Model Mechanics

August 1979 45p
(U.S.A. & Canada $2.00)

MAP HOBBY MAGAZINE

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Editor's Chat

Several people have been enquiring about wheels for John Bridge's Scooter which appeared in the June issue of Model Mechanics. Unfortunately we have not yet found anyone able to supply purpose made wheels, but we have in fact recently seen a Scooter fitted with plastic wheels obtained from an ironmongers, the sort used for the Sandyacht in this issue, which were quite satisfactory.

Quite a few Colleges have written informing me of evening classes that offer help to the amateur mechanics, and I list a few of these below:—

The Charles Keene College of Further Eductaion have an evening class commencing on September 26th, from 7.00-9.00 p.m., for two terms. This is for all model makers who wish to work in metal and is open to amateurs at all levels from beginners upwards who will be able to take advantage of the College's facilities, including machining, fitting, brazing, soldering, sheet-metal work, rivetting and forging, under expert tuition. For further information, please contact the College.

Turton High School, Bromley Cross, Bolton, have model engineering classes in September; enrolment dates are the 17th and 18th September. These classes are for Model Engineers and other Model makers in both wood and metal. There are large capacity lathes, milling and shaping machines, gas and electric welding, forge and non-ferrous casting facilities. For further information, please contact Mr. E. Birchall.

The Thornden Adult Education Centre, Chandler's Ford, Eastleigh, are also starting evening classes on 28th September, from 7.00 p.m. to 9.00 p.m., for thirty weeks. This is for beginners and experienced modellers. Work can cover anything from small scale electric to large scale steam and petrol. Well equipped workshops — eight lathes from Unimat to Colchester Student, drills to $\frac{7}{8}$ in. capacity, shaper, mill and surface grinder, also aluminium casting, brazing and gas welding.

Mr. G. Hulme, who is a Tutor at Whitby School, Prospect Hill, Whitby, North Yorkshire, has informed me of evvening classes which he holds on Monday evenings from 7.00 - 9.00 p.m., commencing in September through to July the following year. They have built their own portable track 3½/5in. gauge, 60 ft. long, which in the next year they are hoping to double in length to make a continuous track. At present they have a completed Rob Roy, Minnie and stationary steam and petrol engines. There is also an active interest in small tool making and machine accessories, including a milling head and machines such as bandsaws and toolgrinder.

On June 15th, M.A.P. Ltd., in association with Archaeological Advisers Ltd., launched a new magazine entitled 'Popular Archaeology'. It is edited by Magnus Magnusson and will be available the third Friday in each month, cover price of 65p.

NOTICE 1979

Government Budget increase of Value Added Tax.

The increase of V.A.T. from 8% to 15%, effective from June 18th, have not been incorporated in all advertised prices in this issue.

744cc O.H.C. Austin racer. A tether car built by Mr Tillet.

Sand Fairy Ann a free sailing land yacht to build.

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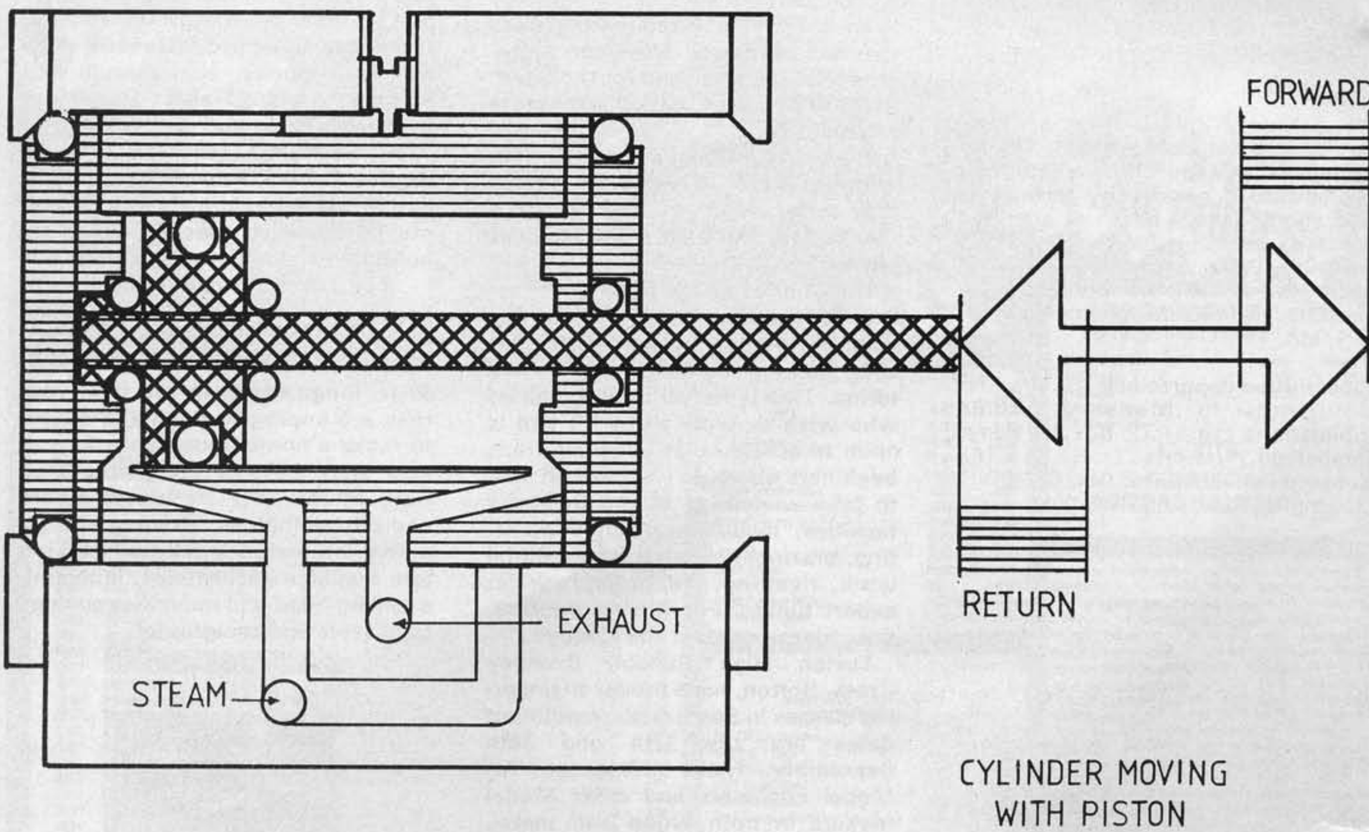
M.M. Query Coupon August 1979

Sweet Sixteen part 2

A Traction Engine to build on a small lathe. Last month *Rex Tingey* described how the boiler was made.



CROSS-SECTION OF ENGINE (theoretical)

THE GEARS ARE CUT with home-made cutters on aluminium alloy blanks, using the indexing attachment. The change gears are cut eight teeth to the inch and the drive gears ten to the inch. These differ from standard gears, as bought, which are cut to have a certain number of teeth related in size to the pitch diameter. My system cuts a number of peripheral teeth per inch and allows the diameter to find itself. But ratios are ratios, and it works out to be very similar in the end. Generally it should be said that gears cut with the same cutter will tend to run well together. The cutter employed here are straight hobs, made from silver steel then hardened and tempered. The hobs have five sets of cutting teeth, and make a gap, centrally, rather than a tooth, the other cutters each side modify the tooth shape as the blank is indexed around.

Full details of the hobs and other gear cutting methods have been reported previously in "Model Mechanics" (see my article "Gear Cutting Simplified").

For the timid who prefer not to cut the gears, gears can be bought from Bonds of Euston Road to an approximation, in stock sizes, but this could involve great changes to the centres on the hornplates, and to the gearchange fittings.

Cutting Gears

The gears are cut from aluminium alloy blanks either sawn from round stock or cut from sheet. If sawn from the round, make them overthick, drill the centres ¼ in. in the three-jaw chuck and turn as much as the jaws will allow, and reverse onto a ¼ in. mandrel for completion of the other surface and turning the periphery to size. This is made easier if each job is completed on all the blanks before going on to the next stage. If the blanks are made from sheet material, just mark out, drill the centre ¼ in. for the mandrel and rough-cut the circle to be finished on the mandrel.

Finally, with all the blanks made the centres are all drilled out to 9 mm, making a 9 mm mandrel for cutting the teeth on each. The teeth are indexed onto the blanks, the requirements being covered by the plates available for both Unimats. With the 60-tooth and the 80-tooth wheels the requirements are met by the 30 and 40 position plates and the cutters will have almost completed the intermediate tooth-gap the first time around, so that there is little difficulty in finding the correct positioning for the second cutting operation.

A tooth is cut so that the cutting hob just bottoms on the diameter of the blank, needing perhaps two passes on the soft alloy, noting each time the final handwheel position, which should be the same. Any minute turning variation of the circles will be equalised on the 9 mm mandrel in the cutting, and the shape of each tooth modified as the next gap is indexed around. Take off any burrs on fine emery cloth, and then number punches, lightly mark the number of teeth on each wheel for easy identification.

Make two 9 mm alloy centres, just stubs, with light centre pops made in the lathe using a No. 1 centre drill. These stubs are for pushing into the gear wheels to determine the combined radii of two wheels running together, so that the hornplates may be accurately marked out.

The Hornplates

The hornplates are made from 16 gauge mild steel. Marking out will need to be accurate, and made more apparent on the hard steel by using marking-out blue, which can be made by adding aniline dye to French polish. Tool requirements are: a sharp scriber, a 6 in. rule to 64th of an inch, spring dividers, a 4 in. engineer's square and two centre punches, one at 60 degrees and one at 90, both newly sharpened.

Cut the pieces of sheet steel $3\frac{3}{16}$ in. × $3\frac{5}{8}$ in. and finish one long side of each straight and true. Blue one side of each and mark out for the six holes, in the same place on both, using the engineer's square against the true side and measuring from this front side. With the 60 degree punch lightly centre pop the top left and bottom right of the six on both plates feeling for the crossed lines with the sharp punch. With the dividers set to the two pops on one plate, check that the distance matches that on the other plate. Pop with the 90 degree punch and drill the two holes on each $\frac{1}{16}$ in. for eventual rivetting together of the plates. Mark out one plate completely for the nearside, ringing around the top steering bracket hole with black marker to indicate that this is not to be drilled through both. Centre pop lightly with the 60 degree punch, check all measurements before re-punching with the 90 degree punch.

For the bearings a detailed routine is necessary. Mark out the centres, on the hornplate, for the crankshaft and the main axle and lightly pop them to give the dividers a hold. The crankshaft hole needs the surplus given on the long side above it for the easy drilling of a round hole before the top is brought down. Draw the vertical line for the second shaft bearing at the bracketed position shown. With the short alloy centres in one pair of change gears, flat on a surface, measure the distance between the centre points with the dividers, checking with the other pair of gears, which must be the same. Transfer the measurement as an arc through the vertical line using the crankshaft pop as a centre. Repeat the operation with the main axle gear and its drive gear from the third shaft, just making an arc drawn with the rear axle centre as axis. Repeat for the second shaft drive gear and the third other gear, using the found second shaft centre on the vertical line as the axis for the dividers, and find the third shaft centre on the arc. Check the distances against the drawing and mark in any discrepancy, to remember it when fitting the tender.

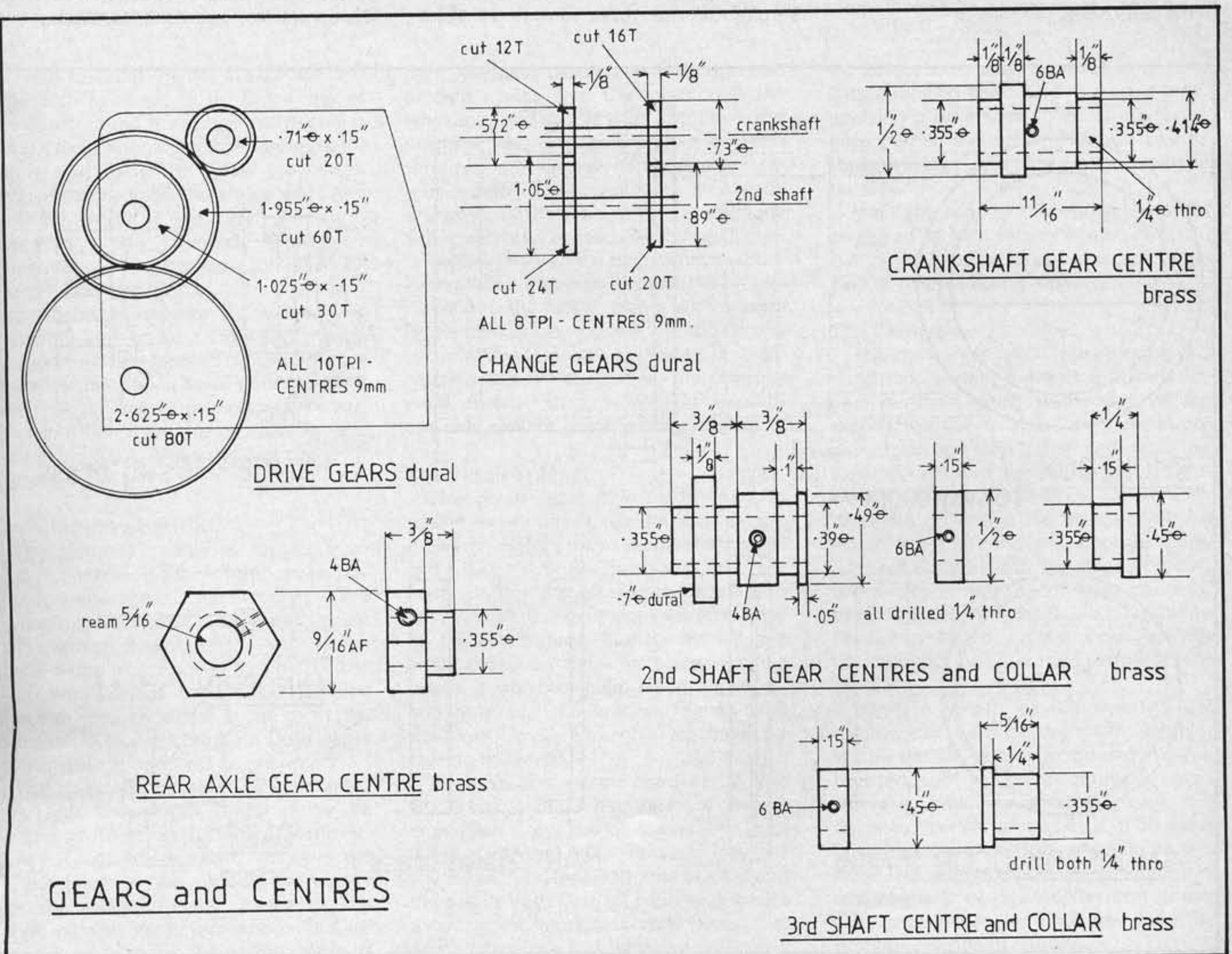
Clamp the plates together, marked-out side uppermost, fronts in alignment and two rivets through the holes, and rivet together. With the clamp still in place drill the three backplate holes and rivet one of these before unclamping and drilling all the small holes. To drill the large holes the plates will need clamping to the milling table, preferably, and on a piece of $\frac{3}{16}$ in. thick dural. Use a slower speed and lubricate with soluble oil, about 20:1.

In the vice, saw and file the plates to finished size. Pop the bottom rivet hard, with the 90 degree punch and drill out No. 33, centre pop the other rivet in the sixth hole, but clamp the plates together before drilling this one No. 33. The other rivet will just pull out of the oversize hole as the plates are pulled apart. Drill the extra hole in the nearside plate, and countersink the lower spectacle plate hole for pump clearance. Tap the holes, as required.

Bearings

The actual bearings are made from phosphor bronze round stock drilled in the lathe and reamed. They are then inserted into prepared alloy bearing blocks and secured in place with the bearing fit grade of Loctite. When cured, and oil hole is drilled through into the bore with a No. 1 centre drill, forming a small well leading to an oiling hole.

The cylindrical bearings are not easily drilled as phosphor bronze will suddenly overheat and grip the drill, slowing the Unimat to a halt. Cooling with very dilute soluble oil helps a little, as does the often withdrawal of the drill. Start with a drill



about $\frac{5}{32}$ in., after centre drilling, and drill right through before drilling to $\frac{1}{64}$th undersize. Ream through with the work held in a vice.

The blocks are made from dural stock; for the crankshaft and the second shaft from ¾ in. diameter, and for the third and rear wheel shaft from ¾ in. square. The round four are all made using the three-jaw chuck, and the square four using the four-jaw chuck, with some filing and sawing by hand on all four sets.

Fitting the Hornplates.

The front of the hornplates come level with the front of the wrapper, but the placing in the horizontal plane can be troublesome. However, here the problem is solved very simply. A piece of hardwood is milled on the milling table exactly ¾ in. thick, and exactly the width of the boiler wrapper, one end is squared off and the block cut to $1\frac{7}{8}$ in. long. Clamp the hornplates either side with the two lower bearings fitted to each plate and slide a length of ¼ in. silver steel into the third shaft position and $\frac{5}{16}$ in. diameter in the main axle bearings, using a little oil for ease. If all is lined up correctly the rods will fit and turn easily in the bearings, if not, then a loosening of the clamp and an adjustment, before retightening, will do the trick. Insert a couple of small wood screws either side into the block from two of the plate holes.

This whole set-up can now be slid over the boiler, lining up the hornplates with the front of the wrapper and the woodblock hard down on the top. Fit two small clamps to the lower edges, one either side and the temporary axles can be removed so that the six holes, either side, can be drilled in situ, or marked out to be drilled after removing the plates.

Make the twelve hornplate spacers and use ½ in. × 6 BA high tensile steel screws to secure through from the inside of the boiler firespace. Try the hornplates in place, securing them on the outside with steel 6 BA nuts; the screws can be cut down to size later. Measure all round to ensure parallelism.

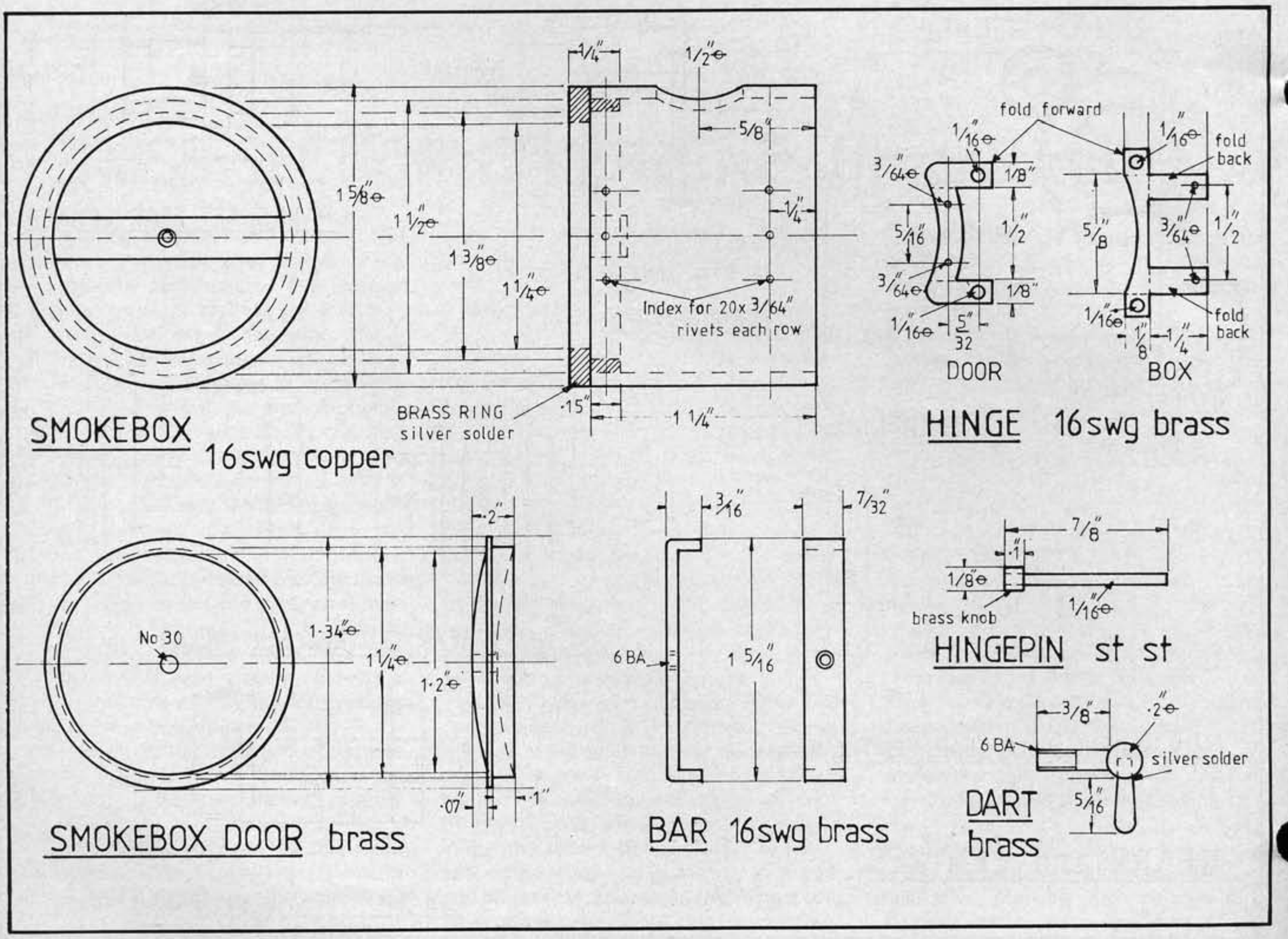
All the bearing blocks can now be secured to the hornplates and lengths of silver steel passed through the bearings to check for line-up, the gear centres and collars are now required to be turned from round brass, the gears fitting tightly on the 9 mm stubs. Put the gears, complete with centres on the shafts to check them for good running. With the change gears there should be a neutral position centrally between a tight change-over from low to high ratio.

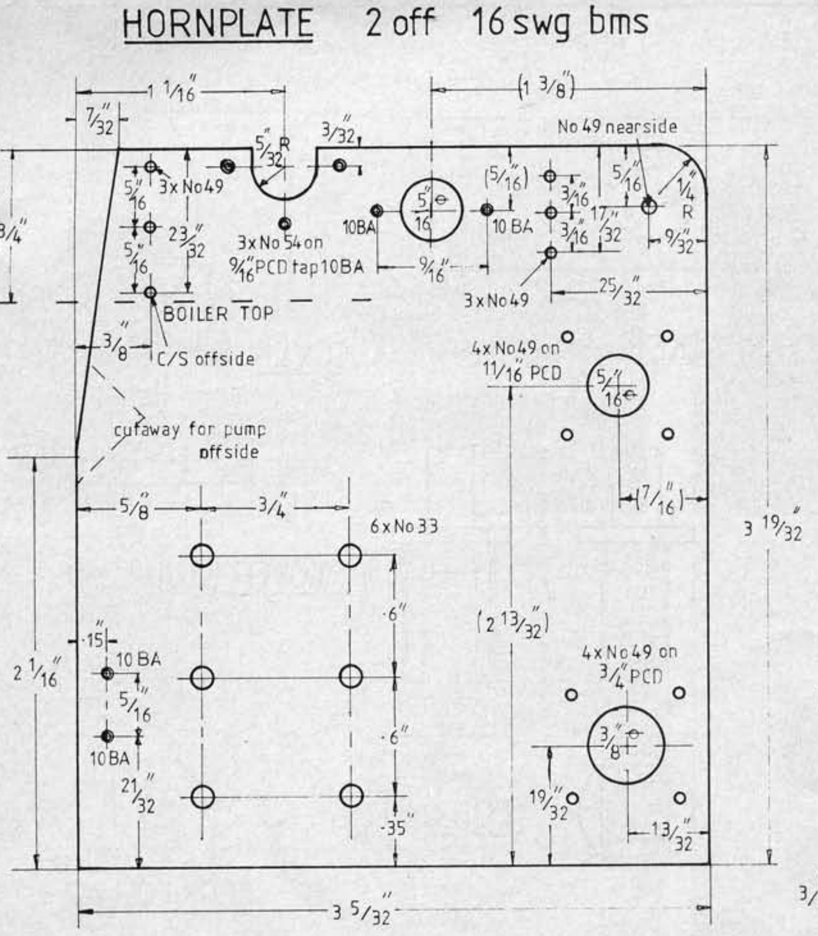
The Smokebox

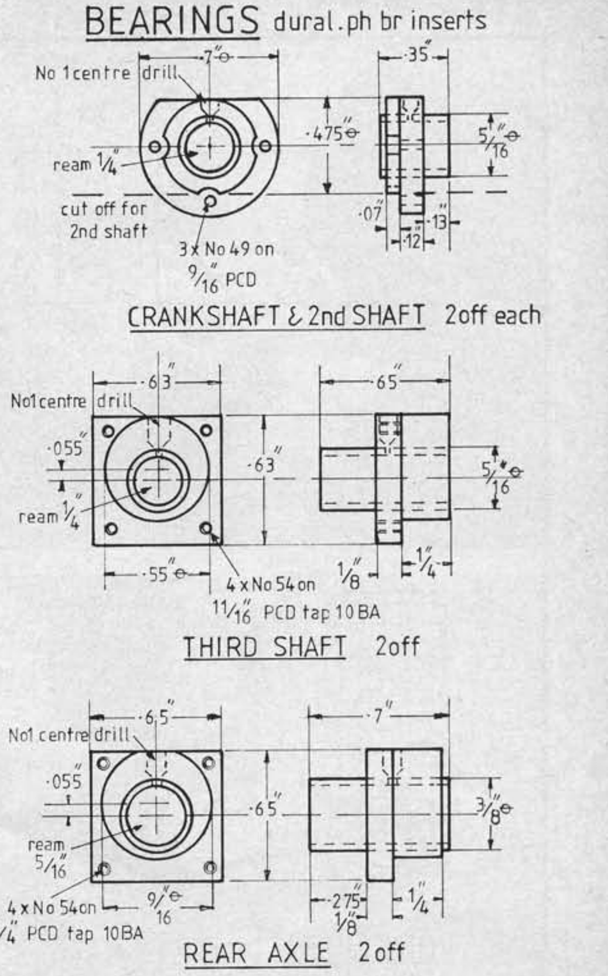
The smokebox is made from 16 gauge copper tube with a brass annulus at the front. For the easiest constructed smokebox the tube to use is $1\frac{5}{8}$ in. diameter, which will only need the ring brazing in to stay the correct shape. A more economical smokebox is made by splitting the 1½ in. diameter tube, as used for the boiler, annealing the split tube and using the brass ring and a circle of the tube just pushed in place temporarily, to obtain the correct circle. Afterwards a piece of the 16 gauge copper is tailored to fit the gap, and, with a short and over-wide piece rivetted to go inside, this is silver-soldered in at the same time as the ring, removing the thin circle beforehand.

After brazing and pickling the round box is indexed around for the rings of rivets with the 20 position plate (40 tooth plate on the SL). The rivets are emplaced with Easyflow paint, and do not need rivetting over. The only rivets which are actually used, merely keep the bar and hinge in position whilst they are brazed in, at the same time as brazing the other rivets. The back row of rivets correctly position the smokebox on the boiler when it is eventually secured. Avoid any surplus fillet on the outside of the box or inside the ring, where the door will fit. Drill the top hole, opposite the copper insert.

Make the door from round brass, turning a 1 in. long piece in the three-jaw chuck and making the flange to be a perfect fit in the smokebox ring. Hollow out the back, manipulating a good cut across with minute variations of feed. Centre drill No. 1 and drill No. 30 about ¼







in. deep to bring up the live centre and parting-off at about ¼ in. Put a ring of thin dural around the flange and secure it in the chuck, bringing up the centre, hard, before tightening up. Take the centre back, measure from the chuck jaws and turn the front of the door correctly, producing the domed front by manipulation, as before. use a small round-nosed tool for this.

If difficulty is experienced with folding the hinge then make a cardboard model first and try this in place. The door half fits inside the smokebox half. With the door in the ring drill lightly through into the bar, smokebox back on the cross-slide, and tap the bar 6 BA. Make the dart and try it in place.

The Chimney Saddle

The chimney saddle is turned from $1\frac{3}{8}$ in. diameter brass in the three-jaw chuck, jaws reversed, and held by the live centre in the tail-stock. The top, flanged, part is turned down and the $\frac{3}{16}$ in. radius made with a round-nosed tool before the ½ in. bore is made through. The saddled part can then be either flycut to fit the diameter or filed by hand, in both cases further work by hand will be necessary.

The handwork on the brass will need new files if enough metal is to be removed, then a suitable diameter, covered with emery cloth, will give the correct finish to the saddle, but ensure that the saddle, in situ, keeps its top flange parallel to the smokebox line, or the chimney will tilt. When the saddle is right, file away the corners right down to present a nice line. Clamp through the smokebox and saddle with a nut, bolt and washers, and drill for a pattern of rivets through both. Determine the back centre relationship of the saddle to smokebox and mark for the exhaust fitting; make the fitting and blast nozzle, drill the saddle.

Paint with Easyflow paint and insert the fitting from the outside and the nozzle inside into the fitting, clamp with a small G clamp. Braze the nozzle and fitting securely in the saddle, ensuring that the nozzle will point straight up the chimney when fitted. Pickle, wash and place to one side until the perch bracket is made.

The Perch Bracket

The perch bracket is made from 18 gauge steel sheet, as shown in the drawings. Bend up and saddle the bracket and make the studs, push lug, and fork bush. Braze the bracket to its saddle with Easyflow 24, using Tenacity 4A flux. Rivet on the cover studs, flux for the lug and bush and push these in place. Paint a touch of Easyflow paint along the studs, and braze up the bracket fittings with Easyflow No. 2, with only the paint for brazing the studs.

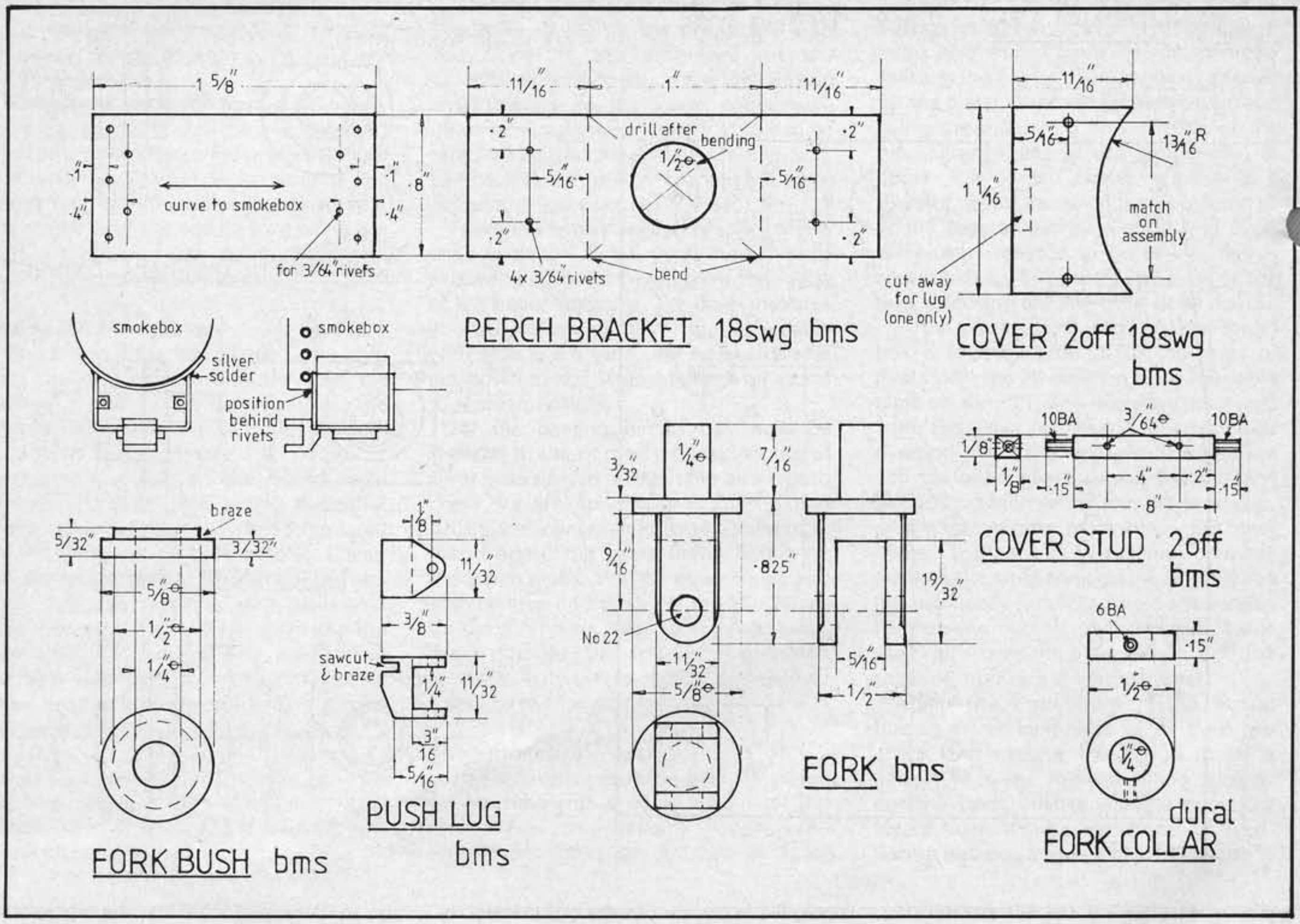
Position the perch bracket on the smokebox so that when the front cover is in position it will just be against the front rivets. Drill the holes through into the smokebox, and then paint the bracket and the saddle with Comsol paint and secure them to the smokebox with rivets, just pushed through and bent over a little in the smokebox space. Heat the smokebox with a moving flame until the paint runs, applying a little stick to fill any obvious gaps. When the solder just sets plunge the box in a bowl of cold water to remove the flux.

Make the back and front perch bracket covers to fit, and secure in place with 10 BA nuts. Remove one cover and wipe over all the steel parts with an oily rag.

The Chimney

The chimney is made from 1 in. or $\frac{7}{8}$ in. dural rod, sawing a length $\frac{1}{8}$ in. oversize and centring both ends and centre drilling. With ¼ in. of the rod in the three-jaw chuck and the other end with the running centre in the tail-stock turn the length available down to ¾ in. Remove the tailstock and fit the steady. Set the headstock just under 2 degrees back (Unimat SL) and with the steady holding off-centre, at about $\frac{1}{8}$ in. from the end, turn the taper from the 0.375 in. down to the 0.2 in. shown on the drawing. With the Unimat 3 the taper turning attachment is used.

