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Model Engineer

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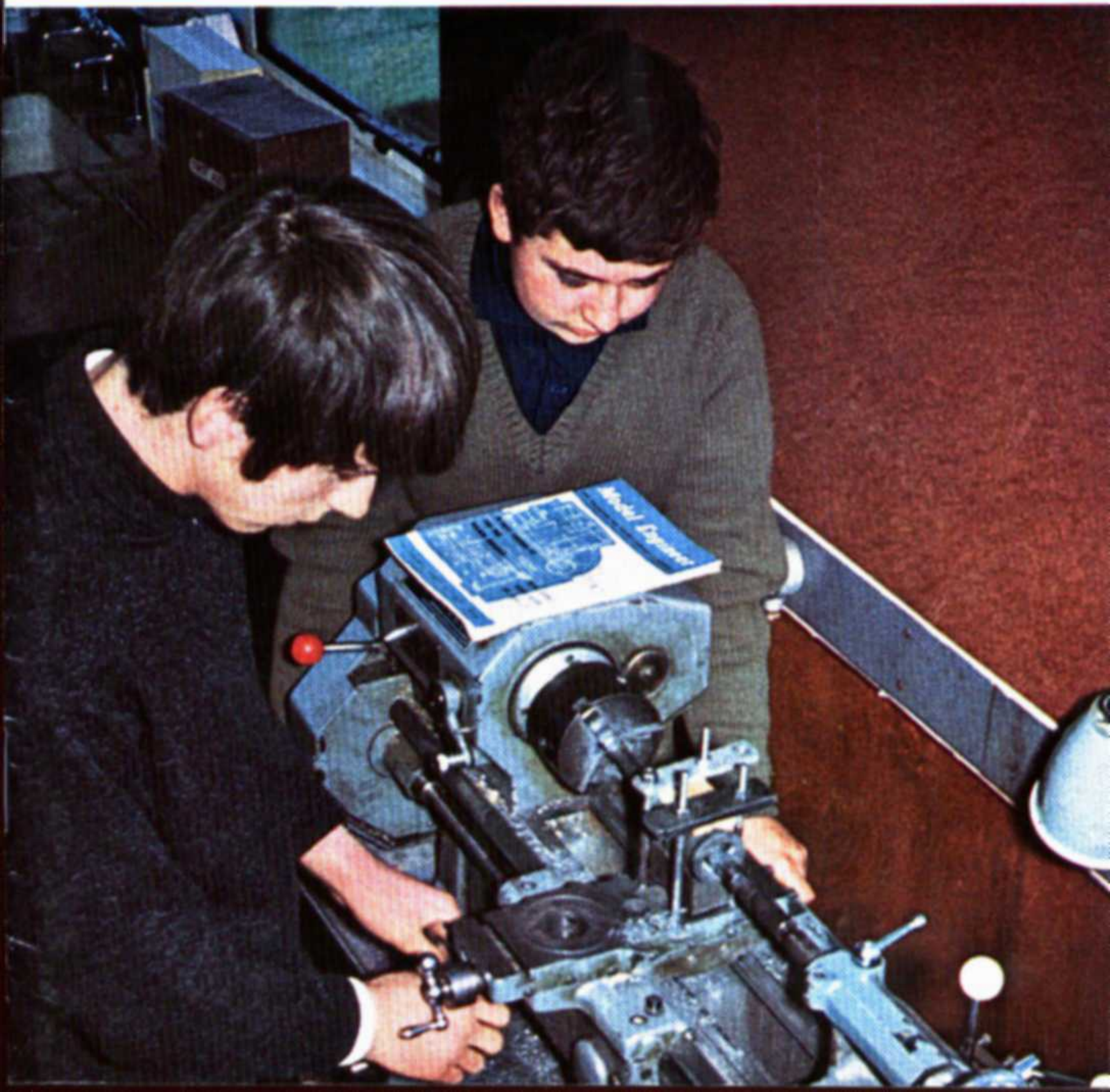

Model Engineer

MAP

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Volume 135 **Number 3371**

June 20 1969

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COVER PICTURE

Two boys of the County Secondary School, Bodmin, working on a model M.E. beam engine. The lathe is a Boxford. Colour photograph by F. R. Pascoe.

NEXT ISSUE

Talking about steam: Legal liability at miniature passenger-carrying tracks.

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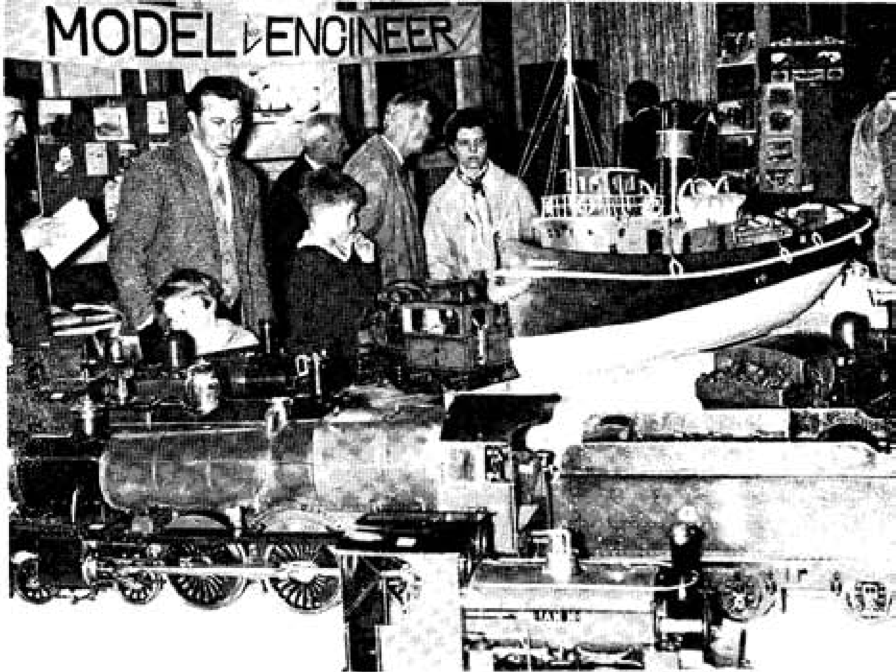
The Editor is pleased to consider contributions for publication in *Model Engineer*. Manuscripts should be accompanied if possible by illustrations and should also have a stamped addressed envelope for their return if unsuitable.

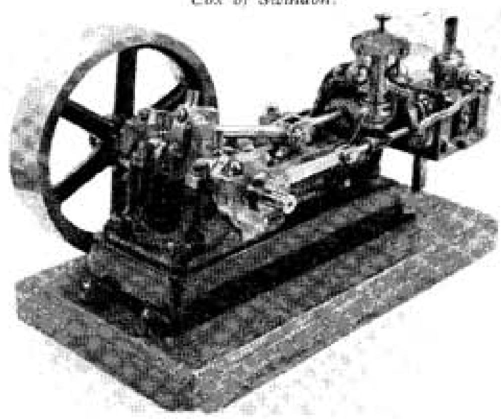
SMOKE RINGS

A Commentary by the Editor



A view of some of the models at the recent Cheltenham exhibition.

Below: A Stuart No. 9 horizontal engine built by Mr C. F. Cox of Swindon.



Brunel bicentenary

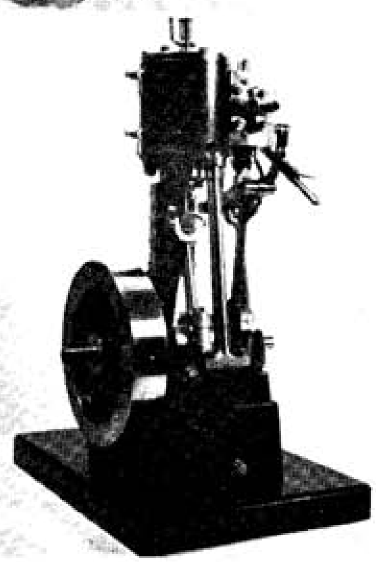
The Science Museum, London, has arranged a special commemorative exhibit for the 200th anniversary of the birth of the great engineer and inventor, Sir Marc Isambard Brunel, the father of Isambard Kingdom Brunel. It will be on view in the East Hall of the Science Museum until July 8.

Sir Marc Brunel was born in Normandy on April 25, 1769, and escaped to the U.S.A. during the French Revolution. He lived in England from 1799 until his death in 1849. His son, famous as a railway and marine engineer and bridge builder is perhaps more widely known.

Sir Marc was a pioneer of mass production and his highly successful plant for the manufacture of pulley blocks for the Royal Navy—the Portsmouth blockmaking machinery—was in use until recent times. Several of the advanced machine tools designed by him for this purpose are exhibited in the Museum. *Continued on page 596*

Right: A Stuart vertical engine, 2 in. × 2 in. built by Mr. Cox in 1914.

Left: A view of the Gauge "O" model railway at the Cheltenham Exhibition.



FLASH STEAM

Part III

Continued from page 531

by Edgar T. Westbury

THE CRANKSHAFT BILLET is now set on edge and the crosswise centre found in the same way; to check the central accuracy of these marks, the bar should be set both ways up in each case. The scriber is then raised $\frac{3}{16}$ in. above the cross centre and the throw centres marked out on both sides of the main centre, all the cross lines being produced along the full length of the bar on both side faces. After carefully centre-punching the intersections of the lines on the end faces, they should be centre-drilled to a depth sufficient to give proper support for turning; it is best to use a centre-drill with a small diameter pilot, so that the countersunk part gives the maximum bearing area. When marking out any work in this way, it is important that it should be bedded down firmly on its packing, during the operation; if it can be clamped or held down magnetically, so much the better. These methods are elementary workshop practice and it is generally assumed that every model engineer knows all about them; but this cannot always be taken for granted.

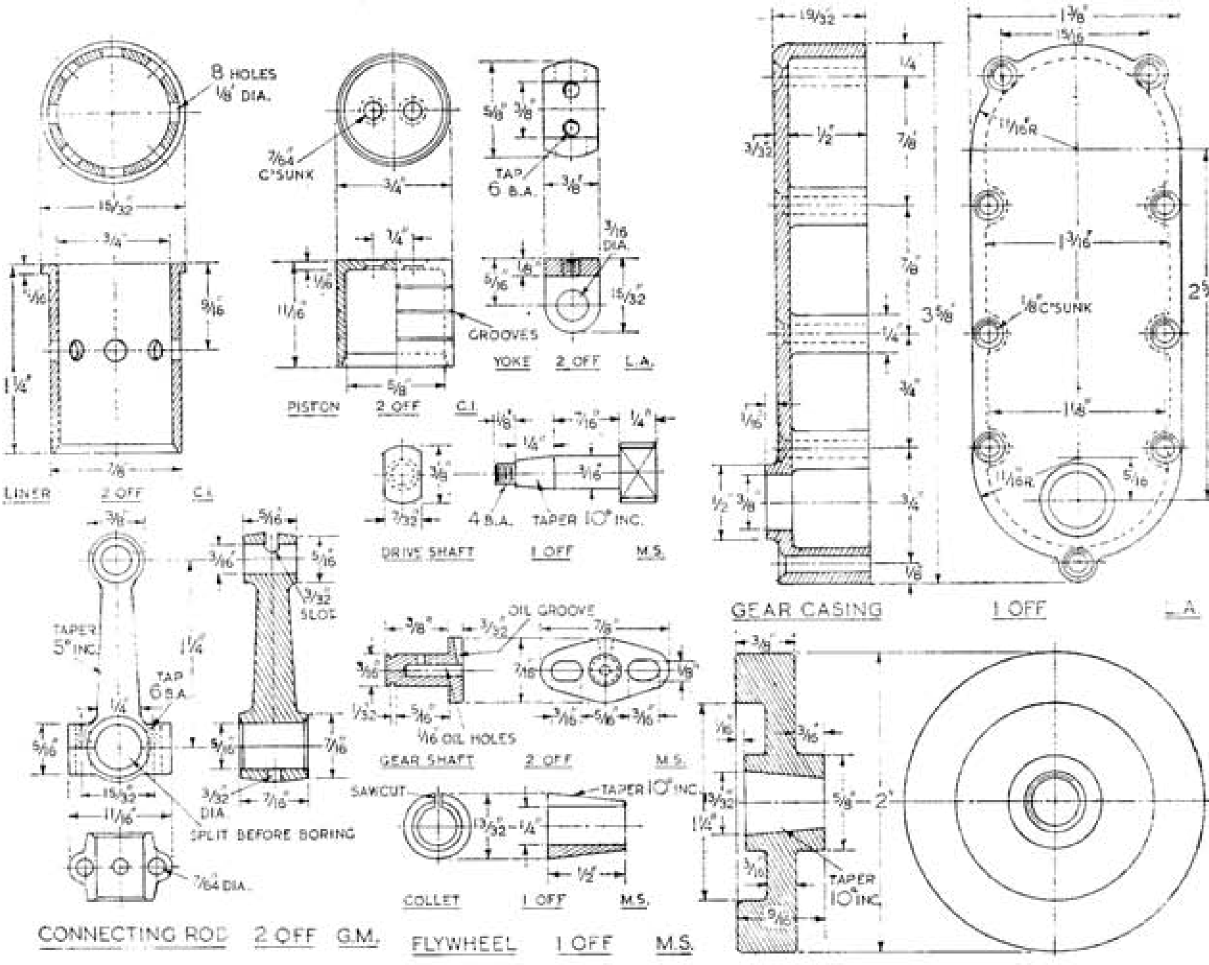
The outline of the main journals, crankpins and webs can be marked out on the face of the bar, as a guide to cutting away most of the surplus metal, but at first the journal ends should be left intact, to preserve the throw centres for the time being. Care should be taken to leave sufficient metal in the region of the crankpins to ensure that they will clean up to size when turned. Most of the metal can be cut away with a hacksaw, but a row of small holes adjacent to the inner side of each crankpin, close enough to each other to enable the metal to be broken out, may be necessary. The bar may now be mounted between the throw centres in the lathe, and each crankpin in turn machined to finished size; the outer webs can also be faced at the same settings. A small but definite internal radius should be left at each of the four shoulders; sharp internal corners on stressed shafts cause weakening and may eventually form a focus for starting cracks. If desired, the oblique sides of the centre web may simply be filed or machined square across, but by setting the top-slide over to 50 deg., they may be faced to produce the rounded edge as shown in the section.

The surplus metal on each side of the two main journals may now be sawn away, and the bar mounted on its main centres for turning each of the journals in turn. Here again, fillets should be allowed in the corners, not only at the webs but also on the stepped diameters at the outer ends. It will be seen that the shaft is symmetrical and may be fitted either way round, except that if a sleeve nut, as shown in the detail drawing, is used at the gear end, a longer thread is necessary here. Some readers may consider that the shaft should have a right-hand thread at one end and a left-hand thread at the other, to prevent the risk of one nut spinning off when running. As the engine can be tuned to run in either direction, no definite rule can be laid down about this, though it may be desirable in certain circumstances. But if no definite torque is imposed on the nuts, and reasonable measures are taken to prevent them loosening, it is quite in order to use right-hand threads at both ends; I have done so on several of my engines without any trouble ensuing.

Balance weights

These may be initially made from a single disc for convenience in machining, either a casting or stock material being suitable. Both sides are faced flat, and the groove is machined or filed to fit closely across the crank web, before cutting the disc in half across its diameter, and trimming the angular edges. Each of the weights is secured to its web by a single 4 BA sunk-head screw, preferably of the high tensile socket-head type, which must not project unduly on either side. When fitted, the circular edges may be turned *in situ*, flush with the edges of the crank webs. The object of these balance weights is to reduce the rocking 'couple,' which, in twin engines with cranks at 180 deg., is often more troublesome than the unbalanced reciprocating forces in a single-cylinder engine. Some constructors may prefer to machine the crankshaft from a $1\frac{1}{4}$ in. round bar, which is quite practicable, though of no advantage so far as I can see; it calls for a good deal more machining work and wastage of metal, and forming the balance weights from the solid, though desirable, is a further complication.

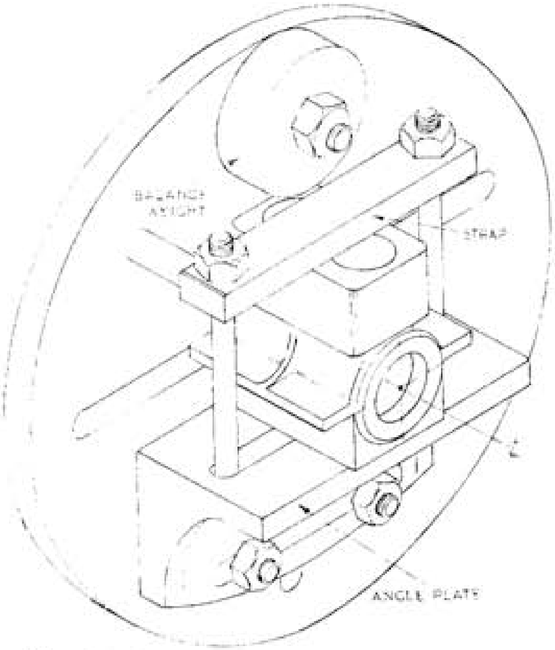
The material specified for the cylinder liners is cast iron, which is beyond question the most durable material for withstanding sliding wear at high speed and with minimum lubrication. If



this is not available, a tough hard-wearing carbon or alloy steel may be substituted; mild steel is not suitable, unless the working surface is carburised or chrome deposited, after major machining is carried out. A cylinder, or liner, made of unsuitable material will be liable to scuffing or scoring, with an increase of working friction and a relatively short life. Ferrous materials (with the exception of stainless steel, which is *not* recommended) are often objected to because of their liability to rust when used for steam cylinders, but this disadvantage is over-rated and can be avoided by taking precautions when engines are laid up for any length of time.

Cylinder liners are best made from cast ' quills ' with a flanged or thickened waste end to serve as a chucking piece and avoid risk of distortion through pressure of the chuck jaws. If a plain hollow bush is used, the chucking end should be plugged, with the same aim in view. In either case, both the external and internal machining should be carried out at one setting, and the liner parted off when it is finished. The alternative method of machining a liner which is not long enough to provide a chucking piece is by boring it first, and then mounting from the bore on a mandrel between centres for external turning. This is open to the objection that the finished bore may be scored if it should shift on the mandrel, and if it is distorted in any way, the inaccuracy may be transferred to the outer surface. These risks are more real than some machinists realise, and in dealing with relatively thin parts, every care should be taken to guard against them.

Although it is obviously essential that the liners should fit closely in both the upper and lower registers of the body, a tight interference or shrink fit is unnecessary. It is quite in order to machine the outside with a very slight taper—not more than about 0.001 in. in its length—so that it can be



Mounting the engine casting on the lathe faceplate.

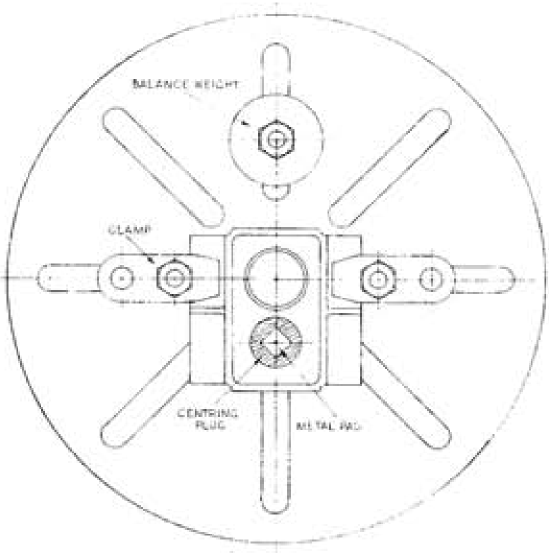
pushed nearly half-way in by hand. Nowadays, with the aid of modern sealants such as 'Loctite' or 'Casco' it is possible to make good really sloppy fits, provided that they are used only on chemically clean surfaces, but this is not always easy to ensure. In the past, I have found that a smear of jointing varnish, such as 'Wellseal,' which helps to lubricate the surfaces during insertion, is sufficient to seal a properly fitted liner. Make certain that the top rim of each liner will fit nearly into the recess of its seating and that its depth is equal to, or slightly greater than, that of the recess, by offering it up in the inverted position. Before finally finishing the bore, the eight uniflow ports should be drilled in the liner; their location should be checked so that they are just fully uncovered by the pistons at the bottom of their stroke, in case there may be discrepancies in other dimensions. Lapping of the bore may be carried out by a rotating lap held in the lathe chuck, but in this case also, the services of someone who owns a honing machine will be found helpful. For convenience in applying the liners to the lap or hone by hand, a whipping of stout cord on the outside may be used, or a rubber sleeve may be pushed on.

Pistons

The method of making the pistons is an old and well-tried one, which enables them to be kept fairly light, and prevents any risk of the gudgeon pins coming in contact with the cylinder bore; but the more conventional type of piston, either made from a casting, or machined from solid with internal bosses, may be used if preferred. Some constructors may fancy aluminium alloy pistons but I have misgivings about the use of this material in contact with steam, at the temperature which may be attained either deliberately or inadvertently, under the particular conditions. Steel as specified above is permissible, if the liners are of cast iron, or *vice versa*. As before, the piston shell should be machined inside and outside at one setting if possible. The exact width and position of the oil grooves is not important, but they should not be more than 0.010 in. deep, to avoid weakening the wall. A suitable tool for grooves of this nature is a piece of high-speed hacksaw blade, clamped between two pieces of mild steel about $\frac{3}{4}$ in. deep by $\frac{1}{4}$ in. thick, to form a suitable holder to mount in the toolpost, and ground on the front edge to normal cutting angles. Incidentally, I have used such tools for quite deep grooving, and even parting off mild steel up to 1 in. dia., with complete success. The outside of the pistons may be lapped by means of a ring lap, but a tool finish is quite satisfactory, if it produces a smooth parallel surface, fitting the liners with the finest possible working clearance. Although steam engines will *work* with imperfectly fitted pistons, any leakage past them will not only cause loss of efficiency, but also make it difficult to maintain the oil film which is essential to lubrication. The standard of piston-cylinder accuracy which is produced *of necessity* in small i.c. engines is equally desirable for those which employ externally generated pressure.

