POM-POM A Great Central 0-6-0 in 5 in. gauge

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Part 6 — Progressing the Chassis

When I gazed in dismay at the amount of held over material after putting LLAS No. 37 together at the printers, it became very clear that one of the construction series would have to be suspended in this issue, the choice being a very difficult one for me. No. 78000 had reached the exciting stage of starting on the chassis and indeed I started to write this up ahead of POM-POM, but then I looked into the crystal ball as to the timing of the next new series and decided instead on the penultimate installment for POM-POM. Part of the blame for my decision rests on the broad shoulders of Dave "Jonah" Johnson, a report on which may well appear elsewhere in this issue, though Dick Black fought back strongly with another photograph of his excellent No. 78065 on the very day that I sat down to type these notes, which had me faltering for almost an hour! Before I get into even deeper water, let me hurry on with description.

Horns and Axleboxes

The driving horns are from the castings originally introduced for No. 78000, but lest builders of the latter be tempted to machine their horns to the following description, let me warn that they vary in one, important, dimension. At least the method of machining can be identical, which will save me needless repetition, so please pay attention.

The horns are cast in pairs, the first requirement being to assess the machining allowances, and I can never stress this too strongly. Rub a file over the projecting spigot so it sits flat on the body of your 4 jaw chuck, then grip in same to face across the inside, then reverse and face across to 19/32 in. overall thickness, cleaning up the sharp edges with a file.

The rest of the machining will be carried out on the vertical slide and we require two "strongbacks" to hold the horns securely to same, so cut them 1⅜ in. long from, say, ½ in. x 3/16 in. BMS flat and drill a 9/32 in. hole through the centre of each. Choose the tee slot which will allow you to carry out all the milling operations without moving the job, slide a nut in either end of said slot and bolt the horn in place, then chuck an end mill of about ⅜ in. diameter in the 3 jaw and tidy up the flange profile. Next we must concentrate on the frame fixing spigot, keeping same nice and central in the casting and taking a little metal off at a time until achieving a tight fit in the frame slot, arriving at the ⅛ in. dimension at the same time. Grip over the just machined flange with dogs before removing the strongbacks, to deal with the axlebox slot. Again remove a little metal at a time, with the ⅜ in. end mill, to keep the slot central about the spigot and using a micrometer to check same. Use a piece of 1¼ in. wide bar as your gauge and when satisfied, change to a smaller end mill to deal with the corners, though these will have to be completed with a square file. Remove and saw into individual horns, then grip in the machine vice to mill the feet to dimension, when you can bring up the hornstay, spot through, drill No. 21 and tap 2BA.

The leading and trailing horns are dealt with in similar manner, save for the actual dimensions, the main point being that the castings are not of the same regular shape and this has raised a few queries; just mill the profile until they are to drawing.

Enter a horn into its frame slot, then take a 2BA bolt and nut, fitting same into the axlebox slot to keep it open at the bottom, then drill through in 14 positions at ⅛ in. diameter for the rivets. These rivets must be fitted firmly, for which we need a wee dolly and puller, both made from ¼ in. steel rod and each about 4 in. long. Chuck in the 3 jaw, lightly centre the first piece and use a 3/16 in. drill to form a cup for the rivet head to sit in; the second piece is simply drilled No. 29 to about ⅜ in. depth. Grip the dolly in the bench vice, sit the rivet head on same, sit the puller over the rivet shank extending through the frame and give it a couple of decent blows. Now peen the rivet into the countersink, filling it completely. The shank will in fact overfill the countersink, so you can either file flush afterwards, or crops the shank before rivetting as you wish; fit all six horns in this way.

Axleboxes are again cast in pairs, the first job being to machine them to the overall sizes, and once more the 4 jaw chuck is my favoured way of arriving at same. Back to the vertical slide, this time with the machine vice fitted, to deal with the slots to suit the horn. With the ⅜ in. end mill, cut a slot to ⅛ in. depth centrally along one face, then widen it to suit the horn, taking careful note of the micrometer collar readings when the final cut is taken, then rotate the bar through 180 deg. and repeat, this time checking against the actual horns until the bar just enters. Saw into individual axleboxes and face them off to length, doing this in pairs and marking them accordingly. Find the centre of a driving axlebox by the 'X' method, centre pop and set to run true, then centre, drill and bore, or complete with a reamer, to ¾ in. diameter; now deal with that 1/64 in. raised face. Slacken two jaws only, fit the next axlebox, tighten the same two jaws and repeat, then deal with the leading and trailing axleboxes similarly.

Back to the machine vice to mill the oil reservoirs with an ⅛ in. end mill, though of course you can remove the bulk of the metal with the ⅜ in. one; these reservoirs want to be about ⅛ in. deep. Drill No. 60 holes from the ends of the reservoir to lubricate each sliding face, and it is better to drill these from the reservoir outwards rather than the reverse. The rule says that one should never feed oil into the crown of a bearing, though I have never yet found it detrimental with an axlebox in miniature, but you may vary the position if you wish.

Ease each axlebox into its horn to initially be a tight fit, then bring up the hornstay and deal with the 3/16 x 40T tapped holes for the spring pins. Later on we must ease the fit further so that each axlebox can be lifted independently from its partner by about 5/32 in. so that the wheels can follow any undulation in the track, which means relieving the sides as shown, but for the moment we need them to be tight as they will be our drill jig for dealing with the coupling rods.

Coupling Rods

With careful machining, we can get the leading rods from 1 in. x ⅜ in. section BMS flat, two 9¾ in. lengths being required. Mark on the centre line of the rod, and remember this is not the centre line of the bar, then scribe vertical lines at 8 9/16 in. centres, the front one a bare 11/32 in. from the front edge of the bar.

Next we need a couple of drill bushes to convert the axlebox bores into the sizes we require; these bushes can be mild steel. For the driving axlebox, chuck a length of ⅞ in. diameter bar in the 3 jaw, face and turn down to ¾ in. diameter, a tight fit in said axleboxes, over a ⅞ in. length, then centre and drill ½ in. diameter to the same ⅞ in. depth, parting off at ¾ in. Face and turn down again to suit the leading and trailing axleboxes, then centre and this time drill 7/16 in. diameter, again parting off at ¾ in. overall.

The frames want to be separated for fitting the horns, etc., so fit a bush to a leading and driving axlebox, pack the latter hard down onto their hornstays, bring the embryo coupling rod up and sight through the bushes onto the marked 'crosswires,' then drill through. Transfer the leading rods, one at a time, to the machine vice on the vertical slide, to drill the 11/32 in. hole for the knuckle pin bush at the stated 9/16 in. dimension.

Those possessing a milling machine can "eat" coupling rods, though my ML7 still copes admirably, that is when I get the opportunity! The requirement to machine them in the lathe is a 12 in. length of bright steel angle, a piece that is perfectly square, the actual section not being important. In the centre of one face, drill 9/32 in. holes at approximately 3 in. centres to suit the tee bolts for fixing to your vertical slide and in the other face drill 3/8 in. holes at 8 9/16 in. centres; bolt the embryo rod through the latter holes. Bolt the angle in turn to the vertical slide, grip a Woodruff key cutter in the 3 jaw and check that the assembly is both level and the rod square across the lathe axis. Although it is possible to mark out the rod profile, likely your first cut will destroy said careful marking, so rely instead on direct measurement. First mill a 3/32 in. relief right along the bar between the two end bosses, then mill the edge of the rod furthest from the chuck; this is where the key cutter comes into its own. Although you can change to an ordinary end mill to deal with the edge nearest the chuck, the Woodruff key cutter is equally suitable. Clamp the rod to the angle towards the leading edge, remove the bolt and take 1/32 in. of metal from that leading boss. At all stages, remove all burrs and sharp edges from the milling, to save recourse to your first aid kit, then turn the rod over, pack it up to be level and deal with this side similarly. Both ends can be dealt with by the end mill and mandrel technique, the rest will have to be filing. Drill No. 40 oil holes down through from the tops of the bosses, and another at the knuckle pin will extend its service life, when we have to relieve the rod at the rear for said knuckle. Back to the machine vice to remove 3/32 in. of metal at each side with an end mill; now for the rear rod.