Using a length of rod through the tommy bar hole in the main spindle, secure the chuck against turning. With a pointed tool in the toolpost, angled forward, make a groove along the chimney, taking off about 2 thou each pass (unplug the motor when doing this job). This groove represents the joint in a real chimney of overlapping iron sheet. The groove can be improved later by running a file along one side.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5/32"
3/32"
5/8"
1/2"
1/4"
FORK BUSH bms
1/8"
11/32
3/8"
sawcut & braze
1/4
11/32
3/16
5/16
PUSH LUG bms
1/4"⌀
7/16
3/32
9/16
·825"
19/32
No 22
11/32
5/8"⌀
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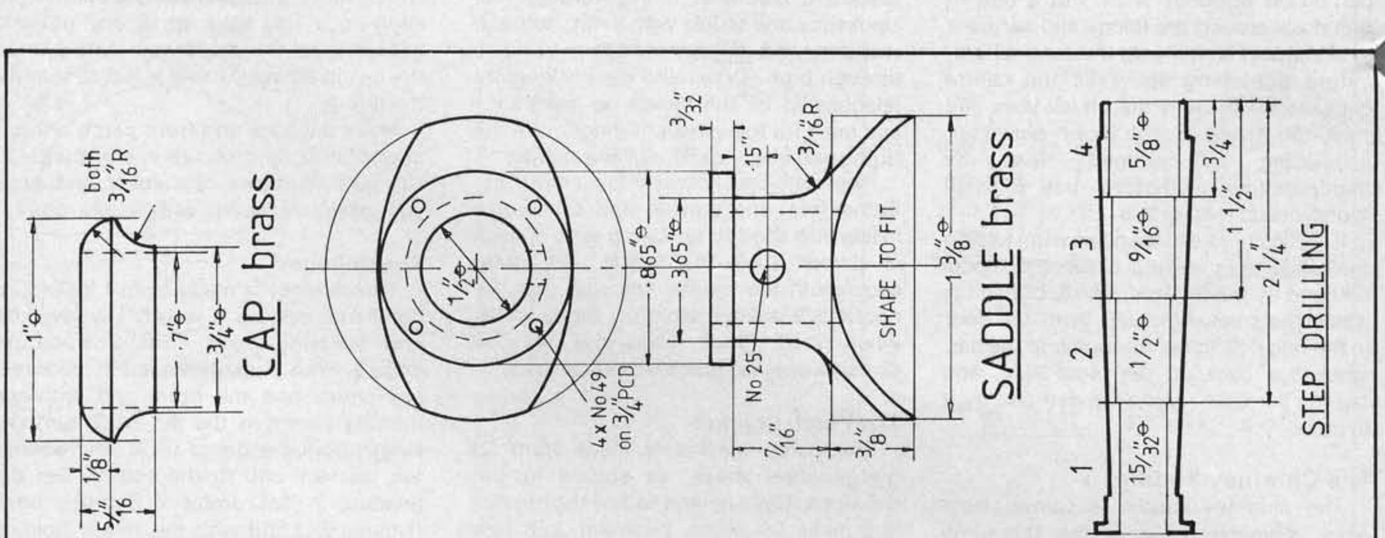
1/2"
FORK bms
6BA
·15"
1/2"
1/4"⌀
dural
FORK COLLAR


both 3/16" R
1"⌀
·7"⌀
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CAP brass
1/2"⌀
·865"⌀
·365"⌀
4 x No 49 on 3/4" PCD
3/32"
·15"
3/16" R
No 25
SHAPE TO FIT
1 3/8"⌀
7/16
3/8"
SADDLE brass
1
2
3
4
15/32"⌀
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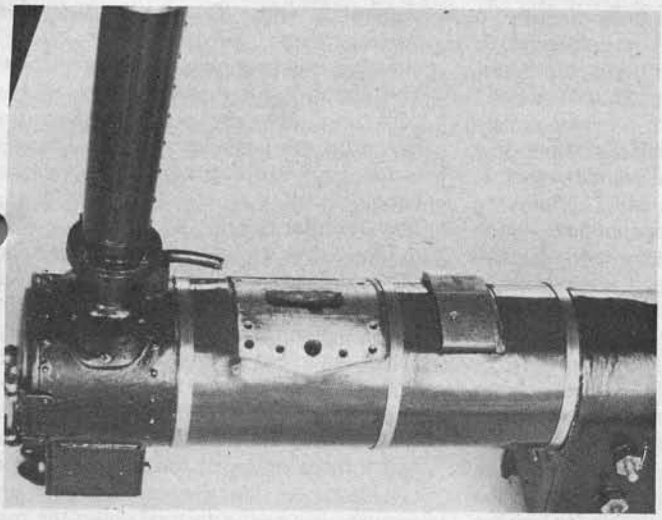
9/16"⌀
5/8"⌀
3/4"
1 1/2"
2 1/4"
STEP DRILLING
step drill
file away
·7"⌀
3/4"⌀
3/8"
3/64 rivets epoxy in place
3 1/8"
·2"
1/16
·615"⌀
·635"⌀
4 x No 49 on 3/4" PCD
·865"⌀
CHIMNEY dural



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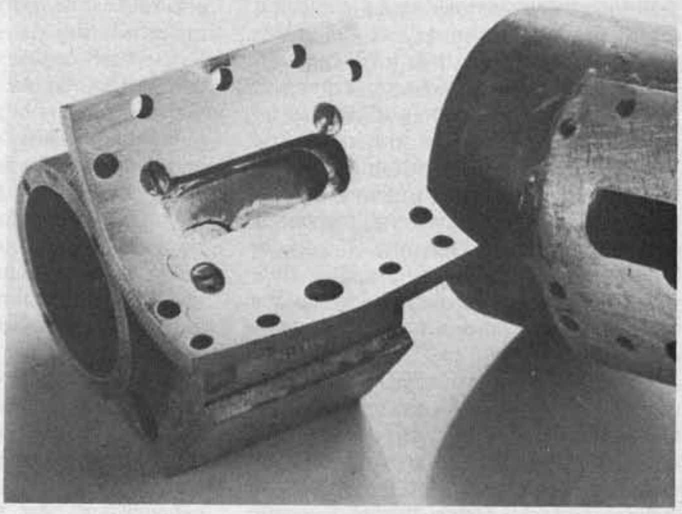

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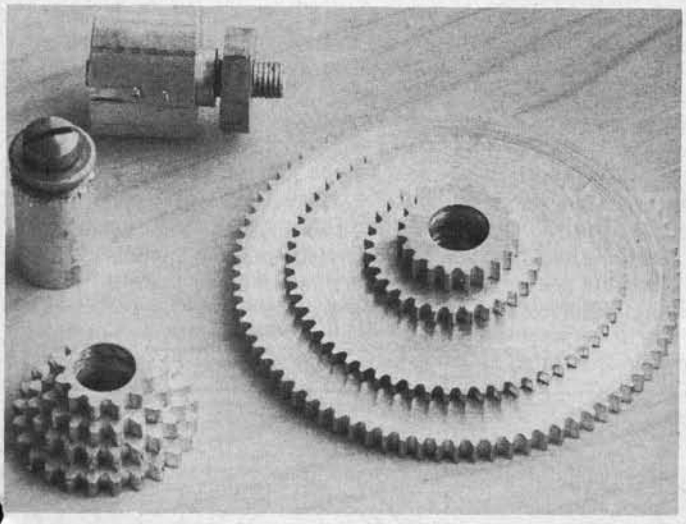

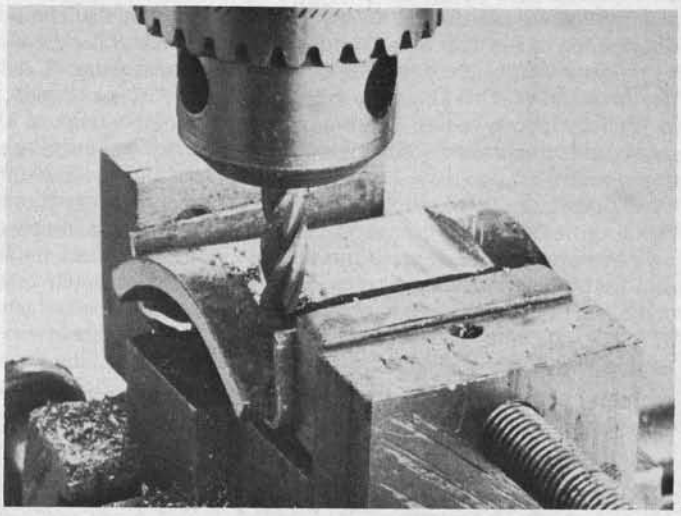

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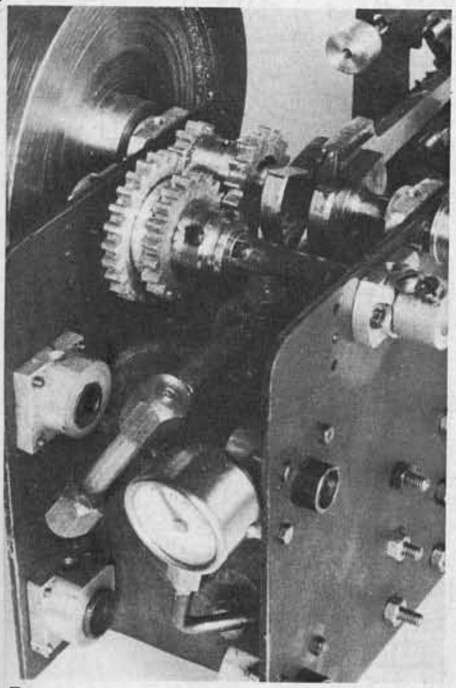

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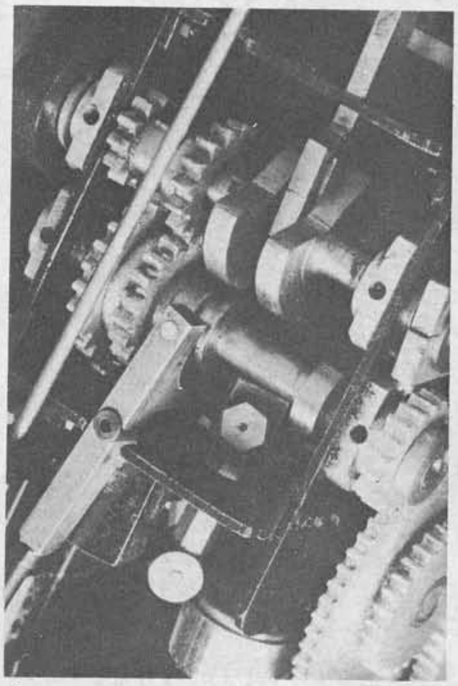

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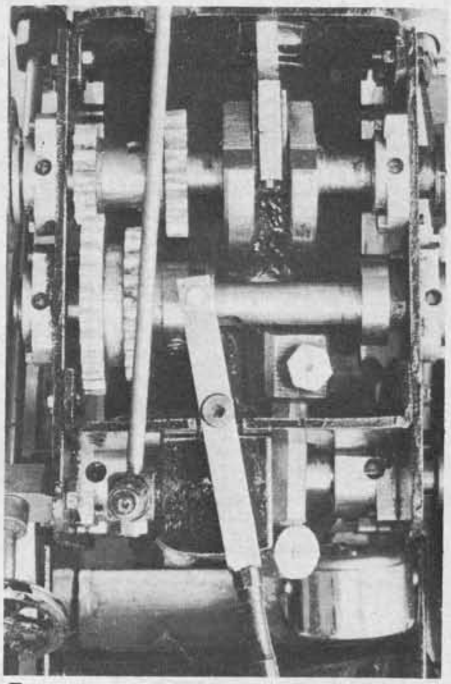

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1 *The boiler, finished and clad.*

2 *The saddle block and boiler, milled and drilled.*

3 *The change and drive gears, with the turning and gear-cutting mandrels.*

4 *Milling the flat on the engine saddle.*

5 *Hornplates and bearings in position.*

6 *Gear change in high.*

7 *Gear change in low.*

Return the headstock straight and the steady to hold concentric, and drill down 2¼ in. with the ½ in. drill, following with the larger drills for the shorter distances. Bring up the tailstock and the large diameter live centre and turn down the top of the chimney to 0.7 in. Reverse, wrap brass shim around the finished top, and hold in the three-jaw. With the steady holding near the end turn the chimney to length and drill through to the ½ in. bore $\frac{15}{32}$ in. Remove the steady, bring up the large live centre and turn the part above the flange.

Carefully mark for the PCD holes, using a centre square and rule and drill. Mark for the seven rivets, drill and push rivets in place, bending the ends over inside. Turn the brass cap from a short length of 1 in. diameter stock. Finish the end, centre drill, bring up the centre in the tailstock to turn the top radius with a round-nose tool by manipulation of the handwheels, then the lower radius. Drill $\frac{3}{8}$ in. deep with a ½ in. drill and bore out to 0.7 in. before parting off. Secure the chimney top with epoxy resin.

The Engine Unit

I have previously described the engine unit in Model Engineer, but as a self-contained engine rather than one saddled and domed, and fitted to a traction engine, so for those who missed the previous account I present a recapitulation. I call my design a "Valveless" engine, but perhaps a better description would be "Shuttle Valve" engine.

The engine has no external valve gear and consists of a fixed cylinder block in which a cylinder moves. The moving cylinder has a standard piston which moves with steam pressure, and plates at either end; it also has two steam holes in line with its movement going one to each end of the cylinder to admit steam and release exhaust.

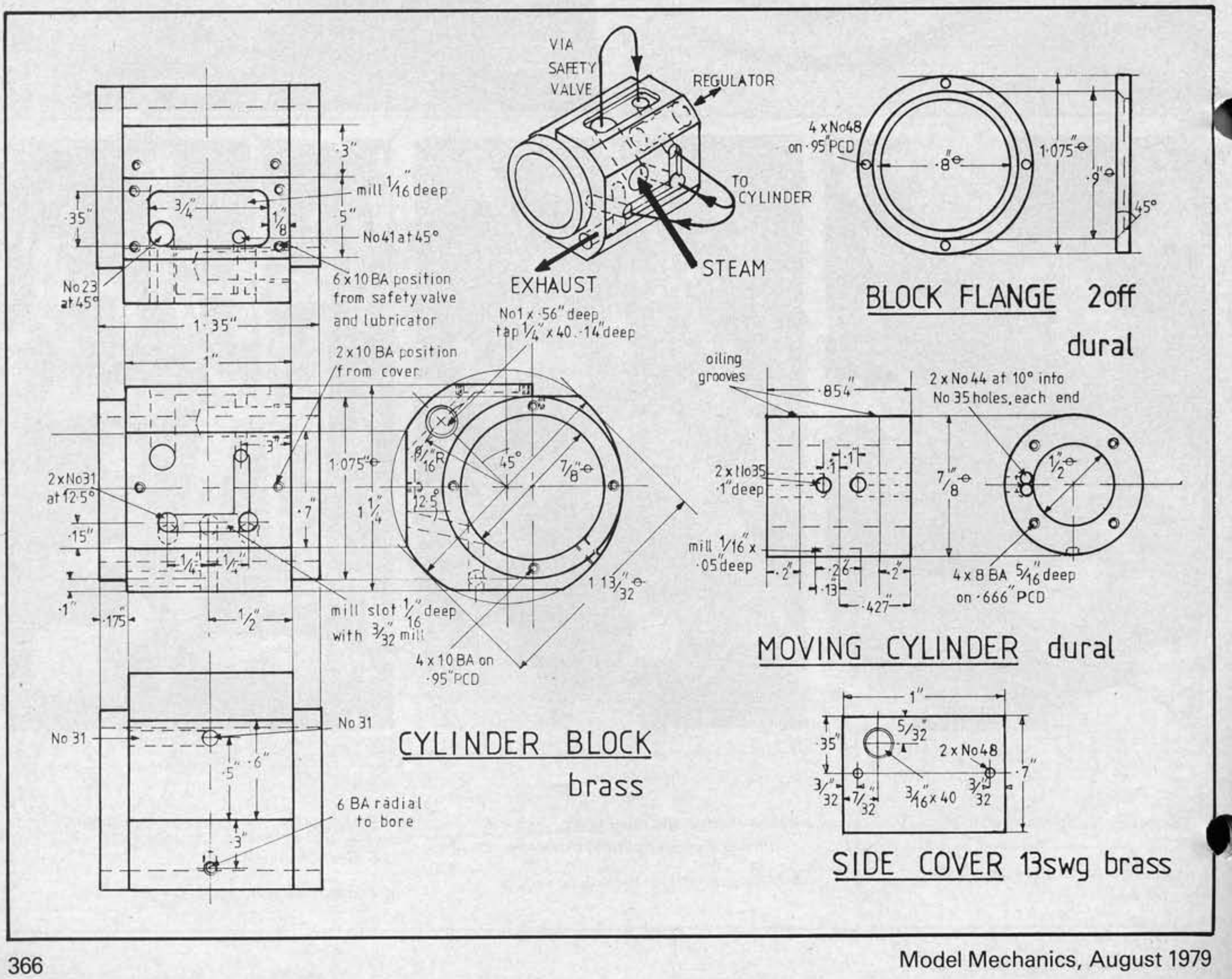
The cylinder block has three steam holes in line to coincide with the holes in the cylinder which is prevented from rotating by a set screw in a slot. The central hole of the three in the block is the exhaust and the two outer holes are steam inlets. The piston in its travel pulls the moving cylinder to coincide the first hole to exhaust, admitting steam to the second. The steam pushes the piston to the other end of the cylinder, and the stroke carries on to push the cylinder over and change over the holes, exhaust to steam, steam to exhaust, the continuity of motion being ensured by the flywheel.

To eliminate the knocking of the piston on the cylinder cover plate the piston is fitted with silicone rubber "O" rings on its rod, one either side, and these cushion the shock. The moving cylinder is fitted at both ends with "O" rings which butt against flanges secured to the block, ensuring quiet running and a good seal. The piston is fitted with a black rubber "O" ring, the rings all ensuring the minimum of leakage and an efficient quiet-running engine—there is no banging at all.

The Cylinder Group

First, make the cylinder group, leaving all the drilling until later so that the holes all match up. The cylinder is turned from 1 in. diameter duralumin, cutting a piece 1¼ in. long and centre popping one end. Chuck the other end in the three jaw, jaws reversed and centre drill with a No. 3. Drill through No. 20, bring up the live centre and turn as much of the outside as you can down to $\frac{15}{16}$ in. Reverse and true up with the live centre to turn down the rest to $\frac{15}{16}$ in. and drill through ¼ in. then ½ in., the drill held in the 4-jaw chuck.

Hold the best end lightly in the three jaw and centre with the large bore running centre, and tighten up. Sharpen the right-hand knife tool, set the Vernier caliper precisely to $\frac{7}{8}$ in., and carefully take the outside down. Use soluble oil very dilute and one handwheel division until nearly there, then reduce the cut to a half a division to exactly $\frac{7}{8}$ in. Cut the two lubricating grooves with a pointed tool, face off the front surface and part off at exactly 0.854 in.



Chuck a piece of ½ in. dural for the piston in the three jaw and centre drill lightly, No. 1, then drill ¼ in. deep No. 37 and tap this hole 5 BA in the lathe. Face the front surface, then with the parting off tool turn down to 0.498 in., start to part off at 0.23 in. so that the position of the groove can be centred, and cut the groove. The wide groove allows the "O" ring to roll a little and provide a good seal. Angle the tool and take the corner off each side of the groove to avoide damage to the "O" ring, before parting off. Cut a piece of stainless steel for the piston rod, file up the ends and thread both ends in the lathe using the tailstock die-holder.

Make the collar from ¼ in. diameter brass, turning the outside down, finally, on the piston rod held in the drill chuck.

The cylinder covers and end plates are made from $\frac{7}{8}$ in. diameter brass, drill right through No. 30 and recess drill out, turn and part off one after the other, from the same piece. The front end plate will need its hole filled with a threaded stub of brass soldered in place.

The Cylinder Block

The cylinder block is made from 1.4 in. of $1\frac{13}{32}$ in. diameter hard brass. Clamp the block between the back of the carriage and the cross-slide, not quite touching the cross-slide bars, with a piece of 22 gauge alloy at the rear; use two clamps and lock up tight, also locking the cross-slide. This will put the bore in the right place with no measuring needed, this is on the Unimat SL. For the Unimat 3 the block will have to be clamped on top of the cross-slide with packing to position the $\frac{7}{8}$ in. bore, in which to find the diameter of 1.075 in., which in one place just touches the outside diameter of the $1\frac{13}{32}$ in. block.. Centre drill and drill right through No. 30, followed by a ¼ in. drill, then a ½ in. drill to give clearance for the between centres boring bar. Bore out to $\frac{27}{32}$ in. Put the block upright in the vice, no clamps fitted, don't worry about the outer surfaces, and ream through $\frac{7}{8}$ in., only rotating the reamer in the cutting direction.

Grip the bore from the inside with the three jaws and centre up with the large bore live centre. Run the lathe at just under the fastest speed to minimise vibration from the eccentric workpiece. Use a flat-topped pointed tool of just under 40 degrees, which will turn brass in both directions, and turn down each end round, to leave 1 in. of main block. Clamp the block upright, with the clamp through the bore, and flycut the side at the thickest part, use this flat down on the cross-slide to cut the top and bottom flats.

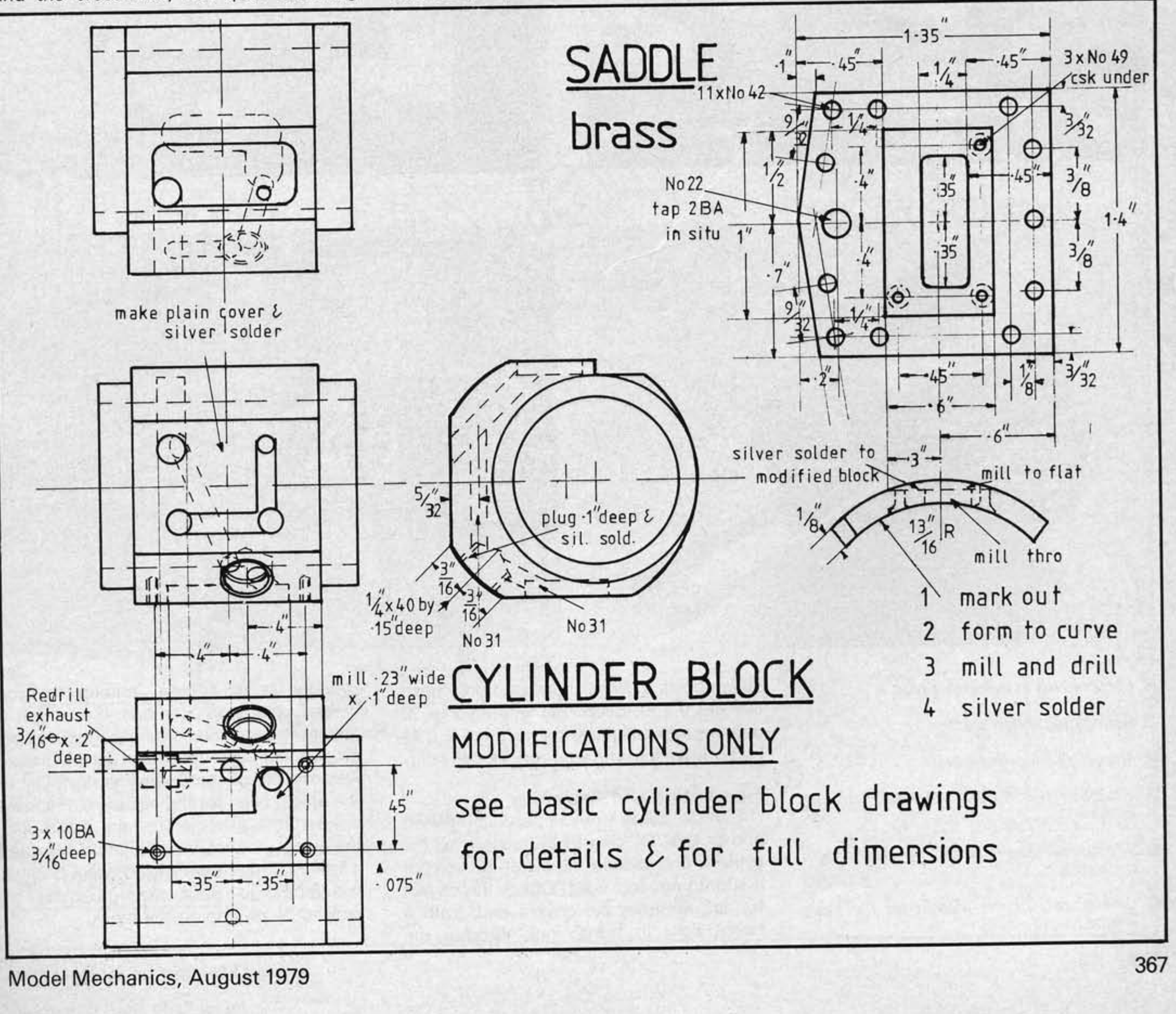
Make the two end flanges from dural, boring out a little after drilling ¼ in. Turn down the bevel before parting off.

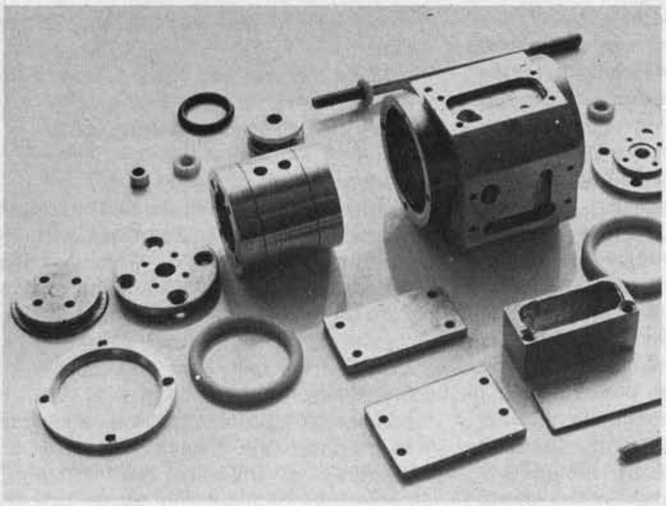
Staking and Drilling

With a centre drill in the drill chuck, the headstock on the column, and the indexing attachment on the cross-slide the unimat makes a fine staking tool; no need for marking out and centre popping.

Use the 40 tooth index plate, and the No. 2 centre drill. First grip the cylinder block, upright, and manipulate the position to stake the top hole, and at ten tooth intervals. Check that this is a diameter of 0.95 in., and correct if necessary. Slip out the centre drill and replace with a No. 53 to drill the four holes $\frac{5}{16}$ in. deep. Reverse the block, and repeat, then stake and drill the end flanges with the same set-up, but this time with a No. 49 drill.

Use the same procedure for the cylinder, end plates and covers. Tap all the holes which require it, but before dismantling the set-up stake the ends of the cylinder for the two steam port holes. Remove the indexing attachment and fit the vice, fitted with alloy clams. Centre punch the side of the cylinder for the two





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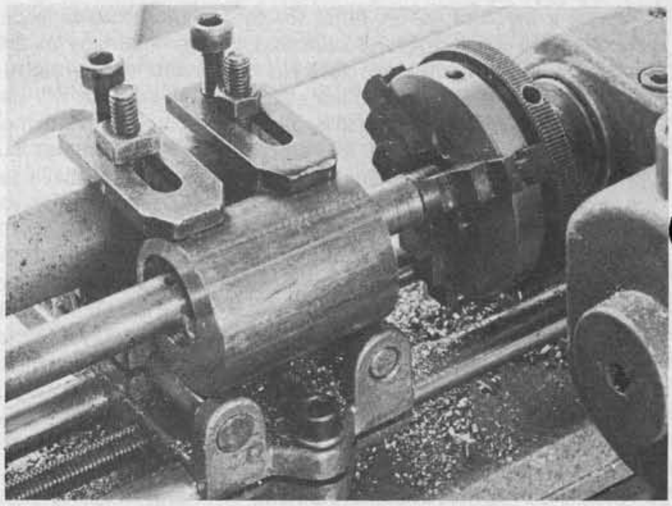

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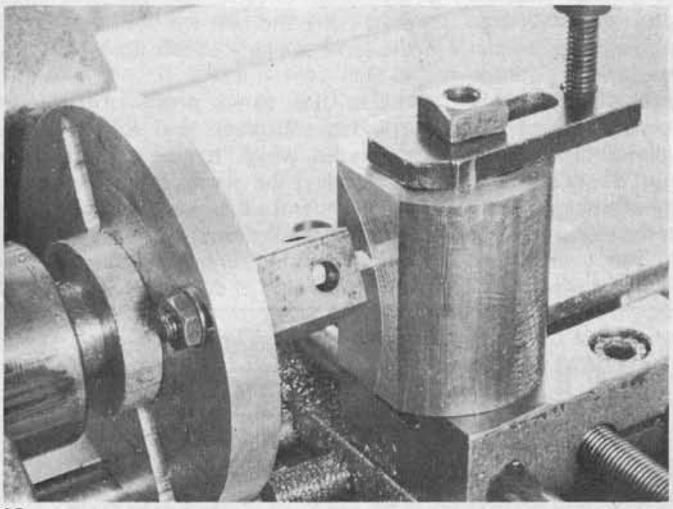

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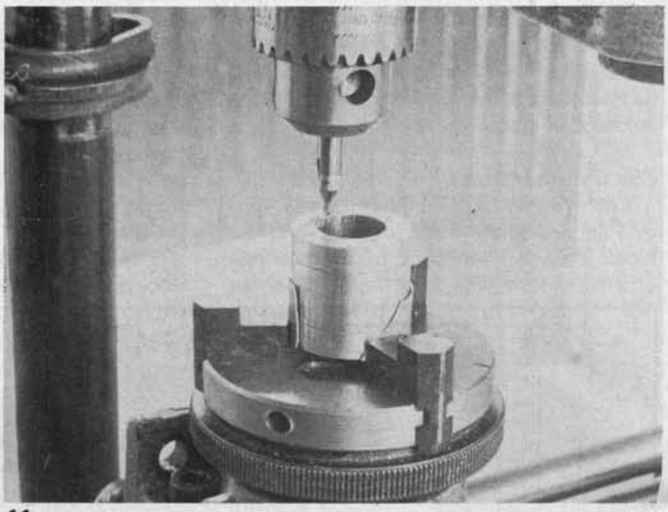

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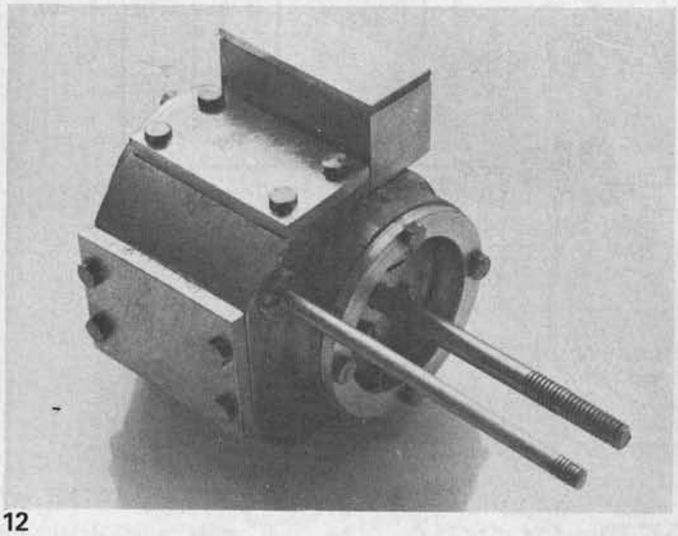

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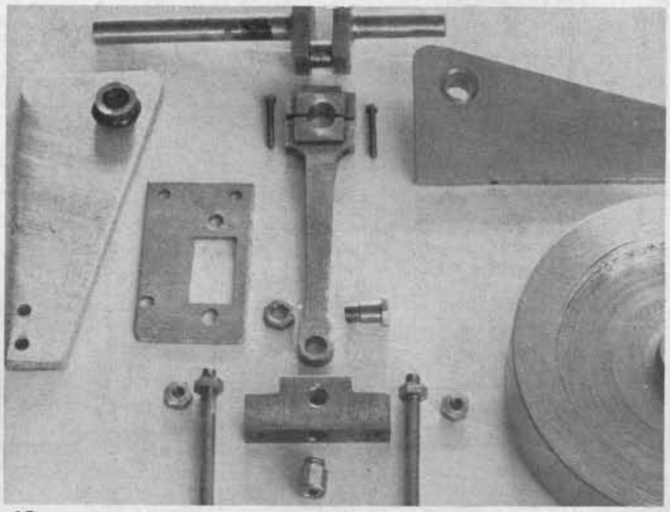


13

8 *Components of the engine unit.*

9 *Boring the cylinder block.*

10 *Flycutting the cylinder block.*

11 *Staking the holes on the moving cylinder.*

12 *The complete unit before converting with the saddle.*

13 *Components of the motion for the basic engine.*

steam ports, 0.2 in. apart, and drill these No. 35, 0.1 in. deep. Set the head to 10 degrees and drill the ends with two No. 44 holes down into the appropriate side hole.

First Fitting and Assembly

Remove burrs from all parts completed and fit the "O" ring to the piston, oil the cylinder and slide in the piston on its rod; it should not feel tight. Check the covers for fit. Remove the covers and, with a bright light in front, look through the cylinder at all angles, holding the rod central, and at all positions. If any light is apparent a piston with a slightly larger groove diameter will have to be made. Remove the piston and try the cylinder in the block, oiled for the occasion, it should need a little pressure to take it through, the oiling grooves may stick and will need a little rubbing down with Brasso. General reluctance to pass through must be tackled by re-lapping the block.

With a flat needle file carefully take away some metal between the steam holes at the cylinder ends, at 45 degrees, and also from the cylinder cover where they coincide. Clean the cylinder group and screws and use Loctite 270 for this assembly. First secure the piston and collar onto the rod, the bevel of the collar towards the piston. Wipe off the surplus Loctite and push 1/8 in. I.D. silicone rubber O rings fore and aft of the piston. Secure the rear cover, with Loctite on the cylinder end, with 4×8 B.A. screws. Push in the piston, fitted with the ½ in. O.D. Viton O ring, the rod passing through its hole in the rear cover, and fit the front cover, with its larger hole to take the collar, and secure with its countersunk screws and Loctite, as before. Fit the front plate, with the blanked-off hole, with four 10 BA screws and a touch of Loctite. Slip a 1/8 in. I.D. Viton O ring over the piston rod and secure the rear end plate with cheesehead screws, making sure that no Loctite gets into the recess. Leave for an hour then place a drop of oil into both steam holes and move the piston and the oil will suck into one and blow out of the other. Ensure that oil enters both sides when the piston should feel very easy moving. Check that the complete assembly slips into the block.

Milling and Drilling the Block

First mill the shallow cavity to be covered by the safety valve, and mill away the top for the lubricator. Drill the No 1 hole for the regulator, and the two holes at 45 degrees, drilled from the top into the side panel. Turn the block upside-down and drill straight down into the bore and from the front end into this hole for the exhaust. The under hole, can be filled in later.

The steam inlet ports are drilled at 12½" degrees from the side panel to be in line, in the bore, with the exhaust port. Note that the holes are eliptical in the bore, presenting large areas for the ports in the cylinder. Drill the side for the cylinder limiting screw. Run the lap through the bore to remove burrs from the drilled holes, clean, oil, and slip the cylinder into the block keeping the ports lined up and mark, through the hole, for the position of the milled slot of the retaining screw. Mill the slot with a 1/6 in. end mill. Drill the holes for the cofer to miss any holes and avoid entering the bore, and tap.

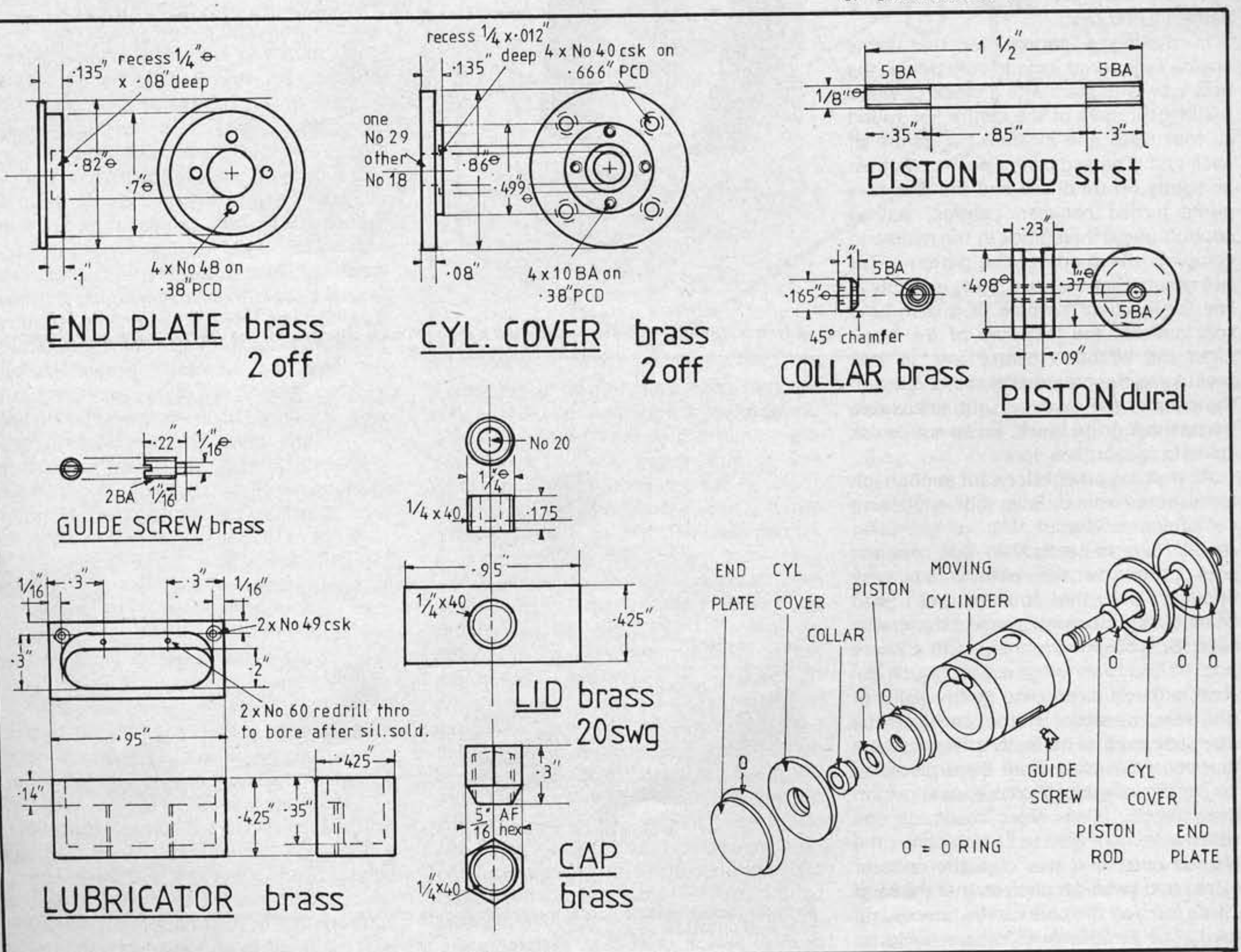
The Lubricator

Basically the lubricator is a box full of oil with two drain holes from a step halfway up in the box. Firstly the oil will lubricate the cylinder in the block by gravity. Secondly, steam pressure will enter the box, via the cylinder groove and force oil down the other groove, and third, the steam condensate will raise the level of oil in the box to continue lubrication by displacement.

The lubricator is cut from a piece of ½ in. square brass. Mill the large area down to the step, then, with the smaller mill, down to the bottom. Drill No 79 and countersink for the two securing screws, locate on the cylinder block and mark the positions of the holes through, drill and tap the block 10 BA. Paint the brass screws and mating surfaces with silver solder paint and screw the lubricator to the block. Silver solder in place using a little Easyflow No 2 at the base when the point runs. Avoid heating the thin side of the block or this will buckle. Pickle and clean off.

Drill the two holes into the bore, from the shelf, No 60, directly opposite the steam inlet holes. Make the lid and fitting and Comsol solder this in place before fitting the lid, also with Comsol. The cap is turned from hex. brass, tapped ¼ in. × 32, and fitted with a silicone rubber O ring, after which it should screw onto the lid no more than 2½ turns; it doesn't need to be spanner tight as the seal of the O ring increases with the steam pressure.

Next month: the final construction and testing of "Sweet Sixteen".



Simple pattern Making

by L. C. Mason part 3

It stands to reason that if the cored hole in the casting is to come in the right place, the core must be held in the mould in the right place also. This is easily arranged by providing the pattern with a protruding round piece at each end, the same diameter as the core will be. The amount by which the end pieces protrude is not terribly important, so long as they provide a firm seating for the ends of the core.

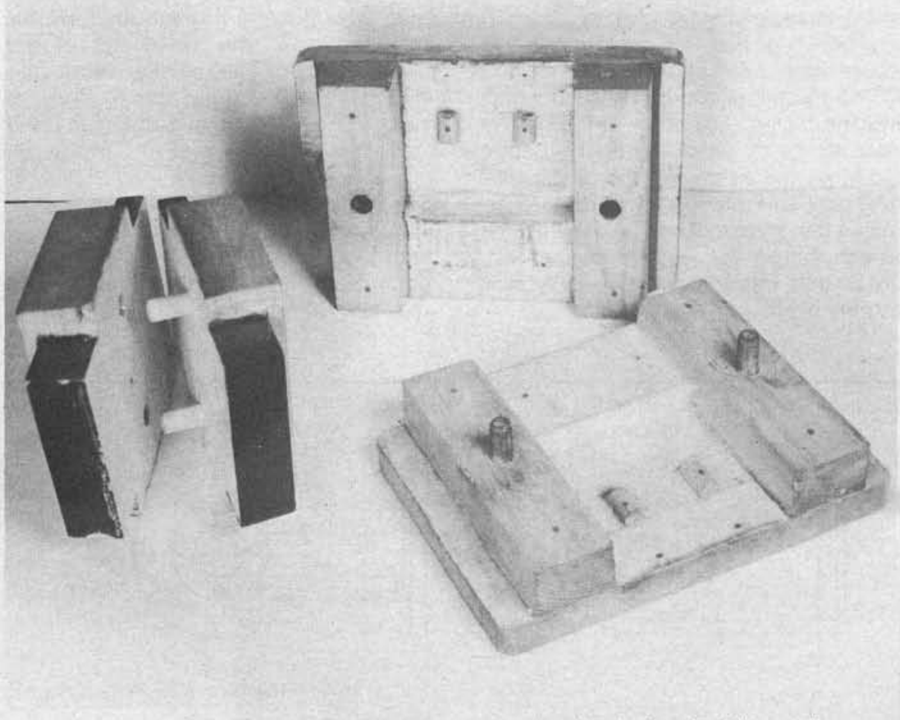
Such extra pieces on the ends of the pattern to locate the core are termed "core prints", and are generally painted a different colour to the rest of the pattern to indicate that that is what they are — but we can look at that in more detail later. In making a pattern having round core prints at each end, make the core prints just a shade full on diameter, so that the sand cores will fit easily but snugly in the impressions left in the mould by the prints. Don't forget too, that the ends of the core prints need just a little doming for taper, as they have to be lifted from the sand just like some part of a pattern to be cast.