Piston yokes

These may be machined from round material and afterwards flattened on the sides, or from rectangular bar $\frac{3}{8}$ in. thick. In either case they should be machined on the diameter (or edges) to fit inside the pistons, and a flat-bottomed hole drilled as a basis for forming the gap to take the connecting rod little end. For both the end milling and cross drilling, it is convenient to keep each component attached to the parent bar for the time being, so that it can be held in the chuck or other appropriate fixture. My usual method of dealing with small fiddling parts like this (in pairs) is to carry out the turning and boring on two ends of the bar, and while still mounted, mill and drill them with a milling spindle set either endwise or crosswise, as the operations require, exactly at centre height. But whatever method is used, it is very important that the cross hole for the gudgeon pin should be exactly at right angles to the axis. When parting off the yoke, squareness is equally important, and the top face should be rounded or



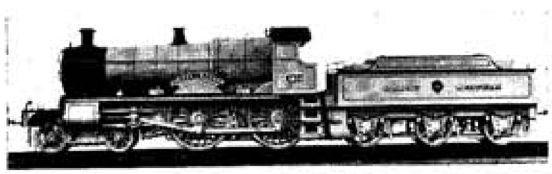
Setting up the body casting for boring for the liners.

chamfered at the edges so that it will fit right home against the underside of the piston crown in each case. The lower end of the 'horns' may be rounded off by filing or other means to reduce the weight to the minimum.

The holes to take the fixing screws may be drilled in the piston crown first, and spotted through for the tapping holes in the yoke. Sometimes in pistons of this type a single central screw is used to fixed the yoke and this is quite sufficient for security, as the load is mostly all one way, but it is more liable to loosening than where two screws are fitted as shown. The countersinking should fit the screw heads truly, and they should be flush with the surface when fitted. To lock them against risk of loosening, one of the sealants already mentioned may be used, but there is an old (and possibly crude) method of doing this which is at least equally effective. This consists of centre-punching the piston heads closely adjacent to the ends of the screw slots, so that burrs are formed which enter the slots and thus prevent the screws from turning. This, of course, should not be done until the connecting rods and gudgeon pins are made and fitted and the screws finally tightened. Details of the gudgeon pin were shown in the group of components, in the previous issue; it is simply a piece of $\frac{3}{16}$ in. dia. rod, drilled through the centre to reduce weight, and a tight working fit in both the yoke and the eye of the rod, so that it is free to 'float' or rotate. It should be faced to length so that it will fit easily inside the piston shell. Mild steel, case hardened on the outer surface by 'Kasenit' or other approved 'open hearth' compound, is recommended in preference to carbon or silver steel, which may become brittle under working conditions.

To be continued.

COUNTY CARLOW



A 3½ in. gauge G.W.R. 4-4-0 locomotive by Don Young

Part V **THE CYLINDERS** ***Continued from page 535***

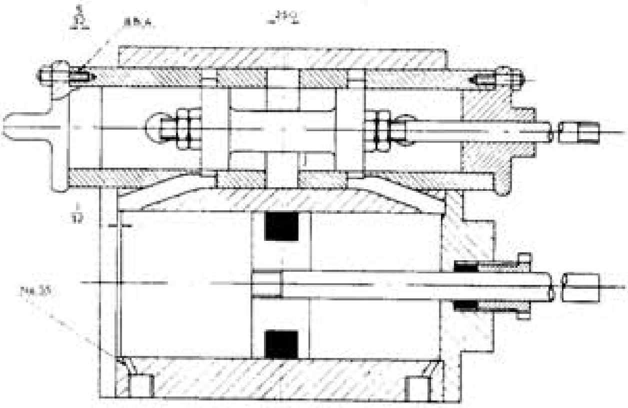
ON TO THE MOTIVE POWER Department of the engine: the cylinders. From a glance through back copies of M.E., there still appears to be some reticence towards the adoption of piston valves. This in spite of the scores of examples of *Ivy Hall*, *Doris*, *Springbok*, etc., now running, and giving excellent service at that!

There are two factors, allied to a reasonable standard of workmanship, that ensure trouble-free long life for piston (and slide) valves. The first is the copious supply of lubricating oil. The second is that steam temperature is insufficient to break down the oil film, or cause oil carbonisation.

To take care of the former, a twin-ram lubricator will be specified, supplying oil individually to each cylinder steam pipe. Ideally there should be two lubricator tanks as well, so oil supply can be readily checked, but space prevented this. The steam temperature requirement rules out a radiant superheater, as do the gunmetal cylinder blocks. Conventional flue type elements are specified, with generous free areas around them, to allow unhindered gas flow.

There is one point in favour of piston valves: they require far less effort to move than slide valves (except possibly the complex balanced variety). The valve gear does not have to be so robust; in another light, more power is available at the drawbar. For those still not convinced, the alternative is the adoption of *Firefly's* slide valve cylinders. But be warned that the alterations will not stop at the cylinders. Fixing details, smokebox saddle, steam and exhaust piping will all require modification.

A friend recently acquired a length of 4½ in. o.d. copper tube and wanted to build a 'quickie,' using the cylinders from our now scrapped "first attempt." His enthusiasm was channelled towards a slightly modified No. 1 Rail Motor. But the point to be made here is that those cylinders, *Doris's* adapted to 5 in. gauge have outlived the chassis, the cause of the dockyard tank's demise, and the piston valves are still steam tight. What is more they have required no attention since initial fitting. With that thought in mind let us carry on.



SECTIONAL ASSY OF CYLINDERS

The block

The cylinder block is almost identical to that of *Ivy Hall*. Castings suppliers will be able to modify the pattern quite simply, so there should be no hold-ups in this direction. Run a rule over the castings to get an idea of the machining allowances, then chuck in the four-jaw and take a cut right across the bolting face. This face has to be tight to exhaust steam, so make sure of a reasonable finish.

Clean up an end face, coat with marking-off fluid, then fit a softwood bung into each of the core holes. Using the bolting face as datum, mark off the cylinder and steam chest bore centres on the bungs and scribe circles on the casting to the bore sizes.

Because of the irregular shape of the casting it will be difficult to grip in the four-jaw for boring, so we will use another tried and tested technique. Fit the faceplate and bolt an angle plate to it. Fix the casting to the angle plate by means of a clamping bar and bolts. Check that the top casting face is square with the faceplate; it can then be relied upon when bolting the block to the frames later on. Clamp a knife edge tool under the tool post and adjust the angle plate until the tool tip traces out the cylinder bore circle. At this stage the inner end of the casting should be at least ¼ in. from the faceplate, so you can see the boring tool emerge. Also it should overlap the front edge of the angle plate so that a facing cut is possible across the outer end.

Now drill out the wooden bung, fit a boring tool under the tool post and take a heavy cut right through the bore. Carry on, taking normal size cuts, until the bore is just over 1 1/16 in. dia. Remove the tool and regrind, then taking cuts of no more than .010 in., bore to the 1⅛ in. finished dimension.

Leave the tool at this setting and traverse through the bore, on fine auto-feed, four to six times. Bear in mind that it is more important to obtain a good surface finish than for the bore size to be 'spot-on.' Adjust the angle plate and bore for the steam chest to 11/16 in. dia., all the above remarks again applying. Finally, with a round-nose tool, face right across the end of the block. This will be the back cover face; mark it and machine the second block the other way round to make a pair.

To machine the front cover face, bolt to the angle plate and use a piece of mild steel flat to align the back face with the faceplate. Take a facing cut (or cuts) right across to finish the block to its correct length. Although my lathe has never misbehaved when machining off-centre lumps on the faceplate, this does not hold good for everyone. Bolt some change-wheels, as a counterweight, to the faceplate, if the lathe is about to "take-off." Be careful these cannot foul the carriage, or the consequences may be rather disastrous. As my car manual so aptly puts it "expensive noises may be heard." The author must have been a comedian!

We may as well finish off the blocks whilst they are to hand, starting with the drain cock holes. These should be accomplished by use of the lathe, or drilling machine. Use a No. 21 drill, to 5/32 in. depth, D-bit to 3/16 in. and tap 3/16 in. × 40 t.p.i. Drill No. 55, obliquely from the bottom of this hole, into the cylinder bore, at each end. It is important that these connecting holes are not restricted by the covers, or piston; lightly countersink, if necessary, to prevent this occurrence.

Steam passages come next. Note that these are angled inwards to line up with the steam chest. Make four centre-pops in the bore, a full 1/16 in. from the ends, at ⅛ in. pitch. Drill first No. 50 and open out in stages to No. 30. File out the metal between the holes to form a slot. Carefully remove all burrs at each end of the slot, without damaging the machined bores.

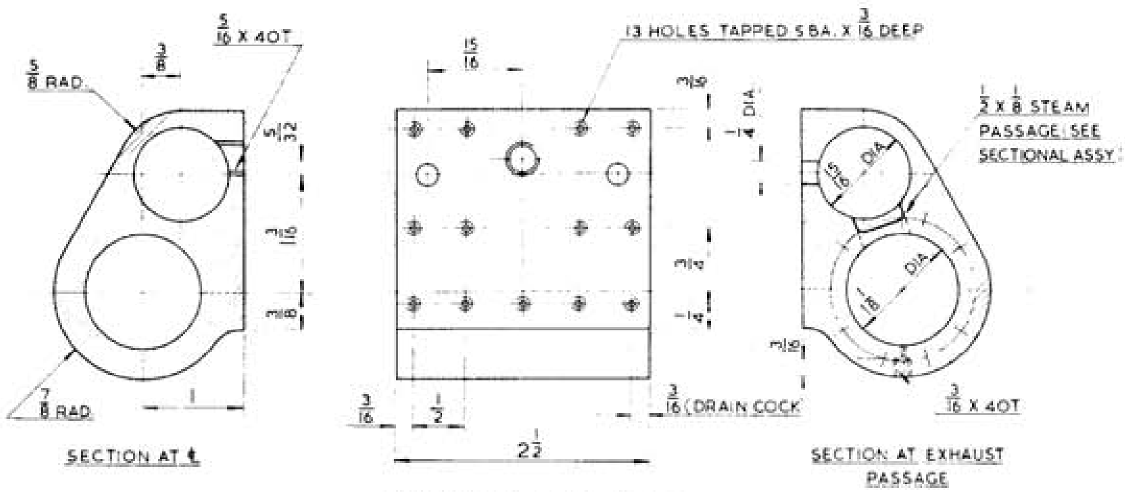
Clamp a cylinder to its frame. The top face should be in line with the frame edge. Check with a straight edge in the bore, back to the driving axle. Spot through the frames, No. 30, into the casting, for the bolt holes. I have an $\frac{1}{8}$ in. drill which is $3\frac{1}{2}$ in. long, so this operation is simple. For those not so lucky, just braze a length of $\frac{1}{8}$ in. rod to the drill shank. You can usefully re-employ an old broken one for this. Stick the business end of the drill into a raw potato, then it won't lose its temper!

Spot through for the steam pipe connection and drill the exhaust passages into the steam chest. Remove the block, drill and tap the marked holes, then tidy up any burrs inside the steam chest.

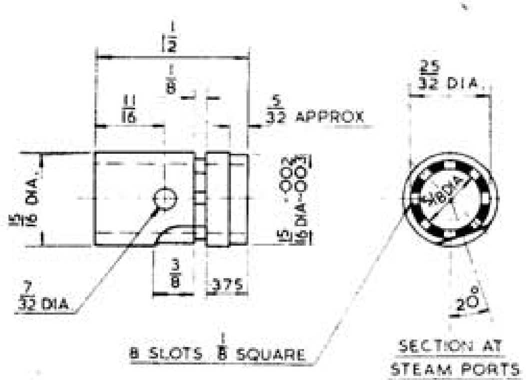
Before we can tap the ends of the block the covers will have to be made. It is an advantage if a chucking piece is provided on the front cover castings. Chuck by the cover and clean up the spigot, then chuck by the spigot in the three-jaw. Face the end then turn a $\frac{1}{32}$ in. length to a push fit in the cylinder bore. Face across the bolting surface and turn the outside down to $1\frac{3}{4}$ in. dia. With a knife edge tool scribe the bolting circle $1\frac{7}{16}$ in. dia., just so deep that the centre-pop point finds the groove. With a parting-off tool skim the cover face adjacent to the chuck and complete the cut to remove the chucking piece. With dividers, pitch the cover holes and drill No. 30, remembering to omit one hole in way of the steam passages.

Fit the cover, spot through, drill and tap one hole 5 BA to $\frac{3}{16}$ in. depth and fit a bolt. Carry on drilling and tapping the remaining eight holes. With a scriber, mark where the scallop has to be made to clear the steam chest and profile in place.

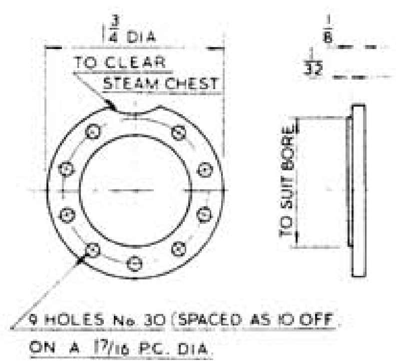
Chuck the back covers by the outside diameter, face across the gland boss and centre deeply. Drill



CYLINDER BLOCK - 2 OFF



STEAMCHEST LINERS - 2 OFF AS DRAWN
2 OFF OPP. HAND

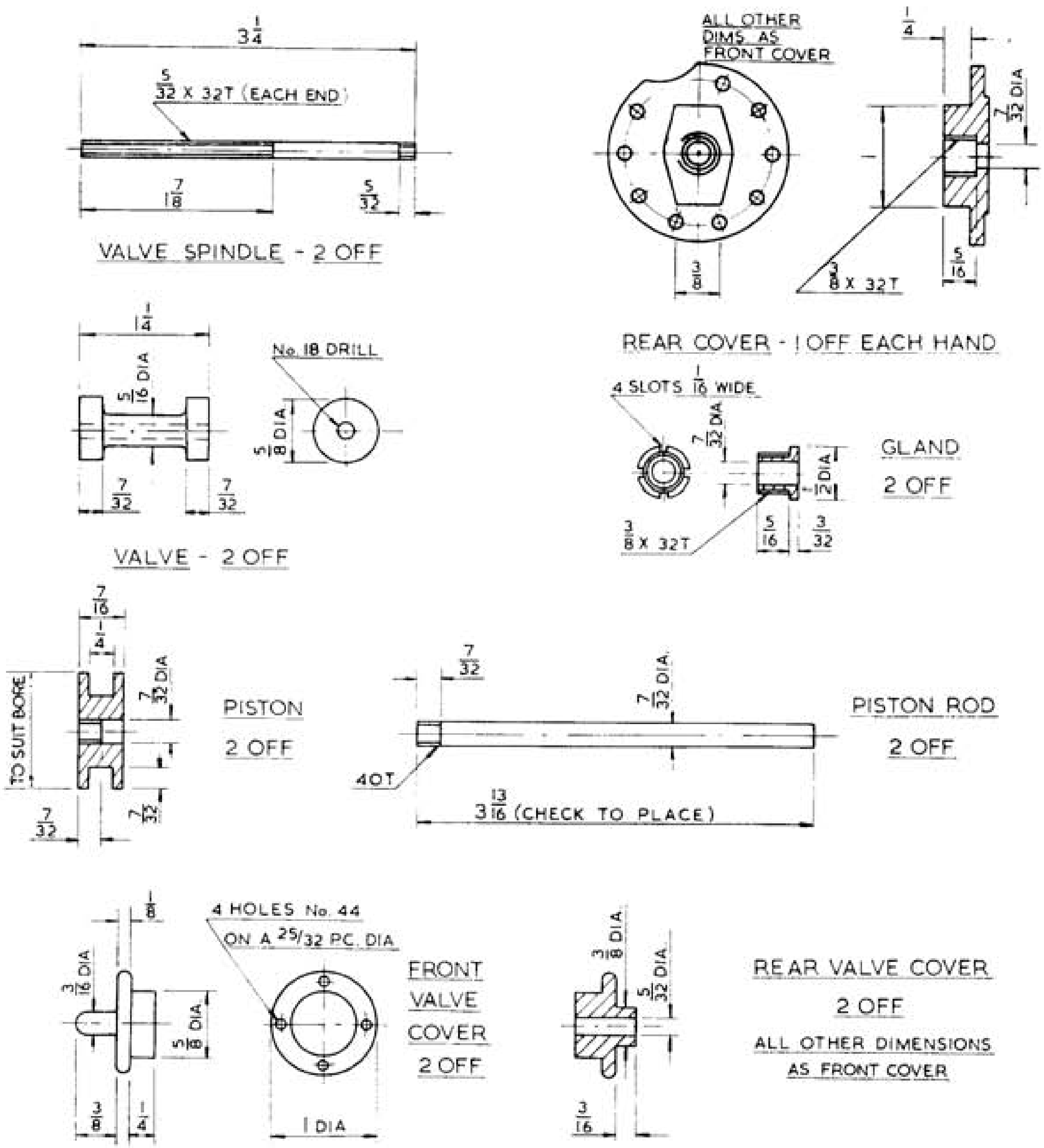


FRONT CYLINDER COVER - 2 OFF

through to 7/32 in. dia., follow up with 11/32 in. to 1/4 in. depth and D-bit to 5/16 in. depth; tap 3/8 in. × 32 t.p.i. Chuck a length of 1/2 in. dia. brass bar, turn down 1/4 in. length to 3/8 in. dia. and screw 32 t.p.i. Screw a cover on to this adaptor and machine the rest as for the front pair.

This leaves only the slidebar facings. I prefer to machine these faces to suit the bars, after fitting the crosshead. This can be achieved with the cover assembled to the block. For cover gaskets, brown paper soaked in raw linseed oil is ideal.

From " Postbag " it was noted that a correspondent disagreed with the practice of finish machining the pistons before screwing to the rods. True enough—but I found that the split collet method of gripping the piston rod did not always lead to perfect concentricity between piston and rod. However our friend's warning did lead me to a



slight change of practice, as follows:

First chuck the piston rods in the three-jaw, face the end and screw for 7/32 in. length 7/32 in. × 40 t.p.i., the stainless steel rod material being about 4 in. overall at this stage. Use the tailstock die holder with the die opened out for a tight thread. Next grip the piston casting in the four-jaw and clean up the chucking piece. Grip this spigot in the three-jaw, face off and centre the outer end. Bring up the tailstock centre, then turn down a full 1/2 in. to a sliding fit in one of the cylinder bores. With a parting off tool, produce the packing groove, then start to part off the piston, but only reduce to about 1/2 in. dia. Drill down to 7/16 in. depth, No. 12, then follow up with a 7/32 in. end mill to 7/32 in. depth. Tap out 7/32 in. × 40 t.p.i. to the maximum possible depth, holding the taps in the tailstock chuck. Now, grip the piston rod in the tailstock chuck and screw it hard into the piston. To check for concentricity, just start the lathe: if there is a telltale wobble I've failed. If your result is the same as mine, the job will be perfect. Part off the piston and rod assembly and repeat for the other side.

The liners

The steam chest liners shown are the split pattern and require careful machining. If your lathe is suspect and produces a slight taper over a long length of bar, revert to a single liner which can then be sweated in if the "press fit" isn't. The liner is balanced for steam pressure, when made in one piece, and will not be forcibly ejected. Knowing the equipment in your workshop, the decision will be quite straightforward.

The best material is 1 in. dia. drawn bronze bar. Saw or part off four 2 1/4 in. lengths. By the way, all the swarf from the cylinders and other gunmetal machinings should be religiously saved and taken to a scrap metal merchant. Two tips: explain how you came by the swarf, or you may get a visit from the Law. Secondly, do not get any steel swarf mixed in, or the price you get will be much less. With the price of gunmetal these days, the saving comes in very handy.

To return to the liners, chuck in the three-jaw, face the end and centre. Bring the tailstock centre up and take cuts to reduce over 1 5/8 in. length to about .008 in. over the steam chest bore size. Reduce the outer 1/8-3/16 in. length further until it just enters the bore. Note the cross-slide "mike" reading, wind back a half-turn, then bring up to within one division of the previous setting. Take a cut at this setting along the outside of the liner. "Mike" the width of your parting off tool. Take a light skim across the outer end of the liner, down to 1/2 in. dia. Now adjust the top-slide by 3/8 in., plus the tool width and machine the steam port groove to 25/32 in. dia. If any troubles are experienced up to this stage, just reverse the bar in the chuck and repeat the process. Next, drill right through the centre to 9/16 in. dia. Bore out until the lead end of the 5/8 in. reamer just enters. Carefully ream right through the hole, supporting the centred end of the reamer on the tailstock centre; feed it in in this manner. Prevent the reamer from rotating with a tap wrench or spanner, running the lathe at its lowest direct drive speed, about 100 r.p.m. For those possessing a machine reamer, just fit to the tailstock. Part off to 1 1/2 in. overall.