Again the section will have to be 1 in. x 3/8 in., though this time a lot more metal will have to be removed; initial length wants to be of the order of 9 3/4 in. At 5/16 in. from one end, and on the centre line if you like, grip in the machine vice and drill through at No. 13. Follow up with a 3/16 in. reamer, then a Letter "D" drill to 7/32 in. depth and ream this portion to 1/4 in. diameter. Turn the bar through 90 deg. to end mill the 3/16 in. slot, or leave it where it was if you have a Woodruff key cutter that is 3/16 in. thick or slightly less. The knuckle bush is turned from 3/8 in. bronze rod and I found years ago that it is best to turn these to a .002/.003 in. interference fit otherwise they have a tendency to come loose in service; just ease the end to enter the rod and press it home, then run the reamer through again.

The knuckle pin is plain turning from 1/4 in. steel rod, the silver steel variety if you prefer, when the rear rod can be assembled to its partner. Again offer up to the axleboxes, use a length of 1/2 in. rod as dowel to locate the driving boss and drill through at 7/16 in. diameter for the trailing one; complete this rod as for the leading ones. Now you can turn up and fit the remaining bushes, except of course the small end of the connecting rod which is a little way ahead yet.

Frame Stay and Motion Plate

Both these items are steel fabrications, so we can progress them together. For the frame stay, start by squaring off a 3 29/32 in. length from 1 7/8 in. x 1/8 in. steel flat, then cut two pieces 1 7/8 in. long from 1 in. x 1/8 in. steel flat and shape them for the end flanges. The stiffener is a 3 29/32 in. length from 7/8 in. x 1/8 in. flat, relieved over much of its length to clear both the big ends and eccentrics. Use 8BA brass screws to hold it together for brazing and if you cannot achieve this with clamps; pickle, clean and zince spray.

The main portion of the motion plate is a 3 29/32 in. length from 2 3/16 in. x 3/16 in. steel flat, the end flanges being from 3/4 in. x 1/8 in. flat which this time want to be fixed with a few 8BA brass screws. Before doing so though, drill and mill the three openings as far as you are able, completing with files. There are four lugs for attachment of the slide bars and if you make the openings in the motion plate a very tight fit, these can be driven home and will stay in place for brazing. Drilling these lugs in situ can also be very tricky, so deal with each separately before assembly and check their alignment ahead of brazing. Bolt or "dog" each fabrication in turn to the vertical slide to mill the end flanges, then for the motion plate, mark off and drill the sixteen No. 42 holes. A known feature from experience with LBSC's MAID OF KENT is the huge loading placed by the valve gear on the motion plate, hence the 24 bolt fixing to the frames, though of course the loading does not stop here, as Dave Johnson discovered! Which brings me neatly to something that did move on his POM-POM, the eccentric sheaves.

Eccentric Sheaves and Straps

We need a hefty lump of 2 in. diameter steel bar for the sheaves, which means first lightly facing it and then centering to bring the tailstock into play. The ideal length of bar is around 3 in; turn down to 1 7/8 in. diameter as far along as the chuck jaws will allow. Change to a parting off tool and start parting off into **five** full 9/32 in. slices; the reason for the extra sheave will immediately become clear. Sharpen said parting off tool and grind it square, then deal with the outer "sheave", only reduce to 1 11/16 in. diameter over its full length, taking careful note of the micrometer collar reading at the final cut. Now, repeat for the other four sheaves, only this time the groove width has to be 7/32 in. and nice and central; part into individual sheaves and face across to 9/32 in. width, again keeping the grooves central. Mark off the 13/32 in. eccentric throw on one sheave and chuck in the 4 jaw; centre and drill to about 5/8 in. diameter. Now although the drawing instruction is to complete the bore by reaming, I would now recommend you bore this out to a tight fit over the axle, as a sloppy fit is a recipe for disaster. Grip each sheave in turn in the machine vice to centre and drill No. 34 into the bore as shown. Open out to No. 3 and 1/2 in. depth, tapping the remainder of the hole at 4BA and removing burrs at the bore. Dave is of the opinion that two fixings would help here, but on being questioned, he admitted he was not sufficiently confident to really graunch the cup point socket grub screw into the axle at the outset, for fear his valve setting was incorrect. As it happened, his initial setting was correct, but not after the sheaves moved! So be warned!!

The eccentric straps are gunmetal castings, ones that have become a "standard" of mine over the years. Chuck first in the 4 jaw and turn the sides down to 7/32 in. overall thickness, a nice fit in the sheaves. I am one of those builders who now prefers plain holes for joining the halves of eccentric straps together, whereas some of you like the front portion to be tapped; in either case, deal with the fixings now before sawing the straps in halves.

Mill the joint faces until the profile approaches its final form and tidy this up if you like, before bolting together, chucking lightly in the 4 jaw and boring out to that fifth "sheave" as your gauge. Complete the profile, including milling the eccentric rod facing, then drill No. 30 for the oil reservoir and drill back No. 60 from the bore to complete the lubrication arrangement.

Quartering the Wheels

The first requirement is that the frames be assembled such that all axles turn sweetly and if you are at all uncertain about this, delay assembly until the cylinders are complete and have been erected. With the completion of the eccentric sheaves, at last the crank axle can be brazed up, axleboxes slipped on and one wheel fitted to its axle, with crankpin 180 deg. to the adjacent main crank; fit one wheel also to both leading and trailing axles. The second wheel on the driving axle, I would set up by eye, though it is almost as easy to set up on a flat surface, or between centres in the lathe, and use a combination of engineers square and scribing block to check things out, which will then set your mind at rest. Erect the driving axle to the frames, then the leading axle, and slip over that side of the coupling rod. Deal with the second leading wheel, bring up the other side coupling rod and check things out before your Loctite or Permabond cures, then deal with the trailing axle likewise. We must now ease the fit of the coupling rod bushes to prevent binding in service, with the almost certain derailment of your POM-POM. Grip a 5⁄16 in. drill upright in the bench vice, slip a coupling rod over same, insert a length of 1⁄16 in. rod down a flute and pull the rod round by hand, paring metal from the bush. Do this a little at a time, checking to place until each wheel can be lifted independently of the others by 5⁄32 in. without the rods binding; the same condition as we achieved a little earlier with the axleboxes. It may sound like a waste of all your accurate machining, but remember you did use said accuracy to correctly orientate the wheels, otherwise you might have required oval bushes at this stage!

THE CYLINDERS

If the lungs of your POM-POM are its boiler, then undoubtedly its heart is the cylinders, and with a little care on your part, they will really dish out the power!

Cylinder Block

Over the years this has become another "standard part", first being used on LANKY, then ASPINALL and GLEN in quick succession and now POM-POM, it being equally suitable for non-DYD designs and available in iron or gunmetal to builders preference. I am often asked to give guidance as to the choice of metal, but whatever I say is likely to get me into trouble, so I simply stock both metals where the choice is an economic one! As with all castings, the first job is to assess the machining allowances provided, most of which are generous, though as the block also caters for frames that are only 4 in. apart, do watch this point. Fit a hardwood bung in each of the bores and mark on the centres, when we can begin machining.

Unlike GLEN, there is no bogie to get in the way of the drain cocks, so these can be the conventional plug type and located on the bottom centre line of the bores. For these, small flats are required, and these can be a datum, so chuck the block in the 4 jaw and machine the four flats. Now reverse in the chuck and machine the portface to line, this being a working surface, achieve a good finish. Although you can fit an angle plate to the faceplate and bolt the same to turn the remaining four faces, as we shall be using the boring table to deal with the main bores, I would bring it into use right now. Bring a bolting face towards the headstock and use strongbacks either through the bores or over the top of the casting to clamp firmly in place. Grip a round nose tool eccentrically in the 4 jaw chuck, it wants to be about 1½ in. off centre, set the lathe to run at about 800 rpm. and try a light cut, adjusting speed if necessary until the cut is a comfortable one, both for the machine and yourself! Occasionally I am asked to quote both speed and rates of feed for machining operations, but such is fraught with perils, especially when dealing with castings, where the skin can be much tougher than the main body of same. The most important instruction I can give you is to protect your eyes with safety glasses, and keep clear of the hot chippings. Turn the block through 180 deg. and complete the second bolting face to 4⅛ in. overall, and if your micrometer will not open out to this dimension, then make up a simple horseshoe gauge, then you can machine drag box, stays and the cylinders to an identical dimension, one that will ensure that the frames are at least parallel in conclusion. Turn again, this time through 90 deg., with a couple of strongbacks right across the block, to fly cut the front face; now comes the really important bit.

