# LOCOMOTIVES IN 4mm. SCALE

**A series in which A. A, SHERWOOD describes the building of two models based on a GWR 2-8-0-T**

THE model locomotives *Rhondda* and *Plain Jane* to be described in these articles, have two unusual qualities. Both are based on a GWR 2-8-0T, and both were built to the somewhat unusual scale for live steam, of 4 mm. : 1 ft.

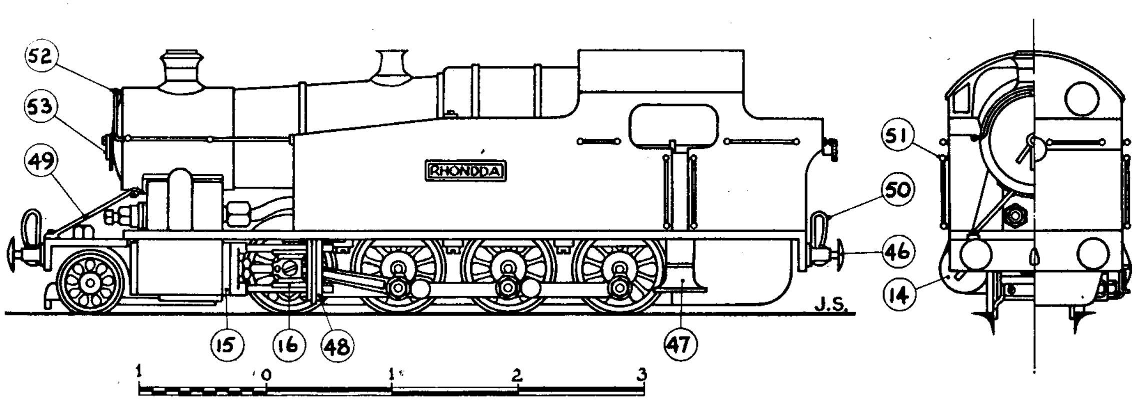
The GWR 2-8-0 tank is by far the most suitable prototype among British locomotives for OO gauge live steam, but even so a few liberties have to be taken with the scale of the leading dimensions. The most noticeable adjustments are the even spacing of the coupled wheels and the overscale length of the cylinders. In any case, 4 mm. scale and 16.5 mm. gauge is bound to result in some discrepancies, but since it is standard practice in model railways, we do not have to justify it. It was chosen in preference to the more exact 3½ mm. scale as it gives a little more space under the boiler where it is needed for more satisfactory combustion.

If desired, the design could be reduced to 3½ mm. scale by making all dimensions, except the frame width and dependent dimensions, in the ratio 7 : 8. The design has been thoroughly tested and proved capable of hauling loads up to the limit of its adhesion for about 100 laps of a 4 ft dia. circular track. Despite the pinhole ports, it will achieve dangerously fast speeds on the level track unless adequately loaded, and can also be loaded to a very realistic "crawl" without stalling.

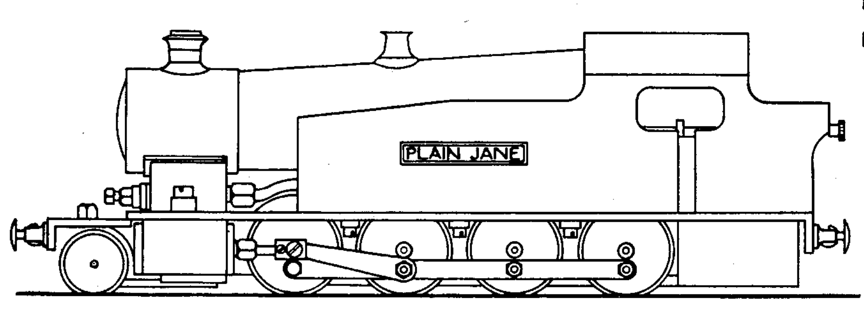
**Functionally identical**

Readers used to larger scale locomotives may be surprised by the complete absence of controls and gauges; but since there is no driver in the cab to use them, there is not much point in providing them. Both these models are identical in functional details; *Rhondda* is the glamorous sister from Glamorgan with all the frills, and *Plain Jane* has only the bare necessities and hence will require only about half the time to produce. It is also possible at various stages to add detail to *Plain Jane* to suit any taste. Full instructions and drawings will appear for each model; machining instructions are devised for those who have to rely on the lathe for all operations.

Owners of other machine tools as well, will probably be quite capable of taking full advantage of their facilities without further instructions. A vertical slide for the lathe has been assumed as part of the available equipment, and 0-1 in. micrometer and dial test indicator are the only precision measuring equipment required.




EXTERNAL VIEWS OF RHONDDA & PLAIN JANE.

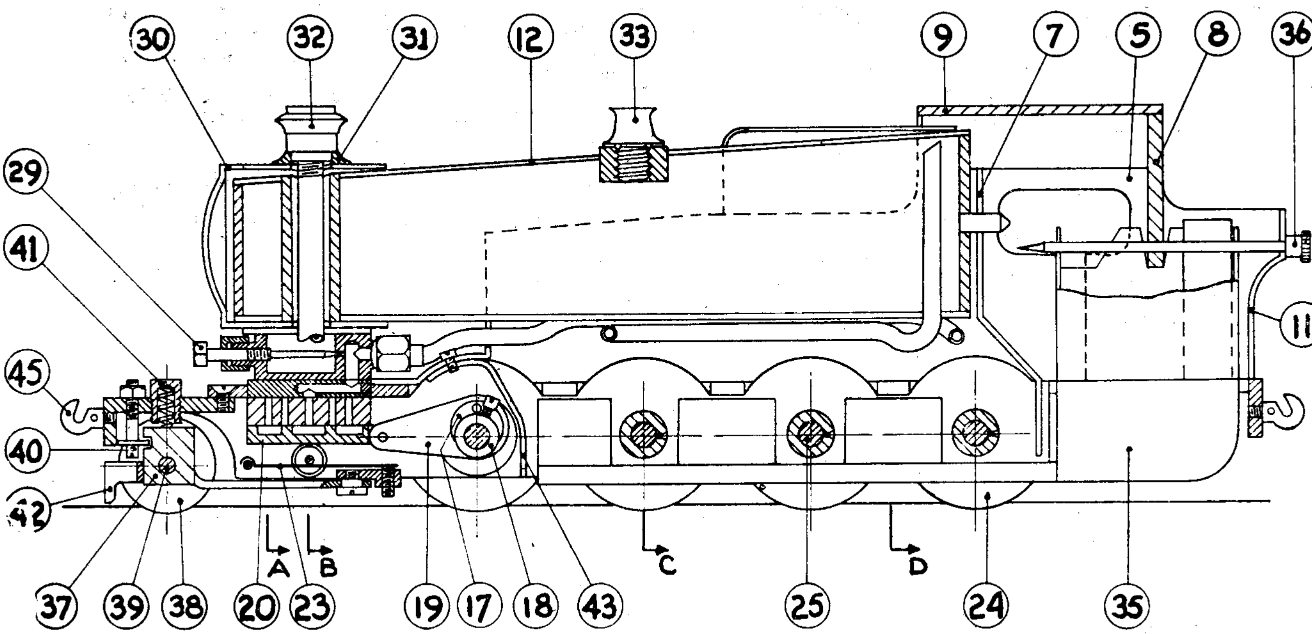


The experienced model engineer may, of course, prefer to work out his own machining procedure, but might be well advised to read the description first, as a good deal of care has been taken to point out the snags that were encountered in making the first edition, and some of them were rather difficult to foresee.

The model of *Rhondda* shown in the picture is made mostly of brass, since it is corrosion-resistant, easy to machine, and heavier than steel. The parts which should be steel colour have been plated. Since the quantity of material required is very small, cost hardly enters into the decision, stated, the nearest gauge size to the stated dimension is satisfactory. Since for jobs of this size most model engineers will get their material from the scrap-box, actual dimensions may be preferable.

Either *Rhondda* or *Plain Jane* could be scaled up to O gauge with little fundamental alteration and still perform quite well, but I would not venture to give an opinion on anything larger than O gauge. On the other hand, in the rare event of any reader being interested in something smaller, either of the locomotives could be scaled down to 2 mm. scale and 9.5 mm. gauge and still work. In tank, and avoids the unsightly excrescences under the cab which are a common feature of the toyshop steam locomotives in O gauge. Water-cooling effects a considerable improvement to the length of run per tankful, and even better results might be obtained with ice, either the usual type made from water, or the "dry ice" of solid $CO_2$.

The boiler is a plain pot, with the steam pipe exposed to the flame. This serves as a steam drier and superheater; the former is the more important function. If the superheat is excessive, lubrication troubles are likely to appear, and also onlookers



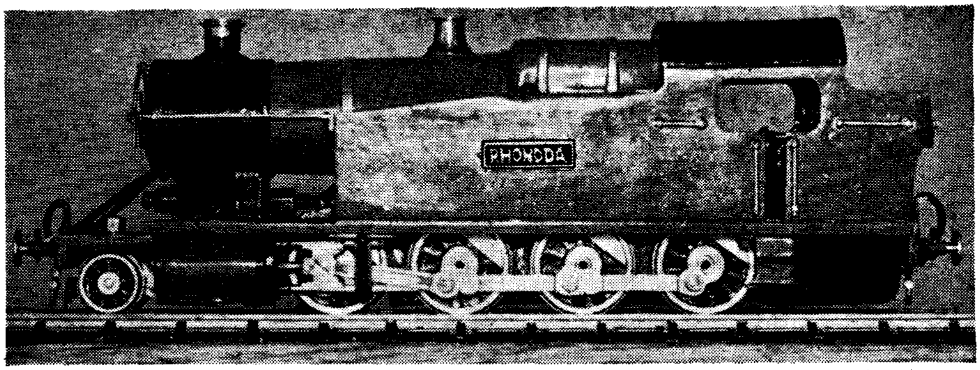

GENERAL ASSEMBLY OF 2-8-0 TANK

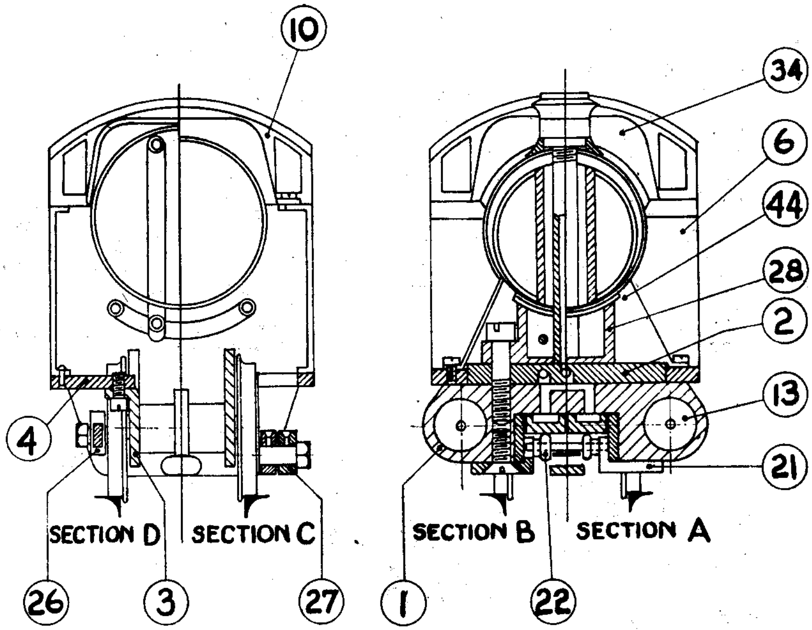
and constructors can make their own choice of the various alternatives suggested for each component.

The order in which the items are made may seem strange, as it starts with the cylinder block, but logical reasons for this are given later. This component involves more precision machining than any other item, but once the constructor has successfully completed this task, he need have no fears about his ability to manage the rest of the job. Actual dimensions have been given instead of gauge numbers for sheet thickness and drill sizes, but this should present no difficulty to a person armed with a micrometer. Except where expressly fact, the main functional features bear a close resemblance to those of my 2 mm. scale *Koala*—but the side tanks should be made as high as possible, and the boiler slightly *decreased* in diameter and pitched as high as possible.

The sectioned general assembly shows the main features of the design. A simple wick-type burner for methylated spirits is used for firing the boiler, with adequate flame guards to avoid the flame flashing back to the container, and a compartment for cooling water above the fuel tank to minimise loss of fuel by evaporation. This enables a reasonable length of run to be obtained from a small fuel will not believe the engine is really steam driven if the exhaust is still so hot as to be invisible. The smokebox saddle serves as a displacement lubricator, and suffers from the faults of most of its relatives, i.e. erratic action. But it is easy to set the valve so that the lubrication is at least adequate at all times.

The cylinders are in one block, which also contains the portfaces for the slide valves. These slide valves are of the internal admission type, and need no valve chest, being held to the portface by springs. This design thus considerably simplifies the whole assembly, as compared with the conventional layout. In






# LOCOMOTIVE.

addition the spring-loaded slide valves also serve as safety valves for the boiler. The valve gear is simple loose eccentric. This is the only practicable gear that will fit in the allowable space, as it is essential to leave the space between frames as free as possible for the burners.

No springing is incorporated for the coupled wheels. There is no doubt that adhesion would be improved by springing, but there are serious objections to springing the first and second coupled axles. The valve events would be badly affected by any vertical movement of the first coupled axle, as the eccentric rods are very short; and since the connecting-rods are also short, the component of force in the vertical direction is quite likely to overcome the spring force on the second coupled axle. Springing the rear pair of axles only would lead to instability.

If it is desired to utilise to the full, the available adhesion, then the connecting-rods should be lengthened to drive on the third coupled axle. If the second and fourth coupled axles are sprung, it ensures that seven of the eight coupled wheels contact the rails at all times, provided, of course, that the constructor remembers to provide working joints in the coupling rods instead of dummy ones. The best and easiest way to achieve satisfactory adhesion seems to be the apparently crude method of putting in dead weights wherever they can be tucked away out of sight.

Keen observers may notice a few minor differences in the design drawings and the photographs; as usual, after building a model, the constructor usually has some ideas which would either simplify the construction or improve appearance or performance. The only modification of importance is in the design of the spring gear which keeps the slide valves up to the portface, and this is not shown in any of the photographs. The design given in the drawings has, however, been tried and not found wanting in other OO gauge live steamers; moreover it is the simplest arrangement I have yet devised to obtain equal pressure on each valve combined with a very easy means of adjustment.

**Valve accuracy**

As in all steam locomotives, accuracy of valve events is of paramount importance. Since it is hardly practicable to incorporate any method of adjustment here apart from the movable stop collars, the valve cavities must be accurate. The first method suggested to attain this condition was the one used on the model in the photograph. The other two methods suggested have been used on previous models, and are probably safer and surer, but the first method requires less than a quarter the time for either of the other two.

In the following instalments, full instructions and drawings are given for the functional essentials; items which only have to look right have not, in general, received the same attention.

★ *To be continued on April* 21

 Continued from 7 April 1960, pages 405 to 407

# A start on the CYLINDER BLOCK, TOP COVER PLATE, and MAIN FRAMES

By A. A. SHERWOOD

It is suggested that the cylinder block be made first, as it is essential that it fits accurately in the cutaway part of the main frames, the axial length of the block being important here. As this length is trimmed to size after a great deal of accurate work has been done on the block, it is obviously better to make the frames later to fit the actual length of the block. I am not advocating slipshod work, but if the block finishes up only a few thou under size, and the cutaway in the frame has already been made to nominal size, the resultant slackness will ruin the valve events.

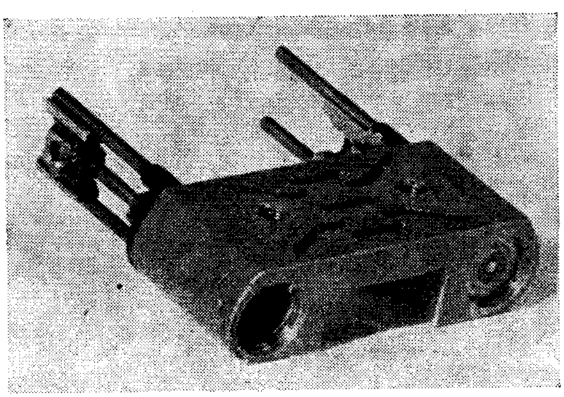
Phosphor-bronze or gunmetal is the best material, but brass is acceptable and easier to machine although it does not wear as well. A fully dimensioned drawing is given, and the expert will obviously require no further instructions. For those with less experience, the following procedure is suggested. Prepare first a slab of the chosen material with all faces reasonably square and flat and about 1/100 or 2/100 oversize in all directions. Set up on the vertical slide as shown, and mill out the recess between the bores. The width of this recess should be held as close to the given size, 0.55 in., as possible, with reasonable care, and also it should be central to within a few thou.

The depth of the slot is not critical to about 1/100, but it is very important to obtain a good surface here, as this forms the portface. I have found that a single point flycutter usually makes a better surface than an endmill. While the block is set up, the ports and holes for the clamp screws can be centred. Since the usual centre drill is too big, a special one is needed; I find dental burrs excellent for this. Just grind off the end to a spearpoint of about 60 deg. included angle. The port positions can be set up using the mike collars on the vertical and cross-slides.

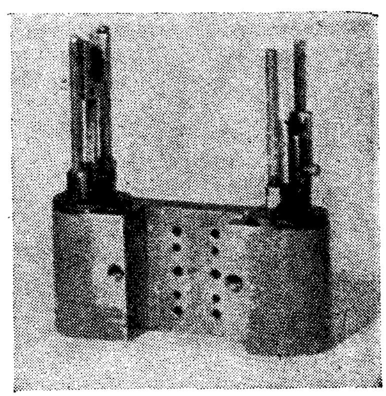
Start each port at this setting, and drill right through later in a drilling machine. It does not matter if the drill wanders, as the hole is started at the portface where its position matters; and in this case, it really is important to space the ports accurately. Although the position of the central and outer ports in each row does not affect the events directly, the method I have evolved for machining the cavities in the slide valves does depend on the accurate spacing of these ports. They should all be drilled slightly undersize at first, then opened out with the correct size drill.

