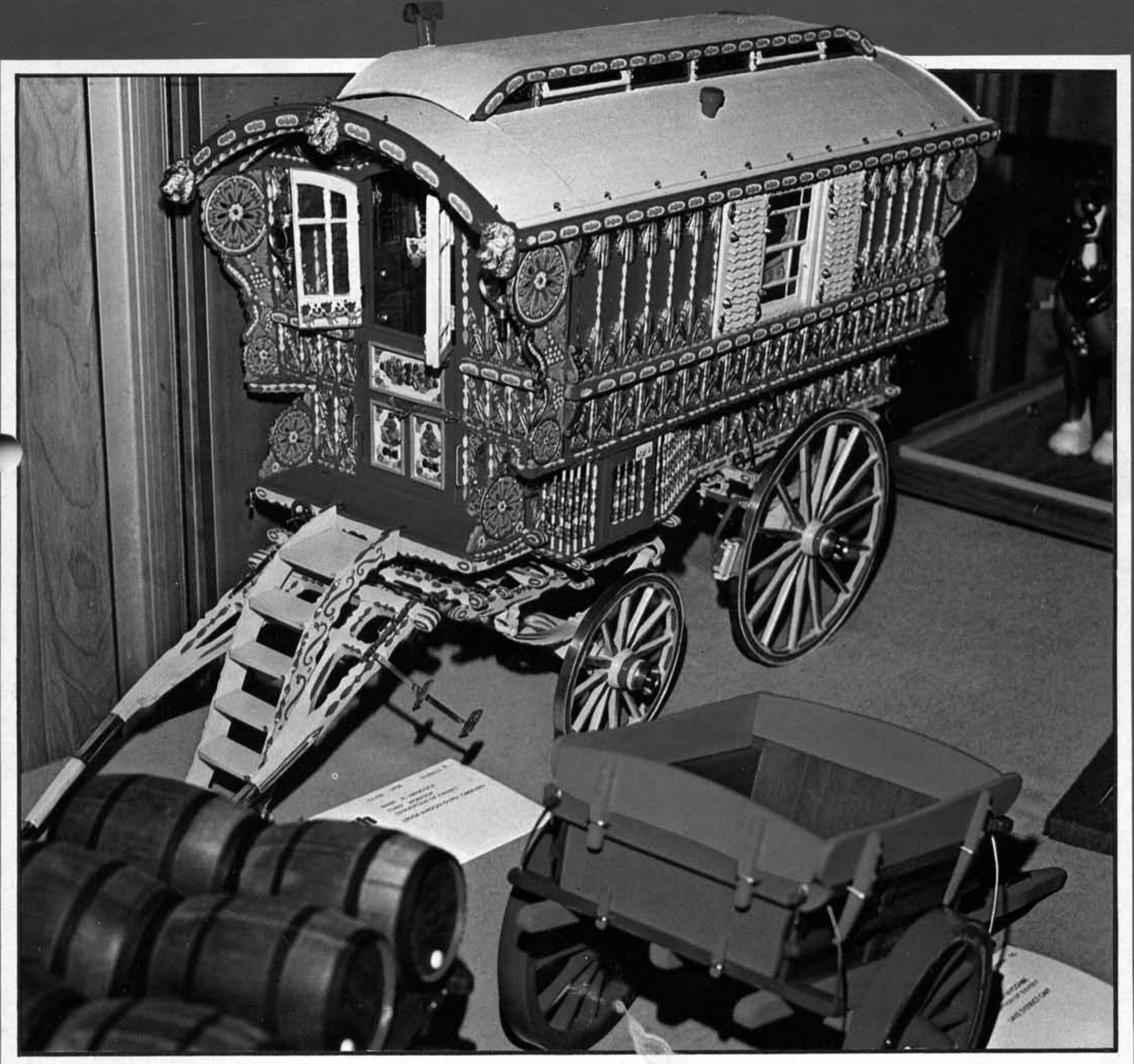
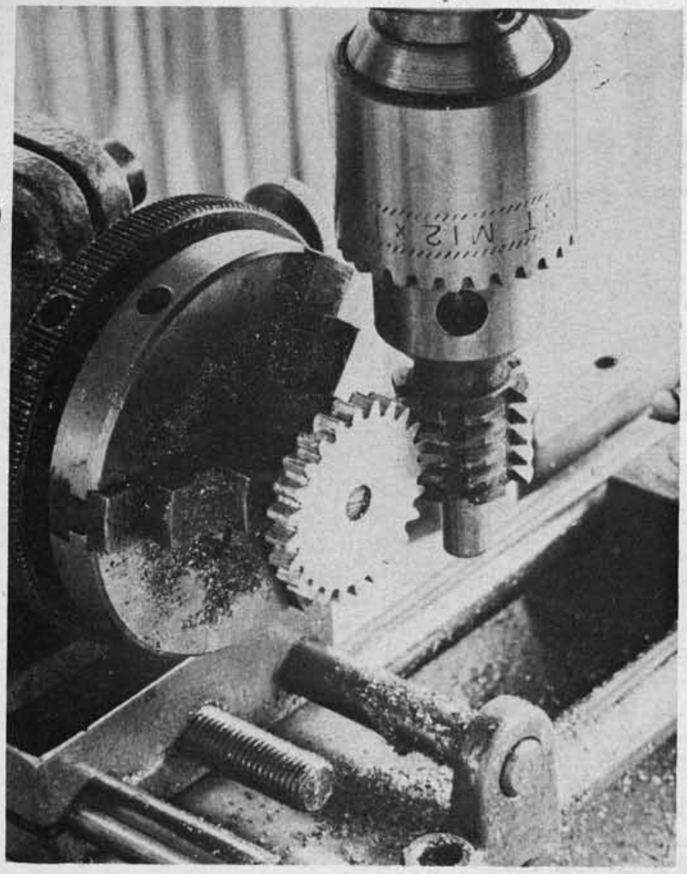
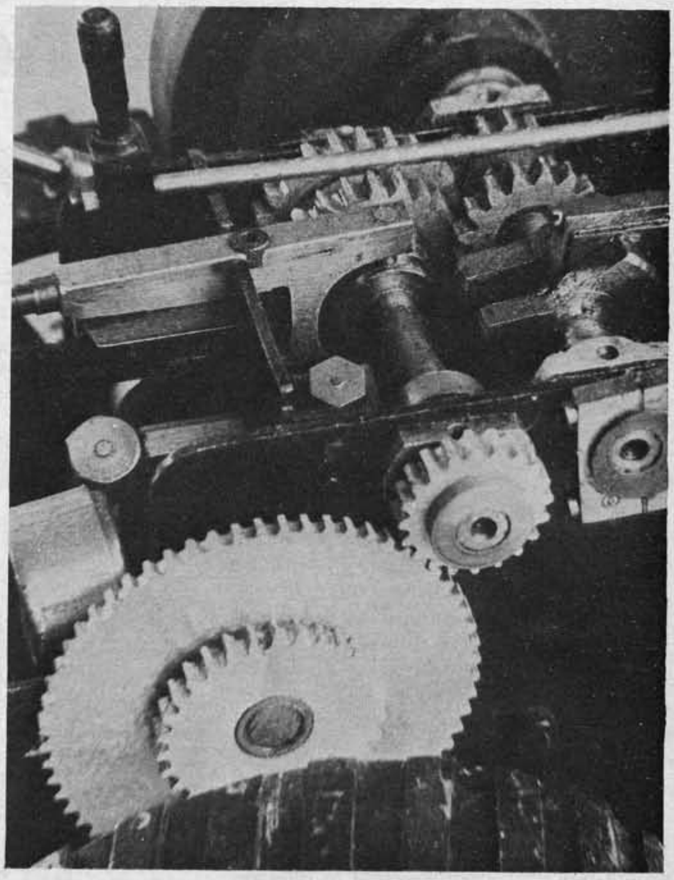


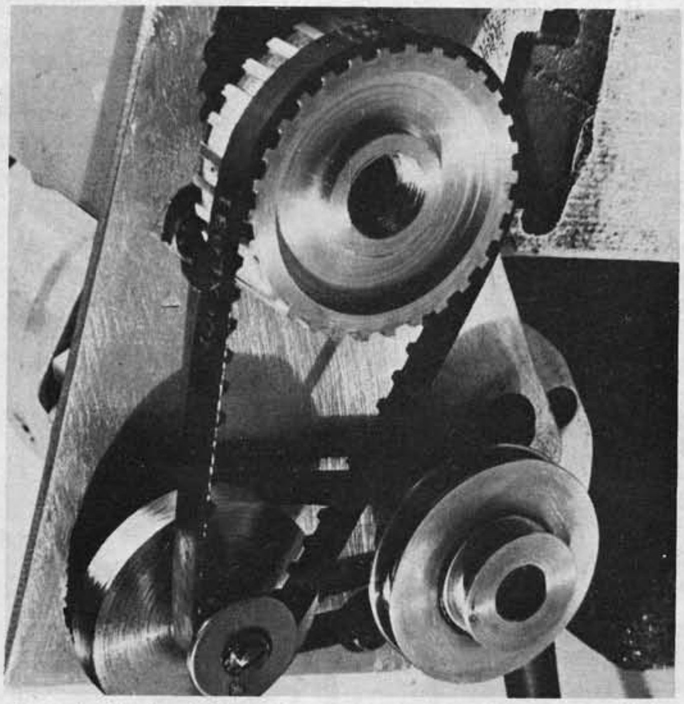
PETROL ENGINES • FARM CART
MECCANO • RAILWAY TRACK LAYING



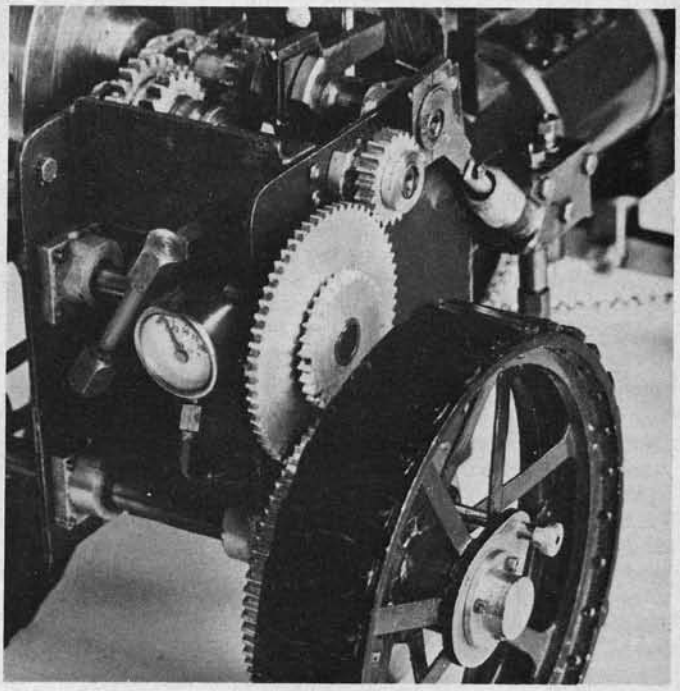
Cutting a gear wheel with the finished hob



Above and below: gears on a small traction engine, cut using these methods



A toothed wheel drive, the way to cut these gears will be explained in Part II



cross-slide movement. Smaller teeth sizes can be made with a single pass, forward and back, then turning for the next indexed cut; lock up whilst cutting. Larger teeth, and teeth in harder materials, will need more than one depth of cut, in which case note the longitudinal slide handwheel setting for each cut and for the final position cut, write them down as you may be interrupted half-way through the job. Remove the completed gear from the mandrel and rub off burrs on emery cloth.

Life of the Hobs

So far I have only used my hobs for cutting gear wheels in aluminium alloys and brass and the cutters show no signs of blunting. To sharpen the hobs the leading cutting edges would need a light stoning by hand, then the hobs should be turned at speed and a flat stone run lightly against the top of the teeth. There is no reason why the cutters should not be used to cut teeth in mild steel blanks, but care must be taken to avoid overheating by using less of a cut, also the hobs will need more attention by sharpening.

Part Two will be published next month.

A working model of BRANCA'S MILL

By
Basil Harley

IT WAS NOT until the 18th century that something of the vast potential of steam power began to be realised. Thomas Newcomen's early atmospheric engines at the beginning of the century were developed to the relative sophistication of the true steam engines of James Watt, and others such as Trevithick and Hornblower, by the end. But even before then in the 17th century, 'natural philosophers' or physicists as we would now call them together with more practical men had observed the power of steam and had sought to harness it — particularly for water pumping. Among them were Thomas Savory, David Ramsay and the Marquis of Worcester.

Everybody knows that Hero of Alexandria was fascinated by the action of the steam jet and succeeded in making it spin his toylike Aeolipile which was described in the March issue. The ancient world also used the steam jet for another, more practical, purpose, that of blowing fires. A typical 'sufflatore' as the devices were called was a hollow bronze casting of a man's or animal's head with a tiny pinhole jet at the mouth. This was filled with water, placed in the fire and, when the water boiled the steam jet was directed into it to increase the draught so as to make it burn more brightly. Towards the middle of the 17th century an Italian, Giovanni Branca, thought to use such a sufflatore to drive a stamping mill. The famous illustration from his book *De Re Machina* (1629) is shown in Fig 1 with the head-shaped boiler fizzing and blowing away.

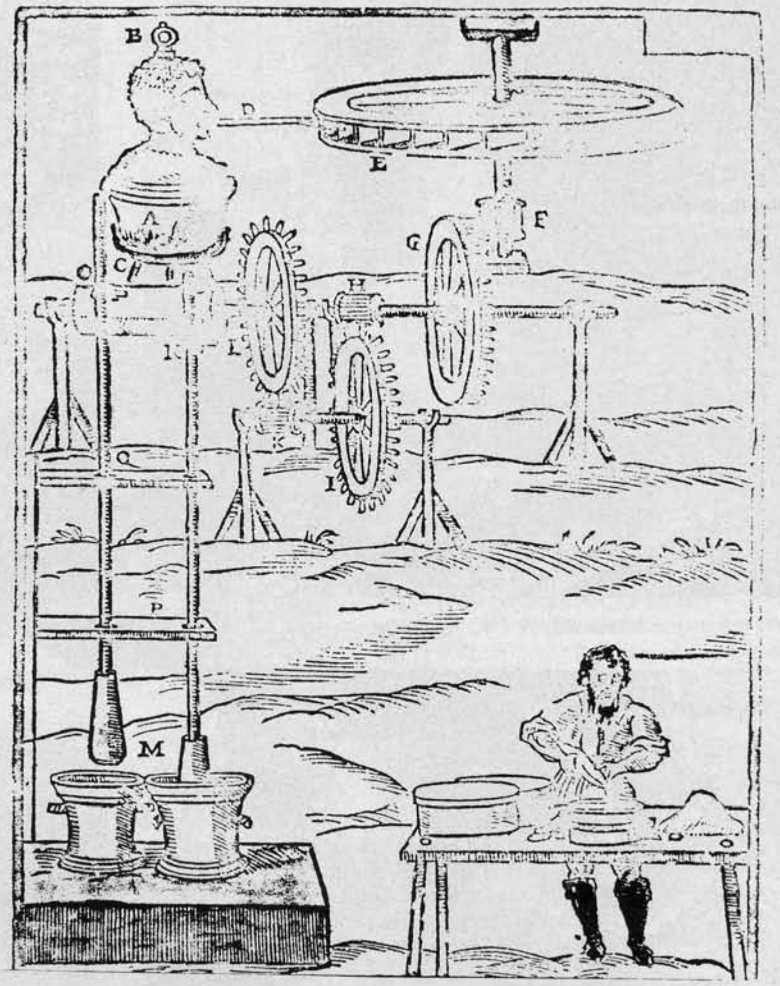


Fig 1 Giovanni Branca's primitive impulse turbine as illustrated in his De Re Machina of 1629

The picture, drawn with a fine disregard for perspective, apparently shows the steam impinging on a kind of horizontal waterwheel connected by crude clock type gearing to an ore stamping mill. The shafts are supported in the crooked ends of tree trunks dotted about a hilly landscape and the two pestles of the mill stamp away in bronze mortars. A miner or a chemist or perhaps even Giovanni Branca himself is depicted measuring out the pounded products on a little table in the foreground. It is not clear whether a laboratory sized experiment is envisaged or whether, as the countryside would indicate, a full scale ore preparation plant is shown. It is however, very clear that such a crude installation could never have really worked. The importance of this picture is that it shows the beginning of the new thinking that was to harness the sciences to the practical skills of the millwrights and the clockmakers, the most respected of the early craftsmen and furthermore it shows proposals to make steam power do some useful work.

The Branca turbine is an impulse turbine; toy versions were made to demonstrate the principle in Victorian times (Fig 2) and are well known today to many a schoolboy as part of his metalwork course. I thought it would be interesting to make a working model of this Branca stamping mill, conforming at least to the spirit of the illustration, so that it could be shown alongside the Hero engine. Figs 3 and 4 are photographs of a version I have built which, though it works satisfactorily is a little more complicated than it need be and uses a worm gear taken from one of those ex-Government wartime mechanisms no longer available.

So my drawings and descriptions here show a slightly simplified mill which will work rather better, for one thing the turbine is more effective since it is lighter and has 16 instead of 8 blades and it more resembles the picture. Crude gearing would, I fear, incur too much friction even

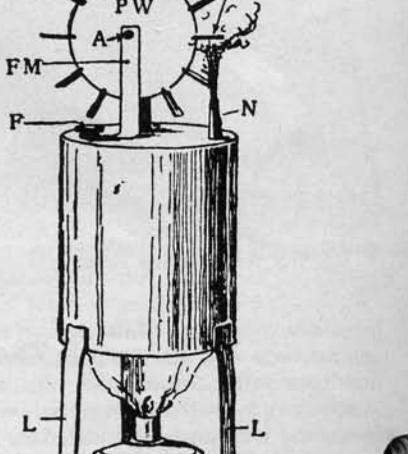


Fig 2 A Victorian tin can version of the Branca turbine

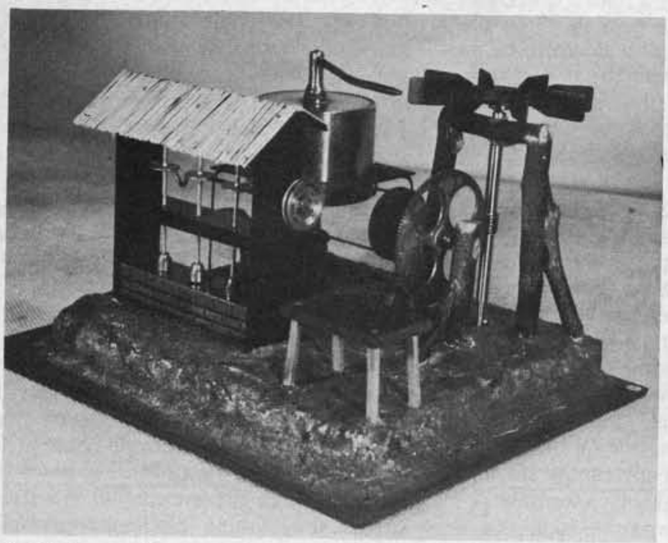


Fig 3 The working model mill Mk 1

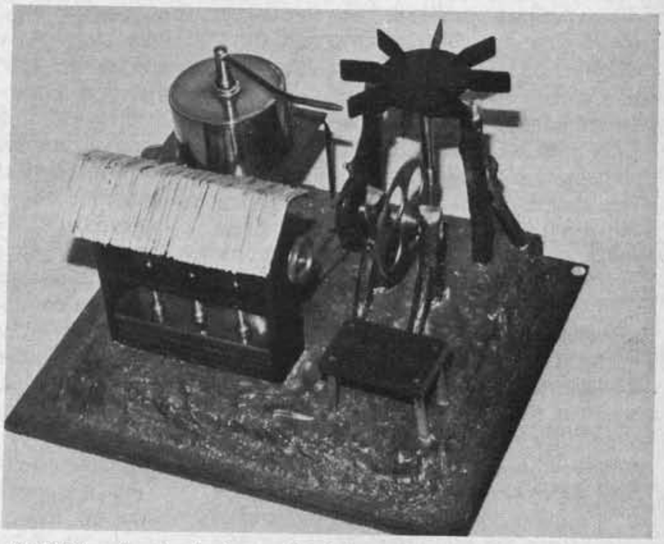


Fig 4 Showing the boiler and turbine

in a model. The stamp mill itself is the commercially available model made by the German firm Wilesco and is stocked by many people in this country. Whilst it is not difficult to make such a mill the Wilesco one is so appropriate that it seems a pity not to use it. The perspective sketch Fig 5 shows the simple rubber band drive from the small diameter turbine wheel spindle to the pulley on the mill.

Construction can well begin with the base board — an 8" by 7" piece of blockboard or the like about ¾" thick. This can be quite rough since it will be finally 'landscaped' by covering with Polyfilla. It is glued to a sub-base made from a piece of 10" by 8" hardboard. The mill is nailed down in position as indicated in Fig 6 which also shows the disposition of the other main units.