Turn the block through 180 deg. to bring the rear cover face towards the chuck and this time pack the block up from the boring table so that the cylinder bores are at centre height; fly cut to 2 15⁄16 in. overall. If you do not have a commercial boring bar by you, and it is a very good investment, then we can make one up from a roughly 8 in. length of 1 in. diameter steel bar. Likely the bar will not enter the headstock, in which case you will have to use a steady to lightly face off and centre each end deeply. Cross drill half way along the bar for a small tool bit; a ¼ in. one being the ideal, then drill at right angles into this hole and tap 2BA for a socket grub screw, one that will hold the tool bit firmly in place. Mount between centres, through a bore of course, and carefully tighten the 4 jaw chuck on to same as the means of driving. Set the tool to produce about 1⁄32 in. cut to get under the skin of the casting, run in lowest direct drive and with the finest possible feed. Approaching size, adjust the cross slide as necessary to get the bore in its right position and let the tool pass 4-6 times for each feed cut; that way you will end up with a parallel bore; complete to size. Release the boring bar, advance the cross slide by exactly 2 in. and repeat.

Fit an angle plate to your vertical slide and bolt the cylinder block to same, down through the bores, with portface towards the 3 jaw chuck. Carefully make out the four steam ports and drill No. 20 holes down the centre of each to 9⁄32 in. point depth. Change to a 5⁄32 in. end mill and form a continuous slot, 5⁄32 in. wide, 9⁄32 in. deep and 1 in. long. Now gradually widen the slot to line until a piece of ¾ in. x 3⁄16 in. BMS flat is a tight fit in same; you will be able to deal with a pair of slots at this setting. Now move down to the second pair and repeat, when you will be able to get a very accurate measurement over the gauge bars stuck in the ports and you will be able to alter the valve to any slight variation from the 1¼ in. drawing dimension. Turn the block through 180 deg. again and deal with each of the cylinder drain cock tappings in turn. To complete these latter, file a wee flat at the entrance to each of the bore ends on the bottom centre line, centre pop and drill No. 55 into the tapped holes, checking when the end covers are in place that these No. 55 holes are not masked. That leaves just the steam passages and it is better to leave these until the cover fixings have been dealt with.

Steamchest and Cover

The steamchest is a plain box casting, so chuck in the 4 jaw, face one joint face, then reverse and complete to ⅞ in. thickness. Bolt next to the angle plate, itself attached to the vertical slide, to deal first with the two frame edges, then the front one, and finally that at the rear. At this latter position, mark off for the pair of valve spindle bosses and the oil tapping, the latter being at 3⁄16 x 40T. Here I must say that cylinder lubrication is taken care of by means of a hydrostatic system as recently described for GEORGE, the only difference being that with inside cylinders, only a single sight glass unit is required. Those bosses are turned from ⅝ in. diameter bronze bar and may be a press fit in the 7⁄16 in. holes you are now instructed to drill, secured with Loctite or Permabond as alternative, though they may also be screwed into situ, thus your choice is a wide one. To complete, mark off and drill the twenty six holes at No. 30. Offer up to the cylinder block, spot through, drill No. 40 to ¼ in. depth and tap 5BA.

I must admit to never having had the slightest success in machining a cast gunmetal steamchest cover for inside cylinders, it always seems to "banana", so have used brass plate instead. Problem is that 6 mm brass, copper neither, is available from our regular supplier, so I am hoping heed will be taken of my plea. If so, then it is only a question of milling the edges to size, drilling back from the steamchest for the No. 30 fixing holes, then marking off and dealing with the pair of 7⁄16 x 26T tappings for the steam entry unions, plus another pair at ½ in. diameter for exhaust.

Next requirement is twenty-six 1½ in. lengths from ⅛ in. stainless steel rod, screwed for $3/16$ in. length at each end, though for ease of valve setting, the four corner ones can be screwed for ½ in. length at the top end only, then you can hold the steamchest firmly in place with the cover removed.

At this precise point, Bill Holland rang to say that his CALL BOY was ready to raise steam all but for the regulator box on the backhead blowing. He had fitted a Hallite gasket at this joint and my advice to him, as it is to POM-POM builders in assembling the steamchest, is to have metal-to-metal contact rather than resort to any gasket. Whether it will work in Bill's case, perhaps I will be able to let you know before the end of this session, for several hundred of you are waiting to hear the result of Bill's first steaming! It has!!

Cylinder End Covers

Chuck a front cover by its periphery, clean up the chucking spigot and face across the back; rechuck by said spigot. Turn down to 2¼ in. diameter, then face across to $3/16$ in. thickness, before concentrating on the spigot to suit the main bore. Reduce this a little at a time, trying to finish with a tight fit in the bore, for although not necessary at the front covers, it is good exercise for getting the back pair correct. With a knife edged tool, scribe on the bolting circle at $1\,15/16$ in. diameter, then part off the chucking spigot; bring the pair up to this stage. The covers have to be cut away both at the frames and on the centre line, so mark this off, grip in the machine vice and mill away the excess, checking as you go, then mark off and drill the nine full No. 30 holes. Offer up as a pair to the cylinder block, spot through, drill No. 40 to ¼ in. depth and tap 5BA, fixing either being by medium of hexagon head screws, or studs and nuts as at the steamchest. Now mark off and deal with the remaining two holes at the joint. You now have the positions of the front steam passages, so file a flat at the entrance to the bores, centre pop and drill a pair of $3/16$ in. holes into each steam port, opening out into a slot with a $3/16$ in. end mill; the rear steam passages will be dealt with similarly.

For the rear covers, chuck by the periphery, clean up the spigot and slide bar boss, then rechuck by said spigot and turn down the periphery to 2¼ in. diameter, facing across to thickness; part off the spigot. Rechuck by the periphery, centre and drill through at Letter 'D'. Follow up with a $13/32$ in. drill to $5/16$ in. depth, 'D' bit to ⅜ in. depth and tap $7/16$ x 26T; ream the remains of the Letter 'D' hole at ¼ in. diameter.

Chuck a length of ½ in. steel rod in the 3 jaw, face, turn down to $7/16$ in. diameter over a $5/16$ in. length and screw 26T; fit a cover to same. Now you can turn the $1/32$ in. spigot to a tight fit in the cylinder bore. Leaving the chucking piece in place, remove to the machine vice to deal with the flats as for the front covers, then grip by said flats in the machine vice; it should open just wide enough to accommodate them. Bring a centre drill with a $3/16$ in. body up to the ½ in. chucking piece, move it away by .031 in. by the vertical slide micrometer collar, centre and drill No. 12 to ¼ in. depth; repeat on the other side of the slide bar boss, then deal with the fixing holes as before.

If I leave the covers as described thus far, I will have a very red face later on when you come to put steam into those cylinders, for the covers are blanking the steam passages and have to be relieved as I have indicated. Again no gasket material is required to seal the covers to the blocks, though you can use brown paper soaked in linseed oil if you like; HM Inspector of Taxes still has the best envelopes for this purpose!

Piston and Rod

Piston blanks in gunmetal are individually cast, whereas in iron a stick for the pair is provided, though of course they can be machined similarly. Chuck by the periphery in the 3 jaw, clean up the chucking spigot and rechuck by this latter. Face and turn down the outside to around $1/64$ in. diameter, rough out the groove for the 'O' ring, then centre and drill $7/32$ in. diameter to $9/16$ in. depth. Follow up with a 6.3 mm drill to $7/32$ in. depth, then tap the remains of the $7/32$ in. hole at ¼ x 40T; part off at a full $7/16$ in. For the piston rod, grip a 4 in. length of ¼ in. stainless steel rod in the 3 jaw and check with a d.t.i. that it is running true, changing over to the 4 jaw if there is any error, as it is critical that piston and rod be concentric. The rod should project ½ in. from the chuck, when you can face and screw 40T for $7/32$ in. length; screw on the embryo piston. Facing off to thickness will tighten the piston on to its thread, when you can turn down to a nice sliding fit in the cylinder bore.

