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COVER PICTURE

Baldwin-built 2-6-2 tank, 2 ft. 6 in. gauge. One of four locomotives which haul "Puffing Billy" which ran for many years between Ferntree Gully and Gembrook (Australia) carrying goods and holiday-makers. Following the closure of the line by Victorian Railways, the train was taken over by the "Puffing Billy Society". The train now carries holiday-makers between Belgrade and Emerald. Colour photograph by S. W. Lowry.

NEXT ISSUE

Final details of "Mountaineer": The Guildford Rally.

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The Editor is pleased to consider contributions for publication in "Model Engineer". Manuscripts should be accompanied if possible by illustrations and should also have a stamped addressed envelope for their return if unsuitable. While every care is taken, no responsibility can be accepted for unsolicited manuscripts, photographs, art work, etc.

SMOKE RINGS

A Commentary by the Editor

National Railway Museum

Dr. John A. Coiley has been appointed Keeper of the new National Railway Museum at York. The Museum building at Leeman Road, York is scheduled for completion at the end of this year and it is planned to open it to visitors in the autumn of 1975.

Drawings of the Tower Bridge

A number of early drawings connected with the building of London's Tower Bridge, several hitherto unknown and unpublished, have come to light as a result of the recent opening of a special exhibition at the Science Museum to mark the retirement of the original 80-year-old steam-hydraulic machinery at the Tower Bridge. Most of the drawngs bear the signature of George Stevenson, A.R.I.B.A. who assisted the City Architect, Sir Horace Jones in the initial design work for Tower Bridge. After Jones' death in 1887, Stevenson undertook the re-design of the cast iron-work on the bridge. He was also responsible for designing the elaborate cast iron lamp standards which are still a distinctive feature of Tower Bridge.

The drawings will shortly be exhibited by the Science Museum.

The late W. H. Lee

Mr. W. H. Lee, one time President of the Hull Society, died on July 9th. He was head of the Metalwork section of the Riley High School, Hull. As a model engineer, he was responsible for a very fine model, for 3½ in. gauge, of the L.N.E.R. *Flying Scotsman.* This was fitted with three cylinders and Gresley 2-1 valve gear. Other models by Mr. Lee included a 2½ in. gauge 0-4-4 tank, a Westbury-designed "1831" I.C. shunter, and many types of steam engine.

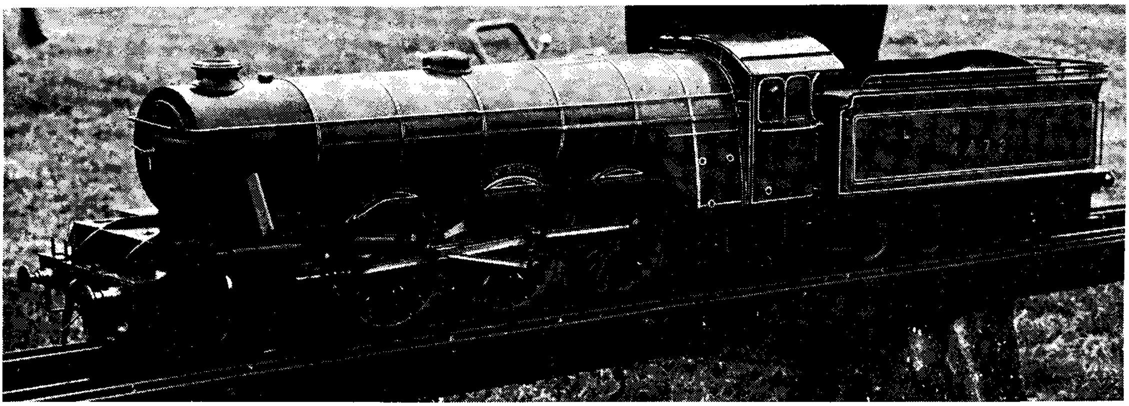
The late W. H. Lee driving his "Flying Scotsman". The locomotive is also seen in the picture below.

Mr. Lee was also responsible for the design of the Hull railway track, on which he spent many hours. He was a man of dynamic character and always willing to help fellow enthusiasts. He will be much missed in the Hull district.

A book offer

Mr. F. G. Benson, who was at one time Managing Director of Cineluxe Ltd., has some books which may be of interest to readers, which he is prepared to send to anyone who will send him a nominal sum (12p or 30p for the three) for packing and postage. These are "Build your own Projector" by W. G. Rowell. "Adapting the 200B to Sound" by R. W. Hall, and "Converting the Kodascope "C" to Sound" by J. A. McKean. Club Secretaries may have multiple supplies on request.

Mr. Benson's address is 1564, London Road, Leigh-on-Sea, Essex.



BUILDING THE ALLCHIN

Part XXII

by W. J. Hughes

From page 757

CONTINUING with the making of the chimney, in parting off the waste (again with knife tools), see that the angle of the edge corresponds with that of the edge of the upper spinning, as shown in the template sketch. The two should fit nicely together as at Fig. 4H, (August 2nd) with a tiny surplus for cleaning up.

When silver soldering my two halves together, I put in a reinforcing ring of 16 G. brass wire at the joint, but some other builders since then have left the ring out and it seems satisfactory. After cleaning and fluxing the two halves, put them together upside down on a piece of asbestos mat, with a suitable small weight on top to keep them in close contact. When the joint is hot, a touch with Easyflo wire should do the job.

The wooden former should have been left in the chuck, and it should now be turned down parallel to fit snugly inside the shell. Support the pickled shell on it by a pressure pad—wood will do—held lightly by the tailstock centre (Fig. 4G). On the outer edge clean off any surplus with a smooth file and emery, and round it to about 1/32 in. radius. Clean up all over with smooth emery and finish off with metal polish. And it takes less time to make this eye-catching piece of hardware than it does to describe how to make it!

Chimney Barrel

When doing the original drawings for the Allchin, the dummy seam on the back of the chimney was shown as cast on, and most builders have found this satisfactory. However a few who wished to turn the casting all over have done so, and have added a separate dummy seam, riveted on. All this is quite satisfactory and to individual taste, of course, providing one does not thereby make the chimney too narrow and thus out of proportion with the rest of the engine, which would be very easy to do, and would quite ruin the appearance.

Clean up the casting for the chimney barrel and drive a hardwood plug into the cored hole at the top, cutting it off flush. Grip the bolting flange in the chuck and set the barrel to run true. Centre the plug and bring up the tailstock centre to support it. Face the end and turn the parallel part at the top to a tight push-fit for the copper cap. Mount the lathe fixed steady to support this parallel part. Set the top-slide parallel with the taper of the chimney and bore out the interior to leave the walls 7/64 in. thick, and to a depth of at least 3 in. Chamfer out the lip at the top to reduce the apparent thickness to about 1/32 in.

For turning the bolting flange plug that end, grip the top parallel of the barrel in the three-jaw, set to run true, centre the plug and support it on the tailstock centre. Turn the flange to diameter and thickness, slightly rounding the upper corner, and turn the spigot to fit the counterbore of the chimney saddle. Support the flange in the fixed steady and finish boring out the tapered interior from this end.

On the dummy seam set out and drill the positions for the dummy 3/64 in. rivets. Using a forked bit of strip tin, insert one rivet at a time from inside, and support its head on a round bar whilst setting the outer head. If you do not have the commercial rivets drill each hole No. 56 (or 3/64 in.) insert a stub of 18 gauge wire, and head it over outside. Under the pressure the body of the rivet will expand in the hole and become immovable. Next insert six 1/16 in. dummy rivets in the flange.

The bolt holes in the flanges of the chimney barrel and the saddle cannot be jigged one from the other. But if you make a kind of "washer" to fit over the spigot, with four holes drilled in it at the correct spacing, this can be used in turn to drill the two flanges to fit each other.

Front Wheels

If now we make the front wheels we shall have an engine which can, so to speak, stand up for itself, looking eager and willing for work as soon as it can get its cylinder and motion made and fitted. Incidentally, it is worth noting how the position of the chimney and perch bracket, placed *behind* the centre line of the smokebox, in the Allchin, make the engine appear to be thrusting forward and ready to go.

Since the front wheels are simplified versions of the hind ones, we can simplify the instructions. To turn the rims, fit the outside jaws to the three-jaw chuck, and mount the casting on the outside. Then at the one setting you can turn the outer surface, face the edge, and bore out the inner surfaces of the tee-ring. Leave about 1/16 in. radius between the web and the rim. Before removing the rim, use your mandrel mounted dividing attachment to divide into ten equal sectors on the vertical web, and four on the outer surface. Reverse the ring if the chuck runs true, and face and bore out the other side.

The hubs are made in three parts, as before, and being equipped with chucking spigots are easy enough to turn. When boring them, they should be a good running fit on the front axle, but you may prefer to leave the holes undersize at this stage. Then when the wheels are fully assembled they can be mounted truly on the face-plate and the bores completed.

In the prototype, the inside of the hub is fitted with a cap as well as the outside, but in the model the cap is a dummy, in one piece with the end. Notice in the sectional drawing of the front wheel that this end is counterbored to be a good running fit on the shoulder or collar of the front axle. If the wheelbores are to be finished later then so should these counterbores.

For setting out the spoke grooves, five in each face, use the mandrel dividing attachment and scribe five lines right across the face and across the flanges. This gives the ten divisions needed, remembering that the five grooves on one face alternate with the five on the other. These grooves need to be milled out 1/16 in. deep with a 7/32 in. end-mill.

There are also three small scallops in the spigots of the dummy inner end-caps, and these can be milled with the same set-up.

To finish the front wheels need not take long, especially if you are using the stamped-out ready shaped spokes from Reeves. These only need draw filing on the edges. For the die-hard who wants to make his own, the twenty blanks can be cut from 16 s.w.g. sheet metal, or more conveniently from $\frac{3}{4}$ in. wide strip.

The method of making will be as described for the hind wheel spokes in Part XVI (1st March 1974), so don't forget the surplus at each end for bolting the blanks to the milling jig. A $\frac{3}{8}$ in. end mill will be required to machine the radii of the palm shoulders, but note that they must then be filed off at a slight slope, and the corners slightly rounded. The front wheel tyres or strakes are from $\frac{5}{8}$ in. by 1/16 in. steel strip, and their true length is taken from the job itself. When riveted to the rims, there should be a 1/16 in. gap between the 45 deg. ends.

A note of caution here—on the general arrangement drawing of the front axle (Sheet 5) the strakes are shown as "handed" for the separate wheels, which I had assumed would match the hind wheel ones. In actual fact on *both* wheels the sloping ends should match, as on the nearside wheel. So take care in the bending. This should be done before drilling the rivet holes. On a suitable mandrel the middles will bend under hand pressure, but light mallet blows will be needed at the ends. Then set out, and drill the holes 3/32 in. and countersink outside.

Assembly

Assembly of the front wheels is done on a jig very similar to the hind wheels, so does not require a full description. Make simple jigs for drilling the centre rivet hole in the spoke palms and for the holes in the vertical webs of the tee rings, and drill them all. Before fixing the spokes, rivet the tyres to the rims, starting each one at the centre rivet holes and working outwards, and using small toolmaker's clamps to hold the tyre in place until riveted. As on the hind wheel strakes, *don't* file the heads flush but leave a very low doming, straight from the hammer.

Make up a jig, and assemble the front wheels similarly to the hind ones. Note that the palms of the inside spokes go to the inside of the tee rings and vice-versa. The hub outside and inside ends are secured by screws and by sweating, and at the same time the oil pipe may be sweated in. Two retaining collars turned from mild steel, and the hub caps from castings, or brass or even steel rod, will finish the job, and enable the engine to stand on its own feet, so to speak.

The Cylinder Arrangement

Outwardly on the model the cylinder is correct in appearance, but as with the boiler there are differences internally. The chief one is that since it would be almost impossible on a block of this size to core in all the steam passages, and especially to make them of adequate capacity, the valve chest is bolted on, and the cylinder barrel is in the shape of a liner. This not only gives an annular passage by which steam passes from the boiler to the dome, but also provides a steam jacket for the cylinder.

The front cylinder cover (which in a traction engine is the one nearest the driver, be it remembered) has also been altered. In the prototype, it is cast in one with the trunk guide, which on the model would have been very difficult not only for pattern making and moulding, but also for machining. So we will make it separate from the trunk, but will conceal the extra thickness of its flange by counterboring the end of the cylinder block to sink it in.

Not only does this locate the flange centrally, so that no spigot is necessary on its inner face, but with a slight chamfer on the outside edge, it looks like the normal raised bolting face of the cylinder, to which the trunk guide is secured by studs and nuts. The gland also appears to be in one with the trunk guide, as in full size. The separate valve chest makes it easy to machine the port face and the ports.

Setting out the cylinder

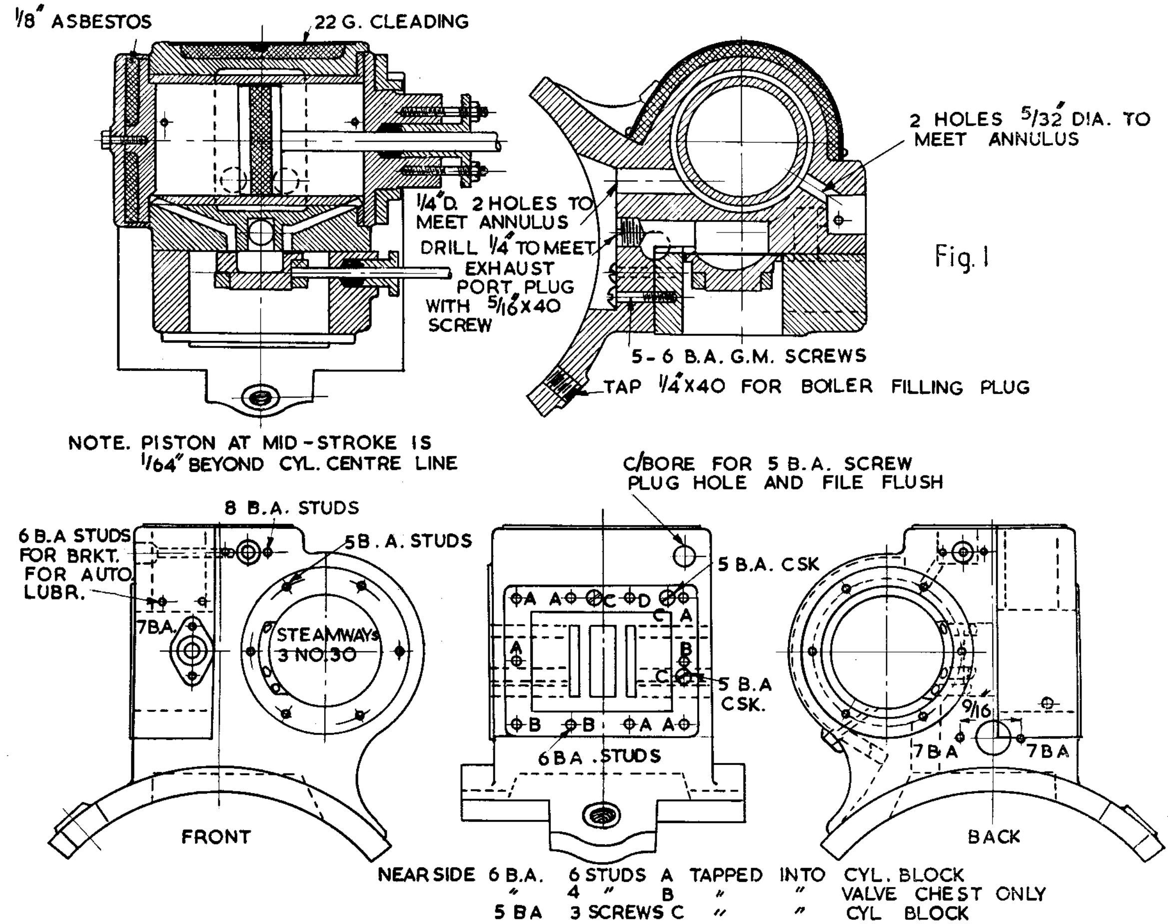
On a casting of this nature, there are several important centre lines, all inter-related, and it is necessary to set them all out before any machining is started. As always, the casting should be cleaned up externally first, and riffler files, dental burrs, scrapers and small chisels can all be useful here. Plug the embossed end of the cored hole with wood, and file it off level. Shape another piece of wood to fit the radius of the saddle, and cement it in place, as in the photographs, to allow the boiler centre to be marked out.

With dividers, find the centre of the cylinder relative to the bolting flange, in case the cored hole is not truly central. Find the boiler centre, with reference to the upper surface of the saddle. Check the two centres to see that they are approximately correct relative to each other. This is only a preliminary check over.

Now, before starting on the "serious" setting out, it is advisable to take a skim off the valve face, and off the step at right angles to it, where the lower edge of the valve chest will fit. To do mine, I gripped the block in a machine vice bolted to the vertical-slide, and used a mandrel-mounted end mill to skim up the surfaces. The setting up must be checked to ensure that the faces, when machined, will be parallel with the centres of the cylinder and boiler. Only take a light truing-up cut at this stage.

Plug the other end of the cored hole, and smear with marking blue all the surfaces where centre lines are to be marked. Set the block on parallel packing on the surface plate—note that I used a vee block (Fig. 3) — with the valve face downwards. It will rest on the packing by its own weight.

Set the surface gauge to boiler centre height (already marked on the wood) and scribe this line right round the block. If you haven't a pukka rule stand, copy mine by clamping the rule to a small angle plate, with one of the inch marks set to the point of the surface gauge—i.e., at boiler centre height. Use a magnifying glass in this, and in fact most marking out, for accuracy.



Set the scriber of the gauge to 1 in. above the boiler centre line, and check the cylinder centre, already marked. If this comes right, scribe the line across both ends of the block: if not correct, it may be necessary to raise or lower the boiler centre line slightly, or perhaps to compromise a little on both. Drop the scriber 1/16 in. *below* the boiler centre line, and scribe a line across the ends and the top of the block. This will denote the true valve face. Raise the scriber 5/16 in. and scribe a centre line for the regulator rod on both ends.

Now the block must be turned through 90 deg. to set out the horizontal centre lines I clamped mine to an angle plate using some large scrap roller races as weights to prevent the angle plate tipping over. Adjust the position of the cylinder on the angle plate to get the cylinder centres and the saddle parallel with the surface plate, and tighten the clamp. This should bring the valve chest step parallel with the top edge of the angle plate.

Recheck the centres of the bore, corners of the saddle, top (now underneath) of the saddle, and the corners of the valve chest step. If correct, set the scriber to cylinder centre height, or scribe the line right round. It may be necessary now to alter the position of the rule, to bring an inch mark to the same height. Then raise the point of the scriber 3 3/16 in. and check the boiler centre height, previously marked on the wood. This should be correct, but if not, a compromise may be necessary between the two centres.

Having scribed the boiler centre line, drop the point $1\frac{7}{8}$ in. and mark a line across the curved ends of the saddle. This marks the top of the inner radius of the saddle, where the saddle will sit on the boiler. Drop the scriber $\frac{1}{2}$ in. further, which should bring it 13/16 in. from the cylinder centre line, and mark off the step for the valve chest and the centre of the exhaust orifice. Drop it a further 15/16 in. and this will give the height of the regulator rod at each end. Finally a further drop of $\frac{1}{4}$ in. will mark off the topmost surface of the cylinder block all round.

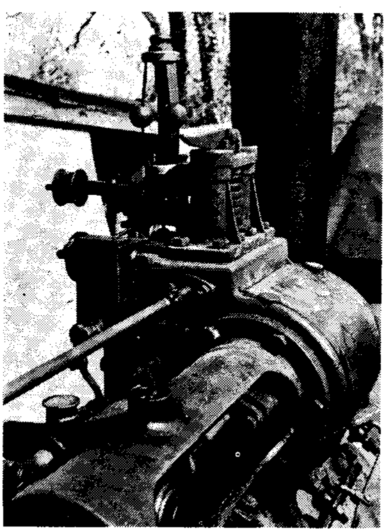
Remove the work from the angle plate, and with dividers set out the arcs of the inner surface of the saddle, $1\frac{7}{8}$ in. from boiler centre, and of the lagging 3/16 in. outside that. This can only be done at the one end where the wooden "extension" is. Use the dividers also to set out the cylinder bore ($1\frac{1}{4}$ in. diameter) on each end, and the counterbore (1 11/16 in. diameter) on the front end (as seen from the footplate) of the block. Lastly, lightly and very accurately centre dot all the lines at intervals, and centre punch the centres for the regulator rod.

I have thought it worth while to deal with this setting out at some length, because it is one of the most important operations in building the whole engine—equally as important as the machining. Hence the beginner especially, is urged to check and double check everything before that crucial step is taken!

Setting up and boring

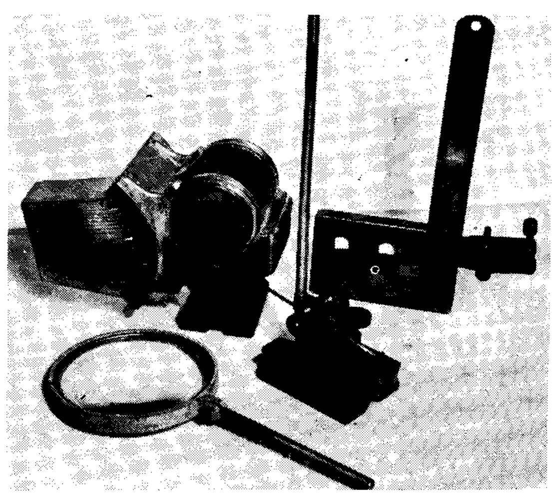
Now of course there are many ways of boring cylinders, but with a fairly large block like this, and the average $3\frac{1}{2}$ in. lathe, it boils down to fixing the block to the saddle, and using either a boring bar between centres, or one from the mandrel, preferably in a boring head. The method about to be described does work well.