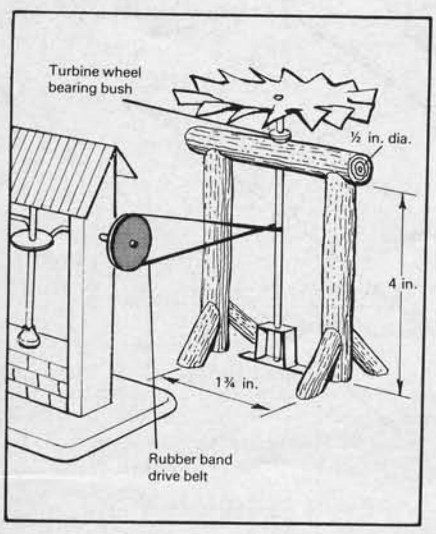


Fig 5 Showing rubber band drive

I have made the bearing support for the turbine spindle of wood, in keeping with the original engraving. A trip to the country, if the garden cannot provide, should produce a few straight branches about ½" diameter with interesting knobbly bark. You will see from Fig 6 that these are all quite short and are cut as shown and glued to the base board. But before doing so thoroughly dry or season them in a warm place for a few days — top of radiator, stove or somewhere quite hot — to make sure they are 'pre-shrunk'. The cross bar at the top should be drilled in the centre $\frac{3}{16}$" diameter for the tiny brass bearing but not fixed in position until the bottom bearing and the spindle have been made. There is no reason, of course, why ½" diameter dowelling should not be used for the framework but its a bit dull even when painted so use real 'tree wood' if you can.

For the spindle use a 5" long piece of $\frac{1}{16}$" diameter silver steel. This is nice stiff material but small enough in diameter to provide a good reduction ratio to the 1" diameter pulley on the mill. The turbine needs to run fast and the mill relatively slowly so about 15:1 is a reasonable reduction. The bottom of the spindle should be pointed to reduce friction and this can be done by chucking in the lathe and applying a small and fairly smooth oilstone by hand. The bottom bearing itself is simply built up from sheet brass as shown in Fig 8. The two pieces are soldered together after the centre pop has been made in the base. I have made it quite tall since there is no collar to hold the turbine and spindle down — it is perfectly satisfactory like this and is easily lifted out for storage or to change the rubber band.

The lower bearing is screwed to the base board and with the spindle in place the top cross bar with its little brass bush pressed in is set and glued in position so that the spindle runs absolutely freely. Since the loads (and the power) are so small it is better for it to be an unashamedly sloppy fit rather than be too tight.

And now is a good time to make the turbine wheel. There are many ways of doing this, depending to some extent on the facilities you have. First of all, however, turn up the wheel centre in Fig 7 from a piece of brass bar and drill and tap the pinch screw hole but don't at this stage drill the spindle hole. A piece of sheet brass about 4" square is now marked out as shown in Fig 10. Centre pop the middle, scribe the 3¾" diameter circle and cut round as neatly as possible, preferably with a fine hacksaw but it will be skimmed up true later. next scribe the 2¼" diameter pitch circle. 16 holes have to be marked out on this. If you have a dividing head this is straightforward and you won't need me to tell you how to do it. It will nevertheless be quite satisfactory to do a careful hand marking out job with the help of a protractor. Whichever way you do it mark the radial lines clearly and drill all the ¼" holes including the centre one and fit the centre boss and solder it in place. You can now put the 'wheel' in the three-jaw chuck, holding it by the centre boss, and at slow speed carefully skim up the circumference taking very light cuts. At the same setting (but at to speed) centre and drill the spindle hole. Using the radial lines as guides saw into each hole as indicated. You will now have the turbine blades made and each one can be twisted at right angles to the wheel disc. Fit it on the spindle, put on a rubber band and couple it up to the mill. A preliminary test run can now be made with your own full-sized head doing the blowing!

A simple 'pot' boiler will give enough steam to work the mill and is not too difficult to make but don't think you can get away with a tin can — a properly designed and constructed pressure vessel is essential for safety. Mine is of somewhat unorthodox design and is capable of withstanding many times the pressures that can be generated. The shell is a 2" long piece of 2½" diameter copper tube of not less than $\frac{1}{16}$" thick. This should be chucked and, at slowest speed and with the sharpest of tools, both ends squared up. A slightly tapering cut should be made in the bore at each end — an internal chamfer.

The usual way of making the boiler ends is to flange them but I have used two plain copper discs — again not less than $\frac{1}{16}$" thick — with a central stay. Copper is not an easy metal to machine and the two discs can pose problems. My solution is to mark out and cut roughly to size with a hacksaw or an Abrafile and drill a $\frac{3}{16}$ in. hole in the centre of each. Then screw to the lathe faceplate a disc of wood ½ in or ¾ in thick and the harder the better — perhaps an old piece of oak or mahogany. This should be screwed in from the back and the front faced off square. Mine has remained on my Myford faceplate for years and is most useful for all kinds of light and awkward jobs. Then, having drilled a small pilot hole on the centre, each disc can be fastened in turn to the wooden faceplate with a woodscrew and a smear or so of Bostik or similar glue. When dry the edge of the disc can be turned with a sharp tool at slow speed until it is a close fit in the chamfered end of the boiler tube. The wood will enable you to run the tool right across the disc without fear of striking any metal parts of chuck or faceplate. A cutting lubricant will be found a great help when machining copper and I find that paraffin works beautifully. When each disc is finished it to drill the $\frac{3}{16}$ in cross hole to allow the boiler to be filled and the steam to come out. When it is finished the boiler tube, the two ends and the bush can be assembled and held together with a 2BA brass or gunmetal screw as shown in Fig 13. The great advantage of this form of construction is that no flanging is involved and all is held firmly together for the soldering operation. Whilst silver soldering is clearly to be preferred since the boiler can then run dry without harm, soft soldering would be acceptable for such a tiny boiler bearing in mind the low pressure at which it will run and the stout central stay. After all, the majority of commercial toy steam engine boilers are soft soldered without any central staying.

Fig 14 shows the jet tube assembly — I gave up trying to make it look like a human head but I expect someone with greater artistic ability will manage to clothe the fitting appropriately. The $\frac{5}{32}$ in tube needs to be reduced in diameter at the end to a pinhole for the jet. This can be done by making a separate nozzle as I domestic pin and continue to hammer round until it is firmly held. Then remove it and you will have a serviceable jet. A point to be watched is that the copper tube does not get blocked when it is soldered into the base.

I have not fitted a safety valve since, if the jet is checked for clearance before lighting up, there can be no great build up in pressure. The boiler is held above the fire in an open stand shown in fig 15. This is a straightforward bit of sheet metal work and the four legs are rivetted on at the corners of the 'table', the tops being extended and bent down to act as supports for the boiler which can be taken out for filling and popped back for steaming. When the boiler is in place the steam jet pipe is bent so that the steam strikes the turbine blades tangentially. The fact that the boiler is free to move in the stand makes the adjustment of jet to blade distance easy to optimize.

The last bit of 'structural' work which I haven't drawn is to fasten a tin lid or a bent up piece of tinplate on to the base

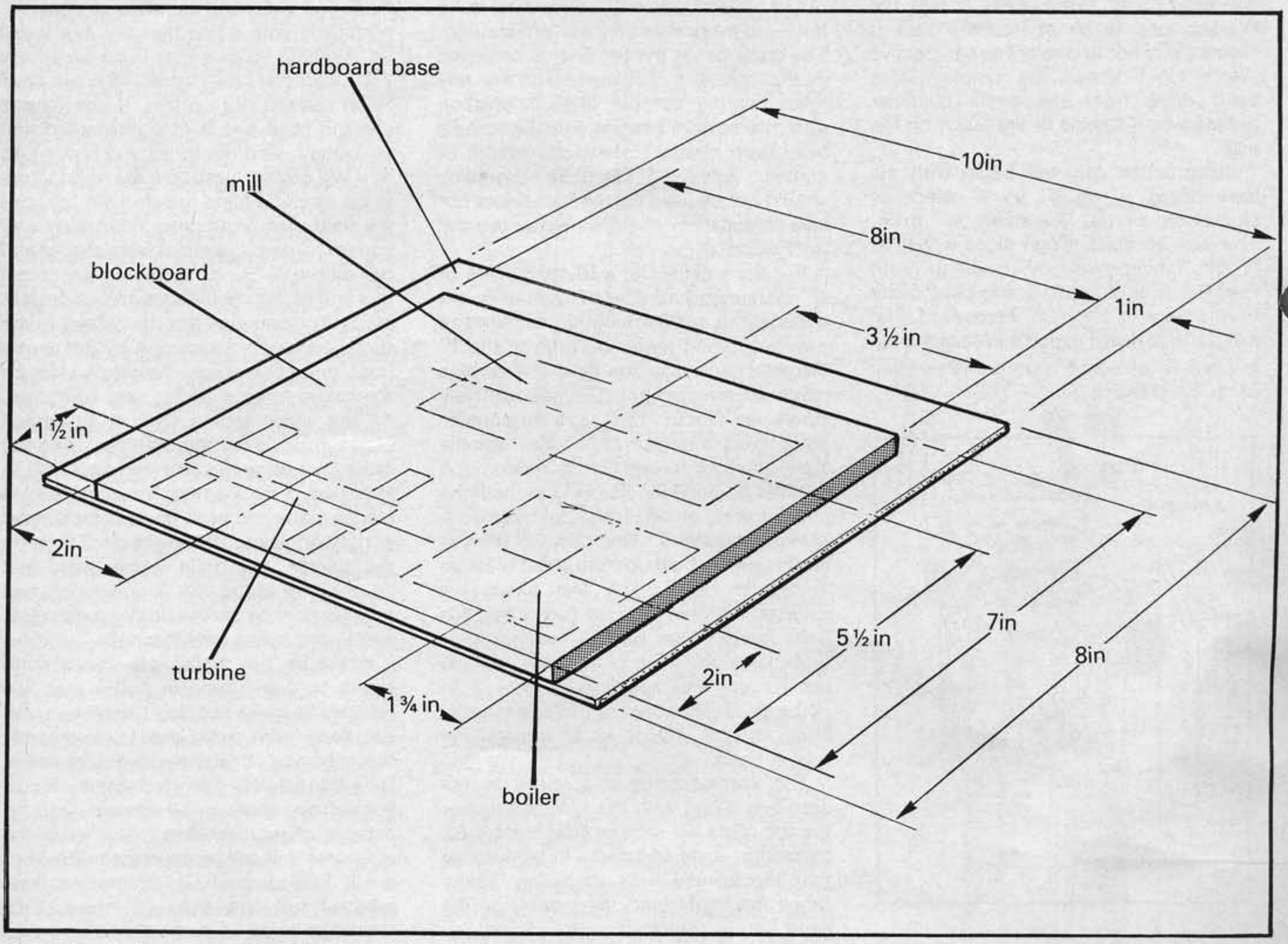


Fig 6 General arrangement of Turbine, Mill and Boiler

can be removed (after taking the screw out) by putting a screwdriver under the edge and levering off. Open out the central hole on one disc to $\frac{3}{8}$ in for the filler bush.

This bush is a straightforward turning and screwing job (Fig 12) but don't forget

described for the Hero engine or by softening the end of the tube by heating to bright red and swaging with a light hammer. It may need one or two such annealings as it work hardens. That is the way my version was made. As the end gets near to the required diameter insert a

under the boiler stand to act as a hearth for the solid Mamod type fuel blocks which will set everything going.

A test run before finishing off would be a good idea. The boiler should be filled about half full with water — a small plastic funnel such as is supplied with Mamod

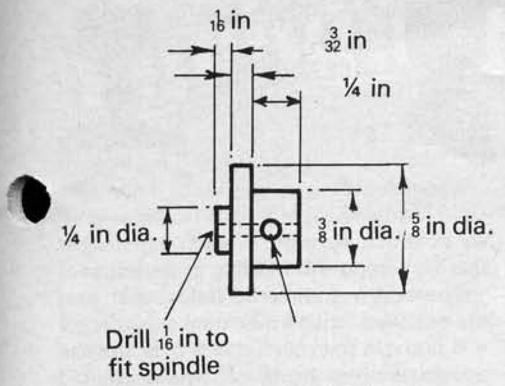


Fig 7 Wheel centre

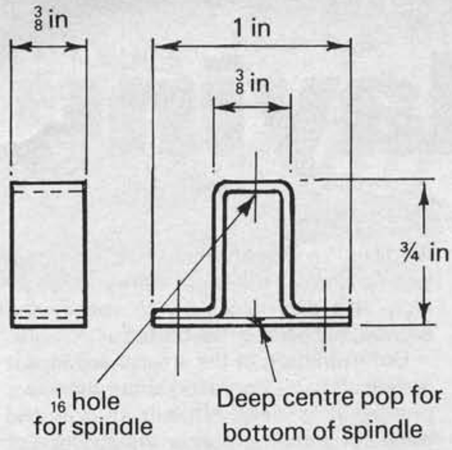


Fig 8 Bottom bearing

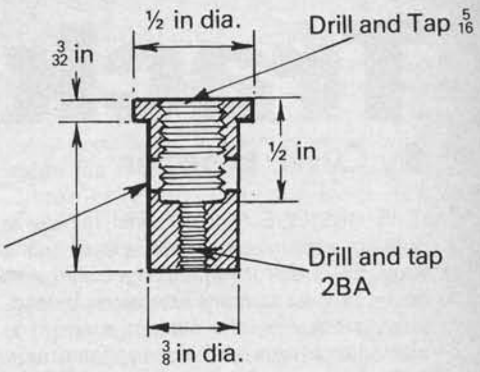


Fig 9 Filter steam outlet

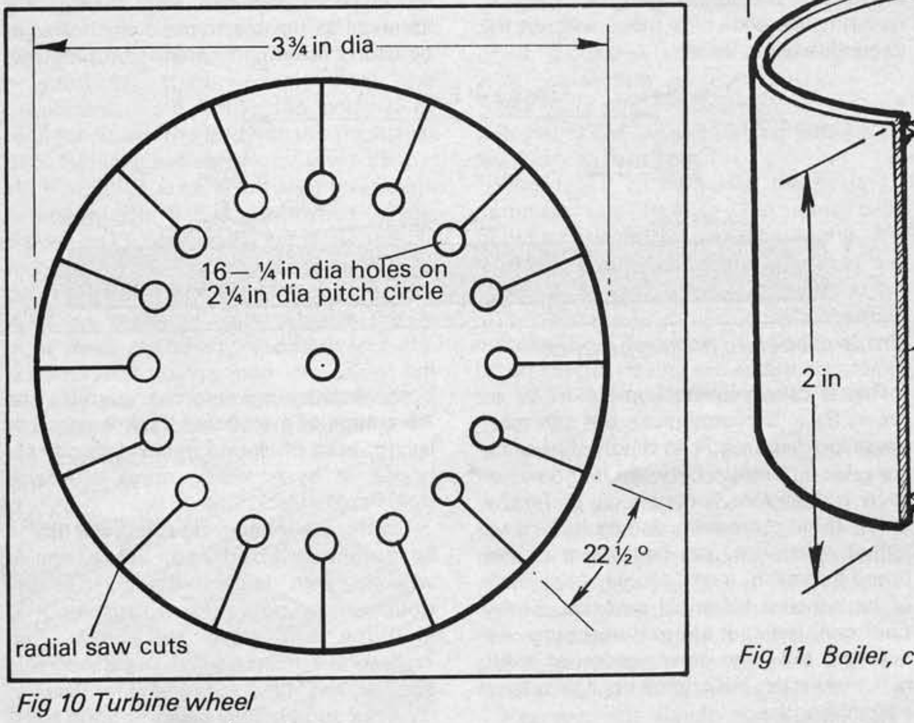


Fig 10 Turbine wheel

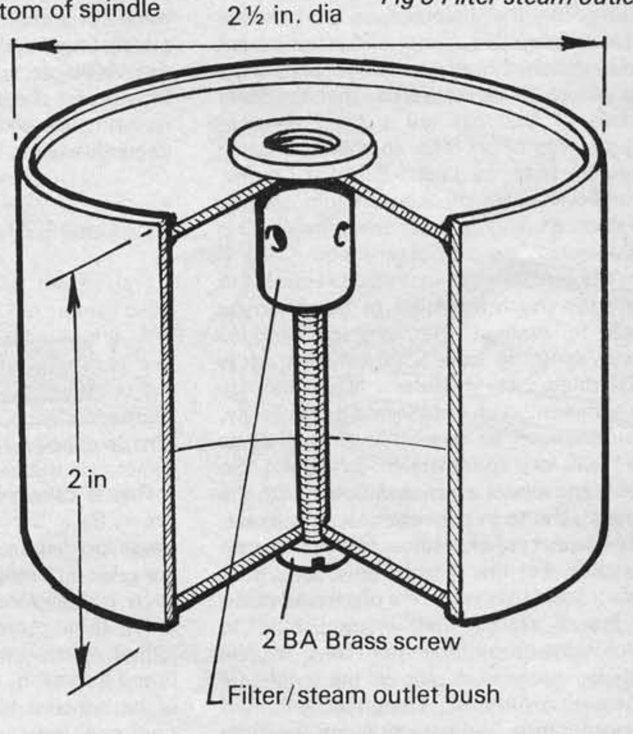


Fig 11. Boiler, copper or brass, not less than 1/16 in thick

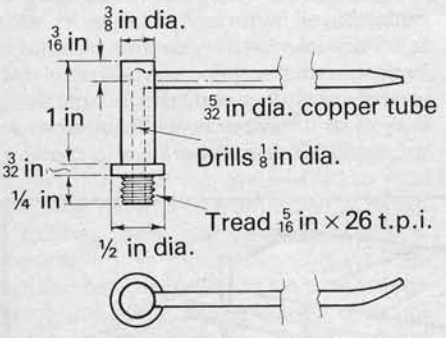


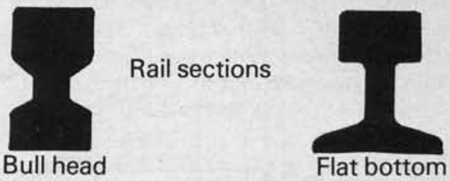
Fig 12 Jet tube assembly

Fig 13 Boiler stand M.S. 20g

engines will help — and the jet checked for clearance. A single block of fuel will get it boiling in a few minutes and, with the steam impinging squarely on the turbine blades it should soon be spinning round. A little experimenting might be necessary to get the right sized jet and perhaps some shaping of the blades might improve performance. It is all easily changed to get it to work as well as possible.

So that the finished model looks like a primitive machine in a rural setting I covered the whole of the baseboard and the tinplate base of the mill with a stiffish mixture of Polyfilla. The side and front edges of the blockboard can usefully be rounded and generally hacked about to provide a key to hold the plaster and also to avoid too regular a line. This part is great fun and is a bit like icing a very technical cake. When the plaster is dry a nice mottled paint finish, mainly browns but some yellow and green streaks will make it look quite realistic. The boiler stand can be painted black as can the turbine. I should give the wood a coat of clear varnish to protect it. The mill is already painted but I glued some straws on to the roof to cover the corrugated metal and to give it a thatched appearance in keeping with everything else. You will also find that you have just got room (though not so much as on my version) for a tiny wooden table alongside for the philosopher to work at.

Tracklaying



By Cyril Freezer

IT IS OBVIOUS that a model railway is nothing without the track, yet in many ways, the track itself is commonly given no more than cursory attention. Indeed, many articles on the subject succeed in placing emphasis on the wrong features.

The purpose of the track is to provide a route for the locomotives and rolling stock. To do this, one provides two pieces of material, normally metal, set accurately to gauge. In other words, that the inner faces of the rails are a fixed distance apart. We often refer to them as being parallel, but in strict Euclidian terms, parallel lines are implicitly straight: railway tracks can, and do meet one another. This is obviously the case at turnouts.

The great danger in model practice is to pay too much attention to the protoype and to assume that one can reduce everything "to scale". Prototype track is patrolled at regular intervals by lengthmen, and is renewed periodically. Furthermore, an error of level as small as ¾" will lead to inevitable derailment. So frequent repacking is undertaken. On the model, the term permanent way is exact, we expect tracks once laid to remain useable. For this reason, deviations from exact scale dimension are often desirable.

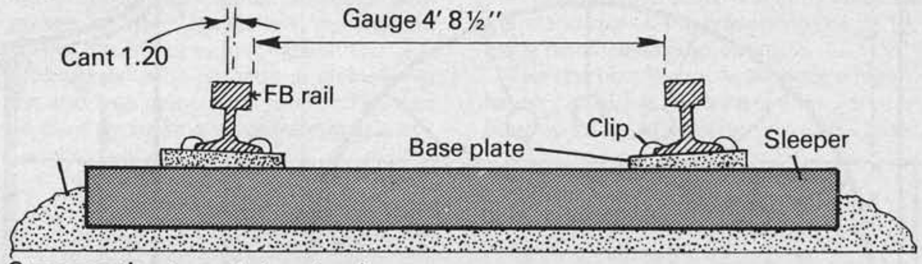
For a start, it is impracticable to reproduce prototype rail cant in the smaller gauges, so rails on the model are theoretically vertical. Then, the method of manufacture — wire-drawing — can introduce a twist in the rail. It certainly introduces stresses which can lead to fractional twists occuring after a period of time. With the wheel and track standards used in the commercial gauges, this is of minor importance, but when one is following the more exacting standards implicit in 18.83mm gauge modelling such considerations must be paramount.

In model railway practice we do not replace rails, but as with the prototype, wear is a factor that must be considered. On commercial operating layouts rail wear is a significant factor, it is not uncommon for .010" to .020" of metal to be worn away in a relatively short time. I can quote two cases. A small 6' 0" × 4' 6" layout at PECO Modelrama had the inner face of the outer rail of the curves worn away in just over one season. A private layout, laid with very fine (and somewhat soft) rail wore so badly in only six exhibitions as to become unreliable.

While the privately-owned layout may not get that sort of running in a year, in 25 years the story may be different. Remember, it isn't just wear, a model railway is frequently cleaned — only we don't "clean" track as a rule, we abrade it.

A word now about the rail. Common practice today speaks of the code, which is quite simply the height of the rail in thousandths of an inch, the common code 100 rail is therefore 100 thou. or $\frac{1}{10}$" high. It is also necessary to specify the section, bullhead or flat bottom.

Unfortunately, in the smaller sections it is difficult to be dogmatic about the exact profile: it is very difficult to see the undercut and, in practice, the absence of any distinct head in rail below Code 100 is not visible at normal viewing distances. Indeed, for the smaller gauges, N and Z, one may use plain strip metal without the deception being visible.