As a check, it is desirable to measure the port spacing, which can be done most easily by putting close-fitting rods through each pair of ports, and measuring the rods with a micrometer. Provided that the anvils of the micrometer are kept in contact with the portface, this method gives accurate results. The port spacing should not err by more than about 0.002 in. or the valve events will suffer. The 7 BA holes must also be positioned accurately or there is a danger of breaking through into the cylinder bore; they should not be tapped at this stage, as the mating holes in the top cover plate will have to be spotted from them, and spotting through a tapped hole with a drill is likely to spoil the thread. The 0.052 in. dia. holes which communicate with the ends of the cylinder bores should be drilled before the cylinder bores for fairly obvious reasons; their position is not very critical provided that they provide a "full bore" passage for steam.

The channels on top face of the the cylinder block can now be cut. In previous years I have done the job by hand with a small cross-cut chisel, but a ball-ended dental burr does a much neater and quicker job, provided that it is spun at about 10,000 r.p.m. If the channels start and finish at the right holes they will satisfy the main requirements; do not be tempted to make the channels to the cylinder ends too large in cross-section, as, although this will provide a free passage for the steam, it will also waste the amount of the steam



*The cylinder block assembly (left) as seen from above and (right) from below*

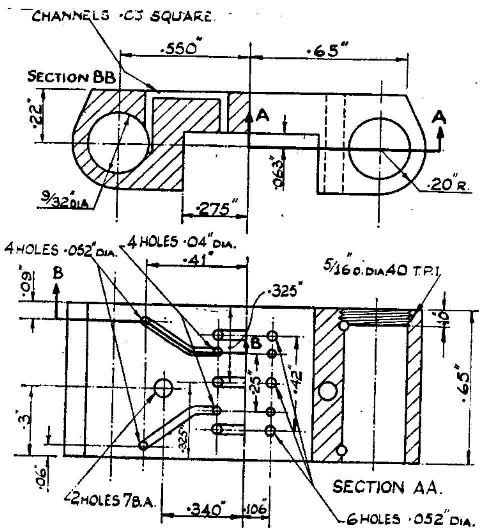


required to fill the channels at each revolution of the wheels.

The cylinders can be bored by setting up on the vertical slide again, and using the already machined surfaces of the block as datum, the bores can be drilled a few thou under size. If you have a 9/32 in. reamer, then open out to a little under this size at this setting. If you haven't, then you may as well drill 9/32 in. dia. and make a reamer to finish about 0.004 in. oversize. The reamer shown in the sketch is simple to make, and does not chatter, especially if the flats are uneven. After hardening and tempering, the wide curved land should be polished, and the corners carefully oilstoned until the last traces of land have disappeared elsewhere.

Before removing from the vertical slide, the front face of the block should be trimmed with a face mill or flycutter. Do not ream the bores at this stage; it is better to postpone this operation as long as possible, as it is easy to scratch the bore during subsequent machining operations. The safest way to produce the $\frac{5}{16}$ in. 40 t.p.i. internal threads at the front ends of the bores is to use a special pilot tap as shown in the sketch. This is double ended, the thread being first cut with the chamfered end. The tap is then reversed for producing a full thread right to the end. This is important as there are only four complete turns of thread available. For cutting threads in brass or bronze, triangular cross-section taps have been found quite satisfactory, and they are much easier to make than fluted taps. The outer curved profile of the cylinders may be obtained by hand filing, or if you prefer, by mounting on a mandrel in the lathe and planing with a tool sideways in the toolpost. If you have a toolpost milling spindle, then the job is easier still.

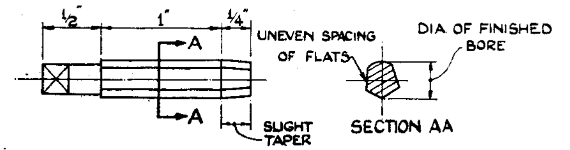
At this stage, it is a good idea to start on the top cover plate, described below. After the holes for the 7 BA clamp bolts have been spotted through, they may safely be tapped in the cylinder block. It is essential that these holes be tapped before the cylinders are finally reamed to size. The last machining operation on the cylinder block is to mount each bore friction tight on a carefully turned and polished mandrel (to avoid scoring the finish) and skim the rear faces



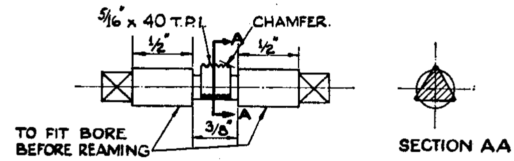

CYLINDER BLOCK. 1 OFF.

MATL - PH. BRONZE, GUNMETAL OR BRASS.

PART No. 1

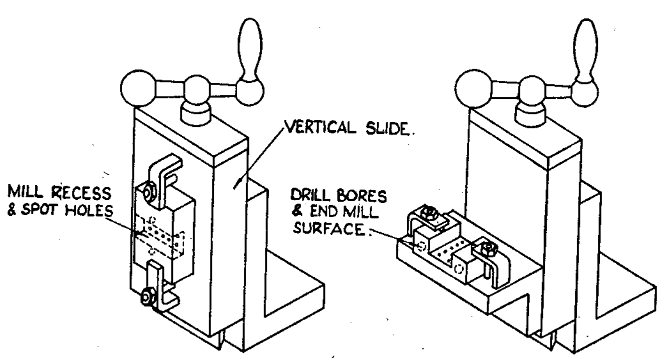



REAMER FOR CYLINDER. - SILVER STEEL. HARDEN & TEMPER.




PILOT TAP FOR CYLINDER. SILVER STEEL HARDEN & TEMPER

SKETCH. B.




SET UP FOR MACHINING CYLINDER BLOCK.

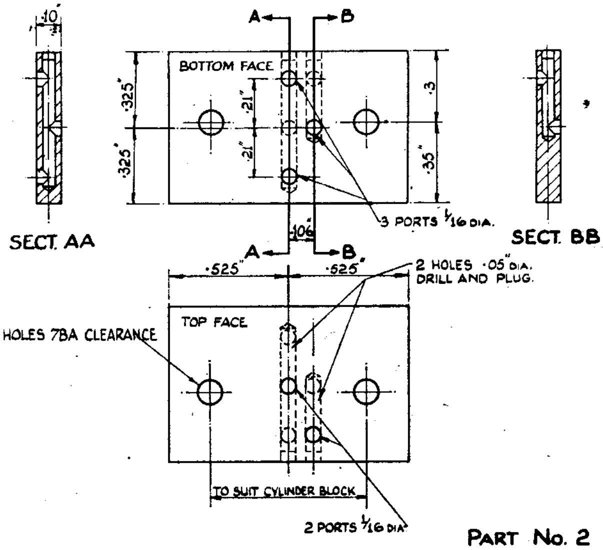
SKETCH. A.

true with the bore so that the rear cylinder covers will seat accurately. This is important for the alignment of the slide bars and gland, and if the suggested procedure is followed, it will not affect the performance if the two cylinder bores are not quite parallel with each other. Squareness of the front face of the block with the bore is not so important, since the fibre gasket will accommodate small errors without leakage.

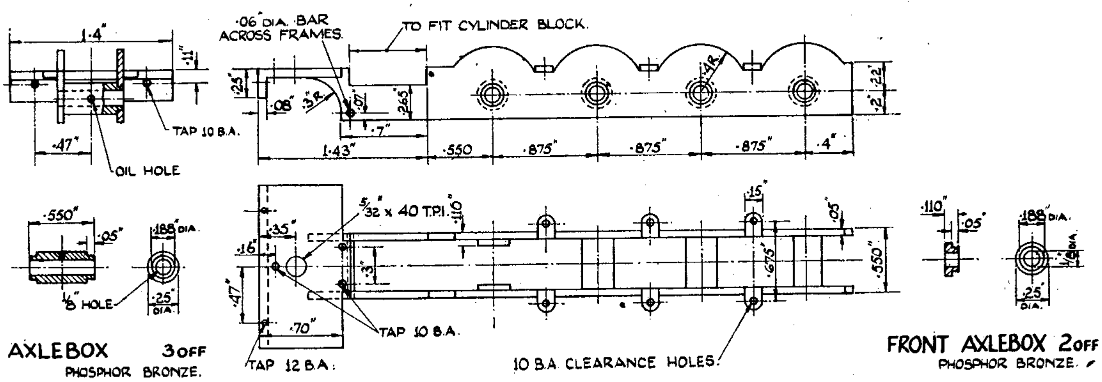
This completes the machining of the cylinder block, and it only remains to remove burrs and smooth the portface. The latter can be achieved with a $\frac{1}{2}$ in. wide smooth file, keeping it well pressed to the surface to avoid tipping. If the tool marks on the portface are deep, don't forget to keep the file well cleared of chips during the procedure.

The top cover plate comes next, as part of the machining procedure is dependent on the cylinder block. The top cover, being made separate from the cylinder block, greatly simplifies the provision of steam passages and enables the pipework to be reduced to a minimum. The only operation which may cause trouble in this component is the drilling of the two long 0.05 in. dia. holes in a 0.1 in. thick plate on edge. Plate 0.125 in. thick may be used if desired, and the adjustment made by reducing the height of the smokebox saddle. If the plate is cut to size and clamped to the partly machined cylinder block, the two clamp bolt holes and the central port on the underside can be spotted through.

The other two ports on the underside should be satisfactory if carefully marked out and centre-punched, as they are slightly larger than the width of the channels they communicate with, and a slight error here will not constrict the steam flow. Note that the three ports on the underside are drilled to break through into the long plugged holes only; do not drill right through the plate. The same applies to the two ports on the upper side of the plate. The plugs in the long holes are made a force fit and just driven in. They may be sweated with soft solder if there is any doubt about their steam tightness.




TOP COVER PLATE. 1 OFF. PART No. 2 BRASS




MAIN FRAMES BRASS OR STEEL 1 OFF.

PART No. 3

The two outer ports on the underside should collect the exhaust from the cylinder block and lead it to the central port on the top face, and the other port on the top face receives live steam and passes it to the central port on the under face, which in turn communicates with the two middle ports in the portface of the cylinder block. The top and bottom faces should finally be surfaced with a smooth flat file, as the various holes drilled in the component will produce bumps and burrs on these surfaces.

On completion of these two items, it seems probable that the constructor would like to get on with the main frames, and satisfy the usual desire of model engineers to get an impression of what the finished job will look like as soon as possible.

The main frames are cut from $\frac{1}{16}$ in. plate. Brass or steel may be used; the former is recommended, and should be in the hard rolled state. Hard rolled plate may vary considerably, however, and before cutting out the frames, make sure that it is not too hard to bend sharply at right angles without cracking. If it is, then anneal it only just enough to stand bending. It is only necessary to mark out one frame, as the pair can be clamped together for machining. In this size, it is probably easier to sweat the pair together with soft solder, as then there is no clamp to get in the way.

The lower edge should first be made straight by rubbing on a large flat file and then on a sheet of abrasive cloth held firmly down on a surface plate or sheet of plate glass or other alternative. Since the axles are not sprung, it is important that the line of wheel centres is straight. The axle holes should first be drilled much undersize, and then checked for alignment. This can be done, most easily by putting a tight fitting plug of silver steel rod through each and holding a straight-edge against them; then use feeler gauges to test the contact of the rods and straight-edge. If unsatisfactory, the offending holes can be "pulled over" with a small needle file, and the test repeated with larger size holes until satisfactory.

Use the drilling machine, or tailstock drill pad, as it is essential that the

● *Continued on page 493*

*is large and heavy and, in such cases, packing the work in coke or asbestos brick to conserve heat as much as possible will be very helpful.*

*Blowlamps generally tend to produce a diffused flame and, as you state that a pencil point flame is required, this can only be obtained by an air-gas or oxy-gas blowpipe.*

## Traction engine

Would you please inform me as to how the cylinder block of the ME 1 in. scale traction engine should be held to the boiler to prevent steam leakage ? I am not certain as to how the grate and ashpan are fitted.—K.C., Newcastle-on-Tyne.

▲ *As there is a tendency for the steam pressure to force the cylinder off its boiler seating, it is important for the cylinder to be firmly screwed down. Contact between the curved surfaces of the cylinder and boiler should be uniform throughout and a steam-tight joint made by the application of Boss white compound.*

*When the first of the original series appeared in ME, 5 January 1933, a blueprint supplement was included. The drawing showed a general arrangement of the traction engine including a section of the firebox and ashpan. Sheet ME 4 in the set of four blueprints (obtainable from this office) shows details of the boiler and the setting out of the firebars.*

*The bars are made of stock $\frac{1}{16}$ in × ¼ in. steel flat bar 2⅞ in. long and spaced $\frac{5}{16}$ in. apart. The grate is carried on transverse bearers fixed to the underside of the foundation ring. Further details are shown in the accompanying drawings.*

## Cone size

The injector on my 7¼ in. gauge engine is reliable, but even at 75 p.s.i. it does not pick up all the water, and on cutting the latter down the injector blows off. Everything is clean and the pipes are all $\frac{3}{16}$ in., the correct diameter.

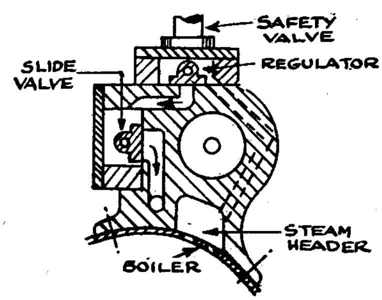
Am I right in thinking that the steam cone should be reamed out to a bigger diameter ? If not, can you suggest any other remedy ?—R.M.T., London, SW15.

▲ *Before you alter the cone sizes, we suggest that you find out whether the injector works better at a higher or a lower pressure. Generally speaking, to operate successfully at a higher pressure requires a smaller steam cone, and vice-versa, other things being equal.*

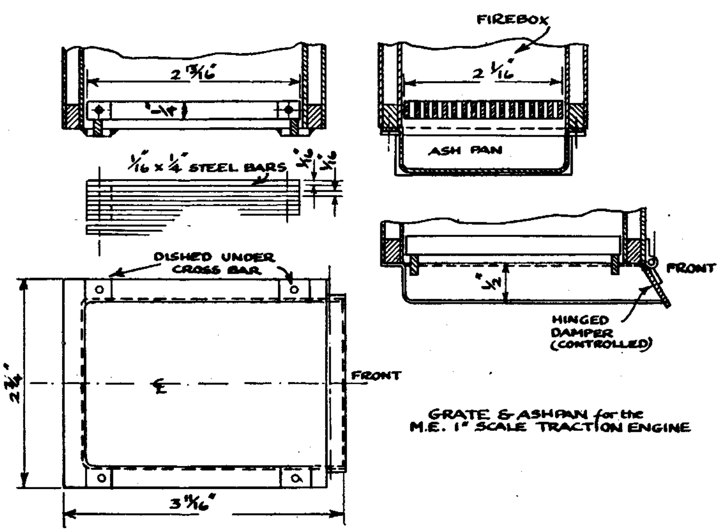
## Britannia's lion

I am building a 3½ in. gauge *Britannia* and wish to paint it green, I also wish to adorn the tender with the lion in a Crown version of the British Railways badge. I believe there is some difference in the colour scheme of the badge for different coloured locomotives and as I only see those that are painted black, I am unsure how to proceed, apart from the red lion and yellow crown. Could you inform me of the colours for background, lion's tongue and claws, wheel, borders and lettering.—J.E.P., Sidcup.

▲ *As far as we know, there is only one official colour scheme for the BR emblem. We are now in a position to supply transfers for these in ¾ in. scale.*




M E TRACTION ENGINE
CYLINDER MOUNTED ON BOILER




GRATE & ASHPAN for the M.E. 1" SCALE TRACTION ENGINE

# LIVE STEAM IN 4 mm

(Continued from page 488)

holes are square to the surface of the plates. The cutaway to accommodate the cylinder block should be left a little on the tight side at the present stage. The pair may now be separated by heating to melt the solder. The three tabs must then be bent over. One way of doing this accurately is to clamp a piece of ⅜ in. square bright mild steel to the frame with the lower edges flush, then grip both in a vice and hammer down the tabs to the steel bar. Use a bar of brass between the hammer and the tabs, or they may look very sorry for themselves after a few poorly judged wallops.

The final profile of the tabs may be cleaned up with a file after bending. The front buffer beam and forward portion of the footplate are silver soldered to the frames after the fitting of the axleboxes, which are soft soldered to avoid softening the brass frames. This procedure is quite satisfactory, as only the front of the frames gets very hot in the process. In order to locate the items during silver soldering, pins of about 0.04 in. dia. are used. The axleboxes for the second, third and fourth coupled axles also serve as frame cross-stays, and are simply turning jobs, but it is important that concentricity of the bore and spigots be maintained at both ends.

For finishing the bores, a reamer or D-bit may be used, but with care. Even a well ground twist drill will do the job if it is first drilled 5 to 10 thou undersize and the final size drill put through slowly with plenty of lubricant. The holes for the 10 BA screws to attach the frames to the footplate may be drilled at this stage; since they will be spotted through to the footplate later, only moderate precision of position is necessary here.

★ *To be continued on May 5*

Continued from 21 April, 1960, pages 486 to 488

By A. A. SHERWOOD

# SUPERSTRUCTURE and BOILER

On the original model, the footplate, side tanks, cab and coal bunker form one silver soldered assembly, although other methods of attachment may be equally satisfactory. The footplate is most easily made in two parts, a left and right side, which may be clamped or soft soldered together and cut out as one piece. It is important to remove all traces of soft solder if it is intended to silver solder the assembly later, or a most horrible alloy is obtained when soft solder and brass attain red heat. The two sides of the footplate, the rear buffer beam and the two " bridge pieces " at the front should then be silver soldered together with coarse grade solder, B6 alloy or similar.