In making a pattern for that same engine cylinder to include core prints, the best way is to start with a block of wood full length, mark in the centre line round all four sides and incidate the centre of each end. The end centre points can then be lightly centre drilled and the two core prints turned between centres, leaving enough untouched block in the middle to complete the shape of the pattern. This will ensure that the core prints are truly in line for locating the core. If it is to be a split pattern, the joint line of the block gives the all-round centre line. In that case, keep the pressure of the centres on the ends of the block as light as possible when turning the block, so as not to risk splitting it apart too soon.

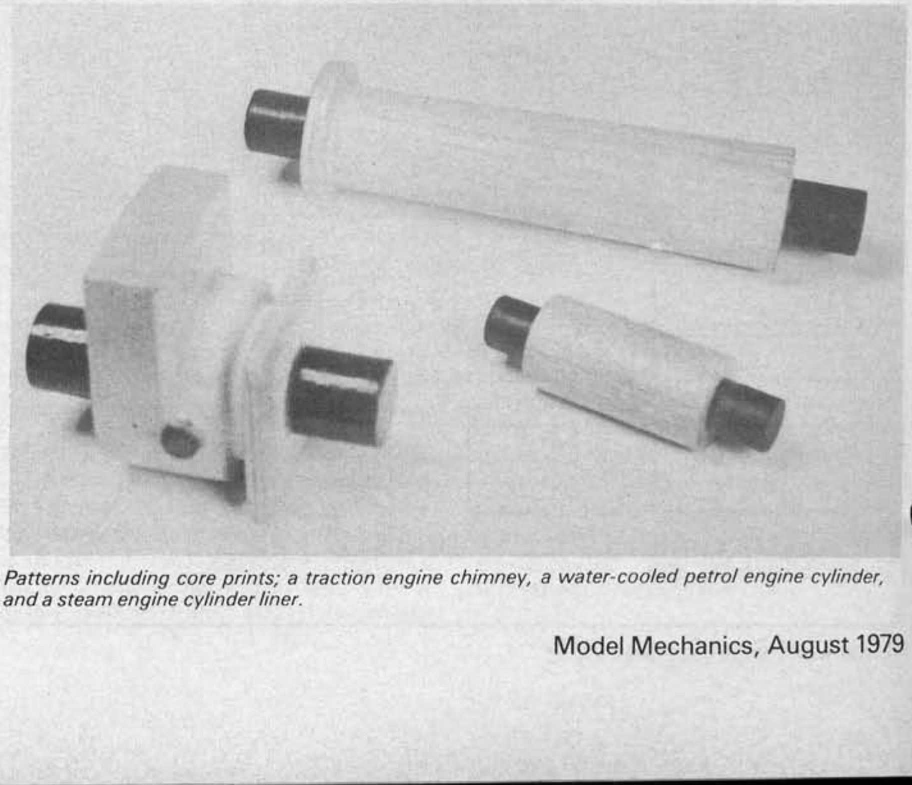
All that is a straightforward enough job for a cored round hole, but supposing something awkward like a triangular section hole is needed? In that case the core prints on the pattern are easy enough, but the foundry will need something with which to make the special core. So you provide them with a "core box". This is very often not too much like an actual box, depending on the shape of the core needed. In the case of the triangular core, a perfectly adequate core box could be made from three pieces of wood, the length of the core, as shown in the sketch. One side needs to be removable for ease of extracting the shaped core, and two opposite ends or sides need to be left open so that the sand inside forming the core can be rammed up hard. The removable side here could be just loosely dowelled to the rest of the box, as quite often with small core boxes the whole thing is held in the hand while filling, with one open side or end resting flat on the moulding bench. With an unsymmetrically shaped core, the core prints on the pattern will need to be positioned so that the core comes the right way up in the mould.

Internal shapes

The method of making fancy shaped cores as outlined above can, of course, be extended to produce quite complex internal shapes to be cored out. A case in point is the core required to give the internal shape of an engine crankcase. Here the core box naturally becomes somewhat more elaborate, and could include little bosses inside to produce internal bosses in the casting for the insertion of studs from outside in the finish machined casting. This is shown in the photograph of the core box for a box-form petrol engine crankcase, where a number of thickened-up points on the bottom edge of the crankcase were needed to accept the screws attaching the engine sump. The top of the core was



A split box-type crankcase pattern and a slightly crude core box for the interior of the crankcase.



Patterns including core prints; a traction engine chimney, a water-cooled petrol engine cylinder, and a steam engine cylinder liner.

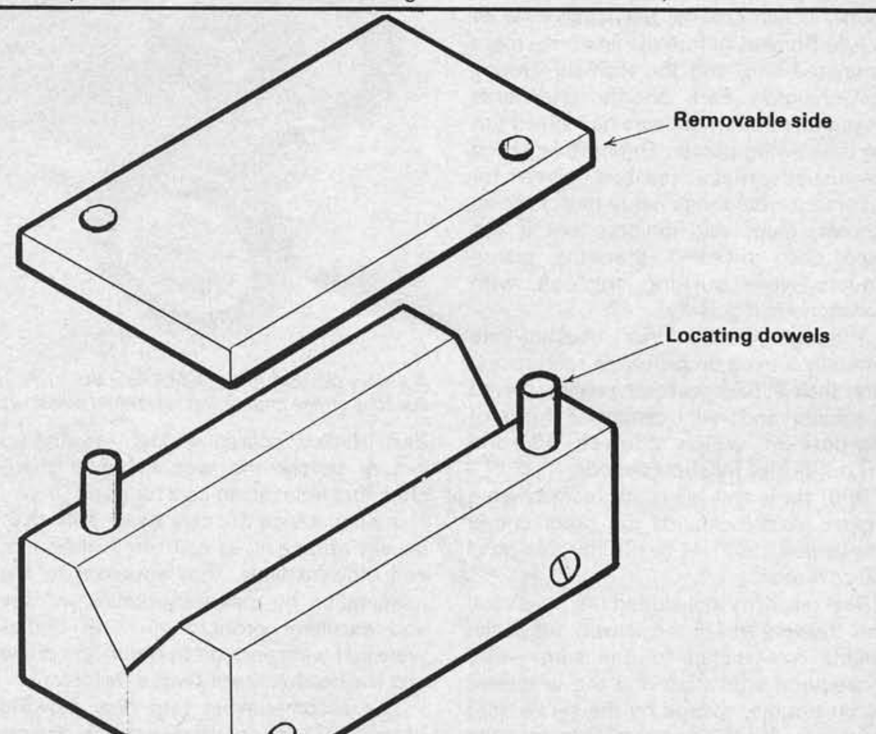
so shaped as to produce a slotted thick top to the casting, to provide for the tappet holes at the top of the crankcase. As a slot right through the top of the crankcase was required, the core top would naturally have to contact the top of the mould. So here the narrow top of the core was extended to form one core print, the opposite one being an extension of the bottom of the core shaping the open bottom of the crankcase. In making these two items, the pattern itself was in effect no more than a split rectangular block, so that there was distinctly more woodwork involved in making the core box than in producing the pattern!

This same core box also illustrates another point; the two core prints on the pattern are of different shapes and sizes, so that it is impossible to place the core in the mould in any but the right position. Even if the core prints could easily be just the same as each other, if the internal features require the core to go into the mould in one way only, the core prints can be shaped so that only the correct location for the core is possible. The difference could consist of having one round and one square print, one square and one rectangular, or in fact any combination of easily produced shapes that have the desired effect.

It is useful to remember too, that there are no rules about the number of core prints a pattern must have. A shape with one big opening like a locomotive dome could well have just the one print, large and deep enough to allow of using an overhanging core. If you have to produce something like that, it is best to make the print protrude far enough to take a core with a long enough "stalk" to ensure that it does not tip over into the mould when placed in position. Similarly, several different openings to be cored in the casting can be utilised to provide several support points for the core. Take a look at your car engine block; there you will see a number of small discs eash pressed into a circular recess. These serve to blank off holes not required in the finished casting, but which were produced where a core support was located. You can find a number of these, the result of providing several core supports to make sure of getting a heavy and complex shaped core in exactly the right place in the mould.

With the larger size core boxes I generally provide some sort of means of clamping the portions of the box together, as a big box could be awkward to hold firmly closed by hand while filling. Any sort of foolproof and quickly operated fastening should suffice, and it should preferably have no separate bits that could get lost. An effective fastening is a pair of hook-and-eye latch fasteners — the chicken-house door sort — positioned so that the halves of the box are held tightly together on clipping the hooks home. Another fixing I have used is a pair of wing-nuts on swinging screws engaging the slotted ends of a metal strip across the opposite side of the box. This was salvaged a long time ago from an old tie press, and has been used on a number of boxes. While the crankcase core box shown ranks as fairly big in model terms, it is fairly slim, and can conveniently be hand-held for use.

So far little has been said about the surface finish on patterns. Professionally made patterns used to follow something of a tradition in this respect, in that the pattern itself was generally brick red, and core prints black. It is necessary to point up the difference here, as should a core box be temporarily mislaid when it comes to moulding — or one not provided for a plain round core — there would be nothing to show whether the core prints indicated a cored hole required, or if the whole pattern was for one solid casting.



Simple Corebox for a Special Core

Personally, I do not now paint patterns red, as it would seem from a glance round a foundry moulding shop that almost any old colour is used, presumably on the grounds that an unconventional colour enables a customer's particular patterns to be picked out quickly. The main thing is a good smooth surface to give clean removal from the sand. A high gloss finish is not essential; a hard satin finish is quite satisfactory. A gloss finish is going to finish up as satin after two or three mouldings, anyway! I find that polyurethane varnish gives a finish satisfactory in all respects. Give the pattern about three coats, the first two lightly rubbed down for a smooth base. Paint the core prints black, finishing up with a top coat of varnish. Core boxes should be varnished inside where the sand contacts the wood, but the outside can quite well be left bare — just sanded smooth. When it came to photographing the crankcase core box, it was realised with a slight shock that the interior had never been varnished at all — but it still worked!

Finally, let me say that it is my experience that foundries are very willing to do their best for model engineers' small requirements — especially if the patterns you produce to them show some evidence that you have taken steps to provide what they can most easily deal with. They appreciate you asking them for any criticisms of your patterns too, which can not only give you a better understanding of what they prefer for ease of casting, but can also lead to a genuine interest on their part in what YOU are trying to do. Useful for next time!

On my last visit to my local foundry I was told the story of an inventor who brought in a pattern made largely of built-up layers of cardboard! The moulder was doubtful of his chances of success with this, but bravely had a go. In the moulding, the sand being slightly damp moistened the cardboard, which began to disintegrate and come unstuck long before the ramming stage. So the moulder abandoned that attempt, dried out the pattern, re-stuck it all together, reinforced various points with glue and scraps of wood and painted the lot. After much fiddling with some of the details in the moulding he eventually obtained a casting satisfactory to the customer.

And that, of course, ranks as the sort of super service that no customer has the right to expect. You should not need it; if you put into practice the various points mentioned, you should come up with a perfectly good casting with your first pattern — thereby confirming that pattern making is not something that you should avoid because of any difficulties.

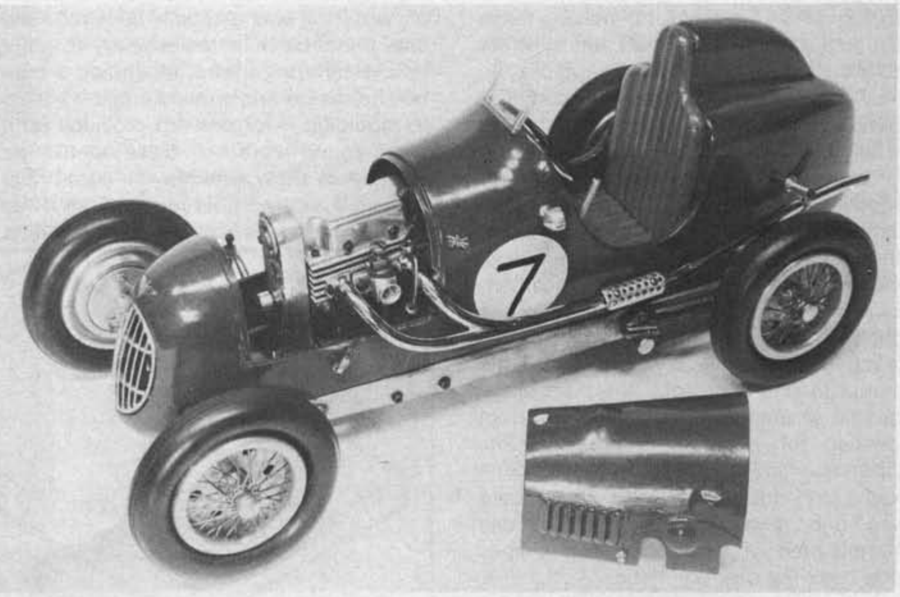
Scale projects 744 cc OHC Austin

The o.h.c. 744 c.c. cars were announced by Lord Austin himself early in 1936, and first raced as a team in the international Trophy at Brooklands, in company with the earlier side-valve car, which, due to the usual teething troubles of the new jobs, was the only finisher. The first glimmer of success came when Dodson broke the lap record in the County Down Trophy, previously held by an Alfa Romeo, before the jinx once more eliminated him, and the Nuffield Trophy at Donington Park shortly afterwards proved afresh that the cars had speed but not the staying power. During this period the usual official reasons given for retirement were those hardy motor racing annuals, plugs and ignition, but it has since been revealed that the piston crowns were burning through with monotonous regularity!

Although the "Works" Austins are generally looked on purely as road racing cars, their initial successes were achieved at sprints and hill climbs, a form of competition which allowed 100-odd b.h.p. full play for short periods.

Both track and hill climb records were broken. At Brooklands the outer circuit was lapped at 121.14 m.p.h. by this small 750 cc motor.

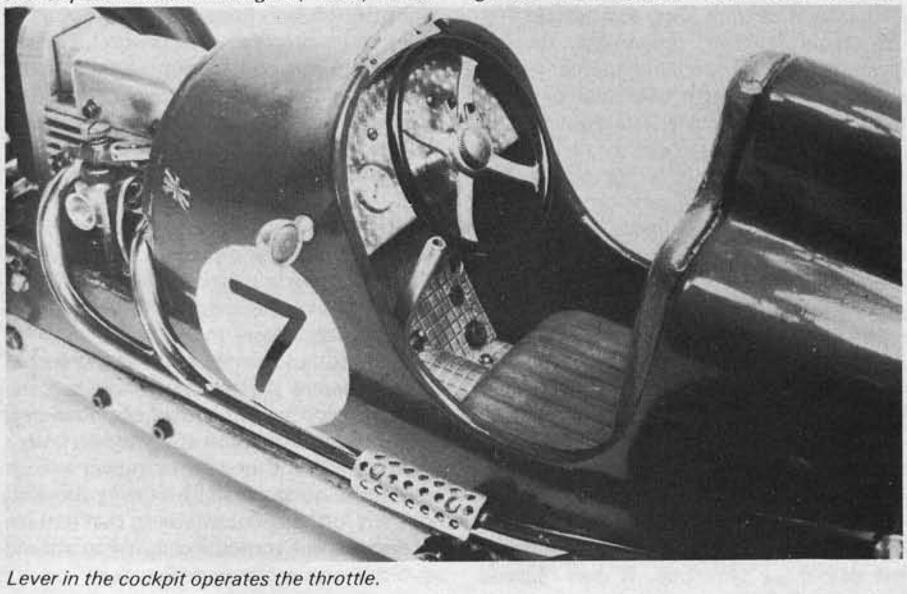
Real reliability still eluded the new cars, until the very end of the season, when the trouble was traced to fuel surge, and consequent starvation and the inevitable piston trouble, caused by the single float chambers. Modified to twin chambers the troubles ceased and the future brought a glittering series of successes in both road and track races. The o.h.c. Austin's final appearance was in the Imperial Trophy at the Crystal Palace in August, 1939, when Bert Hadley scored a last resounding victory before the war removed these charming little racing cars for good.



A Tether car built in the 1950s by a Mr. Tiller, now owned by Mike Beach. It is powered by a twin 6cc four-stroke engine with overhead camshaft.

In appearance the cars were more than usually attractive, as apart from their trim and efficient lines, they appealed to the imagination by their very diminutive size and excellent proportions. The bodies were just wide enough to house the driver and the headrest really was a headrest.

The accompanying four-view drawing of the 1937 version will give model makers most of the details they require, but a note or two on the somewhat confusing variations will not be out of place. In 1936 and 1937 the cars had the normal radiator grilles with vertical bars and external radiator filler caps with quick action levers as in the drawing. The bonnet side louvres were positioned towards the read edge, and were nine in number, of extractor type, i.e. facing rearwards. In 1938 the bonnets were altered somewhat, the radiator fillers being concealed, and additional louvres and cooling slots were cut around the radiator fairing. For a time, in at least one of the cars, a shallow forward-facing scoop was fitted over the top slot above the grille. For the 1939 season the old arrangement of outside fillers appeared again, with a bonnet-line similar to the original, but additional louvres were cut in the bonnet sides and on either side of the bonnet crown. No alterations were made to the main components throughout the team's career. The deep channel section frames had tubular cross members, the centre one being extended beyond the side members to carry the rear spings.



Lever in the cockpit operates the throttle.

The twin camshaft engine had a Roots type Murray Jamieson super-charger, carried at the rear, above the gearbox, and the transmission line was lowered 4 in. and stepped up to the rear axle by spur gears.

Brakes were cable operated, with 10 in. drums at the rear, and 12½ in. drums in front.

The hand brake was external, and the short gear lever was on the driver's left with a bulge in the cockpit side for hand clearance. Tyres were 5.25 × 16, and on occasion twin rear wheels were fitted for sprints and short races. Colour scheme was dark green with silver wheels.

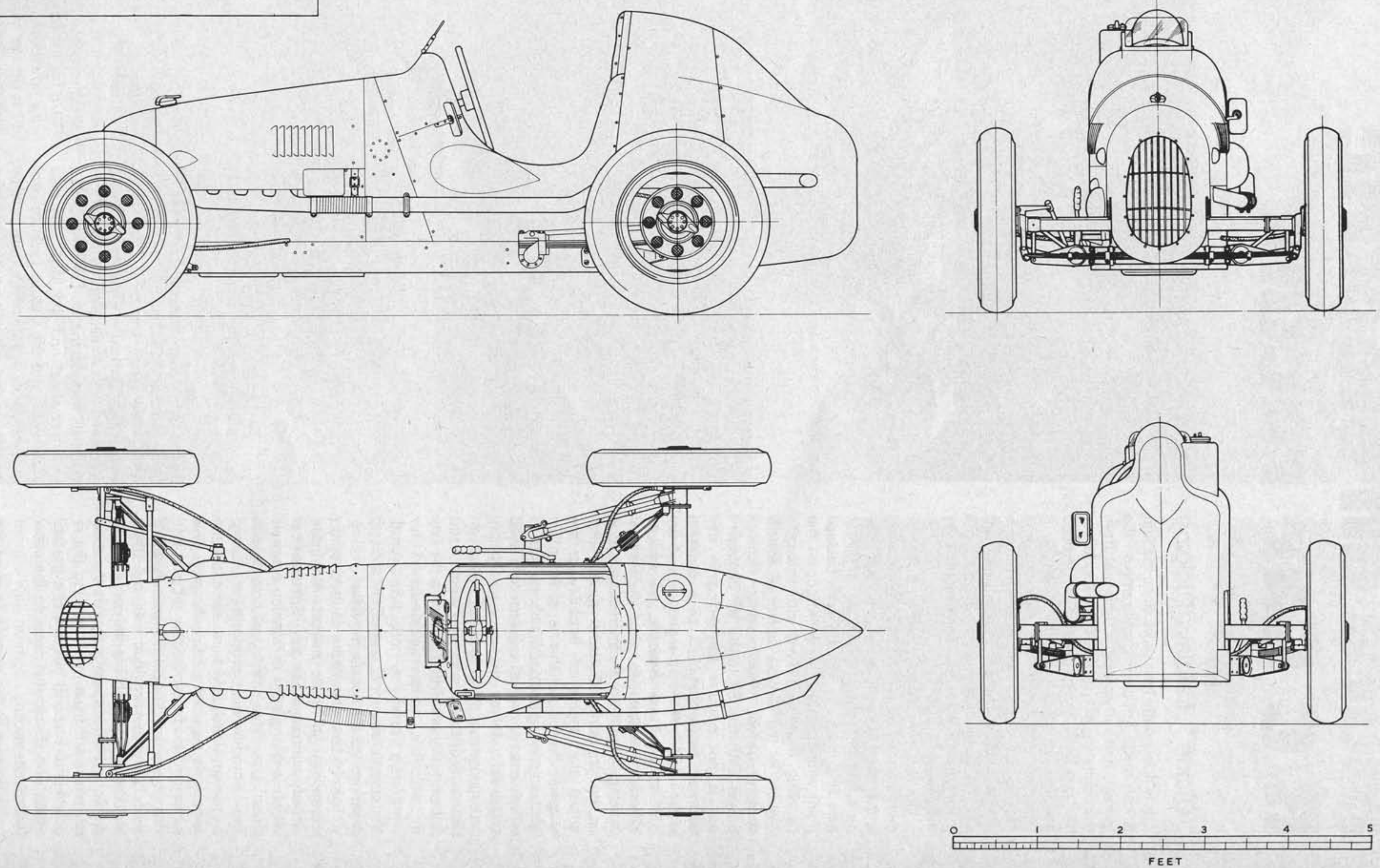
744 cc O.H.C. AUSTIN

1937 Model

Drawn by Maurice J. Brett

Plan No. MM/205

Full-size Plans are available as Plan No. MM205 at £0.55, plus 20p postage, from M.M. Plans Service, P.O. Box 35, Bridge Street, Hemel Hempstead, Herts.



More on electric R/C Car racing

By
"Dickie" Laidlaw-Dickson

Matching Lectricar team at Blackpool. Team races are popular aspect of open races.
(Photo by Blackpool Gazette)

Racing at Hinckley with a bridge and other obstacles to vary the circuit.

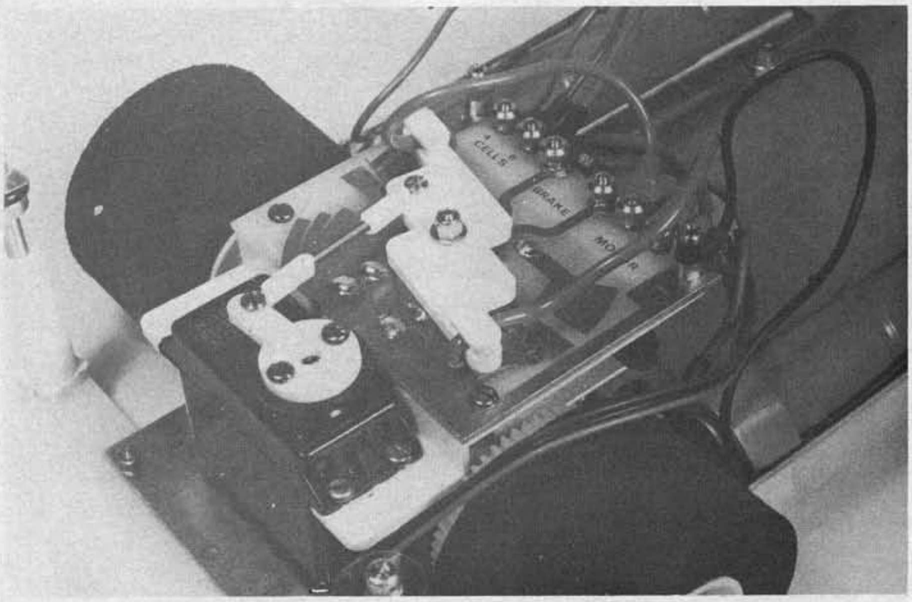
It is now nearly four years since the first British made $\frac{1}{12}$th electric car came on the market, and rather longer than that from the beginning of this side of r/c model car racing in USA. Whilst the faithful Jerobee and Bo-Link cars continue to please a "second generation" of cars is now making its appearance. Lectricar who started it all over here have now produced a significantly different car, embodying a great deal of what has been learnt over the years.

Options are offered of either a rear or mid mounted motor. All this means really is that the heavy motor location can now be either in front of or behind the rear axle line, thus altering the car's balance point which in turn has an effect on the handling. It can be run with either six-cells (which is the almost universal British custom) or with 4-cells which reduces power and may be useful for beginners but is not popular for racing in this country, but the subject of a separate class in USA. Alternative gear ratios from 3.71 to 4.5:1 are available, as well as different resistors to alter degrees of braking. An even more interesting option is the provision of clamp screws that adjust the degree of flexibility in the chassis. Added to this is a far more sophisticated speed control board. Nicads which used to bunch together in a solid block now follow the more customary arrangement of lying in 3-cell strings on each side of the chassis. The whole outfit is beautifully presented and even the box in which it comes is designed for continuing use as the model box to carry the completed model and a few tools to meetings via the handle provided!

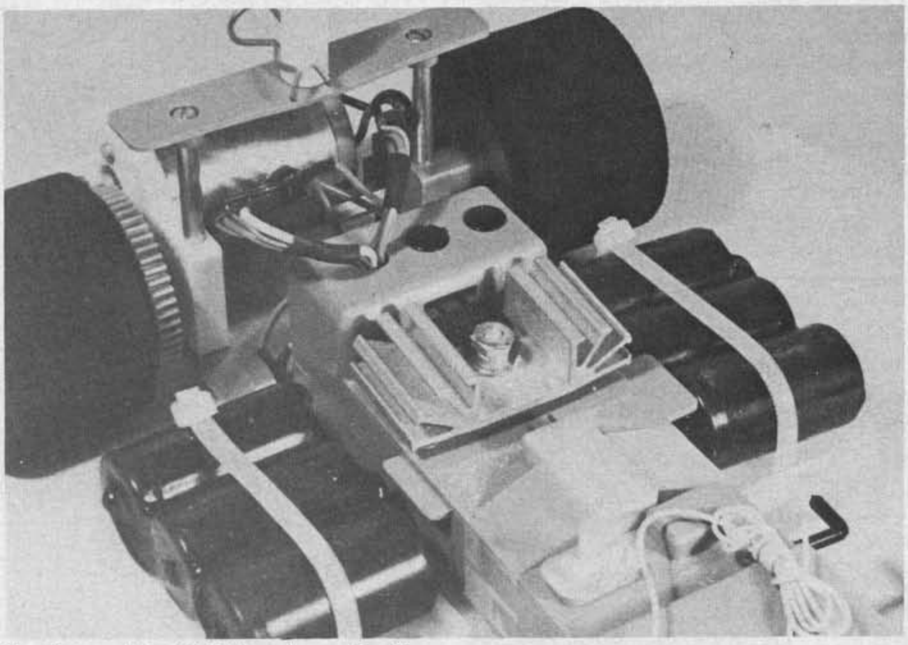
This is but one move in the rapidly expanding $\frac{1}{12}$th scale market. We have already mentioned the new Spectron car which is taking a lot of winning brackets these days. This comes, of course with the Smoothronic proportional speed controller, which saves one servo and the need for a separate receiver battery. This latter can also be omitted by tapping into the six-cell nicad pack to take only six of the 7.2 volts provided, or by using blocking diodes achieve the same result. A minor disadvantage is that as the main current use if used up in running the rx may fail to respond but this is a gradual effect and should not occur in the usual five minute race.

Of interest is the chassis form of the Spectron in that it uses a clear polycarbonate plate which has a degree of built in flexibility. Lectricar continues to use an aluminium chassis, but with its own special flex clamp adjustment. Associated and some of the other American imports use a fibreglass chassis combined with an alloy power pod. Other materials include the Bo-Link with nylon or kydex sheet and the MRP cars also with kydex. For the serious racer control of chassis flex is most important. Ideally the driving end should be stiff with some movement at the front or steering end to compensate for any ground irregularities and to help keep the wheels on the ground. Some degree of front end springing is also incorporated in a number of kits.

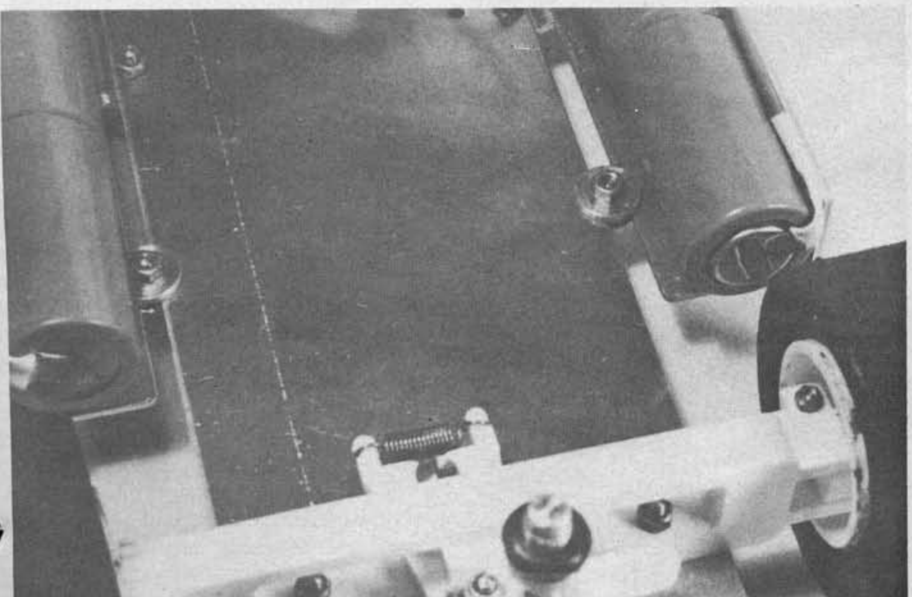
Continuing on the current lines of development we come to the provision of a differential. This was the sensation of 1978 for the larger i.c. $\frac{1}{8}$th scale cars and has now been introduced to $\frac{1}{12}$th electric. First off the mark in a commercial way is the Schumacher diff. designed by Cecil Schumacher who is a Cosworth engineer and a transmission expert. The first run in white plastic has been supplanted by



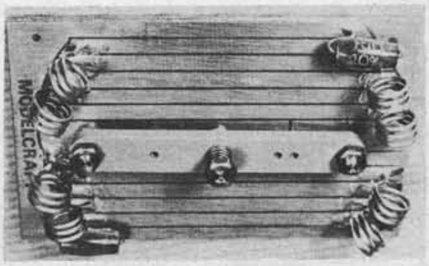
Latest Lectricar speed control panel.



Speed control for MRP. Note the cooling fins.



Movable clamps to adjust flexibility on the Lectricar chassis.

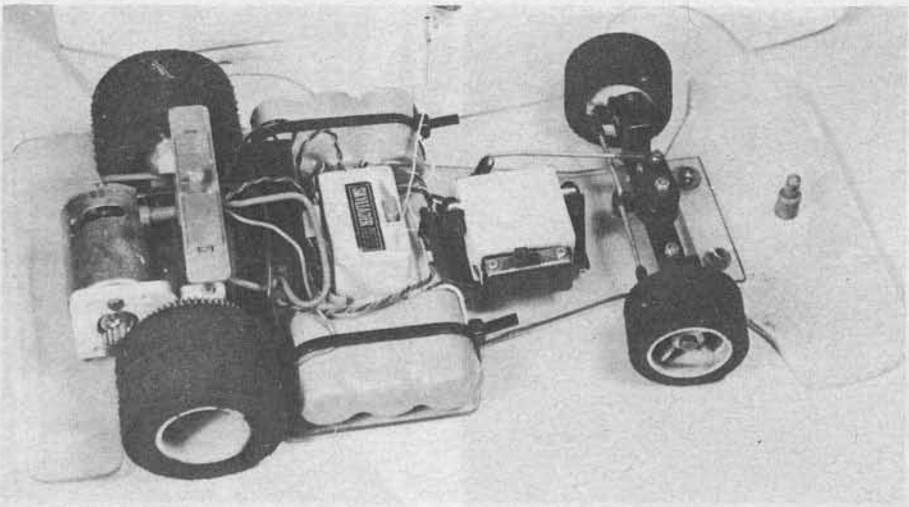


A sophisticated version of control panel for Mardave by Modelcraft.

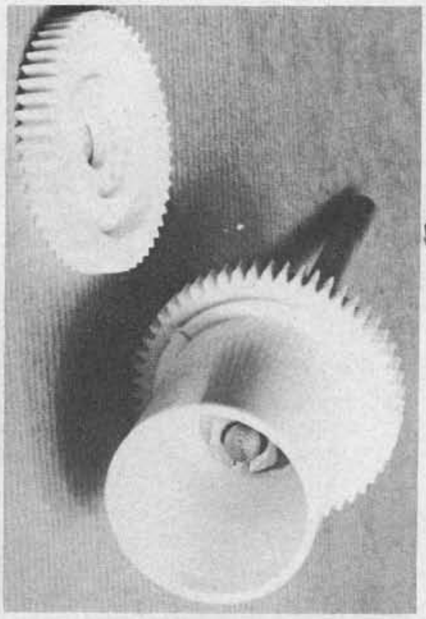
L and M proportional speed control—it has the advantage of a limited reverse faculty.

black nylon for strength and matching black wheels are also available. It will fit most makes of car and a variety of teeth is on offer. It is not essential but it helps. Differential pioneers AMPS will also soon be offering their version for $\frac{1}{12}$th scale racing.

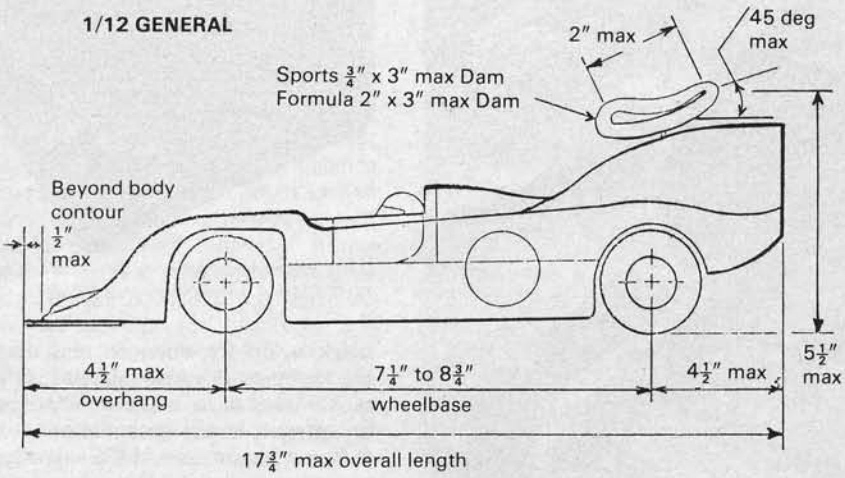
The best motor to use is a very open question. A "standard" motor is the BRECA requirement and this must be capable of inspection to check that it is "unopened", that is to say not taken apart to be worked on. However, within the range of standard motor some are better than others with a difference in factory checking tolerance of sometimes over 10%. Once upon a time all the best motors were put aside on test for use as demonstration units and marked specially so that the trade knew them but with the millions now coming from Japanese factories this is quite impossible. American championships this year all went to the Reedy motor but as and when it comes over here it may be much more expensive than the usual run of motors. The issue is also slightly complicated by the *two* race controlling bodies, namely BRECA which follows a slightly more simple motor requirement of a single class of unopened motor and the Electric racing section of BRCA which accepts the current EFRA rules which divide racing into three classes (1) Production for stock motors with no mods and cars in normal production kit form but changes allowed to wheels, axles, bodies, mounting of Rx and speed control. No ball races permitted. (2) Stock Cars: any car that



Prototype Spection with polycarbonate chassis as run successfully by Wendy Bork.

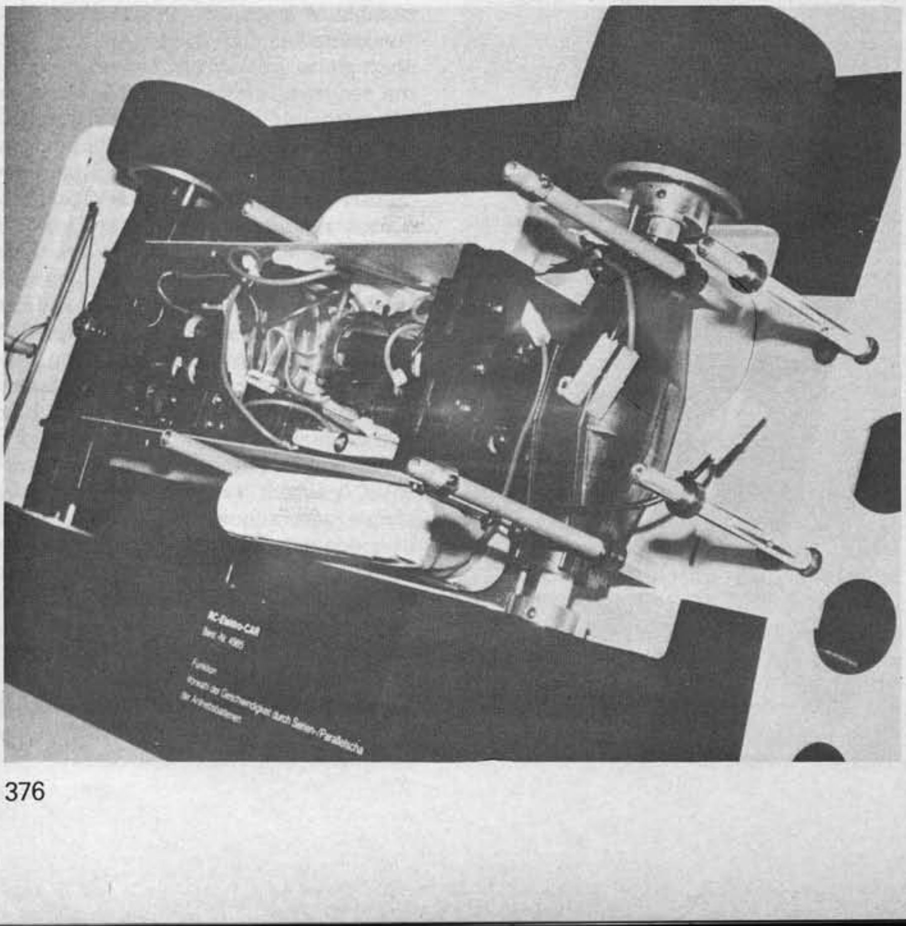


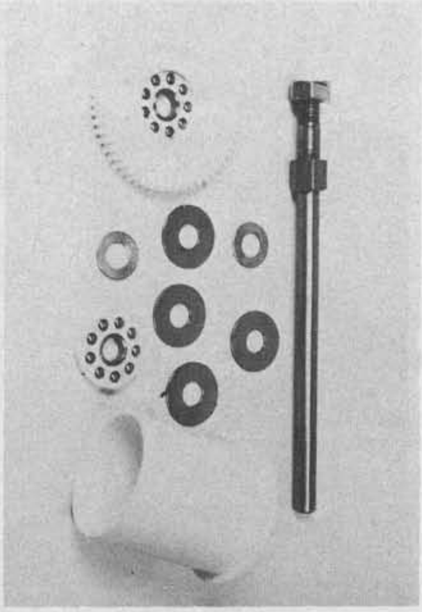
Schumacher differential in original white finish.