The service life of the 'O' ring depends on the surface finish of the main bore, plus machining the groove in the piston to drawing, so that it can roll without being nipped. The latter means grinding up a special tool from ¼ in. square tool steel and completing the groove at a single pass, pulling the lathe round by hand if indicated to get the necessary surface finish. The 'O' ring itself wants to be either from Viton grade or PTFE as you prefer, then it will be both resistant to oil and the temperature environment in which it is to perform.

Gland Nuts

All four gland nuts can be either from brass or gunmetal rod as you prefer and are simple turning. Because it is difficult to adjust gland nuts on inside cylinders, rather than use hexagon bar, I have specified rounds with eight $1/16$ in. holes drilled around the circumference. LBSC used to describe a 'C' spanner for adjusting same, but I have found a length of rod or a screwdriver does the trick much better; something always gets in the way of a spanner!

Value, Buckle and Spindle, and Balance Piston

The valve spindle calls for no special mention, save that its length will have to be determined to place whilst setting the valves; not far ahead now!

The valves are part of my castings supply to your choice of metal, and require careful machining to avoid problems. Because Jay's who cast the valves for me, mislaid the individual valve pattern a couple of times, they now cast in pairs and we can chuck said casting in the 4 jaw to lightly face off at top and bottom before separating into individual valves. Grip in the machine vice, on the vertical slide, to mill to the overall dimensions and for the valve buckle, dealing with one face at a time and keeping the cast-in cavity nice and central; remove all burrs as you proceed. Now chuck truly in the 4 jaw, face across the top to size, leaving metal to be removed at the working face, then centre and drill through to about ⅝ in. diameter. Likely you will not have a ¾ in. reamer by you, in which case bore out to size, remembering what I said about surface finish and 'O' ring life, though this is basically a static application. Back to the machine vice to clean up the cavity, when you may fly cut the working surface at this setting, or of course return to the 4 jaw to turn it to size.

On HUNSLET which was my initial use of balanced valves, I used a single spring to hold the valve away from its balance piston, and this one item caused builders more problems than any other, at least in the early years. Thus I re-thought this area when I came to POM-POM and came up with the solution that I have already described for GEORGE. It means the spring pockets must be properly aligned and the spring themselves fairly uniform; to achieve the former we require a simple jig. Take a piece of 1¼ in. x $3/16$ in. BMS flat and mill the edges to coincide with the top of the valve, then mark off for the five holes. Chuck in the 4 jaw to centre, drill and bore out the central hole to ¾ in. diameter, then drill through No. 30 in the other four positions; align with an odd end of bar and drill the valve No. 30 to $3/16$ in. depth, using a collar on the drill to get the depth uniform.

The balance piston stick that I can provide is actually cast in close grained bronze, which apart from its good machining properties, makes it very suitable for boiler bushes, there being a surplus of material to cover this latter use. Chuck first in the 4 jaw to face and clean up the outside, then rechuck in the 3 jaw, and you may part off a couple of 1½ in. lengths from the bar for the pistons if you prefer, to cut down the overhang from the chuck.

Face off again, centre and bring the tailstock into play, then turn down to 1½ in. diameter over a ⅞ in. length. Next reduce to ¾ in. diameter over a ½ in. length, to be a nice sliding fit in the valve, then deal with the 'O' ring groove similarly to the piston. Drill 13/32 in. diameter to 13/16 in. depth and part off to give a full 3/16 in. flange; chuck again, face off the flange to thickness and chamfer the exhaust exit as shown, so that it does not mask the hole in the steamchest cover.

Only the buckles to complete the cylinders, and if you do not have any odd bits of gunmetal lying around, then braze them up from bits of brass, then treat like a mini-steamchest, finally dealing with the inside to be a close fit over the valve, but not too tight that it prevents the valve from sitting squarely on the portface, or lifting from same as you get rid of the condensate at the start of a run; the drain cocks will never completely clear it at the outset.

Crosshead and Slide Bars

We can now move in any number of directions, but staying in the cylinder area, let me next deal with the slide bars. Their front location is not the best that I have ever devised, so I would start with 4½ in. lengths of ⅜ in. x ¼ in. steel bar and be prepared to turn those spigots on a time or two before achieving success.

The crossheads are from cast gunmetal stick, the first requirement being to arrive at the ⅝ in. x ½ in. specified section. Square off the ends, then mark off and cross drill the 7.1 mm holes, before gripping in the machine vice to deal with the slide bar grooves. Chuck a 5/16 in. end mill in the 3 jaw and mill a 1/16 in. deep groove along the centre of one face, then open out to ⅜ in. width to suit a slide bar. Take careful note of the final feed settings, turn through 180 deg. and repeat, this time trying between the pair of slide bars mounted in the rear cover. When satisfied, clamp the assembly firmly together and drill 6.3 mm back from the cover to about ⅜ in. depth. Back to the machine vice to mill the ¼ in. wide slot to accept the connecting rod, our next job.

Connecting Rod, Strap and Brasses

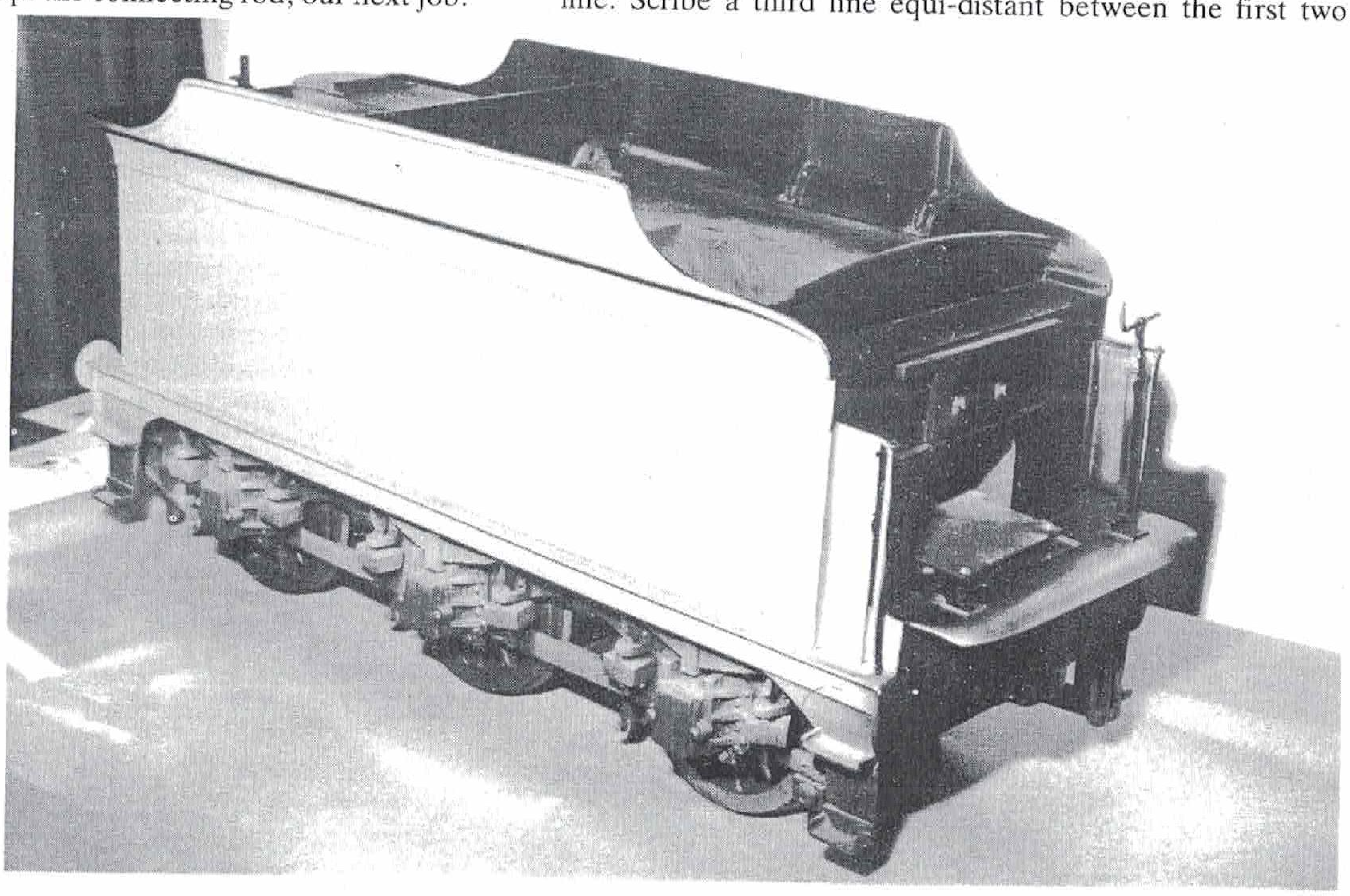
I have specified both rod and strap from 6mm thick steel, though of course ¼ in. thickness is a perfectly satisfactory alternative. Mark out the rod profile, drill the 7/16 in. hole and radius the eye with an end mill over a mandrel, then saw away as much surplus material as you are able. Use the same set-up for completing the profile as for the coupling rod, with a bolt through the 7/16 in. hole and clamping at the other end; press in the small end bush.