It seems to me that in a case like this, the cylinder bore is the important thing—when it is done, it is not a difficult matter to get all the



Left: Fig. 2. The cylinder of the full-size engine.

Right: Fig. 3. Scribing the vertical centre lines.



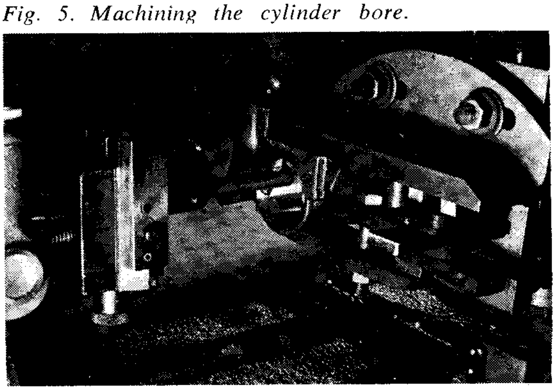
A view of the full-size Allchin showing the cylinder and chimney base.

other surfaces correct in relation to it. The photograph (Fig. 5) and sketch (Fig. 6A) show how I mounted the block on an "upside-down" angle plate, secured to the vertical-slide mounted on the cross-slide.

The method of clamping the block to the angle plate was a bit unorthodox, but it worked. I have mentioned before, my favourite faceplate clamps are bent up from $\frac{3}{8}$ in. square black mild steel. Two of these were used, the inside one being tightened well down to form the main grip. The outside or underneath one was not too tight, partly to avoid disturbing the bore, but partly also because its bolt is "pulling" on the other clip to counteract the latter's tightness. Alternatively a longer bolt could be used, as suggested in the sketch, but my block never moved with the first arrangement.

Every care is needed to ensure accuracy in the setting up. You can check the squareness of the vertical-slide — relative to the cross-slide — by fitting the faceplate, bringing the vertical-slide up to it, and checking the gap at each side by

Fig. 5. Machining the cylinder bore.



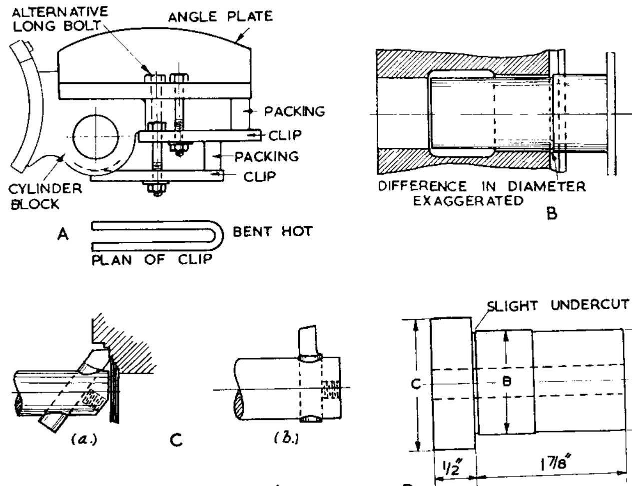


Fig. 6

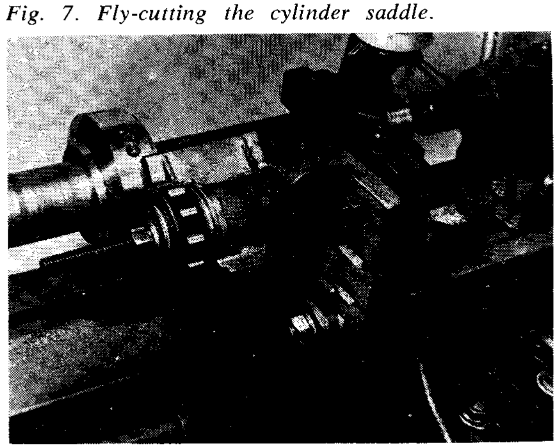
feeler gauge. See that the valve chest step on the cylinder is square with the bolting face of the angle plate, and in turn that this is square with the edge of the vertical-slide.

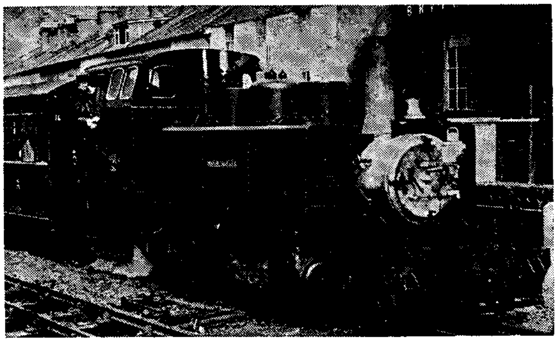
Set the scriber of the surface gauge to lathe centre height, and adjust the vertical-slide until the horizontal centre line of the cylinder coincides with it. Check both ends. Check the vertical centre line of the cylinder with a trysquare on the lathe bed, and adjust the position of the cross-slide until this centre line comes into line with the lathe centre plugged into the mandrel. This can be "sighted" from above. Finally, make a note of the readings on the micrometer collars of both slides, in case you move either inadvertently.

For the actual boring I used the borrowed boring head seen in Fig. 5, though I now have a "Dore" one of my own which I can recommend.

To be continued

Fig. 7. Fly-cutting the cylinder saddle.





MOUNTAINEER

A narrow-gauge 2-6-2 tank locomotive for 3½ in gauge

by Don Young

From page 796

My suggestion is that the cleading be made up as a box, to simply slide over the firebox, the lagging material being screwed to the cleading with a few screws, or perhaps wired on. Then when a boiler inspection becomes due the whole box of tricks can be lifted off. The cleading can extend hard up to the back of the spectacle plate; at the rear end it should extend to within ⅛ in. of the backhead face. To close off the back end, and blend into the backhead, the polished brass surround is required. This surround is formed by flanging the brass over a hardwood former, just like an oversize backhead, and then the centre portion is cut out to leave the section shown on the detail drawing. Fasten the surround to the cleading with a few rivets or 10BA screws, and of course dimple the surround in way of the top gauge glass union as already mentioned.

We must now connect from the gauge glass top fitting to the manifold, via a 3/16 in. o.d. thin-wall copper tube, to the valve on the manifold. This water gauge valve is identical to the blower valve so we can kill two birds with one stone.

Construction is much akin to the injector steam valves, so much of the description can be dispensed with. Start with the valve body, which resembles a "T" piece. Chuck a length of ⅜ in. dia. bronze rod in the three-jaw and reduce for ⅝ in. length to 11/32 in. dia. Centre and drill No. 11 for ¾ in. depth then tap 7/32 in. x 40T before parting off at 19/32 in. overall; just take off the sharp corner at each end. At 9/32 in. from one end drill a No. 41 hole, which will later be the steam exit, and tap this 5BA. For the outlet boss chuck a length of 5/16 in. rod, centre and drill No. 11 to 7/16 in depth, tap 7/32 in. x 40T and part off a ⅜ in. slice. Scallop the end to suit the 11/32 in. dia. body portion and secure to it for brazing with a 5BA screw, complete with large washer under its head. Pickle and polish then remove the 5BA screw, open up the tapped hole to No. 30 and also run the 7/32 in. x 40T tap through the body and outlet boss. The valve seating is a simple turning exercise and the valve stem, spindle, handwheel and gland are either identical or closely akin to the aforementioned injector steam valve. All you have to do now is turn up an appropriate sized union body to suit the pipe to be connected, 3/16 in. o.d. for the water gauge and ⅛ in. for the blower, and this part of the job is complete.

The whistle valve operates both whistles on the cab front simultaneously, otherwise it hardly requires a mention, being of straightforward construction. Screw into the top of the manifold and connect a whistle cord from the lever to the cab roof.

The whistles posed a bit of a problem, those on the cab front that is, until I remembered that fantastic 0-4-2 oscillating cylinder 5 in. gauge logging engine built by Gordon Howell of the Andover M.E.S. In characteristic friendly style Gordon provided information on his whistle when I met him at a recent Southampton M.E.S. open day; and then he proceeded to demonstrate how his engine could be completely dismantled in five minutes flat! Anyhow, the whistle on Gordon's engine is ex-Metropolitan Police and produces a fine note, so all yours truly can suggest is that builders try to obtain one from a friendly policeman, or boy scout. The modification merely entails cutting the mouthpiece away and substituting the cup and connector detailed, sweating to place. To complete the "chime" make up the smaller whistle, it is virtually a half size standard type, and try to harmonise same with its big brother. The end product is going to be something of a screech and will in no way do justice to the melodious sound effect of the full size *Mountaineer*, but to date I can specify nothing better. Perhaps a kind American reader, and my correspondence shows there is no shortage of Live Steam Brothers, will come to my aid and describe an authentic "Whooper" that can be hidden under the footplate.

In order to erect the whistles, a bracket is required on the front of the spectacle plate, being a 2¼ in. length of ⅜ in. x ⅜ in. x 16 s.w.g. brass channel, sweated in position as shown on the sketch, page 795. Connect from the whistles to the operating valve with 3/32 in. o.d. copper tubing and clip the tube to the whistle bracket, securing with 8BA hexagon head brass screws.

Having moved out of the cab, let us enjoy our freedom for a while and concentrate on getting water into the boiler, starting with the clacks. Once again yours truly must apologise for the detail not being strictly correct to prototype, for the full size fitting is a single one, combining both clacks. Despite all the photographs I have taken of *Mountaineer* over the years, the total is well over a hundred, not one shows the clack in anything but side view; from the footplate the clacks are hidden by the sandboxes and massive dome, so the detail could not be brought to mind. When the time came for detailing I had just knocked up a sample for a British Railways class 2 locomotive, which worked a treat, so I simply copied it. There was a little consternation when I received a photograph of the actual clack direct from Boston Lodge, but on further investigation it was thought prudent to retain the separate clacks. Any builder who wishes to provide a single fitting can base same on the top feed fitting that was specified for Rail Motor No. 2. Let me quickly press on with a description of the construction.

For the bodies, chuck a length of ⅜ in. dia. bronze rod and face across the end. Centre and drill No. 32 to ⅝ in. point depth, following up with a 7/32 in. drill to ⅜ in. depth, before "D" bitting to 13/32 in. depth and tapping the outer 5/32 in. or so at ¼ in. x 40T. "D" bit the remaining portion of the No. 32 hole at ⅛ in. dia. and then part off the body at ¾ in. overall.

At 3/16 in. from the bottom end drill a No. 50 hole into the central bore and tap 8BA. Turn up the inlet connection as shown and fix temporarily to the body with an 8BA screw and large washer, for brazing. The boiler connection is turned up from ⅜ in. A/F hexagon bronze bar, recessed by approximately 1/16 in. depth at the upper, head, end to suit the 3/16 in. o.d. copper pipe. Bend this pipe to ½ in. internal radius and cut to suit until the clack body is vertical when fitted to the boiler. It is a little tricky holding the bits together for brazing, an understatement after the antics with the prototype, and on reflection it is preferable to drill into the clack body at No. 12 so the copper tube is a press fit therein, instead of scalloping the tube to suit the body. The little 16 s.w.g. web completes the pieces required prior to brazing; pickle, clean up and remove the 8BA screw before opening out the tapped hole to No. 40.

Seat a, 5/32 in. ball on the valve seat then turn up the cap, from 5/16 in. dia. brass rod, to allow the ball from 3/64 in.-1/16 in. lift. There is a golden rule in the making of satisfactory clacks—do not restrict the outlet. This refers to the cap itself, so finish the screwed portion in the position shown and turn the "pip" as slender as feasible. Equally important this rule applies to the clack ball, which must not be allowed to restrict or block the exit. On to the injectors themselves.

For the last two years or so, yours truly has been an avid reader of *Live Steam Magazine,* courtesy of local American Locomotive fan Stan Lenz. Said magazine contains a wealth of information for the advanced model engineer, but scarcely anything at all for the tyro; this is only a personal observation. Anyhow, when it came to describing injectors for *Mountaineer* there just wasn't anything to write about. My own humble design of injector will lift after a fashion, but not with sufficient certainty to guarantee operation in the position specified on *Moutaineer,* which is above the tank tops. Whereas those produced by injector king Arthur, and available from most of our suppliers, have superb lifting properties; need I say more!

The full size engine was modified in 1971, when the injectors were lowered and injector water valves fitted as there is now a positive head. There are two reasons for not following suit; simplicity and accessibility. The feature of merely opening the injector steam valve is a good one, providing the water metering properties of the injector are correct. There will be no problems on that score throughout the normal working range, and beyond this the only evidence of inefficiency will be a 'wet' overflow. As for accessibility, the injector water valves would be located on each cab side, low down, and would be difficult to operate in service; so why have them!

That dispenses with the actual injector, which brings me back to *Live Steam* and a letter in 'Mail Stop' from an old friend, Harold Crouch of Newark, New Jersey. Harold asks for some notes on injector maintenance and as manufacture is not being described hereabouts its seems a good idea to accept the suggestion, subject to our worthy Editor's approval.

In service there is only one major defect that will occur, blockage due to dirty feed water. It can largely be avoided by using rain water, taken from a large tank in which the delivery valve is sited above the sediment level, allied to a good filter fitted in the tender, or tanks. The arrangement shown for *Mountaineer* will be ideal, as there is a large area of gauze. Those little finger filters, so beloved by the late LBSC and which yours truly has unashamedly copied, have insufficient area to give a satisfactory performance over long periods. For tenders it is a good plan to include a well, covering the top of it completely with a gauze screen.

Even with all these precautions, debris can still get by on odd occasions and become trapped in the annulus between steam and water cones, the smallest clearance within the injector. Initially it may manifest itself by a 'wet' overflow, before a complete failure occurs. Arthur has a few injectors returned as unsatisfactory and nearly all suffer from this particular defect. It is but a moment's work to remove the steam cone and clear the debris, after which they invariably behave. In this respect it is always best to fit the largest practicable size of injector, the clearances are larger and less prone to blockage.

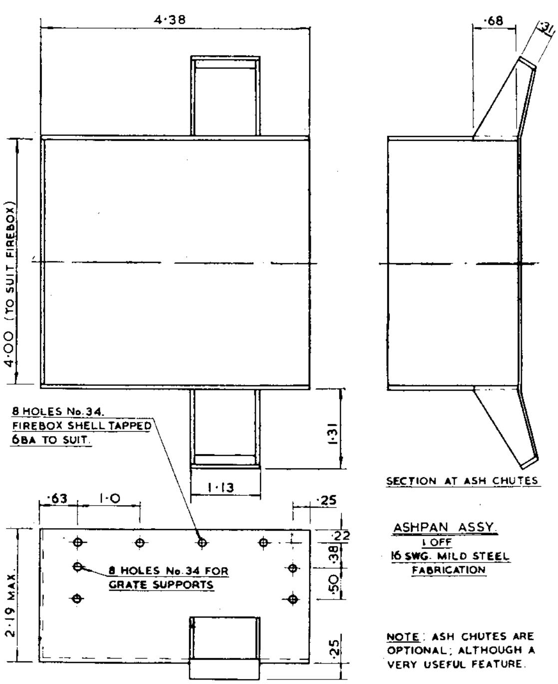
A temporary cure to a blocked injector during a run can often be obtained by closing off the overflow, with a length of rubber hose, containing a suitable plug. Open the water valve, followed by the steam valve, to blow the debris back from whence it came. But remember this is only a temporary cure and the system should be cleaned more thoroughly after the run.

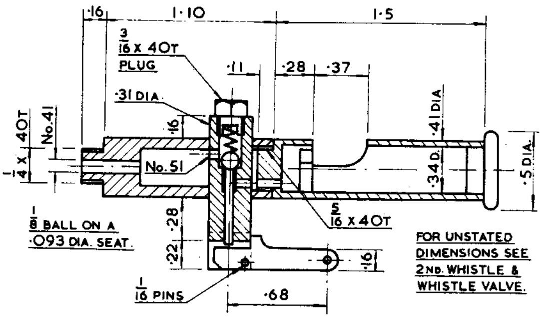
Little needs to be said concerning the steam supply, save to keep the reduced portion at the steam valve free from blockage, to ensure a good steam flow at the injector. The same goes for the injector itself, it requires only a minimum of maintenance. Even with 'hard' water, deposits of scale are not a serious problem. One of our local model engineers, Tom 'Jacko' Jackman merely soaks the offending cones in vinegar, acetic acid to the technical members of our readership. These are left to 'soak' overnight, but a few minutes in the pickle that we use for boilermaking will also suffice. Do not attempt to clean the cones by mechanical means, unless you want to consign them straight into the scrap bin. Injector performance will obviously deteriorate over the years, as happened also in full size, the solution being either to make up a new set of cones, or simply purchase a replacement injector.

The only other feature on the injector, the air valve, is not so important as was thought in earlier days. Arthur has demonstrated that both ball and cap can be removed, when his injectors at least can still be seen to deliver the goods. But it is a good plan just to reseat the ball after cleaning the cones; after all the combining cone is cleaned complete with the body, so the seat also gets pickled.

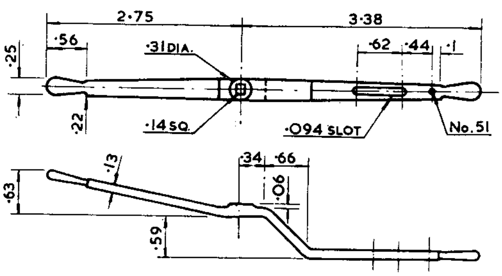
Which leaves only one more feature, the delivery clacks, or maybe a singular clack. Sticking clacks are the second biggest culprits of injector failure, or to be more precise it is the clack valve balls. In this respect top feed delivery is less prone to failure than clacks below the boiler water level. I wonder if this was a reason for fitting top feed in full size, for exactly the same phenomenon occurred and many are the blows that were rained on the unfortunate clack bodies! The cure again is to pickle the clack, to remove the offending scale, and then to reseat the ball or better to fit a new one. That covers the whole subject of injector maintenance, there is very little involved in keeping them trouble-free, once correctly installed.

Just a few quick words on the installation of the injectors on our *Mountaineer*. The injectors, the medium size commercial variety, are positioned as shown on the General Arrangement drawing. The water suction is taken from the elbow fitted to the tank, the next item being the injector suction pipe flange. From this flange to the injector fit 3/16 in. o.d. copper pipe, all the remaining pipes to complete this installation being 5/32 in. o.d. thin wall. In the delivery lines, fit a "T" piece or simply braze on another short length of pipe, to couple to the hand pump deliveries on the inside face of each tank. That just leaves the overflow, a "trumpet" piece being brazed onto the end of each again as shown on

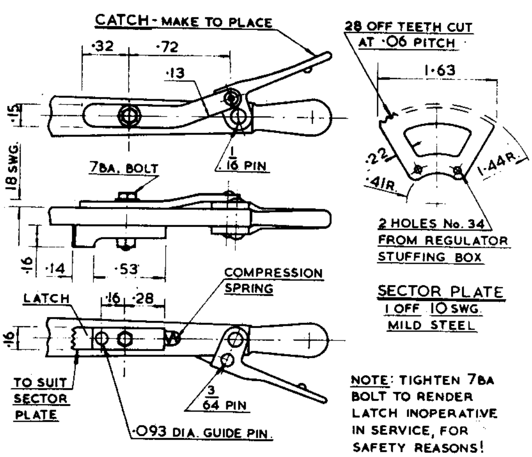




DOME WHISTLE 1 OFF BRASS (STAINLESS STEEL FITTED)



REGULATOR HANDLE (THROTTLE) 1 OFF STEEL FABN.



REGULATOR HANDLE ASSY. (R.H.)
1 OFF EACH ITEM STEEL.

the G.A. drawing and also on some of my humble photographs.

We are moving back towards the cab again, but let us first stop at the dome, to complete the trio of whistles and to attend to the safety valves. The dome whistle is one of those fittings that could well be a dummy, but having stuck my neck out with the other pair it seemed right and proper that this one should also work. The "guinea pig" whistle proved that at least it makes a noise, but in the wrong octave I fear!

For the bottom portion select a length of ½ in. dia. brass or bronze and cross drill a 5/16 in. hole for the whistle valve at 1 1/16 in. from the end. Chuck in the 3-jaw and turn down for 5/32 in. length to ¼ in. dia. before screwing 40T. Centre and drill No. 41 to about 1 5/16 in depth then part off at a full 1¼ in. overall. Reverse in the chuck and drill 9/32 in. dia., careful past the 5/16 in. cross drilled hole, to about 15/16 in. depth, finishing with a "D" bit if preferred, before tapping 5/16 in. x 40T to about ⅛ in. depth.

For the whistle valve, chuck a length of 5/16 in. or ⅜ in. square brass bar in the 4-jaw and set to run as true as possible. Turn down for 23/32 in. length to 5/16 in. dia., face the end and centre. Drill No. 51 to 1 3/16 in. depth, following up with a 3/32 in. "D" bit to 9/16 in. depth. Follow up again with a 5/32 in. "D" bit to ⅜ in. depth, then tap 3/16 in. x 40T to about 5/32 in. depth before parting off at 1⅛ in. overall. Cut the slot to suit the whistle lever, which is very similar to that in the cab, then reduce the end to 5/16 in. square if made from oversize material originally. Seat an ⅛ in. ball on the seat, fit the little stainless steel compression spring and close up with the end cap, then remove these pieces for a moment. Slide the valve body into the whistle stem to mark off and drill the two No. 51 steam passages; braze up, pickle and clean then complete the valve. The actual whistle is turned from 7/16 in. brass rod and is quite straightforward; the body length may be varied from that shown in an attempt to obtain a sweeter note! Screw into the dome and we can move straight on to the safety valves.