$\frac{1}{12}$th scale dimensions.

Below Graupner $\frac{1}{8}$ scale electric prototype.



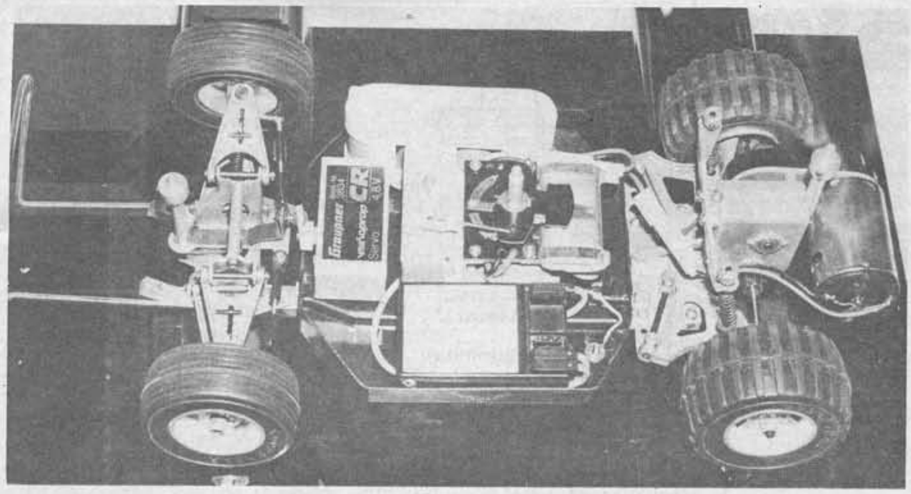


Schumacher differential

meets $\frac{1}{12}$th regs., including scratch built. Ball races permitted but motor must be standard and unopened. (3) Modified class: Virtually anything goes including rewinds etc., as long as the car conforms to $\frac{1}{12}$th regs.

Just for the record here are the basic specifications: Tyres: Tread width ½in minimum 1½in. max. Minimum diameter, front 1¾in rear 2in Overall width: 6¾in max (includes body bumper wing and wheels) Bumper: may extend ¼in beyond side of body or to 6¾in whichever is less. Wing: 6¾in width max. Chord 2in max. Spoilers: Max height 1in max length 1in. Sketch shows other permitted dimensions.

For outdoors running on car parks school playgrounds etc with good surface grip tyre adhesion seems to be fairly universal, only rate of wear differs. Racing in halls where surface is smooth and often shiny, then nature of tyres is most

1 

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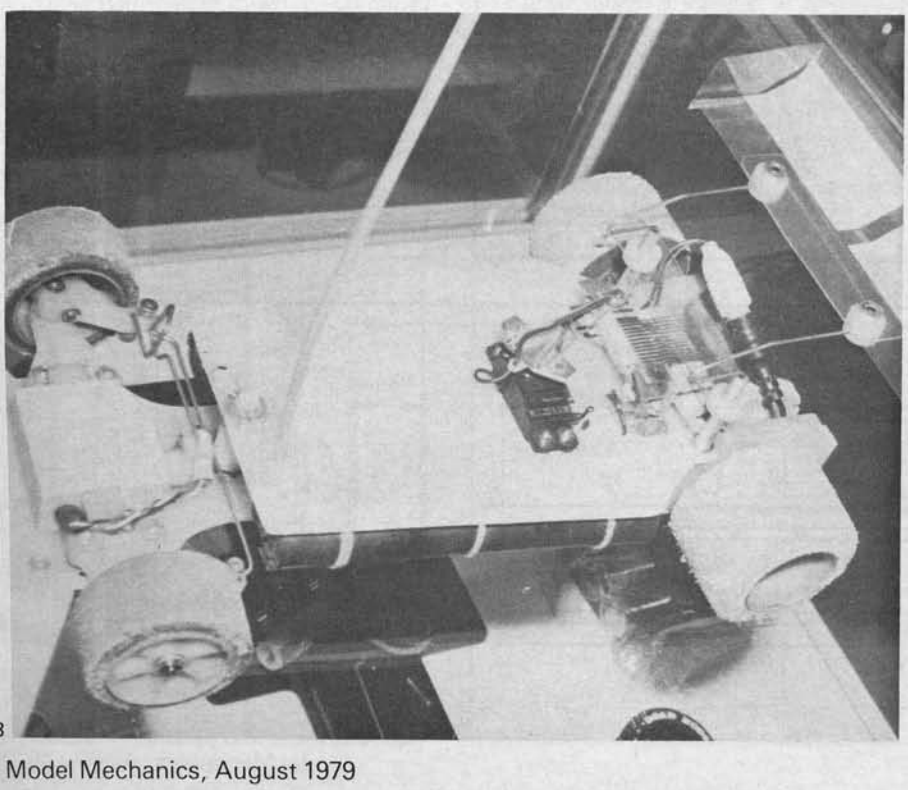
3 

1 *Graupner $\frac{1}{10}$th scale full sprung electric car.*

2 *The SG $\frac{1}{8}$th scale electric car.*

3 *Minicars $\frac{1}{12}$th scale electric car coming in the early autumn.*

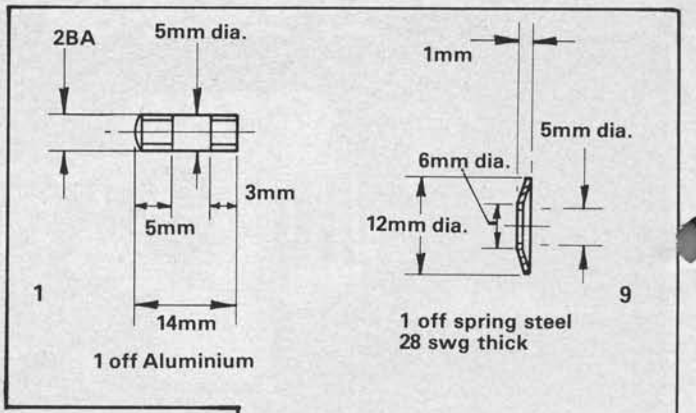
important. Currently a soft neoprene tyre such as Radiotyres is proving most successful. In most cases the tyre alone is not enough, it must be annointed with your favourite choice of silicone additive. Even here there is a range of methods in that the experts vary the stippling to suit the particular surface in use. You can have a few big blobs or a lot of little blobs, or an all-over stippled pattern. Tyres require to be cleaned off after each race and re-siliconed. This can be done by washing off at once or having a spare set that can be fitted quickly, and then clean off at leisure.

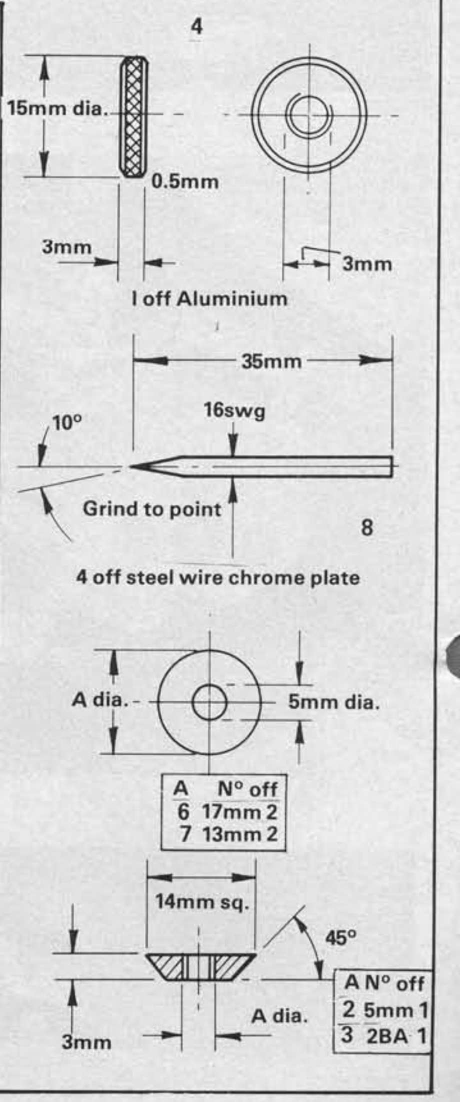
Tyre balance is also very important. Unbalanced tyres are nearly as bad as running a foot race with one foot in the gutter. Put on an electric drill and balance by rubbing down inequalities and then spinning them free to see they are truly balanced (just like fullsize you can add balance weights — small pins in this case!) Rub down by holding medium sandpaper against the revolving wheel. This balance question is more important for front wheels than rear. By the way, front tyres should always be harder than rear tyres. There is now a wide choice of tyres in all degrees of hardness; your local circuit must decide your final selection.

Before leaving consideration of the current scene, what is likely to show up for the future? My own guess is a quite new class: $\frac{1}{8}$th scale electric car racing! This year's Nuremberg Toy Fair, always the "kite-flying" centre of Europe, had Graupner, the Toy Fair "king", showing a $\frac{1}{8}$th electric car, and incidentally, a $\frac{1}{10}$th scale fully sprung car; Robbe was showing a SG car in $\frac{1}{8}$th electric; there was also at least one $\frac{1}{8}$th offering from Record of Switzerland and from a Swedish company. They would have an attraction for the i.c. boys too in that it might be possible to practice in places where i.c. glow plug noise would rule it out. They are also much faster than might be expected even with the $\frac{1}{12}$th size motor; move up to a bigger motor and who knows what might be the result. Limited length of charged run seems the main snag. Meanwhile, there are still a lot of interesting $\frac{1}{12}$th offerings in the pipe line, including a front-wheel drive car from Cumbria in the next few weeks, and a quite new layout designed by Swede Olle Soderholm promised by Minicars for September.

How to make a pair of Proportional Dividers

C. R. Houlbrook





Introduction

Under normal circumstances drawings are produced to a scale depending on the size of component to be drawn. To produce these drawings special rules known as scale rules are used. The normal scales found in engineering are shown below.

IMPERIAL		METRIC
¼″ = 1ft.	⅛″ = 1ft	1:2
¾″ = 1ft	⅜″ = 1ft	1:5
1″ = 1ft	½″ = 1ft	1:10
3″ = 1ft	1½″ = 1ft	1:20

If it is necessary to produce an existing drawing to a new scale various methods are available, one of these is the use of proportioned dividers. These are much easier and quicker to use than measuring and then calculating each new dimension individually. It also gives a method of converting imperial scale drawings to a different scale in metric. In addition they can be used to take dimensions at one scale and produce them to another, when the scales used are not to any standard.

Description

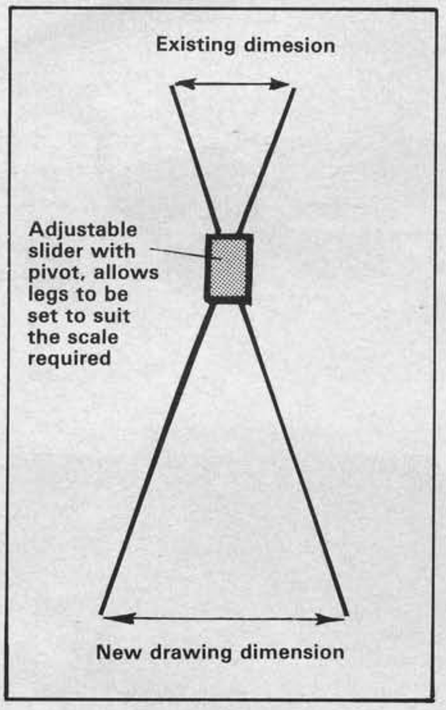
The general principles for Proportional Dividers are as shown below:

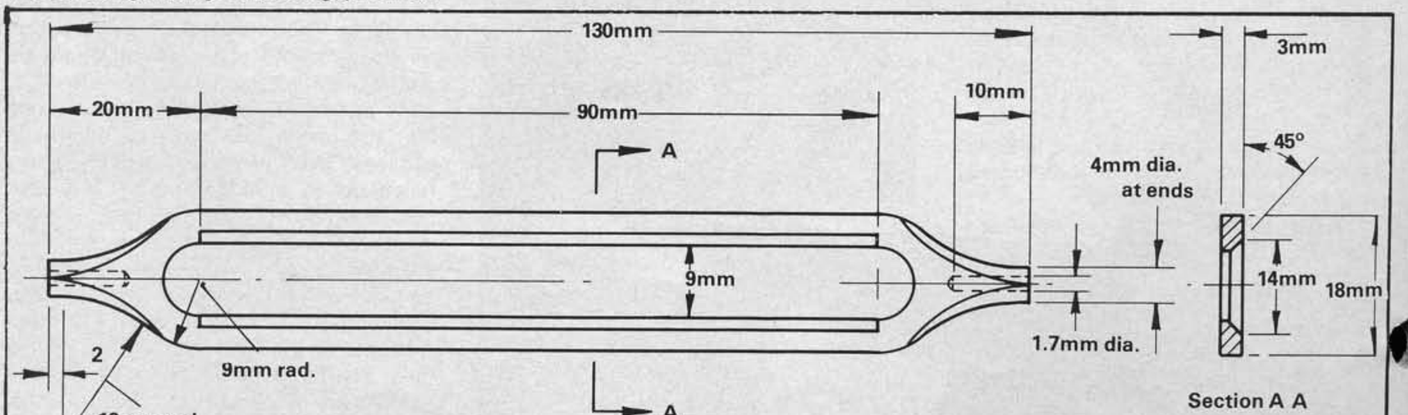
Existing Dimension

Adjustable slider with pivot, allows legs to be set to suit the scale required

New drawing dimension

The points at one end are set to an existing drawing dimension and the slider moved along the legs until the gap formed by the pair of points at the other end is set to the corresponding dimension at the new scale. The slider is then locked in position to prevent it from further movement along the legs but it must still allow the two legs to pivot when pressure is applied to the legs. As the proportion between the legs has now been fixed they can now be opened and closed to transfer dimensions as required.





Construction:- 1 legs

These are made as a pair from flat aluminium bar. Cut 2 pieces each 130 mm long.

1. Mark off centre line along length of one bar.
2. Measure from end 20 mm and mark centre line of 9 mm dia hole. Use pair of dividers to mark the other position at 90 mm centre 'pop' both positions.
3. Mark out the end profile starting with the 9 mm radius. After this a template of the end profile is made from a piece of this gauge sheet say (0.010"). Mark off centre line and then profile of end. Cut out template shape and use to mark outline on aluminium bar ends, line up the centre line on the template with the centre line on the bar.
4. With the marked out bar uppermost clamp the second plate on to the first.
5. Drill 5 dia holes at the 90 mm centres. (These will later be opened out to 9 mm dia).
6. Use 2 - 2 BA × 15 mm bolts with washers to clamp the two plates securely together.
7. Mark off a series of positions along the length at steps of 8 mm centre 'pop' each one and drill 8 mm dia at each position.
8. Clean out the drilled slot by filing the edges up to the scribed line do not remove the clamping bolts yet.
9. Cut end profiles to shape by use of a saw, to remove the bulk of the material and then file to shape. It is necessary to use a half round smooth file to clean up the concave radius.
10. Remove clamping bolts and drill out 5 mm dia holes to 9 mm dia. Clean edges to blend into slot.
11. Mark the edges of the 45° slot on each of the legs. Using a smooth file take the material down to just above the line checking that the 45° angle is being maintained by use of a square.
12. Drill the 1.7 dia end holes, it is important that the holes should be drilled square otherwise when the points are fitted they will not line up with each other.

2 Sliders

Can be made from either brass sheet or bar.

1. Cut square at 14 mm.
2. Mark off the position of the centre. (The easiest way to do this is to join opposite corners with diagonal lines, and centre 'pop' the position where the lines cross).
3. Mark off a line at 2.5 mm along two edges and on one face this is the amount of material to be removed to make the angle of 45°. File down to the line checking that the angles are even and equal.
4. Drill one of the sliders at 5 mm dia item 2, and one off at 2 B.A.

4 Clamp Screw

1. This is a straight-forward turning operation and should present no difficulties.

5 Stud

1. Start off with a length of about 30 mm × 5 dia bar. Thread one end for about 10-12 mm.
2. Thread the other end of the bar until an unthreaded section of 5 mm remains in the centre.
3. Screw into item 3 noting that the direction of the stud is on the 45° direction on the slider.
4. Cut off the surplus screwing just clear of the slider face. File flat.
5. Measure 11 mm from the other face and cut the stud off, slightly radius the top and remove any sharp edges.

6 & 7 Brass Washers

1. Mark out on brass sheet, drill and file to dimensions given. Ensure when washer is finished, it is flat and free from sharp edges.
   An alternative method of making washers is shown below. Rough brass blanks are drilled at 5 mm dia and a small tool used to stamp out the profile with a hammer.

8 Pointer

1. These are made from 16 SWG Piano wire.
2. To ensure that the points are consistent it is worthwhile making a simple jig to hold the wire at the correct angle while being ground. See sketch below.
3. After grinding cut off to 35 mm long and send for chrome plating.

9 Spring Washers

1. These are made from spring steel strip 12 mm wide × 28 SWG thick.
2. Mark out the 5 dia hole and the outside dia of 12 mm.
3. With the spring steel in the annealed condition drill out the 5 dia holes and cut out and file the O/D te 12 mm dia (if a punching tool to cut out the brass washers has been made this could be used to stamp out the O/D provided the faces of the tool were hardened and the clearance increased to about .2 mm.
4. To make the dish shape select a small hammer with a ball pin end, place in vice with ball upper-most, place washer on ball and select a piece of tube with a bore of about 10 mm locate over washer and strike end of pipe. This should now produce a washer as shown in the drawing.

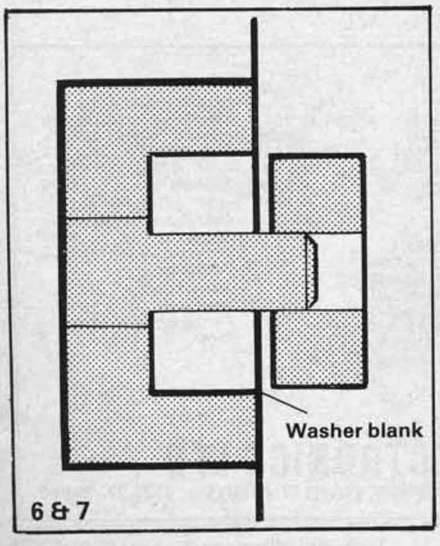
Assembly of Dividers

Take the legs item 1 and pointers item 8. It is important that the pointers on each of the legs are set at the same length, if they are not the accuracy will be affected. To ensure that the pointers are set equal after 'aralditing' set legs on a flat surface one on top of the other and then use a square to ensure the pointers at each end are level; leave to set after checking.

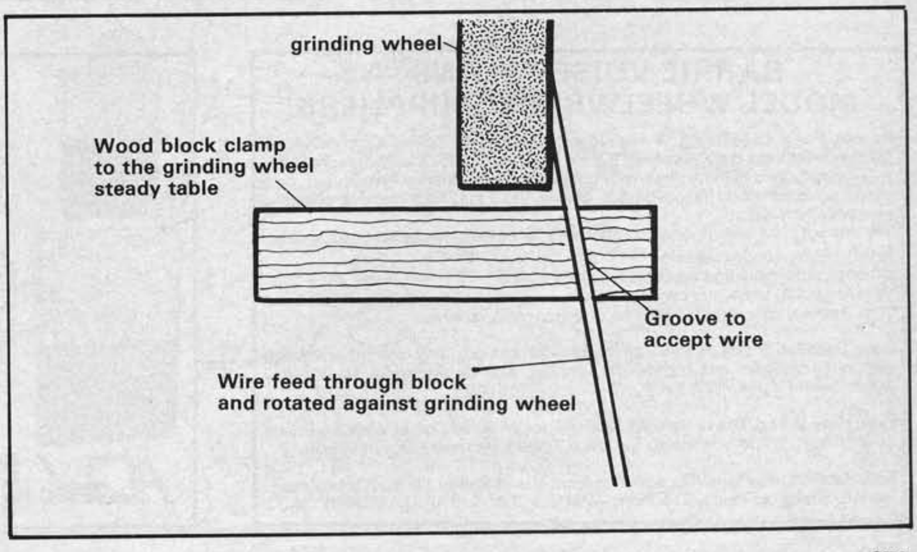
The rest of the assembly is fairly straight-forward, ensure the sliders items 2 & 3 are a good fit in the vee slots, over the full length slight inaccuracies may be removed by careful filing of the slot.

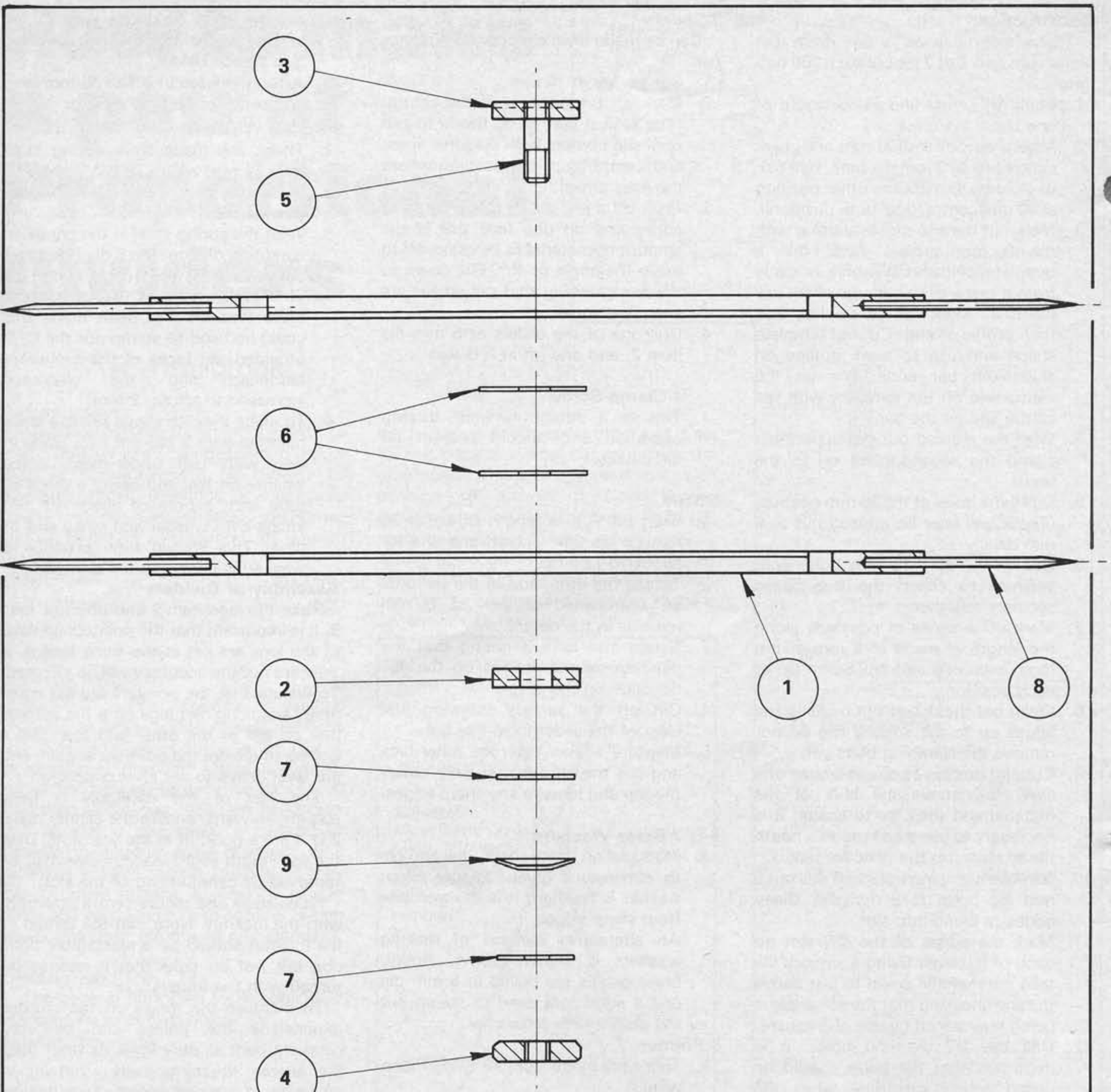
Fit washers and secure centre assembly with the locknut. Note that the thread in the locknut should be a reasonably tight one but not so tight that it cannot be turned with the fingers.

To increase the range on the smaller dimensions the points can be very carefully bent slightly inwards until they are almost touching each other. It is advisable to use some form of protection on the pointers to stop them from being damaged.



6 & 7

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Radio Control Land Yachts

Some successful experiments by G. T. SMITH

THIS ARTICLE on model land yachts is the offspring of a recruiting campaign by one club for more members, the club being H.M.S. Collingwood's Radio Control and Modelling Club.

What the club needed to attract attention was working models on the parade ground instead of miles away at lakes and flying sites. The parade ground, being large with low profile buildings on three sides, rarely suffers from lack of wind. With these conditions, land yachts sprang to mind. They are seldom seen, espcially model ones. None of the existing club members, or myself, have ever seen one so we had no idea of their performance capabilities.

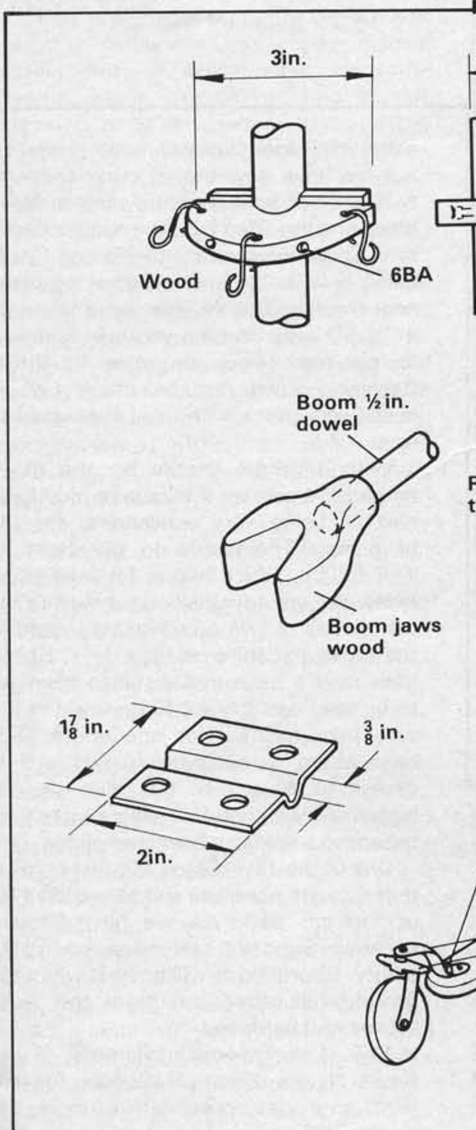
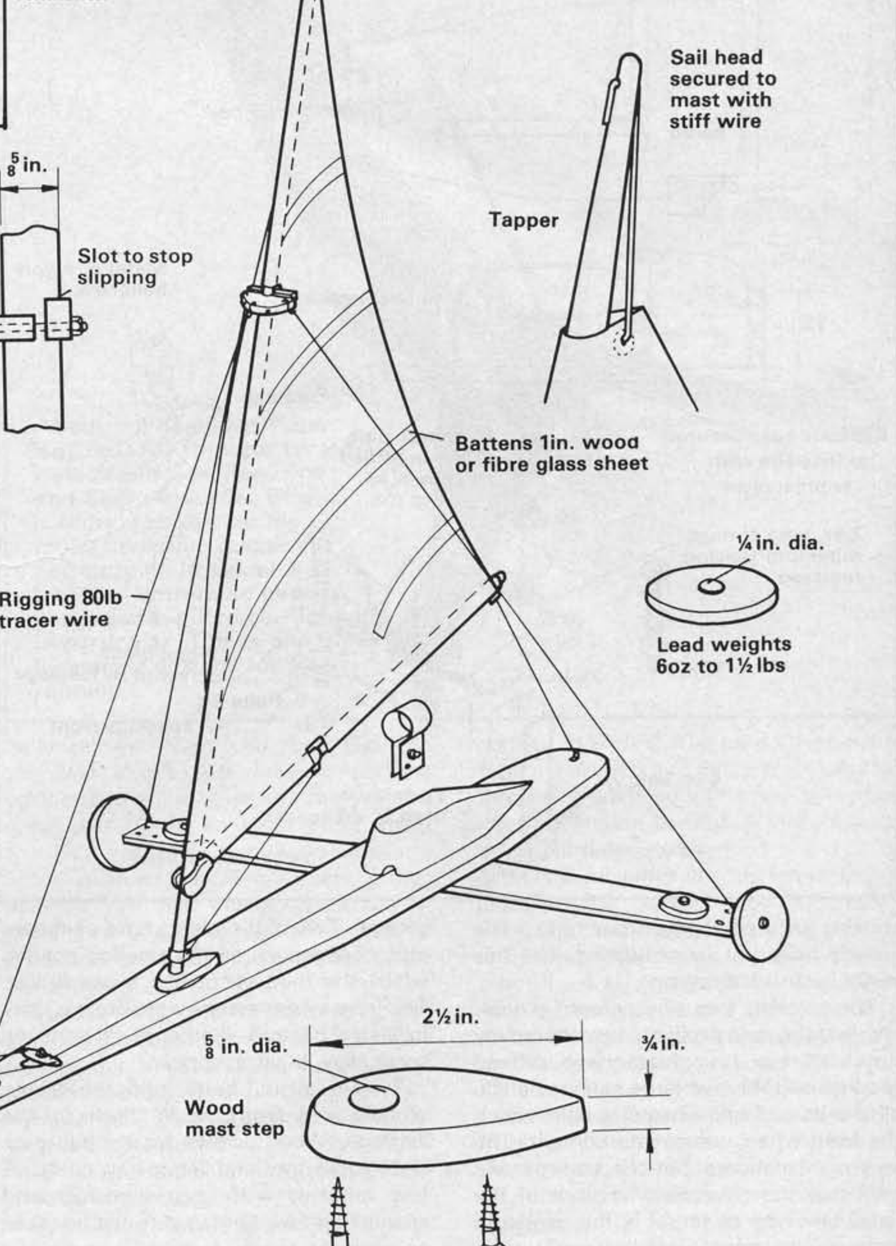
With the aid of a book on "Landsailing", by G. Siposs, which we had recently discovered, we planned our yacht, ending up with a modified American D.N. class ice boat.

With saws, drill, etc., Ian, my son John and I set to work. The scale chosen was 1:3 from the real ice boat. This gave us a 6 ft. mast and a 4 ft. fuselage. 4 ft. planks, 6 in. wide and ½ in. thick were shaped, as was the 34 in. plank which carried the rear wheels. The woodwork was primed and painted with ordinary household paints.

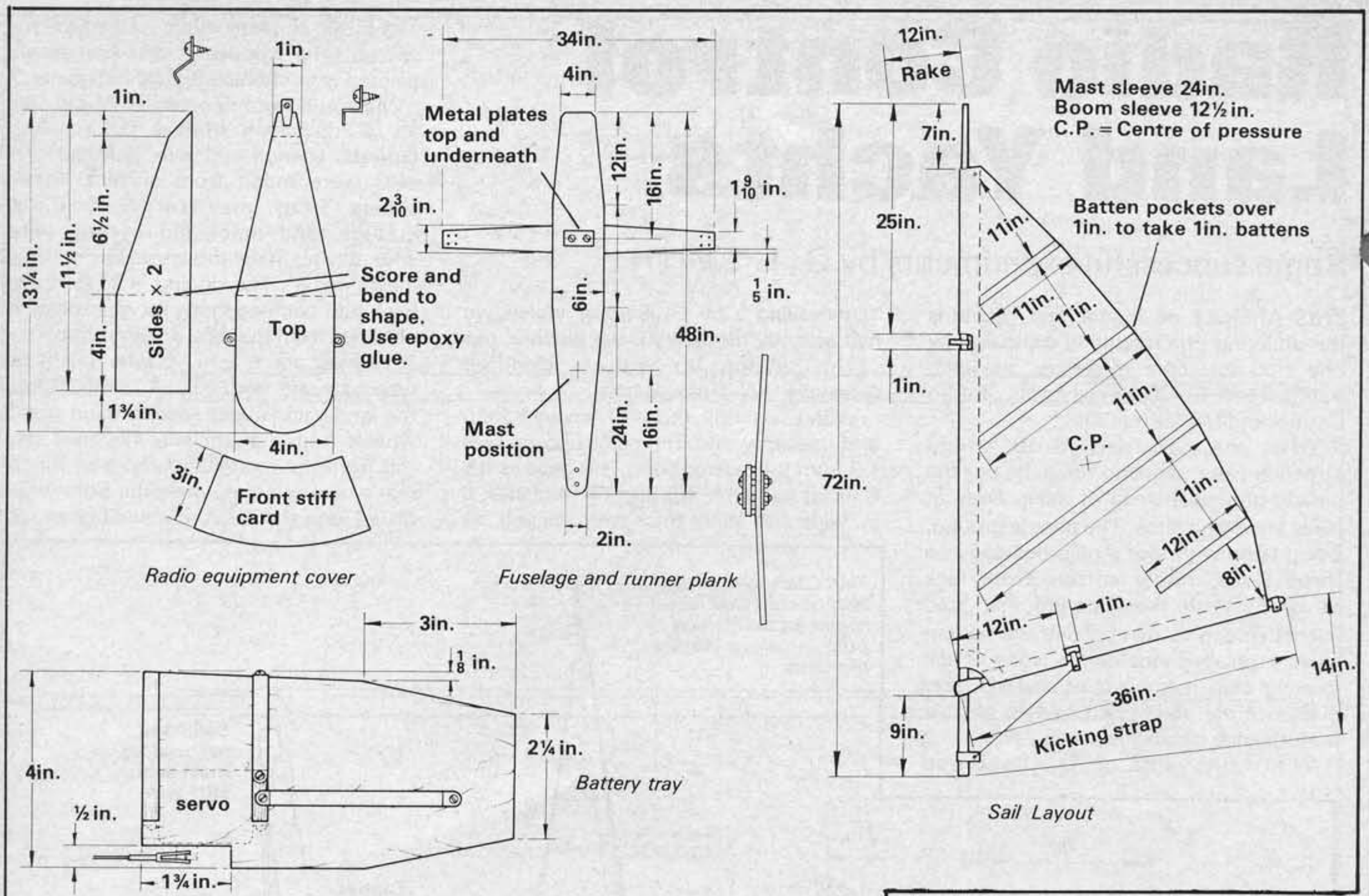
Mast and boom consisted of $\frac{5}{8}$ in. and ½ in. dowelling from a D.I.Y. shop, tapered, stained and wax polished. The sails were made from surplus cotton sheets (they may be dyed if required), and machined by my wife, who, having made three sets has declared 'never again'. The rigging is 80 lb. tracer wire with crimped loops for quickness, all obtained from the local angling shop.

Wheels are 6-7 in. plastic pushchair type obtained from a D.I.Y. shop. One of the land yachts uses second-hand plastic wheels from a pushchair, $\frac{3}{8}$ in. mild steel rod from the model shop is used for the rear wheel spindles, while the front wheel uses a long shank $\frac{3}{8}$ in. nut and bolt or rod,

The Collingwood class land yacht. One good source for sail material is from a drapers remnants.

Collingwood class land yacht

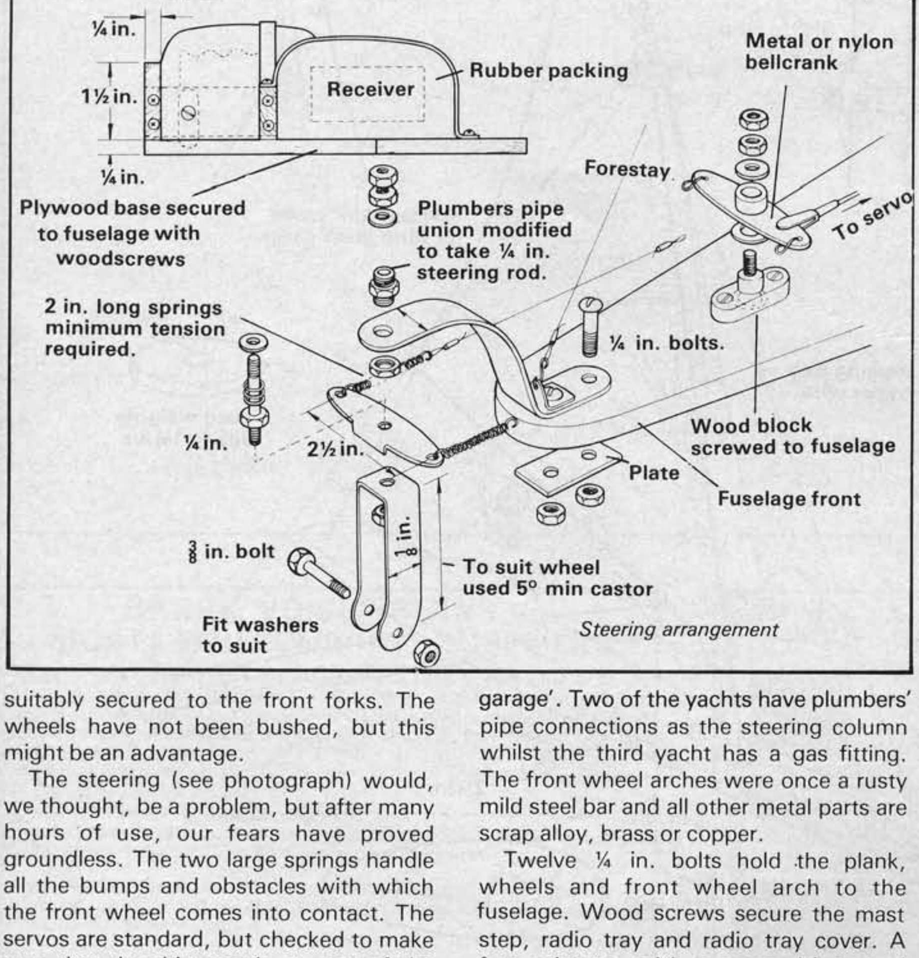


Radio equipment cover

Fuselage and runner plank

Sail Layout

Battery tray



Steering arrangement

suitably secured to the front forks. The wheels have not been bushed, but this might be an advantage.