Drill No. 35, from the steam port groove into the bore, at four or six positions. After all the correspondence in "Postbag," this decision I will leave to the builder. With a Swiss file, carefully cut the ports square, using the machined groove sides as a guide. Next, file the flat to form the steam passage to the end of the block.

We now need some equipment to press in the liners, starting with a 1/2 in. BSF or UNF bolt, about 6 in. long. Two stepped bushes are also required; chuck a length of 1 in. brass bar and turn down 3/8 in. to an easy fit in the liner. Drill 9/16 in. dia. to 5/8 in. depth and part off at 7/8 in. overall. For the second bush, chuck a length of 1 1/4 in. bar. Turn down 3/8 in. to an easy fit in the steam chest bore (15/16 in.), drill and part off as before. Enter the liner in its bore and fit its bush in the end. Slide the bolt through and fit the larger bush at the other end. Tightening the nut will now draw the liner into the chest. Make sure that the passages line up between liner and block. The liner should be just visible at the steampipe tapped hole.

For the second liner the procedure is the same, except that a distance piece is required over the first liner. Chuck the 1 1/4 in. bar again and bore out to a full 7/8 in. depth to 15/16 in. dia., a very easy fit over the fitted liner. Part off to 7/8 in. overall, fit over the first liner, assemble the gear as before, and draw in the second liner. Use a piece of 1/4 in. dia. silver steel, through the steam entry hole, to obtain the correct spacing between the liners.

Drill the exhaust passages through from the block, then carefully ream right through, by hand. This will remove all the burrs and counteract the contraction caused by the press fits. The cylinders are now almost finished but before the final effort, take a break and turn up the valve covers and piston rod glands, nice simple stuff! The rear covers have reamed holes, to suit the 5/32 in. stainless steel valve rods. Should this arrangement appear crude, fit a gland, but remember it must not protrude further than the spigot shown, or it will foul the valve crosshead.

To be continued

BRITISH COMPOUND LOCOMOTIVES

By K. N. Harris

Part V

Continued from page 542

VERY SADLY Smith died at the early age of 64, too soon to see the fine work his engines did later. Smith was probably one of the very best Chief Draughtsmen that any railway in Great Britain ever had, and he not only understood the essential principles of compounding as applied to locomotives, but knew how to design his compound engines to use them to best advantage. His great memorial lies in the 240 odd Compounds built by the Midland and the L.M.S. on his principles, which for their period and power, were amongst the very best express engines in the whole country.

From the model locomotive enthusiast's point of view, these lovely engines are just about as fine prototypes as can be found amongst British Compounds. I would, however, suggest three minor modifications: (a) to fit four sets of Walschaerts valve gear, with separate control for HP and LP engines, and (b) to use Woodward's articulated connecting and coupling rods on the outside motion, (c) to substitute open-backed balanced slide valves for piston valves on the LP cylinders.

There would be no need for the LP valve gear to have inside eccentrics, the links could be driven by the return cranks and eccentric rods of the outside motion; of course each LP crosshead would operate its own union link and combination lever. These suggestions are in no sense a reflection on the original designer. Smith would undoubtedly have liked separate valve control to HP and LP engines and Woodward's system came after Smith's untimely death. Reverting to separate valve gear controls, the cold fact was that the engine drivers who could be relied upon to make intelligent use of such controls were about as common as hen's teeth, and the extra expense in first cost and maintenance that such arrangements entailed, simply was not justified under the circumstances; even such a forceful and arbitrary character as F. W. Webb was unable to get his drivers to operate such controls intelligently.

All in all, Smith was a great designer and a great locomotive engineer and his untimely death was a loss not only to the N.E.R. but to British Locomotive Engineering as a whole.

In 1907, Mr Hughes of the L. & Y. designed a four-cylinder 0-8-0 compound locomotive for freight traffic. A year before, Hughes had converted one of the 0-8-0 simple engines into a four-cylinder compound and the new engines, of which ten were built, were based on this experimental engine.

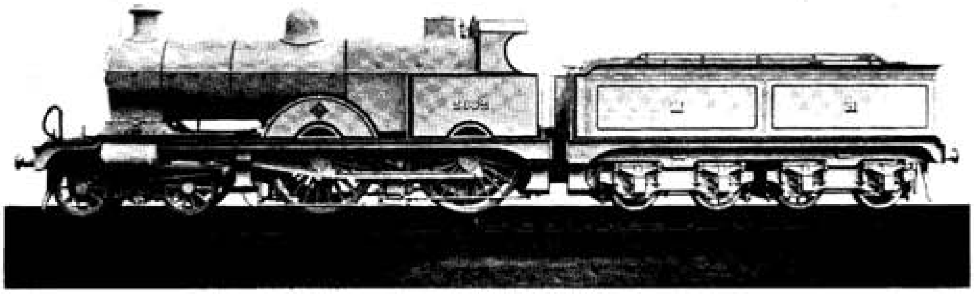
The HP cylinders (outside) were 15½ in. × 26 in. whilst the LP cylinders were 22 in. × 26 in., all four driving the second axle. Ratio of HP to LP 1 to 2. Piston valves were used for the HP and Richardson balanced slide valves for the LP, and though I do not know for certain, these latter were probably of the "open back" type exhausting direct to the blast pipe and eliminating exhaust ports, which was a usual feature on the L. & Y.

Joy's valve gear operated the LP valves direct and the HP valves by means of rocking levers. An ingenious starting gear was fitted, which admitted boiler steam to the LP steam chest. This was controlled by the reversing gear and only came into effect when the engine was in full gear, forward or backward. The arrangement was such that the HP pistons were practically in equilibrium, and in effect the engine started as a simple two cylinder engine with a pair of 22 in. × 26 in. cylinders taking boiler steam. As soon as cut-off was advanced, the supply of boiler steam to the LP steam chest was automatically cut off, and the engine operated as a compound.

These engines appear to have given good service, but the type was never duplicated and it was, once again, probably a case of increased maintenance and repair costs equalling, or exceeding the saving in fuel. It has always to be borne in mind that the cost of fuel is only one item in the total cost of operating a locomotive, first cost and maintenance and repair costs, are also of major importance.

Around 1925 one of Hughes' L. & Y. four-cylinder simple express engines was converted to the compound system. A new pair of inside LP cylinders were fitted 22 in. bore and the outside cylinders, now the HP cylinders were lined down to 15½ in. bore, Ratio HP to LP. 1 to 2. Pressure was retained at the 180 p.s.i. used on the engine in its simple form, a distinctly low pressure for a compound in 1925 but presumably it saved the expense of a new boiler.

Most of the working life of this engine was spent on the Crewe-Carlisle section and it was apparently well liked by its engine crews.



No. 2632, the second of the Midland compounds by S. W. Johnson.

Its simple brethren were equipped with piston valves which wore rapidly and were anything but steamtight, and working on trains of around 350 tons it showed a fuel saving of 26 per cent. When, at a later date the engines were fitted with new piston valves with six narrow rings, the saving in fuel dropped to 9 per cent, a very clear indication of the importance of steamtightness in the valve, whether slide or piston.

The first Midland Compounds were built by S. W. Johnson, almost at the end of his long career as Locomotive Superintendent of that great railway. There were five of these engines built between 1901-3 and Johnson adopted the Smith three-cylinder system, influenced almost certainly by the successful rebuilt 4-4-0 on this system on the NER, already referred to.

Johnson's engines too were of the 4-4-0 wheel notation, and for their period big, with a total heating surface of 1,598 sq. ft. a grate area of 26 sq. ft. and a working pressure of 195 p.s.i. The HP cylinder was 19 in. × 26 in. and the two LP cylinders 21 in. × 26 in. and all three drove the leading axle; the wheels being 7 ft. dia. At the time they were built, they were amongst the heaviest 4-4-0 express engines in the country, weighing 59 tons 10 cwt. in working order.

Ratio of HP and LP cylinders was 1-2.45. The HP cylinder had a piston valve below and the LP cylinders had plain slide valves on vertical faces in a common steam chest into which the HP piston valve exhausted directly. Valves were actuated by three sets of Stephenson gear, a type of gear, by the way, in the design of which Johnson was a great artist. The HP and LP valve gears were independently controlled. These engines could be worked as " simple ", " semi-compound " or " compound." In running they almost always worked as compounds except at starting and occasionally under exceptionally hard conditions.

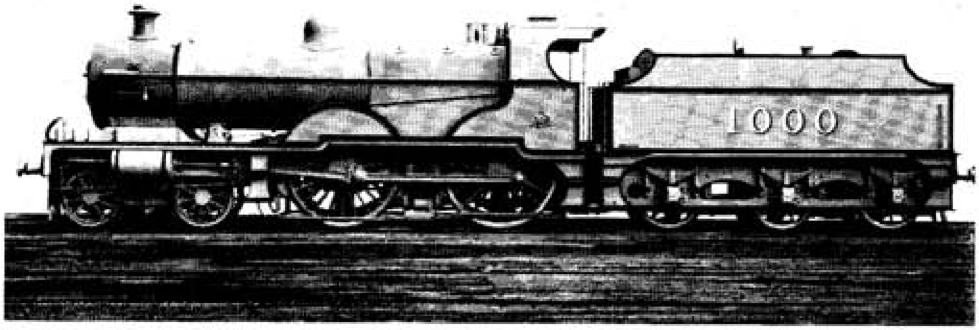
For starting purposes, boiler steam was admitted to the LP steam chest via a reducing valve, the setting of which was under the control of the driver, but was so designed that when the maximum allowable pressure was reached in the LP chest, the supply was cut off. Under " simple " running conditions the HP piston was practically in equilibrium and the maximum pressure in the LP chest was kept at 160 p.s.i., which was under the control of the driver through the reducing valve already mentioned.

When working compound, the pressure in the LP steam chest would usually be from 50-60 p.s.i., depending on the cut-off in the HP cylinder. There was a pressure gauge in the cab to indicate to the driver the pressure existing in the LP steam chest.

In starting with steam admitted directly to the LP steamchest the HP piston was practically in equilibrium and to ensure that this condition was not upset, non-return valves were provided, so arranged that steam could pass from the LP steam chest to either end of the HP cylinder. These valves only opened when there was a difference in pressure on one or other side of the HP piston and that existing in the LP steam chest.

The boiler had a Belpaire firebox, which Johnson had recently adopted for his simple 4-4-0 express engines. Two of the engines were originally fitted with " Serve " internally ribbed tubes, which were much in vogue on the Continent, notably in France, but these were later removed. These tubes added 121 sq. ft, to the total heating surface. I have no information as to why they were removed, but most probably it was because they were much more difficult to keep clean internally.

A point of interest, which has nothing to do with compounding, relates to the engine brake gear. Johnson adopted the N.E. system with what were in effect, clasp brakes, on the coupled wheels, there being brake blocks on each side of each wheel. In the NER, which was a Westinghouse brake line, the operating cylinders presumably used compressed air, but on the Midland, which was a vacuum brake line, the cylinders were steam operated. The great advantage of this system is that it is a balanced one, and braking does not entail



The first of the Deeley compounds, No. 1000, now preserved

any *internal* load on the axleboxes, whereas with the single sided application, the brakes create a considerable direct load between journal and axlebox. The scheme also avoids stressing the coupling rods under certain conditions of wear in the axlebox journals or horns.

These engines were highly successful from the outset and did splendid work on the difficult Midland system, notably on the mountainous Leeds-Carlisle section.

When Deeley succeeded Johnson, on the latter's retirement, he produced a further series of very similar engines, but modified in detail. Apparently it had been found (once again!) that the drivers either could not, or would not, make intelligent use of the separate valve controls for HP and LP engines, and Deeley abolished this feature, and arranged a single control for HP and LP valve gears, which gave a slightly later cut-off in the LP than in the HP cylinders.

He also abolished the efficient but rather complicated starting arrangements, and in their place fitted a most ingenious regulator. This was fitted with a pilot valve, on the back of the main valve (it was of the vertical sliding variety) which at starting opened a small port, which by means of a separate steam circuit, allowed live steam access to the LP steam chest.

On moving the regulator further over, this supplementary port was closed and the engine functioned as a compound. If for any reason, when running, it was desired to boost the LP steam chest pressure, the regulator had to be closed and then re-opened. This arrangement, of course, very much simplified the operation of the engines, though almost certainly at the expense of obtaining the maximum efficiency from them. Once again, it was a case of it being useless to provide means of attaining greater efficiency, if those responsible for handling the engines were incapable of using them intelligently and consistently.

Deeley provided a boiler, again with a Belpaire firebox, with the grate area increased to 28.4 sq. ft., the largest ever applied to a 4-4-0 in this country, and raised the working pressure to 200 p.s.i.

Later the original five Johnson engines were modified to conform with Deeley's series, making 45 in all. A small point of interest: these engines had the connecting rods of the outside cylinders *inside* the coupling rods, in order to keep the cylinder centres down to 6 ft. 3 in., the width over the lagging being 8 ft. 6 in. In 1914 Fowler installed superheaters in these engines, with markedly beneficial effects. Around 1923-24, Sir Henry Fowler, who succeeded Deeley as CME of the Midland in 1909, built many more compounds.

Again, these were almost identical with Deeley's engines, but the driving wheels were reduced from 7 ft. dia. to 6 ft. 9 in. dia., whilst the HP cylinders were increased to 19¾ in. bore and the LP to 21¾ in. bore. This change however was not successful, and the cylinders were very soon lined up to the original dimensions of 19 in. × 21 in. This is a good example of how sensitive the dimensions of this nature may be in a compound; on the face of it there does not appear any obvious reason why this small increase should not have been successful, but the fact remains that it was not.

The difference in ratio between HP and LP was negligible, only affecting the second decimal place, and as the boiler was an extremely fine steamer and always well on top of its job, one would not have expected an increase in the volume of the HP cylinder amounting to 5½ per cent would have made any noticeable difference.

Eventually there were no less than 240 of these engines and they were to be seen over the whole vast system of the L.M.S. They edged out the "Precursors" and "Georges" of the old L.N.W.R. on the Euston-Birmingham route, though not before the stubborn drivers of that rather unprogressive outfit had put up a stiff rearguard fight of non-co-operation.

To be continued.

The New Model Engineer
TRACTION ENGINE

PART XII

A one-inch scale model built and described by L. C. Mason

Continued from page 539

NOW, TO COMPLETE the rear axle assembly, come the rear road wheels. The most suitable material for the rims would be malleable iron castings, but supplies of this were difficult some time ago, and are probably worse now. Cast-iron is dangerously brittle in view of the riveting required, so there remains the choice of gunmetal castings, aluminium castings, or mild steel fabrications. The latter would be very suitable, but at the time of building numerous enquiries rather surprisingly failed to find any steel tube approximately near the required size.

If you can get steel strip rolled up and welded into true rings thick enough to permit of light machining, flat rings cut from steel sheet could be silver soldered inside them to produce the double " T " section. This would be as good as anything. However, in my own case for various reasons by far the easiest way out was to use cast light alloy rims. Trials on odd bits of this material showed that it would stand up to the necessary riveting; it is very easy to machine, and when painted, close examination would be required to determine what the rims were made of. Last, but by no means least, if castings are to be used, light alloy is about the cheapest material for the job.

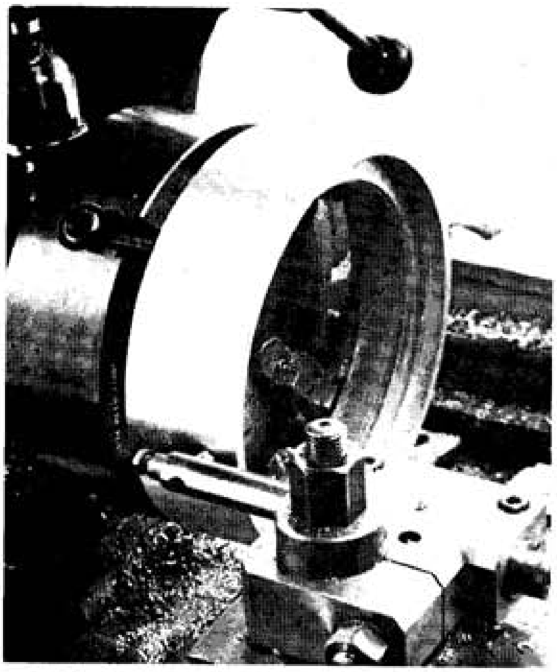
One slight drawback is that it is advisable, for the sake of strength, to leave the various thicknesses somewhat heavier than the strictly scale size. However, this is not at all obtrusive.

The rim castings can be entirely machined in the four-jaw chuck on the ML7, and to make a start on the first one, grip it inside the rim with the web pressed close up to the jaws. Incidentally, mine were cast all in one piece, with a wide solid web in the middle, needing to be machined out to produce the double T section. This simplified both the pattern making and the casting. In the real job, the rims are in two separate " T " rings, held together by the strakes. Sometimes in the larger engines the two rings were also held together by long strips riveted along the joint inside the rim, between the webs.

Take a light trial skim over the outside of the rim and check how the rim thickness in various places will work out. The rough casting may not be truly circular, and you may find it necessary to adjust it in the chuck to run a shade eccentric at first to average out the rim thickness. While light alloy is best finished with a fairly high turning speed, keep down to the lowest direct-drive speed until the tool is cutting all round. On this diameter the cutting speed at the tool point is pretty high even on low speeds—low r.p.m., that is. If it does turn out necessary to adjust the position of the casting in turning, keep an eye on the back rim edge too, so as not to get caught out with a thin spot.

The outer diameter can be finish turned right down to size. You will probably find that with a casting of this width, the top-slide cannot be extended far enough out to reach right across the rim on the average 3½ in. lathe. Mine couldn't on the ML7. However, you can get around this quite easily by using a stout boring bar held parallel to the lathe bed, using a normal inserted boring cutter held in the bar the opposite way round to boring,

Pair of rear wheel rims, finish machined.



Machining the outside of the rear wheel rims.

i.e., as if for boring with the lathe running in reverse. The photograph of my set-up shows the idea.

With the 'tread' the correct diameter, check across the webs and decide how much has to come off the outer face of the web that you can reach. Face this web back the required amount, using a tool with a small radius on the point so as to avoid a sharp corner at the root of the web. At the same time the inside of the rim edge can be machined out to give the finished rim thickness. Skim back the edge of the rim to the correct dimension from the web face. Reverse the rim in the four-jaw, this time gripping it by the outside, and taking care to get it running really true. Face back the second web to dimension, machine out the inside of the rim to thickness and skim back the rim edge to final width.

Assuming that the casting is a complete rim, with solid double webs, machine the inside edge of the web rib to leave it the correct finished depth (i.e. distance from inside the rim towards the centre). The space between the webs will probably need a special tool and the sketch shows the shape of mine, made up from a piece of silver steel. You may find it easier to make up a cutter for use with the boring bar, but check first that the bar can travel inside the rim far enough to bring the cutter to bear on the back web without the end of the bar fouling the chuck jaws. My bar has an end pinch screw for the cutter, and this was not possible in my case.

Owing to the unavoidable overhang on whatever sort of tool is used for this operation, it is advisable to machine between the webs at a rather lower speed, keeping the tool on the move across the inside of the rim to avoid chatter. The thickness of the centre of the rim can be checked by a depth gauge, comparing depths either side of the web.

With the rim completely machined, leave it in position for dividing operations, of which there are two: on the web for the spokes and on the rim for the strakes.

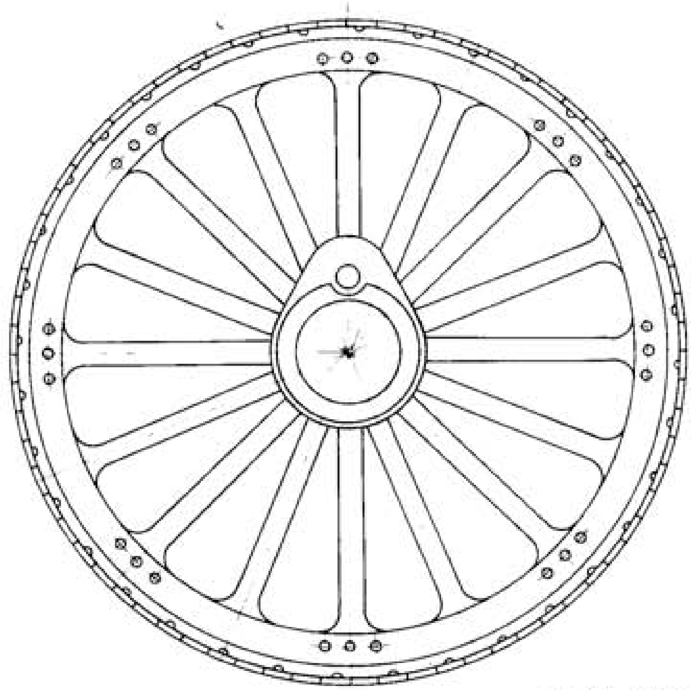
The question arises here of how many strakes to be fitted. The 2 in. Fowler ploughing engine described some time ago has 26 strakes; the 1½ in. Allchin has 36, while another 1 in. design of many years ago has 40. It seemed to me that a fair compromise here was 35. This number reduces the work slightly from 40, it would give a smoother rolling motion than the Fowler's 26 on a much smaller wheel, it is between the largest and smallest numbers and lastly, 35 is a number into which it is beautifully easy to divide.