Cross-section to prototype track

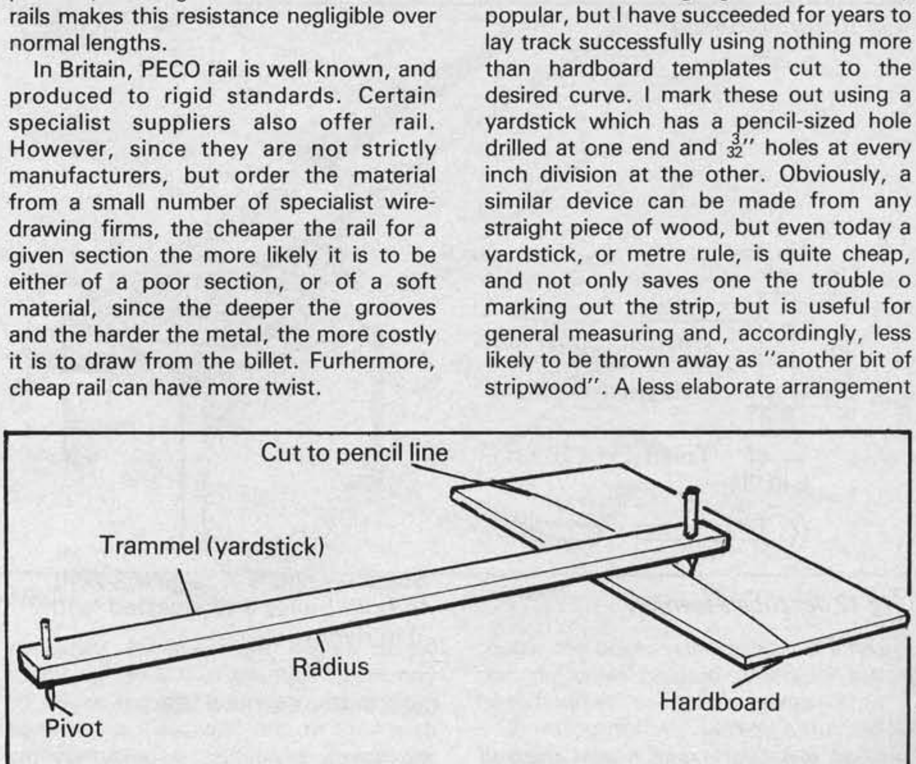
Rail is drawn in steel, nickel silver or brass. Steel is prototypical, but can rust. Brass looks wrong — in theory, but since the price differential between it and nickel silver is negligible, most people prefer the latter. It has, however, one fault, it has a higher resistance, yet because it is less prone to tarnish, many people happily talk of its superior electrical qualities. Truly, one can believe almost anything. In practice, the large cross-section of most rails makes this resistance negligible over normal lengths.

In Britain, PECO rail is well known, and produced to rigid standards. Certain specialist suppliers also offer rail. However, since they are not strictly manufacturers, but order the material from a small number of specialist wire-drawing firms, the cheaper the rail for a given section the more likely it is to be either of a poor section, or of a soft material, since the deeper the grooves and the harder the metal, the more costly it is to draw from the billet. Furhermore, cheap rail can have more twist.

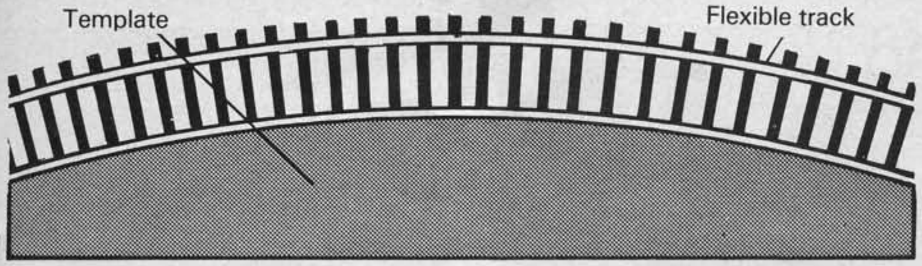
There are three categories of track, pre-set ready assembled, flexible and scratchbuilt. As with all such categories, there is a degree of blurring at the edges.

There is a commonly held belief that pre-set track equals toy track. Insofar as you find it in train sets, this is true, but the opinion is none the less outworn. The old crude toy track is a thing of the past, modern present track has a solid section rail in plastic sleepers, and is physically identical to flexible tracks, which are, of course, "scale". In practice, therefore, both systems are interchangeable. The advantage of a sectional track is speed of laying, ease of alteration and facilities for re-use. It is, however, more expensive than flexible track.

On the other hand, flexible track has to be accurately positioned. When one is working with large radiis this is not troublesome, but on sharp curves it is anything but easy to avoid. The Tracksetta curved gauges are deservedly popular, but I have succeeded for years to lay track successfully using nothing more than hardboard templates cut to the desired curve. I mark these out using a yardstick which has a pencil-sized hole drilled at one end and $\frac{3}{32}$" holes at every inch division at the other. Obviously, a similar device can be made from any straight piece of wood, but even today a yardstick, or metre rule, is quite cheap, and not only saves one the trouble o marking out the strip, but is useful for general measuring and, accordingly, less likely to be thrown away as "another bit of stripwood". A less elaborate arrangement

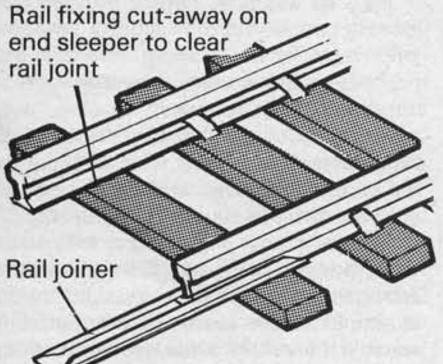


Marking out track template



is a length of string with a loop at one end, tied at the other to a nail. Accurate adjustment can be made by winding the string round the nail.

It has often been suggested that curved tracks should be laid with a trammel. This has one serious objection, the centre of the curve is in at least 80% of the cases outside the elementary 6′ × 4″ system (which is best served by pre-set curves of a sectional track system) off the baseboard. Frequently, the centres of radii fall inside the body of the tracklayer or outside the walls of the railway room! With flexible tracks, there are three points to watch. The first is that, when joining tracks, it is necessary to cut away the rail fixing on the sleepers nearest the join to allow the rail joins to slide over them, as it does on sectional track. Unless this is done there will be an unsightly gap in the sleepers. Of course one can insert an extra sleeper, but in practice, this is one of those jobs that never gets done.



Joins on flexible track

The second matter is that of cutting the rails to length. I've found the best way is to use a small block of wood in which two grooves have been cut to take the rails. This is held onto the track with one hand while the rails are sawn through with a miniature hacksaw with the other.

Finally, if you want to use the foam ballast underlay, you are advised to glue the track down, since any attempt to pin produces an undulating effect. Personally, I've never found ballast inlay satisfactory, so I prefer to pin direct to the base, using fine veneer pins. These are driven partially in at first and left proud until I am certain the track is correctly aligned, then driven fully home with a pin punch.

I prefer loose ballast, this is spread in position dry, then PVA latex adhesive let down 50-50 with water with a drop of washing-up liquid added to improve the flow is allowed to soak into the ballast. This sets overnight and at the most, the ballast only needs the minimal touching in subsequently.

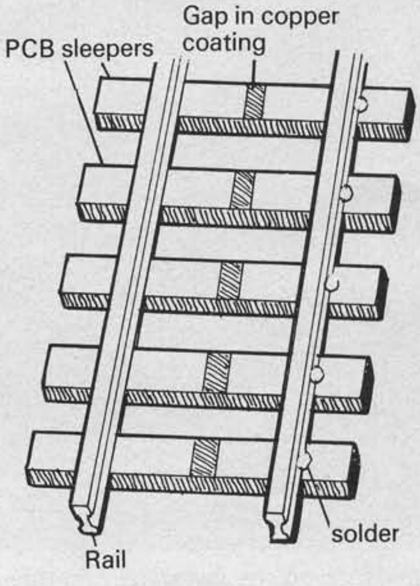
Building one's own track is not strictly economic, since the cost of sleepers and rail is comparable to that of ready-assembled track. However, if one wishes to use fine rail sections, or is prepared to cut sleepers at home, then self-assembly is possible. It is, however, worth pointing out that SMP offers flexible track with fine-section rail in the OO and EM while Ratio offers bullhead track (of GWR pattern) in EM. For 18.83 it is essential to lay your own track.

There are three basic methods in common use today. One uses pre-punched sleepers in which rivets are inserted. The rail is then soldered to the rivets. This type of track is marketed by the EM Gauge Society, who supply instructional booklets. Indeed, these books on tracklaying are essential reading for all 4mm scale workers who want to build their own.

The second method uses sleepers made from printed circuit board. The copper coating is gapped in the centre so that there is no electrical connection and the rails are soldered in place. This system is growing in popularity, it is very versatile and relatively simple. Furthermore, if the home workshop is equipped with a fine slitting sawbench, the sleepers can be readily cut from large sheets of PCB.

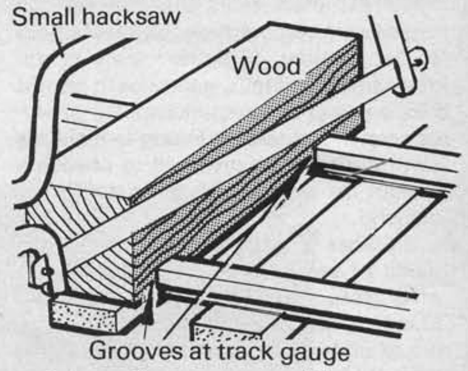
However, for simple home assembly, the ideal system is to use wood sleepers on a ply or hardboard sub-base with the rail soldered to gimp pins.

The sleepers are cut from 1mm ply or veneer. I have done a lot using one-ply of cheap 3mm ply which has come unstuck, but the improvement in glue technology in the past 30 years has meant that even tea-chest ply no longer disintegrates in damp conditions. Indeed, changes in our social life mean that tea-chests can no longer be easily acquired for a few shillings.



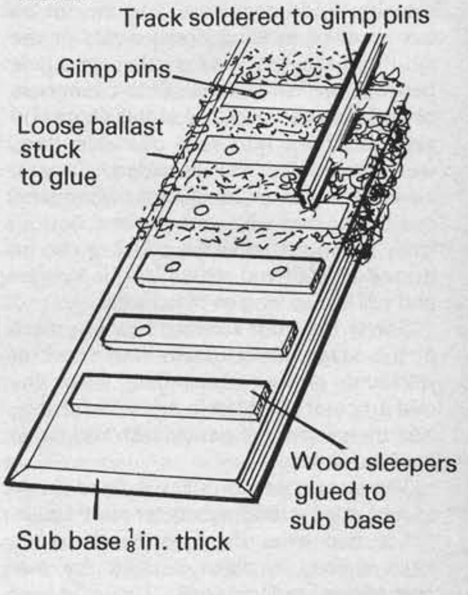
Track soldered to PCB sleepers

Sleepers are cut to scale size, 8′ 6″ × 9″ (34mm × 3mm for 4mm). I do this by half-cutting across the grain at sleeper length then, using a pair of engineer's dividers and an engineer's square. I slice off-sleeper widths. A heavy trimming knife is ideal for this purpose. When marking out, I also indicate where the track pins should go. Having done this, and separated the sleepers they are stuck to a 3mm thick sub-base. You can space with a gauge or use the invaluable engineer's dividers. Then, before the glue has set, the whole is smothered in ballast, which is pressed firmly down and set aside to harden.



The next day ¼″ gimp pins (small flat-headed pins) are driven into the sleepers. Finally, using an accurate track gauge, the rail is soldered in place. The object is to make each blob of solder roughly equal in size. This system is reasonably simple and not unduly expensive. The result is a home-made sectional track, and can be lifted and re-laid. The joins between track-sections are hidden with additional ballast.

I shall be dealing with pointwork next month.



Track soldered to gimp pins

R/C car racing

Stox

'Dickie' Laidlaw-Dickson

RADIO CONTROLLED Stock Car racing or "Stox" as enthusiasts like to call it offers opportunities for the skilful driver rather than the man with a deep pocket and/or great engineering skill. It can be compared to one-class dinghy racing in that a construction formula limits design factors and a cost restriction prevents either car or engine to be highly finished or tuned beyond stated limits. Some claim this has limited development, but this is not really so as a glance at the variety of vehicles running at any Stox meeting will show.

Current cash limits are £38 for the engine and carburettor as at retail prices on 1st January, 1979; car, ready to run (less engine and radio gear) not to exceed £35, again at January prices. The would-be scratch builder is at liberty to make his own, but must be prepared to provide a similar car within the price range on demand.

So what is the best way to enter the world of stox? Three kit manufacturers offer their services in this country, Mardave, Ke.Jon and Puma. Kit prices are all under £30—down to £23.75 in the case of Mardave. This is the kit suggested for the beginner. Probably, he or she, will already have some experience with glowplug engines in control line flying—combat particularly. Dare I risk offending combat flyers by saying that stock car racing is in some ways similar? It attracts youthful enthusiasm combined with a rather shallow pocket when the game is still the thing rather than winning at all costs.

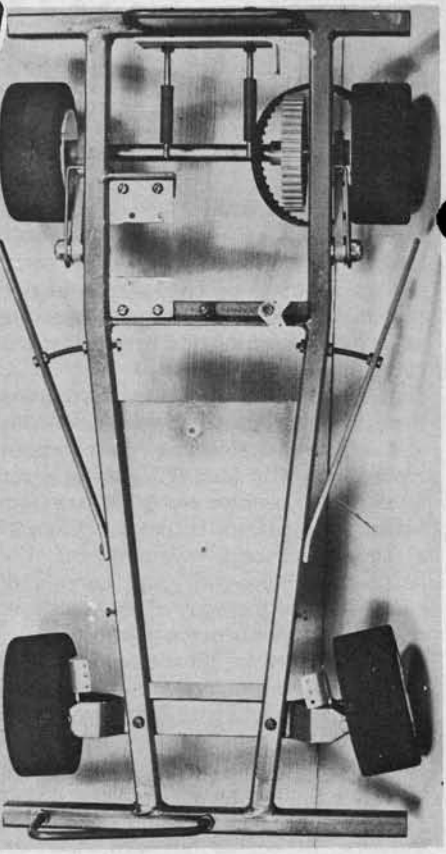
Basic component is the chassis. This has already been welded up by the manufacturer from half-inch square tubing. The scratch builder will have this as a first job, but can probably get some friendly garage to spot weld it for him if he lacks the equipment. A certain amount of cleaning up is necessary, but do not be over zealous in filing down welds or the structure may be weakened, particularly beneath engine mounts. Side crash bars or nerf bars can be fitted at this stage and also the front and rear over-ride bars, using the $\frac{3}{16}$ in. rod provided. Chassis must be drilled to take them, when they can be secured with nuts top and bottom (they are threaded at the ends) or can be brazed or soldered. Nut fixing is simpler and will last as long as the chassis.

Screw the front steering beam in place at this stage. Clean down with Gunk or similar de-greaser and prime. I use any odd drops of paint left in aerosols for this, and then finish off neatly with red oxide colour cellulose.

The large-toothed pulley is fixed firmly to rear axle by drifting tubular pin through pulley and axle. Bearings have already been welded in place to take the rear suspension radius arms. These are of plastic and can be fitted either way up, with a washer on each side of them, and secured with the castle nuts. Rear axle is then slipped through left-hand arm bearing, toothed belt looped over it and right-hand arm slipped on axle before securing to chassis.

Steering arms are formed by cutting out filing and bending aluminium sheet provided. The purist may wish to make up a more elegant steering arm from angle an alternative illustration is offered. If alloy is used, remember not to make the bend too tight or the metal may crack or be weakened. Fit stub axles using serrated washers and nuts. Fit the sprung king-pins—springs at the top.

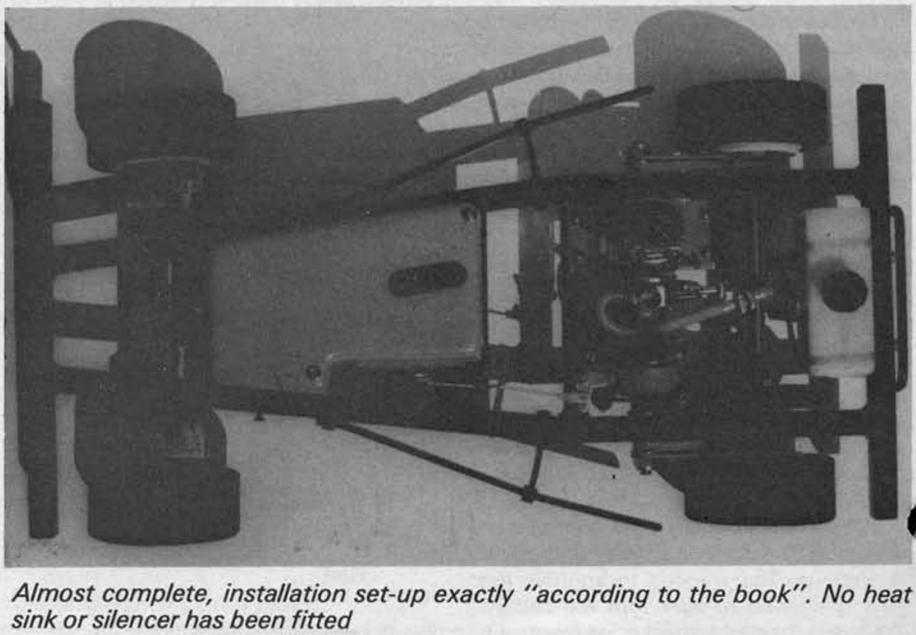
Taking a rest from assembly this is a good time to work on the tyres and wheel. Tyres must be bonded to the hubs with an impact glue. Evostik is the almost universal choice. Hubs should be roughed up a little with glasspaper to give good adhesion and then coated with the glue. Inside of tyres should also be coated. Do **not** leave to set off, but slide tyres straight onto hubs. This is a messy job however neat your are. I save the plastic bags parts come in and use them as throw-away mittens for the task. Happily, petrol can be used to clean off glue which has got on unwanted parts of tyres and hubs and off hands. Or you can be posh and use the special Evostik cleaner!



Mardave welded chassis

They do not take long to dry and rear wheels can be fitted, securing with the nyloc nuts. Before so doing, insert the two ready-bent-up springs through radius arms and into chassis, looping over retaining nuts at the chassis bearing. Front wheels are fitted with washers on inside of stub axles and nuts screwed down to give free running without slop.

The car is now beginning to take shape and thought must be given to steering arrangements. That provided with the kit is simple in the extreme, but perfectly suitable if carefully made. However, since the kit was first devised—some six or



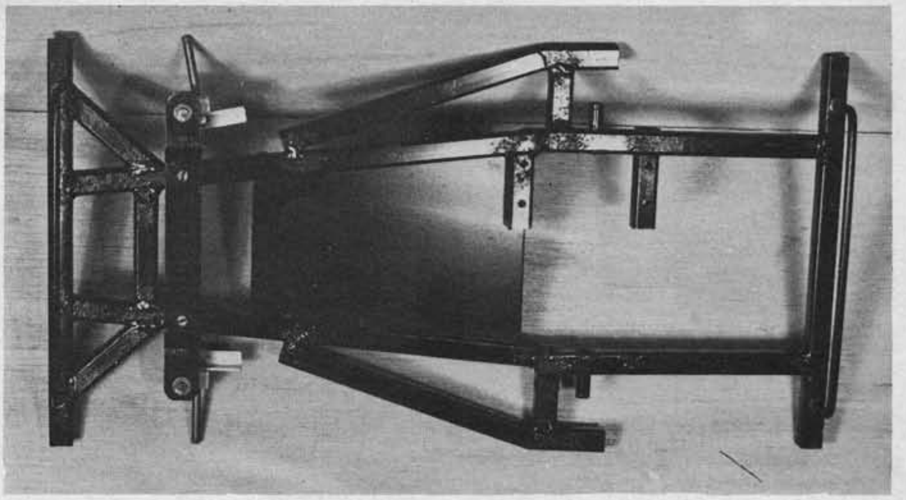
Almost complete, installation set-up exactly "according to the book". No heat sink or silencer has been fitted more years ago—supplies have become more available and some form of servo-saver of a more elaborate nature can be considered. This is a necessary part of the gear, since it prevents burning out of expensive servos when they are given a radio command they cannot fulfill—such as turning through an obstacle—a spring-loaded device released the arm, going back into place as soon as the need to be displaced is over. The one fitted on my car is from the Italian SG company, but there are various makes available at reasonable prices.

Track rods can be bent up from piano wire and secured either with plastic retainers, or with Allen-screw held collets. I have used the collets in the more important places. Threaded track rods are also very useful in adjusting the exact amount of toe-in that you desire. On the subject of toe-in, which helps to keep the car running straight, about 5° should suffice. If you reckon 1° is the angle formed by two lines separated 4 in. from their apex by $\frac{1}{16}$ in., then a separation of $\frac{5}{16}$ in. gives you required toe-in.

Quite a number of engines come within the permitted price range. To name a few there is Irvine 20, HB 21, Enya, Fuji, and of course the old favourite Veco 19. I have fitted this old workhorse as there are probably more about than most others, and spares position is good. If you are buying new then give some thought to makes which include the essential heatsink such as HB 21 and Irvine 20. Fuji include that other essential a silencer, but I am by no means sure it meets the required noise level of 80dB at 10 metres.