The steering (see photograph) would, we thought, be a problem, but after many hours of use, our fears have proved groundless. The two large springs handle all the bumps and obstacles with which the front wheel comes into contact. The servos are standard, but checked to make sure that the drive teeth are not of the small fine type as found in the miniature servos. The metal parts are made from 'that heap of rubbish in the corner of the garage'. Two of the yachts have plumbers' pipe connections as the steering column whilst the third yacht has a gas fitting. The front wheel arches were once a rusty mild steel bar and all other metal parts are scrap alloy, brass or copper.

Twelve ¼ in. bolts hold the plank, wheels and front wheel arch to the fuselage. Wood screws secure the mast step, radio tray and radio tray cover. A few minutes with a screwdriver and spanner and the land yachts can be taken on a bus.

Our first trials saw many two-wheel acrobatics and capsizes were frequent, but we have now armed ourselves with two pairs of lead weights, melted down scrap and moulded in 1 oz. round tobacco tins. These weights are drilled and fitted, using ¼ in. bolts, to the ends of the plank near the rear wheels. The weights are ¾ lb. and 1¼ lb. so on a very windy day, 2 lb. per rear wheel can easily be fitted. Capsizing is now rare, but lifting a wheel is still very much with us, I'm pleased to say.

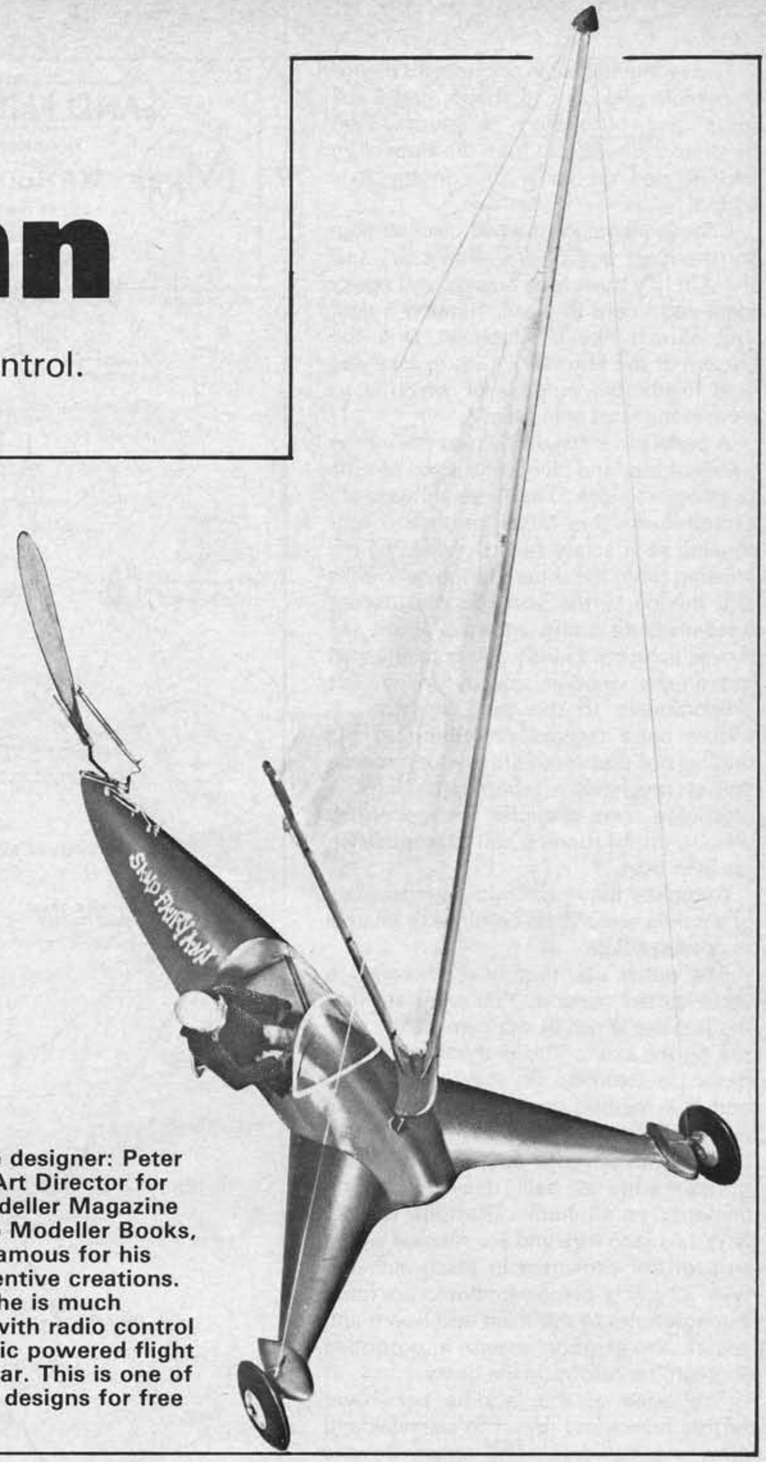
With all three yachts on the move around the course, it is quite a picture as well as being very exhilarating for the helmsman. The yachts do 'go about' as well as jibe, which makes for interesting races. We are now looking forward to the completion of two more yachts to add to the thrills and spills on race days. Speed trials over a measured distance have yet to be tried and this we hope to do in the very near future. Our spectators have been heard to estimate speeds well in excess of 30 m.p.h. but then we are biased and will therefore say no more until the speed trials have been completed.

One of the advantages of land yachts is that they are noiseless and so are ideal for use in car parks as we have proved because Sundays see many car parks empty. Sports fields will be tried when the ground has dried out from the rainy season and hardened.

H.M.S. Collingwood incidentally, is the Royal Navy's Electrical School for the fleet, so it was appropriate to show the electrical flash on the sail and name the land yachts the Collingwood Class.

Sand Fairy Ann

A free sailing land yacht with vane control. Designed by W. P. Holland



About the designer: Peter Holland, Art Director for Radio Modeller Magazine and Radio Modeller Books, is world famous for his many inventive creations. currently he is much involved with radio control and electric powered flight in particular. This is one of his earlier designs for free running.

THUS lightheartedly christened, our latest yacht trundled down its slipway to its native habitat . . . LAND. Why worry if you live far from a suitable pond? *Sand Fairy Ann* will perform happily on any car park, hard court or playground, and is just the model to start a racing hobby new to the model field. In view of the excitement caused by the full-size yachts, it is surprising that comparatively few models have been made of land yachts.

There should be no reason why model land yacht racing should not become an energetically supported sport using a vastly greater number of handy venues.

There is plenty of scope for design, and whilst considerably less costly than a sailing craft or similar size, the same careful design can be put into chassis planning as is lavished on hulls, a big advantage being adjustability, even during a day's trimming . . . just imagine a yachtsman with an elastic-sided hull!!

Seriously though, this sand yachting business is great fun, whether you "sail" for competition or not, and this little model has attracted considerable interest among the modelling fraternity. The designer, though keeping the functional layout in mind, felt that a little embellishment in the way of a "crew" and cockpit would attract an initial sports following, with a view to starting model racing organisation capable of growing to a national following.

Perhaps it would be pipe dreaming, but try these for rules:

1. Sail area similar to existing model sailing craft rules.
2. Total weight of movable ballast, 2 oz./100 sq. in. sail.
3. Maximum track, ⅓ sail peak above ground.
4. Maximum movement of movable ballast, ½ track.
5. Steering to be operated by radio or direct action of wind on sail or vane.
6. Racing beat and run, course marked out with tape or cord with bollards for markers.
7. Penalty for third touch on any one board, leg, or tack.
8. Retrim prohibited in same leg.

A separate radio-controlled class could be used for speed steering events round a tortuous course on small tracks.

Well, now, let's get down to building. *Sand Fairy Ann* is a kitchen table model, so do not be worried by the apparent technicalities. When you see it working you will realise just how simple the solutions to our problems became in this application. As for vane gear; frightening though it may be to some land lubbers, it is now reduced to its simplest and lightest possible form and needs only a pair of pliers and a dab or two of solder to produce a self tacker to keep your model "on the rails".

Start by cutting the chassis parts from $\frac{1}{8}$ in. ply, glue together and add $\frac{1}{8}$ in. balsa formers for body and front outriggers. Make the front axle blocks from $\frac{3}{8}$ in. beech or oak, glue to outriggers and drill to take stub axles (unashamedly 1½ in. nails!). Slot and drill for bellcranks and file to streamline shape.

By now the formers should be ready for covering. Note that the outriggers are covered first, followed by adding the top parts of F1 and F2. The mast step is made from a 4 BA bolt and nut, a piece of brass tube being soldered to the end of the bolt after running on the nut. A strip of brass or tinplate is soldered to the nut as additional support, and the whole unit is glued to the chassis, tube uppermost. Complete the $\frac{1}{16}$ in. body sheeting and add tail block. Drill chassis for rear steering tube (force fit) and bent 16 s.w.g. piano wire rear axle to form a safety pin type spring, finally bringing it through the tube and bending down as reversed tiller.

Secure the rear wheel with a scrap of plastic sleeving from wire covering. Rubber-tyred wheels are a "must". Streamlined sponge rubber of the type sold for model aircraft are shown. 2 in. front and 1½ in. rear. In order that weather may not hold up operations, a set of skis are illustrated as an accessory.

The swinging seat is cut from 18 s.w.g. aluminium and bent to shape, and 6 BA bolts and nuts from a pivot. Two bellcranks are also cut from the aluminium and pivoted on panel pins in the axle blocks.

Choose a straight-grained piece of pine for the mast and boom, $\frac{3}{16}$ in. × $\frac{3}{8}$ in. Cut the $\frac{3}{16}$ in. ply mast foot bracket and epoxy mast and boom in place, forming a rigid unit almost like a wingsale. Drill the bottom of the bracket 1½ in. to take nail (less head), the purpose of which is to pivot in the mast step tube.

A panel pin is fixed in similar manner at the mast top, and pivots in a scrap of tube or perspext block. The three shrouds are attached to this latter unit, the rear running to a screw hook forward of the steering tube, the others to the bellcranks and thence to the seat, so that excess wind pressure acting sideways on the sail moves the mast slightly and pulls the seat out on the weather side by an amount proportionate to the wind strength. A rubber band returns everything to the original position. So there is your movable ballast mechanism, simple, isn't it? A plasticine crew provides the necessary weight, aft for running and to weather on reach or beat.

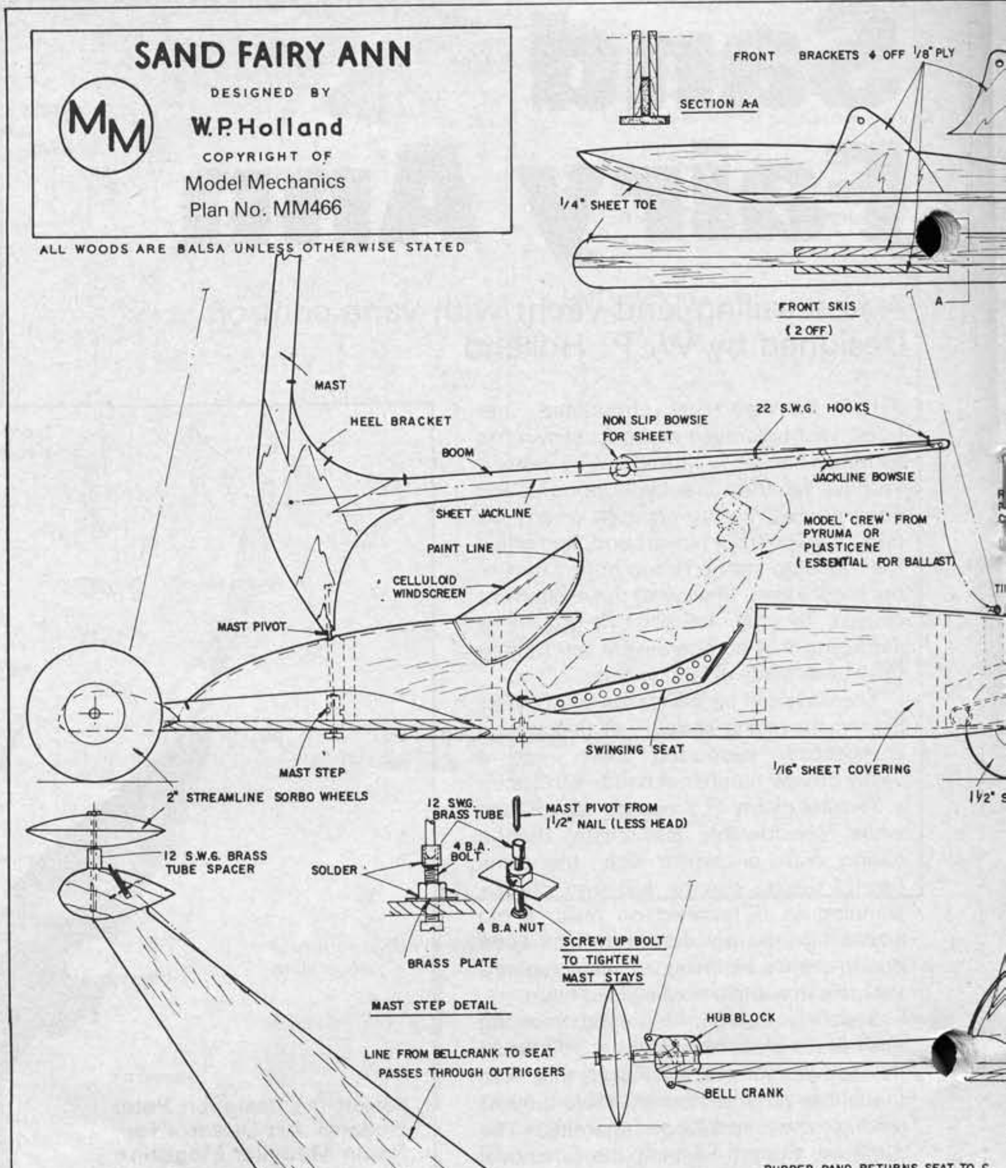
Complete the model with several coats of sanding sealer then cellulose or enamel to desired colour.

The rather unorthodox rig warrants a word on sail making. You will note that the jackline is run in the hem of the sail, not on the spars. This is the result of the desire to clean up on mast turbulence, and is a method used successfully on a number of the author's sailing craft. Cut the sail with selvedge parallel to the leach or rear edge of sail, use polystyrene cement for all hems. Battens are 22 S.W.G. piano wire and are secured with a strip of silk cemented in place over the wire. 22 s.w.g. piano wire hooks are fitted through holes in the mast and boom and secure the jackline where it protrudes through the cutouts in the hems.

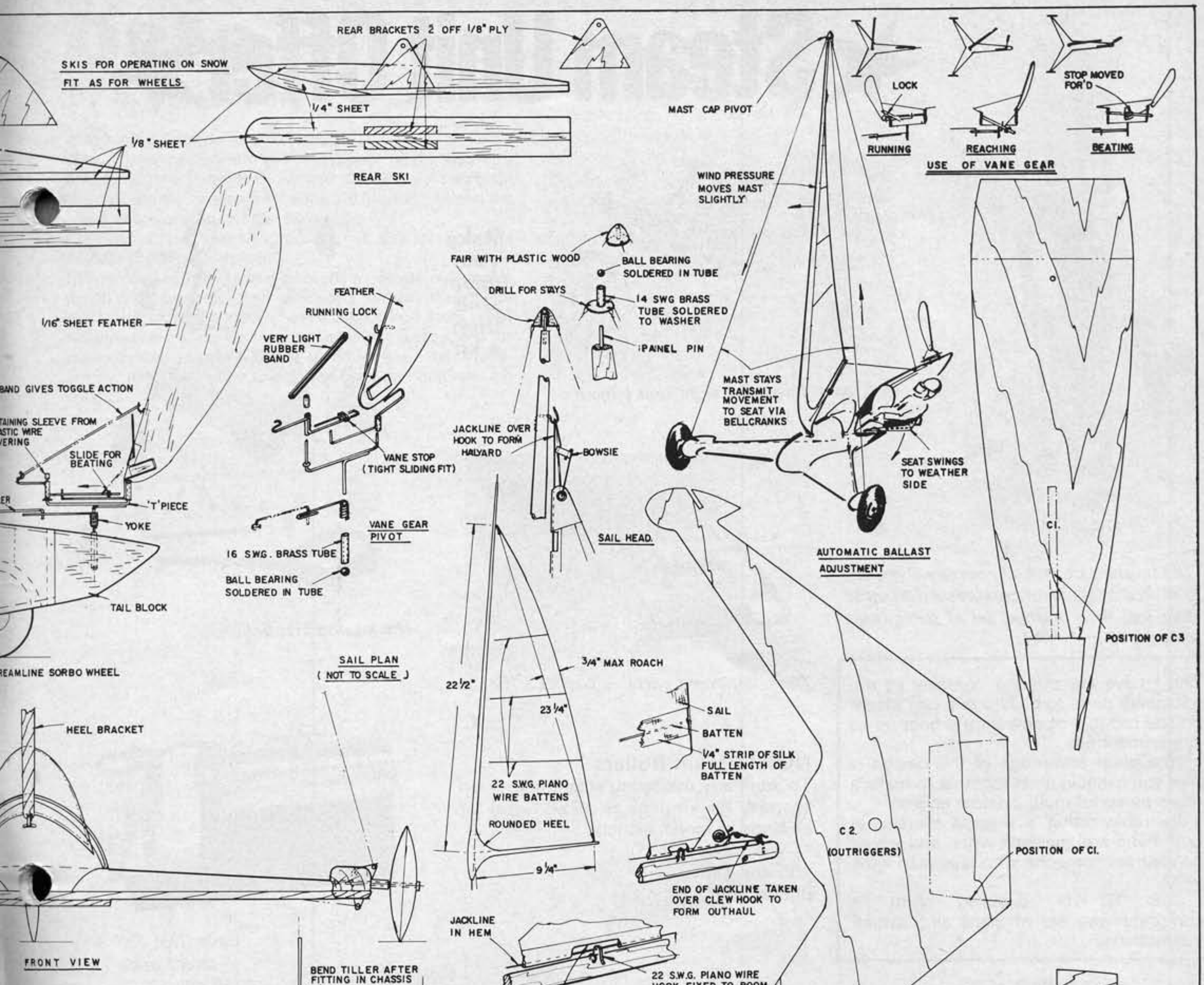
The ends of the jackline pass over further hooks and return to sail peak and clew via bowsies. The sheet bowsie should be of the non-slip type.

The vane gear should be self-explanatory from the plan, but a little extra gen may be useful. The tube bearings contain a ball bearing or lead shot forced in place. Be careful to file or grind the ends of the wire smooth to bear on the shot. Wind the tiller link on a piece of 18 s.w.g. wire if difficulty is experienced in obtaining a sufficiently tight grip on the tee post.

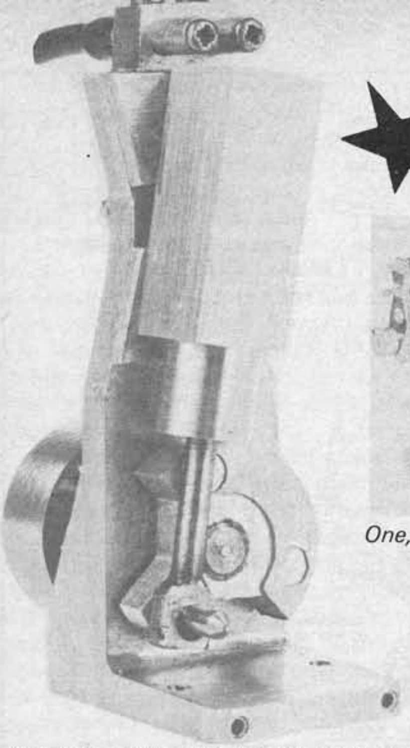
To trim for closer tack slide the stop forward on the vane yoke. The running lock drops over both vane arm and yoke. The newcomer to vane gear will find this little unit simple to operate, and being on terra firma, a close inspection can be made whilst in action.



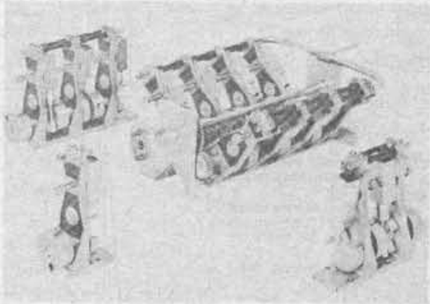
Full-size Plans are available as Plan No. MM466 at £1.10, plus 20p postage, from M.M. Plans Service, P.O. Box 35, Bridge Street, Hemel Hempstead, Herts.



REAR BRACKETS 2 OFF 1/8" PLY
SKIS FOR OPERATING ON SNOW FIT AS FOR WHEELS
1/4" SHEET
1/8" SHEET
REAR SKI
1/16" SHEET FEATHER
BAND GIVES TOGGLE ACTION
SLIDE FOR BEATING
'T' PIECE
YOKE
TAIL BLOCK
EAMLINE SORBO WHEEL
HEEL BRACKET
FRONT VIEW
VANE GEAR TUBE
F8
TO MAST CAP
PIVOT ON PANEL PIN
BELLCRANKS 2 OFF 18 SWG. ALUM.
TO SEAT
SIDES & BACK UP
3/8"x 3/16" SPRUCE TAPER & SAND TO STREAMLINE SECTION
MAST
FEATHER
RUNNING LOCK
VERY LIGHT RUBBER BAND
VANE STOP (TIGHT SLIDING FIT)
VANE GEAR PIVOT
16 SWG. BRASS TUBE
BALL BEARING SOLDERED IN TUBE
SAIL PLAN (NOT TO SCALE)
BEND TILLER AFTER FITTING IN CHASSIS
16 S.W.G. BRASS TUBE
16 S.W.G. PIANO WIRE REAR AXLE & LEG
RETAINING SLEEVE FROM PLASTIC WIRE COVERING
FAIR WITH PLASTIC WOOD
BALL BEARING SOLDERED IN TUBE
DRILL FOR STAYS
14 SWG BRASS TUBE SOLDERED TO WASHER
PANEL PIN
JACKLINE OVER HOOK TO FORM HALYARD
BOWSIE
SAIL HEAD.
3/4" MAX ROACH
22 1/2"
23 1/4"
22 SWG. PIANO WIRE BATTENS
ROUNDED HEEL
9 1/4"
SAIL
BATTEN
1/4" STRIP OF SILK FULL LENGTH OF BATTEN
END OF JACKLINE TAKEN OVER CLEW HOOK TO FORM OUTHAUL
JACKLINE IN HEM
CUT OUTS
22 S.W.G. PIANO WIRE HOOK FIXED TO BOOM AND MAST
MAKE ALL HEMS WITH DUROFIX OR POLYSTRENE CEMENT
MAST CAP PIVOT
WIND PRESSURE MOVES MAST SLIGHTLY
MAST STAYS TRANSMIT MOVEMENT TO SEAT VIA BELLCRANKS
SEAT SWINGS TO WEATHER SIDE
AUTOMATIC BALLAST ADJUSTMENT
LOCK
RUNNING
REACHING
STOP MOVED FOR'D
BEATING
USE OF VANE GEAR
C1.
POSITION OF C3
C2. (OUTRIGGERS)
POSITION OF C1.
C4. 2OFF
C3
F1A
F1
F5A
F5
F6
F7
F8
ALL FORMERS 1/8" SHEET
F2
F3
F4
2 OFF
COVER BALSA SHEETING WITH LIGHT MODELSPAN TISSUE GIVE WHOLE BODY 3COATS OF SANDING SEALER, SAND & FINISH WITH CELLULOSE OR VALSPAR . VARNISH SPARS.
3/16" PLY HEEL BRACKET
MM.466

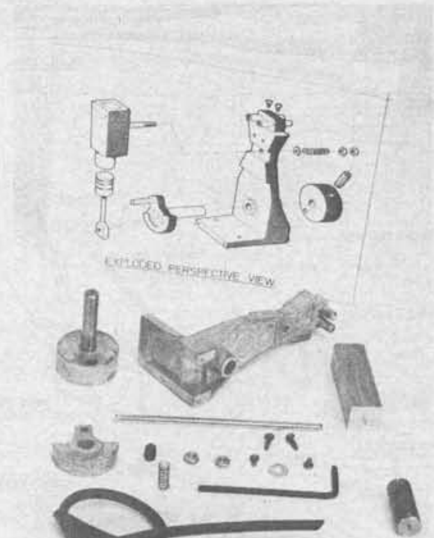


★ Steam Unit Offer ★



One, two, three and eight unit engine.

Make your Steam Unit from a kit



The kit and instructions.

The finished kit, this of course will require a source of steam or compressed air up to 40lb psi. — a finished set of parts costs only £8.75 incl. VAT.

The component parts — costs £3.15.

The kit we are offering contains all the necessary parts to build a one unit steam engine capable of powering a boat up to one metre long.

One great advantage of this design is that you can join units together to make a more powerful multi-cylinder engine.

Its construction is a good exercise in both hand and machine work, and would be ideal for someone who is new to lathe work.

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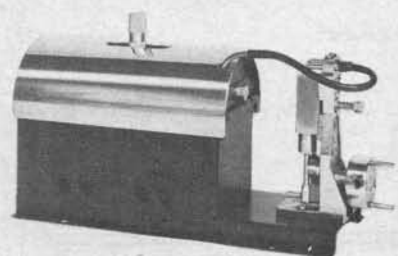
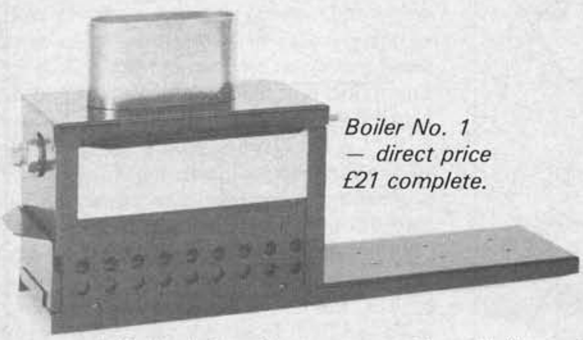
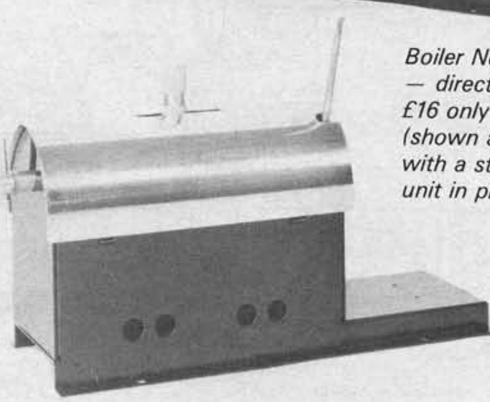


Boiler No. 1 — direct price £16 only (shown above with a steam unit in place).



Boiler No. 1 — direct price £21 complete.

This is designed to run up to three Unit, engines. The base is ready drilled. It uses solid fuel with adjustable side dampers. Base size 270mm × 65mm.



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SPECIAL STEAM UNIT KIT OFFER

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Data

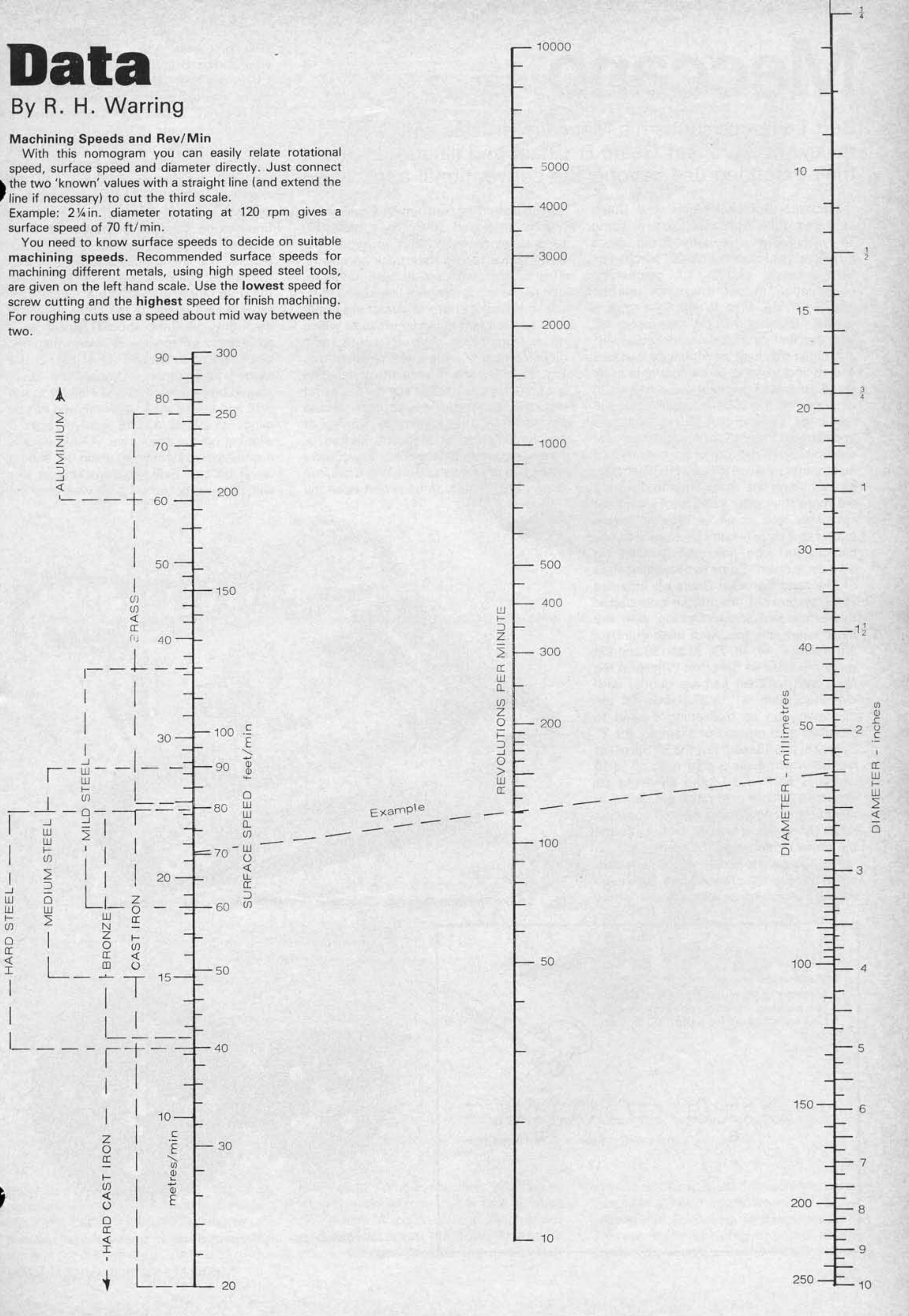
By R. H. Warring

Machining Speeds and Rev/Min

With this nomogram you can easily relate rotational speed, surface speed and diameter directly. Just connect the two 'known' values with a straight line (and extend the line if necessary) to cut the third scale.

Example: 2¼in. diameter rotating at 120 rpm gives a surface speed of 70 ft/min.

You need to know surface speeds to decide on suitable **machining speeds**. Recommended surface speeds for machining different metals, using high speed steel tools, are given on the left hand scale. Use the **lowest** speed for screw cutting and the **highest** speed for finish machining. For roughing cuts use a speed about mid way between the two.



Meccano

Bert Love continues his Meccano articles with a review of Sprocket Gears & Chain and illustrates their extended use beyond the conventional applications.

Meccano Sprocket Gears and Chain appeared quite late in the system, some 14 years after the early brass gears produced for Frank Hornby's "Mechanics Made Easy" system of mechanical construction. In fact, it was not until the middle of the first World War that a special "Inventor's Outfit" appeared and was the first to include sprocket wheels and chain although an American rival was already including such components in its standard sets. The simple wire-link chain is shown in the various illustrations and has been commonly used in industrial applications (early cine-projectors for example) since the turn of the century and its manufacture continues at the meccano factory along the same lines to-day as it did more than sixty years ago! Using the sprockets and chain is a fairly simple matter and usually comes naturally to any constructor who has ever handled his own cycle chain. Some five standard sizes of Meccano Sprocket Gears are included in the system but this may be extended as this article will show. Dealing with the basic range, the following teeth numbers are included, 14, 18, 28, 36 and 56 and the gears are listed as Sprocket Wheels in the Meccano parts list and are quoted with diameters from ¾" to 3". However, the diameters can be misleading if used to calculate gear ratios. For example, the 1" Sprocket has 18 teeth but the 3" Sprocket has 56 which gives a gear ratio of 18:56 which is NOT a 3:1 ratio as might be expected. Where gear ratios are critical in mechanisms depending on the sprocket ratios for timing, it is essential to calculate the ratios by counting the teeth.

Fig 1 shows a simple application of a chain drive to the crawler track (Meccano Plastic Track) of a small excavator where the gear ratio has no timing significance and is employed solely as a reduction drive to increase the effort applied by the motor drive to the final track sprockets. This simple arrangement also underlies one of the weaknesses of link-chain drive, which is subject both to stretching under load and tolerances in manufacture which do not guarantee a 'fixed' length for a given number of links. It will be noted that Fig. 1 shows the drive centres between the sprockets as fixed at standard spacing but the advanced constructor would always arrange for adjustable bearings at one end by use of Meccano slotted or screw adjusted components. Newcomers to the use of Meccano Sprocket Chain are often not sure how to open and close the individual links when connecting up a chain drive. Standard 1 metre lengths of Chain are normally supplied and fresh chain is advisable if a model is to be run on frequent occasions. Starting with a full, or adequate length, the chain is passed round the sprockets and dropped into the teeth valleys with minimum slack between the sprockets. Overlap of the links is carefully noted and the appropriate link is opened as shown in Fig. 2, using a fine bladed screwdriver as used for set screws in small insulated connector blocks. The link should then be joined to the end of the chain length selected and the lugs closed again with a pair of fine taper nosed pliers. If the chain is to run smoothly, all links should appear as a parallel run when viewed "along the line" as illustrated in section 'b' of Fig. 2. If a ragged appearance is noted, the chain should be discarded as it is unlikely to run well and in any case, chain should not be oiled as this is a sure way to start it slipping off the sprockets. A little slack is permissible on running chain (it should never be taut between sprockets as this will put undue strain and wear on the

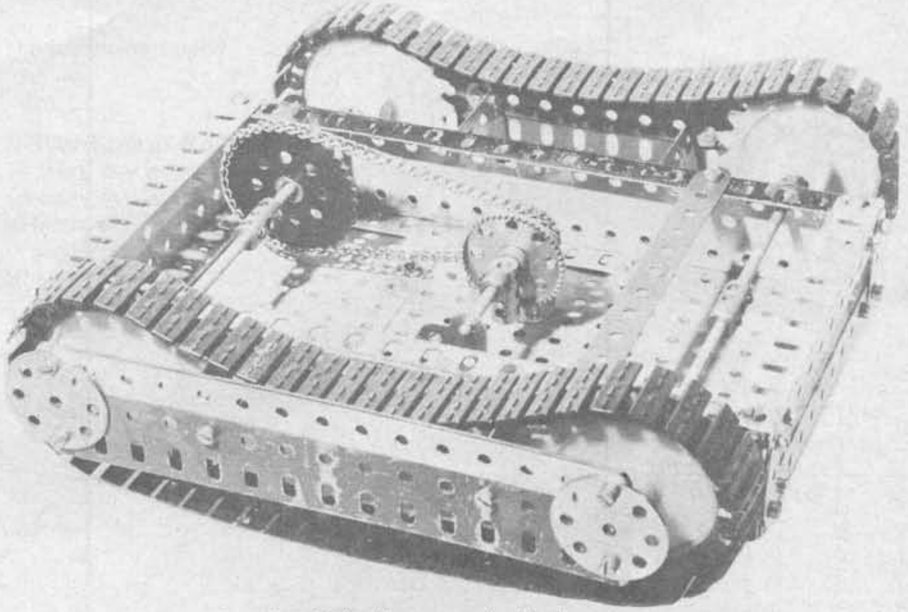


Fig 1 Simple Meccano Sprocket Chain drive to crawler blocks on a model excavator.

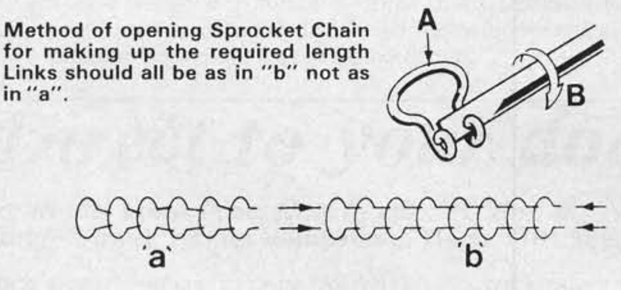


Fig 2.

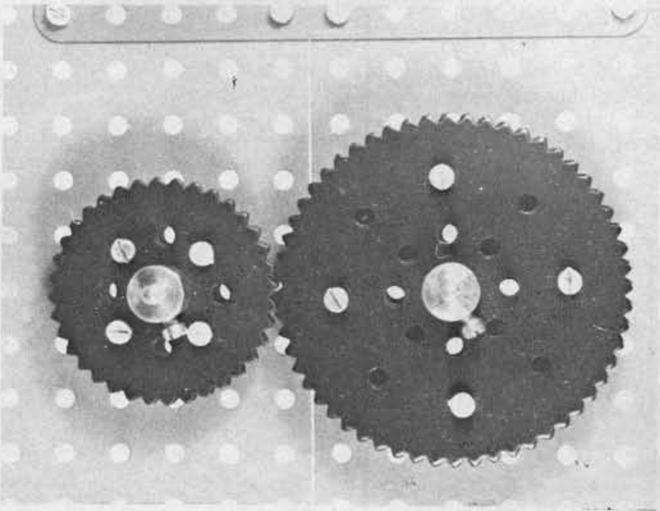


Fig 3 Unorthodox use of Meccano Gears in direct mesh at standard spacing.