Safety Valves

It must be admitted that the safety valves caused a lot of trouble at the outset and various schemes unfolded on the sketch pad, yet the final design turned out quite simple and these valves will dispense with any surplus steam that the boiler generates; quite a lot we hope!

For the valve seating, chuck a length of ¾ in. dia. bronze and face across, then centre, drill and ream 7/32 in. dia. to ⅝ in. depth. Bore 15/32 in. dia. to 9/64 in. depth and then tap ½ in. x 32T. Check that the threads are well formed, increasing the depth to say 3/16 in. if not completely satisfied, lengthening the whole item by the same amount and parting off at the length decided. Chuck a length of ½ in. brass rod and screw 32T for about ¼ in. length, then screw the embryo seating to this mandrel. Turn down the outside as shown, screwing ⅝ in. x 32T to suit the dome bushes; finish by seating a ¼ in. stainless steel ball.

To be continued.

CHINGFORD'S ANNUAL RALLY

reported by K. S. Lane

EVERY YEAR, the annual Whitsun Rally at Chingford provides an interesting collection of engines from visiting clubs. This year was no exception and although the number was not as high as recent years the interest was greater.

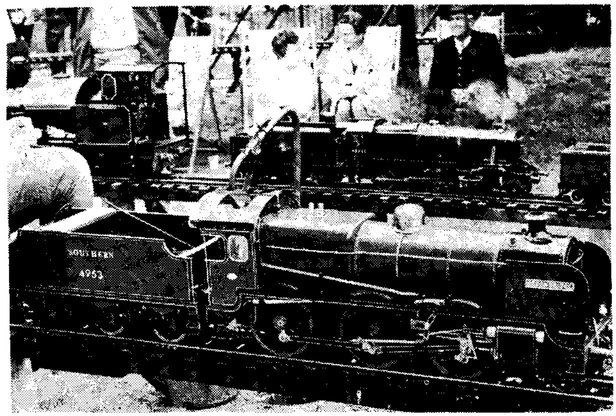
The main reason for this was the presence of two German engines which had not previously run on English rails. Herr Manke and Herr Verboom had travelled over from Germany specially for the Rally and what an impressive sight their engines were, standing on the steaming bays.

Herr Verboom was the first of the two to take the track with his 5 in. gauge 4-6-4—an express engine with a 10 wheel tender. This was when we found that our transporter was not big enough, and the tender had to be put onto the main line by hand. This engine was fired by propane, so no problems with firing. The propane bottle was carried in the tender and was out of sight at the beginning of the day. Unfortunately, the gas got cold which resulted in a loss of pressure to the burners, so another bottle was used, this being strapped to a passenger trolley. Because of the size of the tender, extended controls were used for driving. The engine is not yet completed but looked very impressive in its red and black livery.

Soon to join Herr Verboom was Herr Menke with his 5 in. gauge 4-6-4 tank engine, also propane fired. This was a very fine model again in red and black livery. Herr Menke used his own driving trolley, which he uses on his ground level track. This holds water and the propane bottle and when used on a ground level track makes a comfortable driving trolley. However, when used on a raised track the problem was to keep one's balance and to remember to keep one's head down when going over the bridge.

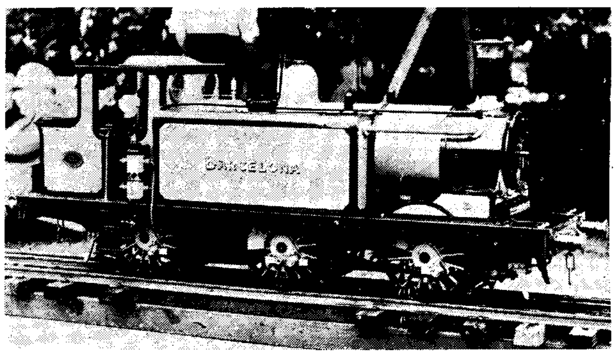
Both of these engines were on the track for best part of the day with quite a number of Chingford members taking a hand at the controls of both engines.

Contact had originally been made with Herr Menke by members from Chingford, Lea Valley and Harrow on their visit to Germany and they were all present to see the visitors. In the afternoon the German wives were taken sightseeing to Cambridge whilst their husbands remained at the track.



F. La Roche's 5in. gauge S.R. 2-6-0.

Below: Phil Hains' 5in. gauge L.B.S.C.R. tank.



The first engine of the day to take the track was Phil Hains, with his *Barcelona.* This 0-6-0 tank is always a pleasure to see on the track and runs as well as it looks. Some of the others

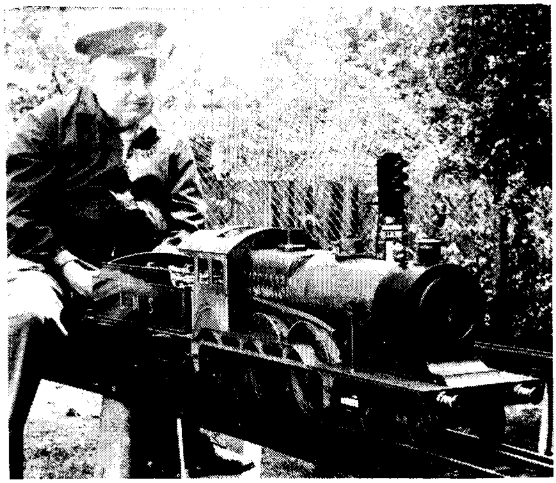
Below: Herr Menke driving his 5in. gauge 4-6-4 tank locomotive.

present were Mr. A. Bray's B.1. from Chelmsford, Ray Milliken from Maidstone with his *Consolidation* and also from Maidstone Fred Laroche with *Groombridge*.

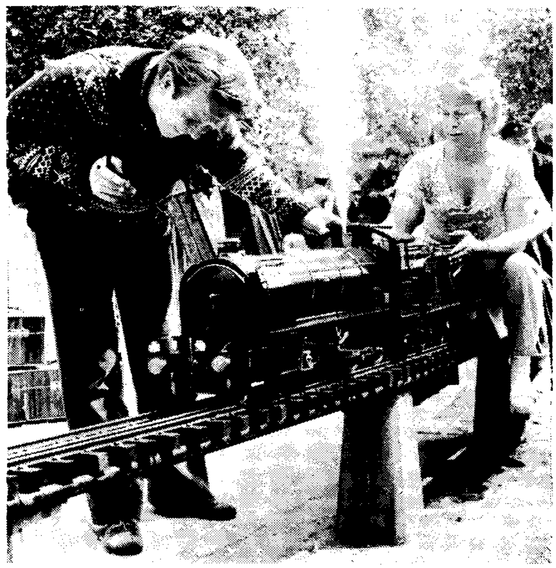
Three other not so common engines were Mr. R. Nixon's "Sentinel" from Hatfield, Mr. L. Disney's 5 in. gauge *Rainhill* from Harrow & Wembley, while Tom Mallett from the same club had his $3\frac{1}{2}$ in. De Wington Coffee Pot.

A total of eight clubs were represented and the day was made complete with the continuous supply of refreshments supplied by the Club members' wives for which we offer our thanks.

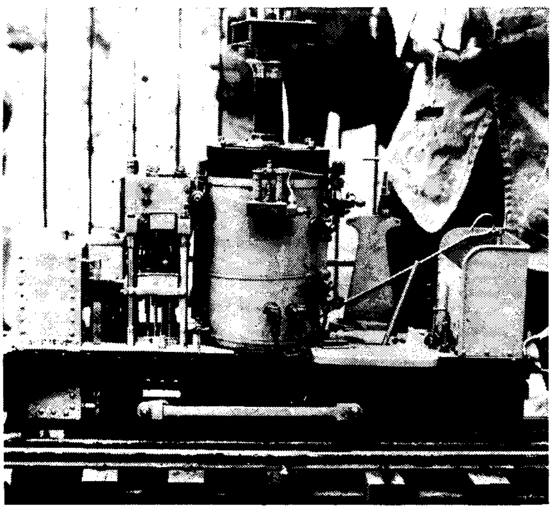
Right: Ron Heathcote from Maidstone drove his unfinished G.E.R. 4-6-0.



Mrs. Ray Milliken driving her husband's 2-8-0.



Below: Tom Mallett's $3\frac{1}{2}''$ gauge De Winton "Coffee Pot".



Paddle Engines

SIR,—I would like to add my small voice to reader Chatfield (M.E. Vol. 140, No. 3492). I am building K. N. Harris' Twin oscillating paddle engines as described in "Model Stationary and Marine Steam Engines". I intend to build the boiler described in "Model Boilers and Boiler Making"—the Scotch marine type which Mr. Harris intended should match the paddle engines. I would like to provide natural gas heating for this boiler and some sensible guide lines or parameters would be of great assistance to me. The engines and boiler are intended for a paddle tug, yet to be built.

I have tried using bottled gas in the past, Ronson refills being the size that a small screw tug (28 in. LWL) would accommodate. My attempts at scaling down a blowlamp to fire the boiler met with the following problems:—

1. Cooling of the gas container thus reducing gas flow.
2. Difficulty in providing gas tight seals.
3. Inability to maintain flame i.e. flame blown out by force of gas.
4. Difficulty in inducing flame to burn in a confined space, in this experimental case a simple tube representing a furnace tube.

Would you therefore add my request to Mr. Chatfield for more information. Incidentally, I would like to see more articles on marine steam plant, not being a polywheeled prime mover lover. The only locomotive that I have seen photographs of that have appealed are the American or Canadian logging locomotives that have a vertical engine strapped on the side and the drive is via bevel gears to the bogies.

Mr Harris in his drawings shows a strap across the big end, item 11a on page 75, "Model Stationary and Marine Steam Engines". Could any reader explain what this is intended for and what material it is made out of?

Blackburn. DENNIS J. KNIGHT

PISTON RINGS

by Michael W. Smart

Part II *From page 825*

TURNING TO MY own engines; a *Rob Roy* $3\frac{1}{2}$ in. gauge and a Midland Compound 5 in. gauge. These have now been doctored within the preceding rules and treated to rather fancy low friction rings which have so enhanced performance that they bear mention. Both engines were free before yarn graphite packing was fitted and promptly went stiff when packed. A little running or a repack would have probably cured the disease but developments at work on low friction devices led me to experiment with multi-piece rings. These are eminently successful and give a very free engine (even newly built) and have virtually zero leakage. See Fig. 3. Tests on a pressurised cylinder show very low friction compared to yarn packcoupling two cylinders in line, pumping up the opposite ends from a common source and then pushing the rods in and out (Fig. 4). The inner ends are of course open via the ports to atmosphere. Using air pressure, connections can be placed in a bucket of water and leakage compared between different ring designs.

The compound's rings are 1 7/16 in. dia. h.p., $1\frac{1}{2}$ in. dia. l.p., and very typical of medium sized 5 in. gauge engines. The *Rob Roy* has had pistons from $\frac{3}{4}$ to 1 in. dia. fitted but now runs on .925 dia. Digressing for a moment, *Rob Roy* builders will be interested to learn that $\frac{3}{4}$ dia. is quite adequate for traction but the boiler draught is a little low for steam generation, and, at the other extreme using 1 in. dia. pistons the engine slips

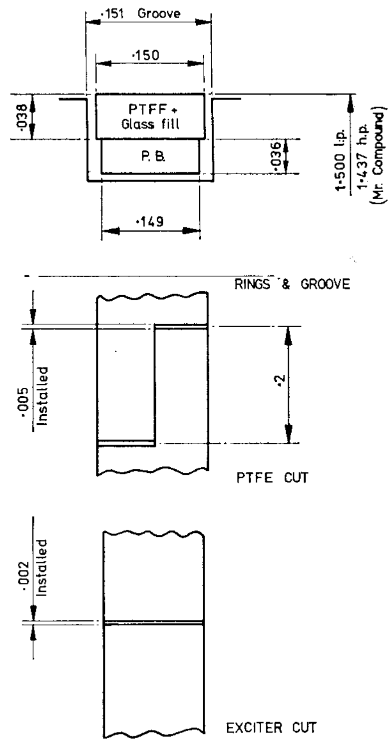


FIG. 3 2 PIECE RING

excessively and fails to produce sufficient steam as it gobbles it up too fast. I have met several *Rob Roy* builders, and they fall into two categories, the delighted and the disappointed. The usual complaint is poor steaming. Experiments with a sliding petticoat pipe and chimney throats gave great improvement to mine. The chimney throat is now only $\frac{5}{8}$ in. dia. and petticoat position can be varied considerably with little effect save for a firework display when too low. A load of 6 cwt is frequently pulled around the Cheltenham Club track and at good speeds too (I once managed 9 cwt with a terrible struggle).

Back to those rings—they are two piece type of 10% glass filled PTFE caps with dog leg splits and plain phosphor bronze outspringers with straight splits. See Fig. 5 for split leakage. "Fluorosint" would be an even better choice for the cap and on next rebuild the PTFE will be replaced with this material. Both materials exhibit extremely low friction and are satisfactory for the environment. The basic fits etc. are as previously recommended. In order to reduce split leakage a dog leg cut is used. This is far too difficult in C.I. or brass but easily done on the plastic materials with a broken razor blade and a steady hand (make a wooden dolly to fit inside the ring).

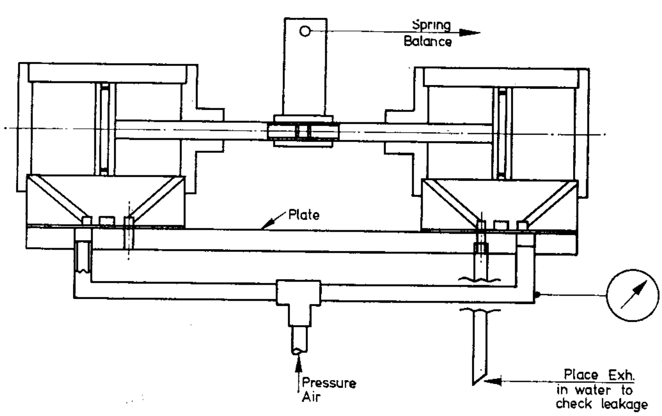


FIG. 4 RING FRICTION TEST RIG.

To prove its effectiveness the cylinder was dead weight loaded by pushing the rod and blanking the pressure side. Creep was so slow that attempts to measure it were abandoned after about 15 min.

Manufacture is simple and as a normal ring save that the cap ring is made with its O/D exactly to bore size. This ensures that it stays truly quite rectangular when installed. During production quality checks and development testing at work it came to light that manufacture of rings in PTFE or Fluorosint posed problems. These were the difficulty of obtaining truly sharp corners and removal of fraize from the edges, plus Fluorosint being somewhat brittle. Both gave considerable variation to ring leakage test results. Plastic materials tend to smear and plastically flow and the ring finishes with turned up edges from the last cut which promptly turn the other way when dressed. The cure is to use the highest speed available, a very sharp tool (like a razor), very fine feed and a light cut so that the finishing operations are only fetching a dust off. The tools themselves require high rake in all planes to get under the material and lift it off clean to avoid the flow effect.

Fig. 6 shows a very common ring used in diesel engines, hydraulics etc. Known as a triple seal it comprises two similar caps with outspringer as exciter. The reason for the design is to make an effective dog-leg joint in hard materials with ease. By setting the three splits at 120° to each other, full sealing and an effective dog leg are formed. See Fig. 5 for dog-leg leak curve. From diesels this type of ring has progressed, with a variety of cap materials, into hydraulics and pneumatics where it is employed for its very low friction property and good seal under compression. Remarkably the individual rings do not rotate relative to each other in service.

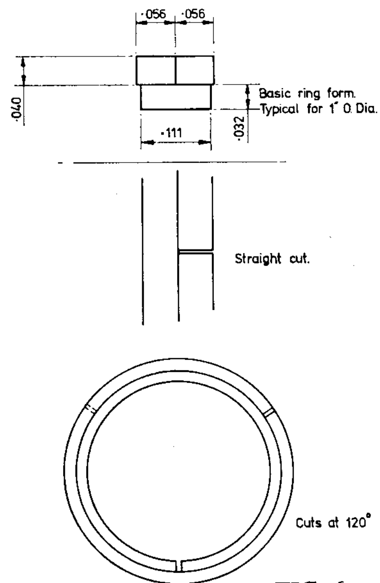


FIG. 6

TRIPLE SEAL

Before leaving the subject we must discuss multi-ring applications. The use of several rings is generally believed to be good practice. This is so whilst one continues to use the plain rectangular straight split compression ring. The pressure is broken down as the system of rings leaks by a series of resistances. The chances of a hang-up in one ring does not matter as the rest will take over and seal. Friction will be raised but only by the outspring since total pressure drop is distributed over the rings bit by bit, and remains substantially equivalent to a single ring. If the two or three piece ring is matched against the plain ring the 2 and 3 piece types show advantages in lower leakage and less drag. Use of plastic low friction materials enchances these advantages considerably. It has been found that a properly designed two or three piece ring is a better bet than multi rings of plain form, is easier to make and takes up less space when considering the duties we envisage for model work.

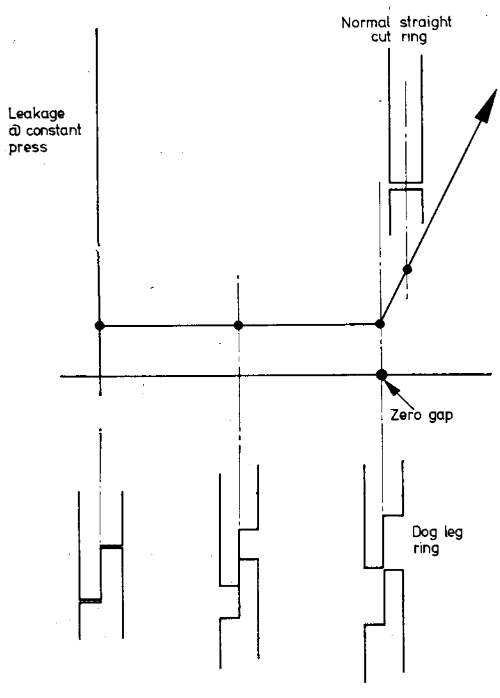


FIG. 5 LEAKAGE DUE TO CUTS

Continued on page 854.

A LARGE SCALE BURRELL

by Fred Horseman

Mr. Horseman Senior and daughter Mrs. Perkins with the 4½" scale Burrell.

MY ADDICTION to traction engines started ten years ago when Mich Glenn acquired the Fowler *Empire Pride*. With Arthur Mason we enjoyed long hours transforming this beast into a magnificent Showman's engine renamed *The Iron Duke*.

After several years grounding in traction engine engineering I decided five years ago to build my own engine. It had to be big enough to carry me and pull several wagons so the Lion Engineering 4½ in. scale Burrell 6 n.h.p. was about right. Several features have been upgraded within the scale and character of Burrells to make a robust hardworking engine.

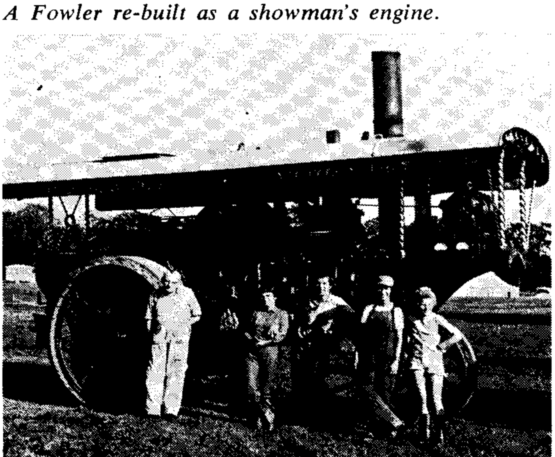
To start with I needed some floor space and just sufficient capacity to cope with the machining that was going to be necessary for a model of this size. My garage at home gave me space enough, but eventually my car was turned out to face the elements, and has rusted less by the way!

Scrapyards have a fascination for me and vast quantities of new off-cuts have been used to reduce costs. A Churchill Cub lathe came to light at a local shipbreakers, and this 6 in. centre lathe was my only machine tool for a year, using it as a milling machine at times until the cylinder block arrived and then I realised a milling machine was going to be essential. Fortunately a friend found an old model Cincinnati, lend-lease from the last war, I think, in a scrap yard, which turned out to be my second best bet. With its 3 h.p. motor it was quite a lump to squeeze into the corner of the garage.

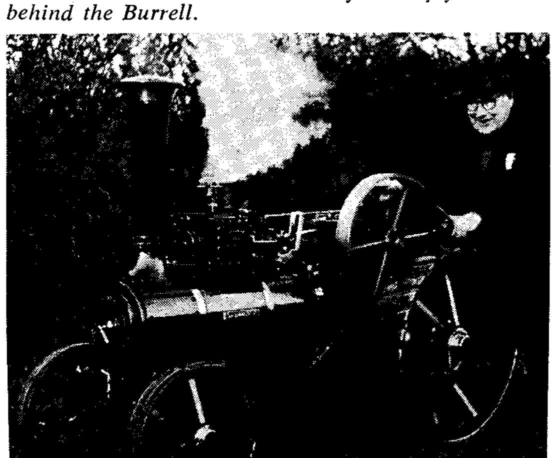
Everything I made for the Burrell was my first attempt, so inevitably several parts were made two or three times. Eccentrics, slide bars, hornplates all had to be thrown away. Fortunately one crankshaft and a cylinder block were right first time made.