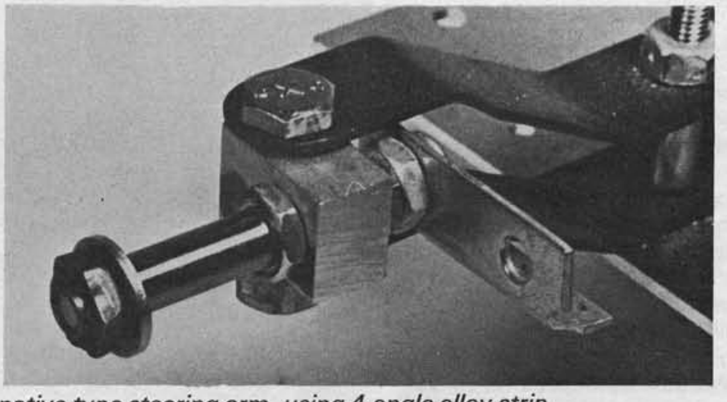
Which ever engine you are going to use, the engine plate provided is drilled to suit the Veco 19. This will also fit several of the other available engines. For non-fitting engines do as instructions say, cut plate to suit and turn over to drill appropriate new holes. Drill out engine mounting holes very slightly to take the attachment bolts provided. Be sure the engine lines up with radius arm pivot studs.

Fit up flywheel to engine, attach the clutch shoes which are held away from the clutch drum or bellhousing by little springs, slip the drum in place and screw in the crankshaft adapter. This is threaded ¼ in. UNF, but if required, an alternative 6mm adapter can be obtained. The assembly should just clear inside of chassis (which also helps to keep the belt in place) and drum should run freely. It may be necessary in some cases to grind off a few threads from the crankshaft. This can easily be down on a grinding wheel, or with rather more effort using a file. Belt can now be seen to link up with the large pulley and the small spur gear on the bellhousing. Inside of bellhousing is lined with cork or similar material. Procedure is that as engine speeds up it throws out the two shoes which grip the bellhousing against the cork or rubber lining and power is transferred to the driving wheels, via toothed belt.



Ke'Jon chassis with steering cross-beam, stub axles and steering arms fitted

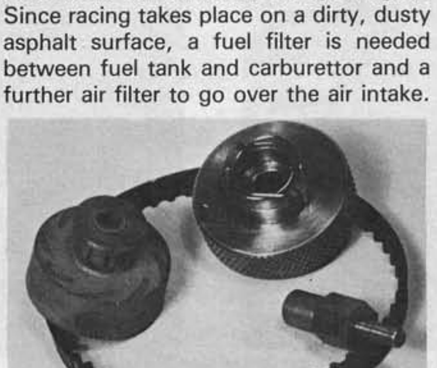
Some adjustment is possible on the little springs, so that at idling speed the clutch is just slipping without too noticeable a tendency to creep forward. Without these, engine life is brutish and short! Up in the air with a plane, air is a little more pure and protections are less needed.



Alternative type steering arm, using 4-angle alloy strip

Then as throttle is opened away the car goes. As the throttle is eased for corners and such like the car slows almost to a stop. With stox no brake is fitted, speed is controlled entirely by engine control.

Fuel tank provided is 4 oz. size, but rules do not specify a limited size, provided there is enough for the usual 4-5 minute heats that are run so there is no object in fitting anything substantially larger. Two long-shaped bolts are supplied on which the tank rests, leaning back on a small piece of sheet which is bent over to prevent tank sliding towards and fouling the drive belt. Fixing is by means of elastic bands (your postman uses some for letters that are just right). Since racing takes place on a dirty, dusty asphalt surface, a fuel filter is needed between fuel tank and carburettor and a further air filter to go over the air intake.

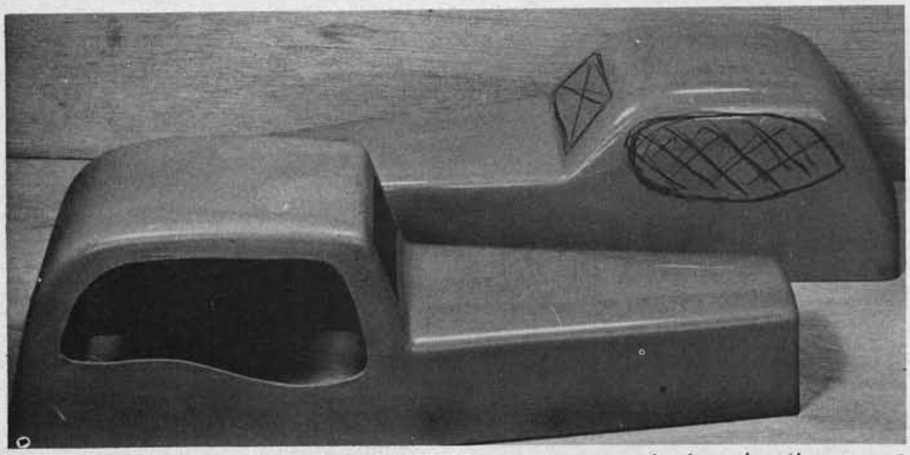


Crankshaft adapter, flywheel with clutch shoes fitted and drive belt

A plastic box is supplied to take the radio which should keep it clean. However, when so enclosed it is less accessible and limits the arrangement of components. I have omitted it and fitted the servo saver on the chassis floor, pushing the rest of the radio gear backwards a little, so that the radio rests on top of the throttle servo and battery stands upright. In the photo, these are some foam sheet protection would be wrapped round and they would be anchored with further elastic bands.

Throttle bellcrank will have to be filed up and drilled. It sits on a bolt on the chassis crosspiece. For ease of running up the engine it is recommended it should be spring loaded in the near closed position, adjusting the spring to be just idling. The engine can then be blipped without turning on radio and warmed up at meetings without causing any radio interference (very unpopular!).

I have fitted my trusty Futaba equipment, but this is by no means mandatory. Today there is a good choice of equipment at prices for a complete two-channel set, Tx, Rx and two servos at prices from £70 upwards' Ballbearing servos, deacs, chargers and so on would be extra. Suitable, but by no means all, makes are Futaba, MacGregor, Skyleader, Sanwa, Talisman, KO Digiace.



Two body shapes. Windows have been cut, in one case, in the other they are as yet only marked out for removal

Minor changes will be needed according to make used. Since stock car circuits are small there is no need to have an extended aerial until you specially wish. Serial can be looped back and forth on inside of roof, and joined to the receiver via a small connection block. If you are club racing you should have at least a couple of spare crystals of different frequencies for Rx and Tx.

If you follow the kit layout, any of these will fit into the plastic box provided.

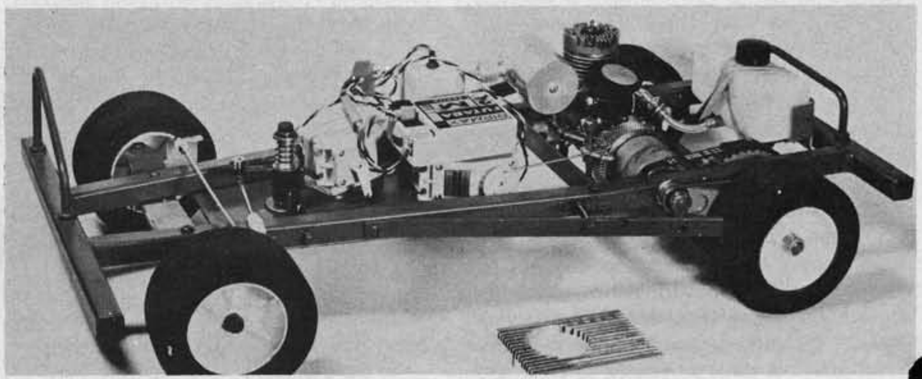
A body in ABS of good robust thickness comes with the kit. Windows require to be marked and removed. This can be done by drilling a hole and then cutting out with a fretsaw; or by using a hot soldering iron and melting away the outline. This is rather smelly and should be done in the garage rather than the house. Window shapes are to choice—just something elegant and plausible.It is a good idea to make sure the side windows are large enough to get a finger or two in for engine adjustments and throttle blipping. Two holes are drilled one each side of the bonnet for bolts to hold retaining springs which hold the front to the chassis. A strip of Velcro on the tank locating plate and on the inside of the body will hold the back firm.

A slit should be made in the roof about 1½ in. long to take the racing number. Number plate must be 1 in. high. A piece of sheet alloy will do the job, pushed up from inside the roof, and allowing about half an inch extra to fold left and right to epoxy to the inside of the roof. Size lengthways depends on your number, now in three figures for certain.

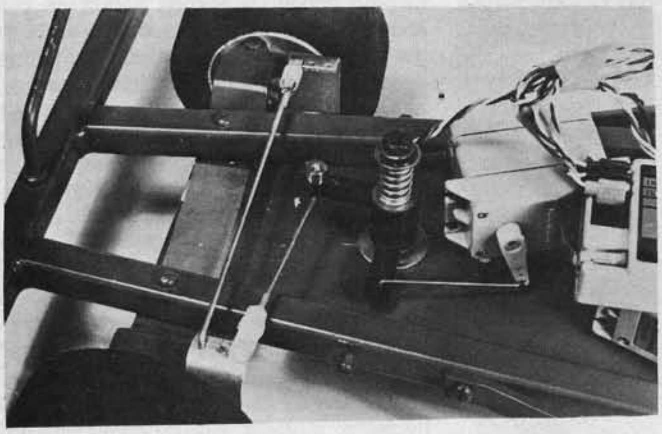
Rough up the body with glass paper and spray using ordinary car cellulose aerosol. As a beginner, roof-top and down to main body line must be painted white. As you begin to win races you will be allowed to change roof colour to yellow, blue and then red—or even gold for the national champion. Rest of the car is to your choice. Good bright colours help in identifying your car in a race, plus any fancy decoration you think up. Your name must also appear on each side. No size of letters specified. A coat of fuel proofer and you are nearly ready for battle. Parcel brown paper tape which requires licking is still the best way of separating areas for spray painting. Then wash off the tape with water. I find it much better than using a self-adhesive tape.

You will need a device to start the engine. This can either be an aircraft type electric starter (Kavan, Sullivan, etc.), modified to rub against the flywheel. A ring comes with the equipment if needed for cars, but a hard rubber ring will be needed when this wears out and has a longer life. A home-made starter can be rigged up from an ex-full-size car starter motor, obtained from a car dump and mounted with a similar rubber ring, but this is for the rather more experienced driver.. As and when you join a club you will see what is being used. Current is taken from a 12-volt car or motorcycle accumulator.

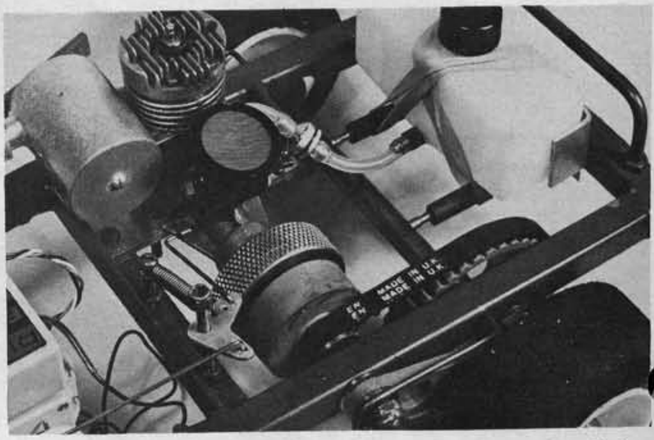
Your car is finished. Now what do you do? Subject to having kind neighbours, there is nothing to stop you trying it out on the lawn. The high ground clearance of a stock car makes this perfectly possible. Noise will be about the same as a motor lawnmower—but don't try your neighbours' patience too highly! Fuel will be the same as for any aircraft glowmotor. There is no need for a special hot fuel for stock cars, the "regular" mixture is good enough. By the way, do not try to run the engine without the clutch drum in place—things will fly all over the place, get lost, or stick into someone.



Note use of Servo Saver on steering unit, engine fuel filter and air filter. The heat sink for the engine is shown in the foreground.



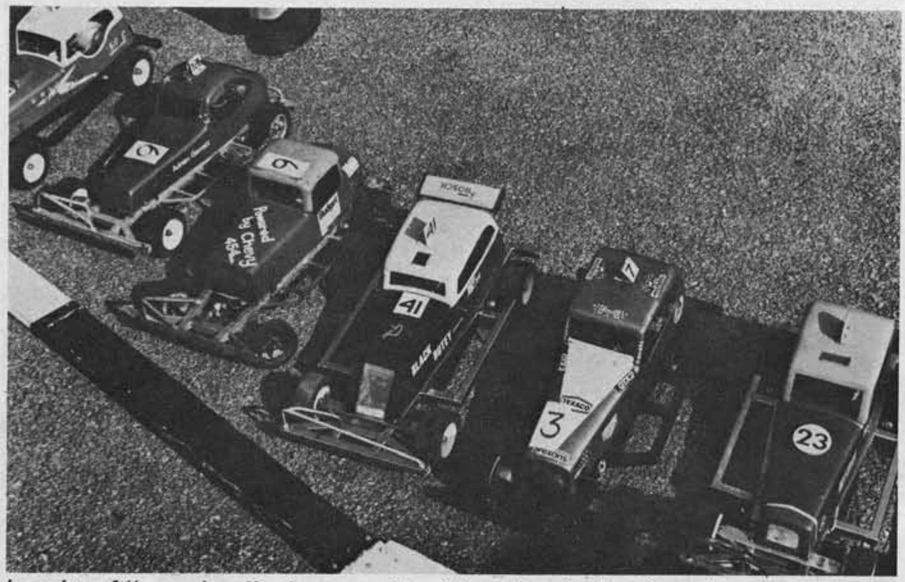
Close-up of front with detail of steering fail save and track rod attachments



Close-up of rear. Detail of springing is clear, also fixing of fuel tank and the filters

Complete stock car with body in place. White-top painting and roof located racing number will be seen. Simple name is all decoration added, but decals, sponsor's name (if any!) would be added as acquired

Electric hand-starter with rubber ring as provided. A hard rubber is recommended as soon as the original is worn out



In spite of "one class" rules, considerable variety in detail can be seen

Ideal fate for the car is to join a club and get some running done. If there is no club in your immediate district it might be worthwhile trying to start one. Happily only a small amount of ground is needed for a stock car oval—about a 150 ft. lap length for the oval is ideal. Cars are then reasonably bunched up and racing looks and is more exciting. There are at present seven main clubs operating: Chessington, Coventry, Keighley, Leicester, Haywards Heath, Worthing and Studley. The Worthing club which runs under the title of Southern Radio Car Club will be masterminding the Open Event which takes place over the two days of May 12-13th at Sandown Park racecourse, during the annual Radio Control Symposium held there. It is a good place to go along and watch events, or even to take your car along as an entrant if you have already progressed that far.

To get into the racing picture you must certainly join the Radio Stock Car Association. Entry costs £1.50 a year and secretary is Mike Varley, who lives at 10 Briarwood Avenue, Riddlesden, Keighley, Yorks. He would like a stamped addressed envelope to accompany your enquiry. You will also need a radio control model licence. This costs £2.80 for five years use (no examination required) and applications can be obtained from Home Office, Radio Regulatory Department, Radio Regulatory Division, Waterloo Bridge House, Waterloo Road, London SE1 8UA.

That gives some sort of an introduction to building and running a stock car. Get into stox if you enjoy people, like cars, want to race, and have a really good time and a laugh without getting too dedicated. Good racing!

Radio Stock Car Association—Rules Effective from 1.1.79
Construction Rules

1. Models are to be 1/8th scale, and a reasonable representation of a full size car.
2. Overall length to be between 16¾" and 17¾" or scale.
3. Overall width to be a maximum of 9".
4. Wheelbase to be between 11½" and 12½" or scale.
5. Front and rear bumpers must be fitted, with a contact surface of ½" to ¾", and shall not project beyond the outer edges of the wheels. The distance between the bumper centre line and the ground must be 1¾" to 2¼". All bumpers and nerf bars must be plugged, and have no sharp edges.
6. Overiders must be fitted to front and rear bumpers. The height from the top of the bumper must be: FRONT 1" to 1¾". REAR 1" maximum.
7. Nerf bars may be fitted, but must be on the same level as the bumpers, and have a maximum contact surface ½", and they must not project beyond the outer edge of the wheels.
8. Tyres must have a maximum width of 1¼", and the diameter should be between 2¾" and 3¼".
9. The maximum engine size is 3.5cc or 0.214 cu. ins. If more than one engine is used, then the total capacity must not exceed this limit. Also see cost rule.
10. There is no limit to the size of the fuel tank.
11. The engine must be silenced to the satisfaction of the race organisers, and must be below 80 dB at 10 metres.
12. The height of the body from the top of the body from the top of the chassis must be 4" to 5" or scale.
13. The drivers name must be on the outside of the car.
14. The driver's number must be on a 1" high fin on the roof of the car, and facing sideways. The numbers are to be BLACK on a WHITE background.
15. Roofs must be painted down to the waistline of the body with the driver's classification colour. All new members should have a WHITE roof.
16. Exterior roll bars are not permitted for racing.
17. Aerofoils may be fitted with the following restrictions. Maximum area to be 10 sq. in. Maximum width to be 5". Maximum depth to be 2". Maximum height above chassis to be 5" or scale.

Cost Rules

1. The inclusive cost of the engine and carburettor must not exceed £38 at retail prices on the 1st January, 1979. The only modifications permitted are those which may be carried out using hand tools (i.e. filing out of exhaust ports).
2. The cost of the car, complete and ready to run, including body, but excluding engine, carburettor and radio equipment must not exceed £35 at retail prices on 1st January, 1979.

The Above Prices Include VAT

3. In the case of scratch-built cars, the entrant must be prepared to produce a replica of the car, if so requested for under £35.
4. In the case of modified kit cars, alternative parts may be fitted, and the cost of the original part may be deducted from the total, which may not exceed £35. The entrant must be prepared to produce replica modified parts, if so requested, unless they are available as currenly made items.

NOTE
SCALE IS DEFINED AS A PARTICULAR FORMULA ONE BRISCA STOCK CAR (BRITISH STOCK CAR ASSOCIATION).

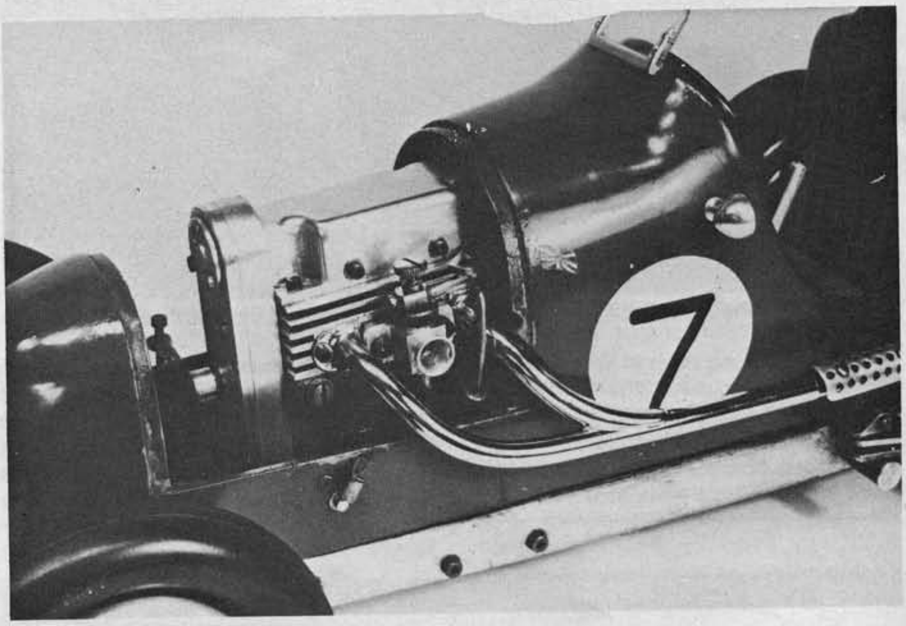
Tether Car Racing

Mike Beach shows us his superb collection of cars

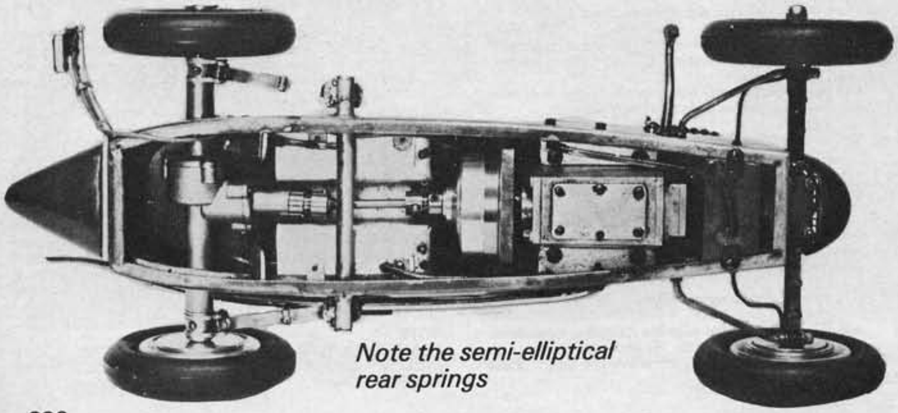
Built by Mr. Tillet in the mid-1950s, this is a replica of the single-seat pre-war Austin Racer. Powered by 6cc twin four-stroke with geared over head camshaft, spoked wheels, working leaf-spring suspension, and centrifugal clutch.

IN THESE days of radio control it can be difficult to understand why tethered race cars had such a large following in the immediate post-war years or why there is an upsurge of interest now. We have a chance to benefit from hindsight and a study of why they started, the talent they attracted and why they faded away is rather interesting.