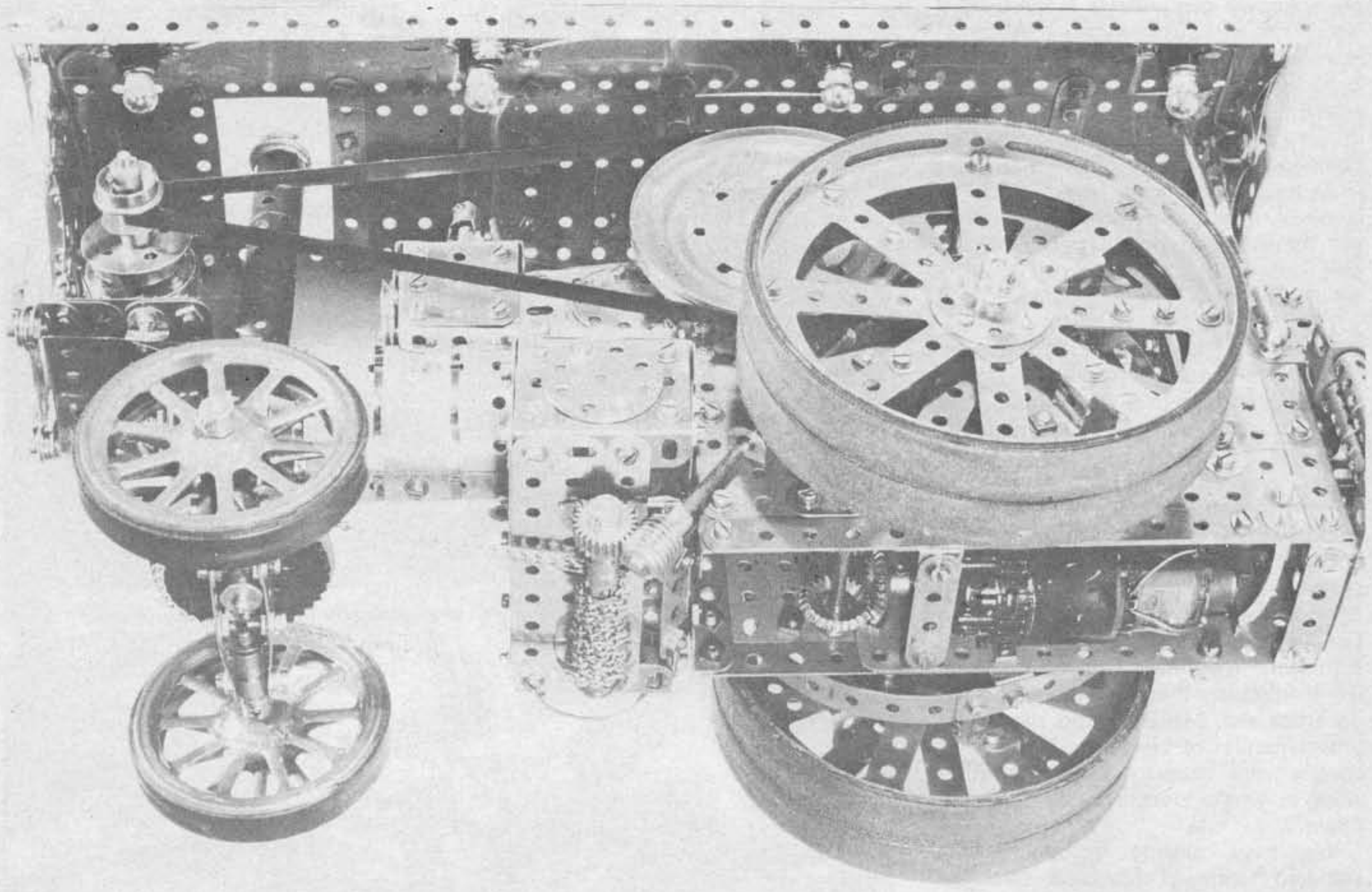


Fig 4 Sprocket Chain used as steering chain on a simple model showmans engine. Winding barrel is studded with Grub screws to provide chain grip.

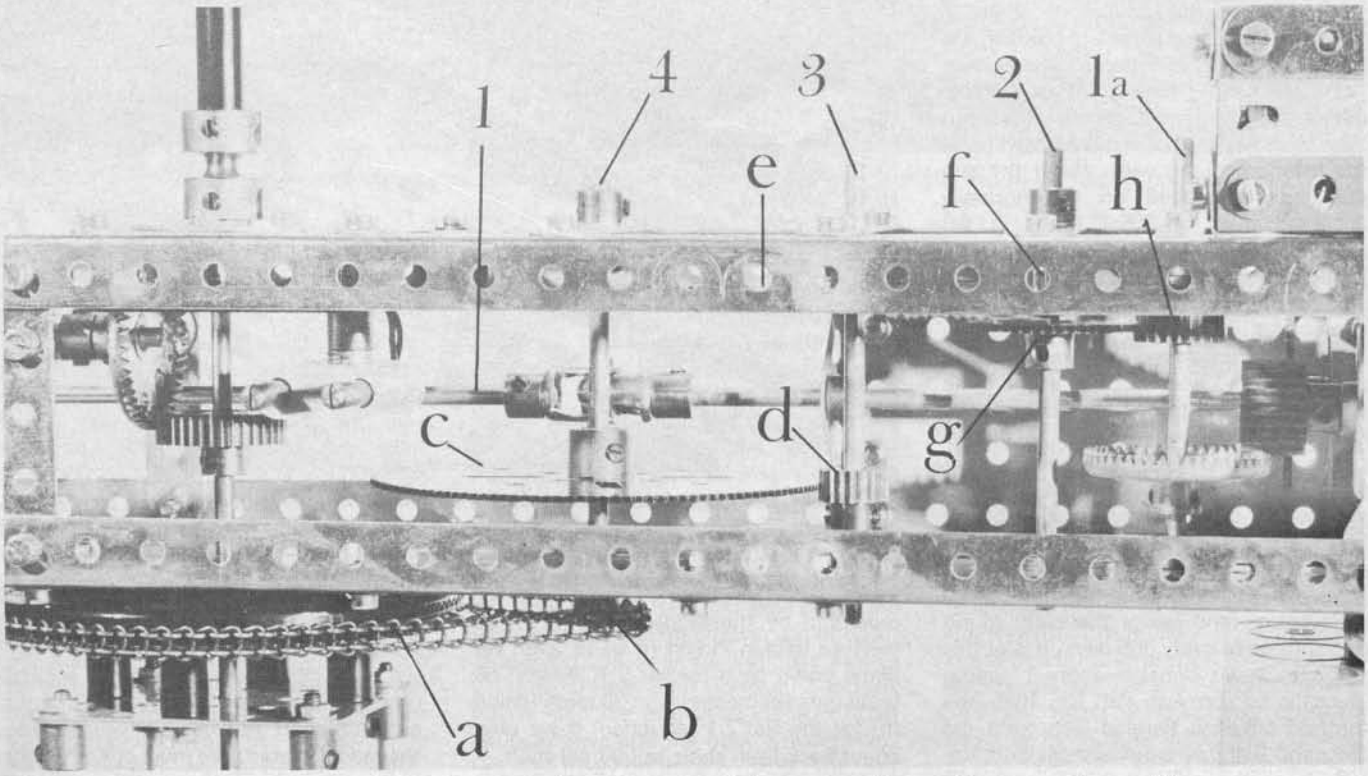


Fig 5 Combining Meccano Sprocket and Gear drives to produce an accurate timing sequence in a working planetarium model.

bearings and motor drive) and if a substantial amount of slack is unavailable, a spring loaded jockey-pulley (sprocket) should be allowed to bear against the outside (or inside) of the slack side of the chain loop. Where possible, this jockey wheel should be mounted to take up slack on the side of the chain loop which is not under tension from the drive. There is a way in which a positive and non-stretch drive may be obtained between Meccano Sprocket Wheels as shown in Fig. 3. by placing the Sprockets in direct contact. This is actually 'cheating' of course as the chain is dispensed with and the Sprockets are acting as gear wheels in mesh. It is interesting to note however, that the 2″ Sprocket will mesh directly with the 3″ Sprocket and at standard (six-hole) spacing. If both Sprockets are "doubled up" and clamped together with compensating washers between faces to allow for the slight inner boss protusions, a pair of rugged gears is produced which will transmit considerable loads. In the case illustrated, a gear ratio of 36:56 is achieved (note this is 1.555 to 1, not 1½:1).

There are alternate uses for the Meccano Sprocket Chain and Fig. 4 shows one such use. This small scale model of a Showman's Road Locomotive employs Sprocket Chain for steering purposes and a winding barrel is made from a series of Couplings or Collars on a standard Rod, and by filling all screwed holes in these components a series of projections is achieved as the Grub Screws employed stand just proud of the Couplings or Collars. This ensures sufficient "roughness" of the winding barrel to ensure that the Sprocket Chain does not slip. Making cargo slings and ornamentation of buildings, railings and bridges with catenary loops are other ways in which modellers use Sprocket Chain.

We have already introduced the standard range of Meccano Gears in previous articles and Fig. 5 illustrates a good example of combining standard Gears with Sprocket drive to achieve a criticial timing chain of gearing. When constructing planetary models, it is possible to achieve laboratory standards from Meccano gears, used in suitable differential or epicyclic combinations but even with the mechanism illustrated here, the rotation of the earth about the sun may be reproduced on the normally accepted ratio of 365:1 (days in the calendar year). Fig. 5 shows the central portion of a boom, carrying a motor drive and counterweight box at one end and a planetary turret at the other carrying an orbiting moon round a rotating Earth globe. Shafts 1 and 1a rotate at the same speed equivalent to one revolution per 24 hour day and hence known as diurnal shafts. The main shaft 1 passes right along the boom and it is from its drive that the moon's orbit and the rotation of the Earth are correctly synchronised. That part of the mechanism with which we are concerned is responsible for rotating the main boom (and hence the Earth round the Sun) once every 365 days. It is at this stage that we depend upon a special Meccano component, Part No. 168b, the toothed ball-race flanged disc from the Meccano Ball Bearing Assembly Part No. 168. It so happens that this part has exactly 73 teeth cut for Sprocket Chain and as 73 is a factor of 365, we may arrange a first reduction from the toothed flange (a) in Fig. 5 to the 14 tooth Sprocket Wheel (b). We "cancel down" the 14 teeth of the Sprocket by a 7:1 reduction from gear (c) 133 teeth to

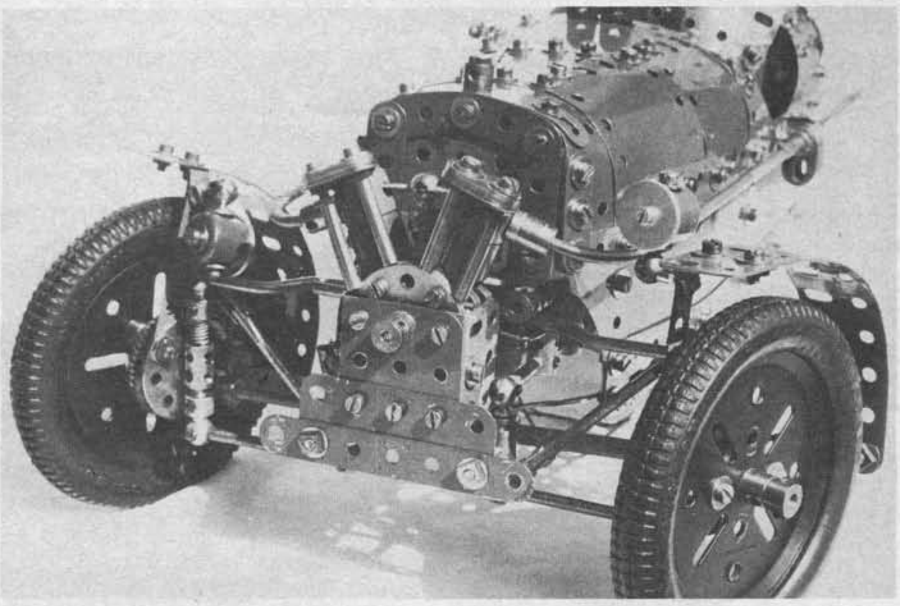


Fig 6 A working model three-wheeler vintage car very suitable for Meccano Chain drive.

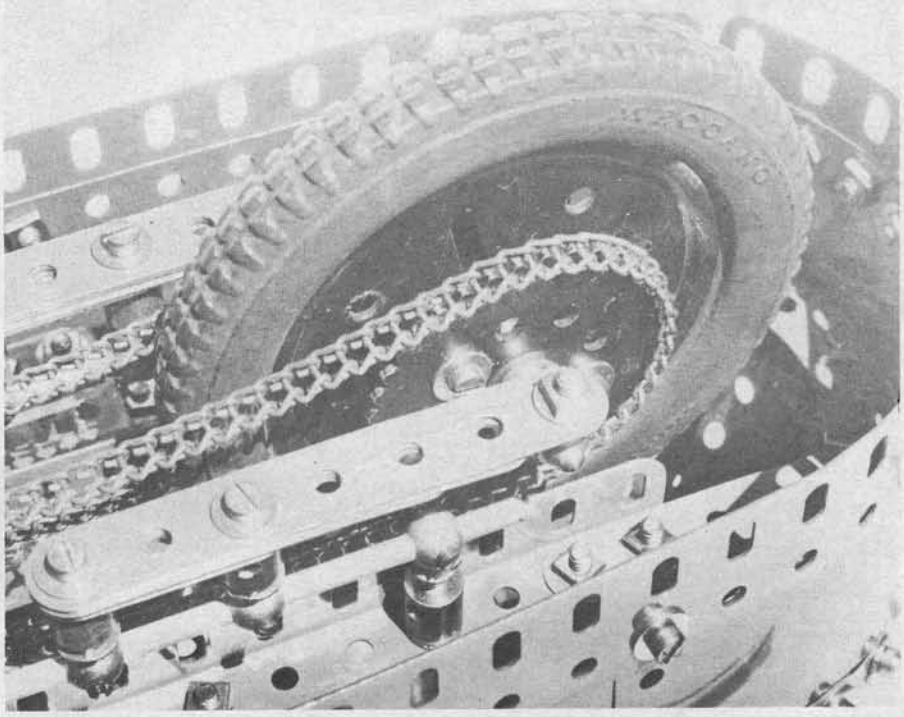


Fig 7 Chain drive to rear wheel of a Meccano model three wheeler. Note cantilever suspension and adjustable slides for chain tensioning.

Pinion (d) 19 teeth. Continuing the reduction by the hidden gear (e) of 95 teeth to hidden Pinion (f) of 19 teeth we come down by a further 5:1. Finally, 50 teeth gear (g) meshes with 25 teeth Pinion (h) for the last 2:1 reduction. If we now count back from shaft 1a (diurnal shatt — one rev. per day) the reduction train via shafts 2, 3, 4 and centre post are as follows $(2{:}1) \times (5{:}1) \times (7{:}1) \times (14{:}73)$. If we now do this as "arithmetic" in fractional form we get $\frac{1}{2} \times \frac{1}{5} \times \frac{1}{7} \times \frac{14}{73}$. Simple cancelling will remove the 14 from the top line to leave us with $\frac{1}{5 \times 73} = \frac{1}{365}$. This means that we will get exactly 365 revolutions of the diurnal shaft for a complete revolution of the boom. Even if we take 365¼ days for a more accurate 'year', it needs only one quarter of a turn extra on shaft 1a *Once per year!* to keep the model in step. We must still remember that we are dealing with generally acceptable measures of time and that because time is a relative matter, there are many other factors which we would have to take into account before sweeping claims of accuracy are made. Nevertheless, the simple gear and sprocket combination outlined shows

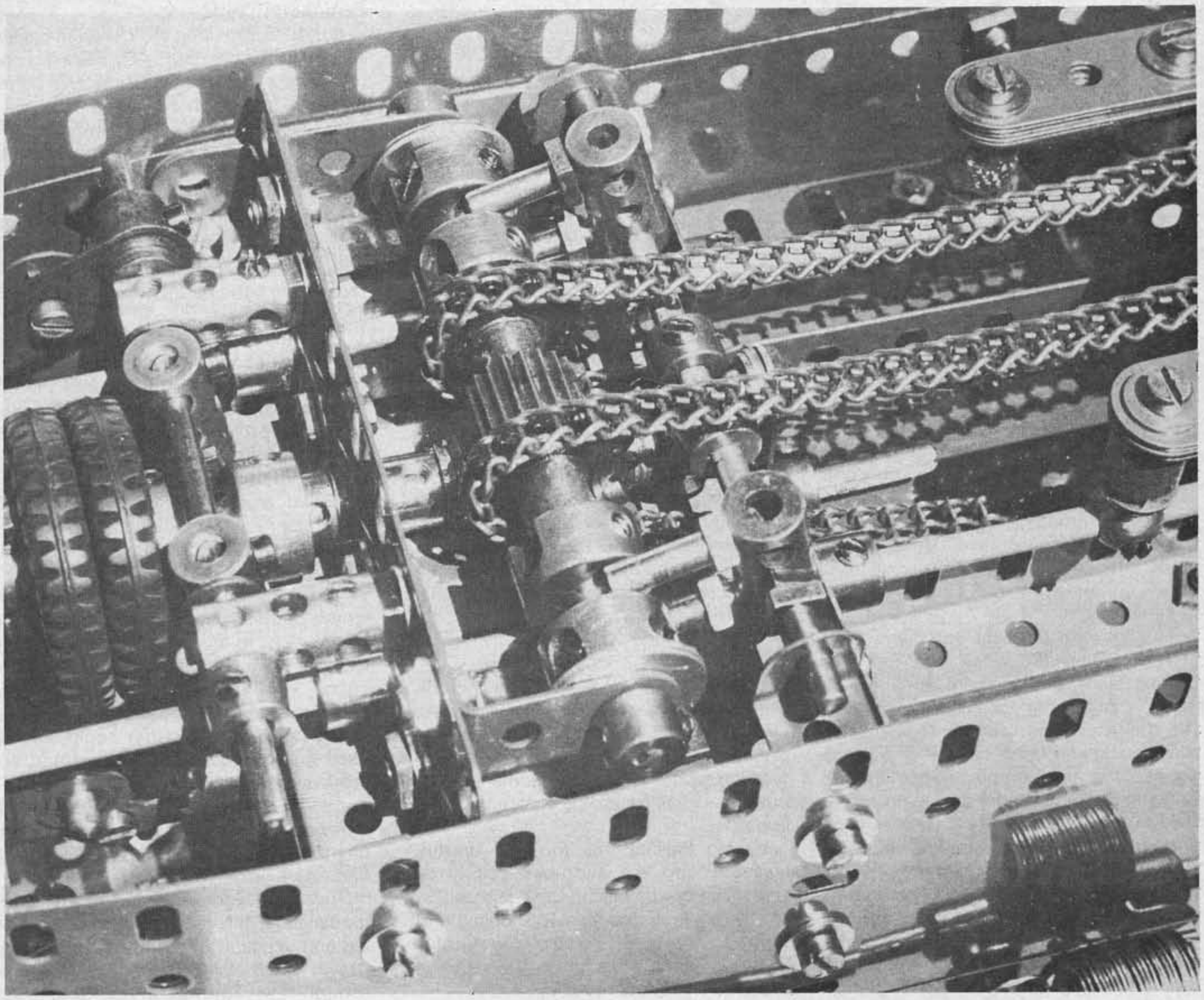


Fig 8 Close-up of the twin chain-drive showing the sliding dog method of changing gear in the simple two-speed "crash" gear-box, using the special Keyway Rod.

how useful the Meccano system can be in one of many branches of science and engineering. It should be noted in Fig. 5, that the toothed ball-race flanged disc is mounted rigidly to a central structure and it is the upper non-toothed ball-race flange that actually revolves with the boom. In other words, the first small Sprocket Wheel (b) "runs round" the centre post inside its own loop of chain. Link size of the original Meccano Chain for Sprocket Wheels has been pitched to fit any of the standard Meccano gears (the 'thin' ones, 50 teeth, 57 teeth, 60 teeth, 95 teeth and 133 teeth) in a ratio of one link of Chain to every *two* teeth on the standard gears. This opens up even further ratios to the advanced constructor who exploits them to increase the standard range of normal Sprocket drives.

Fig. 6 gives a general view of a neatly constructed three-wheeler vintage car reminiscent of the old Morgan jobs with the J.A.P. motor-cycle type engine. Designed and built by Brian Edmonds of Bedford, this model typifies the suitability of chain drive to the rear wheel using Meccano Sprocket drive. Figs. 7 and 8 show that a twin drive to the rear wheel is employed but the two-speed drive attained is by use of different size of Sprocket Wheels attached on either side of the rear wheel. Fig. 8 shows a 2" Sprocket (36 teeth) bolted on to the 3" Pulley with Tyre but on the far side, a 1½" Sprocket (28 teeth) is similarly attached. It will be noted from Fig. 8 that cantilever leaf springs are used for mounting the rear wheel and these springs are secured to Meccano Threaded Bosses fitted with Handrail Supports (part No. 136) so that they can slide along the Axle Rods shown for adjustment of chain tensioning. Bearings for the back axle (a 2½" Rod) are also Handrail Supports which hold the axle in place with fitted Grub Screws and the back wheel simply revolves freely on the 2½" Rod. The very simple two-speed "crash" gear-box relies on another special Meccano item, Part No. 230, Rod with Keyway. This runs across the car as seen from below in Fig. 7 and has a 19 teeth Pinion of ½" face fixed in the centre and picking up the drive from a Worm gear on the output shaft from the clutch mechanism. On either side of the fixed Pinion are ¾" Sprockets, free to turn on the Keyway Rod but fitted with "Shouldered Bolts" taken from a Meccano Universal Coupling (one shouldered bolt in each Sprocket). Towards either end of the shaft, Socket Couplings are fitted, free to slide laterally on the Keyway :Rod but fitted with an internal Collar which carries the special Meccano Keyway Bolt. This special bolt has a fine turned tip which fits into the slot of the Keyway Rod, allowing the Socket Couplings to slide but ensuring that they rotate all the time that the Keyway Rod is turning. A pair of ordinary Couplings fitted with short Threaded Pins engage the waist of the Socket Couplings and are fitted to a sliding cross-rod operated by a simple sideways movement of the "joystick" in the Morgan cockpit! Each Socket Coupling has a slotted section which engages the heads of the shouldered bolts in the ¾" Sprockets, one at a time and hence alters the speed of drive to the back wheel. Very similar components are used to disengage the 1" Pulleys with Tyres used as clutch plates which can be seen at the left of Fig. 7.

The 'Eagle'

A simple 2½ in. gauge 4-4-0 locomotive
By Martin Evans

THE CROSSHEADS for *Eagle* are about as simple as I can make them consistent with a realistic appearance. I have always thought it a great pity that in the attempt to make a model locomotive as easy to build as possible, some designers specify for a crosshead what I can only describe as an oblong slab of metal!

A mild steel crosshead does not work too well against steel slide bars, so ours will be made from gunmetal. Possibly one of our castings suppliers will be able to supply gunmetal castings for the crossheads which will save a great deal of work. Alternately, they can be cut from drawn gunmetal, ¾ in. × $\frac{3}{8}$ in., which is a commercial size.

To deal with the cast crosshead first, start by filing the sides and top and bottom faces, getting them as square as possible and to the dimensions shown on the drawing. Next, set up the vertical-slide facing the lathe spindle and get it square by the simple expedient of bringing the whole lathe saddle up to the face-plate until the vertical-slide is hard against it, when the clamping bolts are tightened. If a small machine vice is available that can be clamped or bolted to the vertical-slide, this will be ideal, as each crosshead can then be held in this, on its side, and an end-mill of $\frac{3}{8}$ in. dia. used to face the top and bottom surface of the crossheads, but note that the centre of the crossheads must be brought to exact lathe centre height first.

Now change to a ¼ in. end-mill and mill out the slots for the slide bars, $\frac{1}{32}$ in. deep. If the lathe is fitted with a graduated handwheel to the lead screw, it is very easy to get the slot to the exact depth. If not, the depth will have to be measured—a simple way is to hold a $\frac{1}{32}$ in. drill, or a piece of flat metal of this exact thickness, in the slot, while holding the blade of a try-square against it. Although this may sound a rather crude method, with a little care, one can get the slot correct to within a "thou" or two.

Incidentally, having milled one surface and its slot, the crosshead is turned round, and to get it quite square to the end-mill again, use a true piece of bar of such a thickness that when put between the crosshead and the back of the vice, the crosshead protrudes just enough from the vice jaws to enable machining to proceed. Pressing the crosshead against this bar while tightening the vice will ensure that it is presented truly to the end-mill.

If no suitable machine vice is available, the vertical-slide set-up can still be used, but before machining the top and bottom surfaces and the slide bar slots, drill for the gudgeon pin, but only with No. 27 drill at this stage. Now set up a piece of steel angle about 3 in. long, 1 in. × 1 in. angle will do nicely provided that the angle is really at 90 deg., bolting or clamping it to the face of the vertical-slide.

A No. 4 BA tapped hole is now required in this angle, at such a distance from the outer edge that when the crosshead is bolted down, it will overhang by about $\frac{1}{16}$ in. Set the crosshead square by bringing it up to the blade of a try-square held between it and the lathe faceplate, while tightening the screw. (Use a socket-head screw or bolt with a brass washer under the head.)

End-milling

End-milling can now proceed as before, but take only very light cuts or the crosshead will be twisted round under the pressure from the end-mill. If it persists in twisting round, teach it better manners by putting a small toolmaker's clamp against one side.

Having finished the top and bottom surfaces and the slide-bar slots, the crosshead can be held in the 4-jaw chuck, set to run truly and the neck drilled and tapped $\frac{5}{32}$ in. × 40T. (Use $\frac{1}{8}$ in. drill), finishing with a plug tap to the required depth.

To complete the crosshead, we have to open out the body of it to take the small end of the connecting rod. For this we need a $\frac{13}{32}$ in. pin-drill (obtainable from model engineers' suppliers such as Reeves, Kennions, etc.) with a "guide pin" of $\frac{5}{32}$ in. diameter. Open out the hole first with a No. 24 drill, then ream $\frac{5}{32}$ in., finally open out the hole at the back with the pin-drill to a depth of $\frac{17}{64}$ in., which will leave a wall thickness at the front of the crosshead of $\frac{7}{64}$ in. Hold the crosshead firmly in a machine vice for this operation of course, and don't press the pin-drill too hard.

To make the crossheads from gunmetal bar, end-mill the top and bottom faces and the slide-bar slots first, machining a piece long enough to make the two crossheads. Then hold the bar in the 4-jaw to machine the neck, drilling and tapping this as before. Reverse the bar in the chuck and turn the neck on the other end, for the second crosshead, then drill, ream and pin drill for the gudgeon pin.

Finally, part the two crossheads from the bar and finish by filing to shape.

The gudgeon pins can be turned from silver-steel $\frac{13}{32}$ in. dia., or the nearest larger; these are straightforward lathe jobs.

Connecting rods

For the connecting rods, we will require $\frac{5}{8}$ in. × $\frac{3}{16}$ in. bright mild steel. Mark out one rod, centre pop deeply for the two holes, and drill both with No. 27 drill to start with. Now bolt the two embryo rods together with 4 BA screws and saw and file to outline. Any builders lucky enough to possess a milling machine will be able to remove most of the unwanted metal without resort to the hacksaw, but "lathe only" builders may find setting up the rods in the lathe hardly worthwhile in this size.

The rods can now be parted, the small end holes opened out with No. 14 drill and then reamed $\frac{3}{16}$ in. diameter, and the big end holes drilled $\frac{5}{16}$ in. dia. ready for the bushes to be fitted. But first we need to reduce the thickness of the rods to $\frac{5}{32}$ in., apart from the big ends, so $\frac{1}{64}$ in. has to be removed from each side. Again, this could be done very quickly by filing, though it would not take very long to mill this small amount off by using the vertical-slide set up as described earlier. A length of steel angle is bolted or clamped horizontally to the vertical-slide and the rods are bolted down on this, any suitable cutter of the side-and-face type, preferably $\frac{5}{16}$ in. wide, being suitable, though a Woodruff cutter could also be used if two cuts taken. This method will still leave the last ½ in. or so at the small end to be thinned out, due to the bolt at that end being in the way of the cutter, but this can be done very quickly with files.

The small end will have to be case-hardened to give reasonable wear but the big end needs a turned bush, pressed in. Drawn gunmetal can be used for this, though cast gunmetal or phosphor-bronze is a better bearing metal (small quantities of this can be obtained from Norman Spink of Chesterfield).

Lining up the motion brackets

Assuming that the cylinders are now bolted to the frames in their correct position, we can go ahead and locate and fix the motion brackets. Have the front covers off, screw the piston rods into their respective crossheads with the rear covers between (not forgetting the gland nuts) and enter the pistons into their bores, leaving the rear covers clear of the cylinder.

Slip the finished connecting rods over their crankpins, insert the small ends into the crossheads and push home the gudgeon pins. Now slowly turn the driving wheels by hand, at the same time supporting the crosshead with the other hand, as there are no slide bars to support it as yet, and watch the movement of the piston. If the piston stops short of the cylinder ends by an equal amount at each end (i.e. at the front and back dead centres) all is well, and the piston can be fixed permanently in its crosshead by a pin about $\frac{5}{64}$ in. dia. or alternately a taper pin of about this diameter, put in at 45 deg. The pistons can now be packed, also the stuffing boxes, with graphited yarn, and gaskets cut ready for bolting on the front and rear covers.

On the other hand, if the movement of the piston in the cylinder is not uniform, either the piston rod will have to be screwed out from its crosshead by a small amount, or the piston rod will have to be shortened slightly. In either case, this should not be a matter of more than a $\frac{1}{64}$ in. or so, if all dimensions have been adhered to.

For the cover gaskets, stout brown paper, soaked in cylinder oil, should be quite satisfactory, and this can be cut out with scissors or a single-edged razor blade, the holes for the cover screws being punched out.

We can now slip the slide bars into position, bolting them to the rear cylinder covers with 5 BA hexagon-head or socket-cap screws. Unless your workmanship has been absolutely "spot on", it will probably be found that one or more of the slide bars is either too close to the cross head, or to far out. Not to worry — this is quite a normal hazard, and the solution is just a matter of some trial and error. If too far away, remove the offending slide bar and remove just enough metal by filing to put things right, being careful to file "square". Only the area in contact with the rear cover is touched of course.

If the slide bar is too close, a shim will have to be inserted between the cover and the slide bar. Every model engineer's workshop should boast a small supply of shim brass (Reeves of Birmingham stock a very useful tin of assorted brass shim—usual disclaimer) and a small piece of the desired thickness will quickly put things right.

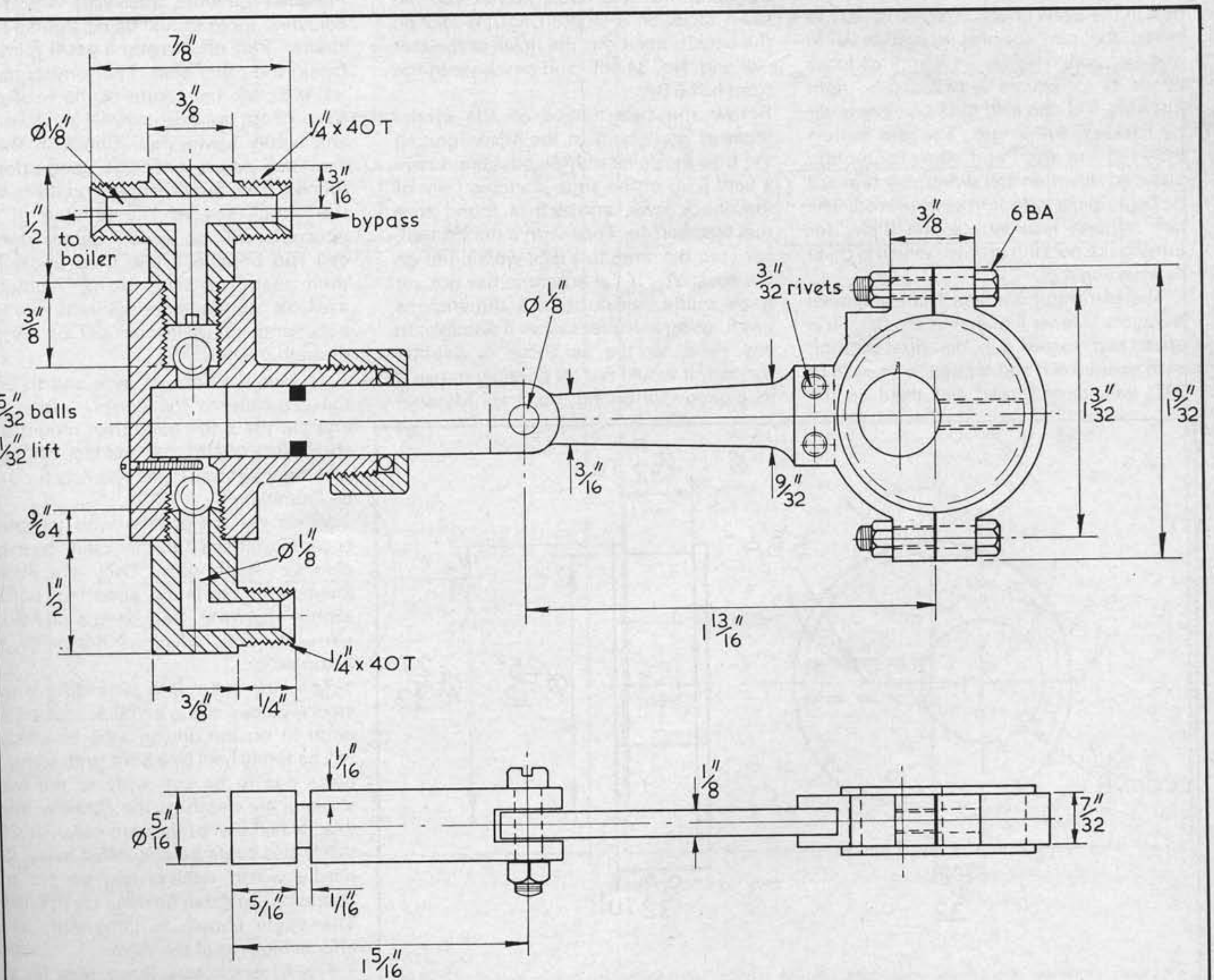
Having got the slide bars right at the cylinder end, we can now put the motion brackets in place, pulling the crosshead and piston rod out to its fullest extent. Put a small toolmaker's clamp over the slide bars just in front of the motion bracket, and tighten it just enough to stay put. Put another clamp over the angle of the motion bracket and the engine frame. Now with inside calipers, check the distance between the piston rod and the frame at each end. If the piston rod is seen to be out of parallel, this can quite easily be corrected by either filing a shade off the angle of the motion bracket or by inserting a shim of suitable thickness, as the case may be.

When satisfied that the piston rod is parallel to the frame, and that the crosshead and rod can be moved smoothly from end to end without binding, the drill can be put through the fixing holes in the motion bracket angle, and the bracket bolted to the frame for good.

Feed pump

Back to the feed pump now. The body of this was described in the May issue. The valves are $\frac{5}{32}$ in. stainless steel balls. Set up the pump-body/stretcher on the bench, drop a ball in and seat it by using a short length of brass rod about $\frac{5}{32}$ in. dia. with a countersink in one end. Hold this quite upright and give it one sharp crack with a light hammer. Don't overdo this, or the ball seating will be damaged.

The top fitting of the pump is in the form of a tee, on branch going to the check valve on the boiler barrel, the other to a by-pass valve, to return any excess water to the tender. Little gunmetal castings can be obtained from our advertisers for these tee pieces, which



DETAILS of FEED PUMP (x2)

saves having to build them up by silver-soldering etc. Turn and thread the part that screws into the valve chamber of such a length that the ball is allowed a rise of $\frac{1}{32}$ in. File two deep nicks across the end, so that when the ball rises off its seating it doesn't block the "way out" for the water.

The bottom fitting is somewhat similar to the top fitting, but has only one union, for the water inlet from the tender, and the inlet ball seats on the stem. As the inlet ball seating can be turned in the lathe, it is a good plan to machine this to a conical shape, as shown in the drawing, as this helps to prevent dirt or grit getting under the ball. This ball must also be restricted in its lift. This can either be done by chiselling a couple of nicks in the passage just above the ball, or better still, by inserting a very small brass screw, not bigger than 12 BA, just above the ball, as shown.

The pump ram is a length of $\frac{5}{16}$ in. dia. stainless steel. Drill the driving pin hole first, then slot out for the eccentric rod. This can be done by clamping the ram under the lathe toolholder and using a $\frac{1}{8}$ in. slotting or face cutter either between centres or mounted on a stub mandrel held in the 3-jaw chuck. The safest way to clamp the ram for this operation is to make a proper holder—a length of brass about ½ in. square is drilled $\frac{5}{16}$ in. right through, and one side of the square is slit by hacksaw full length. The ram is then inserted in this and the toolholder clamped down on top, when the ram will be held rigidly without being scored. The ram is then returned to the 3-jaw for turning the packing groove, which is done by a parting tool.

The gland nut is made from gunmetal hexagon, $\frac{9}{16}$ in. or $\frac{5}{8}$ in. across the flats. It is drilled and reamed $\frac{5}{16}$ in. dia. right through then opened out and tapped ½ in. × 26 or 32T, whichever thread was used on the pump body. Finish with a plug tap. Either ordinary graphited yarn may be used for the two packing rings, or for the gland nut, a synthetic-rubber "O" ring may be preferred. A suitable "O" ring is No. OII, $\frac{5}{16}$ in. bore, $\frac{7}{16}$ in. o/d obtainable from "Locosteam" of West Mersea, Colchester. However, if an "O" ring is used, remember that the threads must not be cut right to the end of the recess in the gland nut, as otherwise the "O" ring would be rapidly cut up. Further, the internal diameter of the recess for the "O" ring must be such that the "O" ring is slightly compressed, while the gland nut must be screwed home just far enough to allow the "O" ring to roll along the ram by a bare $\frac{1}{32}$ in. This means that adjustment of the nut is rather critical, and this really calls for a thin locknut to ensure that the nut stays put where it belongs. For these reasons, beginners may do better to stick to graphited yarn packing, which is not so critical.