If necessary, the footplate should be flattened, then clamped to the frames for spotting through the holes for the 10 BA screws. The safest way to do this is to spot through one of the corner holes first, drill and tap this one hole, and then attach the footplate to the frames with one 10 BA screw. The other end will still need clamping, of course. Check the alignment at the screwed end, and if satisfactory set the clamped end in alignment also, and spot through the opposite end hole. If the alignment of the screwed end is not satisfactory, you will be glad you didn't spot all six holes at the same wrong setting; you have only one hole to " fiddle."

If both the diagonally opposite corner holes have been correctly positioned, the parts may be held together by the two screws and the other holes spotted with confidence without the trouble of clamps slipping or getting in the way. If you do need to " fiddle " a hole, screw in a small piece of brass and silver solder it and no one will be able to tell the difference. The two screw-holes right at the front of the footplate are for countersunk screws which are inserted from the top; these holes should also be spotted through at the same time.

### Side tank and cab sides

The side tank, cab side and coal bunker side is cut from one piece of brass sheet. For *Plain Jane* the 8 BA holes for handrail knobs may be omitted. For the best results, the flanges should probably be turned down on a steel former, but it is possible to make quite a good job in well annealed brass without going to this trouble. The lower flanges of the side tanks and coal bunker were held to the footplate with a few 3/64 in. rivets—actually plain copper wire was used for this. The rear boiler support plate was also put in by the same method, and the joints silver soldered with Easyflow.

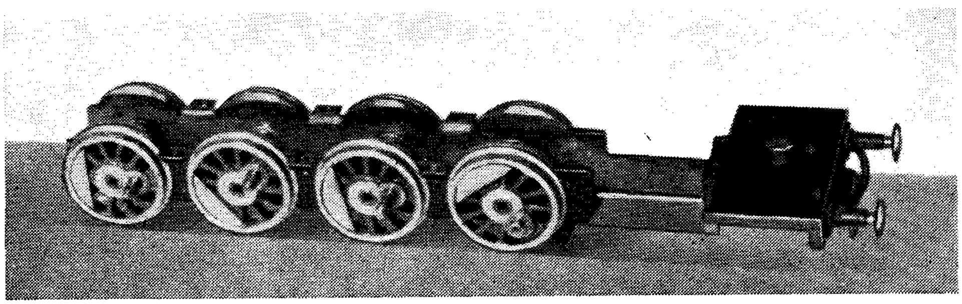
It is probably better not to proceed any further with this assembly until later, as the dimensions of the boiler will affect some of the items. When the boiler is made, the front plate of the side tanks can be inserted, and the curved recess therein fitted to bring the boiler to the correct height at the front. The front spectacle plate of the cab should also be fitted to the curve of the boiler. The rear spectacle plate, cab roof and back of the coal bunker complete the assembly, except for trimmings in the case of *Rhondda.*

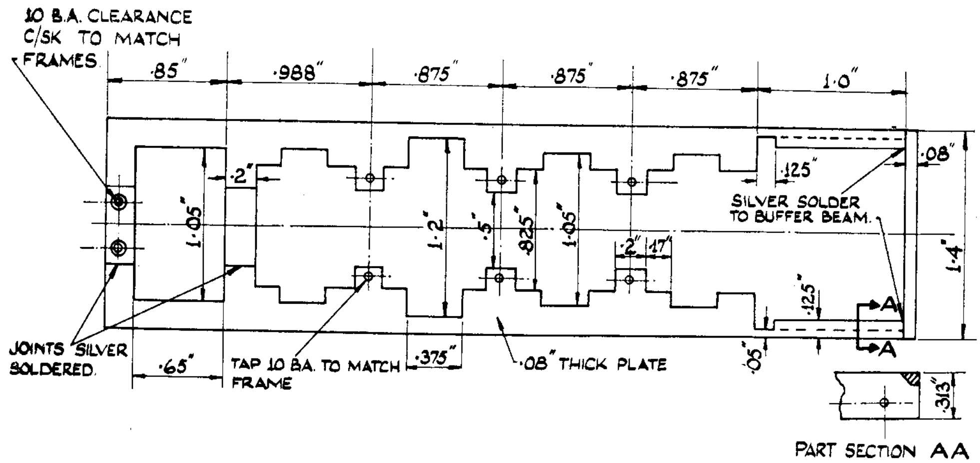
It is desirable to check the squareness of the whole assembly after silver soldering, and correct where necessary, as platework is prone to warp badly due to uneven heating. Note that the footplate is reduced considerably in section at the cab entrance. This is to reduce the heat conducted back to the fuel tank, but it is also a weak place in the assembly, and this should be remembered during the subsequent handling of the component. The tab at the bottom of the rear boiler support plate should be trimmed to fit snugly between the frames to form a flame baffle to prevent the fuel tank catching light at the vent. In the original model this has been very successful, as the fuel tank has never caught light, even when the locomotive has overturned at speed.

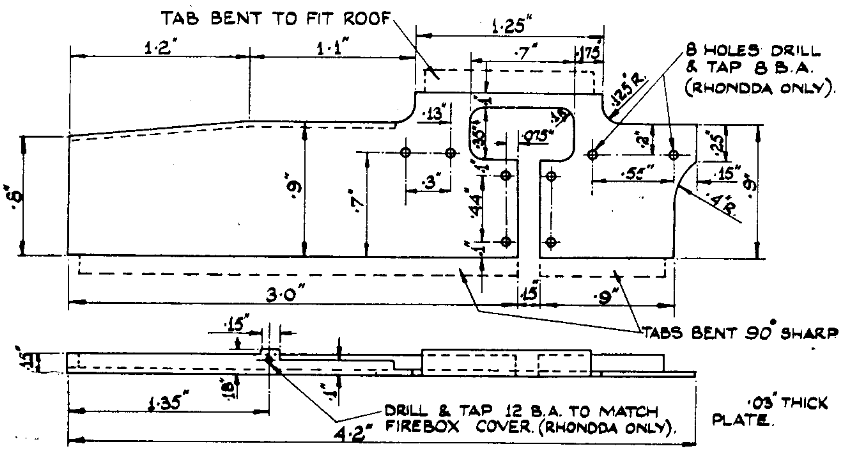
Since it is difficult to make these locomotives heavy enough to utilise their full tractive effort without slip, it is a good idea to tuck in weights wherever possible. There are quite a few possibilities in this component. Quite a bit can be accommodated, for example, under the cab roof, but don't use lead as it is likely to get hot in this locality. Copper is about the best of the metals for density; anything really heavy is likely to be really expensive. The usual cure for slip, namely sand, is not to be recommended anywhere near OO gauge mechanisms.

The dimensions of the boiler affect the completion of the assembly detailed in the preceding paragraph. The boiler of the prototype has quite a complicated profile, like most GWR locomotives. The boiler of the model has a constant taper throughout its length, an attempt being made to give the impression of the original by encasing the fore part in a parallel

*The main frames and the coupled wheels of the small engine*



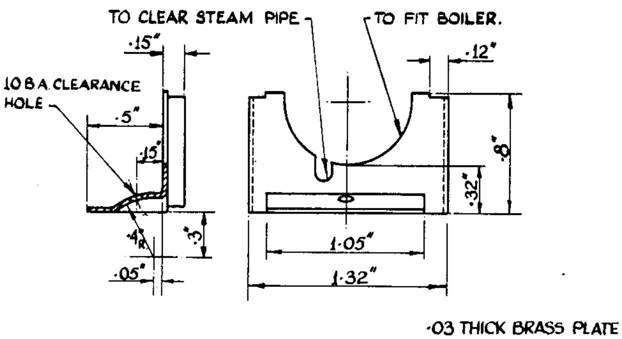


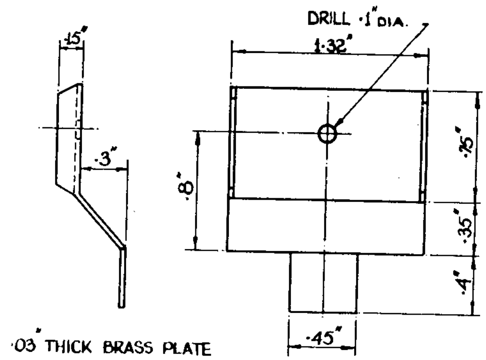




*Above: The footplate*

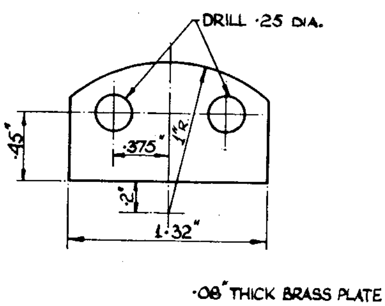
*Left: Sketch of the tank, cab and sides of the loco's bunker*

*Below: Support plate for the rear boiler*

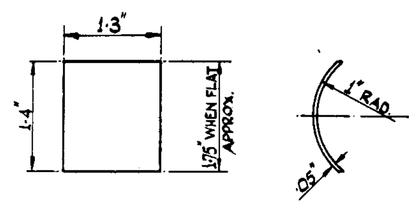



*Above: Sketch of the front plate of side tank of locomotive*

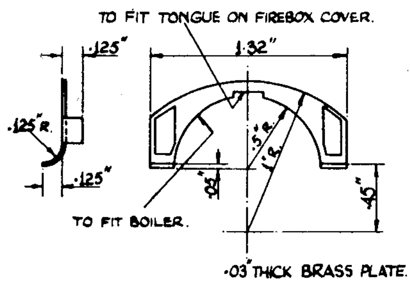



*Left: Rear spectacle plate of locomotive*

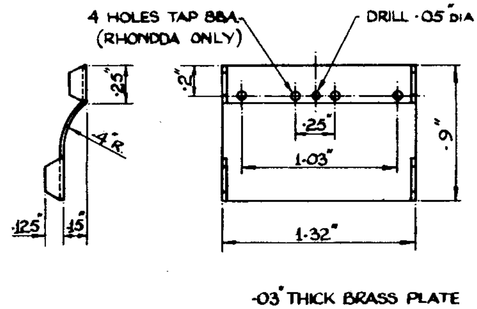



*Right: Cab roof*

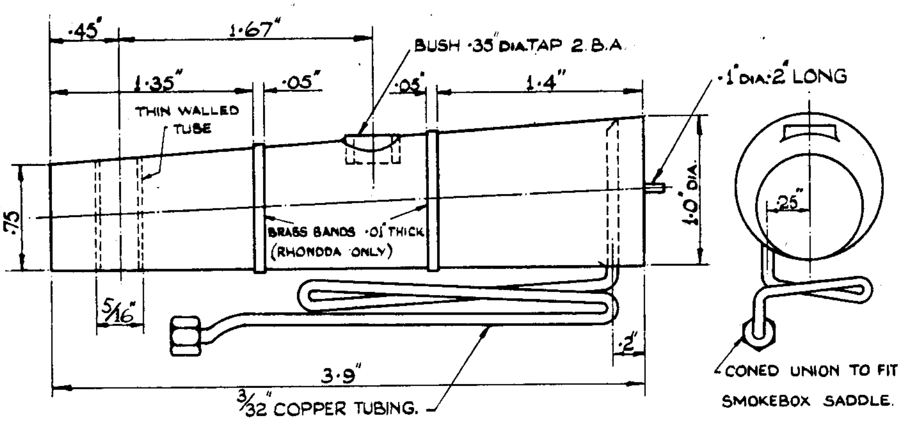

*Above: The superstructure assembly of* RHONDDA




*Left: Front spectacle plate*




*Right: Bunker rear plate*




*Below: Locomotive boiler*

cylindrical smokebox and providing a dummy Belpaire firebox cover at the rear. The effect is quite realistic, considering the extreme simplicity of the boiler. The original model has a boiler shell of 0.02 in. phosphor-bronze sheet, which was formed on a taper turned steel former, and the joint riveted and silver soldered. Phosphor bronze retains its stiffness much better than copper or brass after heating.

Alternative methods of production are beating or spinning a parallel tube over a tapered former, but it is likely to be difficult to get a tube thin enough for the job. It could also be turned from 1 in. o.d. thick walled tube—or even solid bar ! It is quite practical to turn the wall to a thin section without trouble if both the inside and outside are roughed out before taking any finish cuts. Warning to beginners—don't use cast material for boilers. The main criterion of plate thickness in small boilers is not the steam pressure, but the stiffness necessary to avoid dents due to fair wear and tear. In general, 0.02 in. to 0.03 in. thickness will be satisfactory. The end plates may be thicker; about 0.06 in. thick which will not need to be flanged or stayed.

Silver soldering with Easyflo can be done over an ordinary gas ring in this size. When fitting the bush for the filler cap and the tube at the front, remember that the lower side of the boiler is horizontal, and ensure that the filler cap stands up straight. The little spigot in the centre of the rear end of the boiler should be a very easy fit in the hole in the rear boiler support plate. Too much heat will be conducted away from the boiler in any case, without helping the heat transfer by providing a good thermal contact. It is better not to attach the steam pipe until the superstructure has been adjusted to receive the boiler barrel, as it is only in the way during this process. When the steam pipe is fitted, it should be silver soldered to the boiler while still straight, making sure that the pipe reaches right up to the top of the boiler. Then bend it to shape by hand (anneal if necessary) and finally trim it to length and fit the coned nipple. Do not forget to put the nut on first !

It may have been noticed that no safety valve is mentioned; this is no oversight, but intentional. Small safety valves are not well behaved; they dribble and waste steam and water, which in this case falls on the lamp flame and makes it splutter. Once having opened, they don't shut until the boiler pressure is much below blow-off pressure. To reassure the apprehensive, there are in fact two safety valves, but they are not on the boiler. The spring loaded slide valves act very well as safety valves; the oscillation helps the valve to close and open at the same pressure, and if there is a water leak, it does not fall on the lamp flame. The two brass bands on the barrel may be omitted in the case of *Plain Jane*. The boiler should, of course, be tested for leaks; a hydraulic test up to 100 p.s.i. will do no harm.

★ *To be continued on May* 19

Continued from 5 May 1960, pages 542 to 544

# PISTONS, PISTON RODS and the CYLINDER COVERS

**By A. A. SHERWOOD**

FOR pistons and piston rods it is desirable to use corrosion resistant metals; silver steel piston rods will be found to pit rapidly unless protected from corrosion after running the locomotive, and this is a troublesome job. The best metal for both items is stainless steel, but the usual non-ferrous alloys of copper are in general satisfactory.

Preferably, the piston should be of different metal from the cylinder. Some model engineers claim that aluminium alloy pistons are good, but I have had no experience of these. Although most stainless steel is difficult to machine, there are some free cutting varieties obtainable which make the job a good deal easier.

Since the most difficult operation with stainless steel is the drilling of small holes, the design suggested shows a stainless steel piston with a brass bush in the centre, and the piston rod fitted in this bush. Hence, instead of having to drill a $\frac{1}{16}$ in. hole in the steel, a $\frac{1}{8}$ in. hole is needed. The sequence of operations suggested for the pistons is as follows. First rough out the pistons in stainless steel, leaving about ten thou oversize on diameter and length. Then chuck a short length of brass rod about $\frac{3}{16}$ in. dia. and turn down the end to a force fit in the piston, and make it a heavy force fit.

### Fitting the rods

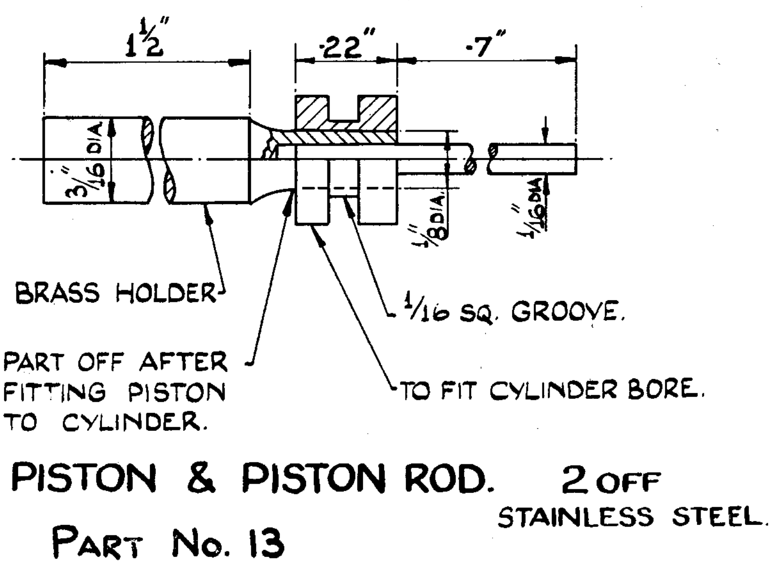
Having force fitted the piston to the brass rod, rechuck the rod with the piston about $\frac{3}{4}$ in. clear of the chuck jaws. Check that the piston is sufficiently concentric to clean up to final size, then centre it from the tailstock and drill for the piston rod. There are two ways of fitting the rod; drill for a force fit, and push the rod in while gripped in the tailstock chuck, or drill and tap the piston and screw the piston rod in. Whichever method is used, ensure that the rods are in for good with no chance coming out again; do not remove from the lathe when force fitting or screwing in.

The piston rod should now be accurately centred in the lathe, but it is desirable to check this with a dial gauge. It will almost certainly be true near the piston, but the other end is liable to wander. If so it should be carefully bent until it is truly centred all along its length to within 0.001 in. When this happy state of affairs is achieved, the piston can be finish turned to fit the cylinder. If using stainless steel for the piston, it may be difficult to take the last small "scrape" due to its work hardening propensity; if so, then the safest course is to remove the last thou with a fine file and abrasive cloth.