Lets look back to around 1938 or so when small petrol engines began to be generally available to aero-modellers, some experimenters in America began to fit them to simple cars and had a lot of fun. The cars initially used basic techniques and borrowed a lot from model aircraft — they had simple wood chassis, block balsa bodies and a friction drive to model aircraft rubber wheels. But they ran, and well enough to show the potential. Initially speeds were low enough for the cars to be run free in circles or held by a strong fishing line so they sped around the operators, designs were scalish and based on speedway cars — the hand-held line permitted on occasion more than one to run in the same circle and the large size (about 24") unsilenced 5 to 10 cc cars must have been quite a spectacle at 30-40 m.p.h.



The engine compartment of the Austin

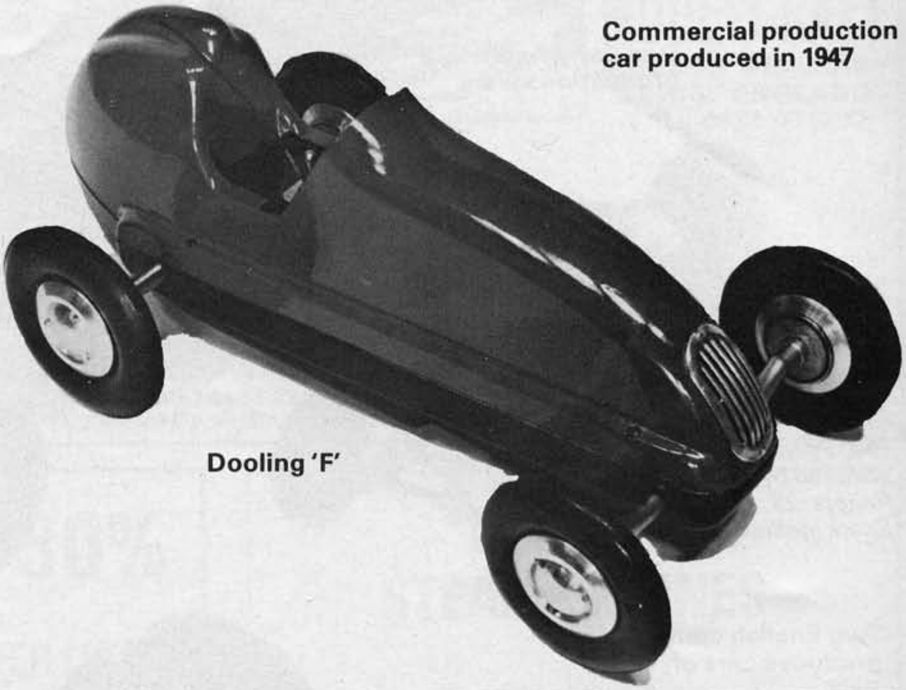


Note the semi-elliptical rear springs

However, human nature being what it is a competitive streak began to emerge and cars soon began a change. Fading away was the kitchen table special and arriving was the cast metal chassis, specialised wheels and gears and expensive factory produced car. The growing hobby, now divorced from its aero-modelling connections produced a new type of enthusiast prepared to spend money and with engineering background, this was the truly formulative period.

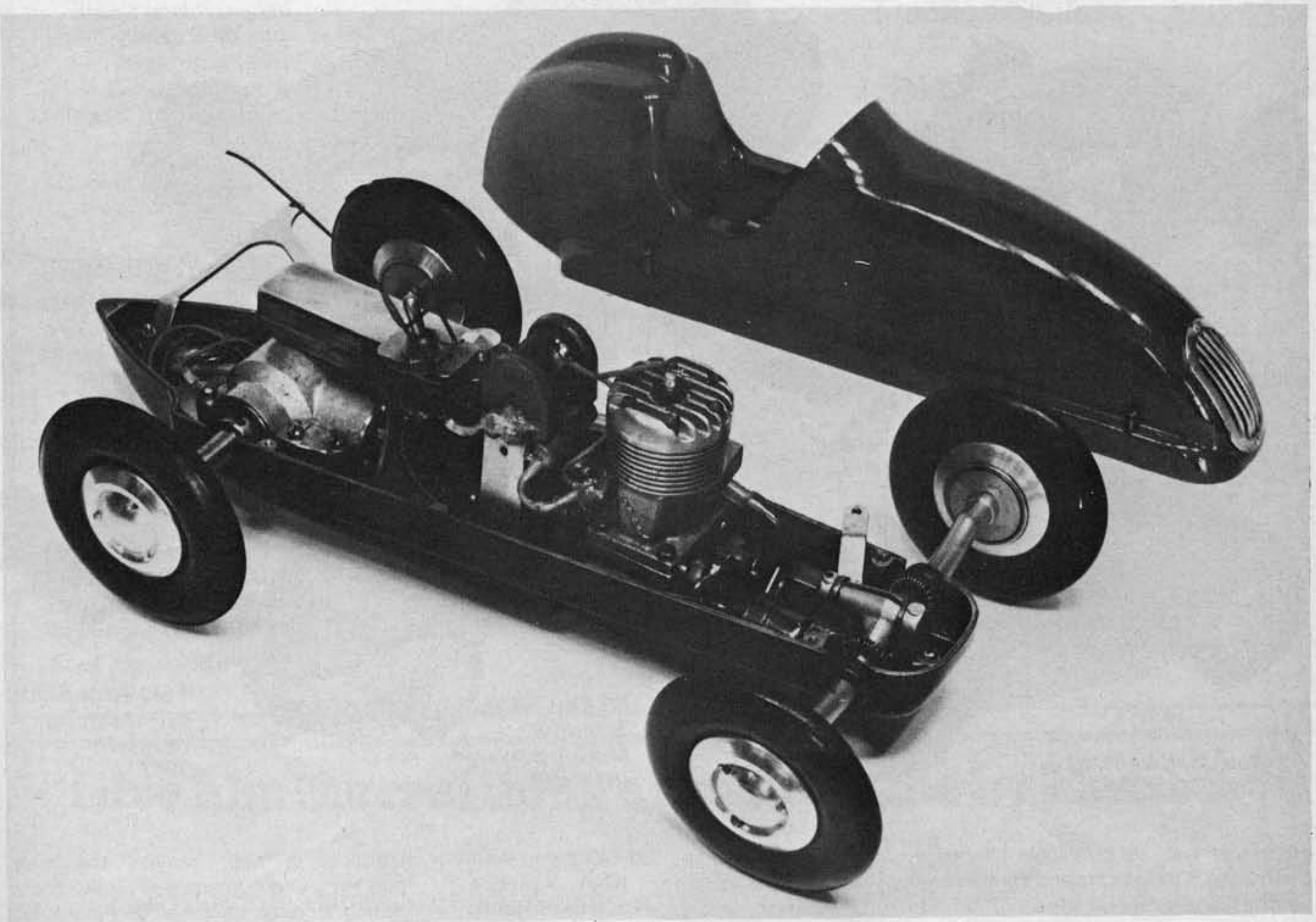
To understand this growth one must appreciate the interest in petrol engines for their own sakes and the scope the cars offered for design subtlety. The proof of your knowledge and skill could be easily verified by a direct comparison with another car at the track. Your knowledge of engines, fuels, tuning, gears, tyres, suspension and streamlining was put to the final test, the stopwatch. Obviously cars had outpaced the fishing line era and special tracks began to emerge using ball-bearing centre posts with aircraft cable tethering lines, speeds rose and the next big step was approaching — the specialised racing motor.

While all this was happening Europe was going to war and nobody took any notice of tethered cars, America, however, had another year or so and the truly hot car motor just began to arrive. Up to now converted model aircraft



Commercial production car produced in 1947

Dooling 'F'



Dooling 'F' chassis showing the Hornet spark ignition engine

engines had been used, but Ray Snow was making the big jump with the "Hornet", the first real production racing engine. It had about twice the power and revs of anything available, a solid, methanol burning motor, it opened another door to enthusiasts.

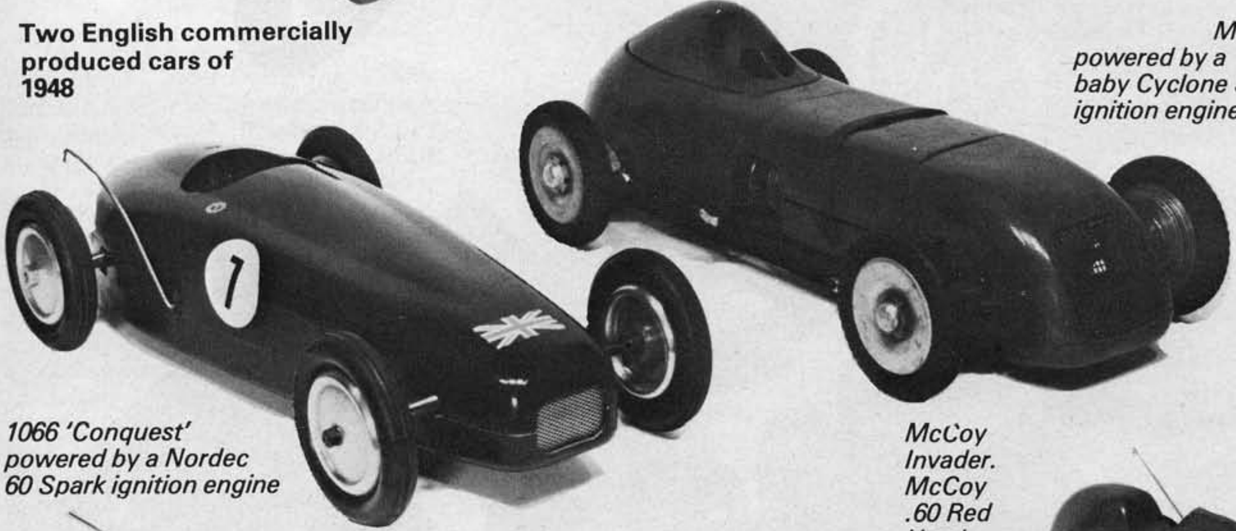
War effectively put a stop to everything. Americans's continued the hobby for a further two or three years, and its growth after the war was quite dramatic. America was quite quickly in production of developed cars using Hornets and the new McCoy engines, while we were just beginning to realise the hobby existed. Autumn in 1946 saw the first issues of two new magazines catering for the now growing interest here, although a study of the early issues shows an understandable lack of really suitable engines and components. Round this time began a problem that was to prove serious in Great Britain there was a lot of excellent model engineers to whom a

Two Early American production cars

1940 Peerless powered by a Rogers .29 Spark ignition engine

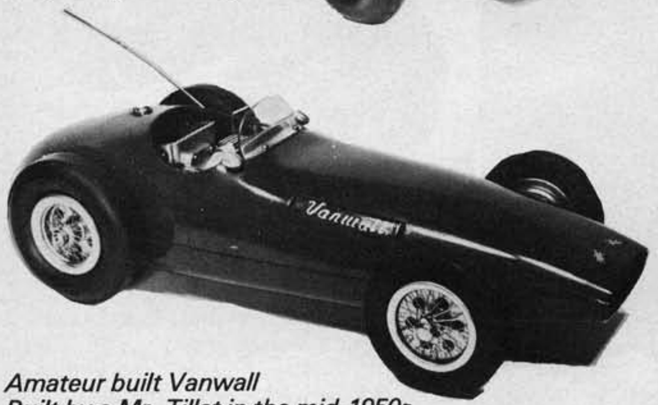
Mow 'Speed Chief' made in 1940 and powered by a Dennymite .57 Spark ignition engine

Two English commercially produced cars of 1948

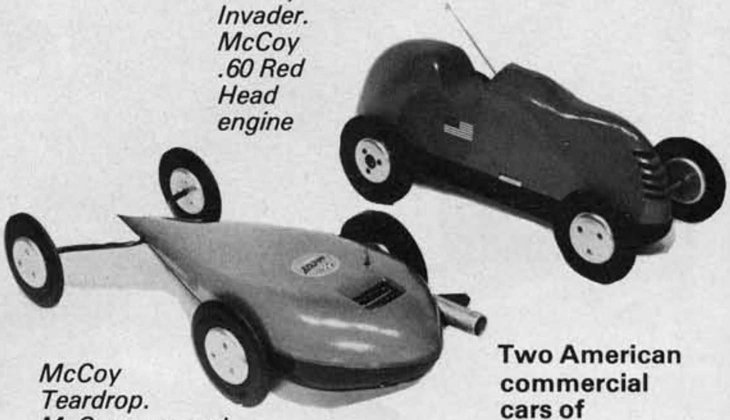


1066 'Conquest' powered by a Nordec 60 Spark ignition engine

M&E Special powered by a baby Cyclone Spark ignition engine



Amateur built Vanwall Built by a Mr. Tillet in the mid-1950s



McCoy Invader. McCoy .60 Red Head engine

McCoy Teardrop. McCoy powered .60 engine

Two American commercial cars of 1947

model car was an irresistible challenge, they began building cars and engines with emphasis on scale plus speed. In America, however, a complete car could be purchased that was faster than anything over here — note I said "purchased". A glance at the photo of the "Dooling F" will show what I mean, this car is a production masterpiece with die-cast magnesium body, special gears, wheels and tyres. It has chicken hopper tank and the all-conquering Hornet motor, this outfit will have cost about 100 dollars and perhaps £30-£40 if you could have got it over from America. Incidentally, this was a small fortune then. For a while this did not cause any problems, but as interest grew the ability to purchase performance began to cause a growing resentment among model engineers — certainly the "reader's letters" comments were dominated by this subject. Perhaps I am over simplifying, but I suspect that this may have been a major factor in the hobby fading away, however, other factors probably helped, maybe the ever-increasing speeds caused difficulty in getting suitable tracks or perhaps it just became too technical. What I do know, however, is that at its peak there were around 30 tracks in this country and 300 in the U.S.A., thousands enthused, attracting vast talent and producing some exotic machinery — how exotic? Well look at the pictures.

Back to basics in the workshop

By John Wheeler

JOHN WHEELER LEAVES his steam engines to enlarge upon those basic subjects which may cause a problem in Model Engineering.

Materials

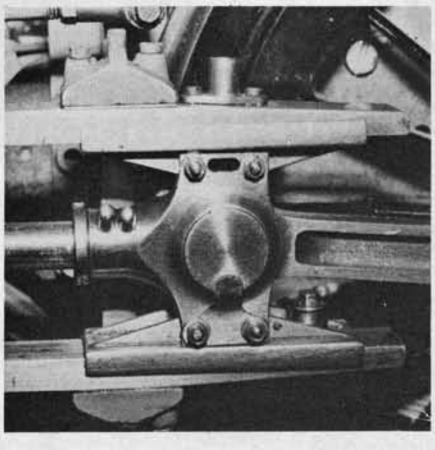
What material is that? How will it machine or work with hand tools? How can you find the right material for your particular requirements from your scrap-box supply of odds and ends of metal? Yes, it is true; modellers do collect, more and yet more for their scrap-box. Oddments of all sorts, shapes and sizes that may one day come in useful—well, so he hopes! One thing he rarely does is to mark the source of each piece of metal. Don't decry the scrap-box, it is a very handy place to find just the piece when the shops are closed or the bank balance is low and stocks are short. But what are the properties of that latest piece you picked up whilst out walking, and will it be suitable to use.

Mild Steel

This is best identified by the rust spots on the piece and that it can be picked up with a magnet. If it is dirty, file or scrape a section clean and immerse it in clean water. If it rusts and can adhere to a magnet, then it is likely to be mild steel. It will cut fairly easily with a hacksaw and files to a good finish. It also takes a good polish with emery or aluminium oxide cloth, drills and reams a clean hole. It will also hold a strong thread, and turns well on the lathe. Whenever you are cutting, drilling, threading or turning mild steel, use a cutting fluid such as soluble oil. This helps to cool and lubricate the process and prolong the life of the cutting tool.

To the experienced worker, mild steel has a bright grey colour, sometimes matt, sometimes polished with a heavy, but not too dense a feel. It is available in a very wide range of shapes and sizes; sheet, in various thicknesses, bar, in rectangular, square, hexagon, round or other shapes. Also angles, rolled or drawn tubes and structural sections, e.g., Rolled Steel Joints (R.S.J.). Additionally, there is the choice of bright mild steel or black mild steel. Black mild steel has a covering scale of iron oxides left on the surface. This is because it has been left to cool naturally from the red heat of the forming process. It is, therefore, in an annealed state. It is most often used for hot formed, or simple cold bent shapes, e.g., forgework, where the iron oxide scale gives some protection against rusting. Bright mild steel has had this oxide scale removed by mechanical or chemical processes. The section has then been produced by rolling or drawing whilst the metal is cold, e.g., Bright Dawn Mild Steel (B.D.M.S.). This sets up some internal stresses in the steel, sometimes seen when you hacksaw down the length of a flat bar, and the hacksaw cut looses up at the starting point. When you try to bend a bright drawn strip through 90° whilst cold, more often than not, the strip will break and fail at the bend, before the 90° has been achieved. This is also due, of course, to the metal stretching and reaching its yield point. This is best avoided by heating to red heat and then forming, or for the thinner sections, annealing, then when cold, bending will be possible once more.

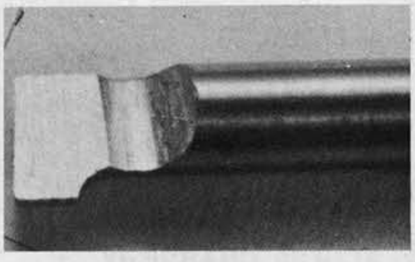
Bright mild steel is often used in preference to Black mild steel because of its dimensional accuracy and clean square corners on flat or square drawn bar. The removal of large sections of the metal to leave an unsymetrical shape in say a milling or shaping machine, will release the internal strains and the metal will 'warp'. I well remember my first attempt at making connecting rods. I had taken great care to achieve the outline shapes and had cleaned them up to a good finish, spending many hours on making the pair to match. I set one up in the milling machine to reduce its thickness and on completion, removed it from the vice—the rod finished up looking like a banana! I tried to straighten it, but only succeeded in putting an extra kink in it, so it meant making that rod all over again. Be warned— for such jobs always anneal the steel before any unsymmetrical machining takes place. That is, heat the steel up to red heat as quickly as possible to avoid a thick scale forming, then leave to cool as slowly as possible, e.g., bury in dry sand.



Crosshead detail of Bert Meads GWR 'Saint' made in mild steel usually case hardened

Silver Steel

It is so named because of its very smooth, shiny appearance as supplied. It does not contain any silver, but has a sufficient percentage of carbon dissolved in the iron to allow it to be hardened and tempered. This makes it very useful to the modeller as a tool steel for the making of small cutters, D bits, taps, etc. It is magnetic and will rust if exposed to a wet atmosphere, but is much harder to work than mild steel. It is available in 13 in lengths, occasionally 39 in is available in square or round sections. This maintains a very close accuracy to size, either in imperial or metric dimensions. This makes it very useful for shafts, which run in reamed holes or for D bits to cut standard size holes when a reamer is not available. Silver steel is a tougher steel than mild steel and requires a lower working or cutting speed, with a plentiful supply of cutting fluid. If it has to be bent, it will require annealing first, or shaping at red heat. When the process is complete, the silver steel should be hardened and tempered to regain its toughness.