Mark off the strap on material about 2 in. wide and first drill the two No. 41 holes to 1½ in. depth, then saw out the surplus centre portion and mill to a good fit over the connecting rod end. Profile the outside then drill the No. 30 oil reservoir, continuing at No. 55 towards the brass, our next item.

Machine two pieces from bronze or gunmetal to 1⅛ in. x 9/16 in. x 5/16 in., then grip one piece in the machine vice, on the vertical slide, and mill a 3/16 in. groove to 1/16 in. depth along one of the long edges, opening out to suit the strap and keeping the side flanges even. Take a note of the final cut readings, repeat at the two ends, then deal with the second piece identically, getting both pieces a tight fit in the strap. Chuck strap and brasses in the 4 jaw, to centre, drill through to ⅝ in. diameter and bore out to a fit over the crankpin, then separate and file a wee oil groove down into the bore. Assemble again, this time to the connecting rod, to drill from both sides No. 41 for the strap bolts. These latter are 1⅝ in. lengths from 3/32 in. stainless steel rod, screwed 7BA at each end; a single nut at the top which is then peened over and nut and locknut at the bottom. When you check the assembly, likely you will find the brass is not held tight enough by the end of the connecting rod, but introducing a .002 in. shim between the rod end and brass will cure any slop.

Taking the 'bumps'

Clamp the cylinders in place between the frames, bring up the motion plate and check that the crossheads slide freely, adjusting if necessary, then spot through, drill and tap to drawing, and that includes the outer slide bar fixing. Cut and square off the crosshead pins to length and erect the connecting rods, packing the driving axle up to its nominal height. Turn to front dead centre and push the piston forward until it strikes the front cover, scribing a line where the piston rod enters the crosshead. Turn to back dead centre, push the piston back until it strikes the back cover and scribe another line. Scribe a third line equi-distant between the first two,



Over the years I have come to place great reliance on Doug Yarnell's knowledge of GCR locomotives. Here is his nearly completed tender for a 3½ in. gauge IMMINGHAM and Doug asks builders of POM-POM to take particular note of the detail at the front of the body.

align this with the front of the crosshead, drill through and ream for an 1/8 in. taper pin, cutting off any excess piston rod.

THE VALVE GEAR

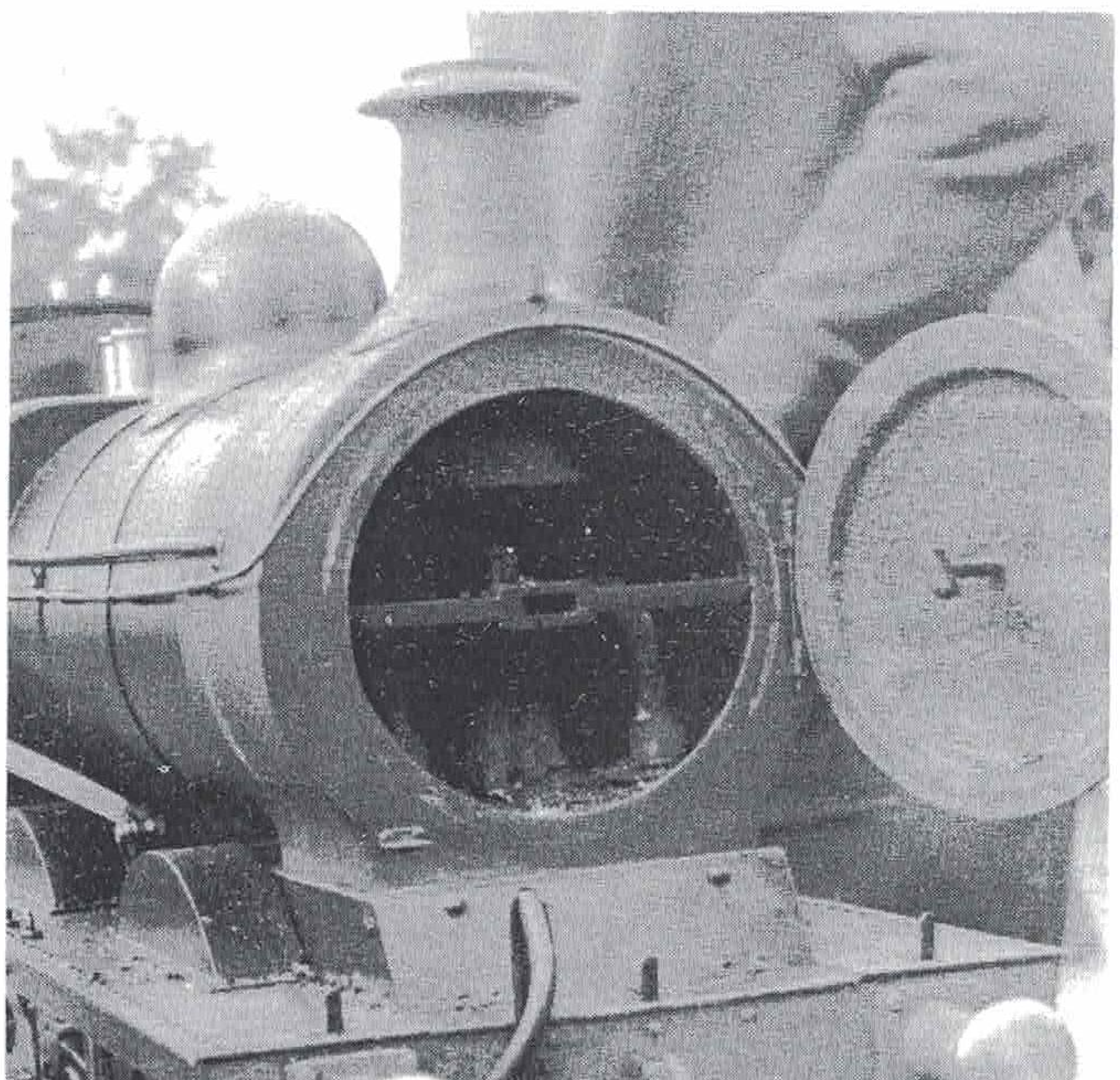
I did vow after struggling with Stephenson Gear with rockers as fitted to LBSC's MAID OF KENT, never to inflict such a thing upon builders of DYD's, which is the reason why both DERBY 4F and 2P have Joy valve gear. When it came to POM-POM though, I was so enthusiastic as to the Robinson variant that I could not but adopt it. For those interested in valve gears, that for POM-POM makes a very interesting comparison with that specified earlier for SAINT CHRISTOPHER, but I must press on with construction before space runs out.