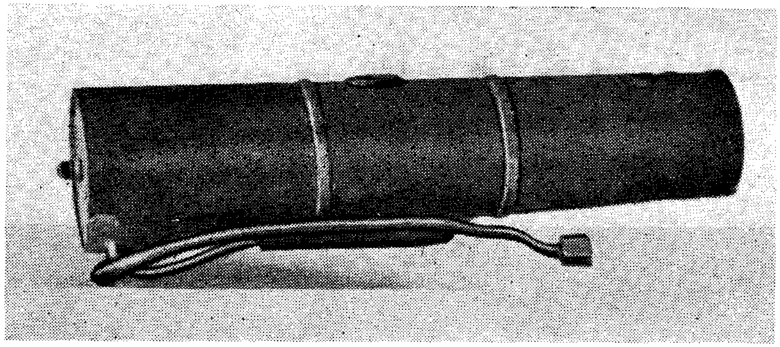
The piston should be made a fairly tight fit in the cylinder, but not tight enough to seize. It should be run in by hand using plenty of lubricant—graphited oil is excellent for this purpose. The benefit of the brass "handle" will be apparent at this stage, as it avoids the possibility of straining the slender piston rod. It is quite satisfactory to turn larger size pistons when supported by their piston rods, but it is a risky business in gauge OO. When the pistons have been run in to a nice smooth fit in their bores, then the piston rods can be trimmed to correct length and the pistons parted from their brass "handles."

The front cylinder covers are simple turning jobs that can be done at the one setting with the exception of the screwdriver slot. The thread should preferably be screwcut, as it is too short for a die, although it is permissible to finish off the job with a die provided the unchamfered end is used. Make sure the fit of the thread in the cylinder block is good, as there are not many turns of thread, and a loose fit will soon lead to a stripped thread when tightening up to ensure steamtightness.

After parting off, the slot must be cut; the design shown is unobtrusive and will permit a firm grip to be taken with a suitably shaped screwdriver without danger of slipping. It can be cut with a small Woodruff type cutter; since the cutter will probably have to be made specially for the job, full slot dimensions are given, but these are obviously not critical, and an existing cutter of approximately the same size will do. Other ways of achieving the same result are to use an ordinary screwdriver slot, (which is the easiest and no doubt will do for *Plain Jane*) or two diametrically opposed drilled holes and an appropriate two pronged spanner.



The rear covers entail a little more work, especially for *Rhondda.* The other engine *Plain Jane* has no slide bars, so an "inside out" gland is used to give the piston rod adequate support. My first OO gauge live steamer was made in this way about 14 years ago, and still performs as well as ever after many miles, so constructors need have no fears about omitting slide bars. In fact, I only fit them because no full size locomotive would get far without them.



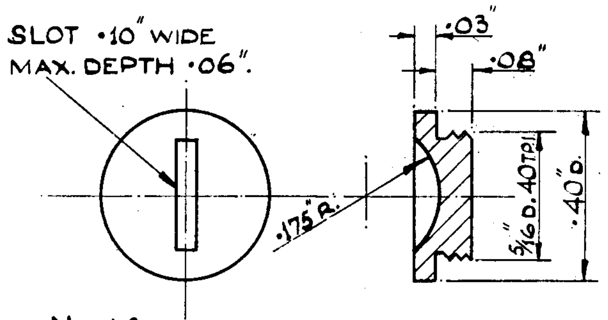
*The boiler for the miniature locomotives described in these articles*

**Rear cover**

The rear cover for *Plain Jane* is a simple turning job, the main essentials being concentricity of hole, thread and spigot.

The suggested procedure is to turn and thread the 1/8 in. × 60 t.p.i., then hold each in a tapped bush in the chuck and drill the hole and turn the spigot at the same setting. The spigot should be a good press fit in the cylinder. Note the chamfer, which forms a groove for soft solder, which is used as added insurance in case the press fit is not so good. Be sparing with the amount of solder used, and keep it out of the bore and passages. Warning: don't fix the rear covers until the pistons have been fitted and run in by hand, as it is desirable to have both ends of the cylinder open for this operation.

The rear covers for *Rhondda* are more involved as the holes for the slide bars have to be carefully positioned. The suggested technique assumes the minimum equipment. Chuck a short length of 7/16 in. dia. bronze or brass bar, and drill the piston rod hole and the tapping size hole for the gland. Tap the gland recess 1/8 in. 60 t.p.i. with the tap held in the tailstock chuck to ensure concentric threads. Part off slightly overlength, and repeat the whole procedure for the other side rear cover. Then turn up a small screwed mandrel with a spigot to fit the piston rod hole. The thread on this mandrel

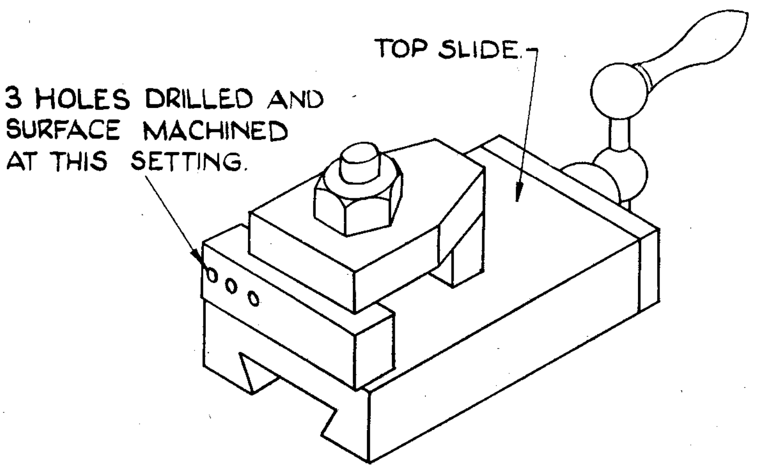



PART No. 14. BRASS
FRONT CYLINDER COVER. 2 OFF.

should be put on with a tailstock die-holder, or better still, screwcut in the lathe if your machine will do threads as fine as this.

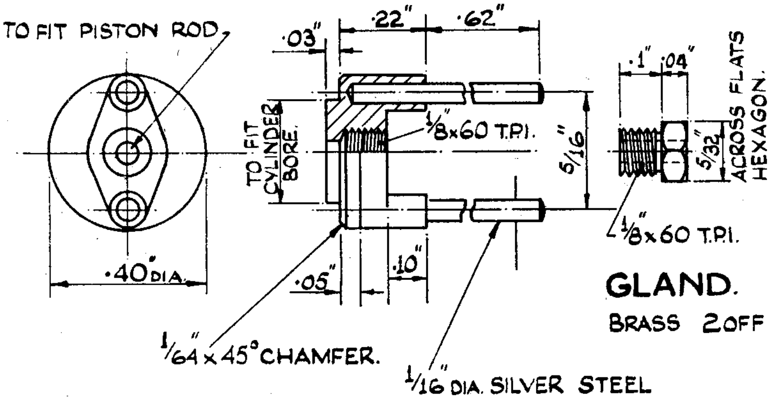
The rest of the turning can be done with the covers mounted on this mandrel, which will ensure concentricity. A jig for drilling the slide bar holes can be made from a piece of 1/2 in. square bar held in the toolpost. The three holes can be accurately spaced by using the cross-slide index, and the surface milled or flycut at the same setting. This, of course, assumes that the lathe can be relied on for accuracy. It is rather optimistic to apply the usual marking-out technique on models of this size and hope for sufficient accuracy. The central hole should be tapped 1/8 in. 60 t.p.i. This jig is attached to the rear cover by a short length of threaded rod, and the slide bar holes drilled in the drilling machine.

The slide bars in this design are of circular form, since they are much easier to make and fit than the correct rectangular form, and one has to look closely at the model to notice this



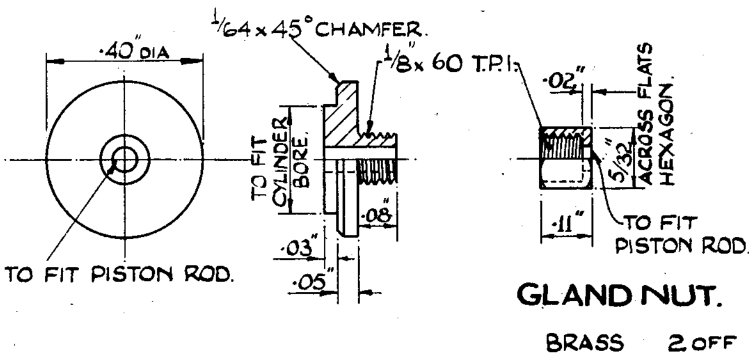

SET UP FOR MACHINING JIG FOR DRILLING SLIDE BAR HOLES IN CYLINDER COVER.

SKETCH. C.




REAR CYLINDER COVER. (RHONDDA) BRASS 2 OFF

PART No. 15A.




REAR CYLINDER COVER. (PLAIN JANE) BRASS 2 OFF

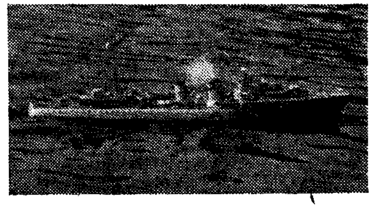
PART No. 15 B.

discrepancy. Real super-detail enthusiasts may, if they wish, go to the extent of fitting true GWR type slide bars, but they will have to evolve their own production methods. The slide bars are of silver steel, press fitted to the cylinder covers. The covers are then pressed into the cylinder block, setting the slide bars at the correct angular position (i.e. top and bottom) with a square. After pressing in, the covers are sweated with soft solder. The excess metal still on the rear cover can be trimmed by hand after the covers have been fitted, as it is easier to grip the block than the cover itself: but remember to use soft clams in the vice jaws.

The drill sizes have not been given for most of these operations. The main essential is that the slide bars should fit tight, and their diameter is not critical. So, if the drill has cut a little oversize and the specified $\frac{1}{16}$ in. dia. slide bar is loose, use the next larger number size bar. The next larger fractional size would, of course, be excessive. If the whole process has been carried out with care, the alignment of the bars should be excellent, but it is as well to check this. This may be done by mounting the cylinder on a mandrel in the lathe, and checking the bars in horizontal and vertical alignment with a dial gauge attached to the toolpost. For this purpose, it is best to use a flat ended anvil on the dial gauge plunger.

If you are unlucky (or careless) and drop the assembly, it will still be possible to salvage the remains by carefully bending the bars until they pass this test to within about a thou. The rear ends of the slide bars are not supported in this design, the rear guide bar support being merely a dummy. To make and accurately align a rear guide bar support would entail a lot of difficult work in this size, and a badly aligned support is worse than none at all.

★ *To be continued on June 2*



## HMS COSSACK IN 1/72 SCALE

A successful model which has already won a cup and two First prizes for Mr C. McAllister

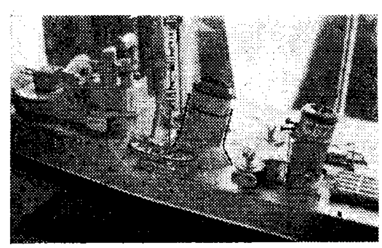
HMS COSSACK, a Tribal class destroyer, was laid down in 1939 and launched in 1940 with a total displacement of 1,870 tons, overall length of 379 ft and a beam of 36½ ft. She appeared an attractive vessel to build as a model.

Plans were available for a 3 ft model and these were doubled to give a scale of 1/6 in. to 1 ft, giving a finished model of about 6 ft with a beam of 7 in.

Bread-and-butter was the chosen method of construction, and building, using obechi planks, commenced in October 1958. The hull proved to be the least difficult part to make and it was shaped and hollowed in approximately two and a half months.

The very extensive deck details occupied the next six and a half months, construction and fabrication being carried out mainly in ply of various thicknesses. The funnels were built from sheet tin, and the main guns turned from brass rods.

The power plant is a 7 c.c. Taplin twin-cylinder diesel engine, exhausting through twin silencers and oil trap, then through the main forward funnel. This arrangement gives a fine sense of realism when the model is in action, and the power unit provides a flexible range of speeds well suited to the size and type of hull. ■



 Continued from 19 May 1960, pages 604 to 608

# From CROSSHEADS to SLIDE VALVES

THE main precision requirement in the crossheads is to obtain correct alignment and position of the piston rod hole and the surfaces which contact the slide bars. This may be most easily achieved by drilling three holes in the same manner as for the jig made for the slide bar holes in the rear cylinder covers. It is advisable to leave a generous excess of metal all round at this stage, as it does not make the positions of the holes so critical if the exterior can be trimmed to size later.

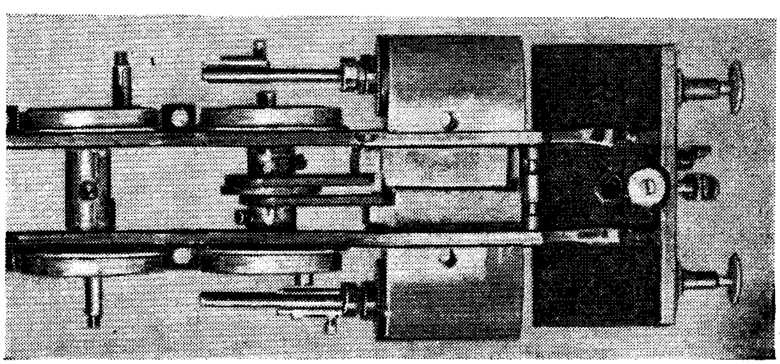
## By A. A. SHERWOOD

The hole for the wrist pin and 12 BA lock screw are then drilled, no extreme precision being required here. The recess to clear the small end of the connecting-rod will require a special pin-drill or counterboring cutter, the making of which has previously been described many times in MODEL ENGINEER.

The wrist pin-hole should be counterbored until the last trace of the piston rod hole in the immediate locality just disappears. Before filing the outside to shape, it is as well to test the component on the slide bars; if tight, the two appropriate holes may be slightly enlarged until it slides easily. Then the piston and rod may be attached to the crosshead, and the whole assembly checked for freedom of motion. Do not pack the piston yet. When satisfactory, the exterior of the crosshead may be filed or machined to size.

The foregoing instructions, of course, apply to *Rhondda*. The crosshead for *Plain Jane* is simple by comparison, and can be made from 5/32 in. square brass or bronze. The same metals can be used for *Rhondda*, and the right colour obtained by plating. Do not tackle the job in stainless steel unless you have a good deal of experience with this intractable material. At this stage it is also a good idea to assemble the cylinder block and the main frames, and check the clearance between the back of the crossheads and the frames. It will be a little under ¼ in. if the workmanship is accurate, and this has to accommodate the wheels and coupling rods, so there is hardly sufficient room for the correct type double-sided crosshead.

The eccentrics may be made by turning to the outer diameter a bar of silver steel held in the independent chuck. The bar should then be offset by adjusting the chuck jaws until the required stroke is obtained as measured by a dial gauge, taking maximum and minimum readings as the chuck rotates. The axle hole is then drilled from the tailstock, deep enough for both eccentrics plus parting allowance. The two eccentrics are then parted off the bar, and burrs removed. In order to obtain the accurate 90 deg. phasing, the two eccentrics may be clamped together with a close-fitting bolt (it is worth making one specially for the job, as the usual commercial ones are not likely to fit the holes precisely), set to phase by a micrometer reading as shown in the diagram, and the pin-hole drilled through the pair.



*Plan view of the valve gear*

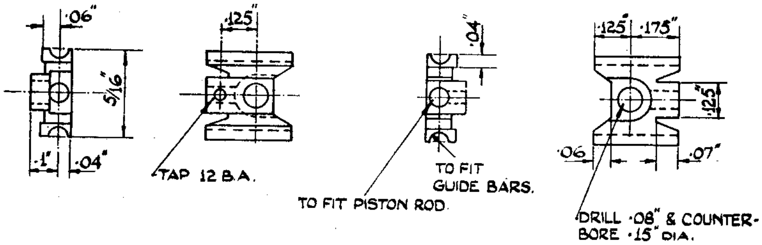
The precise location of this hole is not important, but it should be square with the surface of the eccentric. The pair must always be assembled in the same way as when drilled, so some distinguishing mark should be made on each; also, if you want to follow full size practice, the right-hand eccentric should lead, but this will not affect the performance one iota. The spacing disc should next be made, and the hole for the driving pin spotted through it, using one of the eccentrics as a jig. This hole may be drilled oversize in the spacing disc to simplify assembly later. The eccentrics should be hardened right out in water, tempered to medium straw, and cleaned up with fine abrasive cloth.

### Assembling the eccentrics

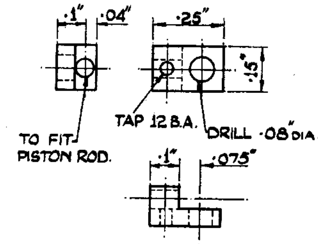
The eccentrics and the disc should then be assembled with a close-fitting driving pin, and clamped together with a close-fitting bolt through the bores, and the assembly secured permanently by sweating with solder. Tinning the appropriate surfaces before assembly will assist in getting a neat job without having a lot of unwanted solder to trim off later. If just enough heat is used to melt the solder, the temper of the eccentrics will not suffer. The clamp bolt could be made of a hard aluminium alloy to avoid adherence to the rest of the assembly when sweating, or you will probably have to drill it out after sweating. The final assembly should be a free fit on the axle but without perceptible shake. It may be necessary to lap out the bore a little to achieve this, but it will have to wait until the axles are made.

### The two stop collars

The stop collars are next in line, and are quite straightforward jobs. They must, of course, clear the driving pins. This can easily be checked by trying the assembly on a piece of ⅛ in. dia. silver steel. To be on the safe side, allow about 0.005 in. clearance. It is a good idea to drill and tap the 12 BA holes right through both sides, then in the unfortunate event of stripping a thread after final assembly, the stop screw may be put into the other hole. The alternative would involve a major operation. The combined length of

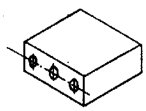



CROSSHEAD (RHONDDA). 2 OFF. BRASS OR STEEL.
PART No. 16A.

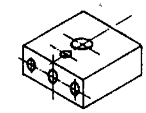



CROSSHEAD (PLAIN JANE) 2 OFF. BRASS OR STEEL
PART No. 16B.

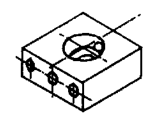
SKETCH. D.



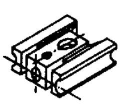
1. 3 HOLES DRILLED RIGHT THROUGH.



2. WRIST PIN HOLE AND SET SCREW HOLE DRILLED.

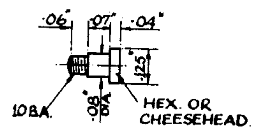


3. BLOCK INVERTED AND WRIST PIN HOLE COUNTERBORED.



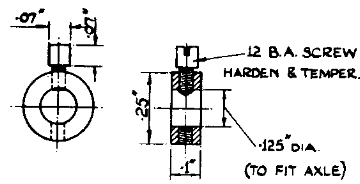
4. EXTERIOR TRIMMED TO SIZE.