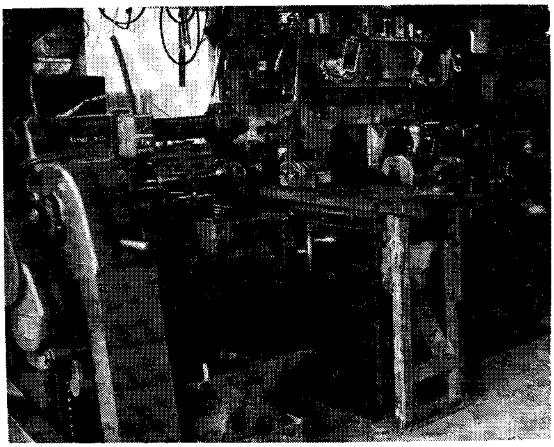
Many full size traction engines have the most appalling gears with teeth way out of mesh to take suspension movement, yet they are satis-

A Fowler re-built as a showman's engine.

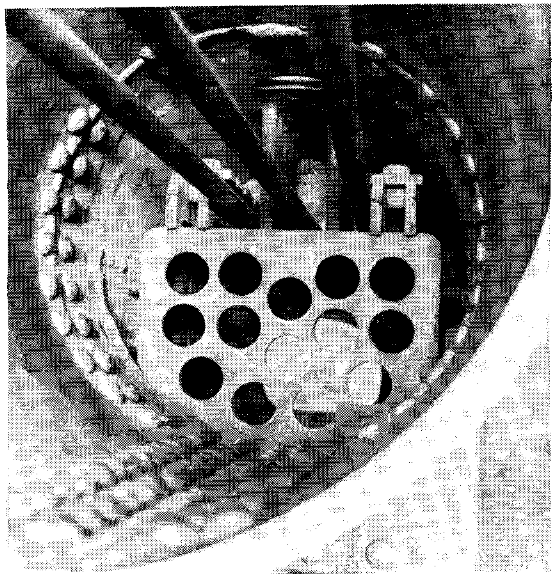


Below: Our contributor Ted Jeynes enjoys a drive behind the Burrell.

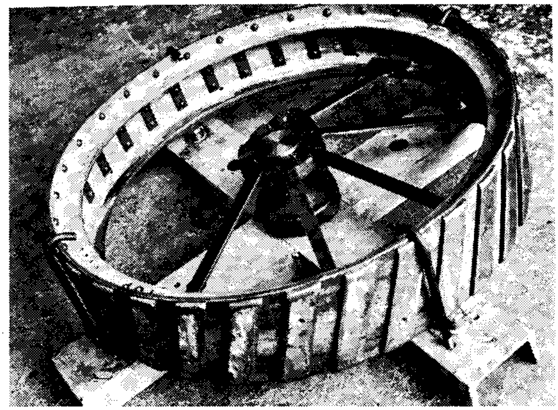




The garage workshop where the Burrell was built. Below right: One of the fabricated all-steel wheels.



The interior of the steel boiler.



factory in use. So with this in mind I was not too worried about machining teeth with a fly cutter and no dividing head. The blanks were marked out with a fine centre punch, a watchmaker's glass and a steel rule in 1/100 of an inch. These gears run very well.

A $\frac{5}{8}$ in. chain is being used as a temporary final drive on one wheel which is alright for driving on firm ground, and with both wheels locked with the driving pins it will bound through deep mud with a delightful slithering motion!

Ted Jeynes has not been over critical of this project, and occasionally I have taken note of his deliberations. The photograph of him on *Mr. Rusty* was taken in February sunshine. Note the reversed expansion link because of the chain drive. Since this photograph was taken, belly tanks of Burrell pattern have been fitted, mainly to give extra weight on the front end.

PISTON RINGS

from page 852.

Expansion must be briefly mentioned before concluding. PTFE has a coefficient of linear expansion of approximately 90 x 10^{-6} per °C. and Fluorosint 30 x 10^{-6} per °C. Both vary according to material manufacture source or stock direction but within reasonable limits. Bronze of course ranges between 18 to 20 x 10^{-6} per °C. Always check your axial float and split gap minima to avoid nipping for any form of piston ring.

Warning, do not smoke when machining any form of PTFE compounds. A hazardous gas can be created in the lighted end of the cigarette. 'Flu like symptoms may result.

The late W. K. Waugh

We have only just heard of the death of Mr. W. K. Waugh, who died on January 22nd this year. Many readers will remember Mr. Waugh who supplied excellent model locomotive and other castings from his Bearsden, Glasgow, address.

IN THE WORKSHOP

A top-slide vernier

by "Tubal Cain"

from page 804.

IF YOU NOW BEND the strip as in Fig. 5 (page 802, the divisions on the inside will have closed up, those on the outside opened out, and only those on the centreline, or neutral axis, will still be 0.1 in. apart. So, if we can calculate how much the divisions shrink when the stuff is bent, we are in business—and we can do just that. All that has to be done then is to engrave the divisions the correct distance apart, and bend the stuff afterwards.

Looking again at Fig. 5, if there are to be 200 divisions in the circle, "x" will be $(2\pi r)/200$, and "y" will be $(2\pi r)/200$. And the width of the material "w", will be twice (R—r). For this exercise we must use an accurate value for π, so instead of 22/7, use 355/113. (which is correct to 2.6 parts in ten million!) Assume that the diameter of the engraved part of the top-slide is 3.5 in. for an example. Then "x" comes out at 0.05497 . . . — no need to go any further than that. Clearly "y" will be slightly greater, so suppose we say we will engrave at 0.056 in. intervals. Then R = (200y x 113) (2 x 355), by inverting the formula given above, and this gives R = 1.78253. Subtract "r" (1.75 in) gives 0.03253, and the width of the strip must be twice that, which is 0.06506 as nearly 1/16 in. as makes little odds, but there is no problem in filing the strip to micrometer to get it exact.

So, all you have to do is to make a piece as shown in fig. 6, with two little ears to take the screw-holes, the width being the figure you have calculated, and say 15 to 20 thou thick. Solder this to a larger piece of brass which is quite flat, and mount this truly vertical on your vertical-slide. Make a little engraving cutter as in fig. 7—there is no need to back it off, as it has so little work to do—and harden it. Put this in the 3-jaw and run as fast as you can. Advance the saddle with the leadscrew handwheel until the cutter just touches, and make a note of the reading—or put a felt-pen mark there. Traverse with the cross-slide, back and forth, a little extra cut each time, till the mark looks deep enough, and again note the handwheel reading—or make another mark. Retract the saddle, and taking the usual precautions against backlash, move the vertical-slide by 56 thou (in the example given) and repeat. I would suggest making the centre mark, the one which will be "zero", a little deeper than the others. In no time at all the scale will be finished; you can then unsolder it, remove all solder from the bottom surface, remove burrs, and then bend it to fit the curve of the topslide. YOU MUST TAKE CARE THAT IT STAYS FLAT, as if it doesn't all your nice calculations will be in error. Fill the engravings with dirt or black paint, and then erect as described for the engine-divided scale. I admit that I haven't used this method in my own case, but I have used it for other jobs, and it is perfectly satisfactory provided (a) the width w is not too great in relation to the length of the piece. I would expect some error if you made it 3/16 in. instead of 1/16 in. (b) That the piece is not so thin that it buckles when bending—in other words, thin in relation to w and (c) that the radius round which the piece is to be bent is more than 15 times the width w. It would work all right on a piece 1 in. wide, ½ in. thick, bent over a 36 in. circle, if you had the strength to do it!

If you have good eyes, there is no reason at all why you should not make the vernier to read to a tenth of a degree; it will then require 9 degrees divided into ten parts, which means dividing by 400, and to get a vernier that reads both ways there will be 20 divisions on the secondary scale—but still spanning the +9 to —9 degree marks on the top-slide. From the information given above you could work one out to read in minutes of angle if you wanted to, but I doubt if the original engraving on the top-slide is anywhere near as close as that, and this has as much influence on accuracy as the vernier scale does. Incidentally, if you have two top-slides—readers will remember I altered an old ML7 slide to suit the Super-7, for ease of changing to deep-section tools from those in the 4-tool turret—don't expect the other one to be correct when offered to the vernier. Any change of top-slide will necessitate resetting the vernier.

There you are, then. A nice little accessory you can make in an evening. Now what about one (or two, to be exact!) to go on the swivelling vertical-slide?

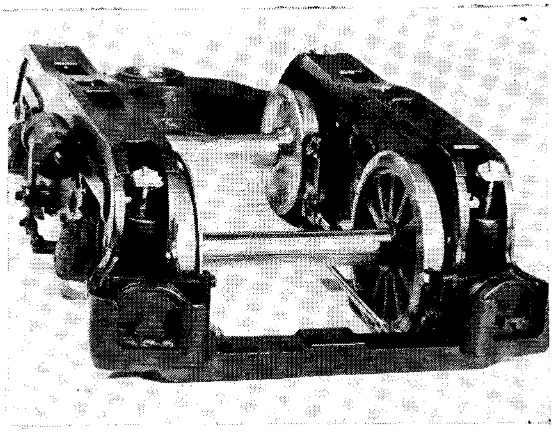
ERRATUM

We regret an error in the caption to the cover picture, August 2nd. The engine is of course a "Climax" not a "Shay".

A Commonwealth 4-wheel Truck

by Jack Kerr

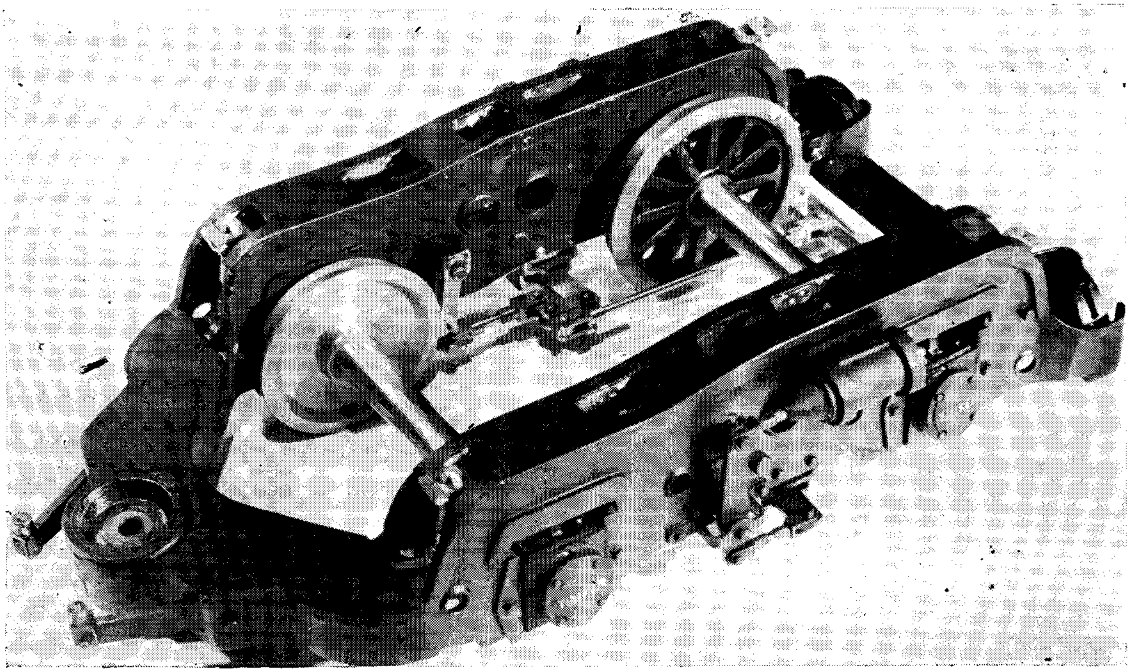
I HAD arrived at the stage in construction of my Northern Pacific A5 4-8-4 ¾ in. gauge locomotive where I was faced with the decision of whether to make patterns and core boxes and have the trailing truck frame cast, or to fabricate. On the full size engine the trailer truck frame was cast integral as a one piece steel casting. To duplicate this in miniature would require some intricate patterns and core work plus the difficulty of trying to interest a foundry in casting it in this day of high production methods and machine moulding, etc.

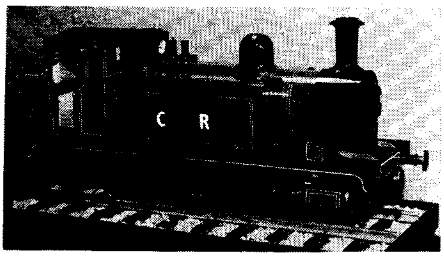


For a "one off" proposition the decision was made in favour of fabrication. The four side pieces were made from 18 s.w.g. cold rolled steel which were temporarily riveted together and cut out on the band saw. Later they were taken apart and, with ⅜ in. by ⅝ in. key steel for spacers at the axlebox positions, they were assembled by riveting with countersunk rivets. The front portions which were cut down to 1 in. in width, were bent around a steel bushing which had previously been turned in the lathe and silver soldered in position. A top and bottom plate were cut from the same material and silver soldered in place making a strong boxed-in section at this point.

The truck is fully sprung and equalized and is carried through to the driver spring rigging as can be seen by the equalizer beams projecting from the boxed section at the front in the photograph. Rocker centring device is provided and pockets for the rockers had to be considered when cutting out the frames. The brake rigging was a problem as nothing showed on my original

Continued on page 866





MODEL LOCOMOTIVE CONSTRUCTION FOR BEGINNERS

By Martin Evans

Part III

From page 761

BEFORE WE LEAVE the subject of locomotive axleboxes, there is one more method of machining them that is worth mentioning. In this method, the outside surfaces of the axlebox are first machined to size, using any of the set-ups described previously, but the axle hole is not drilled, although its position is marked out as accurately as possible by the use of the usual square, odd-leg calipers and scriber. The axleboxes should be a good working fit in their respective horn-slots and both these and the axleboxes should be clearly marked with small letter or number punches. The main frames will be assembled with buffer beams and stretchers as already described. Toolmakers' "buttons" are now turned up from silver steel. A suitable size for a 5 in. gauge axlebox would be ⅝ in. dia. x ½ in. long, other scales in proportion. They must all be exactly the same diameter, but small variations in length won't matter. Drill them about 7/32 in. dia., remove all burrs, then drill and tap each axlebox 4BA at the centre of the bores. Attach the buttons to the axleboxes with cheese-head or Allen screws, assemble the axleboxes on the locomotive and check that the buttons are in line across the engine, using the try-square. If they are not, simply slacken off the screws and lightly tap the buttons until they are in line. Re-tighten the screws and without removing the buttons, transfer the axleboxes to the lathe and set up on the faceplate (A small Vee-block is useful here) and shift around until the button is running dead true, checking by dial test indicator. The button is now removed, and the axlebox bored out in the usual way, using a simple plug gauge or the axle itself, until the correct diameter is reached.

Wheel turning

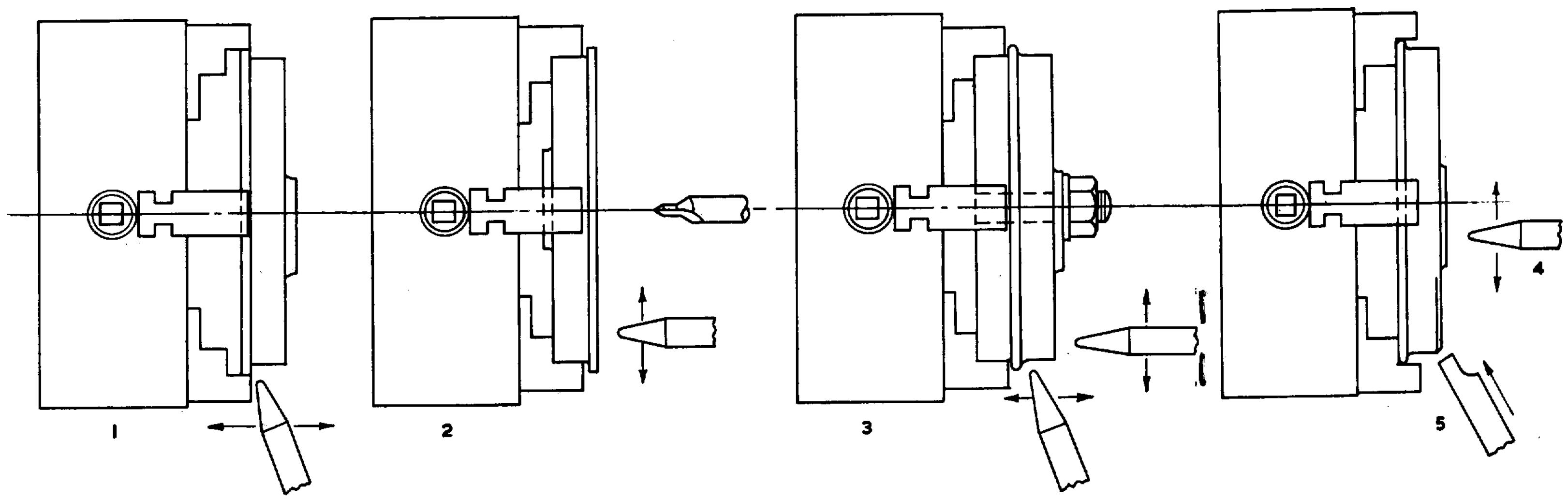
Wheels for model locomotives up to 1½ in. scale are almost always grey iron castings. To obtain better adhesion, some builders go to the trouble of fitting steel tyres, which is of course correct full-size practice, but this is not an easy operation, and as these notes are only intended for beginners, we will concentrate on the plain cast iron wheel.

Before attempting to turn wheels, the budding locomotive builder should acquire a suitable Carbide turning tool. The most useful shape for wheel turning is the very common type, with a uniform taper, coming to a point but with a tip radius of about 3/32 in. Such a tool can now be bought with a ⅜ in. square shank at most good toolshops. It will have no top rake (or only a very slight one) and the usual front clearance, which will be less than that usually provided on a H.S.S. tool, as Carbide tipped tools are inclined to be brittle.

I know that it is often stated that Carbide lathe tools are unsuitable for amateur use on light lathes, as the spindle and slides are not rigid enough to enable them to cut properly. This may well be true when talking about general turning, but it is not the case on wheel turning. High-speed tools are fine until a hard spot is reached (and unfortunately, many wheel castings supplied today do have the occasional hard spot) which will in most cases blunt the tool tip and necessitate a visit to the grinding wheel. Sometimes the hard spot can be got rid of by pulling the lathe belt by hand after re-sharpening the tool, but a Carbide tool will sail through it with no trouble and the only sign left on the wheel will be a small bright area.

Apart from its ability to cut through hard spots in castings, the Carbide tool will last very much longer between re-grinds and the work can be turned at a much higher speed than with H.S.S. tools. It is true that a special "green-grit" wheel is needed to sharpen Carbides, but these are not dear, and once the Carbide tip is right, all the wheels for even a large and complex locomotive can be turned without touching the tool again.

Before starting wheel turning, take a good look at the spokes. Possibly some of them need a little attention from a file, and if so, this should be done first of all. Then it is a good plan to paint all the wheels before turning. It is slow work with a brush and easy to miss a few places, so why not resort to dipping? Look for a circular tin, a little larger in diameter than the largest wheel casting. The lid of a circular biscuit tin is often



STAGES IN WHEEL TURNING

suitable, but if nothing of the right size can be found, an aluminium baking tin can be obtained from Woolworths and similar stores. This is filled with the paint to a depth slightly greater than the thickness of the wheels and the casting lowered into it by a piece of wire round the spokes. It is then lifted out again, given a shake to remove excess paint and laid on something flat to dry.

When the paint is quite hard, we are ready to start turning. Don't bother to remove the paint from the boss or the rim, as the lathe tool will see to this.

The usual first operation is to set the casting up in the 3-jaw (or the 4-jaw if the 3-jaw is not large enough) back outwards, to machine the back and bore for the axle; but some castings are not quite true and this method may lead to a wheel centre which is eccentric in relation to the tread. So a better way is to chuck face outwards first and take a light cut across the tread, sufficient to get down to clean metal all around. Then reverse and chuck by the tread. Mount the lathe tool cross-wise with as little overhang as possible. Clamp the saddle to the bed and advance the tool with the cross-slide. The spindle speed will depend on the diameter of the wheel. Using Carbides, the slowest direct drive can be used, but with H.S.S. tools, the middle backgear speed will do most wheel sizes, the lowest speed only being needed for very large driving or coupled wheels.

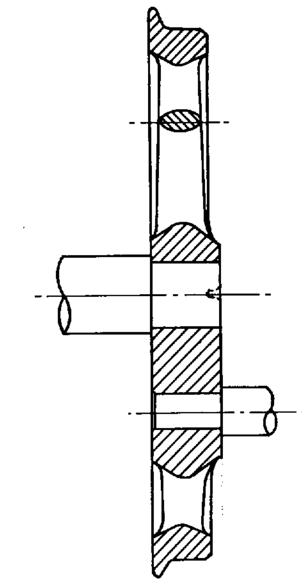
Start by taking a good cut right across the back of the wheel, to get under the hard outer skin of the casting, then shift the tool round and take a cut across the flange, going as far as possible without catching the chuck jaws. At this stage, we must decide how much metal has to be removed from the back, to allow a reasonable amount to be taken off the front. If too little is taken off the back, the spokes will end up too close to the face of the wheel.

Having finish-machined the back, change over to the highest spindle speed and using a fairly large centre-drill in the tailstock, centre deeply and drill right through, starting with a drill about 3/16 in. dia. and finishing at 1/64 in. below final size. A small boring tool should now be used to bring the bore to about 5 thou under final size, after which a reamer can be used. For the reaming operation, run the lathe at slowest speed and move the tailstock bodily along the lathe bed, the reamer being held hard against the tailstock centre and being prevented from rotating by a carrier. Slide the reamer steadily in and out, then a nice uniform bore will be produced and all wheels will finish the same to quite close limits.