Rocker Fulcrum, Centre and Outer

On MAID OF KENT, this was the Achilles heel of the whole valve gear, for it is vital to good valve events that the fulcrum of the rocker cannot move, for even with the benefit of balanced slide valves, this form of Stephenson Gear is quite heavily loaded. The first decision therefore is whether to make the fulcrum pieces from the solid, or to fabricate them, and I would recommend the former, despite the detail showing them to be two separate parts. The centre portion is from 1 in. x 5/16 in. BMS bar, the outer pair from 1 in. x 5/8 in. section; saw into 1 1/16 in. lengths and face one end square. Grip the trio in the machine vice, to drill right through to 11/32 in. diameter at the 25/32 in. dimension shown. Now mill away material to arrive at that 1/2 in. width away from the bolting flange, then grip very carefully with a "Mole" wrench to radius the ends over a mandrel with an end mill. Turn up bushes, press them home and ream through, drilling No. 55 oil holes, although if you can obtain oil impregnated bronze bushes, by all means use them. Clamp all three pieces to the motion plate with a length of 1/4 in. silver steel rod as alignment, then drill through at No. 42 and secure with 7BA bolts, each being 9/16 in. apart.

Pendulum Lever Support Bracket

If you happen to have an odd end of 1 in. x 1 in. x 1/8 in. bright steel angle by you then this is ideal for the pair of brackets, otherwise you will have to mill them out from 1 in. x 1/2 in.



We shall come to the smokebox next time in the last instalment of the POM-POM series.

BMS bar. Mark off and drill the No. 12 hole and fashion the profile around it, then deal with the bolting foot. Although you can offer up to the motion plate and drill through, I would leave this until you are ready to assemble the valve gear, then you can check alignment with the intermediate valve rod to place.

Eccentric Rods

The rod starts life as a length of 3/8 in. square steel bar, the first operation being to cross drill No. 23 at a full 5/32 in. from one end. Turn the rod through 90 deg. and move on by 7/16 in. to drill again, this time at No. 22 to indicate the end of the slot. Back to the same set-up as when dealing with the coupling and connecting rods, to secure to the angle at one end with a 4BA bolt and clamp the other, then mill material away beyond the fork end to arrive at 1/8 in. thickness, which means that the No. 22 hole must be 5/32 in. up from the face now against the angle. Clamp over the 1/8 in. thick portion, remove the 4BA bolt and mill away to arrive at 5/16 in. thickness at the fork end. Radius said fork end over a mandrel with an end mill, profile the rod, then saw and file, or mill the slot to suit your expansion link material. The flanges are 1 in. lengths from 1/4 in. x 1/18 in. BMS flat; reduce to 7/32 in. width. Saw and square off the fore gear rods to arrive at 3 11/32 in. overall, sit on the brazing table and silver solder together. The back gear rods have to be set over by 3/32 in., the end squared off, before silver soldering together. Drill the No. 44 fixing holes, offer up to the eccentric strap, spot through, drill and tap 8BA, securing with hexagon head bolts.

Expansion Link and Die Block

Several people have spoken to me over the years about introducing a service for expansion links by exotic means, yet none to my knowledge has yet materialised. Not to worry, for we can make our pair reasonably easily. Reeves stock pieces of gauge plate which will be ideal for our purpose, so coat with marking off blue and carefully mark them out. Start with the trio of 1/16 in. holes and countersink them on one side only for soft iron rivets, remembering to hand them by said countersinks; next drill and ream the pair of holes at 5/32 in. diameter. We come quickly to the slot, for which drill a row of 9/32 in. holes down the centre of same. With a square file, first break into a continuous slot and then concentrate on the convex edge, filing carefully to line; on this depends the success or failure of the expansion link. When satisfied, take a piece of 5/16 in. silver steel rod and start filing the concave edge, a little at a time, until the rod enters and slides from end to end. Deal with the outer profile, then harden out the links to the instructions provided, this being an oil hardening steel.

Why do I not specify machining the slot? I have told the story many times before, but maybe it is worth repeating yet again. For FISHBOURNE, my 02 class 0-4-4T, I had two pieces of gauge plate specially ground for me in the shipyard toolroom and spent several evenings building a substantial milling fixture. When it finally came to milling the slot, I found the end mill wandered and tried to cut a straight link instead of a curved one and I would not inflict such experience on POM-POM builders whose time will be equally precious.

I do know how to draw a die block; many DYD builders were beginning to wonder, after the lack of them on so many of my drawings! From the information that the detail conveys though, I could well have omitted it again this time!! Start by chucking a length of 3/8 in. square bronze bar truly in the 4 jaw; face, centre, drill No. 23 to 9/16 in. depth and ream at 5/32 in. diameter before parting off two 5/32 in. slices. Now it is simply a question of filing them to suit the expansion link, keeping the hole central, then dealing with the top and bottom edges to drawing.

Link Trunnion and Retaining Collar

For the trunnion, chuck a length of 3/4 in. diameter steel bar in the 3 jaw and reduce to 11/16 in. diameter over a 3/8 in. length, parting off a 1/4 in. slice. Offer up to the expansion link, drill through the 1/16 in. holes and countersink the trunnion. Although the pin can be a press fit in the trunnion, I prefer to braze it in, so mark off and drill No. 22, fit a 1/2 in. length of 5/32 in. silver steel rod and silver solder together. Grip the whole in the machine vice to mill the 1/18 in. step to complete; rivet to the trunnion. If the pin is silver soldered to the trunnion, at least the retaining cap has to be a press fit, so chuck a length of 1/4 in. steel rod in the 3 jaw, face, centre and drill No. 23 to 3/8 in. depth before parting off two 1/16 in. slices.

Intermediate and Valve Rods

The intermediate valve rod is crucial to the whole valve gear, for its movement is somewhat restricted by the presence of the motion plate, yet travel in full gear is of the order of 3/4 in.; it is a bit tight. Start with 5/16 in. square steel bar, grip in the machine vice and use the cross slide to drill the trio of No. 23 holes accurately. Turn over and cross drill No. 22 at the end of the slots, but be prepared to finish the ends of these square if indicated at the valve setting stage. Clamp to the length of angle used for the side rods and mill down to 1/8 in. thickness between the fork ends, again leaving a little metal at the ends in case of modifying the slots. Saw off to length, radius the ends over a mandrel with an end mill, then deal with the slots to complete.

The valve rods are in pairs and start from 3/8 in. x 3/32 in. section BMS flat. Grip a pair in the machine vice to drill and ream the 5/32 in. holes at 1 1/4 in. centres, radius the ends, then file the flanks to match.

Lifting Link and Pendulum Lever

A simple building jig, or rather two of them, is required here, consisting of a piece of, say, 3/4 in. x 1/4 in. BMS flat into which No. 23 holes are drilled at the specified centres and lengths of 5/32 in. silver steel rod are pressed; coat the jig with marking off fluid to prevent spelter adhering.

For the end bosses, chuck a length of 5/16 in. bronze rod, face, centre, drill and ream to 5/32 in. diameter, parting off at the specified lengths and deepening the hole as you proceed. Fit to the jigs, cut pieces from 1/4 in. x 1/8 in. BMS flat to fit between the bosses, pack up to height and silver solder together.

Rocker and Valve Crosshead

Only these two pieces to complete the valve gear proper, so let me hurry on. Start the rocker by squaring off two 1 11/32 in. lengths from 1/4 in. silver steel rod. The upper rocker is from 1/2 in. x 3/16 in. BMS flat; grip as a pair in the machine vice to drill 6.3 mm to suit the rocker shaft, then move on .937 in. to deal with the upper holes at 5/32 in. diameter, they being reamed. Saw away as much metal as you can, radius the ends over a mandrel with an end mill, then file to complete. The lower arms are from 1/2 in. x 5/32 in. section BMS, dealt with exactly as for the upper pair, though the centres do vary at .875 in. Assemble to the shaft, carefully align upper and lower rockers, lay on the brazing table and silver solder together. Chuck the assembly in the 3 jaw to remove any excess spelter in the way of the bearing surfaces, when you can erect the valve gear thus far made using plain lengths of 5/32 in. silver steel rod.