Gunmetal castings will be available for the eccentric strap, both for the pump and for the valve gear. Centre pop both lugs of the straps first, then drill right through with No. 43 drill. Carefully saw the strap into two equal halves, rub the sawn faces on a smooth flat file laid on the bench, open out the holes in the rear half with No. 34 drill, and tap those in the front half 6 BA.

Screw the two halves of the straps together and chuck in the 4-jaw, getting the hole to run as truly as possible. Leave a bare $\frac{1}{16}$ in. of the strap standing clear of the chuck jaws, and with a round-nose tool face across. Then with a boring tool, bore out the strap to a nice working fit on the eccentric. If the eccentric has not yet been made, work to the dimensions given, using a vernier caliper if possible. In any case, as the eccentric is double-flanged, it would not be possible to use it as a gauge for boring the strap. My own preference would be to turn the eccentric first, and at the same time, turn a short piece of steel bar to the same diameter, which can then be used as a gauge when boring the strap. This piece of bar can also be used as a mandrel for finishing the other side of the strap. Chuck it in the 3-jaw, wrap a strip of thin paper round it, then put the strap on, when the screws will hold it firmly for facing.

The lug for attaching the eccentric rod can be slotted by gripping the strap in a machine vice on the lathe cross-slide, and traversing under an $\frac{1}{8}$ in slotting cutter; or it can be done by clamping under the toolholder, packing it up to lathe centre height, and using an $\frac{1}{8}$ in slot drill. The eccentric rod, shaped from $\frac{1}{8}$ in. b.m.s., is held in position by two $\frac{3}{32}$ in. copper rivets, which should be countersunk on both sides.

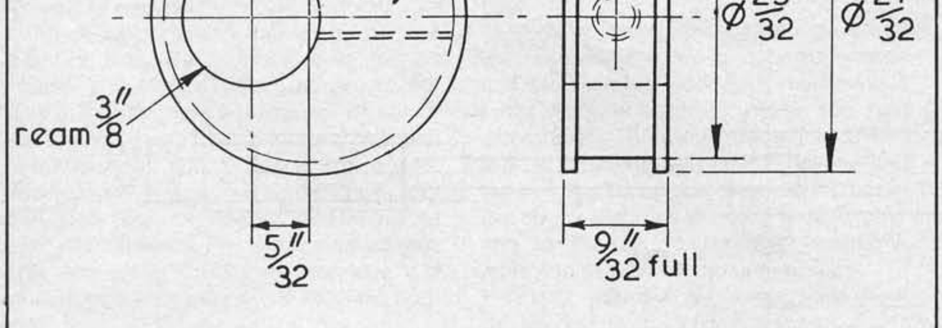
For the pump eccentric, we will need a piece of $\frac{7}{8}$ in dia. b.m.s. or 1 in. dia. if $\frac{7}{8}$ in. is not available. Chuck and turn down to $\frac{27}{32}$ in. dia. and face the end. Now with a parting tool ground square at the cutting edge, form a groove $\frac{7}{32}$ in. full wide, reducing the diameter to $\frac{25}{32}$ in. Run the lathe slowly and use plenty of cutting oil. Provided the lathe cross-slide is properly adjusted, there should be no trouble from chatter. Part off, leaving a good $\frac{1}{32}$ in. for facing the other side. The turning marks will indictate the centre of the eccentric, so mark out the axle centre $\frac{5}{32}$ in. from this and lightly centre-pop. Chuck in the 4-jaw, and adjust until the centre-pop is running true, but do not be too fierce with the chuck key or the flanges of the eccentric will be spoilt. Centre deeply, drill and bore to a few thou under $\frac{3}{8}$ in. then ream to size. If no reamer is available, continue boring, with very light cuts, until the axle can just be twisted through the hole.

To face the "rough" side and to bring the eccentric to the correct width, drill and tap the 5 BA hole, then mount on a short piece of $\frac{3}{8}$ in. rod, and face off, again with very light cuts, as the eccentric will be "tumbling".

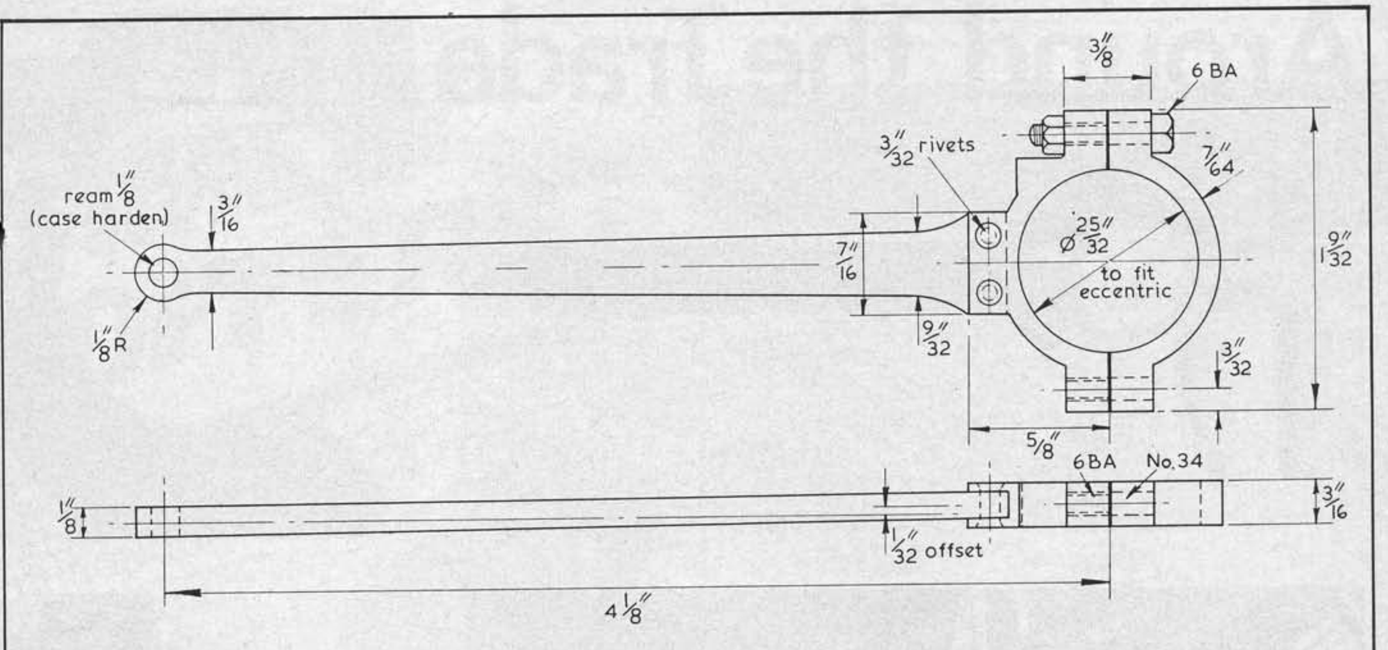
While we are dealing with the pump eccentric, those for the valve gear can also be dealt with. They are almost identical to the pump eccentric, but are slightly narrower, and have a pressed in pin, $\frac{1}{8}$ in. dia., which is driven by the "stop-collar".

The stop-collar is a plain disc of mild steel $\frac{13}{16}$ in. dia. and $\frac{7}{32}$ in. thick, reamed to a good fit on the driving axle, to which it will be firmly held by a 5 BA grub screw. A piece has to be cut away to the angle shown, the depth of the cutaway being exactly half that of the stop-collar, at $\frac{7}{64}$ in. While this could be end-milled away, it is hardly worth whilesetting up for this operation, as it can be done careful filing. The angle shown is important, as it effects the time of the valve.

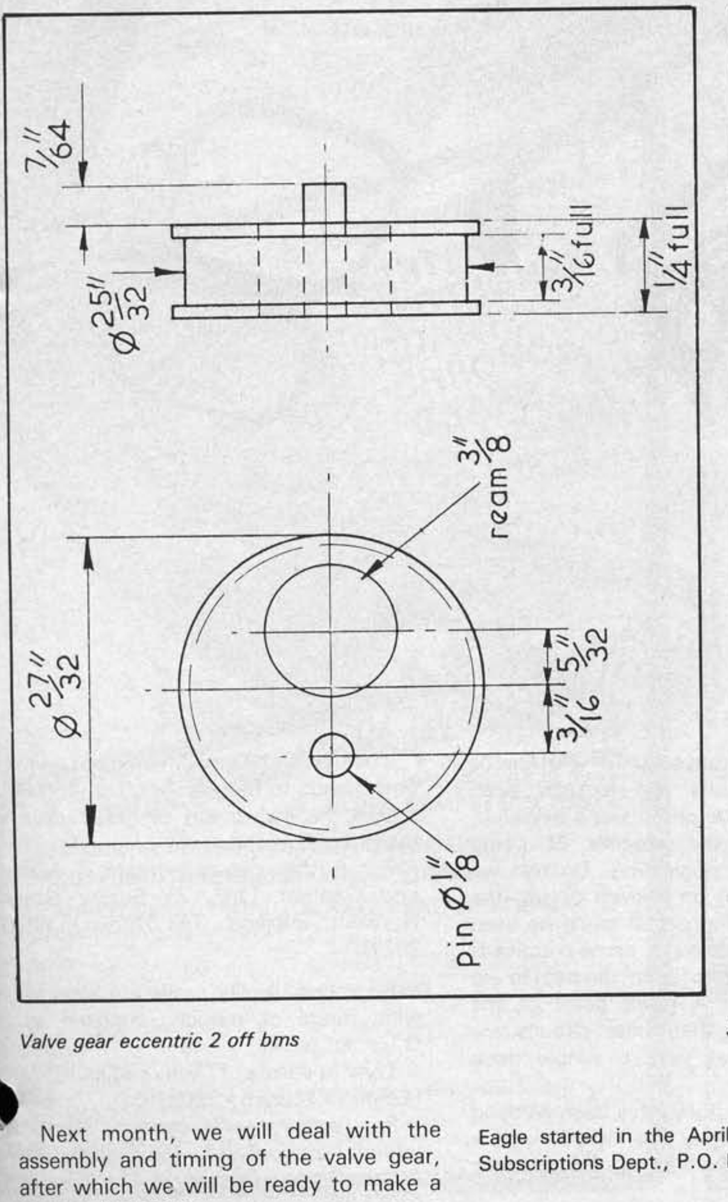
The eccentric straps and rods for the valve gear can be made in a similar way to that for the pump there is a $\frac{1}{32}$ in. offset, which can be put in by careful bending.



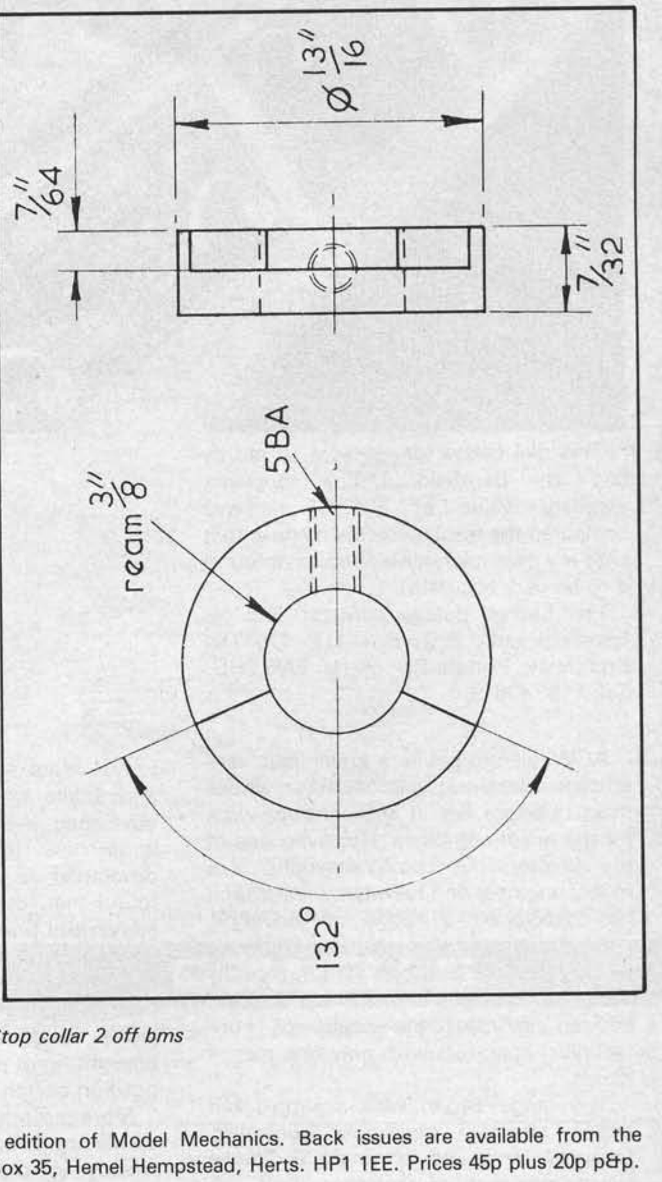
PUMP ECCENTRIC 1 off b.m.s.



ECCENTRIC ROD & STRAP (x 2) Rod b.m.s. Strap gunmetal casting



Valve gear eccentric 2 off bms

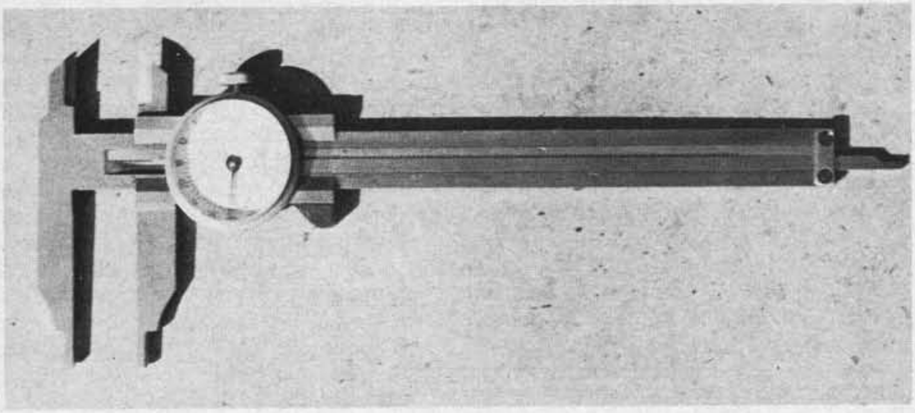


Stop collar 2 off bms

Next month, we will deal with the assembly and timing of the valve gear, after which we will be ready to make a start on the boiler.

Eagle started in the April edition of Model Mechanics. Back issues are available from the Subscriptions Dept., P.O. Box 35, Hemel Hempstead, Herts. HP1 1EE. Prices 45p plus 20p p&p.

Around the Trade



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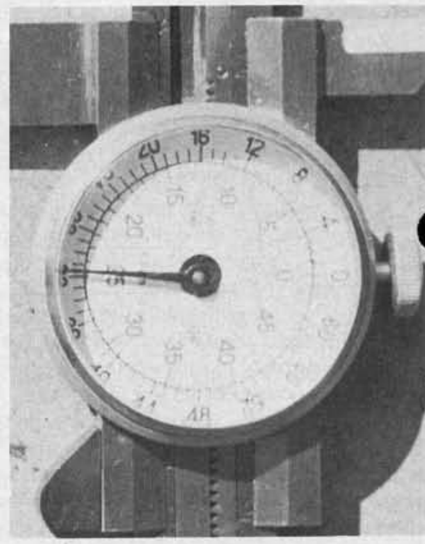

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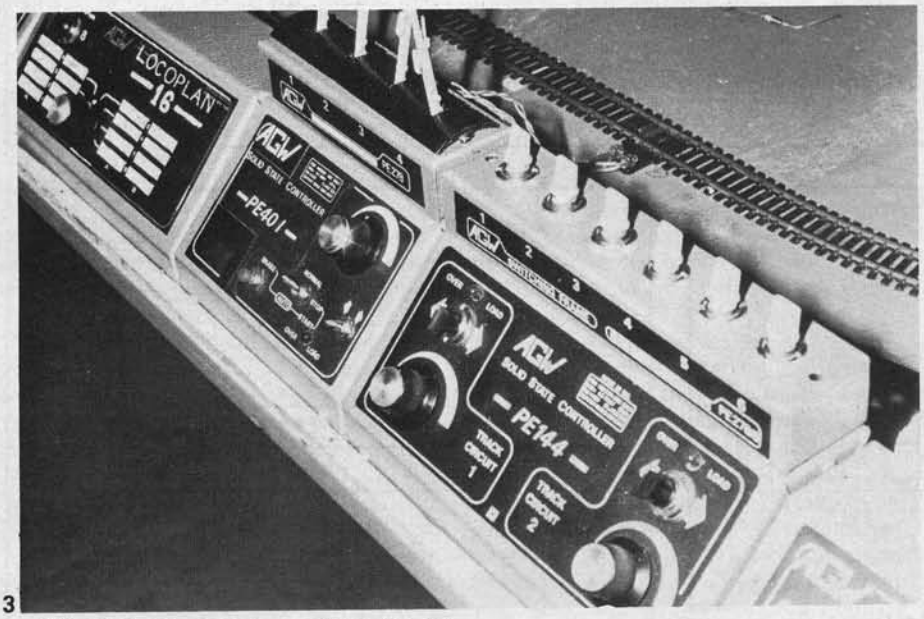

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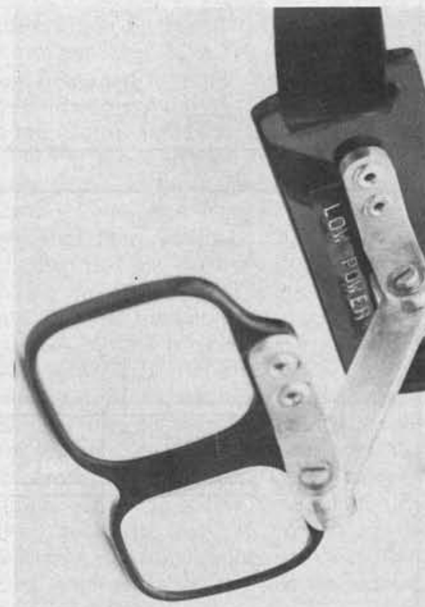

4

1 2 This dial caliper gauge sent to me by Eric H. Bernfield Ltd., represents excellent value at £11.90. I have compared the measurements made with it with my own micrometer and have found it to be very accurate.

For further details contact: Eric H. Bernfield Ltd., P.O. Box 111, 17a The Broadway, Potters Bar, Herts. EN6 2HG. Tel: P.B. 43619.

5

3 AGW Electronics is a small, but very efficient electronic manufacturer whose main business lies in sub-contract work for the major combines. However, one of the directors, George Wainwright, is a model engineer and railway modeller, and has developed a range of electronic control equipment for small scale railways which are, on the one hand, soundly designed from the technical aspect, and devised to meet the needs of non-technical operators with only one pair of hands.

The range began with a simple but highly effective hand-held controller, followed by a robust single and twin transformer-rectifier-controller unit. A newer more advanced unit, with inertia and brake circuits has recently been developed, initially put out as a twin unit, it is now in the process of being developed as a single unit. On test we found that, even on a small circuit, the inertia and braking circuit could be used to advantage, as always, some practice is needed to be able to 'drive' the train to the best advantage. A good point of the AGW design is that these circuits are brought into play with a simple three position switch.

More recently, they have been working on electronic sound. The 'whistle' unit is already in production, it incorporates several tones.

4 The Versator Mark III binocular enables both hands to be used for fine work and makes the instrument of great value in many applications.

For further details contact:— Mason and Gantlett Ltd., 29 Surrey Street, Norwich, England. Tel: Norwich (0603) 28101.

5 Rhombus display cases are ideal for a wide range of models, supplied as a D.I.Y. kit pack.

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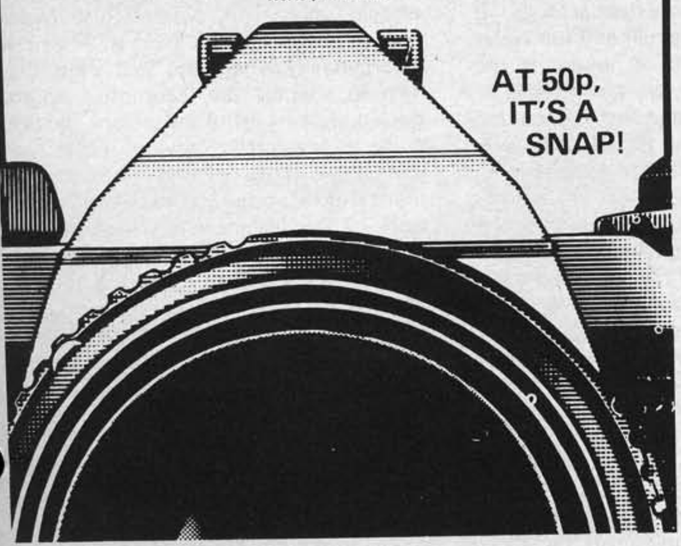

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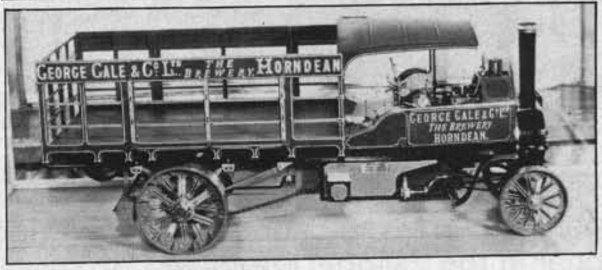

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Introduction to the model steam locomotive

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First let me introduce myself: I am D. E. Lawrence, generally known as Laurie and my writings usually appear in the "Model Engineer". In this short series of articles, my purpose will be to explain the *whys and wherefores* of that very popular model, the steam locomotive.

Fortunately, only those people beyond civilisation and out of reach of the ubiquitous telly don't know what a steam locomotive looks like, but, just in case this magazine finds its way into the wilds of the back of beyond, a photo of one of these fire-eating man-made monsters appears at the head of this page. Of course, a simple picture does not explain *what* it does or *why* it does it. Similarly, even those who know what and why, may not know *how* it does what it does. (Hope you're with me!). Of course, you can find out the hard way and my purpose is to make that hard way a lot easier.

The Steam Locomotive is what is called a *prime mover*, that is, a self-contained machine capable of having a load attached to it, usually behind, and for the load to be moved in the direction desired by the man at the controls. You will see immediately that there is something which sets the steam locomotive apart from nearly every other modelling hobby; *YOU* are at the controls and the load, that's *YOU*, is moved along the track,**1.** And a highly enjoyable and rewarding experience it is too. When the going gets a bit stiff, there will be a few photos of enthusiasts doing the highly enjoyable etc. to relieve any tedium.

Types of Locomotives

The steam locomotive is commonly miscalled an engine, or sometimes a steam engine, but in fact, it comprises four basic parts: **1. Engine 2, Boiler 3 Water reserve 4, Fuel reserve.** If it is a Tank locomotive, all four are in one machine; that is, the water reserve is carried in tanks usually placed on each side of the boiler,**2,3** sometimes in a single tank shaped to fit and sit on top of the boiler and this is called a saddle tank,**4.** There is another variety of tanks called Pannier tanks,**5,6** which are rather like half-way between saddle and side tanks. The fuel reserve, usually coal, but sometimes oil, is carried in a bunker at the rear of the locomotive; sometimes on small tank locomotives the bunker may be set in the rear part of one of the side tanks

1

or may be just a simple hopper on the fireman's side of the footplate which is where the crew stand.

Larger locomotives intended for long trips are usually Tender locomotives and here the word tender does not mean soft and easily hurt, but it comes from the verb to tend, one meaning of which is to carry and that is just what a tender does—it carries the coal (or fuel oil) and the water in separate containers, of course, in the tender. So there are two basic types of locomotives, Tender and Tank. There are some variations on the theme and I may be able to include a few photos of them later on.

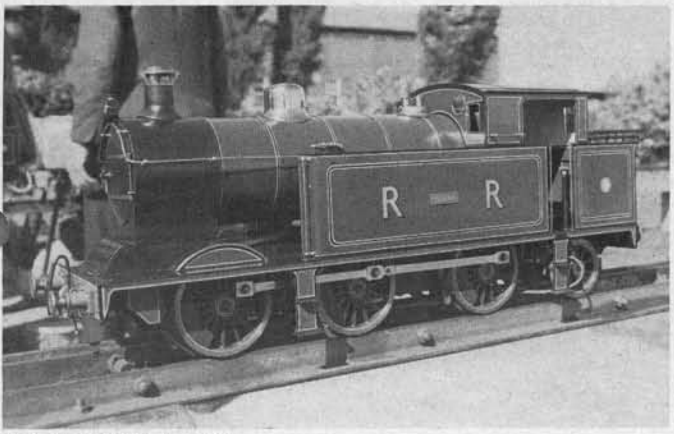
Locomotives are usually grouped by the type of work they do, thus we have Express passenger,**7** Mixed traffic,**8,9** Freight or goods locomotives,**10,11,12.** There were a very few express passenger tank locomotives in modern times; most of this type are tender locomotives. Mixed traffic and goods locomotives can be either tank or tender, but in the days of steam on British Rail, long distance hauls were usually by the tender type. However, tank locomotives were frequently and regularly used on short runs, principally suburban trains and on branch lines. Within the groups there is a ready means of identification and I expect lots of you will have heard of the Whyte notation. This sorts out locomotives by the wheel arrangement and some of these arrangements have names—the figures show the number of wheels:

0-4-0
0-6-0
0-8-0
0-10-0 Decapod
2-4-0
2-6-0 Mogul
2-8-0 Consolidation
2-10-0
2-4-2

2-6-2 Prairie (usually for tanks)
2-8-2 Mikado
4-2-2 Bogie single
4-4-0
4-4-2 Atlantic
4-6-0
4-6-2 Pacific
4-8-2
and so on.

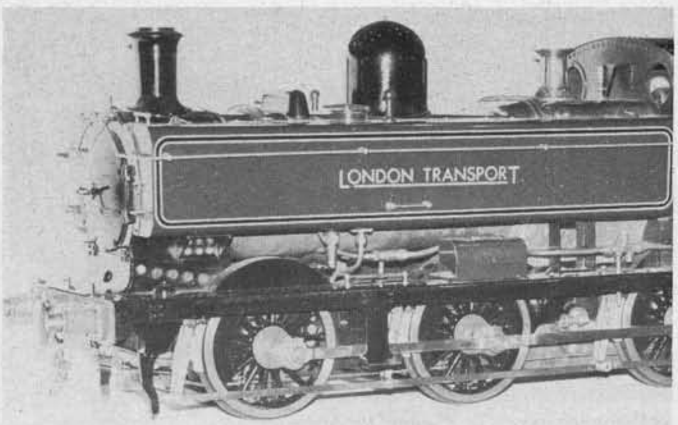
The appearance of the letters T, ST, PT, after the wheel arrangement indicate the type of tank locomotive, i.e. 0-6-0T is just a six-wheeled side tank locomotive; ST a saddle tank; PT a pannier tank.

In the Whyte notation the wheels are identified as to their purpose as follows: the first figure shows the number of carrying wheels at the front of the locomotive, the middle figure the driving wheels, the last figure is the carrying wheels at the rear. Thus 0-6-0 means no carrying wheels front or rear, 6 driving wheels only. The difference between Carrying wheels and Driving wheels is that carrying wheels do just that, they help to support the locomotive on the track and bear part of the weight and help guide it on the rails. Driving wheels have the power of the engine transmitted to them and move the locomotive along the track. There is another wheel notation sometimes used, generally on the Continent; this is part numerical and part alphabetical, only the axles are counted (logically, as each axle has a wheel on each end, you multiply by two to get the number of wheels). It goes like this, 2C1, no dash between letter and figures; 2 means a bogie of two axles with four wheels, C means three axles with six driving wheels, 1 means a trailing truck with two wheels. You will have quite simply worked that out as a 4-6-2; a 2B1 is

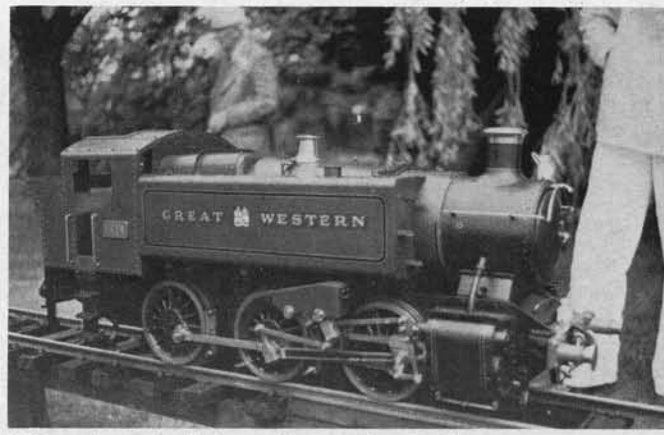


3 *A side tank locomotive.*

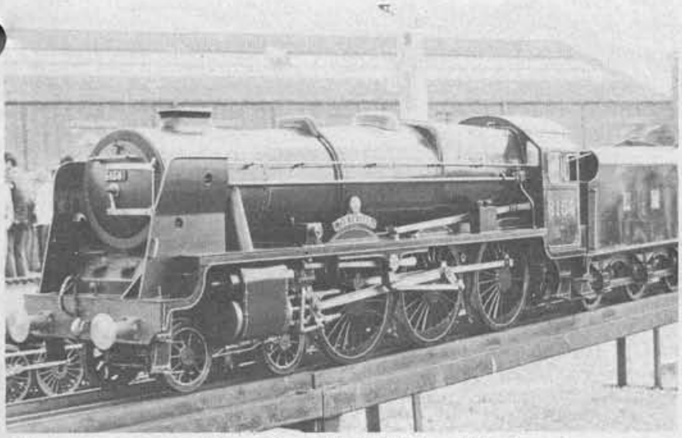
4 *An industrial saddle tank locomotive.*



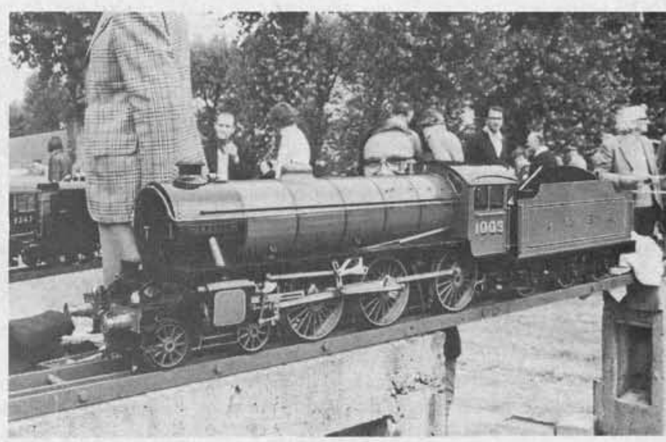
5 *A pannier tank locomotive.*



6 *A pannier tank, this time without running boards.*

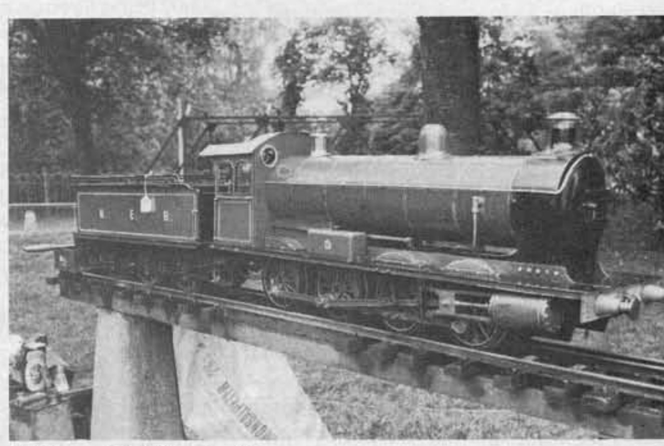


7 *Express passenger locomotive, a "rebuilt" Royal Scot.*

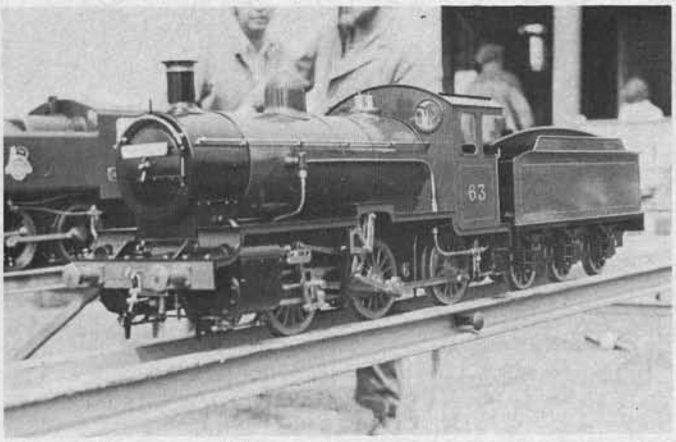


8 *General purpose mixed traffic locomotive.*

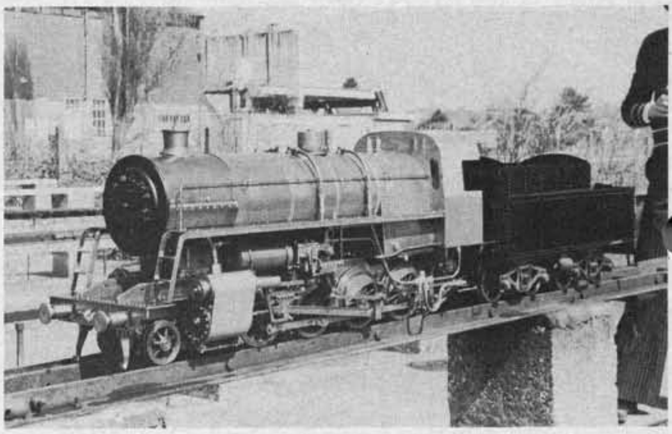
9 *A lighter mixed traffic locomotive.*



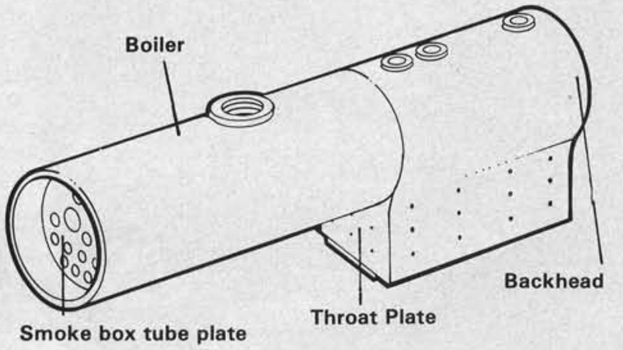
10 *Heavy freight locomotive.*



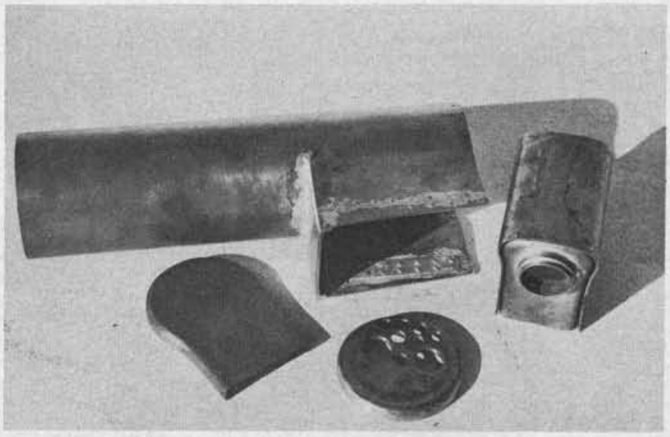
11 *General purpose goods locomotive.*



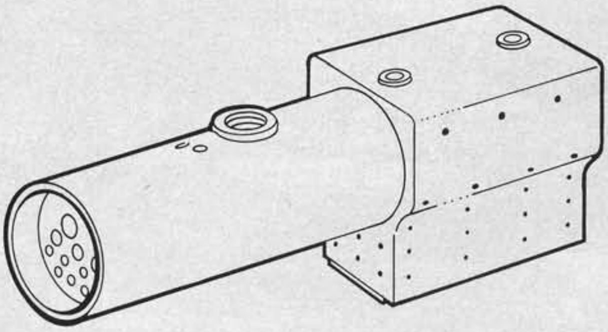
12 *The authors Continental heavy freight locomotive.*



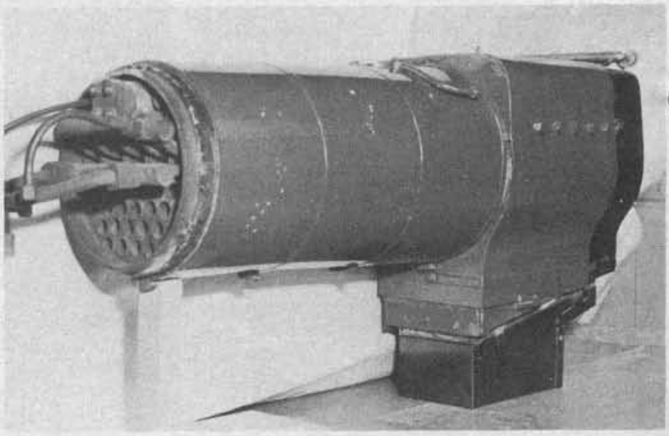
13 *Outline of round top narrow fire box boiler.*



14 *Components of a small round top boiler.*



15 *Outline of Belpaire narrow fire box boiler.*



15a *A Belpaire narrow fire box boiler.*

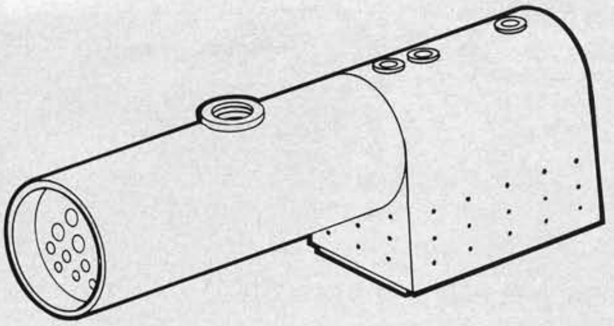
a 4-4-2, a 2C is a 4-6-0, a 2D1 is a 4-8-2 and so on.