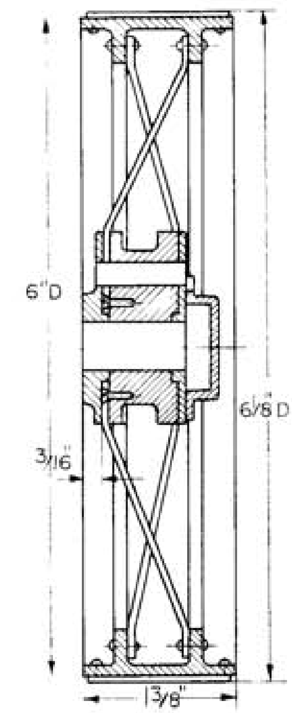
So mount up the dividing gadget on the mandrel with the 35 wheel in position and a piece of plain bar in the toolholder lying across and just clearing the rim. A ground lathe tool blank does fine for this. Engage the detent at any tooth space on the 35 wheel and scribe a short line on the rim—about ½ in. long, nearly out to the edge—with the scriber guided by the toolpost bar. Repeat for every tooth of the 35 tooth wheel, not forgetting to check that the 36th coincides with the first.

That locates the strakes round the rim; now we want to position the spokes. Exchange the 35 tooth wheel for the 40 tooth and re-position the scriber bar in the toolpost so that you can use it to mark across the face of the web. Engage the detent with the wheel and mark in a light line from about the mid-width of the web out to the edge. Withdraw the detent, count round five teeth and repeat. This repeated eight times gives an exact division of the web into eight. These eight stations locate the spokes on one side only. The eight on the other side of the wheel come exactly mid-way between this lot, so we have to fix their positions in relation to the first set.

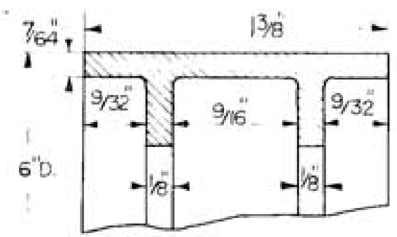
Remove the rim from the chuck, noting which two jaws were slackened, so that the rim can be replaced truly again.

Hold the stock of a small square against the marked web so that the blade lies across the edges of both webs. Slide the square round the webs till the blade edge exactly checks with one of the marks, and scribe a light mark across the thickness of both webs. Do the same again at the next mark round. This has now transferred two adjacent

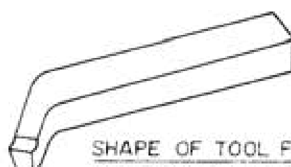




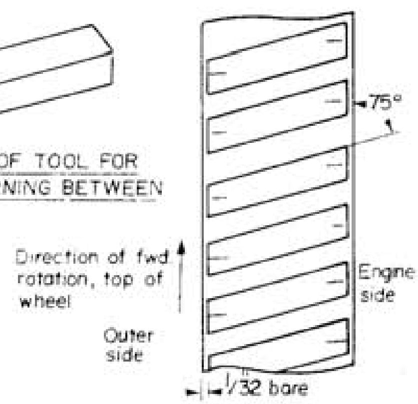
REAR WHEEL



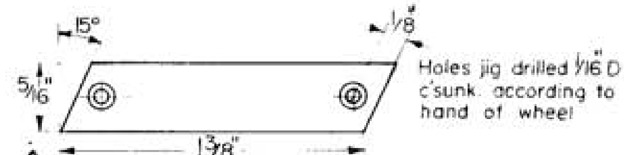
RIM SECTION



SHAPE OF TOOL FOR FOR TURNING BETWEEN WEBS



ASSEMBLY OF STRAKES ON RIM



STRAKE 1/16" B.M.S. 70 OFF

marks to the edge of the opposite web. Now, with the dividers, position one point on one of the marks on the edge of the second web, and by trial and error find the setting that just divides the distance between the two marks into two. At that mid point, mark a line across the web thickness. Replace the rim in the four-jaw, tightening the same two jaws that were released, with the web to be divided outwards. It is highly unlikely that the mark on the edge of the web will line up exactly with a tooth position held by the detent, so engage the detent in the nearest position and slack off the nut holding the 40 tooth wheel in the mandrel. With the detent holding the wheel stationary, turn the chuck the small amount necessary to line up mark and scribing bar, and re-tighten the wheel nut.

You can now mark in a line as before on the web face to tally with the transferred edge mark. This is the first of the second set of spoke locations, and all that remains is to index round by fives for the remainder of the eight stations. On completing these operations on both rims we can leave them for the moment as finished and transfer attention to the strakes.

The strakes are 3/16 in. wide × 1/16 in. thick. This section does not seem to be a commercially produced size, and a local firm who produce sheared strip from sheet were unable to help as their machines were not able to cope with anything narrower than 1/2 in. So unless some enterprising supplier can lay on a supply of the correct section strip for intending builders, you will probably have to do it the hard way, as I did, and produce your own strips from sheet. In the event, this did not turn out to be the formidable job that was anticipated. My procedure was to draw-file the edge of the sheet straight and true, then mark in the 3/16 in. cutting line. A strip was then sawn off, keeping comfortably outside the line, and the cut edge of the sheet re-trued by filing. In this way enough strips were produced to yield 72 strakes—you can so easily lose one or two!

The strakes lie across the wheel rims at an angle of 15 deg., so a strip was marked out—pencil is good enough—for cutting into strakes with their ends at 15 deg. and about 3/32 in. over-long. Clamping two or three strips in the vice at the same time, it does not take long to produce an impressive looking pile of strake blanks. As cut off they will have one long side true, while the other side and both ends require finishing.

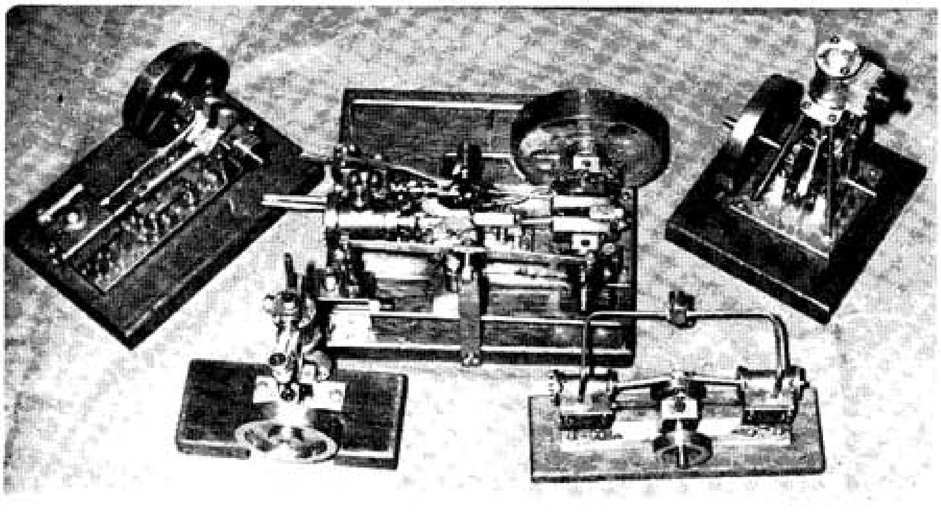
To be continued.

R. W. TANDY describes a collection of

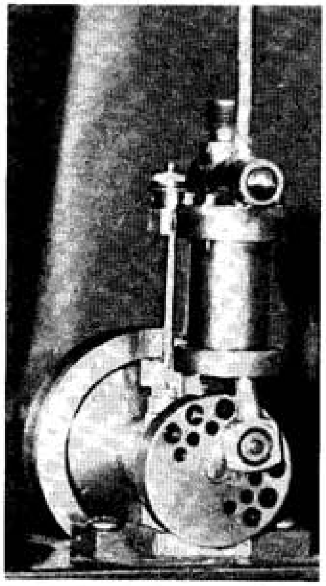
STATIONARY STEAM ENGINES BUILT WITHOUT CASTINGS

THE PICTURES accompanying this article show a collection of stationary steam engines all of which were built without the use of a single casting. The whole of the work was done by Mr Harold Hunt, on a 4 in. round-bed Drummond lathe, treadle driven.

Mr Hunt, who is a maintenance engineer with a large store in Torquay, is a very meticulous worker and he has designed all the engines himself. While they are a general representation of stationary mill type engines, none of them are examples of any particular prototype.



A group of Mr Hunt's free-lance engines built almost entirely from scratch.

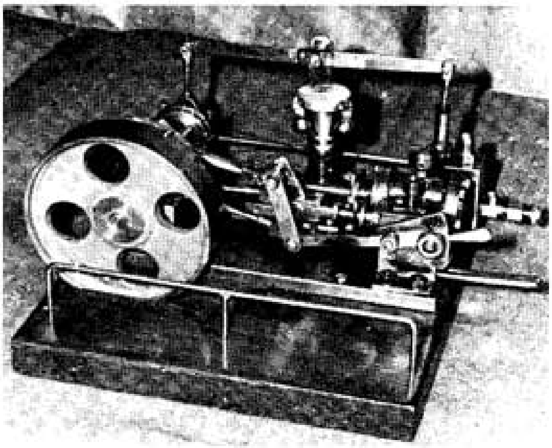


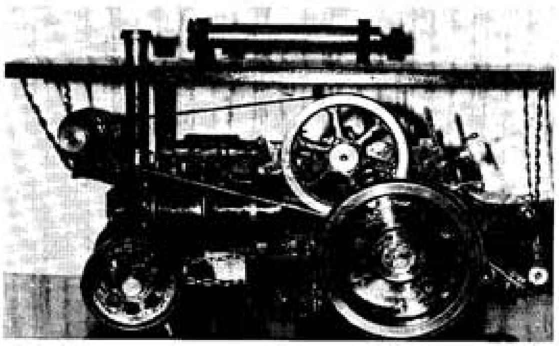
Left: Vertical single-acting engine with horizontal piston valve.

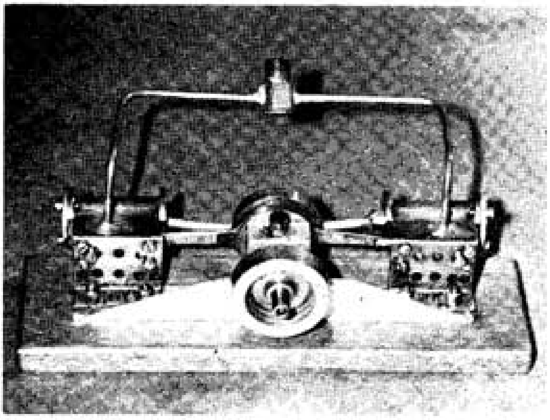
Right: Horizontal mill-type engine.

Below, left: Free-lance traction engine built by Mr Hunt from a fire-extinguisher barrel.

Below, right: Single-acting tandem engine.







Picture No. 1 shows the collection in general, the one in the centre being the largest, about 1½ in. bore, by 2 in. stroke. This engine is built almost entirely from steel, including the cylinder. The mechanical lubricator is driven in a rather novel way by means of a rocking lever driven from an eccentric on the end of the crankshaft. This can be seen quite clearly in picture No. 2. The valve motion is Stephenson link, and very robust. "Built for strength!" says Harold.

In the front right corner of the group in the first picture, there is a rather interesting single acting tandem engine. The big-ends drive on to a common crankshaft, with the two cylinders horizontally opposed. The little engine on the left in the opposite corner is extremely sweet-running: so easy is the action that it will run just by blowing down the exhaust outlet. It has loose eccentric valve gear, and a piston valve which can be seen on the top of the cylinder at right angles to it. Mr Hunt tells me that he has no trouble from rusting, even though he has used steel cylinders. The only essential is thorough lubrication, especially after use before the engines are put away. This of course applies to any steam engine including locomotives. This example of the use of steel or cast iron for cylinders can be quite encouraging to those who may be held up by the expense of bronze or gunmetal for cylinders.

My fourth picture shows a free-lance traction engine built by Harold Hunt from a fire-extinguisher barrel and a large bronze hexagon nut! I say 'free-lance' as some of the parts look like nothing that ever adorned a Burrell or an Allchin!

Nevertheless, the engine was a good exercise in modelling and is a fine example of what can be done by using anything that comes to hand. This engine is spirit fired, has Stephenson valve gear, and a piston valve cylinder which was fashioned from the hexagon nut. The boiler, made from the old fire-extinguisher is 2½ in. dia. and has two tubes of ½ in. bore running through it. While it is admittedly a slow steamer, it steams the engine quite well and she goes at a fair turn of speed. ■

AROUND THE TRADE

New castings

We have just received some samples of castings for our $7\frac{1}{4}$ in. gauge L.M.S. 4-6-0 "Highlander" from Messrs. A. J. Reeves & Co. of 416 Moseley Road, Birmingham, 12.

The castings include driving and coupled wheels with correct shape and number of spokes, bogie and tender wheels, correct type main horns, bogie horns, axleboxes, valve spindle guides, main frame stretchers, bogie centres and stretchers, brake blocks, etc.

The castings are in either cast-iron or gunmetal and are very clean and in good quality alloy.

Some castings are also available for Mr Young's "Rail-motor" 0-4-0's, as can be seen in the illustrations. These castings can be recommended with confidence.

SMOKE RINGS

Continued from page 579

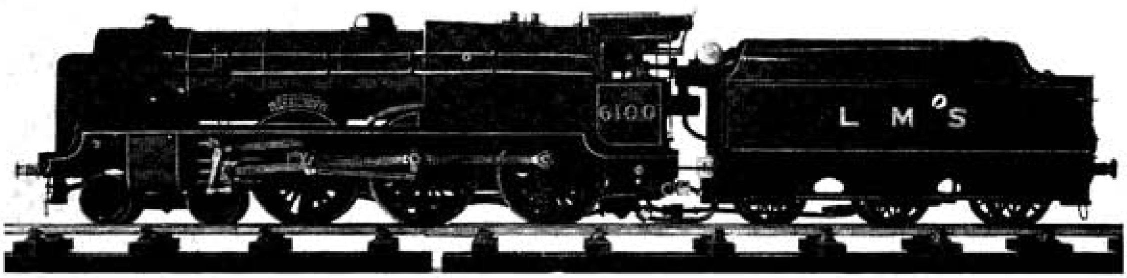
His greatest undertaking was the construction of the first Thames tunnel which was opened in 1843 and is still used by trains between Wapping and Rotherhithe. The Thames tunnel was the first considerable sub-aqueous one and Brunel invented the tunnelling shield to enable the tunnel to be driven. He was a versatile inventor and among the most successful of his ideas were a circular knitting machine and a machine for winding cotton into balls. The blockmaking machinery is to be seen in Gallery 21, first floor, the knitting machine is in Gallery 25, first floor, and a model of the tunnelling shield is in Gallery 9a on the ground floor.

B.R. deficits

Despite all the costs which were to be saved by abandoning parts of the line, and the resultant lucrative sales of redundant property and land, British Railways' deficits have continued to grow, while the system becomes smaller and smaller. The B.R. "modernisation scheme" seems already to have proved a complete failure. The closure of so-called unprofitable lines has now resulted in such comparatively large towns as Galashiels and Hawick being left 40 miles from their nearest railway station, while the roads become increasingly congested by heavy motor car and lorry traffic. Such is progress!

ROYAL SCOT

Martin Evans describes the building of an unusual Gauge "O" high-pressure steam locomotive fitted with a propane-fired boiler



MOST LIVE STEAM enthusiasts regard gauge " O " as too small for much more than the usual simple externally-fired model, with a plain " pot " boiler and methylated spirit firing.

The more adventurous have built high-pressure locomotives for this gauge using a water tube boiler with some form of paraffin burner, and a few have made successful engines fitted with proper coal-fired locomotive boilers.

LBSC's well-known *Sir Morris de Cowley* is a good example of the gauge " O " high-pressure locomotive which can be fired by either coal or paraffin; but having only a slip-eccentric valve gear and being considerably " over-scale," it does not satisfy every owner of a " scenic " railway.

With the advent of small but highly efficient propane burners, I came to the conclusion that this form of firing would be ideal for scale gauge " O " locomotives, especially if the proper locomotive type boiler was required. As Messrs. Severn-Lamb, the Stratford-upon-Avon model makers, had been commissioned to build a high-pressure gauge " O " model of the L.M.S. *Royal Scot*, to be capable of hauling 15 to 16 coaches at speed, I decided to see what could be done about it. The result was illustrated and briefly described in *Model Engineer*, November 15, 1965.

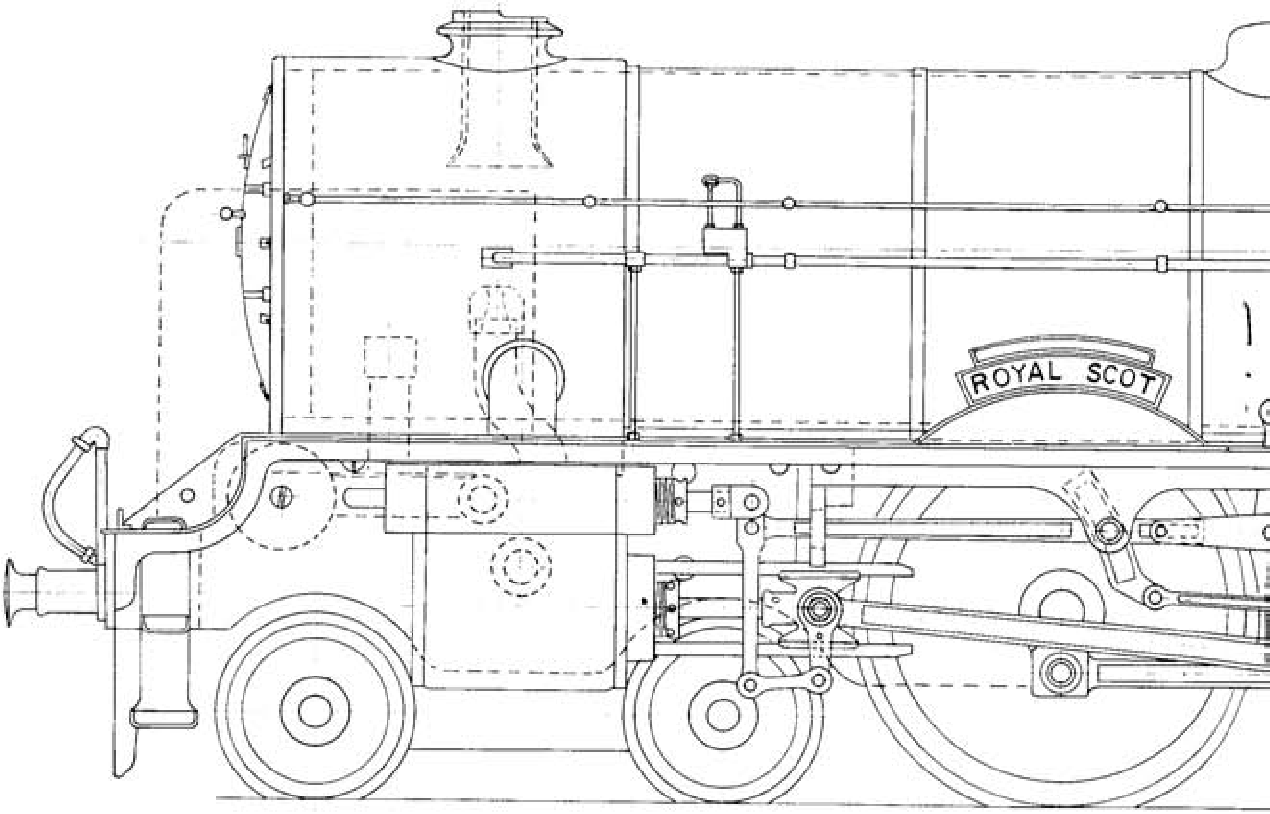
On test, the model proved extremely powerful and speedy, in fact the only limit to its hauling capacity was its ability to grip the rails. Some extra weight in the form of lead ballast would seem to be desirable.

The only real difficulties which arose during the trial period proved to be concerned with the water level in the boiler and over the control of the burner. It was found very difficult to gauge the boiler water level. The boiler was really too small to carry a reliable water gauge and that fitted proved rather awkward to read. For this reason, it is essential that the entire boiler be silver-soldered throughout; the use of soft solder would be fatal, should the boiler be accidentally run dry—an event that can happen very easily with gauge " O " locomotive boilers!

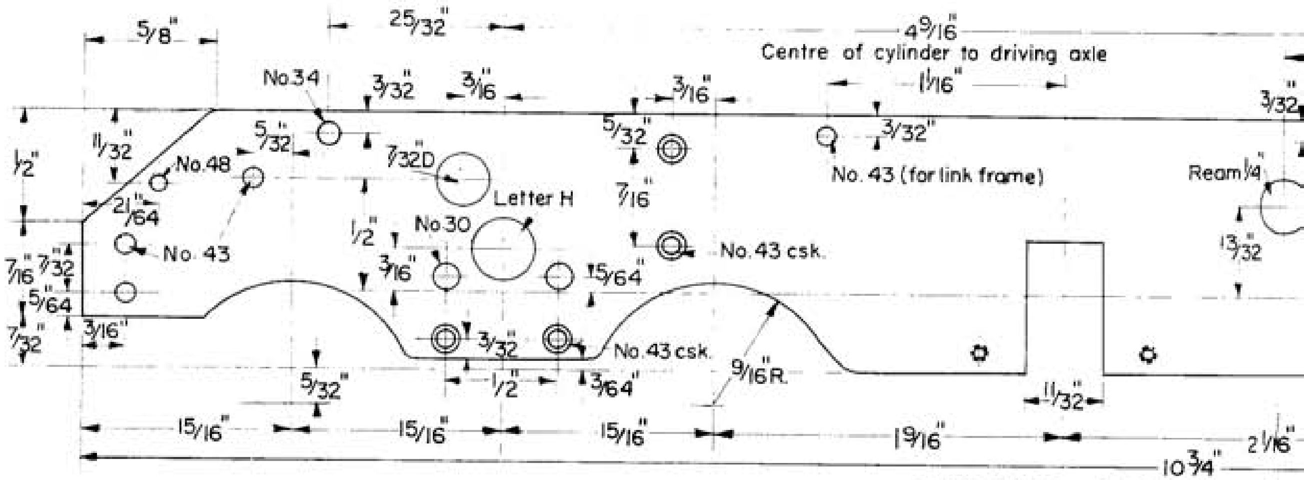
The burner

The design of the propane burner caused the only real trouble. The difficulty was in providing enough air in the very narrow firebox to ensure the gas burning properly. In the event, it was found that the burner functioned best if the blower was left very slightly open for the whole time the locomotive was working. This prevented " blow-backs " if the engine was stopped rather suddenly for any reason.