For the valve crosshead, chuck a length of 5/16 in. square steel bar truly in the 4 jaw, face, centre, drill No. 27 to 1/4 in. depth and tap 2BA. Cross drill and ream 5/32 in. diameter at 7/16 in. from the end, then grip in the machine vice and mill down to 3/16 in. thickness at the cross drilled hole before sawing away. Screw the end of a length of 3/16 in. steel rod at 2BA, attach the valve crosshead, and use the rod as a lever to radius the end with an end mill. To secure the valve rods in place we need four pins, so chuck a length of 1/4 in. A/F hexagon steel rod in the 3 jaw, face and turn down to .142 in. diameter over an 1/8 in. length, screwing 4BA. Reduce the next 3/8 in. length to 5/32 in. diameter, a good fit in the reamed holes, then part off to leave a 3/32 in. thick head, reversing in the chuck and cleaning it up.

Weighshaft and Bearing

The weighshaft bearings are plain turning from 1 in. diameter bar; align them with a length of 5/16 in. steel rod to the holes provided in the frames, spot through, drill and tap 6BA, then saw and file away the excess flange that sticks above the frames.

Square off a 4 1/8 in. length from 3/8 in. bright steel rod for the weighshaft and turn down to 5/16 in. diameter over a 1/4 in. length at each end, a nice fit in the bearings just made. The lifting arms are from 1/2 in. x 1/8 in. BMS flat, so grip as a pair in the machine vice to drill first a 3/8 in. hole, then move on 1.125 in. to drill and ream a second at 5/32 in. diameter; complete as for the rocker arms. The reversing arm is from the same section material, but is trickier because of the set in same. I recommend you produce the set as the first operation, drill the 3/8 in. hole, and check things to place before you go on to deal with the 5/32 in. reamed hole, then complete as before.

Next chuck a length of 5/16 in. steel rod in the 3 jaw, face, centre and drill No. 22 to 1 3/8 in. depth, parting off at 1 1/4 in; take a 1 3/4 in. length of 5/32 in. steel rod and screw 3BA or 32T at each end. Use the rod and sleeve to space the two lifting arms correctly, erect to the weighshaft, bring up the reversing arm, sit on the brazing table and pack it to be correct, then silver solder together. We can now erect the weighshaft, add the lifting links and connect to the expansion links.

Reach Rod

Many builders will now attempt to set the valve gear; it is a mistake, for until the gear can be set and held properly in position by means of the reverser, everything you achieve is hypothetical, so please be patient.

Start the reach rod by taking an 18 in. length of 3/8 in. x 1/8 in. BMS flat, another piece 3/8 in. x 3/32 in., and bending each to form the fork end as shown at the reverser end. Drill both pieces No. 12, align the holes, then deal with the 3-bolt fixing and tidy up this end completely. Set the reach rod over by 13/16 in. as specified, cut off to length and braze a block of 5/16 in. square steel bar on as the start of the forked end at the reverser arm. Cross drill No. 23 at 13 1/8 in. centres, turn over and drill at No. 30 hole 5/16 in. back from the No. 23 one, radius the end, then cut the slot before completing the profile to drawing.

Seat Boxes

I am dealing with the seat boxes far too early, for the boiler must be erected and the cab sides in place to check the clearances and dimensions for same. However, I must assume that these are present, as we need at least the RH seat box on which to mount the reverser for valve setting. Anyhow, each box is roughly 5 7/8 in. long x 1 3/8 in. wide x 3 1/4 in. deep and is made from 1.6 mm steel sheet; obviously it has to be cut away to place to clear the firebox. Build it up with lengths of 1/4 in. x 1/4 in. x 1/16 in. brass angle as we did for the tender body and fit a top plate from the same material. What appears to be the top plate on the drawing detail is in fact a piece of 3/16 in. thick hardwood, not that our fireman is going to get much opportunity to use his seat! The seat box will have to be made wider towards its base to clear the rear coupled wheel, you can best do this to place, when attachment can be to both the mainframes and cab side to give the reverser a firm foundation.

Reverser Stand

Start with the baseplate, which is a 2 3/4 in. length from 11/16 in. x 1/8 in. BMS flat and you can drill the ten No. 44 holes at this stage. The main part of the stand is fashioned from 1 in. x 3/8 in. BMS flat; square off a 3 1/8 in. length. At 1/4 in. down from the top edge, scribe a line right round and chuck this in the 4 jaw to run true; you will see what I mean in a moment. Face,

Dave Johnson's POM-POM No. 6012 ready to make her debut on the Bitterne Park track of the Southampton MES, to whom our grateful thanks.

and with a round nose tool, turn the 11/32 in. diameter boss over a ¼ in. length as shown. Next centre and drill right through to No. 22, then follow up at ¼ in. diameter to at least ⅝ in. depth. Transfer to the machine vice to mill the 2¼ in. wide slot to ½ in. depth, exposing the reverser screw bearings, the nut sliding along the base of the slot, in fact make both screw and nut before proceeding to complete the stand. We now have to mill the bottom edge at a taper to sit on the baseplate as shown, attaching to same with a couple of screws, then taper the back edge also so that we can add the end plate. Make up the pair of lugs for the lock, holding in place with wire, when you can silver solder the stand to complete same; clean up and zinc spray.

Reverser Screw and Nut

The reverser screw is from ¼ in. steel rod, so chuck in the 3 jaw, face and turn down to .086 in. diameter over an ⅛ in. length, screwing 8BA; turn the next 5/16 in. down to 5/32 in. diameter, the 7/64 in. square we shall have to leave until the handle has been made. Part off at 3 7/16 in. overall, reverse in the chuck and turn down over a ¼ in. length to 5/32 in. diameter, checking against the stand, then screw the next full 2⅛ in. at 20T or similar. Next chuck a length of ⅜ in. steel rod, face and turn down to 11/32 in. diameter over a ¼ in. length. Centre and drill 6.3 mm to ¼ in. depth and part off an ⅛ in. slice, assemble screw and collar to the stand, remove any axial movement, then cross drill No. 60 for a 1 mm spring dowel pin.

The nut starts life as a length of ⅝ in. x ⅜ in. bronze rod, which would indicate from ⅝ in. square bar. Grip first in the machine vice and mill the flanks down to ⅜ in. width over 9/16 in. length of bar, then cross drill No. 12 and fit a ⅝ in. length of 3/16 in. bronze or steel rod as the reach rod pin; silver solder together. Saw the bar off at roughly ¾ in. overall, face off, then chuck in the 4 jaw to centre, drill through at 7/32 in. diameter and tap ¼ x 20T to suit the screw. Back to the machine vice to deal with the ⅜ in. wide slot at the bottom to suit the stand, and you will have to check this to place, fitting the screw, as you proceed. To complete, mill away at the top to suit the indicator plate, and file a wee notch to show the cut-off setting.

Indicator Plate

Cut this from ⅜ in. wide strip to match the stand, then mark off and drill the four corner fixings at No. 51; spot through, drill and tap the stand at 10BA for round head screws. Mark on the slot and start forming it by drilling a row of No. 16 holes, opening out with a file to suit the nut. Set said nut in mid travel on its screw and mark the indicator plate to show the mid-gear position, then deal with the full gear positions and add a few intermediate notches to show expansive working.

Back to mid gear, couple up the reach rod, set the die blocks in mid position, then clamp the stand to the reverser seat box, spot through, drill and tap the seat box top; not the wooden seat!

Reverser Handle, Locking Wheel and Lock

The locking wheel is turned up from ⅝ in. steel bar and presses on to the reverser screw; file the slots to place to suit the lock. This latter is fashioned from 1.6 mm steel, so drill the No. 52 hole first and then profile around same. Whilst driving Dave Johnson's POM-POM, it became clear that I had omitted the note about making the lock a tight fit in its lugs, use a brass rivet as the pin and really peen it over to trap the lock quite tightly, for it is an adornment only. You will rapidly find out otherwise in service if you leave the lock loose, for doing so turned the clock back for me nearly 20 years when I first fitted such a fiendish contraption on my K1/1; it gets in the way!