STAGES IN THE PRODUCTION OF THE CROSSHEAD.



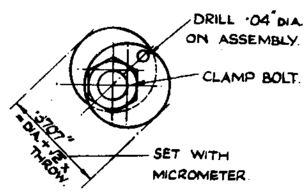

SILVER STEEL. HARDEN & TEMPER.

CROSSHEAD PIN. 2 OFF.

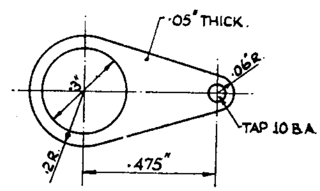



BRASS.

STOP COLLAR 2 OFF.
PART No. 18.

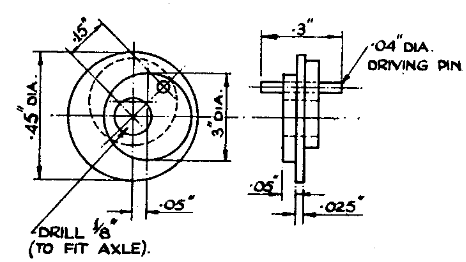



QUARTERING THE ECCENTRICS.
SKETCH E.

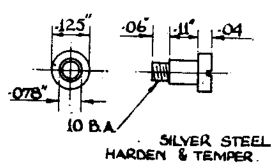



CARBON STEEL. HARDEN & STEEL.

ECCENTRIC ROD. 2 OFF.
PART No. 19.

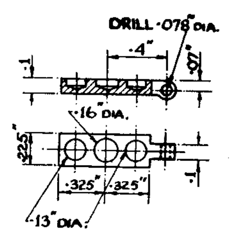



ECCENTRIC ASSEMBLY. 1 OFF
PART No. 17.




SILVER STEEL. HARDEN & TEMPER.

VALVE PIN. 2 OFF.




BRONZE.

SLIDE VALVE. 2 OFF.
PART No. 20

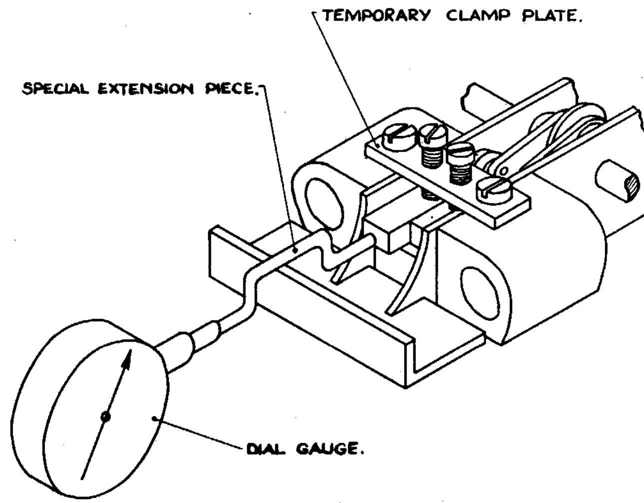
the two stop collars and the eccentric assembly should be about 0.005 in. less than the space between the axleboxes for the first coupled axle; don't leave too much clearance here, as very little sideways motion of this axle is permissible without the coupling rod fouling the crossheads.

The eccentric rods may be made from gauge plate and hardened right through and tempered to dark straw, or mild steel plate and case hardened. The large hole may be bored to fit the eccentric, or preferably left slightly undersize and lapped to fit after hardening. The centre distance between the 10 BA hole and the hole to fit the eccentric is not critical, since the method to be described for machining the slide valve cavities automatically corrects any errors in this component and, in fact, all other errors except the eccentric stroke and the spacing of ports on the portface. If any warping appears after hardening, the item may be straightened if it is of case-hardened mild steel; if it is of gauge plate, the faces may be rubbed down on a flat carborundum stone. The main objection to warping is that, if severe, it may tend to cause seizure at some positions of the eccentric.

The screw which connects the eccentric rod to the slide valve is similar to many others required during the course of construction of the model. My practice has been to turn them from silver steel, and polish the shank, then part off and slot them by hand with a watchmaker's screw slotting file. If you do not possess one, a fine hacksaw blade ground thin at one end will do the job. The screw is then hardened, the shank repolished, the head held in a pin-vice, and a fine flame played on the threaded end until the shank shows a straw colour. By this time the temper of the threads will be drawn sufficiently to prevent breakage at the change of section when tightened fully. After that, the threaded end is held in the pinvice, and the flame played on the head to prevent failure at this end, where the slot forms a serious stress raiser if the metal is left in a hard and brittle condition.

The holes which bear on the shank of these pivot screws are bronze, and can be drilled slightly undersize, and opened out to fit with a slow tapered broach. The standard articles are of pentagonal section, and may be obtained in a range of sizes from a few thou diameter to about $\frac{3}{16}$ in. Although the hole produced is not parallel, the taper is so slow that the difference in diameter is negligible in a short hole, especially if the broach is used from each end in turn. In this particular case the valve must be allowed to rock slightly on the pivot, so that the spring may be allowed to keep it pressed in contact with the portface.

The slide valves should be roughed out about 0.01 in. oversize in thickness and about 0.05 in. overlength at the front end. The valve width must be carefully trimmed until the two valves will fit side by side on the portface and between the frames. All this is probably most easily done by hand filing. The holes for the pivot screws should then be broached to a close fit, and each valve attached to its eccentric rod. A temporary clamp for the cylinder block is required, as shown in the diagram, made from $\frac{1}{8}$ in. × $\frac{1}{2}$ in. steel or brass. This is used to clamp the cylinder block to the frames with two 7 BA screws. If the block still has a slight freedom vertically when the screws are tight, its underface should be carefully filed until this disappears. The other two screws in the clamp plate are used to lock the valves in mid-position.




SET-UP FOR CENTERING VALVE CAVITIES.

SKETCH. F.

**Setting up the valve gear**

The whole valve gear assembly should now be set up, using a piece of $\frac{1}{8}$ in. rod in place of the first axle. The two stop collar screws are set to bear on opposite sides of the driving pin so that the dummy axle and the eccentrics rotate in each direction without backlash. The frames must then be clamped to some fixed base, preferably in the inverted position, and a dial gauge set up to measure valve travel. If you have an attachment for checking the concentricity of set-up in small bores, it will be easy to get at the front ends of the valves with it; if not, the front buffer beam gets in the way of the usual type plunger, and the special extension piece shown in the diagram will have to be made.

First, the valve travel should be checked as the axle is slowly rotated, making sure that the valve is pressed into contact with the portface all the time. If satisfactory, set the valve to mid-position, and then 0.0025 in. past this towards the rear of the locomotive, this being the correction for the obliquity of the eccentric rod when the eccentric is 90 deg. from dead centre. Lock the valve in this position with the appropriate screw, using gentle pressure initially and watching the dial gauge all the time for the least sign of movement.

**Drilling accurately**

When fully locked, unclamp the frames from the base, and spot through deeply the two end ports and the centre port with a close-fitting drill. Repeat the whole operation for the other valve. These holes must be opened out to the diameters given on the drawing, and it is important that the drills used do not wander and that they cut true to size. One way of ensuring this is to make special pin-drills with very short and close-fitting pilots. Two alternative methods for the cautious are to leave the cavities undersize and gradually open them out later on when the locomotive is sufficiently advanced to test the valve events on compressed air, or drill the cavities right through so

*Continued on page 681*

## HERKULES

Continued from page 667

four engines are reversible so that the crankshaft can run in either direction. For quick changes in movement when manoeuvring, one set of engines is made to run clockwise and the other set anti-clockwise. As I have already stated, the drive to the propeller shaft is through clutches so that it is only a question of engaging and disengaging the clutches to bring about a change in direction.

The propeller shaft does 183 r.p.m. against the engines 675 r.p.m., the reduction resulting from the different diameter of the V-pulleys. The propeller is of the variable pitch type.

The engines and pitch of the propeller can be controlled directly from the bridge, independent of the engineer, by a pneumatic system developed by Deutz, or by the engineer receiving his orders from the bridge on the ship's telegraph. The engineer does not stand by his engines in the manner that most of us assume to be general practice, but has his own control room off the engine room. Here he can control the whole vessel by manipulating levers, blobs and gadgets which seem to be in triplicate ! Personally, I thought the control panel with its clocks, gauges, red and green lights looked more like something off the flight deck of a giant airliner.

The room is sound-proofed which shows that the designer went into great detail and certainly had the interests of the engine room staff prominently in mind.

The steering gear is electrically operated but in an emergency can be operated by hand through the hydraulic system.

In the engine room there is one 250 kVA a.c. generator driven directly by one of the main engines or, alternatively, via the propeller shaft by any main engine. Two 69 kVA generators powered by Deutz auxiliaries and suitable for parallel connections, and one 23 kVA generator are also driven by a Deuty. There are two hydraulic pumps for powering the deck machinery.

The deck equipment is all hydraulically operated and consists of a towing winch with a 40-ton pull and 750 metres of towing wire, a 5-ton deck winch, anchor winch and capstan.

The *Herkules* is equipped with the latest gadgets modern science can provide to aid in navigation, including such things as a gyrocompass, gyro-pilot, radar, echo-sounder, electric log, direction finder and v.h.f. radio. Most of this equipment appears to have been manufactured by Decca.

The salvage equipment is of the latest and most up-to-date kind as one would expect on such a vessel. For firefighting there are two monitors and hydrant points positioned on the deck. There are also transportable pumps which can be used for fire-fighting or salvage work. These portable pumps are capable of discharging 1,800 tons of water an hour.

Compressed air for salvage and diving is supplied from three compressors and among the equipment for underwater repairs are such things as a box gun, electric welding and cutting gear.

A first-class repair shop is also provided suitably equipped with a 6 in. centre lathe made by A. Fielding, of Keighley, a Wolf press drill, oxy-acetylene welding gear and a full range of hand tools.

In addition to these main items, there are about 80 tons of miscellaneous salvage gear such as towing hawsers, dredge anchors, and similar material.

My impression as I left the *Herkules* is that she should live up to her name, and with every facility provided to make the crew as comfortable as possible, be a most happy ship to be aboard.

## OPERATING SMALL I.C. ENGINES

**Small Engines Service Manual (4th Edition).** (*Technical Publications, Inc.*, 1014 *Wyandotte, Kansas City, Mo., USA*). *Price* $4.95.

THIS book deals in close detail with the running, maintenance, repair and adjustment of small internal combustion engines as employed for industrial purposes. It might be described as a compendium of the information which is normally found in instruction books issued by manufacturers, as it includes lists of spare parts under catalogue or code numbers.

Although the engines dealt with are nearly all of American manufacture, with two notable exceptions—the British JAP industrial engines and the Italian Vespa engines, as fitted to motor scooters—the information is applicable generally to any engines having a capacity up to about 100 c.c. or 6 cu. in. per cylinder.

The principles of ignition, by battery coil and h.t. magneto systems, are explained, with illustrations of various proprietary units and accessories. Carburation is similarly treated, including gravity, suction and pump-fed installations; also the characteristics of two-stroke and four-stroke engines, governor control, impulse couplings, and the location and correction of faults.

Apart from one make of solid-injection compression ignition engine, the engines described are all spark-ignition types using petrol or light fuels, and mostly air-cooled. This is a very useful and practical book for anyone concerned with small i.c. engines in any of their many and varied forms.

## LOCOS IN 4 mm SCALE

*Continued from page 680*

that the events can be inspected under a magnifier (about 10 X) and the holes broached out until correct.

In either of these cases, some simple form of angle setting for the axle should be set up, and the valves set to admit at 0 deg., cut off at 120 deg., exhaust open at 150 deg. and close at 330 deg., i.e. " line for line " exhaust. These events are admittedly not the most economical, but any earlier cut-off result in marked discontinuity of torque at drag speeds, and personally, I like to see the locomotive run smoothly with nice even beats at a mere crawl, especially when it's supposed to be a freight type. Furthermore, the model will be difficult to start off at an earlier cut-off, especially when new, due to condensate trouble.

The amount of lead can be adjusted later by the stop collar setting to give the best actual performance on the track. If the cavities are drilled right through, then, of course, it will be necessary to close them by a thin brass plate sweated to the underside of the valve, which should, in this case, be made slightly thinner initially so that the finished thickness comes out right. After the cavities have been correctly sized, the valves should be trimmed to length at the front, eased a little at the sides to give a slight side-play, filed to correct thickness, and the upper faces smoothed truly flat. A fine grade of abrasive cloth on a true flat surface will do the job if slow strokes are taken with care to avoid tipping. Even if the surface is poor at first, it will improve with use; this is one endearing feature of the slide valve.

★*To be continued on June* 16

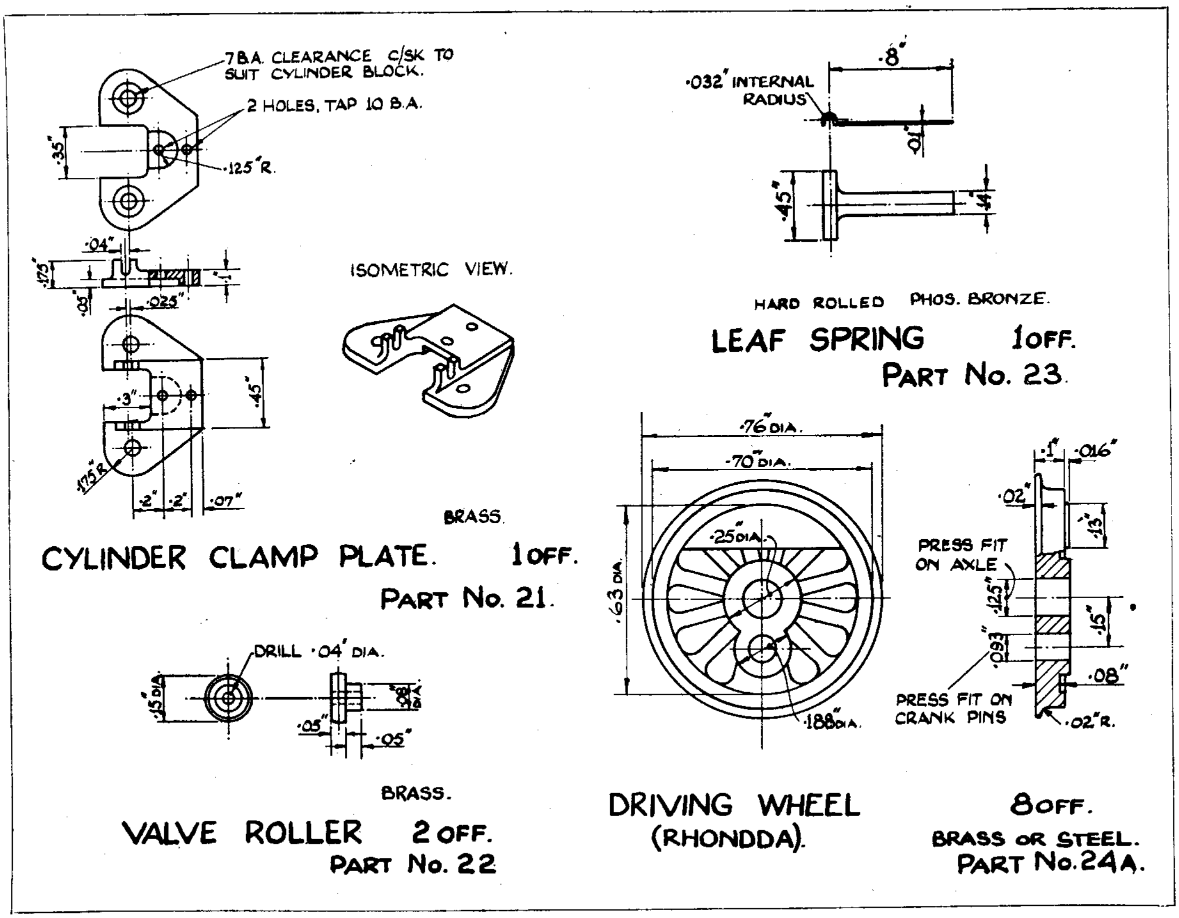
# Clamp plate, coupled wheels and coupling-rod