During the steam-raising operation, it was found that the burner was rather sensitive to the intensity of the auxiliary blower. If this was too strong, the flame would be " pulled off " the burner and would then go out. If too weak, the flames would tend to play outside the firebox and lick the driving and coupled wheels, with disastrous effects on the paintwork. Eventually, an auxiliary blower was built, incorporating a small 6 volt electric motor



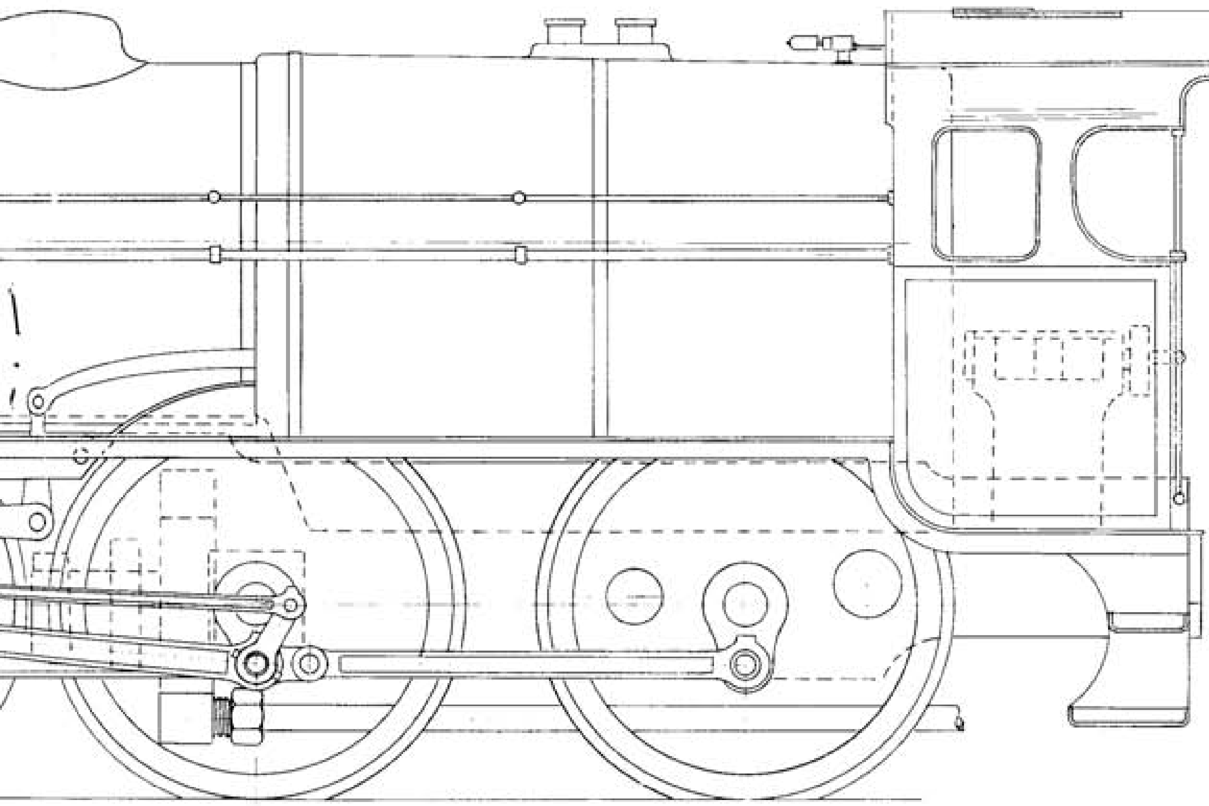
GENERAL ARRANGEMENT OF T



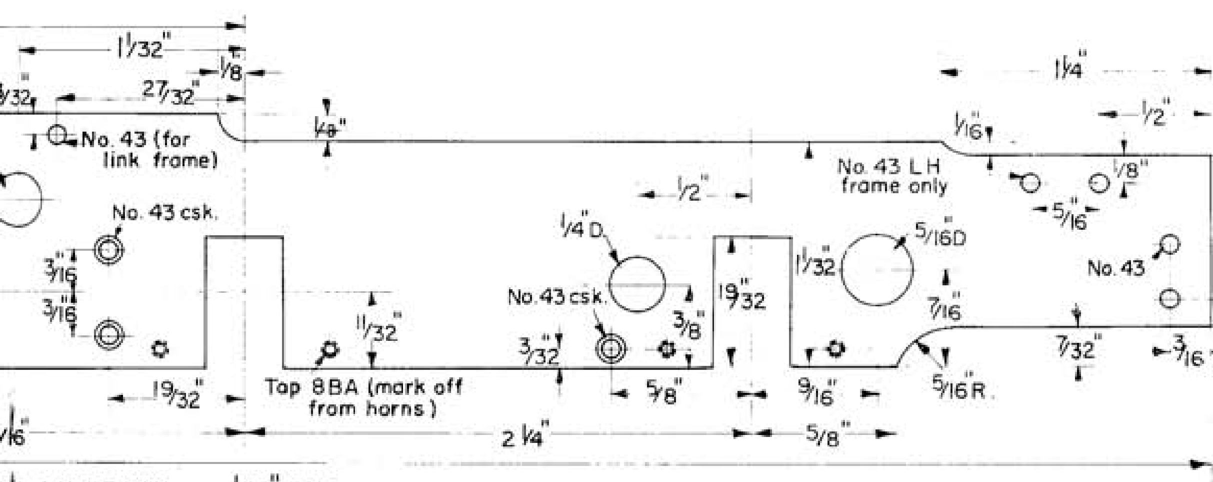
MAINFRAME 2 OFF 1LH 1RH

driven from dry batteries with a variable rheostat incorporated, so that the intensity of the air-stream could be exactly controlled.

Another interesting feature of this *Royal Scot* is the valve gear, which is a correct version of the Walschaerts with proper lap and lead functions, though it is of the outside-admission type as the cylinders have slide valves. The various parts of the valve gear are made almost to scale size, except that the joints and bearings are oversize, to give



THE GAUGE "O" LOCOMOTIVE



longer service without re-bushing, etc.

An axle-driven pump is fitted, with a by-pass arrangement. Lubrication is by displacement lubricator between the frames.

The boiler, which is superheated, has seven tubes of only 7/32 in. outside diameter; with propane firing, there is very little danger of small tubes becoming blocked by soot or other deposits.

I am sure that many readers who are gauge "O" live steam enthusiasts would like to try their hand at building one of these high-pressure propane-fired locomotives, and through the kind permission of Messrs. Severn-Lamb Ltd., I am able to reproduce the working drawings of the original model in *Model Engineer*.

Construction

The main frames for *Royal Scot* are certainly a quick job after *Nigel Gresley*. An evening's work should see them cut out, cleaned up to size and all holes drilled. My drawing shows the frames arranged for fully sprung driving and coupled axles, which are much to be preferred.

Two 10$\frac{3}{4}$ in. lengths of $\frac{1}{16}$ in. bright mild steel are required, 15/32 in. wide. Let us take a look at the various holes required. Reading the drawing from left to right, first we have two No. 43 holes for the attachment of the front buffer beam. The No. 48 hole just above and to the rear is the "lifting" hole. Then we have another No. 43 just ahead of the front bogie wheel which is for the attachment of the displacement lubricator.

To support the smokebox, a 6 BA screw is used, through the No. 34 hole above the leading bogie wheel and further to the right we come to the cylinder fixings; two 5 BA's are used here, through the two No. 30 holes, while the 7/32 in. dia. hole and the letter H hole are for the steam and exhaust pipes respectively. Below the cylinder we have two No. 43 countersunk holes, for the bogie pin stretcher.

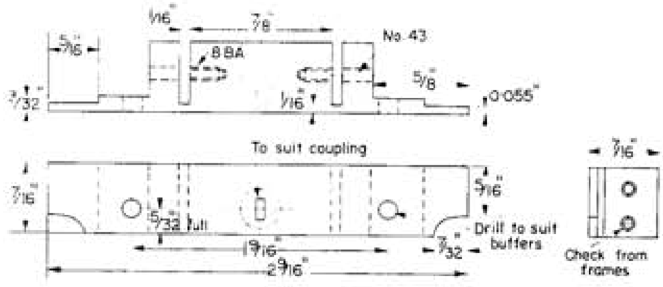
Moving further to the right, there are two more No. 43 countersunk holes, one above the other, just ahead of the rear bogie wheel; these are to take the frame stretcher "A." To support the valve gear frame, there are two No. 43's near the top edge of the frame, one is 1$\frac{1}{16}$ in. ahead of the leading coupled axle and the other 27/32 in. ahead of the driving axle.

For the weighshaft bush, we have a $\frac{1}{4}$ in. dia. hole, 1 1/32 in. ahead of the driving axle, and just to the right of this there are two No. 43 countersunk holes for the pump stretcher. A plain round frame stretcher is situated just ahead of the trailing coupled axle and on each side of this axle, there are two large holes, one $\frac{1}{4}$ in. dia. and one $\frac{5}{16}$ in. dia., provided to allow for better air circulation around the burner.

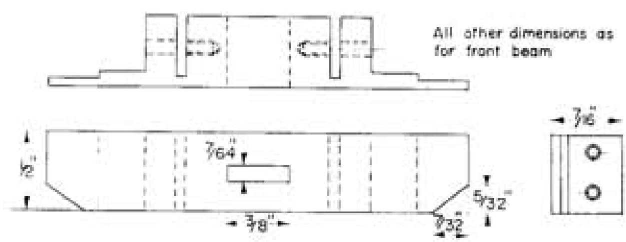
To provide a fixing for the reversing gear stand, there are two No. 43's near the top edge of the frame further to the right (on one frame plate only), and finally there are two more No. 43 holes for the attachment of the drag beam.

Buffer and drag beams

The buffer beam is made from $\frac{7}{16}$ in. square brass bar. It is hardly worth the trouble of making



FRONT BUFFER BEAM
1 OFF BRASS



DRAG BEAM
1 OFF BRASS

a pattern and obtaining a casting in this size, as the slots for the frames can be milled out quite quickly in the lathe, using a $\frac{1}{16}$ in. face cutter about 2 in. dia.

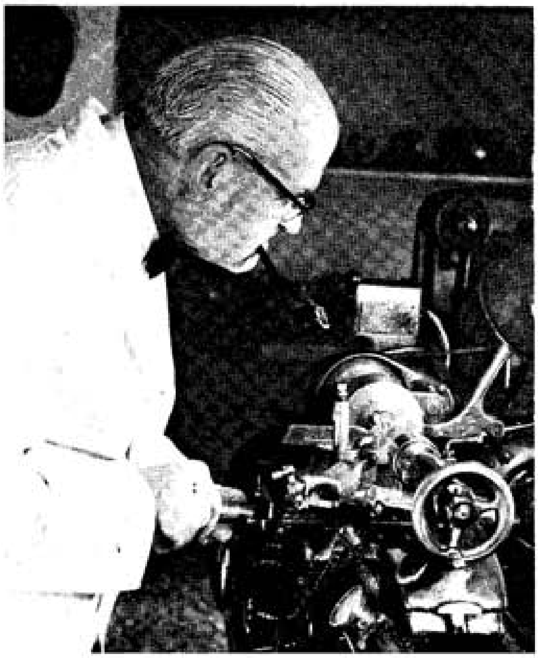
Mark out and drill the holes for the buffers, according to the type to be used. There are some quite good gauge "O" spring buffers on the market, but if the builder intends to make them, drill these holes 5/32 in. dia. In the centre, where the coupling slot is to be situated, drill no 55, right through the bar; turn the bar round, and open out this hole to $\frac{1}{8}$ in. diameter, it will then be quite easy to finish the coupling slot by using a metal fretsaw. Finally mill, or saw and file the ends of the buffer beam as shown in the drawing.

The drag beam is similar to the buffer beam, but is $\frac{1}{2}$ in. deep, so use $\frac{1}{2}$ in. square brass and mill or file to $\frac{7}{16}$ in. wide. The coupling slot can be cut right through this time, starting by drilling a row of holes about No. 37 size.

To be continued.

A Dartmoor Discovery

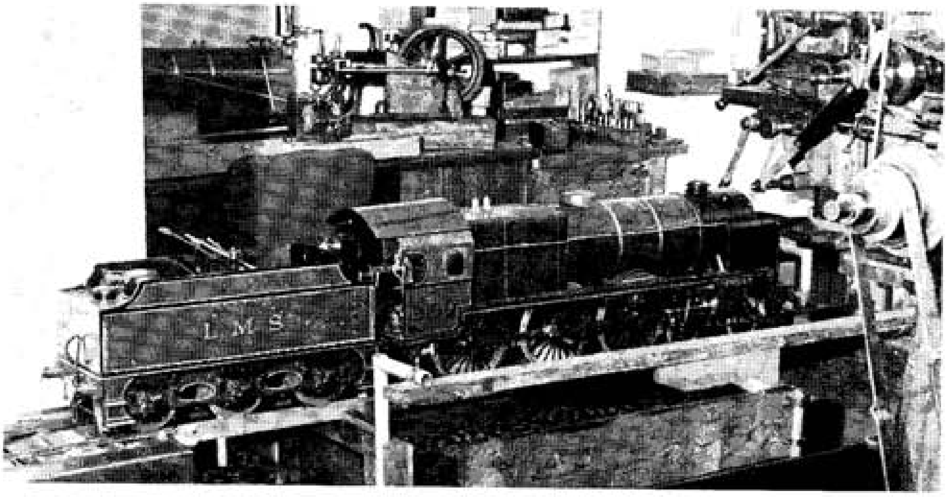
by Charles Herbert


At work on the South Bend lathe.

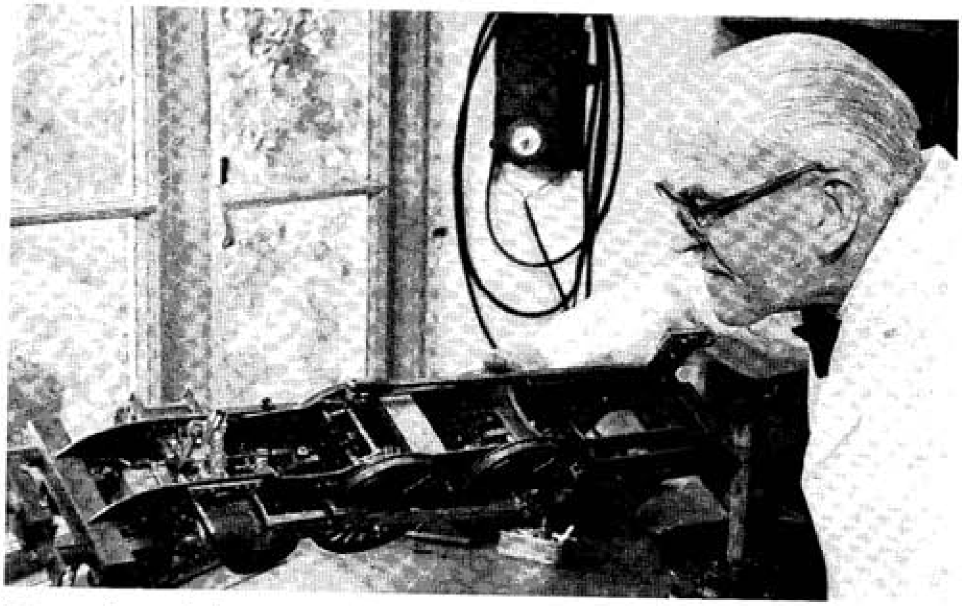
OUR FOUNDER, Percival Marshall, some years ago referred to the "Hermit model engineer"—one isolated, and practising his craft away from his fellows. I have been fortunate, I think, in discovering one of these living in the heart of Devon, perhaps in too much isolation for my personal taste, but nevertheless in an enviable position for carrying out modelling work creditable in the eyes of the few who see it.

His workshop (although he insists that it is a Studio) is a large south-facing ground-floor room, well lit as the photographs show, and equipped with two lathes—South Bend and Lorch—a vertical Boley and also a Van Norman horizontal miller, Tauco drill, mandrel press, bending rolls (of Martin Evans design but longer), Diacro shears, linishor, band-saw and hack-saw machines, a home-built compressor and, not least, oxy-acetylene plant. An almost complete library of 'M.E.' volumes and handbooks line two of the walls of his 'Studio.' Enough there to keep anyone happy, and he certainly is, although the need for a 50 miles round trip to go shopping is a big disadvantage if his stock runs low or, perish the thought, he breaks a drill!

Elderly, he was forced to retire a few years ago from his active life as a company director by cerebral trouble, and on medical advice—which luckily harmonised exactly with his own inclinations—he has gradually benefited from the therapy drawn from the practice of manual exercise, and I was impressed by the standard of work that he has so far achieved. True, he spends more time looking at a piece of material before working on it than most of us, and his wife finds him often in what he calls 'a state of cogitation'; consequently his output is very low. Even so, he has quite a good show of engineering models to his credit, some of which he has made entirely, some reconditioned to exhibition standards and his range of interest, whilst predominantly in steam, extends



One of the completed models, a $3\frac{1}{2}$ in. gauge L.M.S. "Royal Scot" 4-6-0.



Now under construction, a 3½ in. gauge L.N.E.R. "Atlantic," which is being built from full-size drawings and photographs.

to gas engines and dynamos as well. He delightedly showed me these, pointing out how he had preserved the turn-of-the-century features such as commutators made from brass tube, segmented and pinned to boxwood hubs, wipe contact breakers of weird design and the hand operated distribution gear of a horizontal steam donkey pump which once graced the Wellcome collection.

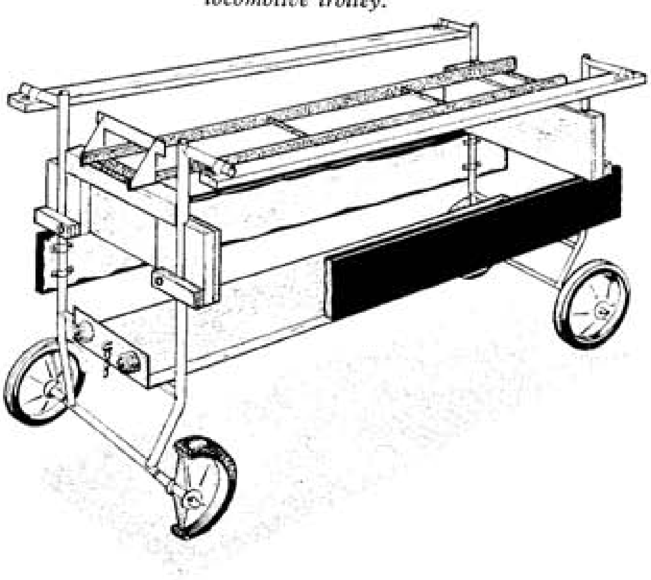
He has two completed ¾ in. scale locomotives—Bond's *Royal Scot* with a 'Curly' designed boiler which gained for him an award at the M.E. Exhibition over 30 years ago and Reeves' six-coupled tank, which he demonstrated on his outdoor track and which started and pulled with the merest suspicion of wheel-slip a load of seven adults. Currently, he is engaged on building an Atlantic direct from almost indecipherable full-size L.N.E.R. drawings and two faded photographs, the frames being cut to a sketch from the late H. P. Jackson in 1939. Unfortunately, since then, all Jackson's patterns and sketches for this locomotive have been destroyed, and detailed information is no longer available; although he believes that someone else made a start at the same time on a similar model his efforts to trace this modeller have been fruitless.