In the previous paragraph I have used a few terms which need some explanation. The assembly of carrying wheels in a frame at the front of a locomotive is called a Pony truck if it has one axle with two wheels. It is called a Bogie if it has two or more axles. At the rear of a locomotive it is simply called a Trailing truck.

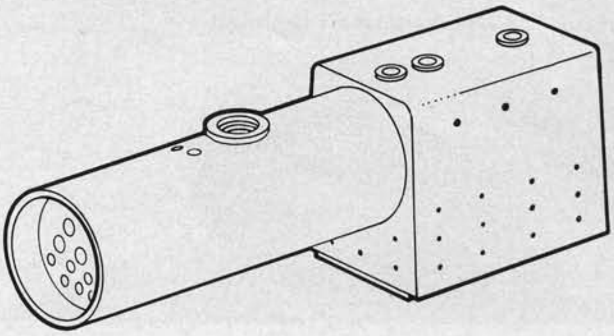
Steam and Boilers

We will come back to wheels later, but I think I should now introduce the stuff that makes out little locomotives work and that is Steam. Steam is generated in a Boiler,**13**, which is a simple name for a pressure vessel, that is, a vessel capable of withstanding an internal pressure or force. Within the boiler and usually at the rear, is the Firebox in which the fuel (coal) is burnt and the burning coal gives up its heat to the boiler plates surrounding it and, in turn, the heat passes into the water. The water boils and, with the constant addition of heat, the temperature rises so long as the steam generated or released from the water is contained within the boiler and, so long as this happens, the pressure also rises until what is called the working pressure is reached. That's the theory, much simplified, anyway. When you get to drive your own little locomotive, you may find a few snags, like trying to keep up the pressure to something useful whilst trying to do some work as well, like keeping your locomotive running on the track. All very simple you may think, but it requires a certain degree of skill on the part of the fireman-cum-driver.

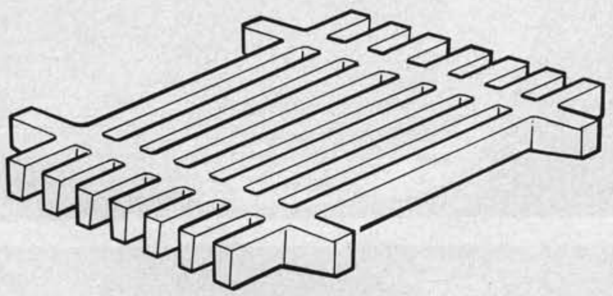
I'd better get back on the rails with a description of the various parts of the boiler. Boilers come in a great variety of sizes, but, with very few exceptions, they follow the classic conception of Stephenson's Rocket (and everybody has heard of that!). There are two basic types of boiler, the Round top and the Belpaire; the drawing,**13**, shows a fairly simple model round top boiler and the photo,**14**, shows the component parts which you can compare with the other drawing,**15**, and photo,**15a**, of a Belpaire boiler. You will see that one is round all along the top from front to rear and the other has a flattish raised portion towards the back.



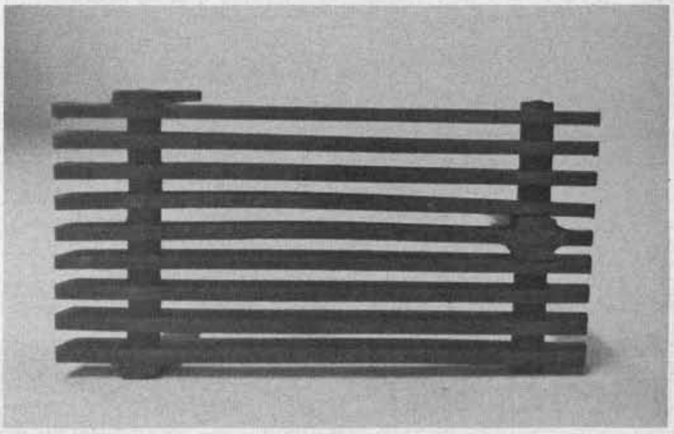
16 *Outline of round top wide fire box boiler.*



17 *Outline of Belpaire wide fire box boiler.*



18 *Grate cast in iron for narrow fire box.*



19 *A grate built-up from steel bars.*

They both have two variants called narrow fireboxes,**13,15,** and wide fireboxes,**16,17,** the narrow type fits the frames—we'll meet them later when we come to the engine—and the wide type straddles the frames or an extension of them at the rear of the engine. A firebox is literally a box, open at the bottom where the grate is placed, and it is usually made of three plates in its simplest form, these are a firebox tubeplate, firebox wrapper and firebox doorplate. The tubeplate is drilled or bored to accommodate a number of tubes through which the burnt gases from the fire are ejected to scape to the front end and so out to atmosphere. The doorplate is at the back of the firebox and has a hole in it in which a short length of large diameter tube is fixed and through this hole—the firehole—the coal is shovelled on to the grate. The grate,**18,19,** is similar to the domestic firegrate and is only a number of cast-iron or steel firebars spaced apart to allow air for combustion to be drawn into the fire. Air contains oxygen which is necessary for combustion of the coal. The wrapper goes right round the tubeplate and doorplate which are flanged to allow a good fixing of the wrapper to them. The photo,**14,** should make this clear.

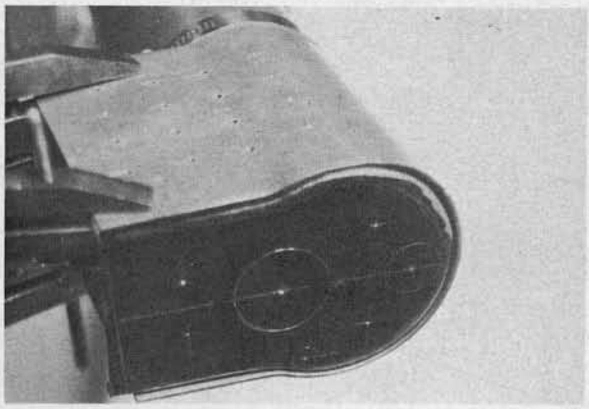
Enclosing this assembly is the outer shell of the boiler which comprises barrel, wrapper or crown sheet, throat plate, backhead, smokebox tubeplate and foundation ring. The smokebox tubeplate has the tubes from the firebox fixed in it and is itself fastened to the barrel which connects to the wrapper and that has the backhead inserted in it,**20,** to close the back of the boiler except for a hole matching the one in the firebox doorplate. The foundation ring goes all round the outside of the bottom of the firebox and the backhead, wrapper and throatplate are scurely fastened to it. The throatplate goes from the foundation ring to the underside of the barrel. In a Belpaire boiler the throatplate extends all round the end of the barrel up to the wrapper. The assembly is usually held together by brazing and/or silver solder to form an inner and outer shell and the space between inner and outer shells holds the water and steam. The assembly should be quite strong as it has to withstand a considerable internal pressure or force,**21,22.** The photos,**23,24,** show a firedoor open and closed.

There are various holes in the boiler shell for specific purposes which I shall deal with shortly. I mentioned the smokebox earlier and this is merely a sort of cylinder or can on the front end of the boiler into which the burnt gases, i.e. smoke, are drawn; its front is closed by a door called the smokebox door, of course,**25,26,27**; the rear end is attached to the front end of the boiler barrel. Lastly, there is a hole in the top into which the petticoat pipe (sometimes called the chimney liner),**28,29,30**, fits. The chimney sits on this assembly over the liner (not—chimney, not funnel, funnels are on ships), and this apparently simple arrangement is much more important than it looks. Through the chimney is the path of thesmoke and exhaust steam; it is here that the familiar chuff-chuff of the steam locomotive emanates.

I now have to revert to the back end of the boiler; having ejected the waste gas (smoke) at the front end, the non-combustible (won't burn) residue of the coal is the ash and this falls through the firebars into the ashpan from whence it can be raked out at intervals. Photos**16,31**, show how ashpans are arranged under the firebox.

Steam Fittings

The boiler needs various odds and ends, called fittings, on it to tell you what is going on and to control the working of the locomotive. The most important of these items is the Safety valve**32,33,34,** and the accent here is on safety. This valve, there may be more than one,**36,37,** is the means whereby over production of steam is not allowed to build up dangerous pressure inside the boiler. The valve is set at what is called the working pressure (sometimes called the blowing off point) and when this pressure is reached and then exceeded, the valved lifts and allows surplus steam to escape to atmosphere. Incidentally, working pressure is a bit of a misnomer because careful drivers try to keep the pressure a little below this and not allow steam to go to waste and do no work.



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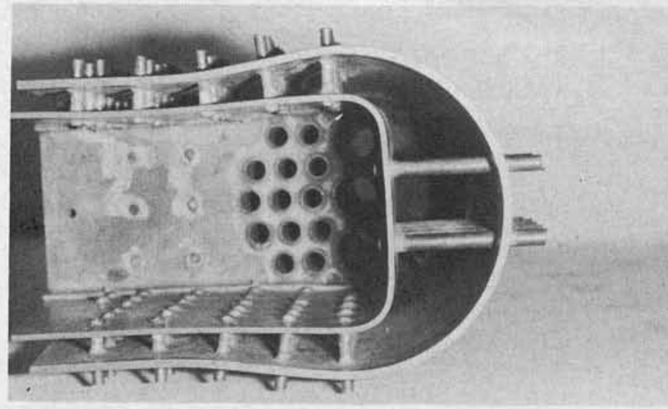

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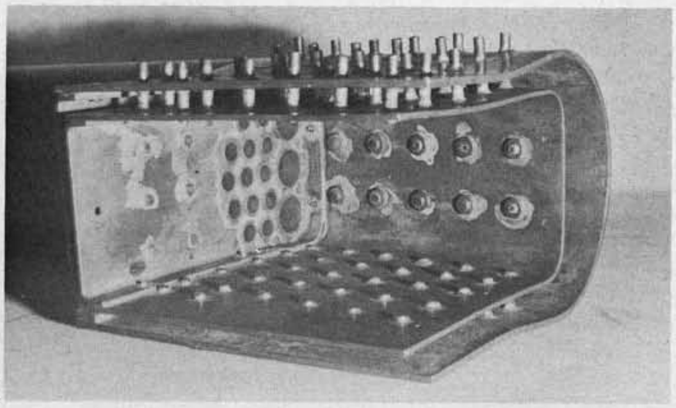

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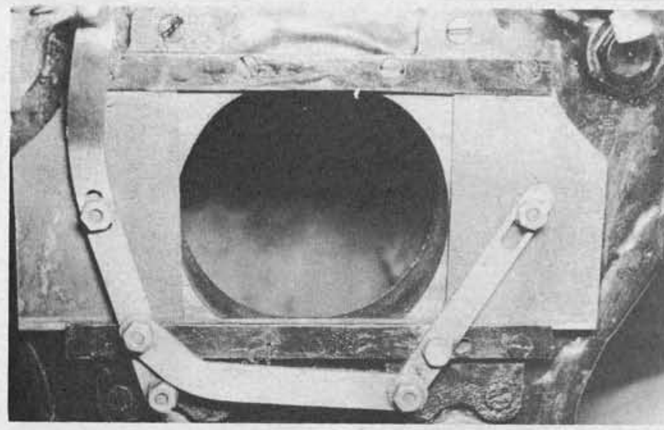

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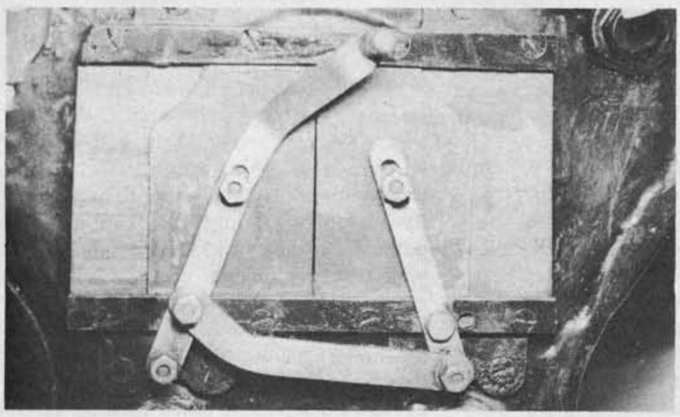

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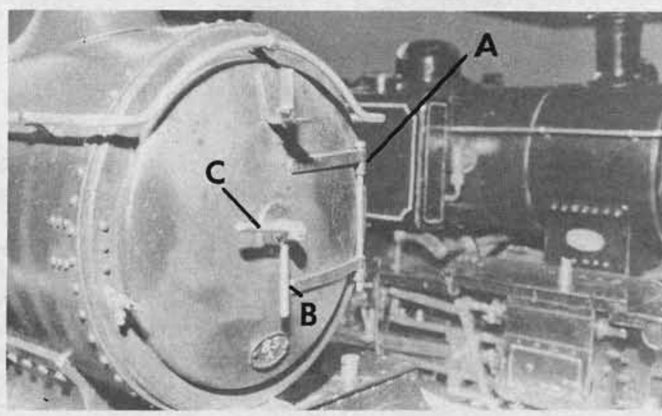

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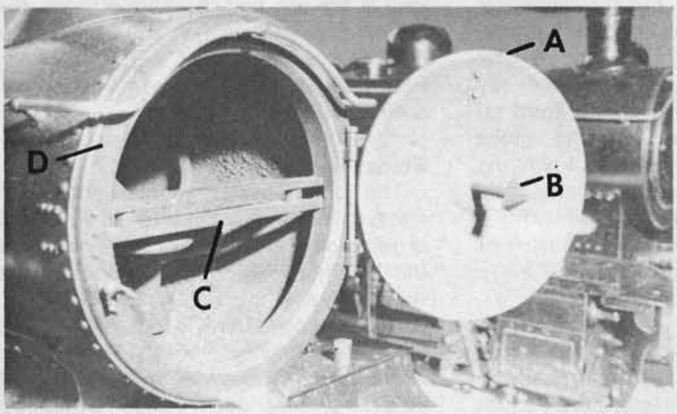

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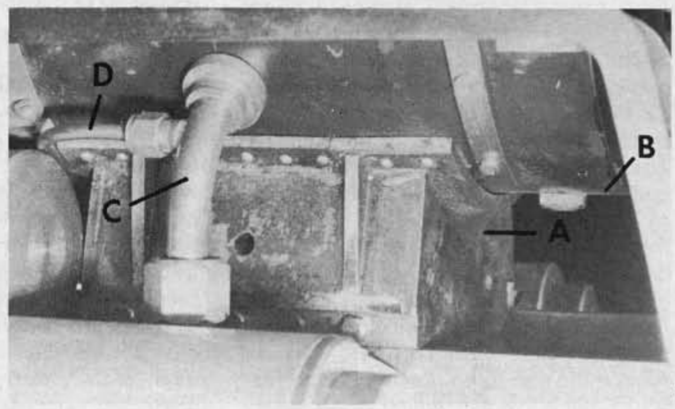

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20 *The backhead fits into the wrapper.*

21 *The boiler plates are supported by stays (rods) brazed into the firebox and wrapper Note: Short rods are firebox stays. Longer rods are roof stays.*

22 *The roof stays have large nuts, silver soldered over.*

23 *Sliding firehole door open.*

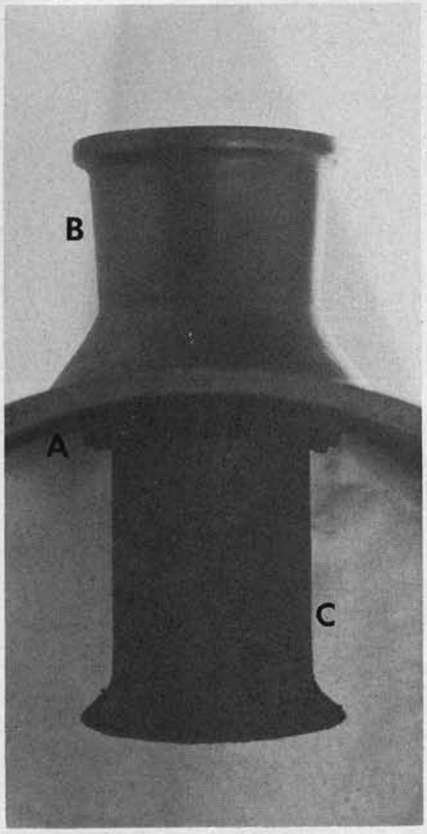
24 *Sliding firehole door shut.*

25 *Smokebox door*
A door. **B** *locking handle, turns dart* ***through 90° in cross bar.*** **C** ***handle screws*** *down to clamp door airtight.*

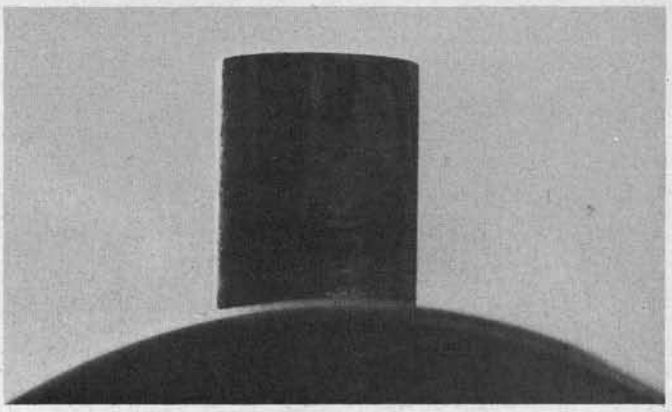
(Caption 25 as printed: **A** *hinges.* **B** *locking handle, turns dart through 90° in cross bar.* **C** *handle screws down to clamp door airtight.*)

26 *Smokebox door assembly*
A *door.* **B** *dart, fits into and turns and locks in* **C. C.** *cross bar.* **D** *Smokebox door ring.*

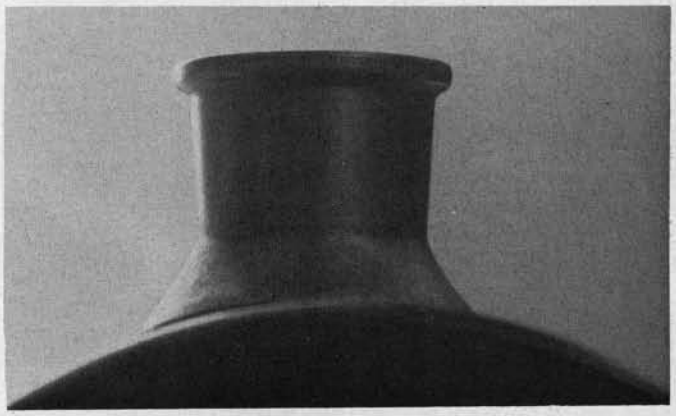
27 *The smokebox is mounted on a saddle.*
A. *Smokebox saddle.* **B** *Smokebox.* **C** *Main steam pipe to cylinder.* **D.** *Oil pipe delivery to main steam pipe.*



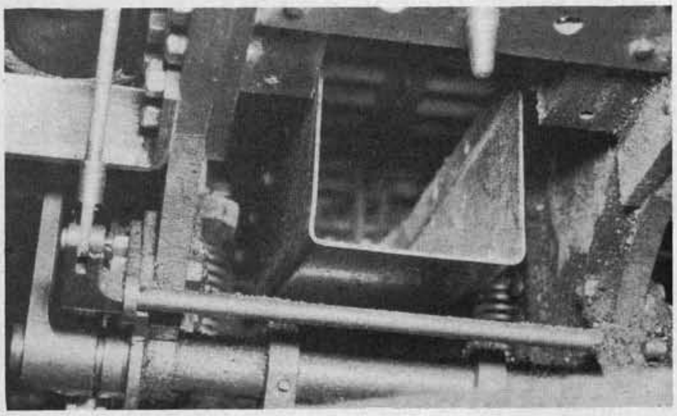
28
Chimney assembly.
A *Smokebox.*
B *Chimney.*
C *Liner extends into smokebox and forms into a bell (petticoat pipe).*



29
Chimney liner in smokebox shell.



30
Chimney fits over liner.



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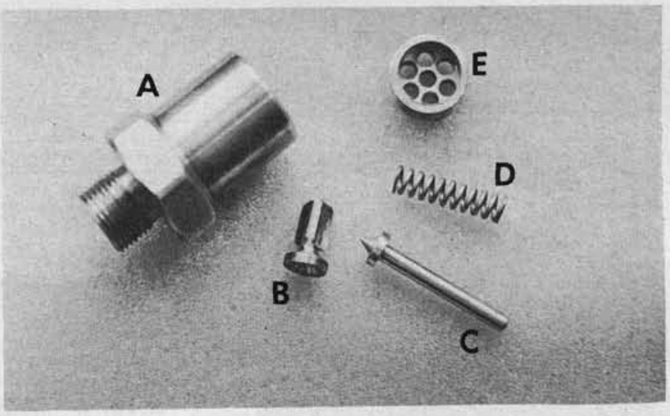

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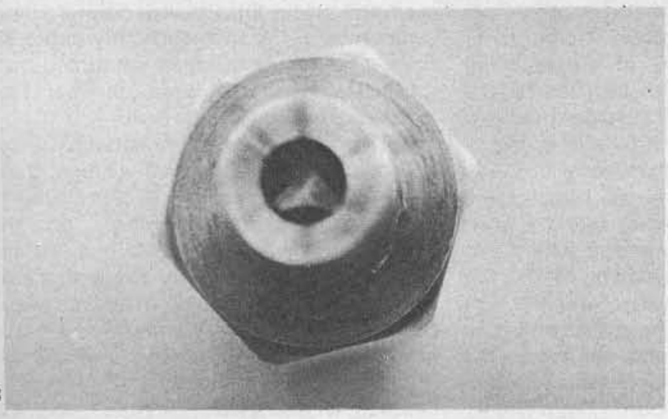

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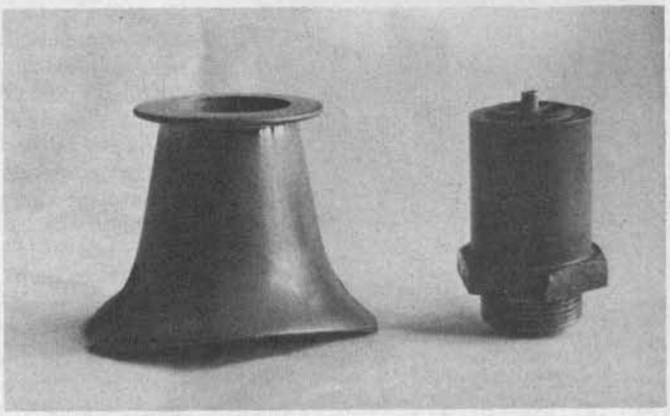

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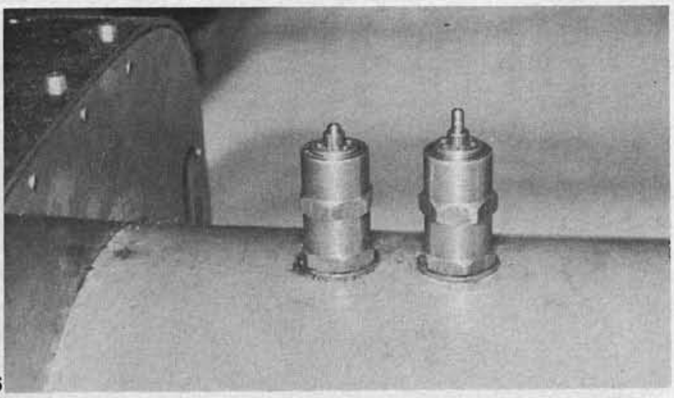
31 *Rear end of ashpan between engine frames under boiler firebox.*

32 *Parts of a direct loaded safety valve.* **A**. *Valve body.* **B**. *Wing type valve.* **C**. *Pintle, point rests in valve.* **D**. *Spring (usually rustless).* **E**. *Retaining cap, note large holes for escaping steam.*

33 *Underside view of safety valve with wing type valve in position.*

34 *Safety valve assembled, with Great Western style "Bonnet", which fits over it.*



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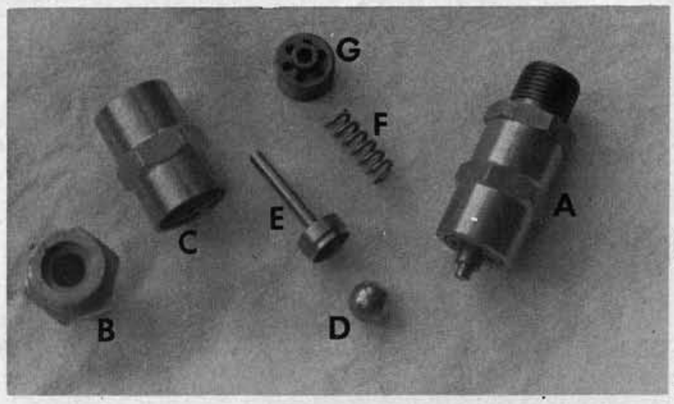

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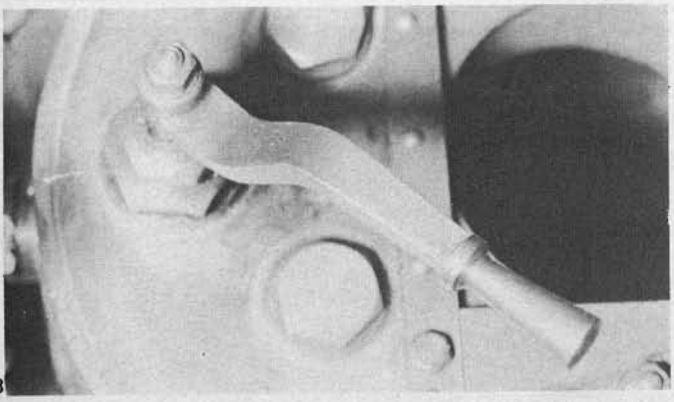

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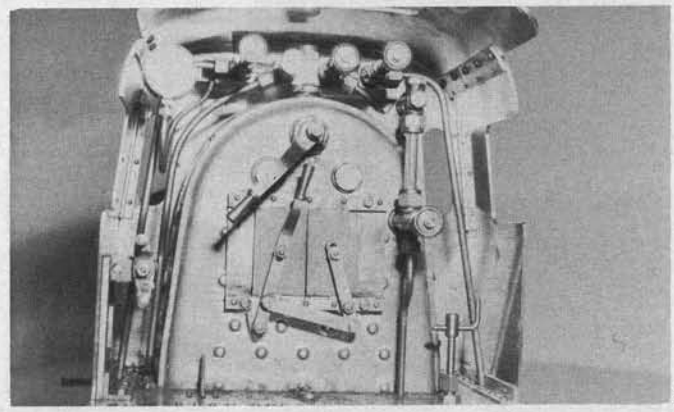

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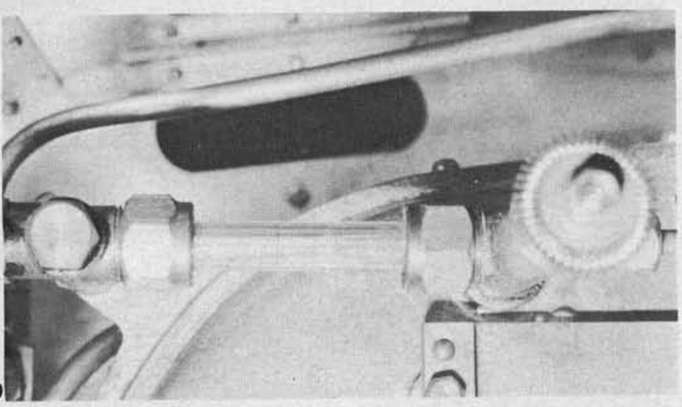

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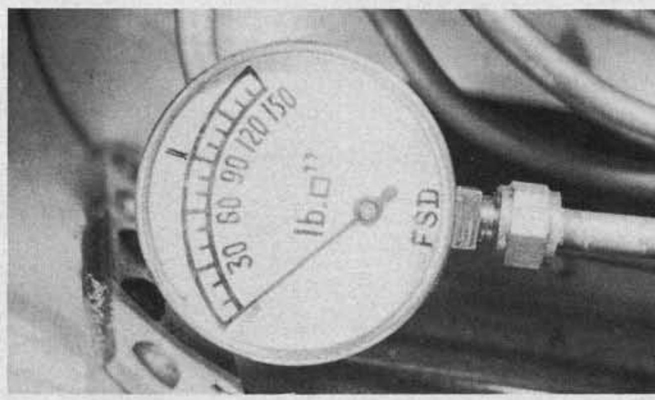

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35 *Large bush silver soldered in boiler, for safety valve.*

36 *Twin safety valves on the boiler.*

37 *Ball type safety valve.*
A *Valve assembled.* **B** *Body bottom fitting, with ball seat.* **C**. *Body.* **D**. *Ball, sits on ball seat.* **E**. *Ball retaining cap on pintle.* **F**. *Spring fits over pintle.* **G**. *Spring retaining cap, screws into top part of body.*

38 *Regulator handle on backhead of boiler.*

39 *Footplate of one of the author's locomotives.*

40 *A water gauge on the backhead of a boiler.*

41 *Steam gauge.*

Another important fitting is the Regulator and again, this is another item which states what it does, it controls or regulates the amount of steam being drawn off the boiler to be used by the engine. The regulator, usually mounted inside the boiler, has a hole in it, but is otherwise sealed, so that steam from the boiler can enter and in the body of the regulator is another hole, called a port, which has a flat plate over it which also has a hole in it. Movement of the flat plate, now termed a valve, over the port allows steam to enter or not according to the will of the driver who can line up the holes by means of a long rod and admit steam through the port. From there, steam enters a pipe, in this case called the main steam pipe, which is sealed from the rest of the boiler and go down to the engine. There are other types of regulators, but the above is a description of the simplest. The Regulator handle is usually located on the backhead and connects via the regulator rod to the regulator itself through the boiler. On some locomotives, all this gear is fitted outside the boiler and connects, through air and steam tight fittings to a regulator mounted in the smokebox. My photo,**38**, shows a regulator handle mounted on a backhead, and **39** shows the backhead with the various fittings on it.

There are two other fittings which should be mentioned at this stage; these are the water gauge, a glass tube in pressure tight fastenings on the backhead, which shows the driver the water level in the boiler. Too high a level means the locomotive may not work properly and some damage may ensue and too low a level is dangerous and can cause damage to the boiler,**40**. The other fitting is the steam pressure gauge,**41**, which shows the pressure inside the boiler. It is usually calibrated (accurately marked) in "Imperial" countries in Pounds per square inch which is abbreviated as lbs p.s.i., and the working pressure is generally around 80 to 100 lbs p.s.i. in our small locomotives. The working pressure is usually marked by a red line on the dial of the gauge.

To be continued next month.

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All classified Advertisements must be pre-paid.
Private and trade rate 12p per word (minimum £2.00). Box Numbers 50p extra. Display box rate £6.25 per column inch (maximum 2"). All advertisements are inserted in the first available issue. Box replies to be sent care of Advertising Department, P.O. Box 35, Bridge Street, Hemel Hempstead, Herts, England HP1 1EE. There are no reimbursements for cancellations.
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TOOLS & EQUIPMENT

Mail Order Protection Scheme

If you order goods from mail order advertisers in this magazine and pay by post in advance of delivery, this publication *Model Mechanics* will consider you for compensation if the advertiser should become insolvent or bankrupt, provided

1. You have not received the goods or had your money returned; and
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Please do not wait until the last moment to inform us. When you write, we will tell you how to make your claim and what evidence of payment is required.

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This guarantee covers only advance payments sent in *direct* response to an advertisement in this magazine (not, for example, payments made in response to catalogues, etc., received as a result of answering such advertisements). Personal advertisements are excluded.

News

Rotherham and District Arts Council in association with the Rotherham Star are presenting Scaledown '79. Last year's show was the largest of its kind in South Yorkshire.

This year the Exhibition will be a major Regional Event and has been guaranteed a large narrow gauge railway layout, a Hornby Clockwork layout plus various battle scenarios and dioramas, indoor radio controlled car racing, outdoor marine, car and aeroplane radio controlled display. It is to be held at Rotherham Arts Centre and in the Town Hall Assembly Rooms, with outdoor displays again at Herringthrope Leisure Centre and Clifton Park.

Entries are open to anyone in the various categories. This year Meccano and Lego Models will be included in the categories.

For further details, please contact J. Turner or G. Cowley, at the Brian O'Malley Central Library and Arts Centre, Walker Place, Rotherham, S65 1JH, or telephone Rotherham (0709) 2121, Extension 3623. Please ask for their Illustrated Entry form which is self-explanatory. (27th to the 30th September).

Dewsbury & Batley Technical & Art College, Halifax Road, Dewsbury, Yorkshire WF13 2AS. **Model Engineering Classes.**

We have had in the past a very healthy and highly motivated group of model makers, who attended classes in this department, despite the rage of the elements. Last year the class had to be cut back, because of financial restraints. I would like to inform your readers, that we are now in a position to offer a 3 hour evening class in the college workshops. This is supervised by enthusiastic staff, who are themselves model engineers. Classes will be held on Wednesday nights and all are welcome, enrolment is on the 10th to 12th September 1979, and classes commence on the 19th September. Free admission is given to Senior Citizens.

4 August 1979
Ickenham & District S.M.E.
Miniature Railway — open to public. Rear of Coach & Horses P.H., Ickenham Village, Middlesex. 2pm-6pm. Fare 5p. Admission free.

SHOP GUIDE

★ Mail Order Welcome

READERS PLEASE NOTE: Due to soaring postal charges many retailers are unable to answer postal enquiries unless accompanied by a stamped addressed envelope.

BERKSHIRE

READING Tel: 51558
READING MODELS ★
5 Chatham Street
Mon-Sat:
9.00 a.m. - 5.30 p.m.

CUMBRIA

PENRITH Tel: 5378
MODELMAKER ★
11 Poet's Walk
CA11 7HJ
Mon-Sat: 9.00 a.m.-5.30 p.m.
Wed: Half Day
Fri: 9.00 a.m.-6.00 p.m.

DEVON

TORBAY Tel: 521767
MANSEL'S MODELS ★
Palace Avenue
Paignton
Mon-Sat incl:
9.15 a.m.-5.30 p.m.
Wed: Half Day
Friday: 9.15 a.m.-7.00 p.m.

HAMPSHIRE

FAREHAM Tel: 234136
G M H BUNCE & CO. LTD ★
206 West Street
Open 9.00 a.m.-5.30 p.m.
Closed Wed.

FARNBOROUGH Tel: 44600
DONS MODELS
24A Queens Road,
North Camp
Open: Mon-Sat:
9.00 a.m.-6.00 p.m.
Closed all day Tuesday

HERTFORDSHIRE

WATFORD Tel: 46966
RAILMAIL OF WATFORD ★
65-67 Vicarage Road
Mon-Sat:
9.00 a.m.-5.30 p.m.

KENT

BROMLEY Tel: 01-460 0818
AVICRAFT LIMITED ★
15 Chatterton Road
Open: 10.00 a.m.-6.00 p.m.
(Not closed for lunch)
Wed: 10.00 a.m.-1.00 p.m.

LINCOLNSHIRE

LINCOLN Tel: 25907
THE MODEL CENTRE
24 Newland, LN1 1XG
Open: Mon-Sat:
9.00 a.m.-6.00 p.m.
Early closing Wed:
9.00 a.m.-1.00 p.m.

LONDON EAST

PLAISTOW Tel: 01-472 2471
A G HERMITE ★
633 Barking Road, E13
Mon-Sat: 9.00 a.m.-6.00 p.m.
Closed all day Thurs.

WANSTEAD Tel: 01-530 4405/4660
AKRON TOOL SUPPLY CO ★
69 Nightingale Lane
E11 2EY
Mon.-Fri: 9.00 a.m.-5.30 p.m.
Sat: 9.30 a.m.-12.30 p.m.

LONDON NORTH

LONDON Tel: 01-607 4272
HENRY J NICHOLLS ★
& SON LTD
308 Holloway Road, N7
Open Mon-Sat:
9.00 a.m.-5.30 p.m.

NORTHAMPTONSHIRE

NORTHAMPTON Tel: 31223
THE MODEL SHOP ★
230 Wellingborough Road
Open: 9.00 a.m.-6.00 p.m.
Half Day Thursday

NORTHUMBERLAND

NEWCASTLE UPON TYNE Tel: 22016
THE MODEL SHOP ★
18 Blenheim Street
Mon-Fri: 9.00 a.m.-5.30 p.m.
Saturday: 9.00 a.m.-6.00 p.m.

NOTTINGHAMSHIRE

NOTTINGHAM Tel: 50273
GEE DEE MODELS LTD ★
19-21 Heathcote Street
Off Goosegate
Mon-Sat: 9.30 a.m.-5.30 a.m.
Thurs: early closing

NOTTINGHAM Tel: 060 744 3094
MILLHOLME MODELS ★
The Old School
Woodborough
Open: Tues-Sat 10.00-1730
Sun 10.30-12.45

OXFORDSHIRE

OXFORD Tel: 42407
HOWES MODEL SHOP ★
9-10 Broad Street
Open: 8.45 a.m.-5.30 p.m.
6 day week

SCOTLAND

GLASGOW Tel: 041-221 3111
RAILMAIL OF SCOTLAND ★
165a St Vincent Street
Mon-Sat: 9.00 a.m.-5.30 p.m.

SURREY

ADDLESTONE Tel: Weybridge 45440
ADDLESTONE MODELS LTD ★
63 Station Road
Mon-Sat: 9.00 a.m.-6.00 p.m.
Wed: Closed all day
Fri: 9.00 a.m.-6.30 p.m.

SUSSEX

EAST GRINDSTEAD Tel: 21750
SOUTH EASTERN MODELS
5 The Parade,
London Road,
Felbridge
Open: Mon-Sat: 9.30 a.m.-5.30 p.m.
Closed Wednesdays

WALES

CARDIFF Tel: 29065
BUD MORGAN ★
22 Castle Arcade
South Glamorgan
CF1 2BW
9.00 a.m.-5.30 p.m.
Wed: 9.00 a.m.-1.00 p.m.

CARDIFF Tel: 31367
RYALL & WALTERS RADIO ★
MODELS
34 Llandaff Road
Open: 9.00 a.m.-12.30 p.m.;
1.30-5.30 p.m.
Monday till 8.00 p.m.; Closed Wed.

YORKSHIRE

KEIGHLEY Tel: 65662
AIREDALE MODELS ★
5 Royal Arcade
Low Street
Mon, Wed, Fri: 10.00 a.m.-6.30 p.m.
Thurs: 10.00 a.m.-7.30 p.m.
Sat: 9.00 a.m.-6.00 p.m.
Tues: Closed all day

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Shops offering a mail order service are denoted by an asterisk.

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HEMEL HEMPSTEAD, HERTS. HP1 1EE

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