The next operation on the wheels is to hold them in the chuck by the partly-turned flanges—which will be square at this stage—and face the bosses to final thickness. For this, the outside jaws are used and the wheel is pressed hard up against the chuck while the jaws are tightened. There are several ways of gauging the thickness of the wheels at the boss. Take the first wheel out of the chuck just before reaching the final cut and measure the thickness of the boss with a micrometer. If the wheel is too large in diameter for this, turn up a short length of steel to the required dimension and lay this and the wheel flat on a surface plate or the lathe bed and compare the two for thickness, with a D.T.I. if available, or by using a surface gauge and feelers. Anyone having a large and accurate vernier caliper can find the thickness of the boss very quickly. Now calculate how much has to come off the boss, put the wheel back in the chuck and advance the top-slide the required amount with the saddle locked to the bed. Take this reading, then all the wheels can be dealt with, with no further measuring.

We now have to turn the tread and flange. My favourite way is to use the faceplate, and a special arbor which is made beforehand. This arbor consists of a Morse taper shank to suit the lathe, plus a short parallel piece of the same diameter as the bore of the wheel to be dealt with, and a short threaded portion beyond this, fitted with a washer and nut, so that the wheel can be mounted on this and screwed up until its back is bearing against the faceplate. But don't overtighten the nut, or this will result in the Morse taper shank being pulled out of the spindle. Rely instead on a small stud in the faceplate, between the spokes. The lathe tool is now mounted close to the left-hand side of the top-slide and inclined slightly towards the chuck, as shown in my sketch. The flanges can now be finished to size and the treads turned.

On small lathes, it is likely that there will be some chatter as the tool comes up against the edge of the flange. If this trouble sets in, stop the lathe and pull the belt by hand for the last few revolutions. The thickness of the flange can be determined by the top-slide handwheel reading, and as for the tread diameter, this can be measured by vernier caliper, dial caliper, height gauge



SECTION THROUGH MODEL LOCOMOTIVE DRIVING WHEEL SHOWING SPOKE SECTION

or what have you, and this can be held for the whole batch of wheels by taking a reading on the cross-slide handwheel. Turn the rim in exactly the same way, the tool being slewed round for this.

Finishing operations

To finish the wheels we need to chamfer the front edge of the rims, to square up the inside edge of the rims, to mark the "separation" between the rim and the centre, and to round off the flange.

The chamfering is sometimes done with a flat file, but a much better way is to use a lathe tool, with a square tip, put in at 45 deg. to a definite reading, then all the wheels will be exactly the same. The "separation" operation is done with a knife tool, and involves removing just a few thou. The rounding of the flanges is also sometimes done with a file, but again a better way is to make up a simple form tool—silver steel will do for this if the speed is kept right down (lowest back-gear). If a file is used, be sure that it is fitted with a decent handle, as it is very easy to catch the chuck jaws by mistake, which can be rather nasty!

When dealing with small driving wheels with long throw bosses (such as the drivers on **Nigel Gresley** for instance), beginners often have trouble facing the balance weight. The difficulty is that before the tool has completely passed across the balance weight, it strikes the tip of the crank, and as this is proud of the balance weight on most types of wheel, machining has to stop. The way I get over this is to stop the lathe and work it by hand, moving the wheel around by pulling on the belt just far enough to prevent the tool hitting the crank. The lathe tool is advanced a few thou at each "pull", and with practice, a reasonable finish can be achieved.

It should not be necessary to use emery cloth or anything of that kind in wheel machining. The finish left by the turning tool should be adequate. Full size locomotive wheels are comparatively rough if examined closely!

I have not said anything about the coning of wheel treads. I always turn mine parallel. However it is easy enough to cone them by simply swinging the top-slide round for the last cut—not more than $1\frac{1}{2}$ deg.

Full-size wheels are of course coned on the tread, the standard angle being 1 in 20, but then the rail is canted inwards to match. The main purpose of this is to minimise "hunting"—that is the rapid side-to-side movement or vibration of the wheels and axle as far as the "play-in-gauge" allows; but its effectiveness is debatable.

To be continued.

A Low Voltage Synchro-Clock

by F. G. Rayer

WHEN I DECIDED to build this clock, the first item was to work out the gear ratio and number of rotor teeth required. With 50 Hertz (or 50 cycles per second) AC mains there would be 100 magnetic impulses each second, or 6,000 each minute giving 360,000 per hour. Thus *Overall Ratio* x *Rotor Teeth* must equal 360,000.

As the clock was to be made with hand tools, Meccano axles, gears and single-thread worms were decided upon. The choice then settled on a 50:1 worm drive, followed by another worm drive of 60:1, in turn followed by 19-teeth and 95-teeth gears, giving a total reduction of 50 x 60 x 5, or 15,000:1. Division shows a 24-tooth rotor is necessary and it was felt that 15 degrees per tooth would be easy to mark and prepare with a large diameter rotor of the kind in view.

Actual construction proved very straightforward, especially as the clock was to be in skeleton form to go under a transparent cover. There is of course no means of changing the rate, which is locked by the mains frequency, as with any synchronous clock. Finally, in view of difficulties experienced in winding mains voltage coils, it was decided to run at low voltage from a bell transformer. This was also completely satisfactory.

It may be repeated that the whole of the work was done with hand tools only—and it is hoped

Fig. 1. Front view of the clock.

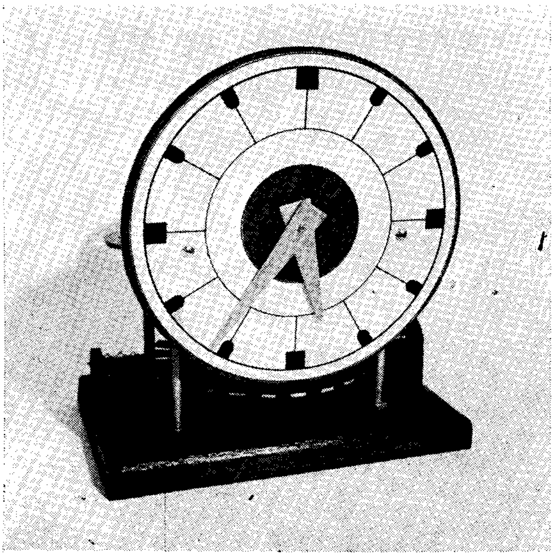
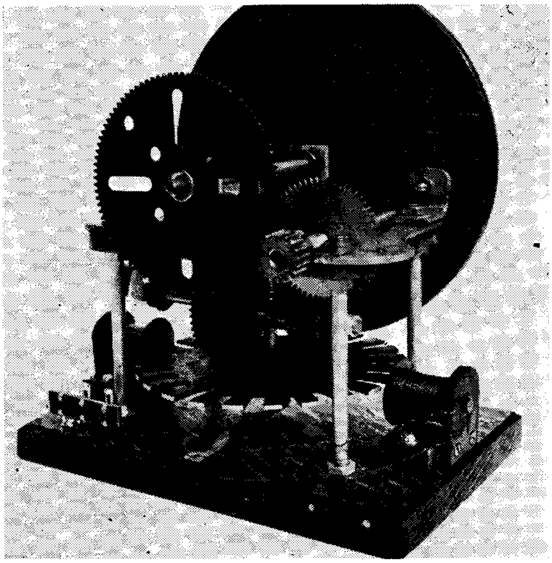


Fig. 2. A back view, showing gearing.



that this is an adequate excuse for some of the procedures adopted.

Rotor

This was made from 1/16 in. sheet iron. (The actual gauge is not important). It is 3½ in. dia. A centre was marked, a circle drawn, and it was cut as closely as possible with a hacksaw. It was then gripped in a vice and filed down to the line. A 2¾ in. dia. circle was then marked, and divided with a protractor. 24 3/16 in. holes were then drilled (yes, with a hand brace) and the pieces removed with the hacksaw.

The rotor is a push fit on its axle to which it is soldered. It was pivoted on an axle set vertically in the vice, and so located that the perimeter of the rotor coincided with the edge of the vice. By turning the rotor a little at a time with the left hand, and filing the teeth ends as needed with a file kept in contact with the vice jaws, the disc was eventually got to run as true as could be observed by eye. The sides of some teeth were also filed, to obtain balance with the rotor on a horizontal rod.

The rotor axle was to be domed, resting in a depression in the bottom bearing. Hand filing with repeated correction failed to obtain a point exactly central on the axle. So the end was filed flat again, and one of the worms attached, to act as a guide for a drill of the same diameter as the rod. This allowed a depression to be drilled centrally in the end of the rod, and this rests on a small bearing ball.

As this item is going to run at 250 rpm continuously, it was felt a substantial top bearing was wise. This is a Meccano collar, soldered to a 1¼ in. long ¼ in. dia. rod, tapped at the other end and secured to a small angle bracket. Two 6BA bolts hold this bracket.

Base and Frame

The base is hardwood, 5¾ x 3¾ x ½ in. Four vertical rods, threaded 2BA each end, hold the upper framework 2¼ in. above the base. The upper framework consists of two hardwood members 4 x ⅝ x 5/16 in. and two metal parts 2⅝ x ½ in. These were made from aluminium. One has an extra ½ in. bent at right angles to support the dial. The other is shaped to clear the 60-teeth gear. This side, a bracket supports the dial.

Pieces are formed to hold the hour hand axle at such a height that correct meshing is obtained between the 95-teeth gear and 19-teeth pinion.

The rotor axle is vertical, and carries a worm. The top bearing is the bush (Meccano collar) described, and ½ in. or so must project above this, to be spun, as the clock is not self-starting.

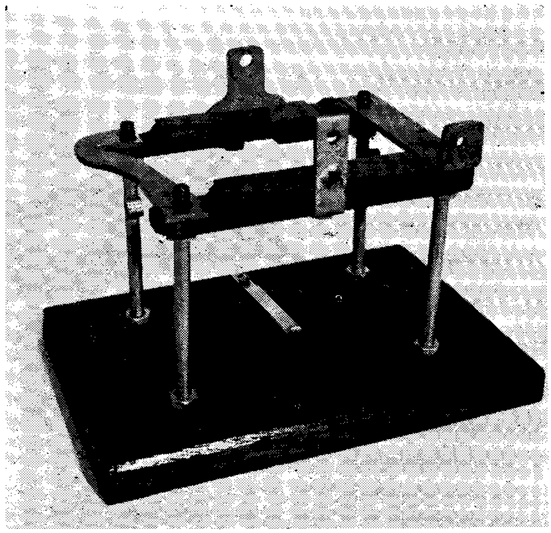


Fig. 3. The base with pillars and upper frame.

The bearing ball mentioned rests in a depression drilled in a metal strip, and the latter can be moved slightly, as necessary to get everything into position here.

The rotor axle worm engages a 50-teeth gear on a horizontal axle carrying another worm. This axle is 3½ in. long and runs in bearings cut from brass tube, soldered to the back uprights.

A 3 in. axle carries a 60-teeth gear engaging this worm, and also carries the 19-teeth gear. This turns in brass bearings held by the 2BA nuts. The hour hand axle is turned by the 95-teeth gear. Ideas for a friction drive (to permit setting the hands) materialised as a little yarn packing under the set-screw of the 95-teeth gear. This is adequate as re-setting is only needed if the clock has been stopped.

The small gears from an old clock were used for the 12:1 ratio between hands, the intermediate dual gear running on a stub axle soldered to the front hour hand bearing bracket. Here, Meccano 60:15 teeth and 57:19 teeth gears would be possible instead.

A word on the first worm drive. Despite lubrication, a very slight scraping sound could be heard from this. It was hoped this might cease in a few months, but it did not. A 50-teeth wheel was accordingly filed from 3/16 in. thick ebonite, by the simple (?) procedure of bolting the original gear and ebonite together, and filing the ebonite until it matched the gear. This is a tight push fit on the axle. The rotor worm was also removed, and a worm or appropriately pitched "spring" was made from 20 s.w.g. wire, also a spring fit on the axle, and thereby reducing the periphery speed where engagement arises to

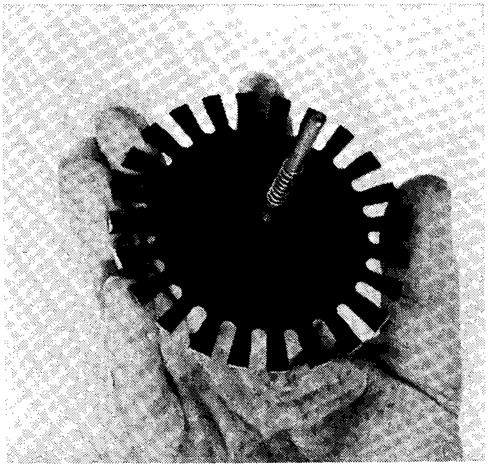


Fig. 4. The rotor on the shaft, with the spiral wire "worm" described.

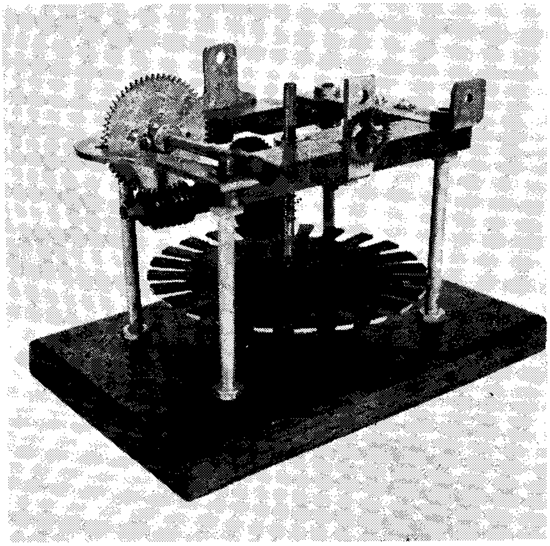
about one-third of that of the worm. One horizontal axle bearing was set forward on a metal strip, to account for the change in worm diameter. The result was virtually completely silent running.

Dial and Hands

The dial is 3-ply, 5 in. diameter. Attempts to number this failed, and the finished dial is thin card, $4\frac{3}{4}$ in. diameter. Three sets of hands were filed, beginning with ornate and ending with the simple hands shown, which were preferred. They are soldered on.

Bell magnets could be used. Those shown were

Fig. 5. Front view, with two worm drives in place, and intermediate gear for hands.



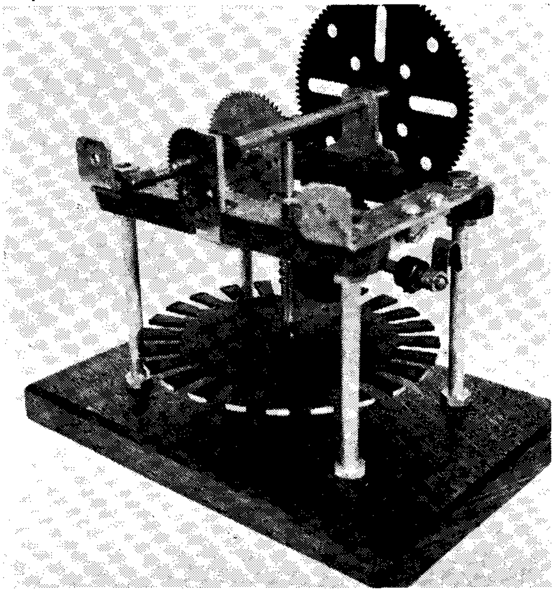


Fig. 6. Front view, with hour hand shaft fitted.

wound with 28 s.w.g. enamelled wire and have iron cores 3/16 in. diameter and 1 in. long. A disc of thin insulating material (paxolin) $\frac{3}{4}$ in. diameter is cemented near the inner end of each core. Each outer cheek is $\frac{1}{8}$ in. About 500 turns of wire are wound on each magnet.

The magnets are screwed to pieces of hardwood $1\frac{1}{4}$ x $\frac{5}{8}$ x 5/16 in. each secured to the baseboard with one screw. They can thus be swivelled in or out slightly, as needed, so that a clear space of about the thickness of a postcard remains between the ends of the magnets and the rotor poles.

Connect the windings in series. Either check the direction in which each is wound and connect so that one is reversed relative to the other, or change over the leads to *one* winding, to find which phase of connection gives best running. This is to obtain dissimilar magnetic polarity at opposite sides of the rotor.

Supply

The clock will run on 3v, but is easier to start on 5v, and is not too critical as regards voltage, provided this is not so high that the windings heat up. Only a low voltage circuit is needed to the clock, but the transformer and mains wiring should be carried out in a proper manner. An 8v 1A bell transformer, tapped at 3v and 5v, is suitable. If it is of approved *double insulated* type, no earthing is required. Otherwise the core and one secondary terminal should be earthed, employing the earth pin of the mains supply plug. Current is best drawn from a 13A type plug fitted with a 2A or other low-rating fuse. A conventional fused clock-outlet could be used with a double insulated transformer. The transformer might be accommodated in a base constructed to take it, but here it was preferred to have the transformer elsewhere, with only the low voltage circuit to the clock.

Adjustment and Starting

The rotor has to be spun at approximately the correct speed, by twirling the axle top between finger and thumb. If the rotor is viewed by electric light, its teeth will then appear still. This effect is just visible with a filament lamp, but is of course best seen with a stroboscopic neon lamp. In any case, a good idea of the correct speed can be obtained by observing that the first gear will rotate at 5 rpm, or once each 12 seconds.

When the speed is correct, the clock continues to run. Having the magnets too near the rotor, or having one nearer than the other, will cause a humming sound, slight but unnecessary.

Final Points

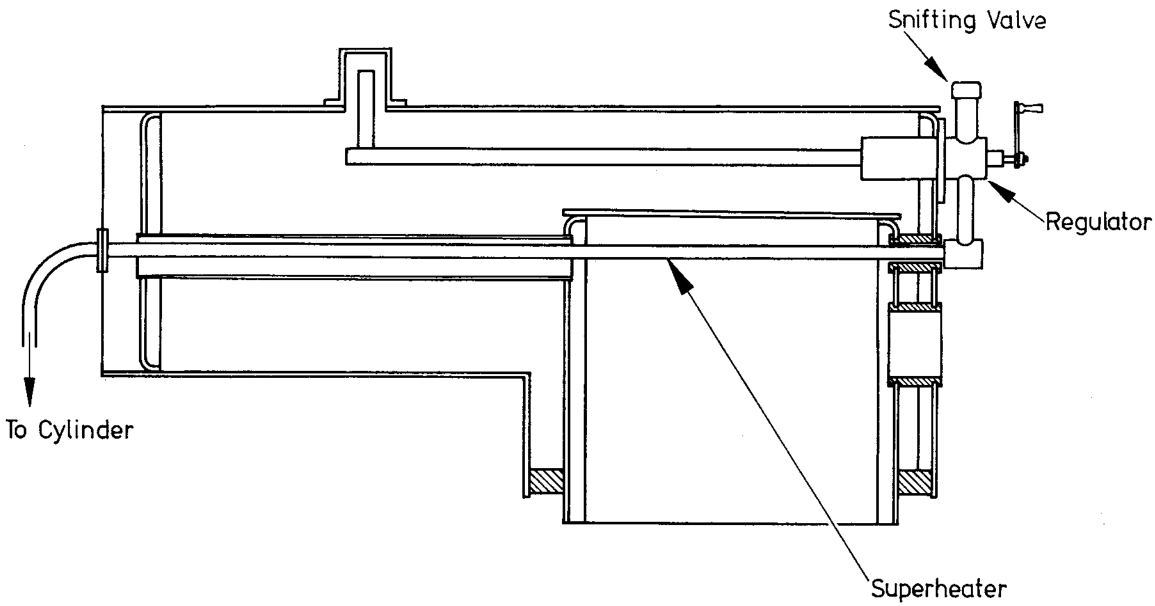
A groove and filled holes in the wooden members arose from fitting gears to turn a sweep second hand, but this arrangement took up too much space and was removed. A solid brass gear was also fitted in the 60-tooth position. Should the clock run backwards, spin the rotor the opposite way to start. With the clock made to the dimensions given, a cover needs to have inside dimensions equal to the size of the base, and to be 6¼ in. high inside.

A simple "Radiant" Superheater

by P. Gardner

AS A NEWCOMER to model locomotive engineering, I have spent many hours absorbing the works of LBSC, Martin Evans and K. N. Harris. When the all-important topics of boiler, regulator and superheater were investigated, it seemed that the almost universal arrangement of wet header, multiple hairpin superheater and dry header is quite involved and results in a congested smokebox. The arrangement I adopted on my version of LBSC's *Mona* is simple but very effective and so it may be of interest to others.

The idea germinated when the use of a backhead regulator was contemplated. It seemed to me rather inefficient to collect steam from the dome, take it back to the backhead, forward to the wet header and then back and forth again through the superheaters to the dry header. The provision of an aperture in the backhead, rather like a miniature firehole, would allow steam to be taken straight from the regulator and forward over the fire to the cylinders. The arrangement was drawn out and the decision made to construct a suitably modified boiler.



A backhead regulator of the screw-down type was fitted though any other could have been used. The regulated steam then passes, in a single stainless steel tube, through the inner and outer backheads, over the fire, absorbing radiant heat, through a superheater flue and into the cylinders as shown in the drawing. Reference to a standard textbook on fluid mechanics indicated that, for streamline flow, a single straight superheater tube of $\frac{1}{4}$ in. dia. running the length of the boiler would create less pressure drop than the three hairpin superheaters of 3/16 in. dia. specified in LBSC's original design for *Mona*. This is because the pressure drop is directly proportional to volume flow and tube length but inversely proportional to the fourth power of the tube diameter. Additionally, sharp bends, as occur in the return bends of a hairpin superheater, cause considerable loss. So a $\frac{1}{4}$ in. dia. superheater was fitted in a $\frac{1}{2}$ in. dia. flue and the fire tubes were rearranged increasing the number from 12 to 16 using the space normally taken by superheater flues. The superheater tube screws directly into an elbow on the regulator and there is a flanged connection in the smokebox so that there are no soldered joints subjected to high temperature. The snifting valve is mounted on the regulator and, for the protagonists of displacement lubrication, this is also an ideal point to obtain steam for that purpose. *Mona* being a tank locomotive, a lubricator steam pipe was passed through one of the side tanks to ensure full condensation before going to a displacement lubricator with a fine needle valve on the oil feed to the cylinders.