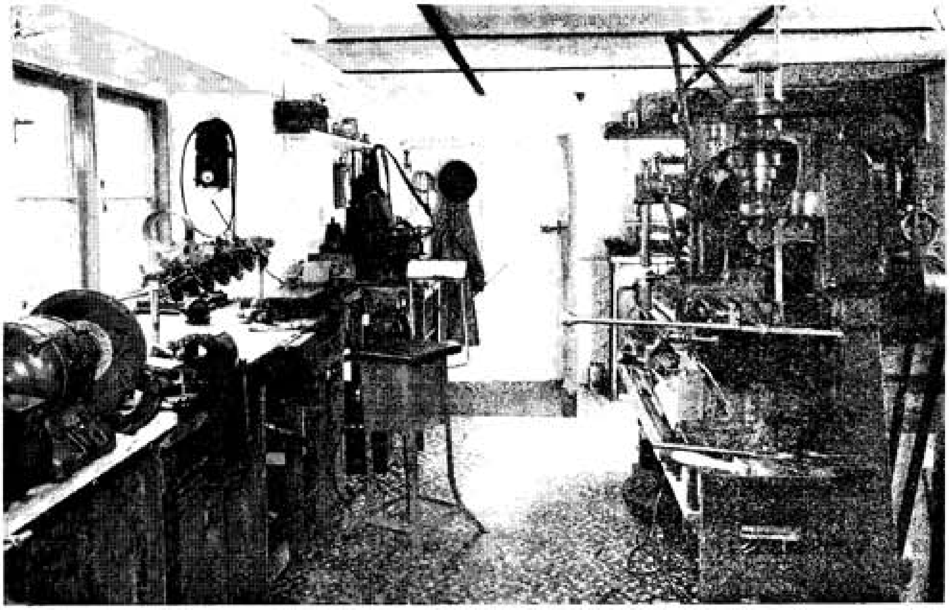
From what I learned during my time with him it was clear that he had not been trained in the mechanical arts, but had been keenly interested from his early childhood days. He has a vivid recollection of the time when his youthful curiosity impelled him to touch the electrolyte in one of the cells of his father's domestic lighting plant, whereby he lost a fingernail—now well over 60 years ago. With business activities absorbing all his time, a resumption of practical work is of comparatively recent date, as I have said.

Three things especially in his 'studio' are worthy of note, and he has willingly agreed that I should refer to them in this article.

As I have mentioned, he is elderly, and he finds heavy lifting beyond him; faced with the problem of running his 'Scot,' he has overcome this in what, I think, is an ingenious way. After carefully considering the various designs of passenger trollies that have been described over the years in the

A sketch of the ingenious combined passenger car and locomotive trolley.

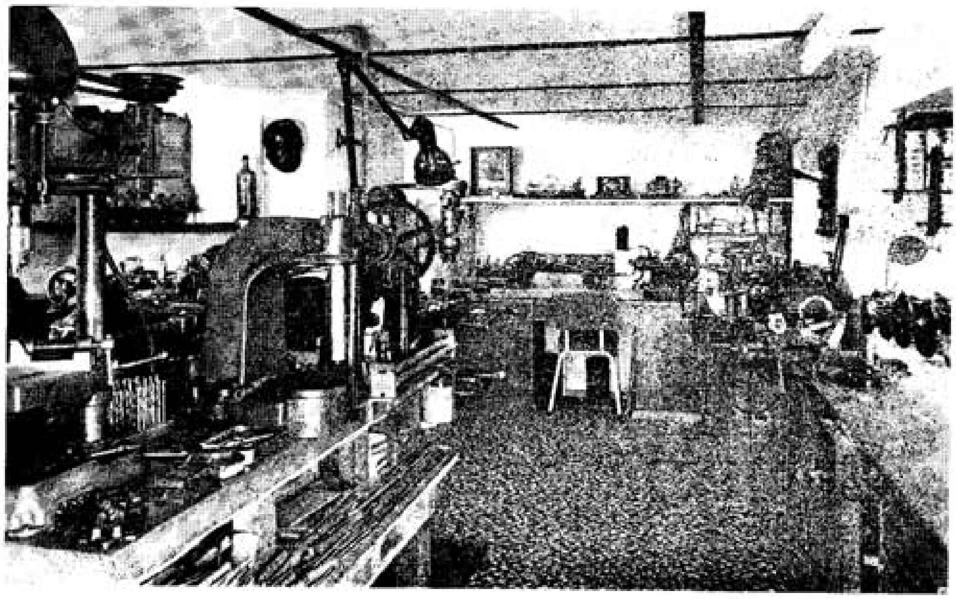




A view of the Dartmoor workshop. Assembly bench with vice and grinder on left. Note the locomotive on the erecting stand.

M.E., he concluded that LBSC's ideas were the ones to follow, but instead of bending the one-piece hand-grips and stirrups, he brazed a cross tube to each of the verticals, making handle-bars, through each of which passes a $\frac{3}{8}$ in. shaft carrying a 9 in. dia. rubber tyred wheel at either end, the wheels being retained by close-fitting split pins. Thus, when the car is turned upside down the wheels make it into a trolley, with the underneaths of the running or foot boards uppermost. Across these is a transverse wooden bearer at each end, located in position by simple wooden buttons, supporting a length of flat iron track on which the coupled locomotive and tender stands at a height matching the outdoor rails.

He merely trundles this outfit to his track (elevated 2 ft. above ground level) where he has a detachable section about 6 ft. long and, butting the ends of the flat iron track against the corresponding rails, the locomotive and tender can be gently pushed on to the running section. Whilst steam is being raised (the electric suction fan and fire 'makings' are stored between the trolley bogies) the 'viaduct' is refitted, the trolley is put right



Another view of the workshop. Drilling machine and mandrel press on the left. Some finished models at the far end.

way up on the rails and the wheels withdrawn from the "handle-bars." After the run the procedure is reversed and, in fact, this trolley arrangement is wonderfully useful for allowing ready access for cleaning the firebox and for facilitating any mechanical attention that might be needed—and within the comfort of his Studio.

Assembly stand

The second thing that intrigued me was his method of coping with the construction of his L.N.E.R. Atlantic. This will be a heavy model when completed (and as I saw the chassis recently it seems a pity that so much fine detail work on such engines is completely hidden from sight when the external trappings are fitted). However, he has contrived, out of a pair of motor frame ends and some conduit fittings, two stands which support the chassis clear of the erecting bench by clamps on the buffer and drag beams respectively. These clamps can rotate horizontally in their housings (conduit tee fittings) and may be locked by thumbscrews at any angle, thus making it possible to work on any part of the chassis with ease. Bearing in mind the ultimate height of the engine when the boiler and cab are fitted, he has arranged that the stems of the clamps can be raised within their motor frame ends to ensure adequate bench clearance at that time.

Lathe additions

Finally, a simple addition which he has fitted to the South Bend. This is a D.T.I. (Herculette with 0.500 in. spindle travel) mounted on a frame sliding on the front shear of the lathe bed and which can be clamped to register saddle movements up to the ½ in. (or, indeed, any longitudinal measures within the free extent of the lathe bed by repeat movement or by the use of standard distance pieces). This gives a clear indication, within very fine limits of accuracy, of the length of cut being taken and, in conjunction with a saddle stop, facilitates greatly the achievement of that accuracy which is the constant aim of the careful worker.

The general tidiness of this studio-workshop is maintained by the habit of immediately replacing tools after using them, and his machine tools are all brushed down—an old-fashioned long shaving brush for the lathes—at the close of the day's operations and, like his models, kept under individual covers. Coping with the miscellaneous stock of small materials necessary for our hobby is always a problem; he uses both large and small square-sided baking tins, segregrating sheet from bar and then allotting separate tins for the various ferrous and non-ferrous pieces. These tins range up to 15 in. long; lengths in excess of this are held vertically in simple racks.

The level concrete floor is covered with vynyl, and when I expressed surprise at the dull mosaic pattern he pointed out that when anything small was accidently dropped on to the floor it meant that he would have to sweep over a fair area in order to find it, thus maintaining a reasonably clean surface!

The ceiling is of polystyrene sheet, battened, giving a good light reflection in the day-time; the bench is lit by the long fluorescent tube and all the machines on the lathe bench, and the Boley miller, are served by one adjustable Mek-Elex standard; another Mek-Elex is mounted on the base of the horizontal miller, and this can be swung to illuminate either the grinder or the Diacro.

So far as grinding is concerned, I enquired how he dealt with his milling cutters. At one time he used a Dumore tool-post grinder in the lathe—a common practice with most of us, but one which is abhorrent firstly from the grave hazard to the machine from the fine abrasive dust and, secondly, from the awful mess to be cleared up when water is used to minimise this risk. Now he uses one of Tillbrook's grinding jigs. This, admittedly, takes a little while to set up, using a cup-wheel on the bench grinder, and his practice is to devote one day every so often to sharpening all cutters and end-mills, then continuing with drills. There are six sets of the latter, including those most useful straight-flute drills, and a Reliance jig is fully occupied down to about $\frac{1}{16}$ in. size; below that, he hand-hones. Dies and taps are, however, still sharpened with the lathe tool-post grinder.

I found my visit to this "hermit" far too short indeed but much more rewarding than I could have expected, and his infectious enthusiasm for our hobby enabled me to depart with a set of photographs and the assurance of his pleasure if any of his ideas should interest others. He has, however, insisted on anonymity, so if readers wish to find him, they must hunt him out themselves! ▣

DRAWINGS FOR *SIMPLEX*

L.O.935

Sheet 1. General arrangement, frames, etc.
" 2. Feed pump, wheels, cylinders.
" 3. Walschaerts valve gear.
" 4. The boiler.
" 5. Superheater, regulator, grate.
" 6. Running boards, cab, side tanks.

All sheets are 6s. 6d. each plus postage, complete set **35s. od.** post free.

BOURDON'S STEAM ENGINE

by A. W. Neal

DURING THE 19TH CENTURY there arose a whole host of inventors, most of whom concerned themselves with mechanical contrivances, in particular those connected with steam. Many of these inventions of that bygone era still linger in this electronic age, and some are still thriving because no one has come forward with a better idea. Others are now but museum pieces.

Monsieur Bourdon belongs to this past period. He is the man of the Bourdon tube and his invention is still paramount in one respect and completely out of date in another.

Anyone that has the least connection with fluid pressure measurement will have come across his gauge. This delightfully simple device relies for its action upon the tendency which a curved, partially flattened tube has to straighten itself when subjected to internal pressure. Nowadays this "sensitive" element is of oval section and bent to the form of a circular arc of about 270 deg. It is closed at one end—the tip—and to the other is attached a boss to which the pressure is applied. The tip is connected to an amplifying linkage, followed by gearing to an indicating pointer. When greater tip movement is needed the tube is formed into the helix of a few turns, or it takes the form of a spiral. The preference for this kind of gauge, the principle of which is now more than 100 years old, over other sorts of industrial measurement seems to be explained by its relative cheapness and reliability. Such gauges have been known to have been in use continuously for over 50 years, at the end of which period their accuracy has been little impaired.

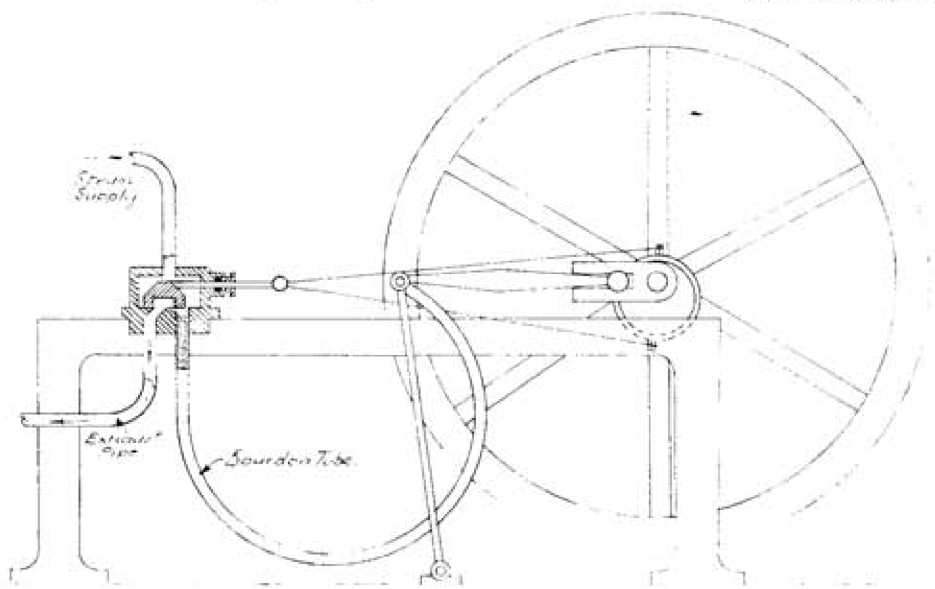
When Bourden took out his British Patent in 1852, he was careful enough to include in his specification an indicator, working on the same principle, to draw a diagram of what was happening inside the cylinder of a steam engine when moving. But this did not stand the test of time; and along came Crosby's and Thompson's instruments for the same purpose, presumably with better results, and Bourdon's instrument assumed a back seat.

Bourdon was also quick to see that his tube idea could be applied to temperature measurement, and he mentioned this in his patent papers. It comprised a twisted tube, one end of which was fixed and the other free to move. When the tube was subjected to temperature changes, the tube untwisted accordingly and a pointer attached to the free end moved across a scale. This idea is still in use.

But his final claim was most peculiar, if not fantastic, and one that will appeal to all steam enthusiasts of today. It indicates how his versatile brain worked and the extent of his business acumen.

It related to a reciprocating steam engine with a fly-wheel, crank, eccentric and steam-chest, and from a casual glance it looked like any other horizontal engine of the period. But it required neither a cylinder nor a piston. In this the small end of the connecting rod was pivoted to one end of

Continued on page 614



A sketch of Bourdon's peculiar steam engine. No governor is shown.

Making Chime Whistles

by D. A. Gulliver-Brown

MR CODLING OF Ormskirk appealed for details of a Gresley Chime whistle for a 3½ in. gauge A4 Pacific. Like him, I am building a model of the class, but in 5 in. gauge. Since, as I shall explain, it is impossible to scale down the whistle without losing the authentic Gresley chime, the constructional details are identical for all gauges.

A visual examination of the whistle reveals that it has three voice slots mounted within one tube. From the beginning of the design I have considered that this would lead to unnecessary complications in the miniature version and would produce rather a bulky affair with problems in mounting it between the engine frames. The natural evolution is three separate organ pipes, each of which can be tuned individually.

For anyone wishing to copy a specific chime whistle such as installed on a Gresley or Riddles Pacific, or on one of the private companies' locomotives, the first starting point must be to determine the chord formation and pitch of the notes produced. A musical ear, recordings and a piano are helpful here and these reveal that the Gresley whistle is a minor chord starting an octave above middle C and comprising the notes C', F' and Ab', as on the following page.

A *slight* variation in overall pitch of this chord may arise due to the sharpening of the pitch of some pianos (i.e. taking a baseline as A = 440 c.p.s., which is normal practice nowadays in all concert instruments). These variations are small however, although the purist may care to tune his whistle half a semitone higher! As the whistle warms up, too, the pitch will become sharper.

Having established the chord form it is straightforward to calculate the theoretical voice length of the whistle. The length of a stopped (or closed) organ pipe is equal to one quarter of the wavelength of the sound it produces. The wavelength is related to the speed of sound in air (1,100 ft./sec.) and to the frequency of vibration of the sound, as follows:

$$\text{wavelength} = \frac{\text{velocity}}{\text{frequency}}$$

Using the frequencies of the notes concerned this equation gives us the theoretical voice lengths of the whistles which we want, according to the following table.

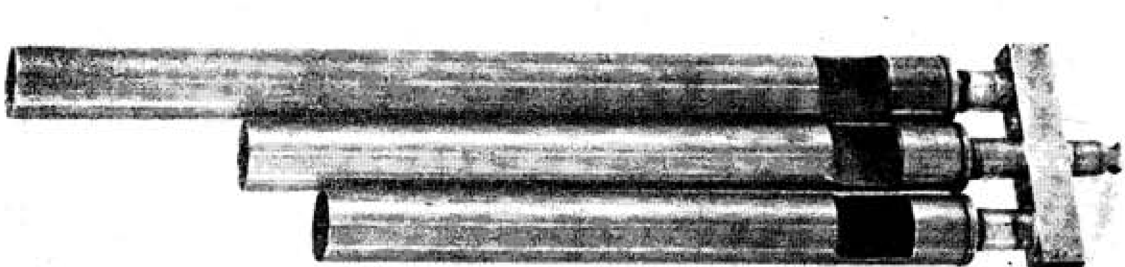
Note	Frequency	Wavelength	Voice Length
C	512	25.8 in.	6.45 in.
F	691	19.1 in.	4.78 in.
Ab	820	16.1 in.	4.03 in.

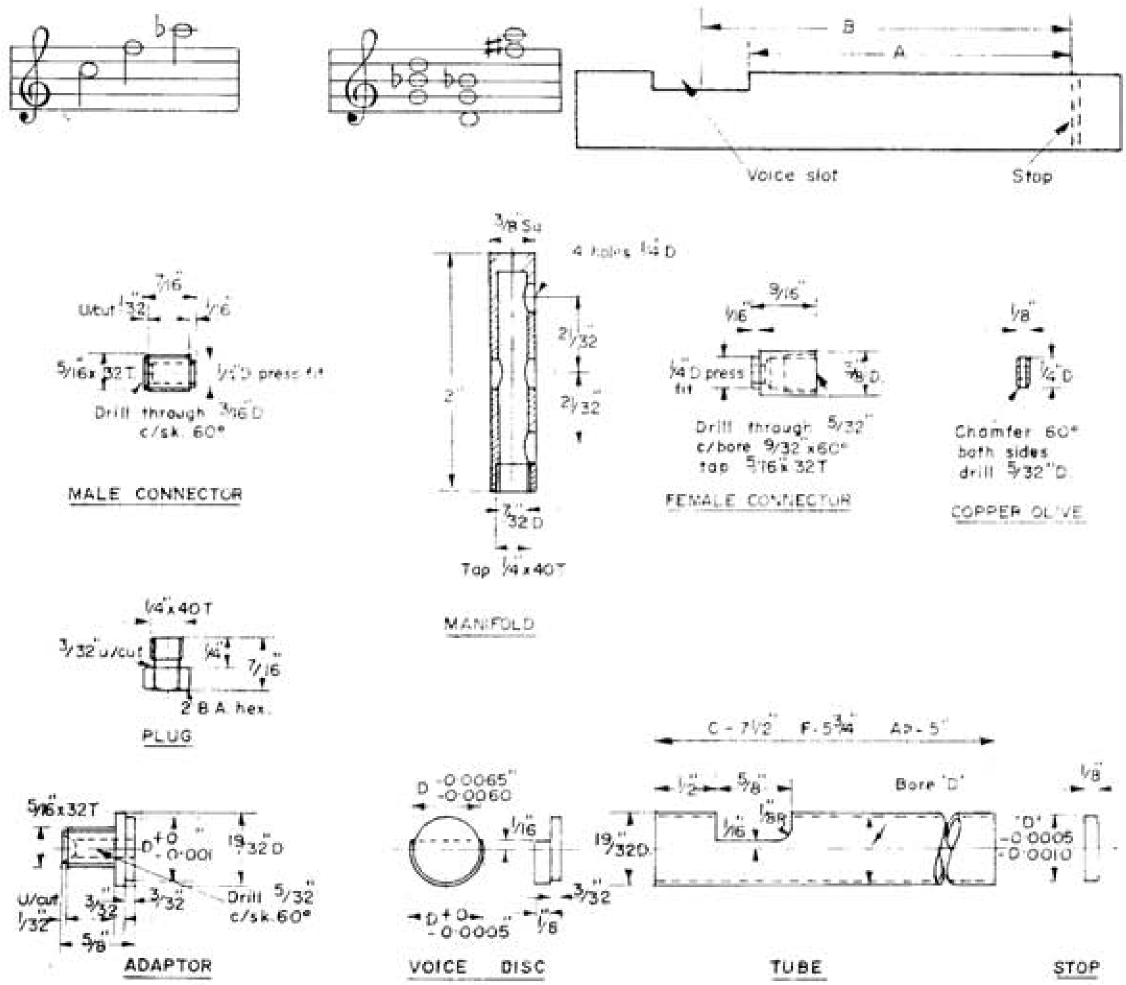
Consider now the shape of a whistle tube. The theoretical voice length A is slightly less than the actual voice length B. This is because steam blowing across the mouth of the voice slot causes the maximum amount of air disturbance a little distance from the edge and this means that one quarter of a wavelength corresponds to a length such as B which can be found only by trial and error.

It is important to note that the stop forms an essential part of the whistle and should be soldered in place to form an air-tight seal.

We now come to the essential details of construction and here it is important to stress that steam should be led to the whistle through ample passages so that the whole pressure drop is available at the voice slot for producing sound and any

A finished chime whistle made for a 5 in. gauge L.N.E.R. " A-4."





tendency for the whistle to be "wheesy" can be avoided.

Starting with the manifold, chuck a length of ⅜ in. square brass rod in the four-jaw, face the end, centre, drill to 1⅞ in. depth with a 7/32 in. drill and tap ¼ in. × 40 t.p.i. Part off to 2 in. long. Scribe a centre line along one face, mark off three points at 21/32 in. centres; drill each position ¼ in., carrying the middle hole right through the block. Remove all drilling burrs. The manifold is fitted with one male and three female connectors which can all be made from ⅜ in. brass round bar. To make the male end, face the rod, turn just over ⅝ in. to 5/16 in. dia. and reduce the first 1/16 in. to a push fit in one of the manifold holes. Screw 5/16 in. × 32 t.p.i. and undercut the left-hand end of the thread for 1/32 in. I find that this treatment to small union fittings avoids subsequent damage to threads and makes them fit more easily. Centre the adaptor and drill 3/16 in. dia. Part off to length. Reverse in the chuck and taking care not to damage the threads, centre with a Slocombe centre drill until an edge is formed at the end of the adaptor. Don't forget to check that the first thread is undamaged. Turning now to the three female adaptors, centre the bar, drill through ⅝ in. deep with a 5/32 in. drill. Then drill 1/16 in. deep with a 9/32 in. drill with the point ground to 60 deg. Follow this with a 5/16 in. × 32 t.p.i. tap. Take a skim over the outside of the bar and part off to 9/16 in. long. Reverse in the chuck and turn the end 1/16 in. as before to a press fit in the manifold.