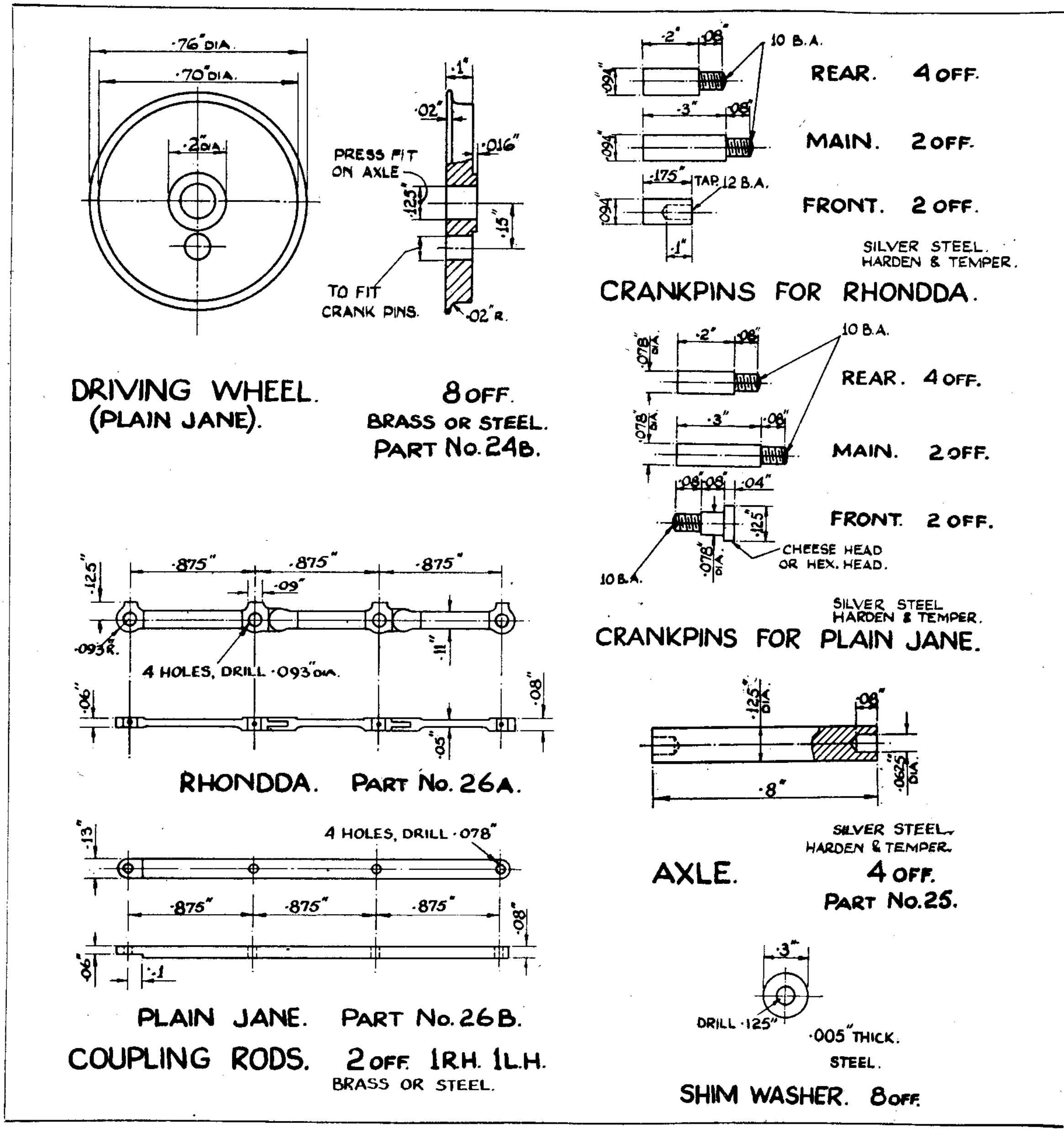
By A. A. SHERWOOD

THE clamp plate has three functions; it clamps the cylinder block to the frames, supports the pivot for the pony truck and the adjusting screw for the valve spring tension. It can be made from 0.05 in. brass plate by bending and silver soldering. This method avoids having to machine out the recess for the rear end of the pony truck radius bar. The design shows countersunk screws for attachment to the cylinder block, as they leave a little more daylight under the frames than projecting heads would, but any type of head may be used as long as it does not foul the rails. The rollers are simple turning jobs, and should be an easy fit on their spindle (0.04 in. silver steel) which, in turn, should slide freely in the slots in the clamp plate.

The leaf spring is best made from hard rolled phosphor bronze cut from the sheet so that the long axis is in the direction of the rolling. It is desirable that the spring should only contact the spindle at its centre to ensure equal pressure on each valve. This may be achieved either by making the spring convex upwards in the cross-section, or by turning the spindle out of slightly larger size rod and leaving a very short length at the centre a larger diameter. If any trouble is experienced with the spring tending to slide off the adjusting screw sideways, this can be corrected by pressing in a dimple to locate the pointed end of the screw. Since there is not much room for a locknut on the adjusting screw, it should be made a close fit in the threads to retain its setting.

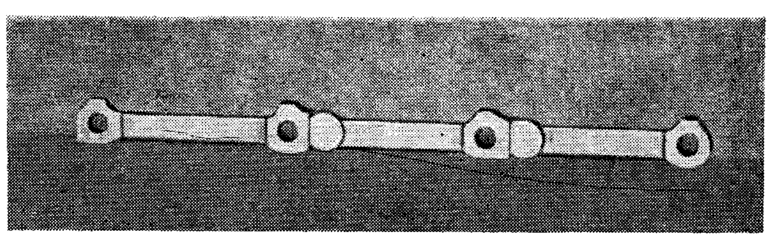
The wheels shown in the pictures were made of brass and dull nickel plated, but a wide variety of metals may be used to suit individual taste. Those for *Plain Jane* are so simple that the drawing is self-explanatory. I have sometimes used commercial brass OO gauge wheels, and although that avoids the tedious job of cutting



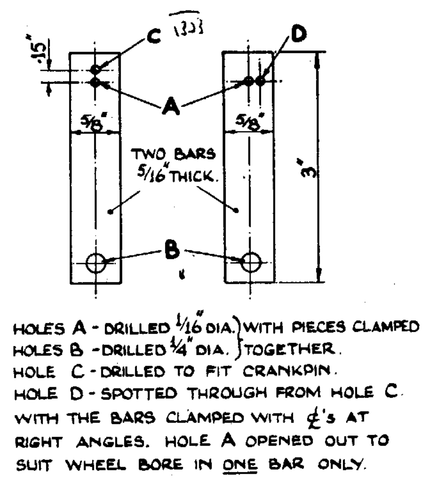



the spokes, I doubt if there was much saving in time as the central hub and crankpin bosses had to be strengthened by building up with brass plates and silver solder.

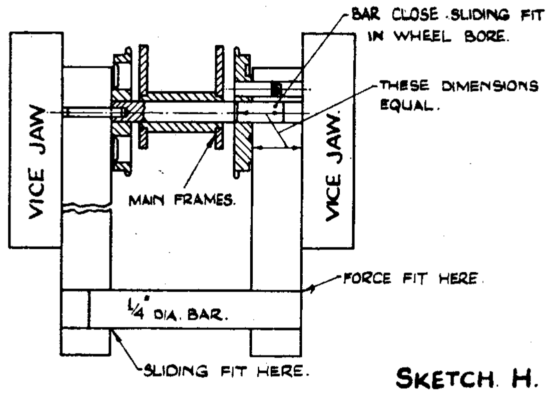
The method used for these particular wheels was to cut the blanks from ⅛ in. plate, and turn the recessed part between the rim and hub to 0.08 in. thick all round. Using a dividing head, holes were drilled for the gaps between the spokes all the way round except for the one gap which would occupy the crankpin position. The



*Coupling rod for* RHONDDA




SKETCH G.
QUARTERING JIG.




SKETCH H.
SET UP FOR PRESSING WHEELS ON AXLES.

rest of the metal between the spokes was removed by means of a triangular punch. The position of the crankpin centre was then marked (precision is not important at this stage) and drilled about 5/64 in. right through and counterbored to 3/16 in. for about half the thickness with a pin-drill. This operation requires care as the cut is intermittent.

Plugs were turned 3/16 in. dia. with 5/64 in. dia. spigots on the end, to fit these counterbored holes in each wheel, and silver soldered in. The balance weights were also attached at the same heat. This provides the equivalent of castings, which may then be machined by any of the usual methods. The methods I normally use is to drill the axle hole about 0.002 in. undersize, and then set up a short length of steel bar (in this case about 3/8 in. dia.) in the independent chuck and skim the outer diameter true. Then turn a spigot, to a close fit in the wheel, on the end of the bar, and thread the end of the spigot slightly under the shank diameter; in this case, 6 BA is suitable.

**Crankpin hole and bosses**

All the plain turning can be done by operations with the wheels in turn mounted on this spigot. If you don't trust friction grip, a peg can be put into the end face of the bar to engage the spokes and give a positive drive. The crankpin hole can be drilled by offsetting the mandrel in the independent chuck to give 0.3 in. total dial gauge reading on rotation; if you allow any error here, make the stroke less than 0.3 in. rather than more. The crankpin bosses can be drilled from the tailstock starting, of course, with a short, stiff centre drill. The various crankpins are press fitted to the wheels before fitting the wheels to the axles.

The axles are cut from 1/8 in. silver steel. If you have collet chucks, the accurate centring of each end is simple. Since the centres will be used later for quartering, they should be accurate. The wheel spacing is dependent on the correct length of the axle, as there are no wheel seats of reduced diameter as is usual on the larger models. The first axle is of constant diameter over the whole length. The other three may, with advantage, be reduced in diameter by about 0.01 in. over the central 0.3 in. of the length to provide a small oil pocket and avoid trouble due to the inevitable distortion after hardening.

**Hardening and tempering**

Each axle should be hardened right out in water and tempered to medium straw. Quench each vertically and if they do come out bent, the easiest thing is to make new ones. Do not forget to chamfer the ends smoothly or the axle will cut its way into the wheel hub when being pressed on, and spoil the press fit. Before pressing the wheels on the axle, it is desirable to open out the hub with a taper broach until the axle will just start to enter without force. One wheel may be fitted to each axle at this stage, but we are not yet ready to put both on.

Making coupling rods is the part of locomotive building that I like the least. I have not yet found any really efficient way of making these items; hand filing seems just about as good as milling in this size. In any case, the outer profile has no functional purpose in this size, so it only has to look respectable. For those tackling *Plain Jane*, appearance is of secondary importance, and the coupling rods are of constant rectangular section over the whole length. In order to clear the footplate, the depth of the rods must be limited, and this explains why the crankpins of *Plain Jane* are smaller in diameter than those of *Rhondda*, since only in the latter are the rods increased in size at the crankpins. The only essential precision operation on the rods is the location of the crankpin bearings. This can be achieved quite easily by using the frames as a jig.

**Making a drill**

An easily made drill for this operation consists of a piece of 1/8 in. silver steel with one end turned down to a little under crankpin diameter for about 0.2 in. length and this end filed to form a spearpoint drill. Harden and temper the cutting end, and smooth the shank to pass through the locomotive axleboxes. Clamp the roughed out coupling rods to the frames, and jig drill the holes. Open out these holes with a long tapered broach until they fit nicely on the crankpins, taking care not to bend the coupling rods in the process. They are a bit on the flimsy side, and if bent and then straightened they never seem quite the same length as before; that is why the drilling of the holes is left till the last operation.

★ *To be continued on July* 30

*Continued from 16 June 1960, pages 722 to 724*

# Quartering the wheels, making the connecting-rods, and testing the mechanism

**Pictures in this series are by Mrs Sherwood, who also assisted with the diagrams and the construction of the locomotives**

**By A. A. SHERWOOD**

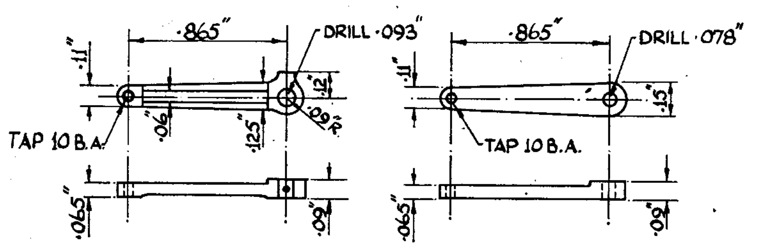
WHEN the coupling-rods are made, the wheels and axles can be assembled for good. If it is desired to enamel the frames, this must be done before pressing on the wheels. The suggested device for quartering is probably not original, and for a small scale locomotive is quite convenient. Two pieces of $\frac{5}{8}$ in. × $\frac{5}{16}$ in. steel are required, each about 3 in. long. The pair are clamped together, and the two holes on the longitudinal centre line drilled through square to the surface.

The hole to fit the crankpin in one piece only is then drilled through at a distance of 0.15 in. (i.e. the crankpin throw) from one of the existing holes. This dimension is important and should be as accurate as you can make it. The two pieces are again assembled with a pin through the $\frac{1}{16}$ in. holes, and one piece is turned through a right angle (check with a try-square) and clamped at this setting. The hole for the crankpin is then spotted through to the other piece.

A $1\frac{1}{2}$ in. length of rod is then fixed in the $\frac{1}{4}$ in. hole of one piece, and the corresponding hole in the other piece opened up to an easy sliding fit on this rod. A short pin is driven into the $\frac{1}{16}$ in. hole and allowed to project about one diameter. The other $\frac{1}{16}$ in. hole is opened out to the same size as the hole in the driving wheels, and a close-fitting pin $\frac{5}{16}$ in. long made for it. The quartering jig is then ready for use. For each of the rear three axles, the procedure is as follows. Put the axle with one wheel already on it into the axlebox, and check for free running. If it binds, it should be eased either by reaming the hole or reducing the shaft with abrasive. Do not on any account expect it to run itself in if it is at all tight to start with, although it is possible to run it in by external power until it is free enough for its own power to run it.

When satisfied with the fit, put the thin shim washers over the axle, one on each side, and start the other wheel on the axle and turn it to right-hand leading (or left if you happen to have made the eccentric assembly that way round) approximately. Locate the jig over the axle as shown in the drawing and press right home until the axle is flush with the outer surface of the wheel. The front coupled axle is treated in the same way, but do not forget to thread on the stop collars, eccentrics and eccentric rods in the right order first. It is much more difficult to remove a press fitted wheel than to put it on—at least it is if the press fit is worthy of its name.

Now is the time for the constructor to try out the coupling-rods. If they allow the wheels to rotate freely without a clearance of more than 0.001 in. at each crankpin, then it is worth full marks. If, as is more usual, binding occurs, then it is necessary to find out just where it is occurring and open out the crankpin holes until the motion moves freely. The model will probably still work even if considerable slackness exists at the crankpins—perhaps even more than the 0.005 in. which we are now told is the figure for a full size locomotive. As a matter of fact, even a clearance of 0.001 in. on the model scales up to over $\frac{1}{16}$ in. in full size, this being the figure that seemed to be generally accepted as fact in our previously unenlightened era.




BRASS OR STEEL.

RHONDDA. PART No.27A. PLAIN JANE. PART No.27B.

CONNECTING-RODS. 2 OFF. 1 L.H. 1 R.H.

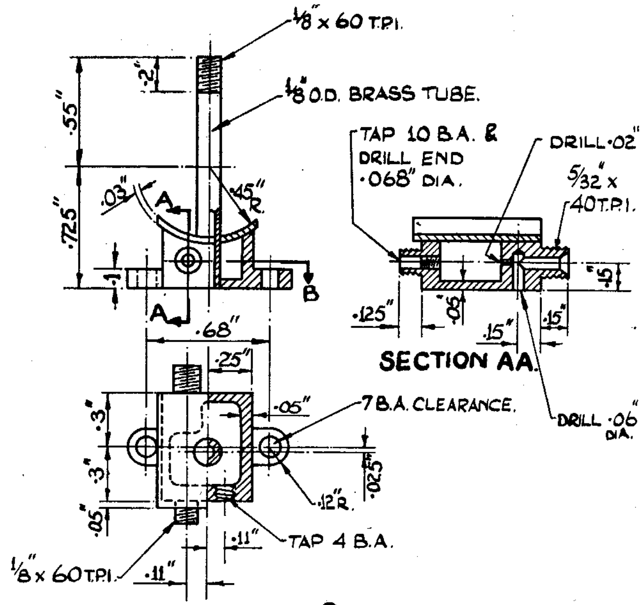
### Connecting-rods

The connecting-rods are made next. The centre distance given in the drawing will be correct if the other items are made to measure, and in any case a small latitude for adjustment exists at the fixing of the piston rod and crosshead; but it is still as well to check up on the model itself. The first check should be on the total allowable piston stroke. With the front covers and gaskets fitted, measure the projection of the piston rod with the piston first against the rear cover and then against the front cover.

The difference of these two readings should be at least 0.02 in. more than the stroke as determined by the crankpins; if it isn't, then the pistons will have to be reduced in length or the front covers can be reduced in thickness on the inside, if they will stand it. Then screw the gland nut right in and unscrew about four complete turns, and move the crosshead right forward until it touches the gland. The centre distance from the crosshead pin to the crankpin at front dead centre will be the required centre to centre length of the connecting-rod.

If the fluted version as shown on *Rhondda* is desired, some milling will have to be done; otherwise the outer profile is just as easy to produce by hand filing. The simple setscrew for locking the piston rod to the crosshead is a little unreliable if no positive location is provided. At this stage, the piston can be adjusted to give equal clearance at each end of the cylinder, and the setscrew tightened. If it is then loosened again, and the piston and rod removed from the cylinder, the mark made by the hardened point of the screw should be visible, at least with the aid of a small lens. If a fine triangular file is used to cut a notch across the piston rod at this point, a positive location is attained. Incidentally, it may be necessary to trim metal from the end of the piston-rod to avoid it fouling the small end of the connecting-rod.

Most modellers, having got thus far, will be anxious to try out the motion on compressed air. In this size, a bicycle pump will provide an ample supply. A small length of tube should be attached temporarily to the top cover plate of the cylinder block with soft solder to admit compressed air to the live steam inlet port. The pistons may now be packed with graphited asbestos. This is a tedious job, as square braided section small enough for this job is (I believe) unobtainable, and it involves careful tucking in at the ends to get the packed piston to enter the bore without the packing catching up at the end of the bore. The threaded end of the cylinder does not help matters here either.




SECTION B. BRASS.

SMOKEBOX SADDLE. 1 OFF

PART No. 28.

If you are impatient to see things work, packing may be dispensed with at this stage provided the bores are well lubricated. The glands are easier to pack, but if you are new to this scale of locomotive you will be surprised at the tiny quantity required to fill the gland. The pistons should be reasonably easy to work up and down the bore, so do not overdo the tightness of the packing. The front covers should be screwed in, with gaskets cut from fibre about 0.03 in. thick. The crossheads should then be attached, and the whole sub-assembly again checked for ease of movement.

The slide valves should be attached to the eccentric rods (which by now are permanently captive in the main frames), the cylinder block located in the cut-away part of the frames, and the slide valves put into contact with the portface. The cylinder clamp plate, complete with valve rollers and spindle, can next be placed in position and secured with two 7 BA countersunk screws to the block. Check that the rollers and valves move freely, then slip the leaf spring into place, and adjust the screw to put a moderate pressure on the slide valves. Fit the coupling-rods, and check the clearance between these and the crossheads, then put the connecting-rods on and secure all relevant nuts and screws. Again check that the wheels will turn without undue tightness in any position.