The boiler is otherwise of conventional construction with silver-soldered stays. The results obtained have been very encouraging; more than enough dry steam is produced, very little draught is required so that the blast orifice has been enlarged and the blower required when stationary is barely perceptible. Sweeping the tubes and cleaning the smokebox is almost a pleasure in the complete absence of wet and dry headers and the superheater and regulator can be removed and refitted in a matter of minutes.

When steam was first raised in February 1973, working pressure was reached within eight minutes from cold and since then, I have been gratified to find that all guest drivers have commented on the liveliness of the locomotive and the way that a good head of steam is easily maintained.

STEAM FEED PUMPS

by Dr. J. M. Gregory

THE RECENT DESIGN for a Weir-type of feed pump in *Model Engineer* No. 3456 prompted me to look again at small feed pumps for model boilers. What are the alternatives?

They include the Worthington type of twin cylinder pump in which the valve gear of one side of the pump is operated by the motion of the piston on the other side. In this duplex pump the two sides work alternatively and there is no fear of the pump stalling since one side is always open to steam. The arrangement works well as a model if nicely made. Secondly, there is the Weir pump with its steam operated shuttle valve to obviate the pump sticking at the end of its stroke. This is a single cylinder pump and in model form is exemplified by Mr. Lindsey's model and by the Stuart Turner design. It is fiddly to build and only works well if very carefully made. Thirdly, there is the form with a flywheel and, usually, a scotch crank drive. In twin cylinder form, the Shand Mason fire engine pump belongs to this class. In single cylinder model form it is not usually satisfactory as a feed pump since it cannot be fitted with a flywheel of sufficient moment of inertia, and still look reasonable.

Casting around the literature for a simple design which would still work as a model, even if built by the author, I came across a design by Worthington and Baker (1849) in H. W. Dickinson's *Short History of the Steam Engine*. Pumps working on this basic principle were apparently manufactured by Thwaites of Bradford into the present century,—so it must have been reasonably reliable in its full size form! I have never seen a model of one. Here is my attempt, which functions effectively as a feed pump.

Fig. 1 shows a section of the author's model, and fig. 2 a photograph of the completed pump. The key to its operation lies at the pump end. The steam valve is a common slide valve operated by a tappet (B) on the piston/pump rod. The water pump is a double acting force pump with a difference. As the pump plunger nears the end of its stroke, it uncovers ports A-A in the barrel wall, which put both sides of the plunger

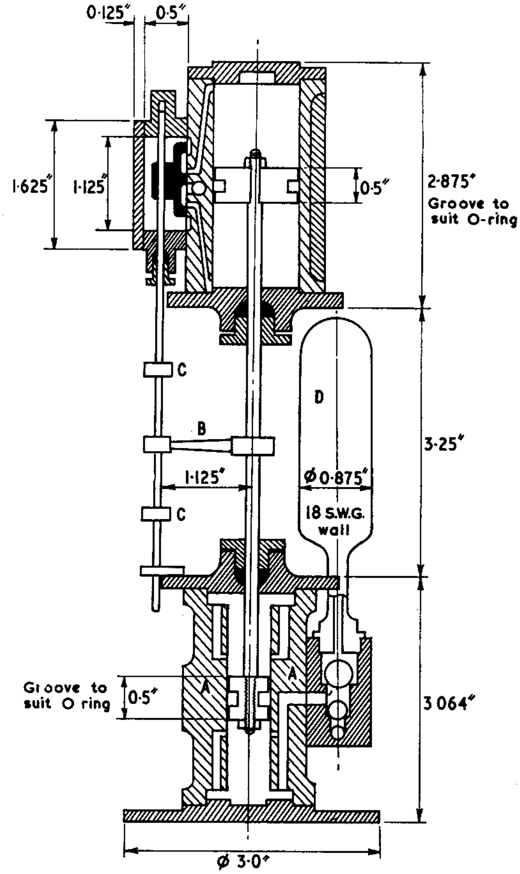


Fig. 1. SECTION OF COMPLETE PUMP

in communication with one another. As the pump completes its stroke, the plunger does no work against the hydraulic pressure head (due to the bypass ports A-A) so that the steam piston can devote all its energy to operating the steam valve gear. Removing the pump load near the end of the stroke helps to prevent the pump stalling and throws the valve over smartly in much the same way as the shuttle of the Weir pump.

The valve rod carries two adjustable collars (CC) which are struck by the tappet (B) on the piston rod, to operate the steam valve. The collars are adjusted so that the tappet (B) engages the relevant collar (C) as the pump plunger passes the bypass port A. As built, the tappet moves the valve rod in phase with the piston rod. If the engine is to work, some thought must be given to the slide valve. Here are three solutions to the valve problem—I leave the choice to the builder.

1) Using an outside admission slide valve (an ordinary D valve) the tappet is replaced by a rocking lever with a central pivot so that the valve rod moves 180 deg. out of phase with the piston rod.

2) Using an outside admission slide valve with the valve and piston rods in phase with each other, the ports are crossed so that the steam port at one end of the valve chest is connected to the end of the cylinder remote from the port. Thwaites did this on their pumps.

3) With the valve and piston rods in phase with each other, an inside admission slide valve is used. Such a slide valve, with two cavities, was incorporated in Worthington and Baker's original specification. As a solution it appealed to me and is incorporated in the drawings and my engine.

Construction of the pump is straightforward. It is nearly all brass or stainless steel to minimise corrosion when left attached to the boiler. Since, short of dismantling the pipe work, it is difficult to drain the pump effectively, the steam cylinder is fitted with drain cocks and its own displacement lubricator. Fig. 1 shows the general arrangement with the pump cylinder rotated by 90 deg. relative to the engine as built, to simplify the drawing. The steam and pump cylinders are united by four 0.25 in. dia. pillars 3.25 in. between shoulders which locate on the cylinder ends.

Fig. 3 shows a section of the steam cylinder and valve. The cylinder is of 1 in. bore and the piston has a maximum travel of 1.75 in. The piston is 0.5 in. thick and has an O-ring seal. The spacing of the ports on the valve face is given. All the recesses should be 0.25 in. wide and the arrangement should be symmetrical with respect to the

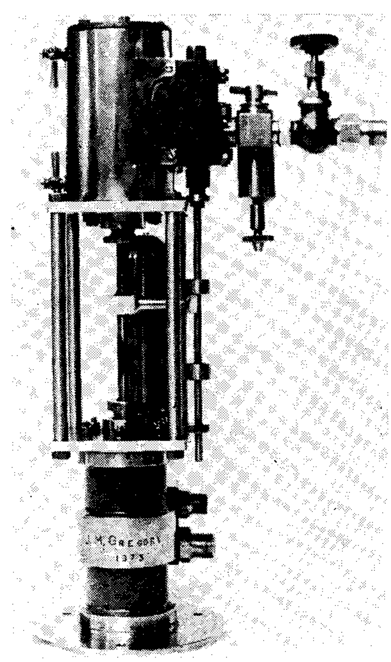
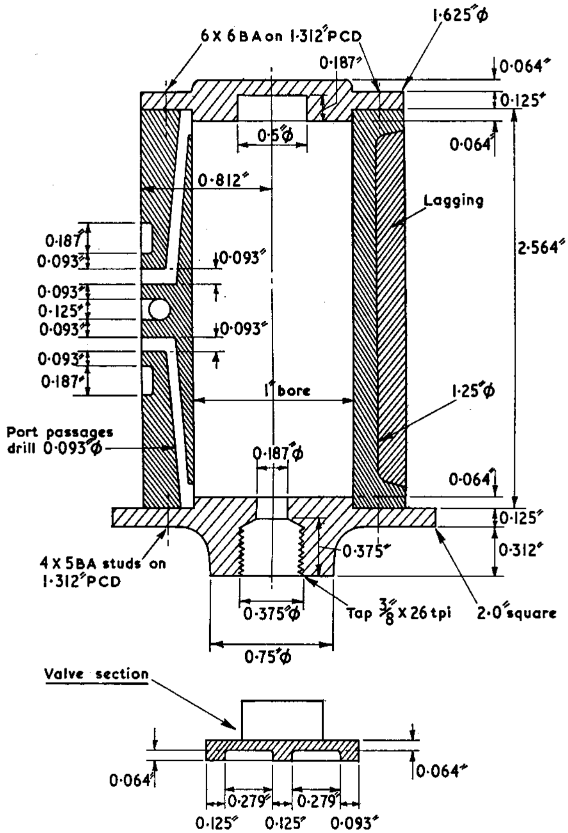


Fig. 2. The completed pump.



STEAM CYLINDER SECTION

Fig. 3.

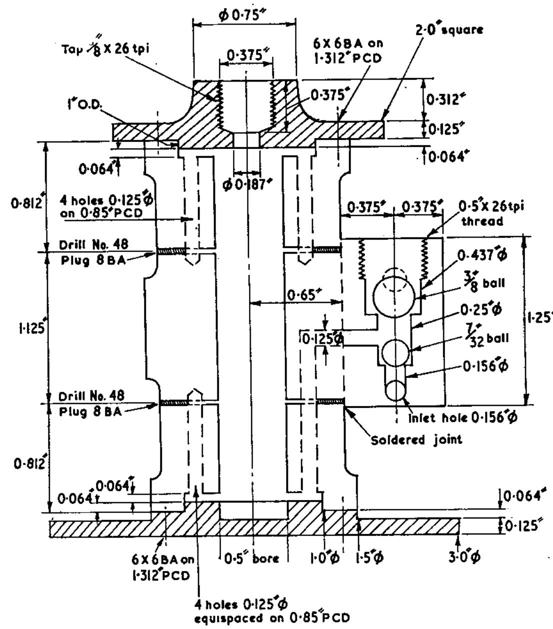


Fig. 4. PUMP CYLINDER SECTION

exhaust port. A section of the valve is also shown. I made this by carefully cutting and filing the recesses as holes in a piece of 0.5 in. by 0.064 in. brass strip. When quite sure that the holes fitted the ports as machined on the cylinder so that the valve has no lap, the brass strip may be silver soldered to its backing block to complete the valve.

Figure 4 shows a section of the pump cylinder. This was machined from a piece of 1.5 in. brass rod with the valve box soldered on. The barrel has a bore of 0.5 in. and the plunger (0.5 in. thick) is fitted with an O-ring seal. Around the bore, four holes are drilled 1 in. deep at each end for the bypass ports. One of these holes is extended to form the passage to the valve box. Connecting these holes with the bore are radial holes (drill number 48) for the bypass. The outer ends of the radial holes are tapped 8 BA and plugged with 8 BA brass studding. The piston rod glands on both pump and steam cylinder are made with soft yarn packing. The pump valve box uses stainless steel ball valves and is surmounted by an air vessel D. The air vessel helps materially to close the water valves quickly as the bypass ports open.

The author's prototype is mounted vertically. However, given reorientation of the pump valve box, the pump should work equally well in the horizontal position with the steam valve chest on top of the steam cylinder. When setting up the pump the collars CC on the valve rod require careful adjustment to get the pump to make a full stroke and yet not stall at the end of the stroke. Since precompression at the end of the exhaust stroke is very undesirable, it prevents the piston completing its stroke, there should be adequate clearance volume at the ends of the cylinder. The pump does not use the steam expansively and, since the valve has no lap, the actual valve travel is small when the pump is in operation. On my pump it is typically 0.070 in.

COMMONWEALTH BOGIE

From page 856

full sized drawing, except the four hanger brackets cast on the inside of the frames. I was finally helped out of this difficulty by a friend in Minneapolis who was familiar with these engines during their period of operation.

Lastly, the Timken axlebox covers were purchased from a supplier in U.K., as were also the correct 12 spoked wheel castings for the rear pair of wheels, and were chosen by myself in person while I spent a grand 6 week holiday in England last summer.

A model Seine-net Fishing Vessel

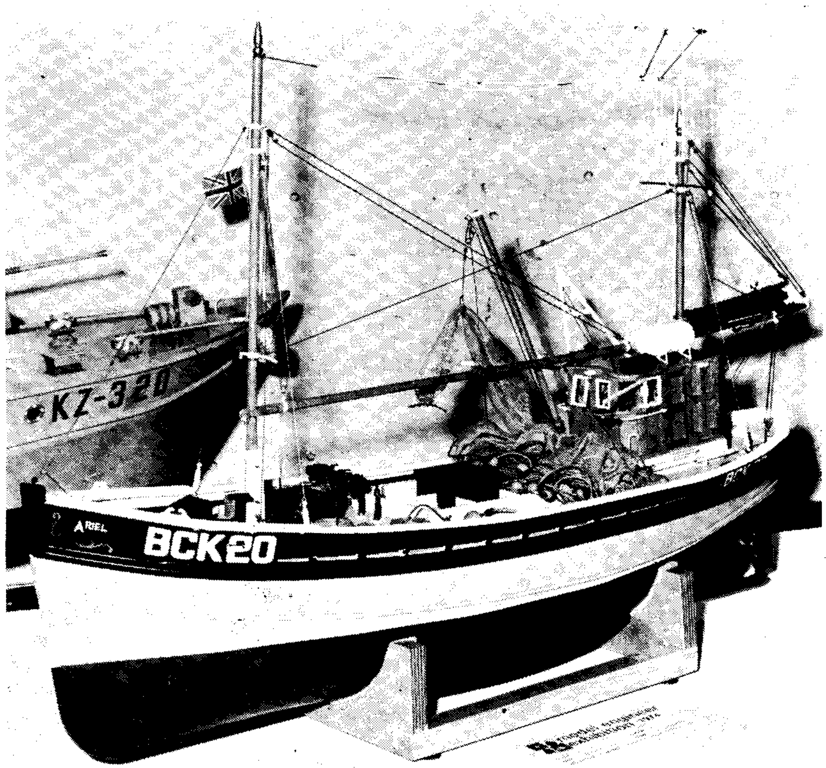
by R. S. Goddard

THE INSPIRATION to build a scale model of a Scottish Seine net fishing vessel came about as the result of visits to Peterhead and Fraserburgh on Scotland's east coast where many of these vessels are based. Their clean lines, sturdy appearance and attractive colour schemes seemed ideal for a model and I have read that their seaworthiness is renowned.

find far easier to work with than glass fibre, especially on a small model such as this.

The deck was cut from 1/16 in. ply, leaving openings to gain access to the motor and radio compartments. These I have found to be too small for practical purposes, removal of the motor or servo being very difficult. The bulkheads were built by using imitation timberheads as indicated in the plan.

The motor fishing vessel built by the writer



The model was a prize winner at the last Model Engineer Exhibition

The model is to a scale of $\frac{1}{2}$ inch to one foot and is based on the M.A.P. plan *Eileen*, suitably altered from information obtained from a Fishing News publication "Scottish Fishing Craft", catalogues of various winch and fishing gear manufacturers and photographs of the actual vessel.

The hull was constructed on the plank-on-frame method, the keel being $\frac{1}{4}$ in. ply, the bulkheads $\frac{1}{4}$ in. balsa and the planking $\frac{1}{8}$ in. balsa. This was my first encounter with this building method and after some initial difficulties due to warping, I found it very satisfying. When completed, the hull was reinforced on the inside with gauze bandage and "Cascamite", which I

Probably the most difficult part was the wheelhouse. Ply was used for this and was steamed to shape using the roof and floor as formers. The outer skin was suitably cut out and an inner skin added to represent the panelling. The wheelhouse is fitted with interior detail and is removable to allow access to the radio and servo.

Access to the motor and battery space is through the hatch amidships ahead of which are the net rollers, coiler and winch. These were built entirely from photographs using scrap plastic from model kits and other odds and ends. The winch barrels were turned using an electric drill as an improvised lathe.

The masts and spars were hand carved from ¼ in. square obechi and as far as possible the deck fittings, etc., were hand made. Dyed curtain netting was used for the seine net and this and the other fishing gear are true scale reproductions of the actual equipment.

The model is powered, inexpensively, by an Orbit electric motor, radio is R.C.S. single channel and rudder and motor control is provided by a Graupner Kinematic servo. I have found this set up rather unreliable and hope to convert to proportional control in the near future.

Building time was approximately two years and I was very pleased that the model, which was my first serious attempt at a scale vessel, was highly commended at the last Model Engineer Exhibition. To those who criticised the high finish, I would say, visit some Scottish ports and see some of the original seiners. The quality of the paintwork is remarkable.

Readers may be interested in another scale fishing vessel, now building, which I hope to exhibit at a future exhibition. It is a ½ in. to one foot model of the stern trawler *Universal Star*, again from M.A.P. plans with the aid of some very detailed drawings which I was fortunate to obtain from the naval architects. The model, which is powered by twin electric motors, features a working stern gantry and trawl winch, both operated by proportional radio, and will, I hope, give a realistic representation of trawling. Watch out tiddlers!!

SOME WORKSHOP AIDS

by Dr. R. Cutler

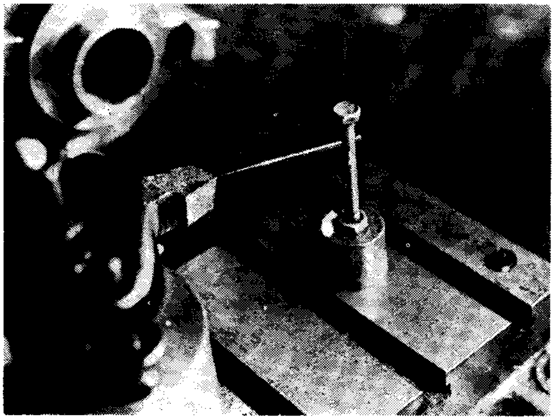
ONE OF the attractions of *Model Engineer* is its appeal to a wide range of readers, almost all of whom suffer from lack of time for their hobby: younger ones because they have their living to earn, older ones knowing the years ahead are not limitless. The writer is in the latter group, blessed with a relatively large workshop, but whatever the size all will agree there is never enough room. In any case, apart from making something for the love of it—a feeling the pure craftsman will understand—it seems sensible to apply the following criteria to the [illegible] appliances one makes. These are (1) Does [illegible] job for which it is designed efficiently? (2) Does it pay its way space-wise, and in the sense of its frequent use, justify the time spent on its construction? (3) Is it time and labour saving?

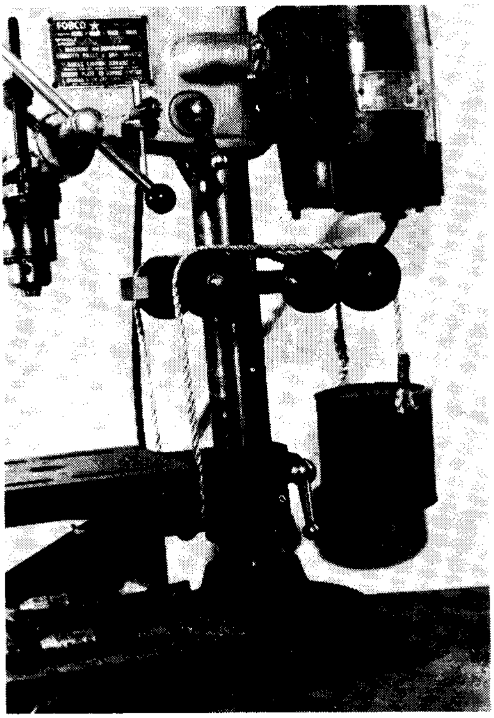
An added pleasure results if all three are achieved by using scrap or other material already in the workshop, or easily and cheaply available elsewhere. To achieve these ends one may have only to copy a design described in M.E. and bless the contributor for ever after; alternatively one may get the basic idea from such a contributor and modify it for one's particular needs: thirdly, and more rarely, something quite new comes up which I am sure our Editor will always be eager to hear about. What follows is of course not new but two example are described as they completely satisfy the basic criteria described above.

Tool centre height finder for the lathe

This is simple, an Eclipse pot magnet (Catalogue numbers 822-3-4 are suitable) is taken and the threaded hole in its top surface identified; the distance from this top surface of the magnet, when resting on the cross-slide, to somewhat over the centre height of the lathe is noted and a suitable R.H. or Hex head bolt and nut is secured; it is threaded for about half its travel into the pot and then resting on the cross-slide is offered up to the lathe centre: at this height a cross hole is drilled in the bolt about 3/32 in. diam. to allow a light force fit for a 2 in. length of silver steel rod ground to a point. A dentist's "straight handpiece" burr with the head snapped off is ideal for the purpose; make a friend of yours and he will gladly give you some discarded ones! The bolt, with its cross limb, is now adjusted in the magnet body to precise centre height and locked with its hex nut as shown in the photograph. It can be slid anywhere or stuck anywhere on the lathe, is never lost, and is always ready for use.

Below: A simple tool centre height finder.





Counterbalance for the Fobco drilling machine.

Counterbalance for the Fobco ½ in. pillar drill

This is applicable to any pillar drill with rise and fall table. The need for such an arrangement was occasioned by the labour of manipulating the table up and down for constantly changing jobs. The writer recalled a chain winching device described years ago in M.E. this being very suitable for floor pillar drills, but for a bench model a counterbalance seemed more attractive and easy to make with readily available material, and the general arrangement should be obvious from the photograph.