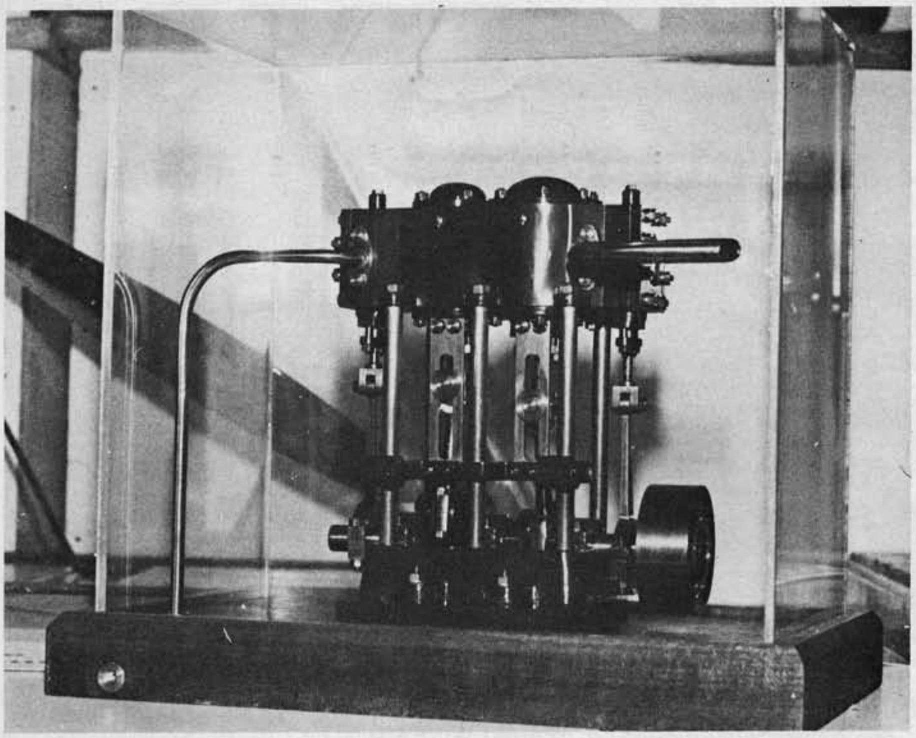
Boring tool made from silver steel. Photograph from George Thomas article in Model Engineer, June 1977

Cast Iron

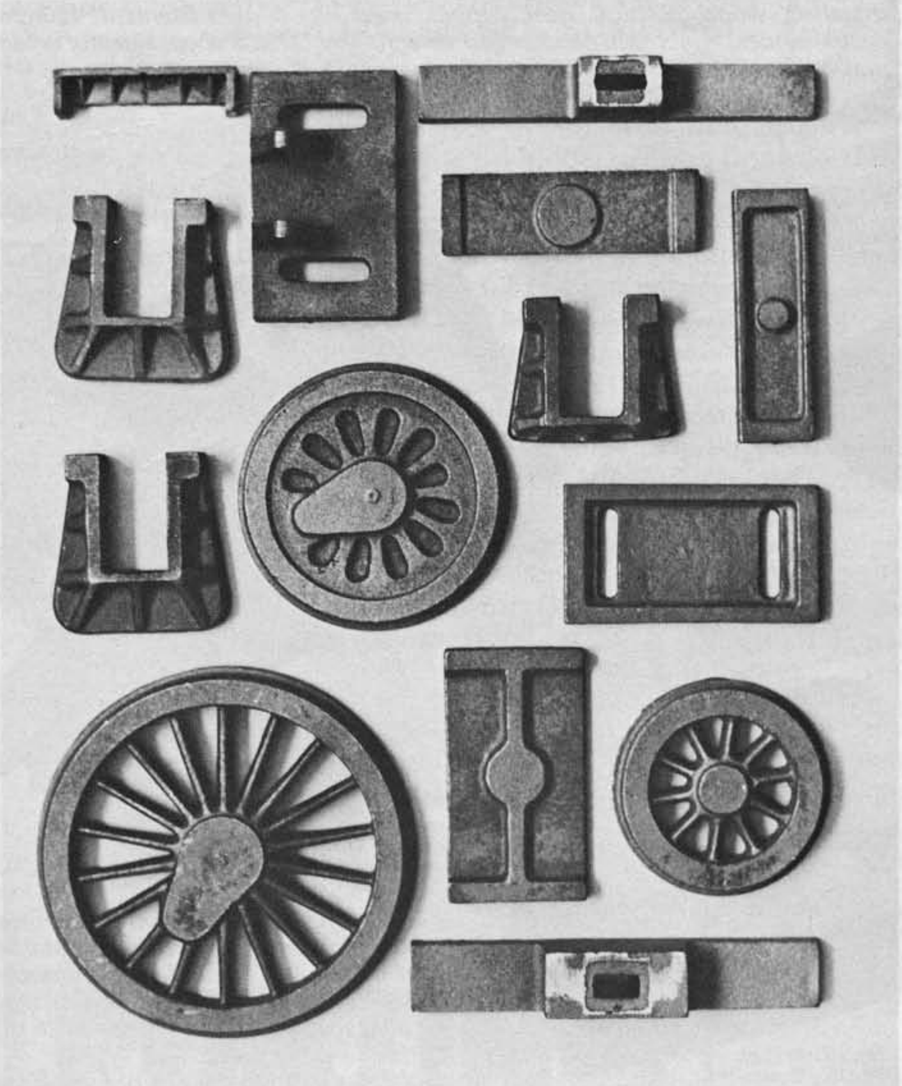
Easily recognised by its dark grey, sandy textured surface and heavy weight. When it is filed and the filings are rubbed between the fingers, the excess carbon present in the cast iron leaves the fingers black. It is magnetic and will slowly rust in a damp atmosphere. It is used mostly for intricate shapes that can be cast, or as a rubbing or bearing surface, e.g., the cast iron cylinders machined in the cylinder block of a piston engine.

Cast iron is strong under compression when supporting items, e.g., lathe beds, but is very weak and brittle if under tension.

Beware of the cast surface, however, because it will soon take the edge off a lathe tool. This is due to the hidden included particles of sand. You need to take the first cut deep enough to get under this skin. Also a surface that has



This is an engine built by John Wheeler, which was exhibited in this year's Model Engineer Exhibition. John Wheeler will describe how he made the case in a future article on the use of materials



Various articles cast in iron for a steam locomotive

been chilled in the casting process will be much harder than the rest of the cast iron. I find it best to use a carbide-tipped tool to remove this skin and hard spots. Near completion, I would probably change to a high-speed tool-bit. Always use a slow cutting speed—as fine curl shavings or chippings are produced as swarf and freed carbon acts as a form of lubricant, no cutting fluid will be required for any of the cutting actions. One further point, if you have to cut a thread in cast iron, don't make it a fine thread as it will easily strip out; use the coarsest thread you have available for that particular size.

Stainless Steel

Some stainless steels are non-magnetic, and none should rust if put into water. However, if placed next to a piece of mild steel in the water, the stainless steel will often show a rust stain that may be difficult to remove. The steel obtains its stainless property from the high percentage of chromium present. If the normal inert oxide layer is broken down, the iron in the steel can be attacked and will form rust under wet conditions.

Stainless steels must be worked slowly under a constant cutting condition with a generous supply of cutting fluid. If the tool is allowed to rub, even for a moment, the surface of the stainless steel will quickly work harden, blunt the tool and make further progress very difficult. The only hope then is to anneal the steel; heat the work up to red heat, and cool very, very slowly. Any slight discolouration of the surface is best removed with an abrasive cloth, e.g., 300 grade aluminium oxide strip, and then re-sharpen the cutting tool and try again.

Working stainless steel requires considerable effort, but at least you have the pleasure of knowing that the finish you obtain will not deteriorate through rust. I have been able to soft-solder some stainless steel using Killed Spirits of Salts (Baker's Fluid), as a flux with tinman's solder.The EUTECTIC COMPANY LTD., of Feltham, have a good low temperature (250°), joining solder, 'EUTECROD 157' an active flux, that is very strong, has a good colour match and uses a gas flame as a heat source. For silver-soldering, I have found that Easy Flo with the stainless steel grade flux, gives a strong joint, but the joint line is slightly visible. The burnt flux is removed by quenching in water and then soaking in soapy water, followed by cleaning up with abrasive strip.

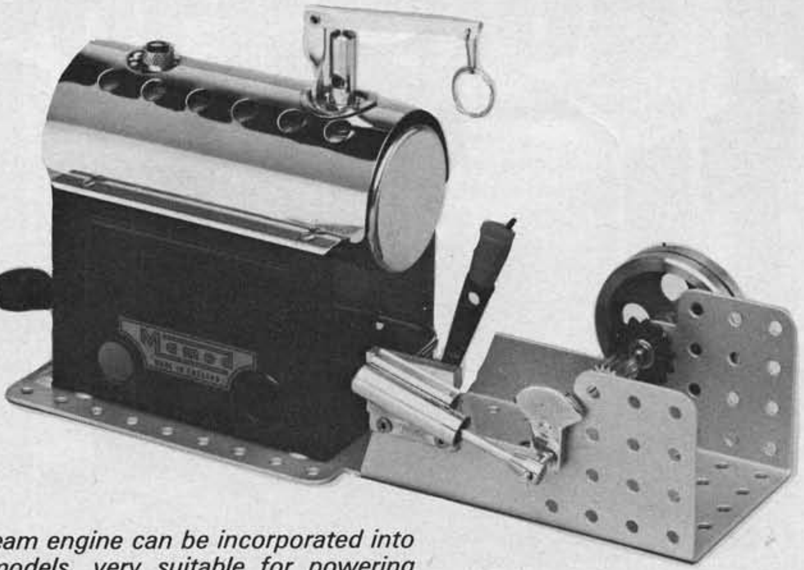
Not all stainless steels or steels for that matter, are suitable for the modeller with home workshop facilities. Some require special work techniques and these are best left alone. If you do know the source, supply, or the type of material, mark any useable off-cuts with a felt pen **before** putting in the scrap-box.

In the next issue, John Wheeler discusses other metals in use by modellers to-day.

Around the TRADE

Mamod steam engines

The SP1 low priced engine for driving small workshop models



SP3 Steam engine can be incorporated into many models, very suitable for powering Meccano constructions. It is fitted with a whistle, boiler sight glass, reverse control and Meccano sized pinion and sprocket

Hegner

Multicut-2 Universal Saw is designed to cut precisely through almost all materials, wood, plastics, steel, copper, brass etc. It uses Standard 130mm jigsaw blades, which can be changed very quickly. This is always useful when making inside cuts. For further information contact: A. F. Scofield, 36 Gt. Eastern Rd, Hockley, Essex.

The wishbone drill sharpener and reconditioner. This has been designed to enable anyone without special skill to restore blunt and broken twist drills up to ⅛ in. dia.

Expo (Drills) Ltd., Unit 10, Sustanum Works, Titchfield, Hants.

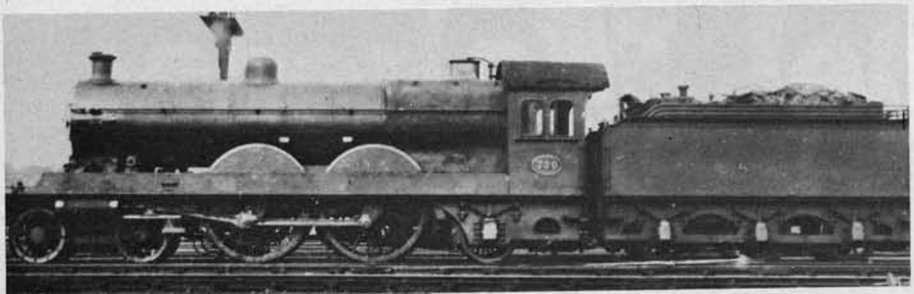
Above

The new Adel hand-operated Nibbling tool, will cut sheet metal like a punch and die and trim undersized holes to fit parts. It will also cut round and square or irregular holes to any shape or size over $\frac{7}{16}$ in.

For further information Eric H. Bernfeld Ltd., P.O. Box 111, 17a The Broadway, Potters Bar, Herts.

The Development of the Railway Steam Locomotive

Martin Evans continues with his description of famous locomotives.



W. M. Smith's 4-cylinder compound

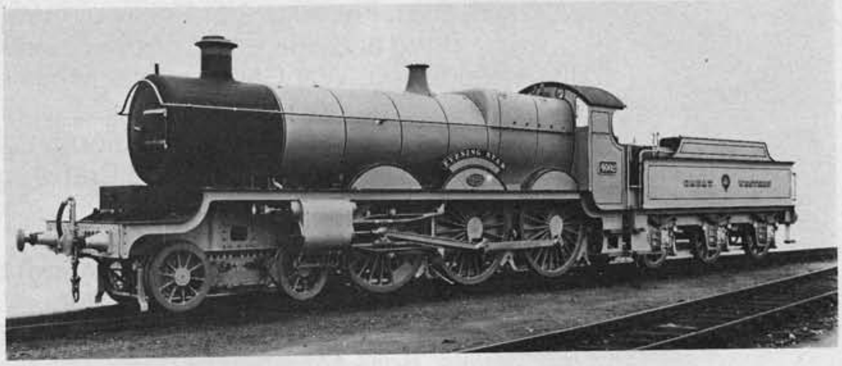
FROM THE TIME when Ivatt's "large" Atlantic first appeared in 1903 up to the outbreak of war in 1939, locomotive development on British railways was very rapid, especially in the realm of express passenger engines. The North Eastern Railway followed up the success of the "Jones Goods" 4-6-0 on the Highland by building some much larger 4-6-0's, both for express passenger work and for mixed-traffic. This railway also brought out some very successful "Atlantics", first there were two excellent 4-cylinder compounds, designed by W. M. Smith, then came Wilson Worsdell's class V 2-cylinder engines, and later, Vincent Raven's 3-cylinder class Z in 1911, which proved most successful.

Meanwhile on the Great Western Railway, G. J. Churchward had taken over from William Dean, and in 1904 produced a 4-4-0 locomotive of unusual design—the "County" class. Outside long-stroke cylinders were used, with inside Stephenson valve gear having exceptionally long valve travel. The boiler had a coned barrel and a Belpaire type firebox. Some American features were incorporated, such as the cylinders cast in pairs with the smokebox saddle, and the frames of bar type, with extensions ahead of the cylinders. Churchward followed up the "Counties" with a highly successful 4-6-0 type, the "Saints", which had similar long stroke cylinders and a boiler working pressure of 225 p.s.i.—very high for the period.

Churchward also ordered some 4-4-2 four-cylinder compounds from France, and to compare with these, built both 4-4-2 and 4-6-0 four-cylinder "simple" locomotives. It was found that the Churchward six-coupled engines were better on the banks, and eventually his "Atlantics" were converted to the 4-6-0 wheel arrangement. Although the French compounds ran very well, Churchward considered they were unnecessarily complicated, and therefore decided to continue to build his own type of four-cylinder engines—these were the famous "Star" class. Both the G.W.R. "Saints" and "Stars" were well in advance of the express locomotives then being built for the other main line railways.

The original "Stars" had cylinders 14¼ in. by 26in., working pressure 225 p.s.i. and a grate area of 27 sq. ft. from 1914 onwards, the cylinders were increased in the bore to 15in. and moderate superheating was introduced.

On the L.N.E.R. meanwhile, C. J. Bowen Cooke had brought out a successful 4-4-0 express locomotive, the "George the Fifth" class. Although somewhat heavy on coal, these moderate-sized engines put up many outstanding performances. Bowen Cooke was probably much impressed by the success of the Great Western "Stars", and in 1913 brought out a four-cylinder 4-6-0 with some resemblance to the G.W.R. engines. However, he adopted outside valve gear, and all four cylinders driving on to the leading axle. Known as the "Claughtons", these engines did very well at first, but in later years their performances seemed to fall off, repairs became frequent, and steaming indifferent. Unlike the G.W. engine, Bowen Cooke had adopted short valve travel and comparatively low working pressure, and no doubt these features told against the engines when not in perfect mechanical condition.

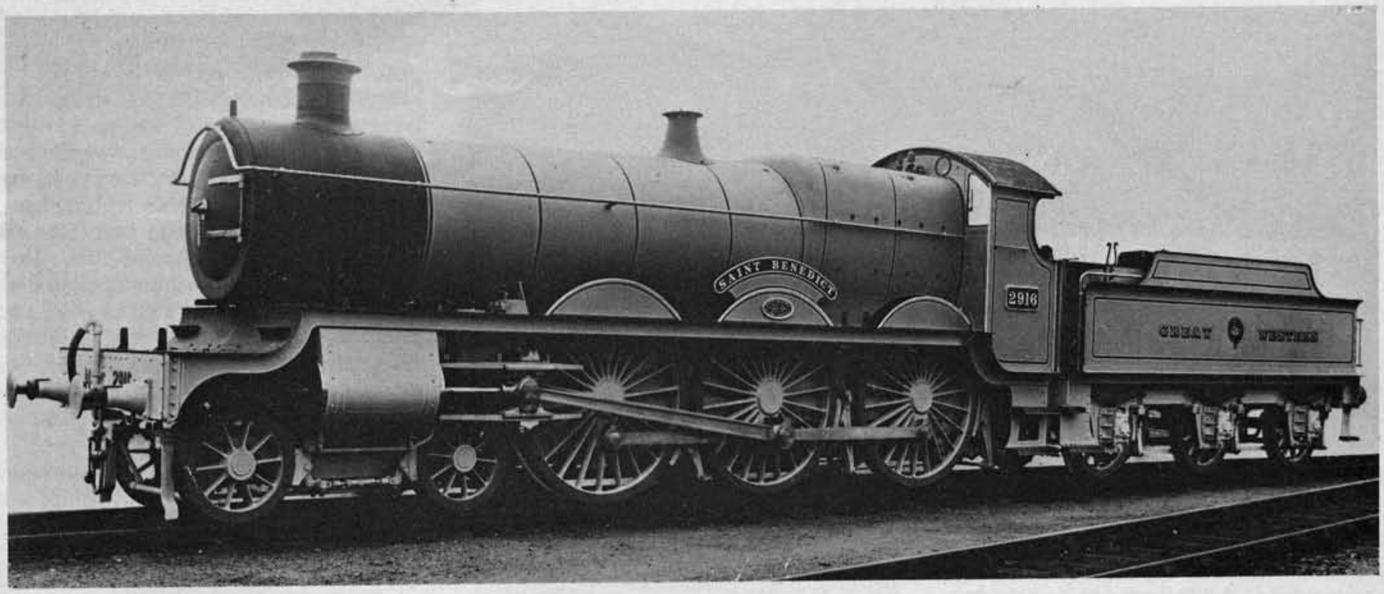


G.W.R. "Star" class 4-cylinder 4-6-0

Mention should now be made of the small, but highly successful "Claud Hamilton" 4-4-0's on the Great Eastern Railway. The first engine, No. 1900, had 7 ft. driving wheels, inside cylinders 19in. × 26in. and a working pressure of 180 p.s.i. The boiler was not large, having a maximum diameter of 4ft. 9in. and a grate area of 21.3 sq. ft. Nevertheless trains of 400 tons were successfully hauled over the difficult G.E. main line. No. 1900 was awarded the "Grand Prix" at the 1900 Paris Exhibition. Later 4-4-0 classes on the Great Eastern were fitted with much bigger boilers, culminating in the "Super Clauds" of 1921-23. The Great Eastern also produced a comparatively small 4-6-0, to the designs of S. D. Holden, generally known as the "1500" class. These locomotives had driving wheels of 6ft. 6in. and cylinders 20in. by 28in. Again, these proved highly successful and had long lives. Gresley rebuilt the "1500's" from 1932 onwards, fitting them with larger round-topped boilers and long travel valves. The last of the class was withdrawn in 1960.

On the Great Central Railway, J. G. Robinson had built both "Atlantics", including some compounds, and several types of 4-6-0. But his most successful type was a 4-4-0, the "Director" class. This design originated in 1913 and had inside cylinders 20in. by 26in., 180 p.s.i. boiler pressure and a grate area of 26 sq. ft. A number were also built by Gresley for the L.N.E.R., with cut-down boiler mountings.

J. F. McIntosh, the Locomotive Superintendent of the Caledonian Railway, built several fine classes of 4-4-0 express locomotives, culminating in his large engines of 1912, which had 6ft. 6in. driving wheels, cylinders 20¼ in. × 26in. and working pressure 170 p.s.i. But perhaps his most notable design was the "Cardean", a very large 4-6-0 with inside



G.W.R. "Saint" class 4-6-0

cylinders 20in. × 26in., coupled wheels 6ft. 6in. dia., a boiler with a heating surface of 2,266 sq. ft. and 200 p.s.i. working pressure.

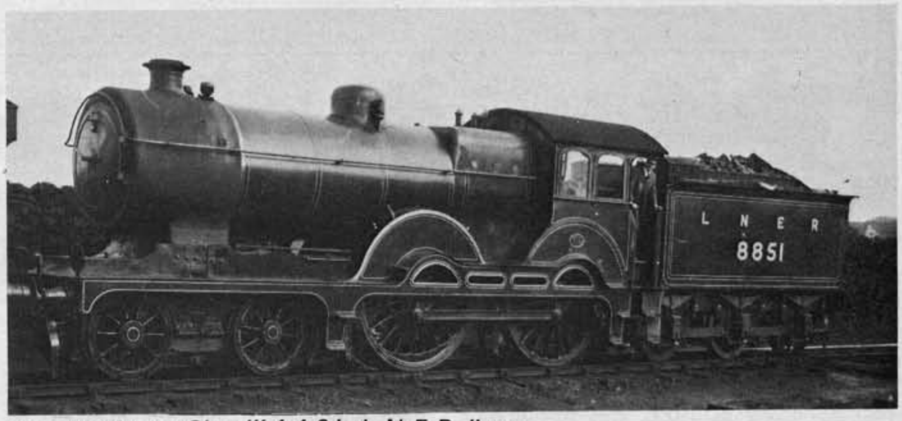
The first "Pacific"

Although quite common in America, no "Pacifics" had been built in Great Britain until 1908, when "The Great Bear" appeared from the Swindon works of the Great Western. It is generally thought that the only reason for the building of the "Bear" was the ambition of the G.W.R. directors to possess the largest and most powerful express passenger engine in the country. It is doubtful whether Churchward, the Locomotive Superintendent at the time, wanted the engine at all. Due to its great weight and long wheelbase, the "Bear" was confined to the lines between London and Bristol. Performance was little, if any, better than the four-cylinder 4-6-0's and some trouble was experienced through overheating of the trailing axleboxes, due to the proximity of the firebox. The principal dimensions of the "Bear" were as follows: Four cylinders 15in. × 26in., coupled wheels 6ft. 8½ in. dia., boiler barrel 23ft. long, diameter tapering from 5ft. 6in. to 6ft. at the firebox end, heating surface 2,831 sq. ft., grate area 41.8 sq. ft., working pressure 225 p.s.i. Total engine weight was 97¼ tons. The 8-wheel tender weighed 45¾ tons in working order. In 1924, "The Great Bear" was rebuilt as a "Castle" by C. B. Collett.

Many big tank engines were built between 1900 and 1914. The Great Eastern had a remarkable 0-10-0 tank engine built to demonstrate that a steam locomotive could accelerate a suburban passenger train as fast as an electric train. It was fitted with a huge boiler having a heating surface of 3,010 sq. ft., with a working pressure of 200 p.s.i., three cylinders 18½in. × 24in., and a total weight of 80 tons. The inside connecting rod was in the form of a triangular frame, embracing the leading axle. Three sets of Stephenson valve gear were fitted.

While the "Decapod" proved capable of competing with electric power as regards acceleration, it was too heavy for the track, bridges, etc., and was rebuilt as a 0-8-0 goods engine in 1906.