The five parts of the manifold are assembled by silver soldering. When preparing for this, I prefer to rub the flat faces of the ⅜ in. square bar on a smooth file held in the vice. This removes any corrosion from an otherwise unmachined surface and makes sure of a perfect joint. Mix a little

"Easyflo" flux with water and press the adaptors into the manifold with flux paste in the joints. Heat the whole lot to a dull red and solder should flash round the joints. If the unit is plunged into cold water as soon as the solder has set, the flux and black film of oxide will come away leaving a clean job.

Three copper olives are next required to allow the individual organ pipes to be tightened up facing the same way. The olives can be turned from copper rod and then heated to cherry red and plunged into cold water to anneal them.

The tapped end of the manifold is filled with a hexagon headed plug. The appearance of such small parts as these is made or marred by a nice chamfer on the exposed end. I always keep a radius chamfering tool in the four-way turret of my lathe. Note the undercut of the thread on this part. If this is made with a parting tool before cutting the thread, no trouble will be experienced with the plug leaking steam.

Each of the whistle tubes is carried by an adaptor. Machining of these parts is generally similar to the previous screwed components, except that the screwed end should be turned and drilled first. This can then be held in the chuck and the large diameter turned to a neat fit in the whistle tube. A few seconds spent taking the burrs off in the lathe are well rewarded.

I mentioned the diameter of the whistle tube and here a choice of material is available. Traditional in model engineering for this purpose is brass treblet tubing but the new thin walled copper tubing used by plumbers is probably easier to obtain and is just as satisfactory. I used pieces of $\frac{1}{2}$ in. nominal bore tubing of this type, which has an outside diameter of $\frac{19}{32}$ in. and a bore (D) of about 0.540 in., but individual samples may vary. The older type of central heating tubing with a thicker wall should not be used.

The drawing of the three organ pipes shows a sufficient length in each case to allow for tuning. It is important to avoid distorting the tubes by squeezing in chuck or vice. This would make voicing and tuning impossible. After facing the tubes to length, carefully cut out the voice slot with a small hacksaw and $\frac{1}{4}$ in. round file. The surfaces of the slot should be smooth and the corners sharp. In all this work uniformity will ensure three notes of equal quality which will give the same amount of sound.

The voice disc is the most critical part of the design. The type described effectively regulates the amount of steam passing over the voice slot, since it has an orifice of only 0.0015 sq. in. (equivalent to an 0.050 in. dia. hole). Face the end of a piece of $\frac{5}{8}$ in. brass bar and turn down just over $\frac{1}{4}$ in. to a light push fit in a whistle tube. Move the cross-slide in exactly 0.003 in, and turn a step $\frac{3}{32}$ in. long which will be 0.006 in. smaller than the tube bore. Partly part-off from the back toolpost without disturbing the first tool. Then clean off the burrs formed by the last two operations using the original tool setting. Leaving the edges clean but sharp, finish parting off and repeat for the other two tubes. Next hold the disc by the reduced diameter in soft vice-jaws. Cut away the unwanted section of the full diameter portion with a small hacksaw and finish with a file. Carefully remove the burrs.

Assembly

Assembly of the whistles can now be carried out by soft soldering. Push a voice disc into the tube until it *just* shows by a few thou in the voice slot. Keeping the large diameter in contact with the tube by means of a file tang or old scriber, heat the assembly with a small blowlamp and run resin cored solder into the joint. It is important not to seal off the 0.003 in. annular gap opposite the voice slot and this third of the tube should not come into contact with the flux. The adaptor can then be sweated on to the end of the tube, remembering that it may have to be unsoldered if a small adjustment of the voice disc position is found to be necessary.

The annular gap of 0.003 in. has been arrived at by experiment. I have tried a range of sizes up to 0.015 in. and would settle on the one stated for reasonable steam economy and performance at 80 p.s.i.g.

In order to tune a tube, a stop is necessary. This should be made a light push fit in the tube and if a turning pip is left on it, this can be gripped by small pliers to vary the length of the tube while tuning. I used a foot pump to supply short blasts of air for tuning each tube. Comparing it with the sound of a piano the correct position for the stop can easily be found by a musical ear (so any budding violinists, guitarists or other virtuosi in the family may find their use in model engineering!)

When all three tubes have been tuned satisfactorily, the stops can be soldered into the tubes and the three units screwed home in the manifold with the soft copper olives taking up any necessary amount of compression. Mounting the whistle under the frames should be straight forward, but it is preferable to clamp the manifold rather than the tubes to allow the latter to resonate freely.

Finally a note about other chime whistles. Some of the A4 class named after Commonwealth countries had a deeper chime. The first two chords overleaf show what I believe to be correct. The third chord is that found in the two note chime of Mr Riddles' Pacifics. ▣

A BORING AND FACING HEAD FOR THE LATHE

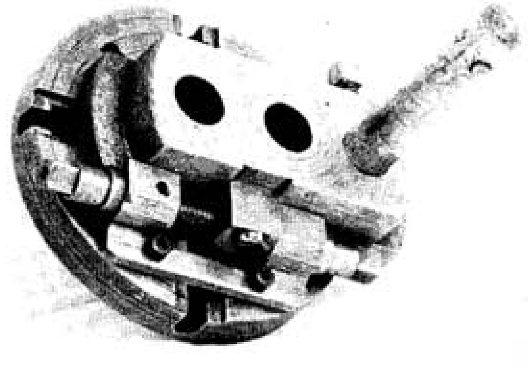


Fig. 1: *The boring and facing head built by the author.*

by 'Base Circle'

YOUR OLDER or should I say your elderly readers may possible remember an advertisement which used to appear regularly in the *Model Engineer* from about 1911 onwards. The illustration showed front and rear views of a four-jaw independent chuck. The advertiser, Arthur Firth of Cleckheaton, offered to supply sets of material to make up these chucks at from 4s. for the 4 in. model to 7s. for the 8 in. model. How prices have changed!

The writer, having acquired a 3½ in. Drummond flat-bed lathe shortly after the first world war and only having a self-centring chuck, purchased a set of materials for a 5 in. model. When finished the result was quite a useful tool. It was slightly slower in operation than the orthodox type but it did a lot of good work for many years until it was eventually superseded by a 6 in. Burnerd.

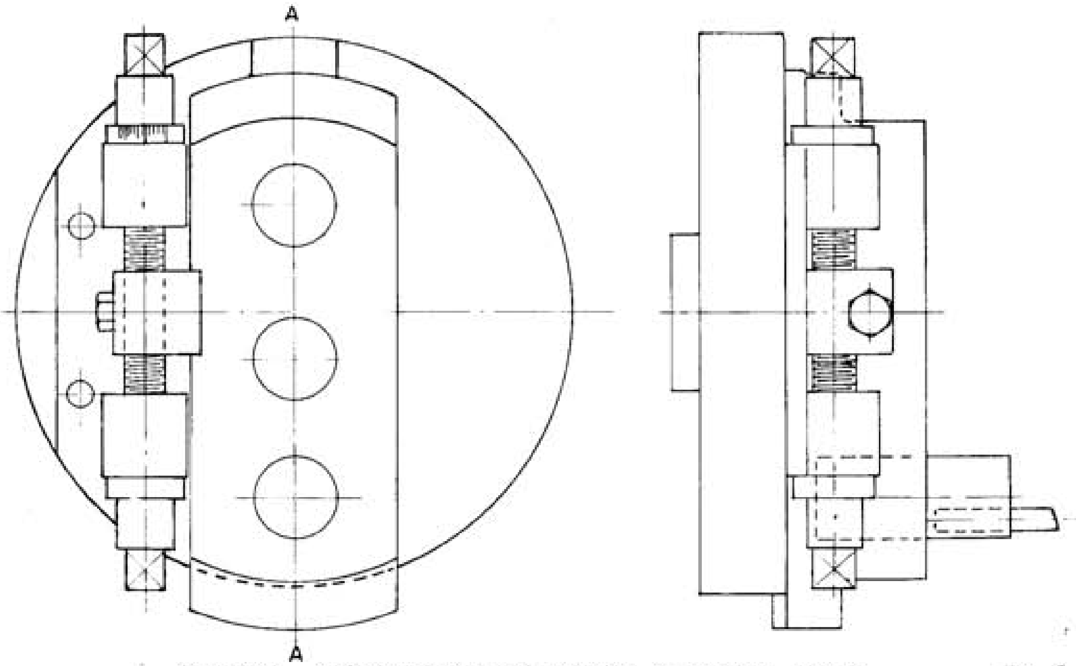
Many years later after a considerable amount of equipment of various kinds—boring bars, steadies, angle plates, a vertical-slide, etc.—some of which have been described in the M.E. in past years—it was felt that what was needed next was a means of carrying boring bars on the headstock which would provide for precision adjustment of the bore diameters and would also facilitate facing operations on parts mounted on the lathe boring table.

A search round the workshop for suitable material was, of course, the first step towards meeting this requirement. The old 5 in. chuck was unearthed and it was immediately apparent that it would lend itself admirably to conversion to the body for the proposed boring head. The fact that it was screwed and fitted to the lathe mandrel meant a considerable saving in time.

The design for the Head was therefore built up round the chuck body and the photograph—Fig. 1—shows the finished head for mounting on the Drummond lathe. It has been used for many years now for all kinds of jobs from boring the smallest bores to facing quite large surfaces. It has proved to be a most useful and adaptable tool.

It will be seen from the general arrangement, Fig. 2, that the head consists of the body (ex. Firth chuck) on which is mounted the sliding bar carrier (Fig. 4) which can be adjusted by means of the screw to position a boring or facing bar, mounted in one of the three ¾ in. dia. holes, at any required distance from the centre of rotation. The screw is fitted with a micrometer head enabling precision adjustments to be made. When facing, the screw may either be used to set the tool to a convenient distance from the centre to give a suitable width of cut using the cross feed on the lathe saddle or in cases where the facing must be concentric to a bore—say for an undercut—the screw can be used as a feedscrew. The feed can be operated quite easily by giving the screw a turn or a fraction of a turn as the head revolves. It was intended to fit a star wheel actuated by a pawl mounted on the lathe bed, but this has never, so far, been done as at the slow speeds at which such operations are usually performed, no difficulty was ever found in using a hand feed. However, at some time, the job may be completed with an automatic feed.

The chuck body is shown in Fig. 3 exactly as it was machined for use as a chuck and the only changes that have been necessary to adapt it for its new function is the drilling, tapping, and reaming of a few holes for screws and dowels. One of the slots which guided the chuck jaws has been used to accommodate the bar carrier. Should any reader think of building a boring head of this type it will be obvious that any backplate casting of suitable size could readily be used as a body for the tool instead of the chuck body and of course

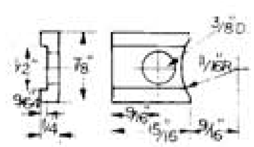


GENERAL ARRANGEMENT OF BORING & FACING HEAD FIG. 2

only one ¾ in. slot would be required.

Referring to Fig. 4 showing the sliding carrier, it will be noticed this part is shown as being completely machined from the solid. The reason for this is that the only piece of suitable material available happened to be a short length of mild steel 1¾ in. × 2¾ in. The obvious and certainly the easier method would be to make two projecting studs and screw them into place, pinning them if necessary. The sectional drawing in Fig. 2 shows how these studs with the clamping plates (Fig. 5) enable the carrier to be locked when it has been adjusted to the correct position. When the facing feed is to be used the ⅜ in. nuts should be eased off slightly. The ¾ in. slot on the side of the carrier locates the adjusting nut (Fig. 6) which is secured by a ¼ in. BSF screw. The nut is made of mild steel but bronze or gunmetal would certainly be preferable.

The bracket (Fig. 7) which carries the adjusting screw is fastened to the body by two ¼ in. screws and located by two dowels. At the left-hand end of the bracket a notch is filed on which is scribed a deep line to serve as a zero mark for the micrometer graduations on the collar of the adjusting screw. Fig. 8 shows the screw—it is built up from two parts and is threaded ⅜ in. BSF, that is 20 threads per inch, so that with 50 divisions on the collar, each division means .001 in. movement of the boring tool. The smaller part of the screw, that is the part carrying the micrometer divisions, is screwed on to the 5/16 in. BSF thread on the screw and should be adjusted until a good backlash-free fit in the bracket is obtained, using a 2 BA grub-screw in the tapped hole to lock the assembly;



CLAMPING PLATE
2 OFF

FIG. 5

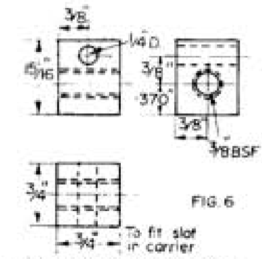
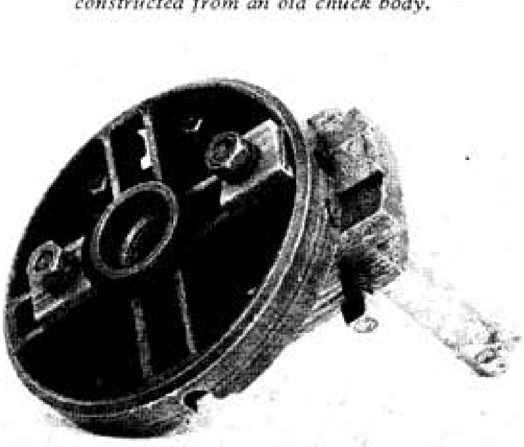
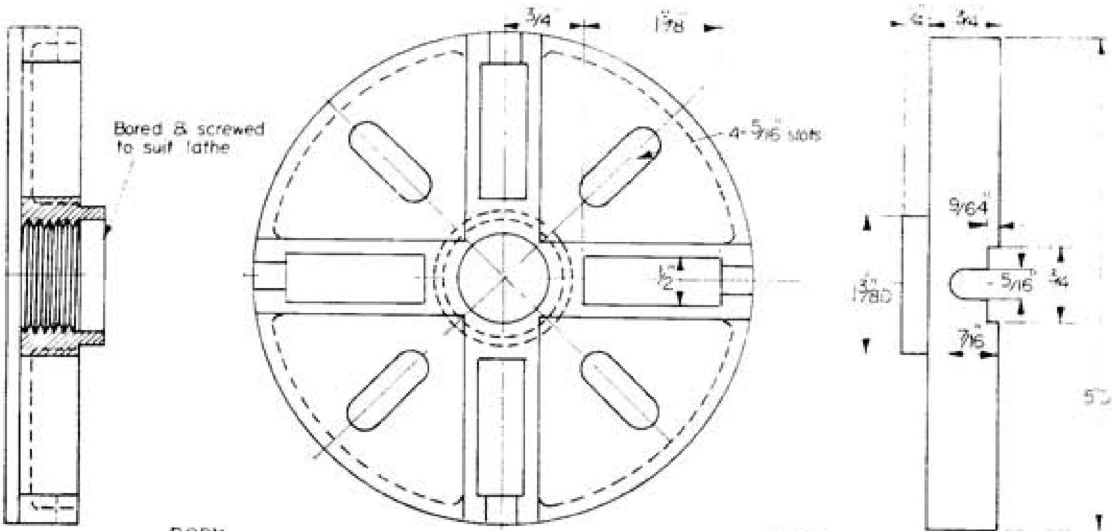


FIG. 6

ADJUSTING & FEEDING NUT

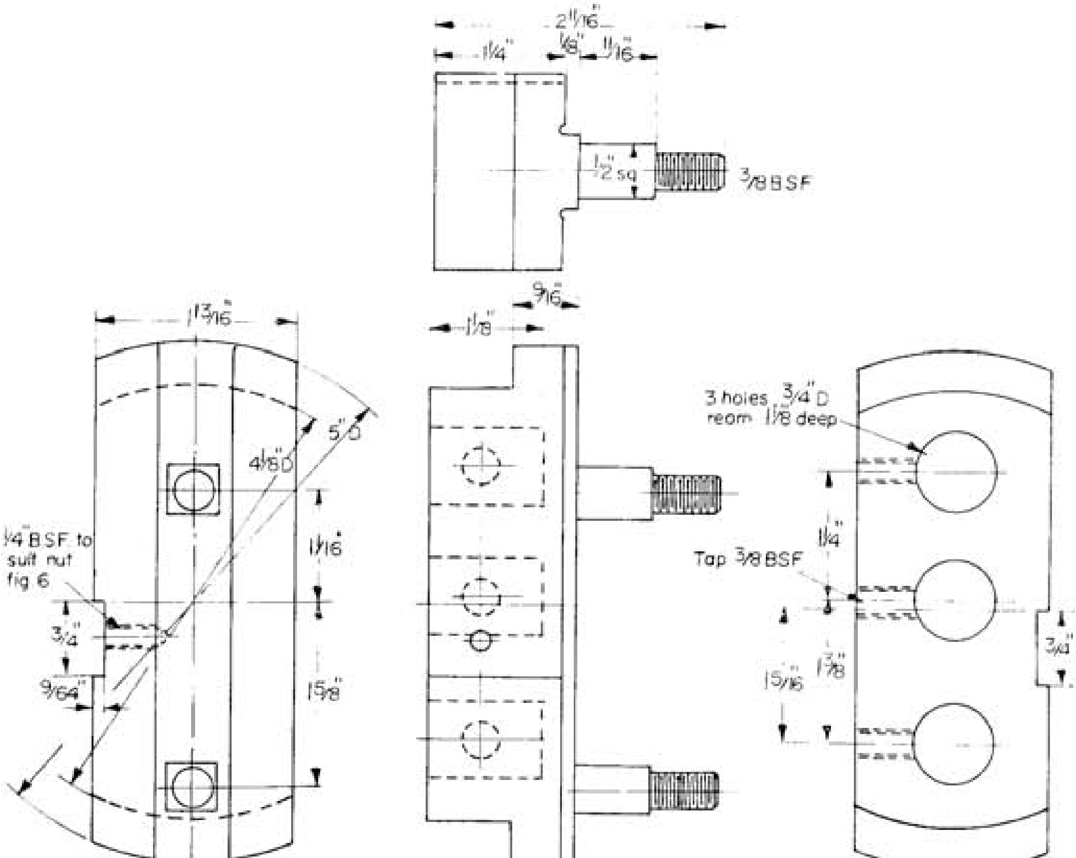
Rear view of the author's boring and facing head constructed from an old chuck body.





BODY

FIG 3

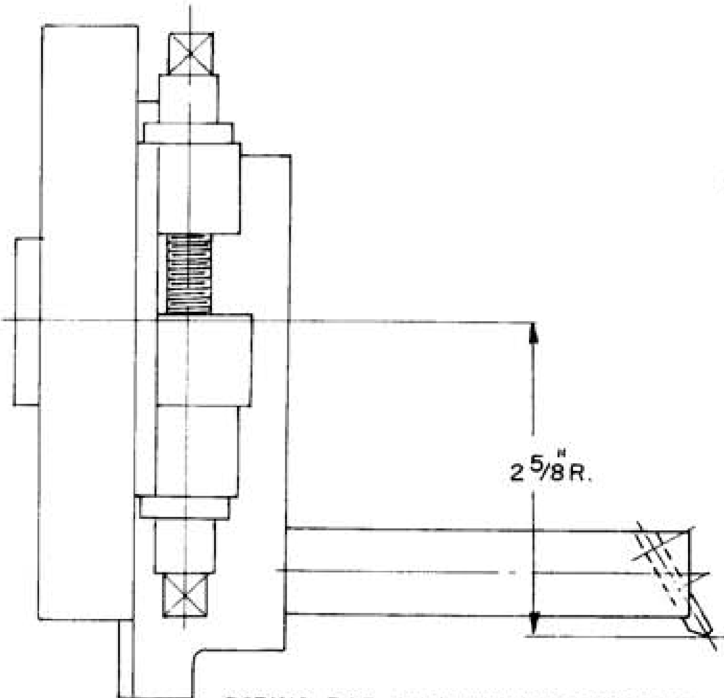


BORING BAR CARRIER

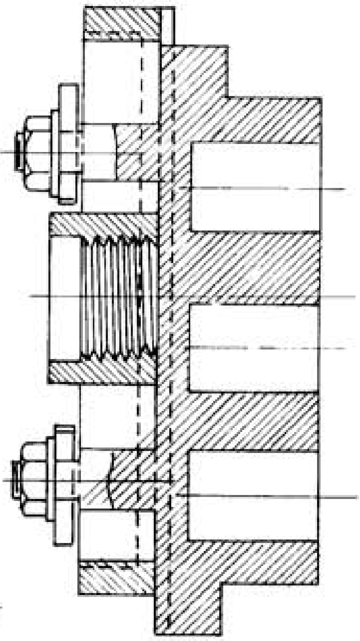
FIG 4

finally when everything is satisfactory a cross hole can be drilled and reamed and a 3/32 in. pin driven in.

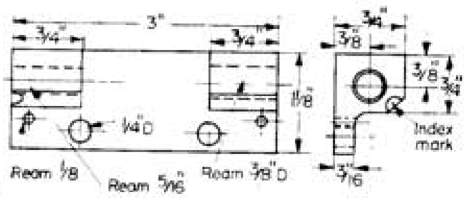
Fig. 9 shows two examples of tool bars. These are fitted with 3/16 in. dia. High Speed steel bits. The bars are clamped in the carrier by 3/8 in. screws and the tools held in by two 2 BA screws. For boring very small bores, the short type of bar fitted with a suitably ground tool bit will be found very convenient.