Materials required:

(1) A piece of hardwood 9 in. (approx.) long. 3¾ in. wide and at least ⅞ in. thick.

(2) Three lengths of ⅜ in. Whit or B.S.F. studding and ten hex nuts to suit.

(3) Four thin-walled sleeves ½ in. long bored to a tight push fit on the studding.

(4) Four pulleys 2½ in. dia., a bare ½ in. thick (or make above sleeves to suit), the pulleys being bored to a running fit on same. A round section belt groove is preferable, hardwood being suitable as a material if plastic or metal ones are not available.

(5) A round tin with lid (not essential) 4½ in. dia. and same depth or any convenient round or square metal container of the same cubic capacity.

(6) Scrap lead, old piping etc., easily obtainable from a builder or scrap metal dealer.

(7) A length of terylene rope—nice flexible stuff —around 5/16 in. dia.

Construction

The hardwood is squared up and marked off; it is mounted crosswise on the vertical-slide with packing pieces underneath and bored to agood fit on the drill pillar, a caliper measurement being adequate for this purpose. The ⅜ in. clearance holes are then drilled, use the machine vice and drill from both sides as marked off. If pulleys of different size have been selected the position of the first and third holes must be modified, the aim being for the rope passing as a yoke under the neck of the drilling machine table should pass directly upwards to the groove on the front pulley and that the tin container should be adequately clear of the pillar. The wood block is then sawn lengthwise down the middle, and the two halves clamped round the pillar using one of the long pieces of studding for the front position and a shorter length immediately behind. When tightened the whole assembly will be found rock solid on the pillar.

The front pair of sleeves are then tapped down against the compression nuts on the front rod, the pulleys checked for free running on the sleeves, and hex keep nuts are added on the outside; these could be pinned but if mildly stiff no locking is necessary. The rear pulley assembly is then fitted up in the same way. Cross holes are then drilled in the tin container under the lid for a tap fit of a length of ¼ in. or 5/16 in. rod so that an inch projects each end. Scrap lead is then melted in a ladle or old tin and the container filled up to rather more than the half-way mark. An eye is then made in the rope, hooked on one end of the projecting rod, passed over the pulleys under the neck of the machine table and back to the container, a final eye in the rope being made at a point where, with the table in its position, the container is still swinging clear behind.

Domestic weights or heavy steel offcuts are then placed in the not completely filled tin until an easy balance is secured, i.e. with table clamp loose finger and thumb action of one hand should allow the table to move up and down easily. The extra weight is then checked and equivalent amount of lead is then taken, melted and poured into the tin; replacement of the lid makes a neat job and the container can then be painted.

WORKSHOP EQUIPMENT & MATERIALS

Part XI **by "Tubal Cain"** *From page 609*

To COMPLETE my list of metals useful to the model engineer, as far as copper rod is concerned, about the only use is for boiler fitting bushes. A quick browse through the *Model Engineer* over a few years will reveal the common sizes. I keep a foot or two of $\frac{1}{4}$ in., $\frac{3}{8}$ in. and $\frac{1}{2}$ in., together with a short piece of 1 in. diameter. I have a few pieces of $1\frac{1}{4}$ in. x $\frac{1}{4}$ in. bus-bar copper, picked up from some scrap electrical switchgear which has had its uses.

Copper pipe for steam pipes etc. is best bought FOR this purpose in reasonable lengths—3 ft. for the larger sizes and 6 ft. coils in the smaller. I don't recommend the stuff sold for petrol pipes and the like. Remember, these pipes are sold by OUTSIDE diameter, and if you want a given size of hole through you must specify o.d. and thickness. Waste ends of domestic water pipe are always useful; if you get on the right side of your plumber you may get them at scrap price. Remember that the building trade has gone metric—these bits may well be a mixture of both inch and mm. sizes. *Thick walled Tube* for firehole doors is a job to hold in the chuck if you only have enough for one hole. I think you will find that the size is pretty standard for any given gauge of loco, so it will pay to get say 3 in. at a time for the size of loco you normally build. Few people will notice if the hole is—or was, before flattening—$1\frac{5}{8}$ in. instead of $1\frac{1}{2}$ in.! As to *Boiler Sheet Tubes* and flue tubes, it is hopeless to expect to be able to stock these. Order as needed, but you may save a bit of money if you get fire-tubes by the length and cut them up yourself.

Copper sheet—all the remarks about brass sheet apply here also. If you do obtain this—through the club or otherwise—in whole sheets, specify de-oxidised copper in case any of you intend to weld it. "Flashing Copper"—the sort used for church roofs and the like, is NOT suitable for making boilers. Incidentally, although the point has been mentioned more than once in the M.E. it is worth repeating that it is NOT necessary to "quench" copper when softening it; further, a temperature of 400°C is quite adequate to this purpose. This is not even dull red—only a faint trace of colour. "Pure" copper—that used for electrical purposes—can be softened at 250°C.

Gunmetal is a high-copper alloy containing about 10% tin and a little zinc, and is generally applied as castings. The material can have a very widely varying analysis, and whilst this is quite satisfactory for the purposes of the model engineer in cast form there is little point in keeping any stock of the drawn material. G.M. is more notable for its wearing properties than for its strength, in which it is inferior to most brasses. It may be worth while having the odd stick of cast G.M. for making little bushes from.

Phosphor-Bronze is also a bearing metal when in the cast form, harder and more wear resistant than gunmetal. Unlike the latter, however, the material has a pretty high tensile strength in the cold-worked form—drawn rod—and is commonly used not only for boiler bushes but also for highly stressed parts where the "coppery" type of alloy is preferred to the ferrous. However, a little goes a long way and a small stock only should be needed. (It is twice the price of brass and rather more than stainless steel). DON'T use drawn phosphor bronze for bushes; it offers no advantage—it is the CAST variety that has the good bearing properties.

Monel Metal is an extraordinary material, being a *natural* alloy of Copper, Nickel, Iron and Manganese. It looks like nickel, is strong and ductile as steel, and better than copper alloys so far as corrosion resistance is concerned. It is magnetic, can be forged, brazed and welded. Most important, perhaps, for the model engineer is the fact that at steam temperatures up to a pressure of around 1,000 p.s.i. the tensile strength is equal to mild steel and about 5 times that of copper. It is, therefore, the ideal material for boiler stays and steam fittings—but very expensive. It is not difficult to machine.

German Silver (Nickel silver) is really a nickel brass. The composition varies according to purpose, but may be about 50%Cu, 30%Ni, 20%Zn. Mechanical properties are those of a very mild steel but its main virtue is its appearance. It can be turned very easily, for which reason it is attractive for making buffer-heads—it can be cast readily. If you don't polish it it will look very like steel and won't rust. Polished on a proper buff it is indistinguishable from silver, though the degree of "silveriness" does depend on the nickel content. In sheet form it cuts very easily and takes solder better than brass, for which reason I used it a lot for making the bodies of "HO" gauge locos and stock. Bassett-Lowke used it for coupling and connecting rods in their better Gauge 1 models. It is a very attractive material, easy to machine and polish, and for components which need both strength and an attractive appearance, but for which brass would not be appropriate, is the obvious choice. Note that there is a low-nickel variety (20% or less) which is neither as silvery nor as strong. *Cupro-nickel* is not the same—this is a copper-nickel alloy with no zinc, with little application in model work.

Beryllium copper—copper with 2% Be.—is worth mentioning as a spring material and having an ultimate tensile strength of around 80 Tonf/sq. in. can be used for diaphragms in governors and servos etc.; the high strength enabling thin sheet to be used. *Aluminium Bronze* is an alloy of copper and up to 10% A1; the properties vary considerably with the proportion of aluminium, and are high strength with moderate ductility. There are many other copper alloys, but it would need a reference book to treat them all—probably two! Over the years I have REDUCED rather than increased the variety of materials kept in hand, if only to reduce the risk of using the wrong one!

Aluminium Alloys. I have put this off as long as I dared! There is a greater variety of these than there is of steel, many developed for special purposes, and one can easily get completely bogged down. It is important to realise that most of these alloys are used in engineering applications where the designer is working at the extreme limit of performance, where an extra ounce may make the difference. On top of which is the ever present problem of fatigue; most of these materials are used in components subject to vibration, as well as high stress or temperature. Finally, it must be appreciated that many need some form of heat-treatment or ageing to reach the design performance. The fact that an alloy is used in RB211 does not mean that it is suitable for a model—probably quite the reverse!

There is another category of alloys whose sole virtue is their appearance after anodising—what I call the "styling alloys", much used in domestic hardware and the motor accessory trade. Again, these need not concern us. Nearly all are extremely brittle and not as resistant to corrosion as they should be.

Pure aluminium—or as pure as is commercially available—we use mainly in sheet form and the associated rivets. It is very ductile and easy to work and resistent to atmospheric corrosion but may be attacked by alkalis, especially in weak solution (e.g. soapy water) and acids other than nitric. Strength is low—about one fifth of steel. It is readily available even in the local "do-it-yourself" shop and most modellers will keep a stock of the gauges they have found most useful—20g up to 16g. If it work hardens it may be softened by heating to about 400°C—tested by rubbing a dry pine stick—a used match—just chars when rubbed on the surface. Soft aluminium rivets may be softened (and should, for they age-harden) in the same way. Pure aluminium stick is not of great use in the workshop.

Alloys. I use only three. The first is our old friend Duralumin Spec. 6L1 which is a good general purpose drawn bar. Next is a few pieces of DTD130A—actually "RR56 alloy"—in the form of forged bars, 1 in. dia. Finally, I have a few sticks of cast Y-alloy, L35, again 1 in. dia. and just over a foot long. (These specification numbers are, by the way, now out-of-date). I use the Dural, which is in sizes from $\frac{3}{8}$ in. to 1 in., for all general work; the RR56 for more arduous duties; and the cast material when bearing properties are needed.

In addition, I have a number of ends of bars, an inch or so long, and up to 4 in. dia., given to me some time ago when I visited an aircraft firm. I use these for making pulleys and so on, for without knowing the nature of the material I would not like to stress them.

If you pick up any odd pieces which have the specification number stamped on, then you will have little difficulty in finding out what it is—but it is a pound to a penny that some form of heat treatment will be needed. Better to stick to the few devils you know than the principalities and powers you don't!

Miscellaneous Metals. I will just list these, with the occasional comment here and there. These are bits and pieces picked up over the years. *Half-round brass beading,* various sizes, for tops of chimneys, open tanks etc. *Square tube,* up to 1 in.; makes little tanks. *Deep channel,* ditto. *Flat spring steel,* including old clock springs. *Brass I-section* curtain rail; it is nearly all plastic these days. *Bearing metal*—Hoyt No. 11, about $\frac{1}{2}$ lb., as well as some melted out of old bearings. *Lead,* melted from old batteries, water pipes, and what-not, for weight-adding. A large box full of the collection of ages. And, finally, a collection of steam, water, gas and electric tube off-cuts; some little while ago I went through all this and weeded out the folded conduit and seam-welded tube, so now it is all drawn.

Before leaving this matter, let me say a little about keeping track of materials. It is, of course, surprising how well one remembers what the odd lengths are, but as stocks grow it becomes more difficult and one can waste a lot of time. By far and awav the best solution is to colour code all stocks, and I can't do better than repeat a proposal made in the "S.I.M.E.C." Newsletter some time ago. The bars are coded both ends, and if of any length by bands at intervals. It is very similar to the system used in many works. You will see that the same colour is often used for two materials when the materials are easily distinguishable. Where two colours are quoted, e.g. Red/Black, the first one is the base colour, the second a stripe; the example being black stripe on red.

NO COLOUR: Black mild steel; BDMS; Pure Aluminium.

RED: Common Brass; Stainless Steels—plus an identifying stamp.

RED/BLACK: Cast Brass.

RED/YELLOW: Copper; Free-cutting mild steels.

BLUE: Tool steel and Silver steel; German Silver.

BLUE/BLACK: Cast Gunmetal.

GREEN: Phosphor-bronze.

WHITE: Nut-size hexagon material, steel or brass.

BLACK: 70/30 Brass; Cast Iron.

BLACK/WHITE: Al. Alloys, with added identifying stamp; H.T. Steels, with added identifying stamp.

I use this system myself and the only snag I have found is that I am slightly blue-green colour-blind and have to be a bit careful choosing these two colours. I use cellulose paint which dries fairly quickly. Another point in storing steels—I give all stock a coat of Shell ENSIS anti-rust oil (No. 254) as soon as I get it. This is most effective, and I have no trouble with rust at all, even on stuff stored in an outbuilding.

Readers will have seen my ready-use bar-rack in the article on the workshop. Sheet is stored on edge in a frame, the thickness being judiciously distributed so that the thick supports the thin, the large sheets at the back, small at the front. Special material is stored in a drawer in an old chest and is wrapped and labelled. Short ends, colour coded, live in a few containers close to the lathe. When I have a particular job—model or otherwise—in mind, I get the material together and keep this in a labelled box; perhaps doing it all at once, perhaps adding over a long period. This makes sure that I don't use a piece of material essential to the project for some odd job.

Conclusion. I must end by emphasising that, although I have mentioned a large range of machines, tools and equipment, this is not intended to suggest that your workshop will be complete until you have them all. I question whether there is much improvement in the quality of the BEST models in the Medal winning category today compared with those of the pre-war era, and many of the latter were made with only the barest of workshop equipment—often with a treadle-driven lathe, too. It is skill and care, coupled with the desire to make a "good engineering job" of the work that counts more than sophisticated equipment. It is worth remembering also that the prototype of your model was probably made 50 years ago, and in some cases perhaps 100 years ago. In those days steam engine cylinder portfaces, and the slide valve itself, were finished with hammer and chisel, file and scraper, NOT with a surface grinder! And, surprisingly enough, this process was often as quick if not quicker.

However, these machines *are* available today, and for those whose daily work is not associated with engineering, a walk round the trade stands at the M.E. Exhibition can be pretty daunting! So, in this series I have tried to strike a balance between discussion at inordinate length on the one hand, and a mere catalogue of accessories on the other. Inevitably there are deficiencies, inevitably I have at times stressed the obvious, and most inevitably of all many readers will disagree with me! (Turn back to page 23 of 4th January and read the second paragraph again!) I can only plead that the problem is not new; I have a book on Turning, dated 1796, and the list of accessories described is formidable. It includes "Un Mandrin à Quelle de Cochon"—a "Pigs-tail chuck". I have one, as it happens. Have you? □

Natural Gas

SIR,—I was interested in Mr. Jeynes' article about natural gas. Regarding the discovery of gas during well boring, I believe this happened at Heathfield many years ago, and that the gas was subsequently used to light the railway station.

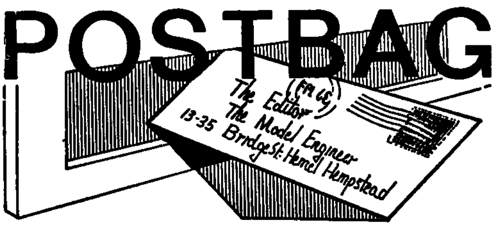
In the United States where experience with natural gas goes back a long way, many engines were built to run on this fuel.

Marks' Mechanical Engineers Handbook (4th Edition, 1941), lists eight engines, ranging from 11 to 1500 b.h.p. The big engine had four cylinders (double acting) 26 in. x 36 in. Speed was 125 r.p.m.

Elsewhere in the book the properties of natural gas are tabulated, indicating that the fuel is substantially the same as North Sea Gas, i.e. mainly methane, so Mr. Jeynes' doubts about getting the right mixture are unnecessary.

I recollect also that in this country there have been proposals to use methane (from underground sources) in liquid form for road vehicles.

Wirral, Merseyside. ANDREW J. BRANDRAM



The Editor welcomes letters for these columns. He will give a Book Voucher for £1.50 for the letter which, in his opinion, is the most interesting published in each issue. Pictures, especially of models, are also welcomed. Letters may be condensed or edited.

Boiler Water Gauges

SIR—In reading the article by Mr. Beaven on the errors due to capillary attraction in water gauges I was struck by the very high values he estimated. I had made some tests years ago and I decided to repeat them.

I took two gauge glasses, one .104 in. bore and the other .133 in. bore and dipped them in a glass of clean water but without specially cleaning the glasses. One can get the water to rise in the tubes by withdrawing them slowly from the water and the phenomena seems to be greater when the tubes are dry above the water level.

With the .133 bore glass the maximum height of the water in the glass was .27 and the normal height was about .20. The great surprise was that when both gauge glasses were held together and dipped in the water, it rose higher in the larger bore glass than the other one. After leaving both glasses in the water for about half an hour and moving them up and down the small tube generally gave the higher reading as would be expected.

According to Kaye and Laby's Physical Constants the surface tension of water at the temperature equivalent to a steam pressure of 80 p.s.i. is only about 65% of that at 15°C. Gauge error for a .133 bore tube at 80 p.s.i. on the basis of my test is .13 to .18 compared with .24 by Mr. Beaven. I do not know, but this may just be the difference due to slight contamination in a tube that looks clean.

The above was written one evening. The morning after leaving the glass in water all night, I remeasured the capillary rise and found it much more consistent and only slightly less than Mr. Beaven's figures.

So much for the water in the gauge glass but what happens I wonder in the boiler? There will be no line below which all is 'solid' water and above which all is steam when the water is boiling. There will be a zone of water with rising bubbles of steam with a lower density than the water in the glass and then a zone of bubbles and above this very wet steam.

I took the gauge off one of my locomotive boilers and fitted it to an open tin can so that I could see what happened when the water boiled. However, with no pressure or rather only atmospheric pressure the conditions were so different to those in a boiler I could not draw any quantitive conclusions from this experiment.

Of course the water is not always boiling when there is pressure in the boiler. If the hand pump or injector is used with the regulator shut and the boiler is not blowing off and the pressure drops there will be, considering the boiler as a whole, no boiling. There could be local boiling offset by local condensation.

If in a model locomotive boiler the water level drops a little below the crown and the fire is at all hot there will be violent boiling on the water line and if the crown stays are of the rod type I would think that there would be a sufficient circulation of bubbles over the whole of the crown to prevent damage. If plate stays are used there would seem to be a substantial advantage in the type shown in Mr. Martin Evans' book "Model Locomotive Boilers" which are ventilated to improve circulation.

Only a fool will be careless about the water level but it is not a simple thing to say at what level damage will occur. Insurance Companies have records of numerous cases of expensive damage, usually leakage or firebox collapse of internally fired boilers due to low water level but fortunately in very few cases are there explosions or risk to life or limb. I have seen a *Rob Roy* boiler which had been run quite dry, but after re-caulking the stays with soft solder it was hydraulically tested and showed no signs of other damage. Explosion is not the inevitable result of low water level.

I think in the estimation of most model engineers the risk is not such as to make them take to their heels and run for safety, but merely to drop the grate and work the hand pump if the water drops out of the glass. Rightly or wrongly I would do the same if I knew the boiler was well made and of sound design.

Boilers should of course be very carefully inspected and hydraulically tested whenever low water level has been suspected.

Some people seem to get quite satisfactory results with rather small bore gauge glasses, but my first model with a .10 in. bore glass was most unsatisfactory. Sometimes there would be a string of bubbles rushing up the glass, at other times there would be one or two stationary bubbles. Friends told me that a new boiler tended to prime or as the Americans say, foam, and that it would get better. It didn't.

A larger glass, nominal 5 m/m O.D. actually 5.4 m/m O.D. and .133 in. bore was a great improvement. The gauge now only plays the fool when raising steam which really doesn't matter. The same size glass in engine number two is quite free of trouble. This engine is unfinished and is at present a very slow steamer whereas number one is a free steamer and I think this may account for the greater tendency for the water gauge to play up.

Stationary bubbles in gauge glasses can of course be removed by blowing down, but what worries me is that if they can form in the glass where they can be seen they can form unseen below the bottom gland nut.

Perhaps one should forget about capillary elevation, temperature correction, unseen bubbles etc., and just follow standard model engineer practice and relax! It seems to be safe.

Bitton, Nr. Bristol. B. G. MARKHAM

"Como"

SIR,—I read with interest the articles by Arthur Smith on Dr. Bradbury Winter's model of *Como* published recently in M.E. Readers may be interested to know that several photographs of the tender under construction appeared in "Mechanics in Miniature", a book written by Percival Marshall and published in 1947. These photographs are the only record of the intricate internal detail of the tender as they cannot be seen without dismantling the tender and this is impossible without destroying it.

A year or so ago I was involved in researching information on *Como* for The Royal Pavilion, Art Gallery and Museums, Brighton, and a feature that has always puzzled me and that I was unable to settle was the incorrect positioning of the clack boxes. As a model of the second batch of D2's *Como* has the differences listed by Mr. Smith on page 593 (M.E. 21st June, 1974), except that the clack boxes are on the horizontal centre line of the first ring of the boiler, i.e. as the first batch.

This is very puzzling to me as Dr. Bradbury Winter knew the full size engine well, on at least one occasion he went into the tender to check details. If the official drawings lent to him by Brighton Works were of the first batch, then all the details would have been as the first batch. The only theory that I have is that at one period of its life *Como* received a boiler change at an overhaul and received a batch one boiler which was removed at the next overhaul, say a period of two years. I have never seen any photographic or documentary evidence of this kind of boiler exchange either with *Como* or any other engine of the class. A great friend of mine who is an expert on the LBSCR tells me he had no knowledge of this ever happening. The mystery remains.

I would like to clarify the building dates given in the article. *Como* was started in 1884 and completed in 1897 taking 13,000 hours. The tender occupied a further 8,000 hours and was finished on the 2nd March, 1915. The model in fact was started the year after the full size engine was built and was completed eleven years after the prototype was withdrawn from service, in 1904. This difference in completion time accounts for the subtle difference in the main colour of the engine and tender, the latter being slightly greener. The paint on the engine would have altered due to sunlight, but also a different batch of paint would have been used with its minute differences in ingredients.