The top cover plate of the cylinder block can now be attached, but shorter 7 BA screws than shown in the general assembly must be used, as the smokebox saddle is not yet included in this assembly. Also a gasket is required at this joint; ordinary soft paper is quite satisfactory if you have none of the more specialised materials. Whatever you use, it should not exceed about 0.005 in. thick. The holes in the gasket should match the underside of the top cover plate. There is no need to waste time and effort in cutting away the gasket at the open channels on the top of the cylinder block.

**Setting stop collars**

If you have cut the valve cavities to finished size already, all that remains to be done before the air test is to set the stop collars. This is done by removing the connecting-rods, and setting the stop collars by trial and error, so that the piston-rod starts to move in the required direction under air pressure just as each dead centre comes up as the wheels are slowly rotated by hand in the forward direction for one collar, and backward for the other. The judgment by eye of the dead centre will be quite adequate; in fact if you can obtain a setting which gives these results on each dead centre with no perceptible error to the naked eye, then you can pat yourself on the back.

If, as is more likely, things do not come out quite so well, there is no cause for despair. Just set the collars to average out the errors, with perhaps a slight bias towards early admission, and it should work almost as well. This assumes, of course, that the errors are not extreme; even if dead centre is only obtained to within plus or minus 10 deg., results will not be too bad. The procedure is much easier if you have an assistant to supply the air pressure while you turn the wheels, and also if the frames are securely clamped down. When the connecting-rods are replaced, the wheels should spin easily under air pressure in whichever direction they are started; the pressure on the leaf spring may have to be adjusted to get best results.

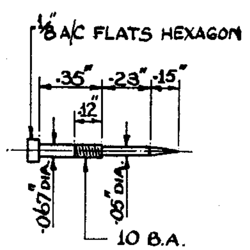
**Pressure connections**

If the valve cavities have been left undersize and not drilled right through, then connections for air pressure should be made at the inlet and exhaust of the top cover plate. The parts should be assembled without the pistons, front cylinder covers and connecting-rods. Lung pressure is all that will be required to check the valve cavities. The stop collars are set against the driving pin in opposition so that the eccentrics and axle rotate as one in both directions.

A method of measuring the wheel rotation is required. The simplest is a thin strip of paper gummed round the wheel tread and marked off about every 10 deg. A more refined variation is to use a split metal ring friction tight on the wheel tread, which has the advantage of an adjustable zero setting. If the wheels are slowly rotated while blowing into the air connections, the port openings are clearly audible, and also their closure. If there seem to be too many of them to pick out, one cylinder can be blanked off with a plug of plasticine at each end. Taking the exhaust ports first, check the angular period of opening of each; if this is less than 180 deg., the exhaust cavities should be opened out to obtain this to within a few degrees at least.

**Period of admission**

Next, the angular period during which each end of the cylinder is open to live steam should be checked. If this period is the same at each end of the cylinder, the inlet valve cavity (i.e. the middle one) is correctly centred, and the cavity only needs opening up until the period measures 120 deg. If the two periods are unequal, different amounts must be removed from each side of the cavity; a dental burr is the tool for this job.




STAINLESS STEEL.
PART No. 29.
NEEDLE VALVE. 1 OFF

After each operation, do not forget to remove the burrs (fuzzy edges not dental ones) and reface the valve.

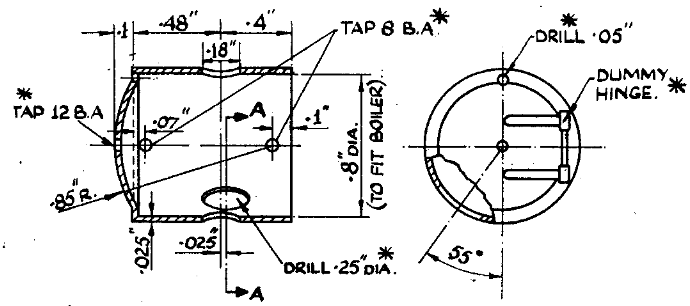
If the cavities have been drilled right through, the procedure is similar, except that the events are detected optically with a magnifier of about 10 power, and of course, the cavities must later be closed by sweating a thin plate on the underside of the valve. When the cavities have been finished to size, the stop collars should be set and the test carried out as described previously. When it does go, do not succumb to the temptation of running it as fast as you can for any long period, and if you have access to compressed air at 100 p.s.i. do not turn it on full. A little running at moderate speed will help to run it in if you do not forget about lubrication. Graphited oil is very good if there are a few stiff places to iron out.

Some model engineers may object to using the smokebox saddle as a displacement lubricator on the grounds that it gets nearly as hot as the boiler; but so does the whole of the locomotive, and this is about the only convenient place to put it where it will not be obtrusive. In any case, it seems to work as well as the average displacement lubricator. The body of the saddle involves a good deal of tedious endmilling in the cavity, but there are no essentially precise dimensions required, although the 0.02 in. dia. hole should be concentric with the 10 BA tapped hole to avoid bending the needle valve. The curved surface at the top of the body may be machined with a fly cutter. The cover plate of 0.03 in. brass should be bent to the required radius and drilled a tight fit on a piece of $\frac{1}{8}$ in. o.d. brass tube, and left oversize all round. The body, tube and cover plate should then be assembled and all joints silver soldered at one heat.

**Needle valve**

The top plate may then be trimmed to size by hand, and the underside smoothed fit to form the jointface for the top cover plate of the cylinder block. The needle valve should be made of stainless steel to preserve the condition of the needle point. This valve needs to be opened only a minute amount for adequate lubrication, or the whole contents of the reservoir can easily be delivered at one gulp. The gland nut for the needle valve has not been drawn in the detail, as it is similar to the gland nut on the cylinder cover specified for *Plain Jane*.

It is desirable to check the joints for leaks at this stage, as they are easier to find now than after assembly, and quite small leaks will seriously mar the performance and still not be very obvious. If plugs are soft soldered into the holes for the pressure test, be sure that all trace of soft solder is removed, if the item again has to be brought to red heat to complete the silver soldering. While the pressure testing is being carried out it is easy to check that the needle valve seats tight. The screwcap for sealing the oil filling hole on the left of the saddle was made from a socket head screw. This is convenient as the screw can be held on the end of a hexagon key to get it into the confined space between the front stays. This screwcap is visible in the photograph of the front view of the finished model.




ITEMS MARKED * FOR RHONDDA ONLY.

BRASS.

SMOKEBOX. 2 OFF

PART No. 30.

The smokebox can be turned from $\frac{7}{8}$ in. o.d. tube and the front plate silver soldered on, or some may prefer to make it in one piece from the solid. For *Plain Jane*, the only other operation is the drilling of the hole at top and bottom to clear the exhaust pipe. For *Rhondda*, the holes for handrail knobs and smokebox door handle can be drilled and tapped at this stage, and the dummy hinges fixed on, but it is best not to drill the holes at 55 deg. to the vertical yet; or, if they are drilled now, leave them well undersize.

These holes are to accommodate the upper ends of the dummy steam pipe covers, and should be adjusted to fit them closely. The appearance will be better if they are left out altogether. The hinge dimensions have been omitted from the drawing, as also are other dimensions which do not affect operation; all these refinements, and more besides, can be added to suit the taste of the constructor.

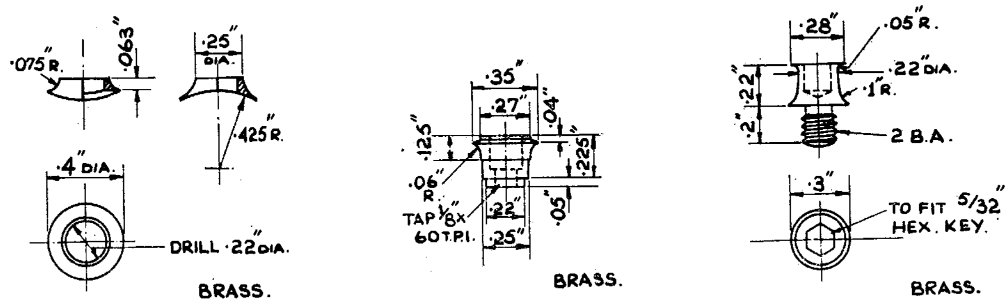
★ *To be continued on July* 14

# Chimney lamp, pony truck and front flame baffle

By A. A. Sherwood

THE chimney is a plain turning job in brass; the really meticulous constructor had better go to the full-size drawings to get the right shape, as errors in this feature seem to be a heinous crime to the ardent connoisseur of the steam locomotive. The lower flange of the chimney must be made separately to enable the chimney to be screwed to the exhaust pipe.

The easiest way of making the flange is to rough turn it in the flat (i.e. as if it had to fit a boiler of infinite diameter), anneal thoroughly, and beat down on a former of the same diameter as the smokebox. The finishing touches can then be put on;




*These three diagrams show, left to right, the base flange (part No 31), chimney (part No 32), and filler cap (part No 33)*

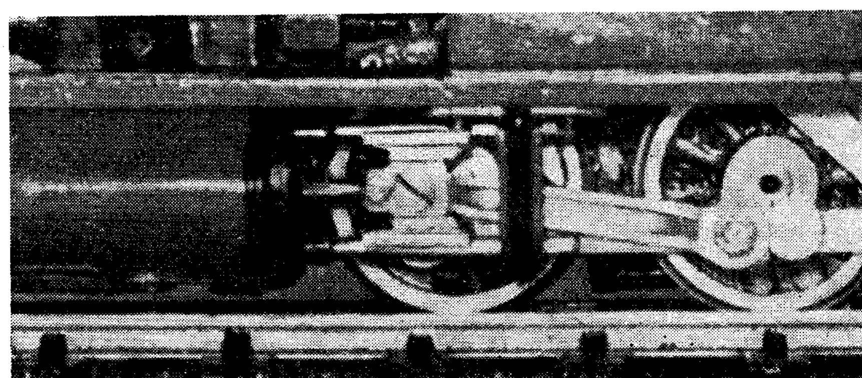
this method avoids the tedious filing of the fillet otherwise required, and also the flycutting to form the concave base.

The filler cap is disguised as the GWR type safety valve cover. A 2 BA thread is specified. Since it has to be removed each time the locomotive runs, it is not wise to use a finer thread. The 5/32 in. hexagon socket can easily be formed by drilling a 5/32 in. hole and driving in an Allen key which has been ground off square at the end. This operation should be performed before finish turning the profile. A fibre washer about 0.03 in. thick provides the seal under the filler cap.

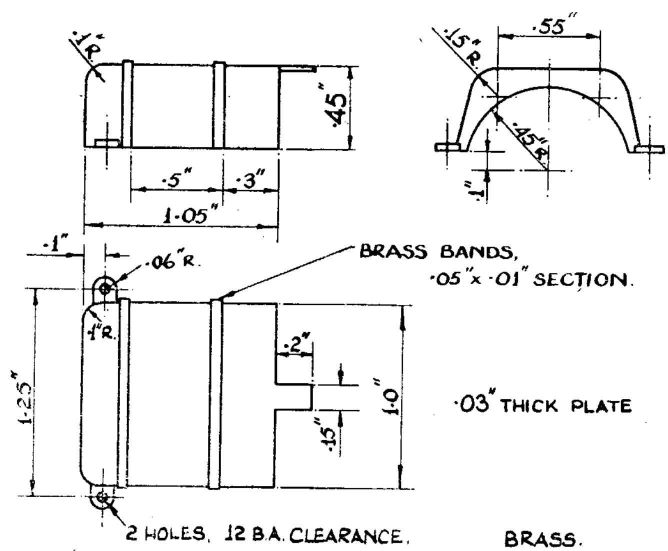
The firebox top cover is another non-essential, but it is so effective in making the boiler look like the the real Swindon job, and so little trouble to make, that it really should be on *Plain Jane* as well. It can be beaten out of 0.03 in. brass sheet over a metal former if kept well annealed. The tab at the rear end should be fitted to the recess in the front plate of the cab, and the front of the cover carefully fitted to the curve of the boiler. The holes for the two 12 BA screws should be spotted through to the top of the side tanks, and the latter drilled and tapped 12 BA. The two brass bands should be cut about ¼ in. overlength, and turned over at the ends to keep them in place while silver soldering, the turned over ends being filed off later so that the cover fits close against the boiler shell.

The fuel tank shown in the drawing has been designed with large radii and sloping sides to make it as unobtrusive as possible consistent with reasonable capacity. To make a neat job of this tank, a well polished metal former is required as the bottom and sides are of thin sheet. It is possible to form the bottom and sides in one piece with no joints, but it is not easy in thin metal without crinkles, so it may be easier to cut away most of the excess metal at the corners and silver solder before finally beating to shape on the former.

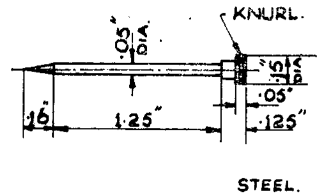
For *Plain Jane* most constructors will probably use the easier solution of making sharp bends at all corners. The burner tubes and feed tube are also made of 0.01 in. plate; this is a little difficult to fabricate, but do not



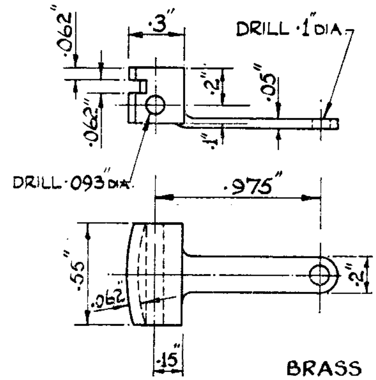
*The motion work*



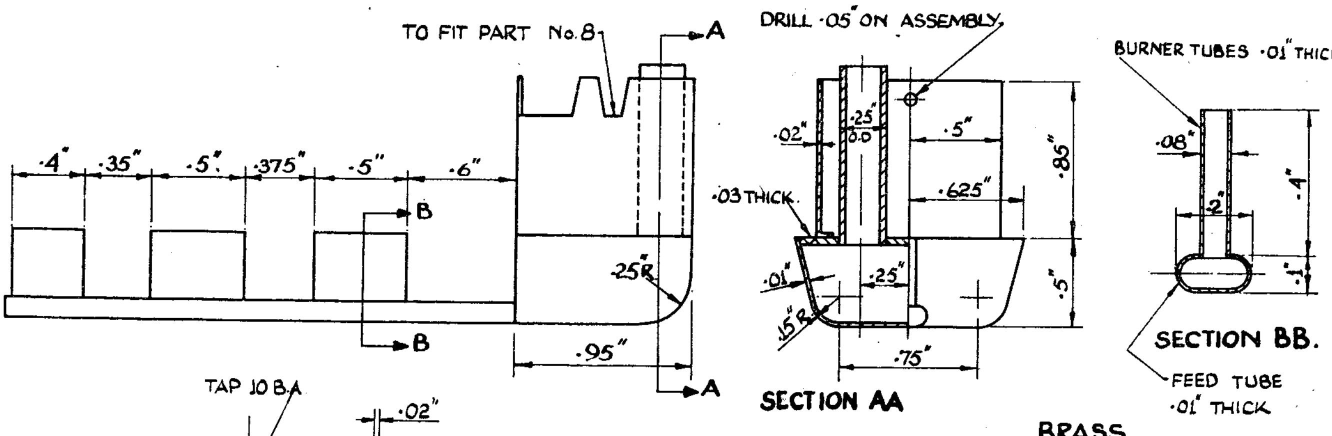

*Firebox top cover for* RHONDDA *only (part No* 34)



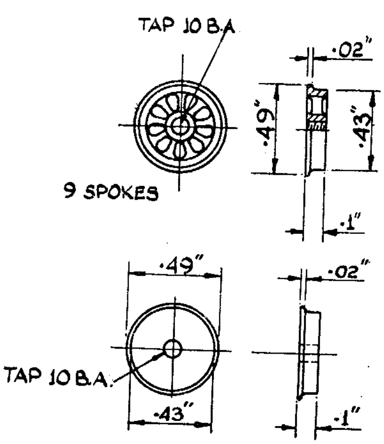

*Lamp retaining fin (part No* 36)



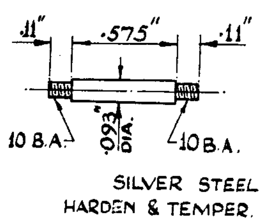

*Pony truck frame (part No* 37)



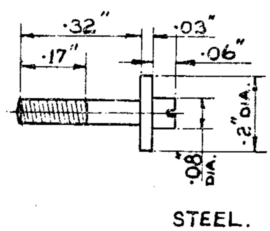

*Lamp (part No* 35)




*Top of diagram: Leading wheel for* RHONDDA *(part No* 38*A). Bottom: Leading wheel for* PLAIN JANE *(part No* 38*B)*

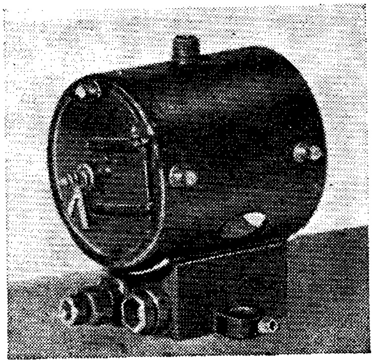



*Leading axle (part No* 39)

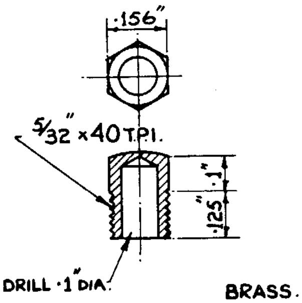



*Pony truck (part No* 40) *adjust screw*

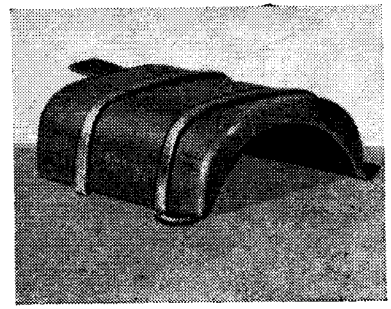
be tempted to use thicker metal, as the tube will conduct heat from the flame more quickly and put it where it is not wanted. The flame tubes, feed tube, tank and 0.25 in. dia. filler tube are silver soldered together, and the water tank, of 0.02 in. sheet, may be soft soldered on later. The sides of



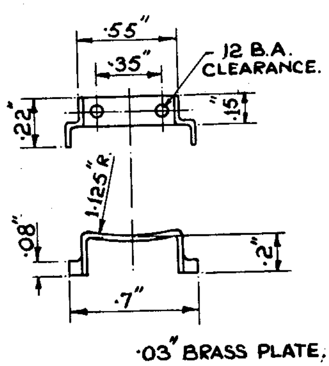
*Smokebox and saddle*



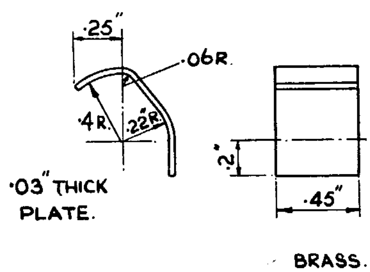

*Spring sleeve for pony truck (part No 41)*



*Firebox top cover*




*Guard irons (part No 42)*




*Front flame baffle (part No 43)*

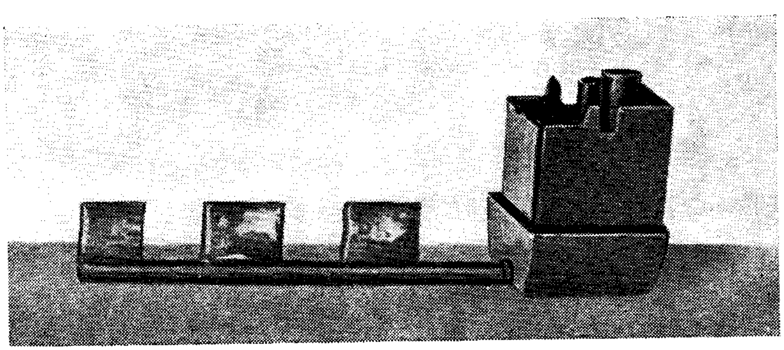
the water tank are cut away to fit the bottom edge of the rear spectacle plate of the cab when the top surface of the fuel tank is level with the under side of the footplate and centrally disposed in the large aperture in the footplate under the cab and coal bunker, i.e. there is a clear space all round the tank. The hole for the securing pin should be marked off and drilled with the lamp in this position.