L.N.W.R. 4-4-0 "George the Fifth"

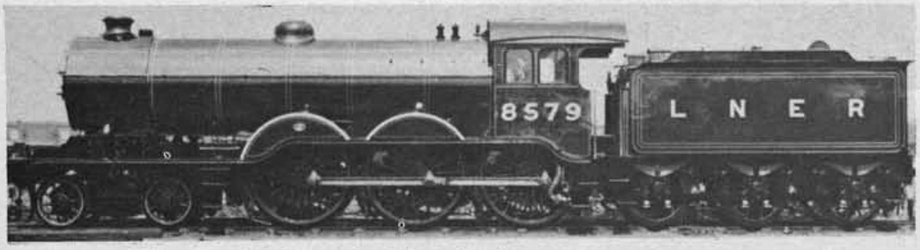


G.E.R. "Super Claud" 4-4-0 in L.N.E.R. livery

Some very powerful three-cylinder shunting tank engines were built by Beyer, Peacock & Co. for the Great Central Railway in 1907. These were of the 0-8-4 wheel arrangement, and had cylinders 18in × 26in., coupled wheels 4ft. 8in. dia., working pressure 200 p.s.i. and weight in working order 97 tons. In L.N.E.R. days, Gresley fitted one of these engines with a booster on the bogie, increasing its already high tractive effort from 34,520lb. to 46,890lb. Gresley subsequently built two similar engines with boosters in 1932, though the boosters were later removed.

Other big tank engines of this period were the 4-8-0's of W. Worsdell for the North Eastern, and Sir Vincent Raven's 4-6-2 tanks for the same railway, both three-cylinder machines. Churchward in 1905 built the first of a series of very successful 2-6-2 suburban tank locomotives for the Great Western. These were typical Swindon engines, with outside cylinders and inside link valve gear, taper barrel boilers, and high Belpaire fireboxes. Cylinders were long-stroke and coupled wheels 5ft. 8in., 5ft. 6in. or 5ft. 3in. Lighter 2-6-2 tanks were also built with 4ft. 8½ in. coupled wheels for branch line work.

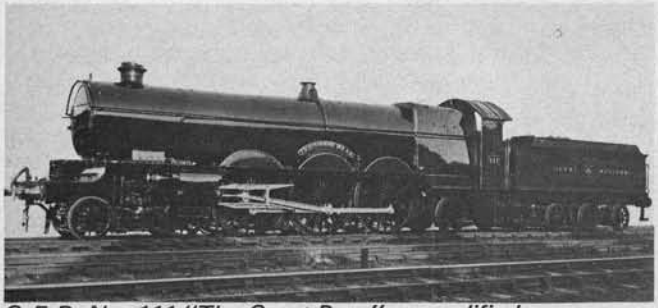
The London, Brighton & South Coast Railway, having short main lines, always built a large number of tank locomotives, and a large 4-6-2 tank appeared in 1910, designed by D. E. Marsh. This had



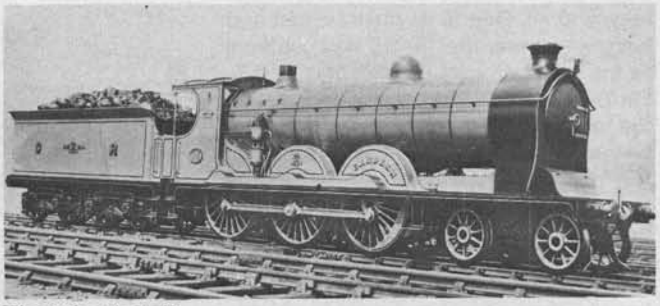
G.E.R. "1500" class 4-6-0 as rebuilt by Gresley

Stephenson valve gear. A second engine of this type built in 1912 had Walschaerts valve gear. A still larger 4-6-4 tank locomotive was built at Brighton in 1914. Designed by L. B. Billinton, this class had very large outside cylinders — 22in. × 26in., outside Walschaerts valve gear, a working pressure of 170 p.s.i. and a total weight of 98 tons. Although the "Baltics" did good work, they proved less efficient than the later "King Arthurs" and were converted to 4-6-0 tender engines by the Southern Railway.

For goods and mineral traffic, Churchward introduced a highly successful 2-8-0 locomotive, with his usual long-stroke outside cylinders and inside link valve gear; this type, with small modifications, was continued by C. B. Collett. Gresley, on the Great Northern and later on the L.N.E.R. also built 2-8-0 mineral locomotives, starting with a two-cylinder machine, but going on to three-cylinder engines, with a special conjugated valve gear in which the outside gears operated the inside valve through a system of "two-to-one" levers. This three-cylinder arrangement was to be used by Gresley for nearly all his future designs, apart from suburban tank



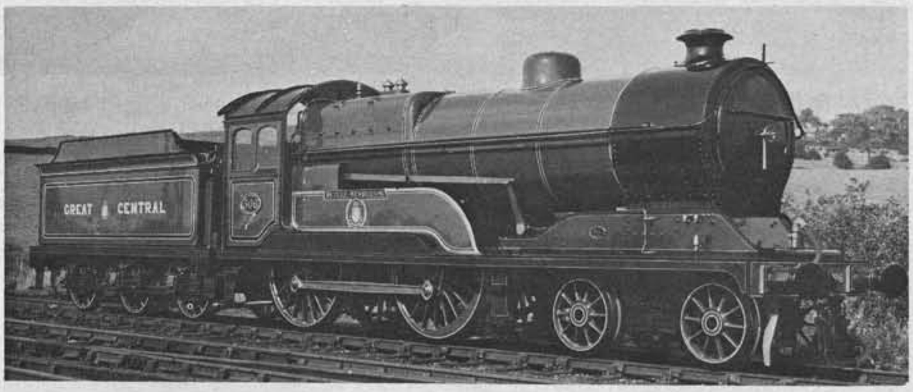
G.E.R. No. 111 "The Great Bear" as modified



The "Cardean"

engines of the 0-6-2 type and shunting engines. The Gresley two-cylinder 2-8-0 first appeared in 1913, and the three-cylinder type in 1918. Gresley also built a number of very large three-cylinder 2-6-0's from 1920, the L.N.E.R. "K.3" class; these proved highly successful, though somewhat rough-riding at speed.

The years 1922-23 saw two outstanding new express locomotive designs, the Gresley "Pacific" and the Great Western Railway's "Castle" class 4-6-0. The latter was really an enlarged "Star", but nevertheless reflected great credit on C. B. Collett. The four cylinders were 16in. × 26in., with inside Walschaerts valve gear as in the "Stars". The boiler was considerably larger, having a heating surface of 2049 sq. ft., and a grate area of 30.3 sq. ft. Working pressure was 225 p.s.i. In 1925, Mr. Collett presented to the World Power Conference held in that year some results of dynamometer car trials carried out on *Caldicot Castle.* Included in these was the figure for coal consumption of 2.83lb. per drawbar horsepower hour, a



Robinson's successful "Director" class

figure that was so much below anything reported previously that some engineers at first refused to believe it!

The Gresley "Pacific", the largest express locomotive built up to that time, was an outstanding design achievement. The boiler was of the wide firebox type, with a heating surface of 2930 sq. ft., grate area 41¼ sq. ft., and working pressure 180 p.s.i. A large superheater was fitted, with a heating surface of 525 sq. ft. The three cylinders were 20in. × 26in., and the "two-to-one" conjugated valve gear was used.

The first batch of Gresley "Pacifics" were not altogether successful, coal consumption being on the heavy side; this being mainly due to the adoption of short travel valves; more of this later.

Gresley's first "Pacific"

At the 1924 British Empire Exhibition at Wembley, a Gresley "Pacific" and a Great Western "Castle" stood side by side, and it seemed almost inevitable that the two classes should sooner or later be pitted against one another. This in fact came about through a challenge from Sir Felix Pole, General Manager of the Great Western Railway, that interchange trials should be arranged between the two locomotives. The trials took place during 1925, the "Castle" taking the Leeds expresses from Kings Cross and the Gresley "Pacific" tackling the "Cornish Riviera" from Paddington.

In spite of the much larger size of the "Pacific", the "Castle" beat the bigger engine fair and square on its own road, and on a much lower coal consumption as well! The "Pacific", however, did well to keep time on the difficult "Cornish Riviera".

As a result of these interchange trials, the valve gear of the Gresley "Pacifics" was modified, to much closer to the "events" of the Swindon engine; and soon after this, boilers with the higher working pressure of 220 p.s.i. were fitted. These modifications were to effect a remarkable improvement, and in their later years, the Gresley "Pacifics" became one of the finest express passenger locomotives in the country.

To be concluded

Martin Evans will complete this series of articles covering from the 1930s up to the "Evening Star".

News ►►►►►►►►►

The Surrey Society of Model Engineers was formed in June, 1978, catering for model engineers in the Leatherhead, Bookham, Hook, Chessington, Epsom and Ewell areas. They meet at the Baptist Church Hall, Lower Road, Great Bookham, normally on the third Thursday of each month. Their interest is covering the whole aspect of model enginering and at the time of writing, they are negotiating for a site for a track in Mill Lane, Leatherhead.

Since their founding, they have had several talks by visiting speakers, including Mr. Barnes of the Lamp Manufacturing and Signallin Equipment Ltd., representatives from Wimbledon Park Depot British Railways, and a model boat-club representative. Internally, several members have given talks on the models they are building.

Their Annual General Meeting will be on the 17th May at the Baptist Church Hall, Lower Road, Great Bookham, at 8 p.m.

On 19th July there will be a visit from Chessington Radio Controlled Car Club who recently appeared on Blue Peter BBC programme. This Club will be demonstrating their models and will show slides and possibly a film of their Club activities. Surrey Society will be joined by members of the Ascot Locomotive club—thus that evening at the Baptist Church Hall should prove an interesting one.

If you are interested in joining this Society, Please write to the Hon. Secretary, Mr. John Cook, 27 Vallis Way, Hook, Chessington, Surrey KT9 1PX.

A couple of events from the National 2½ in. gauge association calendar, which should be of interest to folks building the 'Eagle'.

May 20th—South West Regional Rally. Stndard Telephone and Cables, A. and S.C. track. Brixham Road, Paignton, Devon. (Please inform the Association Secretary of your intention to attend this rally).

July 15th—South East Regional Rally. North London S.M.E. track, Colney Heath, Hert.

Australian builds giant model aircraft

Mr. Cyril Blackman, who is the Press Officer for the Australian High Commission, forwarded to us this story. The Australian mentioned was Corporal Michael Bryson of the Royal Australian Alr Force.

On a recent afternoon at Edinburgh Airfield, in South Australia, virtually everyone, from top brass to raw recruit, turned out to see a successful test flight of Corporal Bryson's radio-controlled model of a C-130A Hercules aircraft.

All air trafic at the base was stopped for the first major test flight of the model 18kg (40 pounds), 3m (10 ft.) long aircraft of 3½m (11½ ft.) wing span, which on the ground is virtually indistinguishable from the real thing and in the air is even harder to recognise as a $\frac{1}{12}$ th scale model.

Inside, the seating, light, instruments and other fittings are reproduced in miniature and Corporal Bryson is satisfied that the model can accomplish a 48-model-man parachute drop, or land scaled-down replicas of army vehicles by parachutes—although these things have yet to be done in flight.

After three years and thousands of man hours work, he admitted that he was too nervous to fly it himself, but cheered along with other spectators as his friend, Sergeant Dennis Scott, brought the machine down after a copybook flight, to a perfect landing.

The Hercules' four 6.5cc engines had enabled it to cruise effortlessly at about 70 knots for six circuits of the airfield before it touched down with puffs of blue-grey smoke and squeals of protests from the rubber wheels.

His aircraft is insured for A$5,000 (£2,800)—but only while it is on the ground.

Loughborough University

Loughborough University are once again holding their residential course for Model Engineers from 22nd July to 28th and 29th July to 4th August, 1979. This is a two-part course, the first week being Model Engineering Workshop Practice, Part I, the second week, Model Engineering Workshop Praactice, Part II, plus Boilermaking. The cost for one week is £77 all inclusive of food and lodgings. There is an extra bonus of a special 6 course dinner on the Friday night.

The facilities for the course are excellent and consist of a large single storey building containing lecture rooms, drawing offices and a large machine shop and stores. The accommodation comprises of a bed, wash-basin, desk and easy-chair. It is suggested that you take your own kettle if you require an early-morning cup of tea!

Applications should be made to Mrs Olive Jones, Centre for Extension Studies, Loughborough University,

A general view of the Loughborough workshops where the course is held. Photograph by Professor K. McCarthy.

Martin Evans — all-rounder

Dear Sir,

I wonder how many of your readers realise that the publication of your April issue marks a minor (or perhaps not so minor) mileston in the history of model engineering? With the presentation of his "Eagle" design, Martin Evans becomes the first designer of model locomotives since the late Henry Greenly to have published designs for every recognised gauge from 0 to 7¼ in., and, I believe I am right in saying, the **only** one to have offered fully detailed constructional articles for all of thes sizes. This deserves to be put on record, and I feel that congratulations are in order.

To be candid, some of us had come to suspect that Mr Evans had something of a "blind spot" where 2½ in. gauge was concerned; we are delighted that this proves not to be so, and we shall look forward with keen interest to having a genuine Martin Evans design in this size. This leads to a further thought which might be worth considering: in view of the extreme scarcity of modern designs for 2½ in. gauge, it seems likely that "Eagle" will be taken up by many experienced workers as well as by beginners. For their benefit would it not be possible to give drawings for a cab-controlled valve gear (probably Stephenson's) as an alternative to the slip eccentrics? I shall probably be told that an experienced worker should be capable of designing his own gear, and of course that is true, but life is short and some of us are handier with a file than with a pencil.

It will be obvious from the above that it is not only beginners who read 'Model Mechanics', but this needs qualification. We are all beginners in, or at least unacquainted with, some things, and a jornal which takes as its field the whole of model engineering and does not assume too much prior knowledge on the part of its readers, will fill a definite gap in the literature. We should all seek to broaden our mental horizons, and any publication which helps us to do this can only be commended. I don't suppose that I shall ever model a horse-drawn vehicle, but I now have some hope of being able to listen intelligently when expert friends talk about this subject. And maybe—who knows?—they will not think me quite such a bore when I talk about steam. These considerations are perhaps of secondary importance compared to your primary and declared aim of attracting new recruits to the finest of all spare-time activities—an aim which we all support—but not, I think, without their place. Long may you flourish!

Yours faithfully,

E. L. Dellow

The 'Eagle' designed by Martin Evans

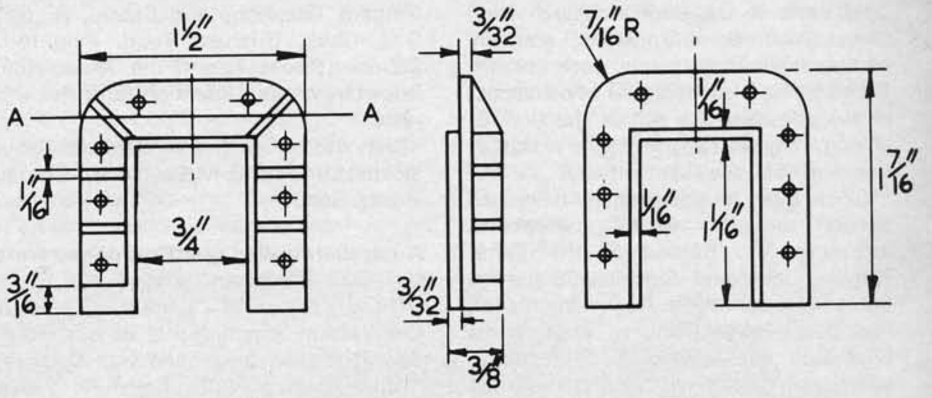
A simple 2½ in gauge 4·4·0 locomotive

HAVING successfully completed the main frames of our 4-4-0, the next operation is the fitting of the main horns. These are necessary to give greater bearing surfaces for the axleboxes, while they also stiffen up the whole frame assembly.

Castings in gunmetal will be available, and it should not be at all difficult to file these up accurately enough for fitting, which will save a rather time-consuming set-up in the lathe. However, for those who prefer to mill the horns,and have a vertical-slide for their lathe, here is a sound method. Set up the vertical-slide facing the lathe spindle, and make sure that it is square. The quickest way to do this is to put on the faceplate and bring the slide up to it. Obtain a short piece of steel about 3/8 in. × 3/16 in. section, just long enough to span the flanges on the contact side of the horns. Drill this centrally ¼ in. dia. and with a ¼ in. BSF cap screw, clamp the horn direct to the vertical-slide, choosing one of the tee-slots of the slide at a convenient height according to the lathe in use.

An end mill about 3/8 in. dia. is now used; this can be held in a collet if available, though the 3-jaw chuck will be equally satisfactory for this job. The lathe saddle is now locked at a suitable point so that a light trial cut can be taken, working the handles of the vertical and cross-slides so that the end mill cuts all around the flanges of the horn. The flanges must stand out from the contact face by 3/32 in., so take a light cut over the flanges, apart from where the clamping bar gets in the way of course (this part can easily be cleaned up afterwards by filing), then advance the saddle 3/32 in. and take the final cut all around the casting. Repeat for the other three horns.

To ensure that the width across the flanges of the horns is correct to fit the frame slots, a vernier caliper is most useful, but if no such instrument is available, a simple gauge should be made, say from 1/16 in. steel, checking this against the frame, then "offering" it up to the horn while this is still on the vertical-slide. The two horns for the trailing axle have to be cut down, to give plenty of clearance for the firebox; so this can now be done with a hacksaw. The horns are now fitted to the frames and are held to them by 3/32 in. rivets, soft iron for preference, though copper could be used at a pinch. They should be snap-head, put in from the back and hammered into countersinks on the outside of the frames, being then filed flush. While fitting the rivets, it helps if a few 7 BA screws and nuts are used, to hold the horns firmly, these being



Main horns 2 off as drawn, 2 off cut at AA gunmetal castings

removed one by one, as they are replaced by the rivets.

We now have to machine the inside working faces of the horns in position. Although these could be filed, it is not at all easy, as one has to keep the two faces quite parallel to one another and at the same time at 90 deg. to the bottom edge of the frame. But these faces can be end milled in the lathe if a good stout machine vice that can be clamped or bolted to the vertical-slide is available; alternatively, an angle plate could be used.

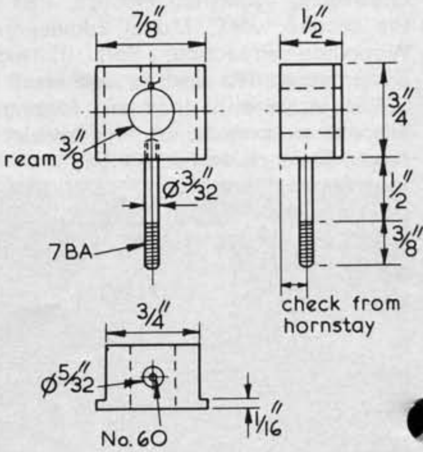
The frames are first bolted back-to-back, using a couple of 6 BA screws at the ends; they can then be held in the machine vice between the two horns. A long end mill ½ or 3/8 in. dia. is now held in the chuck, with about 1⅛ in. protruding from the jaws. Now make a simple width gauge. A piece of round or square steel about ½ in. dia. and turned to exactly ¾ in. long will do nicely. Only very light cuts need be taken, the aim being of course to take the same amount off each face, but great care must be taken to ensure that the feed is made opposite to the rotation of the cutter, otherwise the cutter will "catch up" and spoil the job. It is a good idea to adjust the gib screws of the vertical-slide a little tighter than normal for this operation.

The axleboxes come next. They can be made from gunmetal castings or may be built up. To make the built-up axleboxes, take a length of ¾ in. square mild steel and saw or part off four "slices" a little longer than required, to allow for cleaning up. For the flange, a length of 1 in. × 1/16 in. brass strip will do nicely. This is filed down to 7/8 in. wide and can be held to the steel part by four 8 BA countersunk screws, arranged in the corners clear of the bore.

Find the longitudinal centre-line of the axleboxes with an "odd-leg" (Jenny) calipers, marking this on the flange side. The axlebox can then be held in a machine vice for centring and drilling. Drill to a shade under 3/8 in. dia. (letter U drill) and if the drilling machine has a really slow speed, follow up with a 3/8 in. reamer or D-bit. The reamer can be put through by hand, but not the D-bit, as this has no "lead" and thus is very difficult to start truly. Pair up the axleboxes, and mark them with number stamps, marking their horns to match. In this way, the axles will be at right-angles to the frames, even if the holes are not dead on the centre line.

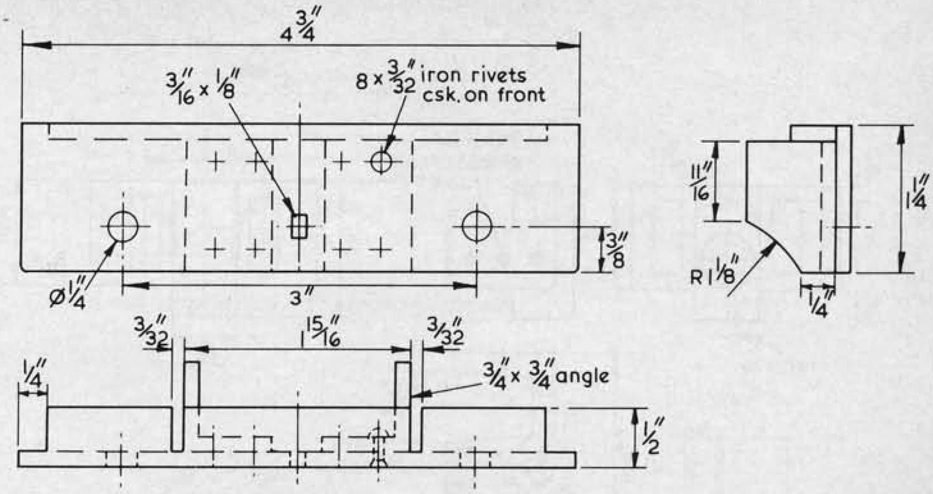
If making the axleboxes from castings they will probably be in the form of a long stick, rather than cast individually. As the stick of four will not be much longer than 3¼ in., it can be held in the 4-jaw while cuts are taken across the front and back, bringing the stick to the required thickness of ½ in.