The model seen at the M.E. exhibition was in fact *Como* No. 2. Last year I had the great pleasure of meeting Dr. Bradbury Winter's son, Mr. Jack Winter and it was with interest that I learned that Dr. Bradbury Winter started a model of *Como* and had in fact completed the chassis when he decided to build a super-detailed model. The chassis was pushed under the sideboard and a start made on *Como* No. 2. The young Mr. Winter used to extract the chassis from its hiding place and push it up and down the carpet at the same time badgering his father to complete it. Mr. Jack Winter was sent to boarding school and on coming home for the summer holiday was told that there was a surprise for him in the garden. Opening the curtains he saw in the garden a ground level track and the model of *Como* No. 1 being steamed. Dr. Bradbury Winter being at that time very busy had had a boiler and smokebox made for him, the boiler being riveted and I assume soft solder caulking. No one needs telling how that holiday was spent.

Dr. Bradbury Winter was a well known character in Brighton. He owned, I believe, the first steam car to run in Brighton and with a surgeon friend of his who also owned a horseless carriage engaged in races up North Street, Brighton, on Sunday mornings to the delight of the local population.

Mr. Smith was incorrect in saying that the visit of *Como* to the M.E. exhibition was the first time that the model had left Brighton. In 1970 it was lent to Worthing Museum for a period of three months in connection with an exhibition illustrating the West Coast line of the LBSCR.

Amongst my collection of relics of the old London, Brighton and South Coast Railway, I have the Brighton Works trial driver's voucher and report book for the period in which *Como* was built. The trial trip took place on July 5th, 1883 and the report to William Stroudley states that the steam chest cover was found to be porous and had to be replaced and the slide valve setting was not to the driver's satisfaction. Brighton Works remedied the above points very quickly as *Como* was delivered to Battersea Shed on the following day, July 6th, and was received by the locomotive foreman, Mr. Richardson, who signed the voucher certifying its condition as "all right".

Brighton. G. F. COLLINS

Indexing

SIR,—In his last letter (M.E. 19th July, 1974), Prof. Chaddock returns to the subject of compound indexing, but I am still unable to agree with his findings and maintain that my original figures for the accuracy of the method were correct. Suppose we have a 127 hole division plate and wish to cut a 127-T gear. Mounting the plate on the work spindle, we now cut the gear one tooth at a time, moving the plate one hole for each cut. Next, mount the plate on a worm shaft geared 40:1 to the work spindle. Because of the gear reduction, we now cut one tooth at a time by moving 40 holes in the 127-hole plate for each cut.

We now find that a 127 hole plate is not standard, but 37 and 49 hole plates are included in the regular set and so we make an approximation to 40/127, stepping 26 holes forward in the 37 hole plate and 19 holes backward in the 49-hole disc. The fractional error in making this approximation is 1 part in 24173, as I previously stated.

As more teeth are being cut, the error accumulates and reaches a maximum after 127 teeth, corresponding to 1 revolution of the work piece (not 40 revolutions as stated by Prof Chaddock).

Because of this erroneous assumption the errors do not accumulate progressively, but they are, as he says, distributed cyclically round the gear, but are never worse than in the case I quote.

Now for some figures. Reverting to the case of 40-hole steps in the 127-hole plate, after 127 steps the division plate will have made 40 revolutions and, because of the worm gear reduction the work piece makes 1 complete turn.

In the approximate case, 127 steps of 26/37—19/49 gives 39.99834528 turns of the worm shaft and 0.999958632 turns of the work, this again representing an error of 1 in 24173.

Suppose we cut a 10DP, 127-T wheel by this method. The circular pitch is 0.3142 in., the tooth thickness along the pitch circle is 0.1571 in. and the pitch diameter is 12.7 in. The error is the pitch circle circumference divided by 24173, i.e. 39.898 ÷ 24173 = 0.00165 in. The error in tooth thickness is thus 1.05 per cent.

Bearing in mind the instrumental errors of dividing heads, including pitch errors and backlash in gears, eccentric mounting, play of index pins and end play in the worm shaft (very important this), the approximation must be regarded as acceptable. As I said before, several gears have been cut, including one of 8DP to drive a rack cutting and thread milling attachment to my milling machine which has a 3 h.p. motor. The gear runs quietly at high speed on quite heavy work so that the errors cannot be serious.

In another test, a 6 in. disc was set up in the dividing head and a radial line scribed on it. Moves equivalent to cutting 127 teeth were made and the scribing block again brought up to the disc. The point fitted the scribed line exactly.

Finally, Prof. Chaddock mentions the use of expensive equipment. In fact, the top dividing head in my photographs was given to me, worn out and with a broken gear casing. It has been completely rebuilt. It came without index plates, which are of stainless steel, parted off from a short end of 5 in. diameter bar. The other used scrap parts picked up for 25p, the dial drive costing 75p in a second-hand shop.

Opportunity sometimes knocks!

Prestbury, Cheltenham. F. BUTLER

Gear-cutting

SIR,—In the issue of 5th July, Mr. T. D. Jacobs gives a brief description with three views of an interesting gear-hobbing machine which he has built and he also refers to previous letters from me published in Postbag. December 71 and June 72. Unfortunately, in my copy of M.E., due to over-inking, it is impossible to see much of the detail of this equipment. There is, presumably, some means of adjusting the angle between the hob and the work to suit the helix angle of the former. I cannot see how this is done, but if it involves a change in the alignment of the universally jointed drive-shaft such that the input shaft and the driven shaft are not parallel to each other, then the latter will not revolve with constant velocity with the result that the hob will alternately lead and lag in relation to the wheel being cut. From the description, it appears that the hob is driven by a lower rigid shaft whilst the universally-jointed shaft drives a worm which, in turn, rotates the work arbor. The above statement, however, will hold good if either the hob or the work is driven by the upper shaft. In either case the effect will be to make the tooth spaces on the wheel rather wider than they should be, although, if the angle between the two shafts is small, the effect of this on the finished wheels would not be serious but as a pair of mating gears would, presumably, be cut with the same hob, the backlash would be doubled. As intimated, I am unable to make out much detail from the photographs so I am writing without full knowledge of the construction employed.

As Mr. Jacobs rightly points out, one hob will cut all numbers of teeth of any given pitch but hobs are very expensive to buy and not easy to make correctly as the teeth should be form-relieved, an operation which is outside the scope of the average home worker. A few years back Mr. J. A. Radford made a speed-reducing head and a relieving attachment for his Super-7 lathe and I examined these excellent pieces of equipment and work done with them when I visited him in New Zealand and when I left he gave me complete drawings and constructional notes on them. At the present time they are on loan to a fellow-reader in Essex who is planning to add these facilities to his lathe. These two attachments will, together, enable anyone to make perfect form-relieved cutters and hobs quite easily.

At the end of his short article (p. 666) Mr. Jacobs remarks that in my earlier letters (December 71) the cutting of a correct worm-wheel, using a single point cutter, did not seem to him to have been properly disposed of and he goes on to describe the action of a "Reinecker" hobbing machine which carried out this operation in a satisfactory manner. The earlier correspondence was concerned with the working of a specific piece of equipment which was made and described in detail by Mr. Radford and I explained that, as described, the attachment would cut worm-wheels having rack-form teeth and Mr. Radford later wrote and confirmed that this was, indeed, correct. In the last part of my letter I described a method of working with the device exactly as constructed and which would enable it to cut correct involute teeth. This method, though tedious, involved shifting the saddle along the bed in steps and making a corresponding angular correction to the wheel being cut by indexing it round independently of the driving gears. If Mr. Jacobs will re-read this letter he will, I expect, be interested to find that the procedure I suggested was actually carrying out the process employed in the Reinecker machine, namely, an axial movement of the hob in relation to the wheel and an added corrective rotation of the wheel. Owing to the construction of the Radford device the means of attaining this end had to be modified; the wheel was moved along the bed in relation to the hob and the hob was rotated a little to compensate for the new position of the wheel. Obviously, the Reinecker machine carried out the process with much greater facility, but Mr. Radford's attachment was very simple. With a correct method of working, it could be made to cut correct involute toothed worm-wheels.

New Milton. G. H. THOMAS

Logging Locomotives

SIR,—No doubt I am not the only one astounded to see the beautiful 3½ in. gauge "Climax" locomotive on the cover of today's issue of *Model Engineer* described in the caption as a "Shay" logging locomotive.

This lapse is less pardonable as you illustrated an equally elegant two truck "Shay" by the same builder, Mr. Kozo Hiraoka of Yokohama, in your issue of 5th January, 1973, page 29; so if somebody can't tell a "Climax" from a "Shay" it is certainly not the builder!

Mr. Hiraoka's "Shay" was more fully described with drawings in the American "Live Steam" magazine for April, 1973. I suggest "M.E." might make amends by publishing a full article on the "Climax".

Epsom. D. CAMPBELL

Information wanted

SIR,—I will be visiting the U.K. in December and January at the end of this year and I would like to see as many steam traction engines, locomotives, models and miniature railways as possible in this time. I would greatly appreciate any information which readers can provide to help me to achieve this aim. Information can be sent c/o *Model Engineer* or to 6/2 Benier Street, Whyalla, Norrie, South Australia 5608.

I. WHITE

CLUB NEWS

New track at Chichester

A new track for $3\frac{1}{2}$ in. and 5 in. gauges was officially opened at Chichester on June 29th. The track has aluminium rail, and the substantial concrete foundations carry pre-cast reinforced concrete beams.

The track was formally opened by the Mayor of Chichester, who after a brief speech congratulating the Chichester & District Society of Model Engineers on its enterprise was the principal passenger on the inaugural train, hauled by Bertie Green's 5 in. gauge *Springbok*.

During the Open Days, a large variety of locomotives worked on the 250 yard track, including a "Terrier", a "Tich", a R.1 4-4-0, a 5 in. gauge *Netta*, a *Princess Marina* and a Great Western Pannier. One of the most unusual locomotives was D. A. Smith's petrol-hydraulic bogie express. The Open Days also saw the completion of a large gauge "I" layout and the reinstatement of the 72 year old *Winnie*, a $10\frac{1}{4}$ in. gauge 4-4-0. Exhibits in the Clubroom included a wide range of models and machine tools and also a large "OO" layout. The Society meets on Tuesdays, Fridays and Sunday mornings at their HQ in Bognor Road. Secretary: B. A. Church, 18 The Drift, Rowlands Castle, Hants.

Above: The Mayor of Chichester departs on the inaugural train hauled by Bertie Green's "Springbok"

Right: Bill Simpson with one of his Gauge "O" models — a steam Brighton tank. Photographs courtesy "Chichester Observer".

News from Aylesbury

At the Annual General Meeting of the Vale of Aylesbury Model Engineering Society, Mr. C. Danton was elected Chairman, Messrs A. Vessey, E. Goodchild, D. Cooper and P. Brackley were appointed to form the Committee, while Mr. D. Rogers agreed to fill the new position of Track Superintendent and Mr. E. Smith, the past Chairman, became Press Officer.

On the 13th July, the Society attended the Manor House Hospital's Fete at Aylesbury, making the inaugural run on the new portable track. Secretary: J. Caudery, 1 Mill Lane, Weston Turville, Bucks.

CLUB DIARY

Dates should be sent five weeks before the event. Please state venue and time.

September 6 Vale of Aylesbury M.E.S. General Meeting. The Church Room, Weston Turville. 7.30 p.m.
September 6 Lincoln M.E.S. Club Night. Unitarian Chapel, High Street, Lincoln. 7.30 p.m.
September 6 Cambridge & District M.E.S. Public track day at Fulbrooke Road, Cambridge. 3 p.m.
September 6 Rochdale S.M.E.E. General Meeting. Lea Hall, Smith Street, Rochdale. 8 p.m.
September 6 Romford M.E.C. Competition Night. Ardleigh House Community Association, 42 Ardleigh Green Road, Hornchurch, Essex. 8 p.m.
September 6 Stockport & District S.M.E. Members' and Wives' Track Social Evening.
September 7 Weston-Super-Mare & West Huntspill Live Steam Society. Open Day and Barbeque. West Huntspill Track.
September 7 Southampton & District S.M.E. Southern Federation Rally at the North London track. 10 a.m.
September 7 Brighouse & Halifax S.M.E.E. Public Open Day. Ravensprings Park.
September 7 Ickenham & District S.M.E. 5in. x $3\frac{1}{2}$in. g. ground level track open to Public. H.Q. rear of Coach & Horses, Ickenham Village, Middx. 2 p.m.-6 p.m.
September 7 Tramway & Light Railway Society. Members' Film & Slide Show. "John Snow" Public House, Broadwick Street, London W1. 6.30 p.m.
September 7 The M.E.S. Northern Ireland. Trackside Meeting. Ulster Folk Museum, Cultra, Co. Down.
September 7 Peterborough S.M.E. Annual Sausage Sizzle. Lincoln Road Clubhouse. 4 p.m.
September 7 & 8 The Leeds & District Traction Engine Club. 11th Annual Rally. Harewood House, Nr. Leeds (situated on A61 Leeds-Harrogate Road). 11 a.m.—events begin at 2 p.m. each day.
September 8 Bracknell Railway Society Public Running Day. Jocks Lane, Bracknell. 3 p.m.
September 8 Bristol S.M.E.E. Public Running Day. Ashton Court.
September 8 Birmingham S.M.E. Illshaw Heath. Model Traction Engine Rally.
September 8 Harlington Locomotive Society. Public Open Day.
September 8 Kinver & West Midlands S.M.E. Federation Efficiency Trials.
September 8 Hull S.M.E. Open Day at the Track in Goddard Avenue.
September 9 Wirral M.E.S. Illustrated talk by D. Postlethwaite on "Tenders". Victory Hall, Upton, Birkenhead. 7.30 p.m.
September 11 Cannock Chase M.E.S. Noel Gosling—Talk. Lee Hall Club, Sandy Lane, Rugeley.

September 10 Sutton Coldfield & North Birmingham M.E.S. Film Night. Co-operative Meeting Room, 286 Brookvale Road, Erdington, Birmingham 23. 7.30 p.m.
September 11 Harrow & Wembley S.M.E. Traction/General Meeting. B.R. Sports Pavilion, Headstone Lane. 7.45 p.m.
September 11 Sutton Coldfield Railway Society. Layouts and Chit-Chat. Wylde Green Library, Emscote Drive, Little Green Lanes, off Birmingham Road, Sutton Coldfield. 7.15 for 8.15 p.m.
September 11 Swansea S.M.E.E. Visit to Llanelli Track. Club H.Q., Heol-Y-Gors, Cwmbwrla, Swansea. 7.30 p.m.
September 12 Hull S.M.E. Meteorological Instruments. Talk by J. A. Edson. Trades & Labour Club, Beverley Road, Hull. (Room 3.) 7.45 p.m.
September 12 Leyland, Preston & District S.M.E. Meeting. "Roebuck Hotel", Leyland Cross, Leyland, Lancs. 8 p.m.
September 13 Colchester S.M.E.E. Film Show—Films loaned by James Neill (Tools) Group. 7.30 p.m.
September 13, 14 & 15 New Jersey Live Steamers. Fall Meeting. $3\frac{1}{2}$-$4\frac{3}{4}$-$7\frac{1}{4}$in. gauges. Live Steamers only, closed to the public. Ronald J. Muldowney — Secretary, 12 West Craig Street, Basking Ridge, N.J. 07920.
September 14 Northolt M.R.C. Annual Exhibition. "The Manor House", Ealing Road, Northolt. 1.30 to 6 p.m.
September 14 Malden & District S.M.E. Bangers and Chips Night (Members Only).
September 14 & 15 Guildford M.E.S. Model Engineering Display. H.Q. Stoke Park. 12-6 p.m. Saturday 10 a.m. - 6 p.m. Sunday.
September 15 Worcester & District S.M.E. Public Running Day. Track and Clubhouse, Waverly Street, Diglis, Worcs.
September 15 Bluebell Railway Preservation Society. Bluebell Railway Vintage Sunday. Static Display of all types of vintage transport and equipment, models, etc., at Sheffield Park and Horsted Keynes, Sussex. Special bus service from Haywards Heath.
September 15 Warrington & District M.E.S. Open Day. Grounds of Daresbury Hall — Turn off the main Warrington-Chester Road on Daresbury by-pass signed to Hatton, entrance to Hall is $\frac{1}{4}$ mile on. 570ft. of track — open to visitors with $3\frac{1}{2}$ and 5 in. locomotives, refreshments. Open from Noon until dusk.
September 15 Northampton S.M.E. Public Running Day.
September 15 Rugby Society of Model & Experimental Engineers. W.M.F. Efficiency Trials at Kinver.
September 15 Cambridge & District M.E.S. Invitation Model Loco Rally at Fulbrooke Road, Cambridge. 10 a.m.
September 16 Peterborough S.M.E. Bits and Pieces and general discussion on further development of the Society. Lincoln Road Clubhouse. 4 p.m.
September 17 Chesterfield & District M.E.S. "Loctite and its uses for the Model Engineer" — Illustrated talk by Mr. P. D. Greaves, in the canteen of the Bryan Donkin Co., Derby Road, Chesterfield. 7.30 p.m.
September 18 Bristol S.M.E.E. Isle of Wight railway films by Derek Buttivant. Unitarian Hall, Lewins Mead, Bristol. 7.30 p.m.
September 18 Sutton Coldfield Railway Society. Speaker to be confirmed. Wylde Green Library, Emscote Drive, Little Green Lanes, off Birmingham Road, Sutton Coldfield. 7.15 for 8.15 p.m.
September 19 Nottingham S.M.E.E. Auction. The Friends' Meeting House, Clarendon Street. 7.30 p.m.
September 20 Rochdale S.M.E.E. Lancashire Mill Engines — W. Porter. Lea Hall, Smith Street, Rochdale. 8 p.m.
September 20 Romford Model Engineering Club. K. Catchpole — History of the Longmoor Military Railway. Ardleigh House Community Association, 42 Ardleigh Green Road, Hornchurch, Essex. 8 p.m.
September 20 Stockport & District S.M.E. "Evening at the Track".
September 21 Sheffield & District S.M.E.E. Open Day. Brincliffe Track, Omega Restaurant, Chelsea Road, Sheffield. Visiting locomotives welcome (all gauges $7\frac{1}{4}$ to 'O' gauge) please bring boiler certificate. 1.30 p.m.
September 21 Harrow & Wembley S.M.E. Night Run. B.R. Sports Pavilion, Headstone Lane. 7.45 p.m.
September 21 Rugby Society of Model & Experimental Engineers. Public Running Day.
September 21 The S.M.E.E. Rummage Sale. 2.30 p.m .
September 21 Southampton & District S.M.E. Open day at track for visitors and barbeque. 10 a.m.
September 21 Wigan & District M.E. Society. Co-op Guild Room, Thompson Street, Whelley, Wigan. 7.15 p.m.
September 22 Bristol S.M.E.E. Public Running Day. Ashton Court.
September 22 Birmingham S.M.E. Visit to Illshaw Heath by members and locos from Kinver Society.
September 22 Kinver & West Midlands S.M.E. Ltd. Kinver visit to Birmingham Society's track.
September 25 Cannock Chase M.E.S. Bits and Pieces. Lee Hall Club, Sandy Lane, Rugeley.
September 26 Leyland, Preston & District S.M.E. Meeting. "Roebuck Hotel", Leyland Cross, Leyland, Lancs. 8 p.m.

CLASSIFIED ADVERTISEMENTS continued from page 883

SITUATIONS VACANT

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2nd STEAM GATHERING

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Closing Date for entries — 1 July 1974

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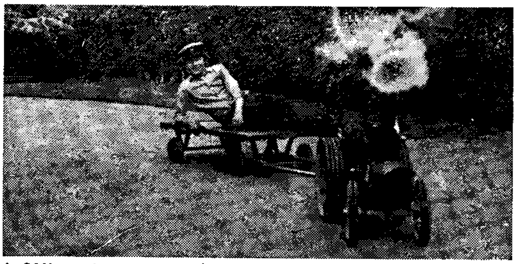

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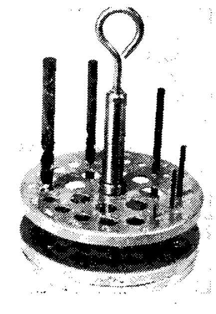

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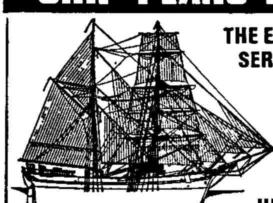

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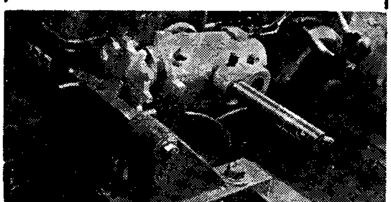

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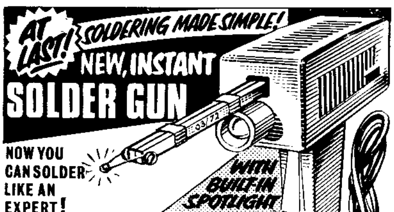

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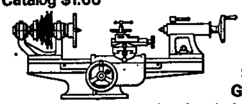

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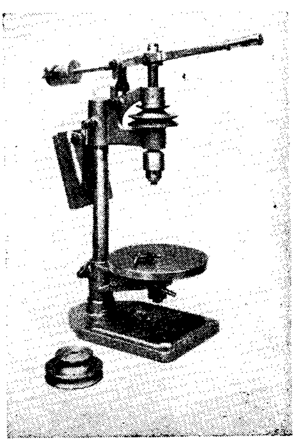

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