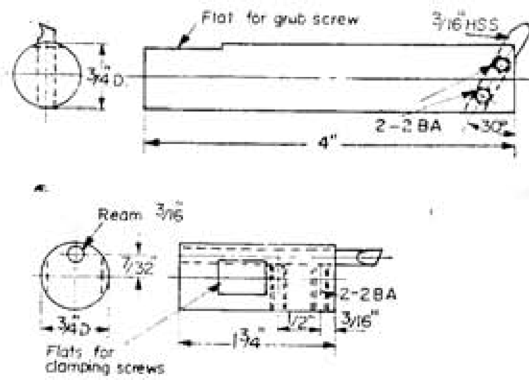
BORING BAR AT MAXIMUM DIAMETER

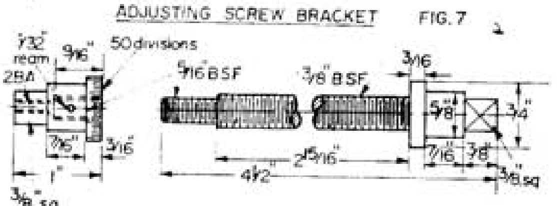


SECTION A A



ADJUSTING SCREW BRACKET FIG. 7





FEED SCREW FIG. 8

TYPES OF BORING BARS FIG. 9

BOURDON'S STEAM ENGINE

Continued from page 605

his tube which was constrained by a rod attached to the floor underneath the machine. The other end of the tube was rigidly held and steam at pressure admitted to it by the action of a conventional form of "D" slide valve drawn backward and forward in the usual manner. To economise in steam usage, the tube was kept full of oil and the alternations of pressure on the surface of the oil caused the curvature of the tube to vary and thus drove the engine.

The writer has not discovered whether engines working on this idea were ever made in quantity; one at least must have been constructed because Bourdon tells us that it made several hundred revolutions per minute, either by steam or vacuum. No doubt he calculated its horse-power by means of his indicator, a happy combination. From his drawing made at the time, however, he does not show a governor, and if one was needed it would have been an even more happy combination had he fitted a steam supply valve automatically operated by yet another tube.

Perhaps one day this break-through in engines will be resurrected again, as it deserves. In the meantime, Bourdon's claim to fame must rest with his pressure gauge.

JEYNES' CORNER

E. H. Jeynes returns to the subject of the Walbottle incline.

SINCE MY NOTES on the Walbottle self-acting incline in *Model Engineer*, October 18, 1968, I have received several letters which broadly raise the same point: "How do they get round sharp curves?" Some of the inclines I am acquainted with have worked well for over a century, during which time many quite elaborate arrangements have been evolved to deal with these problems which apply to both self-acting and power winding inclines. I am quite sure many of these never were designed by a drawing office, but bear witness to the practical ingenuity of the men laying out the incline, with additions by the men who had to work these inclines; it must be freely admitted that some of these erections have a distinct Heath Robinson appearance.

One factor (an important one) is the weight of the rope itself; this helps to keep the rope in contact with the sheaves, which in their turn contain the rope in a great measure by their flanges. This can be noticed in the photograph of an incline, which has already rounded two bends, before entering the picture in the distance, between the building, and the spoil-heap of another colliery. The line, after descending a fairly steep bank, rounds a fairly obtuse bend and enters a straight portion where the rope, which is under load, is seen to lie in the sheaves in the centre of the track; after this, a reverse bend is taken.

Here, as at the previous bends, is the answer to the questions. As the set (number of wagons) arrives at the bend, the rope which is attached to the end wagon, gradually eases off the track, slides up the rope ramp and drops into the groove of the horizontally placed wheel, where it remains until the set returns. A vertical roller is placed on each side of the wheel to receive the rope, should it jump the groove. The piece of line in the photograph is known as a "Dog's hind leg," taking the name from the shape of the layout.

After passing out of the picture on the right, the line continues almost in a semi-circle, crossing the British Rail main line to Newcastle, and then takes another reverse turn to enter the locomotive worked section, where of course rollers are fixed on the opposite side of the track.

From the foregoing, it will be gathered that rollers, or grooved wheels, or a combination of both, are placed beside the track on curves at points selected by practical experience and that as the rope reaches (or leaves) each pulley or roller, the angle of the pull is altered to reduce side-pull which, if allowed to become too great, could cause the wheel flanges to mount the rails.

This incline brings the sets up to the foot of a second incline, which starts off round almost a semi-circle before reaching a mile-long straight wind. These inclines were formerly owned by the Pelaw Main Coal Co.

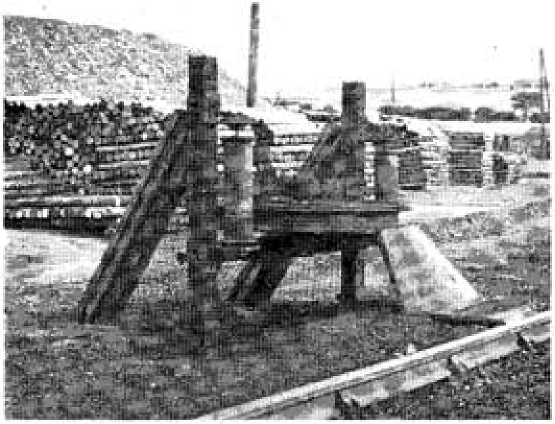
The North Eastern Railway however used a standard type of coned roller fitted vertically, which was patently engineer designed and made. These had a large flange at the base, and a top bearing stay, which has also extended as a rope guard. This type was used throughout on the Tanfield Branch Line in conjunction with ordinary sheaves on the three self-acting inclines. This line is now lifted, bringing to an end a line which in various forms, first as a wooden wagonway, but relaid in 1839 with metal rails, has seen coals trundled for well over 300 years, and practically over the same road-bed. It well merited the name "The Old Way" as it was known over 200 years ago.

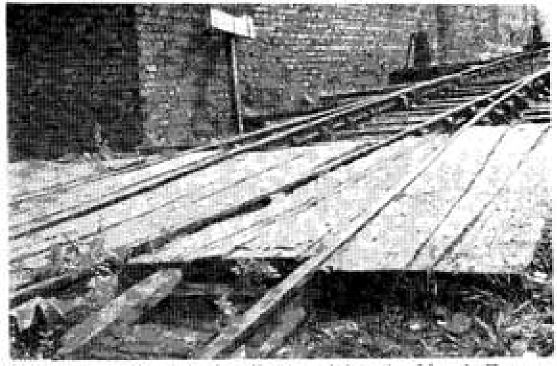
I hope this description, with the aid of the photographs, will at least convey some idea as to how this job was tackled with the material which was to hand, usually second-hand "I" or channel girders as the basic material of the structures. ▣

Rounding the bends: On the upper incline, entering the semi-circle. Note the de-railing switch.

Next page—top left: Another view of the large pulley and guide rollers.

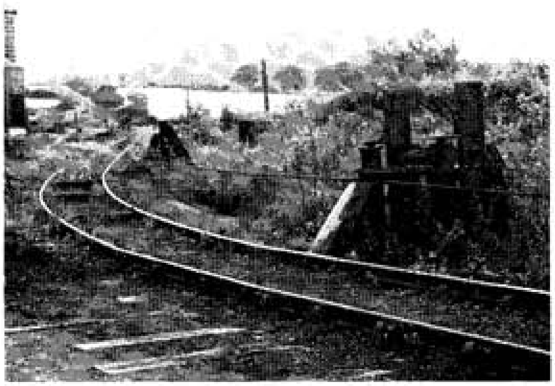
Bottom left: The "dog's hind leg" on the lower incline.

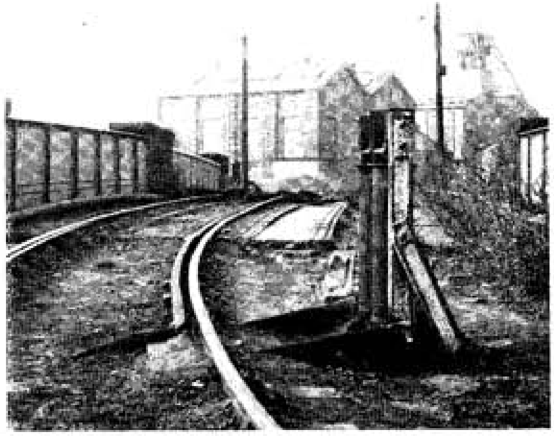




The standard conical roller used by the North Eastern Railway on the Tanfield branch line.

Below: A different type of roller is used here as the rope has to rise and fall.





REALISM IN STEAM PLANTS

by K. N. Harris

I HAVE BEEN following Mr Westbury's articles on "Realism in Model Steam Plants" with the greatest interest. Like everything he writes, it is objective, clear and much to the point, and equally pleasing completely free from irrelevant padding.

He says that "From the middle of the 19th century, very few high power single expansion engines were made for major industrial duties." These facts are recounted, to point out that no model having only one cylinder, or only one stage of expansion, can be a realistic representation of a large prototype built after that date. Whilst that may be broadly true of marine engines (though even here, exceptions could be found) it was not so with Textile Mill engines, and with Rolling Mill engines some of very great horse-power, single expansion engines were by no means uncommon. I worked in the Manchester area for some 16 years, up to around 1937, with several engineering concerns, and during this period I saw quite a lot of high power engines driving cotton and woollen mills some of which were single-cylinder engines producing anything up to 1,200 i.h.p. and all of which had been built much later than 1850.

One of the (at first sight) surprising things about the mill engines was that hardly any two were alike. I think this arose to a large extent from the fact that many of them were replacements for outdated and comparatively inefficient Beam engines and they had to be tailored to fit the existing engine-houses. All these engines were of the condensing type, usually jet condensing and the single-cylinder variety were quite efficient from the steam consumption point of view, using not more than 17-18 lb. of steam per i.h.p. hour. In a recent issue of the "SMLS" News, I described one such engine which had a cylinder 40 in. bore × 10 ft. 10 in. stroke, working at 45 r.p.m. (900 ft. per min. piston speed), a real monster. Unless my memory is at fault, there is in the Marine Engine section of the Science Museum, a fine model of a three-cylinder single expansion condensing marine engine of very large proportions, built for an Italian warship, I would think around the late 1870's or early 1880's. As to Rolling Mill engines, these were usually either two or three crank horizontal engines. When they were compound they were usually tandemed. They were almost always reversible; Gooch valve gear and Joy valve gear were largely used and power reversing was practically universal.

Further notes by K. N. Harris on this subject will be published in our next issue.—Ed.

Knots

SIR,—Knots should not be confused with Nautical Miles. Knots were, and still could be actual knots on the log line. They were equally spaced and when the ship-log was thrown over the stern of the ship the log-line followed and the number of knots which passed in a given time gave the speed of the ship in nautical miles an hour.

The usual spacing of the knots was 47 ft. 3 in. and the observation time 28 seconds, measured by a sand-glass. Thus one knot passing in the 28 seconds would indicate a speed of:

$$\frac{47.25 \times 3600}{28 \times 6080} = 1 \text{ nautical mile an hour.}$$

The Knot was not introduced by the Admiralty, it was first mentioned in 1607.

The modern method of measuring a ship's speed is by means of a Pitot Tube projecting from below the ship's hull. The motion of the ship causes a change of pressure in the tube which is recorded electrically and operates an instrument in the chart room giving the speed and distance travelled. The Pitot Tube can be drawn back into the ship, by remote control from the bridge, in order to avoid risk of

I was interested in Mr Westbury's article in the issue of March 21 on marine engines which recalled some of my own early experiences. He mentioned the old-fashioned thrust bearing consisting of multiple collars on the shaft working against stationary horse-shoe shaped collars on the thrust block. They were often a source of trouble due to overheating as, although the position of the stationary collars was adjustable, it was extremely difficult to make them all take an even share of the load. Fortunately in the last 60 years they have been superseded by the Michell type. This has a single large diameter disc on the shaft and against it are a number of pads attached to the thrust block. The pads can rock slightly and adjust themselves so there is always a film of lubricant between the disc and pads. The Michell thrust bearing was described in "Engineering" December 18, 1906, page 883.

Mr Westbury also mentioned the four cylinder triple expansion engine in which there were two low pressure cylinders. This type found special application in destroyers and other warships requiring high speed engines as besides avoiding the single large LP cylinder it enabled a high degree of dynamic balance to be attained. The system of balancing was known as the Yarrow, Schlick, Tweedy system and took into account the effect of every moving part, even including the eccentrics and valve gear. The final adjustment was attained by making the crank angles slightly different from 90 degrees. I have several times been on destroyers on full-speed trials in which two four-cylinder triples were developing a total of 8,000 h.p. at 330 r.p.m. when the vibration from the main engines was less perceptible than that from the single cylinder engine driving a 10 k.w. dynamo at 750 r.p.m. General arrangement drawings of the above engines were published in "The Engineer" July 2, 1909. The system of balancing is described very fully in Professor Dalby's book "The Balancing of Engines."

In the same issue Mr Jarrams, in a letter, complains of his inability to obtain drawings of the French-built G.W.R. locomotive "La France." In the October 5, 1905, issue of *Model Engineer* there is an article by Chas. S. Lake describing a de Glehn Atlantic Compound of the Northern Railway of France which, it is stated, is virtually of the same size and power as the first de Glehn supplied to the G.W.R. which was "La France." The article includes a photograph and also a longitudinal section, a half sectional plan and two cross sections.

Hampton, Middlesex. SIR ARCHIBALD J. GILL.

Locomotive drawings

SIR,—Mr Jarrams (March 21) is not alone in being frustrated by the non-availability of locomotive drawings. One cannot help wondering exactly what British Rail are playing at.

In 1966 I wrote to Swindon requesting a frame plan and section drawing for a Vale of Rheidol locomotive. An answer arrived by return of post, giving details and also offering an official photograph. I sent the necessary money, about 25s. I believe, and was sent the print within a week. At other times I had similar dealings with Swindon and have only once been told that drawings were unavailable. This was in the case of the "1101" class of locomotive, on which the "Midge" design was based.

Here I had a helpful reply suggesting I try the Hunslet Company, in Leeds, who had taken over the goodwill of the builders, the Avonside Company. All that Swindon could offer was a weight diagram to a scale of ⅜ in. to the foot.

The reason for this digression is this: Someone, somewhere at Swindon, kept records of all the drawings in stock, with their location, and could look anything up in a very short time. Why was not this book or books sent to Clapham with the drawings? If it was, the cataloguing would surely not be necessary.

How different this is from the policy of the old G.W.R. and Western Region, who realised that many people respond to helpful answers and service by bringing more custom. The G.W.R. even prepared special drawings for model makers, probably using the opportunity to train tracers and junior draughtsmen. Many of the older drawings were works of art. I have in front of me a print of Lot 218 of the 4300 class, built in 1926, with Stanier's signature on it. The original appears to have been tinted and is a mass of beautiful detail drawing.

Perhaps Mr Johnson (January 17) is really stating B.R.'s policy. It seems so, judging by events. He should realise however that all model engineers have not the resources, mental, physical or financial, to carry on extensive experimental work. Many, myself included, struggle with old-fashioned equipment and inadequate resources to make things of beauty—not for financial gain but just for the sheer pleasure of creating, or recreating a model.

I for one would welcome articles in M.E. giving drawings of such things as colliery winding engines: photographs are not always helpful as the engine houses are often too confined to get a decent view. The article and drawing by Mr Harrison (February 7) was good and perhaps he can be encouraged to do a large scale drawing of the valve gear.

Only by having decent, correct drawings can the model engineer make an engine that looks like the real thing, and not a nondescript; let's have a few more of them. Let us hope too, that British Rail will cease being "ashamed of the past" in their new "forward thinking" and will recommence the sale of prints.

Now, can anyone help me with a drawing or dimensions of the top feed cover used on G.W.R. tank locomotives of the 1400 and 5700 classes, when top feed was adopted in place of the original backhead clacks? Also has anyone a print of the G.E.R. tram engines (L.N.E.R. J70 class), showing the internal arrangements?

Shrewsbury. D. MATTHEWS.

Locomotive design

SIR,—The subject of steam locomotive design is constantly being brought up in "Postbag," and much of this correspondence deals with the correct design of valve gears. The views that I am about to put forward may sound like heresy to those who worship at the shrine of Walschaerts, Stephenson and Baker and the other lesser deities, but if one faces reality all the usual linkage type gears suffer from two major shortcomings.

(a) When notched-up, the port opening decreases, which leads to throttling when attempting to work economically at high speed unless very large valves and/or long travel in full gear are used. The large port opening in full gear is not of much value.

(b) The four events (admission, cut-off, exhaust opening and closure) are not mutually independent, therefore it is impossible to design these valve gears for the optimum timing of all events.

On the credit side it must be admitted that they are easy to design and make, they work smoothly and wear well and look very impressive on the outside of a locomotive. Now it may be possible to design a linkage that does not suffer from (a)—if so, I would expect it to have at least twice as many links as the conventional gears. But to avoid the faults in (b) is impossible if only one valve is used for each cylinder (assuming, as is usual, that double-acting cylinders are used).

All these facts have no doubt been realised by the originators of the many types of cam operated poppet valves. The initial trials of these valve gears have sometimes shown outstanding improvements; the K4 Pacifics of the Pennsylvania Railroad are reputed to have increased their drawbar horsepower by 40 per cent at 60 to 80 m.p.h. when Franklin poppet valves were substituted for piston valves. This great improvement apparently required an exorbitant expense in maintaining the gear in correct adjustment. When one remembers that these cam operated valve gears were designed as attachments to existing locomotives instead of being designed integrally with the locomotive when first made, one can appreciate the difficulty providing the robustness necessary in a mechanism subjected to large acceleration forces.

All the above preamble concerns the full size machine; now for the aspects as they affect models. We are quite free to design the valve gear integrally with the model, and the dynamic forces reduce to insignificance even for the very large gauges now becoming popular with model engineers. I would however suggest that the excellence of model engineering would be better served by improved design in the smaller gauges to enable them to perform heavy duties rather than by large gauge locomotives which never have to take the loads they should be capable of. Also some letters to the editor have complained about the monotony of locomotive designs appearing year after year in the M.E. I would agree with these sentiments, but I suppose if the M.E. wants to stay in circulation it has got to give what its readers want. One only has to go to any club track run to see that only a very small proportion of the amazing variety of forms taken by the full-size steam locomotive have been considered by the model maker.

For those who would like something different, here are my suggestions based on the first paragraph of this letter. The result will not be a true scale model except externally, but I believe it would get more work out of the available steam than any conventional design. I propose to use cam operated piston valves, two per cylinder.

I have devised a system whereby one cam can control all four piston valves for a pair of cylinders. The cam is shifted axially for notching up. Steam pressure on the piston valves serves as a return spring; this will not result in undue force on the cam, since very small piston valves are adequate, the ports open fully at the earliest cut-off. Steam passages are very short, and the whole system is robust enough to need no adjustment for a long time. Other features on the model under construction are roller or ball races on all bearings concerned with the transmission of power, and an adjustable blast pipe nozzle (if it works!).

If any reader can think of further ways of ensuring that the steam is used instead of wasted, I will be very happy to apply them also to this model.

University of Sydney, Australia. A. A. SHERWOOD.

2½ in. gauge

SIR,—Further to Mr B. K. Bibby's letter, Postbag, February 7. For many years, because I was not able to afford anything larger than a small 0-4-0 or 0-6-0 in 3½ in. gauge and not being in the least interested in these, I ran 2½ in. gauge engines on the Harrow and Wembley Society of Model Engineers track at Headstone Lane with great success and still have some 8 mm. film to prove it. Those who knew the old track will remember that it was extremely heavily graded with a sharp curve at the steepest part of the bank.

My 2½ in. gauge engines proved just as reliable as the 3½ in. and 5 in. gaugers and caused no more traffic hold ups than these did. I believe that my LBSC 4-4-0 Midland Railway "Annie Boddie" became known amongst other members as the fastest engine in the club, often running a full afternoon with no trouble at all and pulling my 15 stone with ease. "Cruelty to little engines," they said. Eventually I sold my 2½ in. stud and with the money bought a battered Hielan Lassie, I carefully rebuilt this to a super detail near scale model of 60113, "Great Northern" in her last B.R. days. But I have found that such a large 3½ in. gauge engine is rather too heavy for one person to lift and carry down the garden path to the car unaided. So anything more than a six-coupled tank in 5 in. gauge would be quite out of the question for me to handle either in the workshop or transit and I expect many others too.

I found 2½ in. gauge so successful in service, easy to handle and transport that now, several large 3½ in. gauge engines later, I am tempted to go back to it. Bringing to bear the knowledge now available to combat wear, ball race and roller bearing axle boxes, case hardened valve gear and motion bushes, "O" ring pistons, etc., I feel sure that a scaled down version of LBSC's "Britannia" would be just as successful and reliable a machine as it is in 3½ in. gauge.

Harrow. DENNIS S. HUNT.

Nameplates

SIR,—Making a model traction engine, I needed some nameplates and finally obtained excellent results using Printed Circuit Board and Lettraset, Blick and Brady adhesive transfer letters. The method used was as follows:

1. Gently clean the copper surface with fine steel wool.
2. Apply the required lettering using the correct size and type and rub well on.
3. Apply strip round edges and circles in the corners. If these are not available this can be done with nail polish or paint.
4. Immerse in a small dish contaning slightly warmed strong solution of Ferric Chloride (obtainable at any Chemist).

In about 20 minutes the nameplate may be removed when the copper should be dissolved away leaving the lettering, etc., intact. Rinse in water, rub off the adhesive lettering giving a paxolin plate with lettering and border in copper. The background may be painted and the plate attached to the model using small screws or Araldite.

Stretford, Manchester. B. G. SLATER.