To machine the working faces, the stick can be held in the machine vice on the vertical-slide. Set the slide quite square to the spindle once again, and insert a true piece of steel or brass bar between the axlebox stick and the back of the vice,

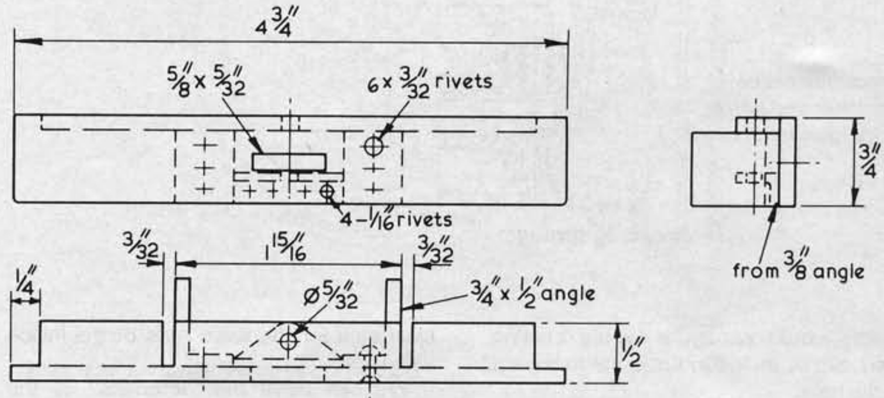


Main Axlebox 4 off gunmetal casting or built up with just enough overhang to enable the cutter to get to the required depth without fouling the vice. The flanges and the working faces can now be matched with an end mill about $\frac{3}{8}$ in. dia. in the chuck. If the lathe is fitted with a handwheel to the lead-screw, the saddle can be moved up and a reading taken on the handwheel, so that the exact depth of cut can be obtained without measurement. Reverse the axlebox stick to machine the other flange and working face, after which the individual axleboxes can be sawn apart and the ends cleaned up using the four-jaw to hold them. Drilling and reaming then follows as for the built-up axleboxes.

The spring pins are made from $\frac{3}{32}$ in. dia. mild steel, one end being threaded 7 BA, and the top end, for screwing into the axlebox, also 7 BA, but for a length of $\frac{5}{32}$ in. only. **Important:** When threading the top end, open out the die a little more, so as to give a slightly oversize thread, as it is essential that the spring pins don't work loose when we are adjusting the springing. The hornstays are very simple, merely 1½ in. lengths of $\frac{3}{8}$ in. × $\frac{1}{8}$ in. mild steel, drilled at the ends No. 34, for 6 BA screws, and centrally No. 39 for the spring pins. It is a good plan to make these before the axleboxes, fit them to their horns, and use the central hole to locate the hole in the bottom of the axleboxes for the spring pins.



Front buffer beam from ¼ in. × $\frac{1}{8}$ in. steel angle



Drag (rear) beam from ¾ in. × $\frac{1}{8}$ in. steel angle

Buffer beams

Both the front buffer beam and the rear or drag beam are made from bright steel angle, 1¼ in. for the front beam and ¾ in. for the rear. Builders who have suitable lathe power can cut the slots using a large diameter face or slotting cutter mounted between centres or on a short arbor held in the chuck. If the cutter is the standard 1 inch bore type, it will have to be of 2½ in. diameter or larger to reach to the bottom of the slot. At first sight, a cutter of $\frac{3}{32}$ in. thickness would seem to be the answer, but the trouble is that even a true running cutter will cut a slot a shade wider than itself, enough to leave the frames rather slack in the beam slots, so it is better to use a thinner cutter, say $\frac{5}{64}$ in. or even $\frac{1}{16}$ in. and take two bites at it.

It is not too difficult to cut the slots by hand, if they are marked out carefully beforehand. Drill a No. 42 hole at the extreme end of the slot, and use a fine pitch hacksaw blade, making two cuts, the unwanted sliver of metal which may be left can be broken out. The slot is then finished by filing, by using a "thin" flat file or a flat needle file, and using the frame plate itself as a gauge. Aim for a tight hand push fit.

The buffer holes in the front beam are drilled ¼ in. dia. while the slot for the coupling, which is $\frac{3}{16}$ in. × $\frac{1}{8}$ in. can be made by drilling a hole at one end of the required slot with a No. 31 drill, then opening this out first with a round needle file (a coarse cut one is best) and finally with a square needle file, using a piece of steel of the desired section as a gauge. To hold the frames to the buffer beam, two pieces of ¾ in. × ¾ in. steel angle are used. First make sure that the angle to be used is actually at right angles — some are definitely not!

The angles are held to the beams by $\frac{3}{32}$ in. iron rivets, put in from the back, and countersunk on the outside. They can be held in position for drilling with small toolmaker's clamps, checking with a small try-square.

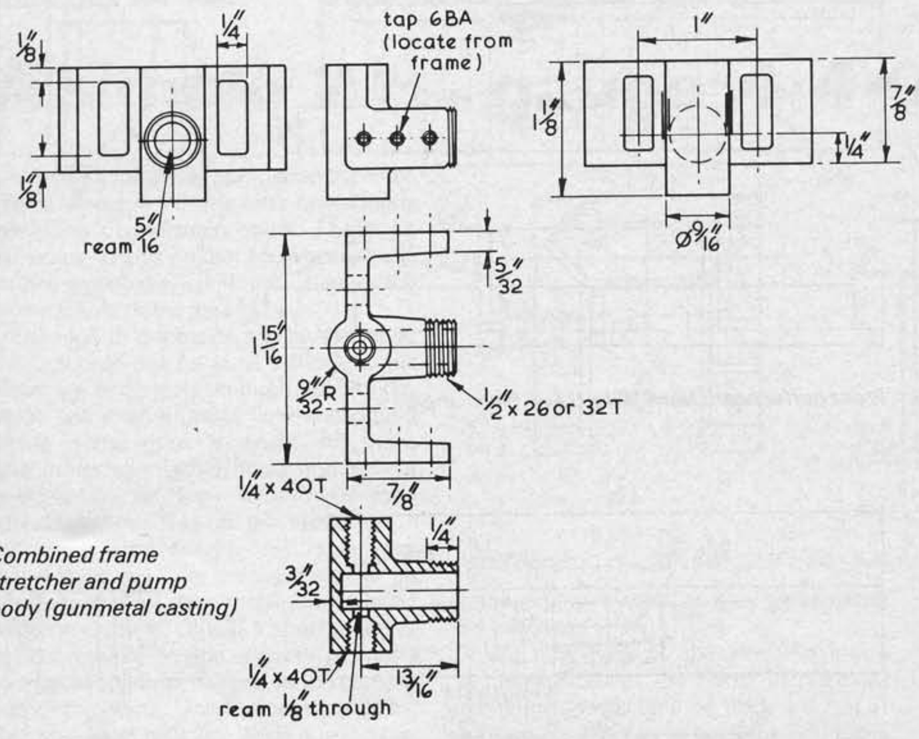
The drag beam is similar, except that there is just the single wide slot for the engine-tender coupling and an additional angle is riveted on as shown to take the coupling pin. This piece of angle can be cut from $\frac{3}{8}$ in. × $\frac{3}{8}$ in. × $\frac{1}{16}$ in. brass angle, and four $\frac{1}{16}$ in. rivets will hold it firmly.

Frame stretchers

Before we can make a trial assembly of the frames, we will require the frame stretchers. There are four of these. The bogie pin stretcher can be made from a gunmetal casting. The ends can be machined using the 4-jaw chuck, to bring the overall width to exactly 1 $\frac{15}{16}$ in. The underside is then cleaned up and the pin, turned from mild steel, bolted to it as shown.

The vertical, or main, frame stretcher is another very simple gunmetal casting which only requires machining at the ends to bring it to correct width. The third stretcher is a turning, made from $\frac{5}{16}$ in. dia. mild steel; it is tapped 6 BA at each end. Finally, there is a rather more elaborate stretcher, which combines the feed pump body. Again, all the machining operations can be carried out using the 4-jaw. Face off the ends first, to bring the casting to 1$\frac{15}{16}$ in. across, then turn it 90 deg. to clean up the top, and a further 180 deg. to clean up the bottom. We can now hold the casting firmly and truly for drilling and finishing the bore. A $\frac{5}{16}$ in. D-bit is the tool for this, but be careful not to go in too far, there must be a good $\frac{3}{32}$ in. left in the far wall, for strength! At the same setting turn the outside of the barrel to ½ in. dia. for a length of just over ¼ in. and thread ½ in. × 26 or 32T, the latter thread for preference. Leave this thread a shade oversize, as it is important that the gland nut, which screws on here, should not work loose in service.

Now turn the casting through 90 deg. again, with the top towards the tailstock, centre deeply, then drill right through the casting with a drill about No. 34, follow up with No. 31 drill, then ream $\frac{1}{8}$ in. dia. Open out with $\frac{7}{32}$ in. drill to a good $\frac{3}{32}$ in. short of the main bore, square the end of the hole left by the drill with a $\frac{7}{32}$ in. D-bit, but be very careful not to go in too far,



Combined frame stretcher and pump body (gunmetal casting)

which would spoil the whole casting. Next, tap ¼ in. × 40t, not quite to the end of the hole.

Reverse the casting, so that the bottom end is towards the tailstock, and open out as before with $\frac{7}{32}$ in. drill, leaving a good $\frac{3}{32}$ in. between the end of this hole and the main bore, then tap ¼ in. × 40t. again; no need for the D-bit this time.

Incidentally, if the two slots in the casting are undersize — they should be $\frac{5}{8}$ in. high by ¼ in. wide — clean these up with a file. These slots are to provide clearance for the valve rods of the inside valve gear.

We can leave the "internals" of the pump for the moment while we assemble the frames.

Assembling the frames

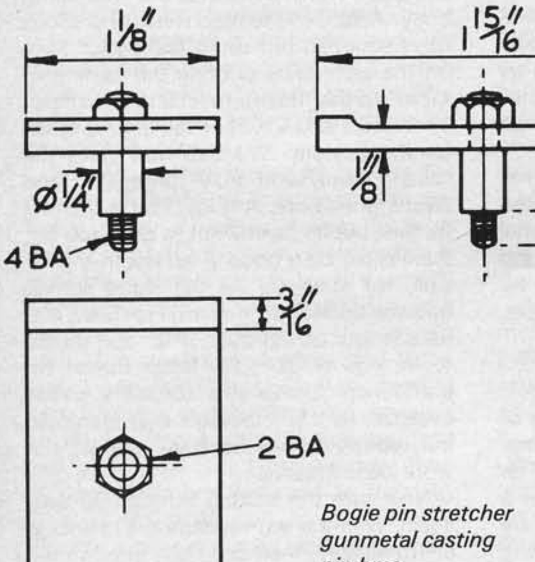
Push the frame plates into their respective slots in both the buffer beam and the drag beam, then set the frames on something really flat. If no proper surface plate is available, a piece of thick plate glass is a good substitute, failing either of these, use the lathe bed, removing the tailstock and sliding the saddle up to the headstock. As the frames are a little deeper below the cylinder cutaways (by $\frac{1}{8}$ in.) we will need something of this thickness to pack up the rear end. A length of $\frac{1}{8}$ in. dia. silver steel will do nicely.

Now put all the frame stretchers in position, putting in the full number of screws (6 and 8 BA countersunk as appropriate), but only screw them home loosely. Check that the frames are properly aligned at both ends, and that there is no sign of any "rock", then tighten all the stretcher screws right home. We can now run a No. 34 drill through the beam fixing holes at each end of the frame and make countersinks on the beam fixing angles. Drill these tapping size for 6 BA without shifting anything (Drill No. 42) and tap, taking care not to use too much pressure on the tap and reversing it frequently to clear the chippings.

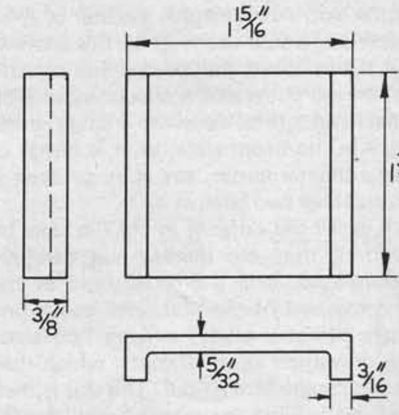
Incidentally, although the stretchers may hold the frames quite square and close to the fixing angles, a wise precaution is to use a small toolmaker's clamp on each corner, before drilling and tapping. As soon as a couple of screws have been put in and tightened, the clamp can be removed and used in the next corner, and so on.

Driving wheels

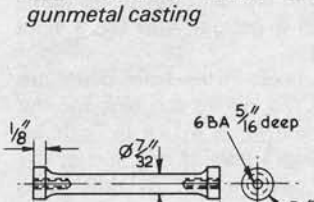
Those with small lathes and using high-speed tools will need to use their back gear to turn the wheels. Owners of lathes of 3½ in. centre and above, can make much faster progress by using a carbide tool and the slowest direct-drive spindle speed. But first, it is worth while to give the wheel castings a quick "going-over" with old files, to remove as much sand and scale as possible. Next, chuck each wheel in turn in the 3-jaw, face outwards,



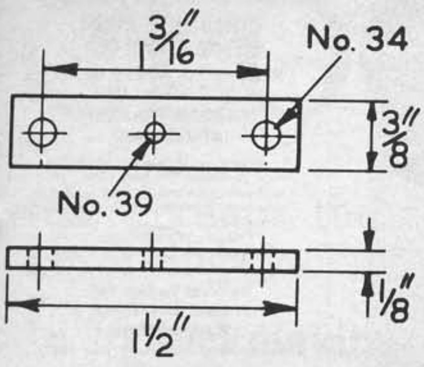
Bogie pin stretcher gunmetal casting pin bms



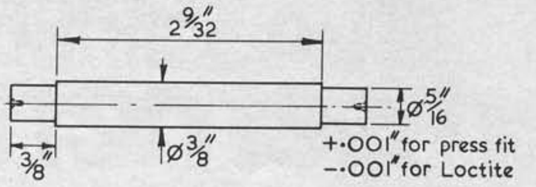
Main (vertical) frame stretcher 1 off gunmetal casting



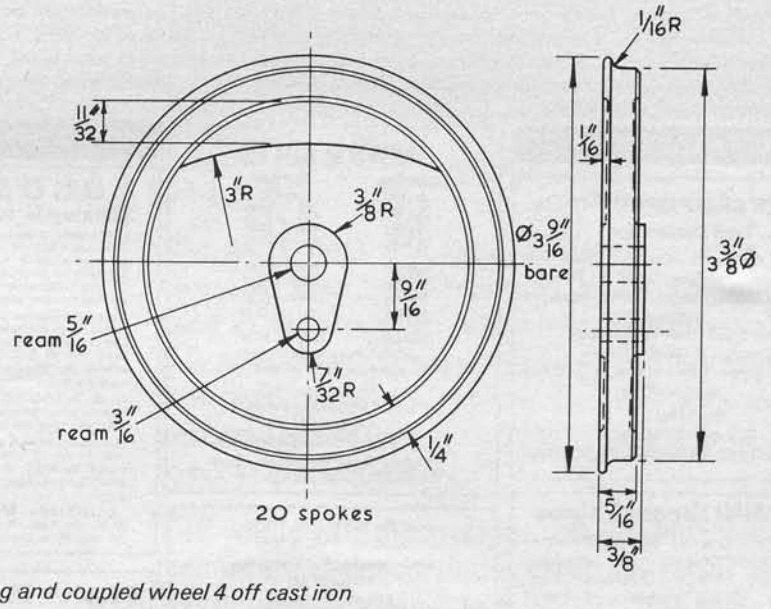
Frame stretcher 1 off bms



Hornstay 4 off bms



Driving and coupled axle 2 off ground mild steel



Driving and coupled wheel 4 off cast iron

and check whether it is running reasonably true; if not, the 4-jaw chuck will have to be used. A light cut, just enough to get under the "skin", can now be taken over the tread, so that the wheel can be held firmly and truly by the tread, while the back is machined.

The turning tool should not have any top rake, and should be of vee-shape with a tip radius of about 1/16 in. The back is now faced off, with the tool mounted cross-wise, taking off half the amount necessary to bring the finished wheel to a thickness of 5/16 in.

Run the lathe at top speed and centre the wheel casting deeply, following up with a drill about ¼ in. dia., then put through a letter N drill (0.302 in.) following with a 5/16 in. reamer. The reamer must be put through with the lathe running at lowest speed. It can be held in a tailstock drill chuck, with plenty of overhang, the tailstock itself being slid bodily along the bed, steadily in and out. In this way a true hole should result. If no reamer is available, a 5/16 in. D-bit may be used. Those who have a small enough boring tool can use this after drilling to say 9/16 in. dia., finishing boring when about 5 thou under 5/16 in., following up with the reamer as before.

Now reset the tool, almost square to the lathe bed and take a light cut over the flange, leaving this square for the moment. Next, set the wheel up again, but this time face outwards, holding the wheel by its flange in the 3-jaw, and pushing it hard up against the chuck jaws so that its back is running truly. Set the tool cross-wise again, and face off the boss, leaving this to give a total thickness of 3/8 in. Using slow speed again, face off the rim, leaving the boss 1/16 in. proud. Repeat for all four wheels.

To deal with the wheel treads, we need something in the nature of an improvised faceplate. An iron disc, a discarded wheel casting or a steel blank that is slightly smaller in diameter than the overall diameter of the finished wheels is what is required. Chuck this in the 3-jaw and set to run as truly as possible. Take a facing cut right across, centre, drill and tap 5/16 in. any thread — BSF or 26t. will do nicely. Then take a further very light cut to recess the casting about 5 thou, to a diameter of about 2 in.

We now need a spigot on which to mount the wheels. This should really be made before our improvised faceplate. A short piece of 3/8 in. dia. mild steel is turned down and threaded 5/16 in. to match the tapped hole referred to above. This is then screwed tightly into the casting, leaving about ¾ in. of "plain" 3/8 in. dia. projecting. Using a sharp knife tool, turn down the spigot until the wheels can just be slid on without shake, then thread the end any convenient thread, 5/16 in. BSF being convenient. Fit a washer and nut, when we are ready to machine the wheel threads.

Put the first wheel on the spigot and clamp it hard against the improvised faceplate with the nut and washer. It should not slip under the pressure of the tool if the cuts are not too "greedy". If it does slip, drill and tap a 2 or 4 BA hole anywhere handy between the spokes and fit a short screw; this will give a positive drive. Use the round-nose tool again, set at a slight angle to the lathe bed so that when brought up against the flange, it will leave a nice radius between flange and tread as per drawing. Use slowest speed. If the top-slide has a graduated dial, clamp the saddle and use this, plus the cross-slide for "in-feed". By noting the readings, each wheel can be turned to exactly the same diameter on tread and also width of tread. On small lathes it is possible to get chatter as the tool tip approaches the flange. If so, stop the motor and pull the lathe belt by hand for the last few turns. Treat all the four wheels the same way, then tackle the rounding of the flange and the small chamfer on the outer edge. These two little operations are best done by lathe tools; the chamfers can be machined by bringing up any square-ended tool at 45 deg. The radiusing of the flanges really calls for a proper form tool, though with only 8 engine and 6 tender wheels to be dealt with, such a tool seems hardly worth-while. But by manipulating the cross-slide and top-slide handwheels, a reasonable shape can be obtained without too much difficulty. A final finish can be done with a second-cut file, but if a file is used, be sure to fit a proper handle and keep well away from the revolving chuck jaws!

To drill the coupled wheels for their crankpins, a simple jig is a "must". All we need is a length of mild steel about ½ in. × ¼ in. section and about 2½ in. long, scribe a longitudinal centre-line and set out two points exactly 9/16 in. apart. Centre deeply, drill one hole 5/32 in. dia. and the other ¼ in. dia. Turn up a short stub of 5/16 in. dia. silver-steel and turn part of this down to a press fit in the ¼ in. hole, leaving 5/16 in. length of the original diameter. To use the jig, line up the scribed line with the "pear-shaped" wheel boss, clamp the jig to the wheel and run a 5/32 in. drill through the appropriate hole. This can then be opened out with No. 13 drill and reamed 3/16 in. dia. ready for the crankpins.

To be continued

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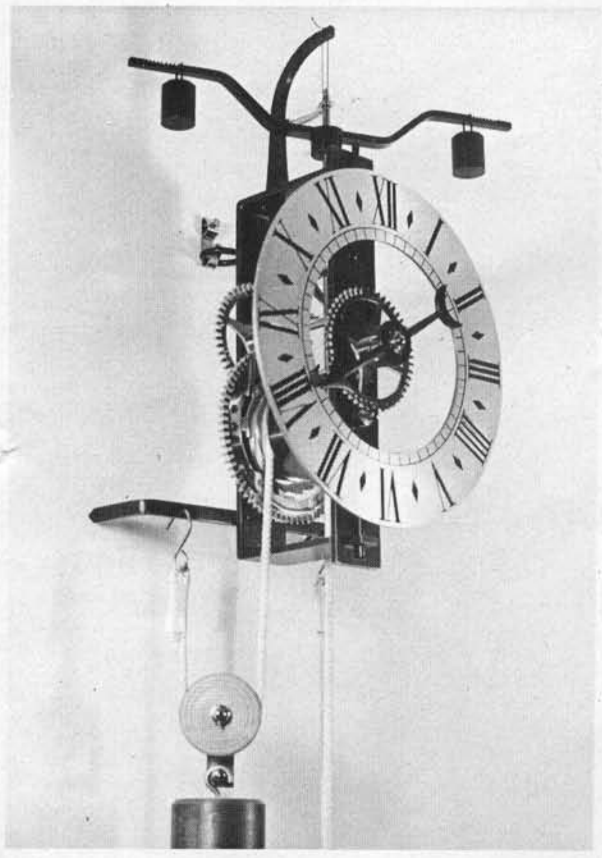

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