It does not matter if the pin is a very easy fit in the holes; the locomotive is not likely to accelerate fast enough to leave it behind, and there is not much vibration to shake it out. The wicks now need to be fitted. I have had no success with asbestos wicks, and always used cotton wicks on the later models. If you try the lamp outside the locomotive you will probably find the flames fluctuate considerably, one wick nearly goes out, then the next minute it is burning higher than the others. This need not worry you unduly, as the combustion chamber formed by the side tanks seems to have a considerable stabilising effect on the flames. The wicks should be packed a little on the loose side, or swelling when wet will restrict the fuel flow, and they should be trimmed so that no threads project at the top of the wick tube, either upwards or sideways. The fuel used is methylated spirit. The securing pin needs no description, the drawing being self-explanatory.

The pony truck frame consists of two pieces of brass silver soldered together. It should be securely clamped to the faceplate and the front surface and groove machined, centred on the 0.1 in. dia. hole for the pivot pin. The axle is cut from a length of 3/32 in. dia. silver steel; the design shows each end threaded for ease of dismantling, but if preferred, the axle can be left plain and the wheels pressed on. Two patterns of wheel are shown, one with nine spokes for *Rhondda* and the simplest possible for *Plain Jane*.

The spokes can be cut as described for the driving wheels. Alternatively commercial OO gauge wheels can be used; even white metal castings will do for the pony truck. The adjusting screw should be machined to engage the groove in the pony truck frame with about 0.03 in. vertical play. The spring socket thread should be a fairly tight fit in the frames so that the adjustment will not work loose. A small shim washer 0.01 in. thick should be slipped on the axle between each wheel and the pony truck frame. For *Rhondda*, guard irons are shown to add to the realism.

The front flame baffle is the only part remaining which must be fitted before the steam test can be made. It consists of a rectangular plate of brass, 0.45 in. wide and 1 in. long when flat, and about 0.03 in. thick bent to shape and fitted as shown in the sectional assembly. The shape of the bend is not critical provided that it does not foul the lamp or the valve gear; its purpose, of course, is to protect the flame from draughts from the front. The slightest leaks of steam from the slide valves will play havoc with the flames unless this baffle is fitted.



*Lamp*

● *To be concluded July* 28

Continued from 14 July 1960, pages 44, 45 and 46

# At last . . . the tiny engine learns to run

By A. A. SHERWOOD

THE moment for steam tests has finally arrived. Ensure that your track is in good order, and do not expect to negotiate curves sharper than 2 ft radius. Adjust the pony truck so that just enough pressure is exerted on the wheels to hold the track; excess here reduces the available adhesion. Take a last check on the motion under compressed air by connecting an air tube to the boiler and closing the lubricator needle valve.

Adjust the pressure on the leaf spring until it is just enough to prevent audible leakage at the valves at moderate speed. This will assist in expelling condensate when the steam test begins, for we require the least practicable spring pressure to enable the condensate to clear itself by lifting the valves off the portface.

Fill the lubricator with heavy steam cylinder oil and graphite, and replace the cap. Apply a little medium grade oil to the bearings and motion generally. Put in sufficient water (preferably hot), no more than half filling the boiler, and replace the filler cap. Fill the fuel tank with methylated spirit, and the water cooling tank with cold water. Light the wicks, then place the lamp on the track, and gently lower the locomotive on to it. This is not very much like full size practice, but it's the most convenient way for this size.

### Expelling condensate

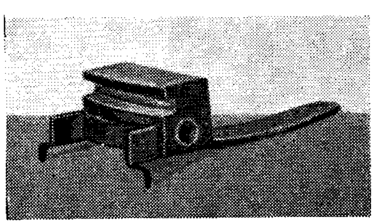
When the locomotive is on the track, the lamp may be raised the small extra amount needed to get the securing pin into place. Wait to raise steam, but as there is no pressure gauge, check about every half minute by propelling the locomotive along the track by hand and noting any tendency to steaming. Since it will probably be necessary to press the locomotive down hard on the track to force the wheels round and expel the condensate from the cylinders, you will need some heat insulator between your hands and the engine. My usual method is to wrap a cloth round my finger several times, and then press with this finger directly on the filler cap of the boiler.

You will probably find that the condensate is difficult to get rid of, and the motion which spun so freely on compressed air has developed considerable stiffness under steam.

If it is any consolation, I would say that only a loosely fitted motion with inadequate packing is likely to get under way on the first steam test without a great deal of trouble; it would be just about worn out by the time a respectably fitted one had been properly run in.

As soon as the engine shows signs of self-propulsion, open the lubricator valve a tiny bit; do not do it earlier, or it will make the job of expelling the condensate much more difficult. If it achieves a few staggering feet under its own steam, give it a short rest and then push it off again, and it will soon show great improvement as it learns to run. When it shows signs of speed, start putting a load behind it to keep it from leaving the track at curves.

From now on you will learn the idiosyncrasies of your own creation by running it; just how much water is needed in the boiler, the best setting of the stop collars, and so forth. Do not expect to get the best results right away; I have spent many hours nursing OO and OOO gauge babies through their teething troubles. One item of warning—do not let the locomotive cool down after a run without removing the filler cap from the boiler, or the suction will draw oil into it.



*Here is the pony truck frame*

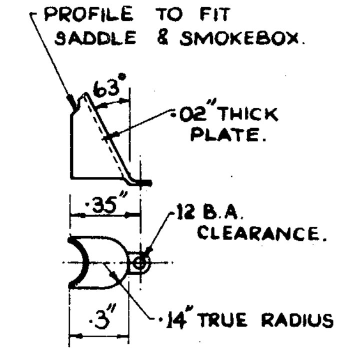
With the functional details complete, the frills can be added to taste. Those suggested here are considered sufficient to please most model engineers, but no doubt they are capable of further refinement. The buffers are made in two parts so that the square flange can be aligned correctly when the shank is screwed up tight. The hooks should be made a tight fit on the thread so that they can be screwed in as far as possible and left the right way up; there is no room for a nut behind them.

### Making the handrail knobs

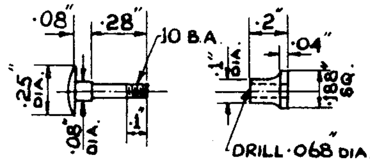
The handrail knobs are needed in a fair number, so it is worth while making a few special tools to speed up production.

The suggested method involves first making a length of 8 BA threaded rod. This can be held in a bush in the lathe chuck, tapped 8 BA and locknutted with just sufficient projecting to make one knob. The ball and shank are turned with a form tool set just a few thou below centre height with the lathe at top speed, and parted off. Since the handrail knobs on the smokebox have longer shanks than the others, the form tool should be made for these first. Only four of these knobs are required, but it is a good idea to make a few spares. Then the form tool can be ground down to suit the other knobs with shorter shanks; make a few spares of these.

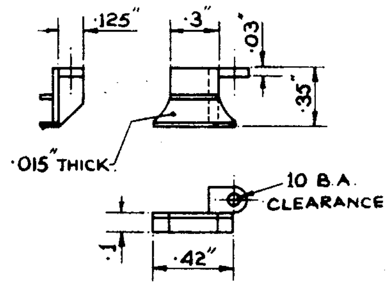
The drilling jig shown in the drawing does not take long to make and it certainly ensures that the hole goes straight through the centre of the ball. The handrails on the original *Rhondda* are of hypodermic tube from the throwaway type injection syringes used by the medical profession, either this or 1/32 in. stainless steel wire can be used. The knobs are just screwed into their respective holes so that the handrails can be slid into place. The two stays which run from the front buffer beam to the smokebox are of 0.05 in. dia. rod with lugs formed on the ends and attached with 12 BA screws.



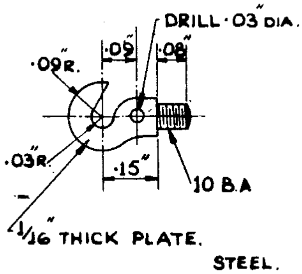

STEAM PIPE COVER.
2 OFF.
PART No. 44.



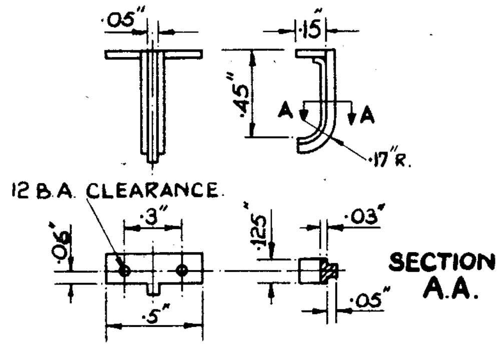

BUFFER. 4 OFF.
PART No. 46.



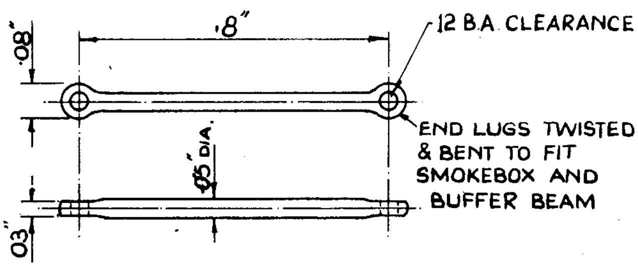

STEP 2 OFF
PART No. 47. (1 R.H. 1 L.H.)



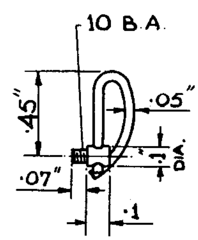

DRAWHOOK. 2 OFF
PART No. 45.




GUIDE BAR SUPPORT 2 OFF.
PART No. 48.




FRONT STAYS. PART No. 49
2 OFF




VACUUM BRAKE PIPE.
2 OFF.
PART No. 50.

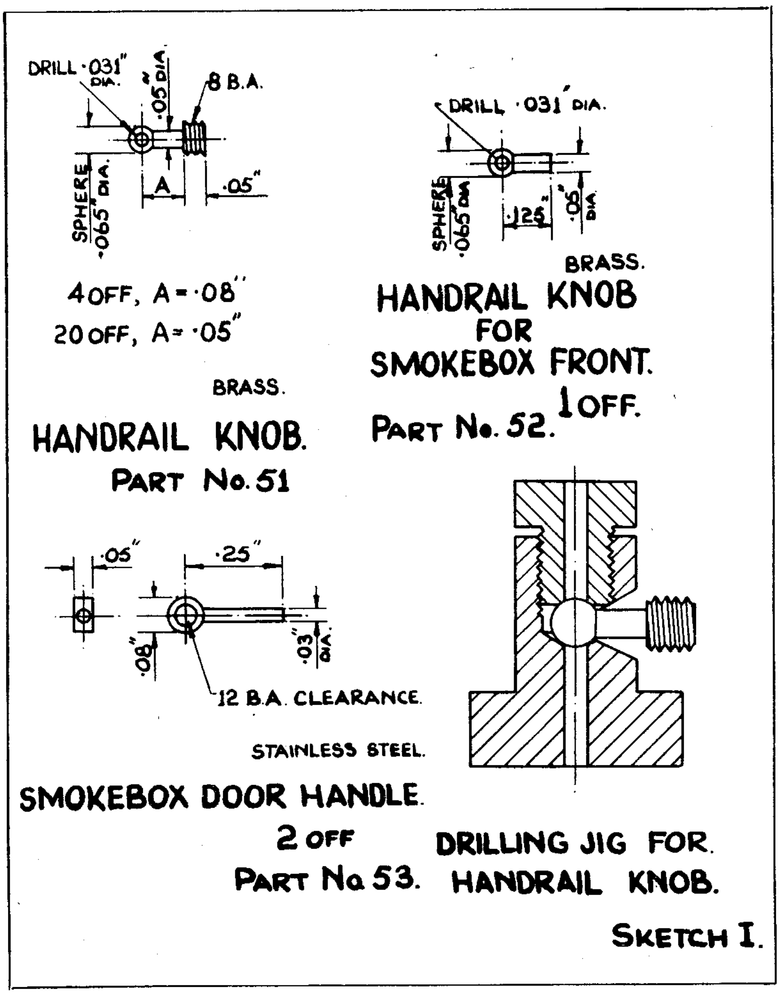
The dummy steam pipe covers are cut from thin sheet brass to fit snug against the saddle. The top ends tuck into the smokebox and the lower ends are secured to the footplate with 12 BA screws. These have a slightly more realistic appearance than the saddle lugs and 7 BA cheesehead screws which they hide. The dummy guide bar supports are attached to the footplate with 12 BA screws so that they hide the fact that the rear ends of the guide bars are unsupported. This is certainly cheating, but perhaps not quite to the extent that is practised in the steam-outside, electric-inside models.

The steps to the cab are a great

improvement as, in addition to being a feature of the prototype, they also hide a little of the fuel tank. The dummy vacuum brake pipes on the front and rear buffer beams complete the trimmings, and need no further description.

The name plate on the original *Rhondda* was made by cutting sunken letters in reverse on a piece of tool steel which was then used as a die for forming the final articles. This gives raised letters; the plate is then enamelled, and the enamel removed from the letters by polishing on fine abrasive cloth without touching the background. The easiest way to attach the plate is by providing two tabs, and drilling matching holes in the side tanks—in other words, the usual method of putting tinplate toys together. Soft solder is obviously useless here; skill would be needed to attach it with silver solder without spoiling the plate, and even 12 BA screws would look far too big. They are the scale equivalent of about 4 in. dia. bolts, which would hardly be used to hold on nameplates in full size.

The correct colour for this locomotive should, of course, be black all over except for the buffer beams, but having obtained some excellent green heat resisting enamel, I heated the model to two coats of this (except for such items as the smokebox, which is black on nearly all full size locomotives), and well baked in the gas oven. The side tanks get pretty hot, but to date no discoloration has appeared. If you want to use any other colour than black, it is desirable to check that it will stand up to the heat. Be particularly careful when baking the enamel on the cylinder block, as this item has soft soldered joints. ▣



SKETCH I.

## FOR YOUR BOOKSHELF

*Manual of Model Steam Locomotive Construction*, by Martin Evans; 158 pages; illustrated. Percival Marshall, 30s.

DURING the past three years the name of Martin Evans has come into prominence in the model steam locomotive field. A handbook from his pen on this fascinating subject is an extremely welcome addition to the comparatively small existing literature.

In a careful reading of this book I have found only one error, a quite minor one, on page 57 under Valve Travel: "In the above formula, lead is neglected, but this would increase the cut-off point." In fact, any lead *shortens* the cut-off point—makes cut-off earlier.

Two matters arise from the chapter on Cylinder Design. First, in modern fullsize practice it is usual so to arrange matters as to ensure that the passages leading from piston valve chamber to cylinder barrel are perfectly straight; the illustration on page 51 shows a distinctly indirect passage. The direct passage is functionally more efficient, and usually simpler to make.

Secondly, while I agree with the comment on inside cylinders with valves between, that "the scheme cannot be recommended to the model engineer," it is nonetheless a perfectly practical one for anyone possessing reasonable experience and skill. A notable design which embodies this feature, and from which many successful models were built, was the late E. L. Pearce's Caledonian *Dunalastair III*, serially described in MODEL ENGINEER nearly 60 years ago; with very minor modifications, *Dunalastair III* could hold its own today with anything having a similar adhesive weight.

It is good to see that Mr Evans will have no truck with that un-mechanical monstrosity, the open sided crosshead with overhung gudgeon pin; he gets over the constructional problem in a sound engineering manner. The credit for originating this scheme is believed to belong to Mr H. J. Turpin of *Likeada* and *Hybrid* fame.

The chapters on valves and valve gears are excellent, and it is pleasant to see that Mr Evans makes free use of simple mathematical formulae; he evidently credits his readers with possessing normal intelligence!

It would be very difficult, indeed, to compress more useful information into a given space and I have only one criticism: *Manual of Model Steam Locomotive Construction* is not nearly long enough!—K.N.H.