That leaves the handle, the main portion of which is from ⅜ in. x ⅛ in. BMS flat. Drill a No. 34 hole at the centre and No. 43 ones at ⅝ in. each side of same, then reduce the ends by 3/64 in. thickness to leave that 15/32 in. portion at the centre; complete the profile, broach the centre hole, and deal with the reverser screw to match. The handles are turned from 3/16 in. stainless steel rod, so chuck in the 3 jaw and fashion with a file. Start parting off at ½ in. overall, but only reduce to 3/32 in. diameter, then move on 3/32 in. and part right off. Insert the handles in the base, peen over and apply a touch of silver solder if at all loose; assemble with an 8BA locking nut.

Valve Setting

There are two little areas to tidy up before we can get down to valve setting. Removing the steamchest cover and taking out the balance pistons will reveal that I did not specify dealing with the spring pockets during their manufacture, so bring up the jig that we used on the valves to drill and 'D' bit to drawing.

Many years ago when visiting Bridgnorth, I became very interested in a Collett 32xx class 0-6-0, that is until I looked between the frames and saw the valve gear. It was so close to the engine centre line that there was evidence of severe rubbing of some of the valve gear parts, and if they rubbed in full size I imagined quite a problem in achieving working clearance in miniature; now that I have done POM-POM I know better. Anyhow, I was reminded of this rubbing by the theoretical touching of the valves and balance pistons within our steamchest, for in practice we should arrive at a clearance of about .002 in., so that they do not interfere with one another.

At the other end of the valve gear, I rather glossed over the critical lengths of the eccentric rods, when assembled to their straps, mainly because this is adjustable. If the rods prove too long on setting, then one simply removes metal at the bolting flange; too short and one adds thin packing; we are ready.

Set the engine in full fore gear, turn to front dead centre, and adjust the fore gear eccentric until the front port uncovers by .005 in; turn to back dead centre and equalise any error. Now do the same in full back gear, adjusting as before. At this point in the procedure, one HUNSLET builder rang to tell me this procedure did not work, too true it doesn't, for one has now to go back again to fore gear, then to back, any number of times before the errors begin to even themselves out, in fact you will likely lose your patience at the first session! With the points of adjustment being the length of valve spindle and position of the eccentric sheaves, it is possible but by no means probable that you will tend to get the valve too far back or too far forward in the steamchest, with the events otherwise OK. This indicates a variation of length of the eccentric rods, so try a piece of shim between bolting flange and strap of each and see its effect. Even if it makes things worse initially, it usually indicates the way forward, and this is the important bit in valve setting, understanding what the little variations do to the overall setting. Over the years I have spent any number of evenings just playing with Stephenson valve gears at the invitation of frustrated builders, very few of which had emerged from my drawing board, though this is immaterial. At the end, I have always achieved a very rough setting, by no means an accurate one, but indicating the way forward to success. I hope these notes will point builders of POM-POM in the right direction.

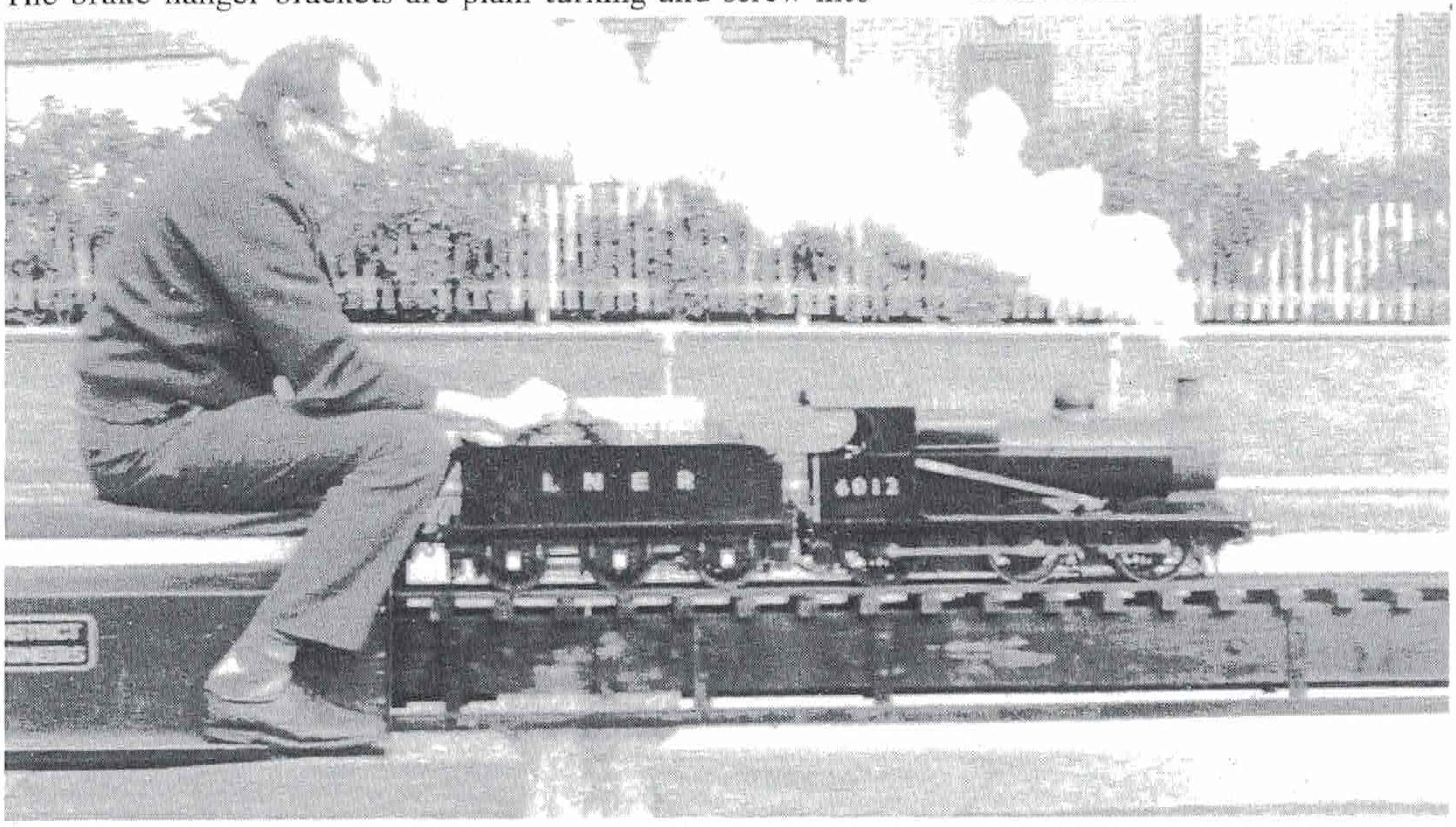
Brake Gear

The session is almost over, it has been a marathon!, but before we close have a look at the steam brake on the engine, and we can make just a couple of parts.

The brake hanger brackets are plain turning and screw into the 1/4 x 40T holes provided in the frames, which leaves the brake hangers.

Take a 3 1/8 in. length of 1/2 in. x 5/32 in. (or 4 mm) BMS flat and mark it off to drawing, then drill the No. 11 holes at the ends, plus No. 30 for the brake shoe pin. Radius the ends over a mandrel with an end mill, then complete the profile with files; make your best job of this as it will be the master for the other five brake hangers. Heat to a bright cherry red and dip in casehardening powder, then repeat to get a decent hard skin. Now we can use the master hangar as the drilling and filing jig for the remaining five hangers. I am glad this point came up in this session as it allows me to mention that some of the valve gear parts would benefit from casehardening, in particular the pendulum lever support bracket, otherwise that No. 12 hole may wear in time.

Next time we shall be completing POM-POM and getting her to the track!



Merlin Biddlecombe takes an hour or two off from moving house to sample a POM-POM. Note the passenger trolley, as described in Model Engineer by the late and great Bill Perrett.

Book reviews

CHINA'S RAILWAYS — **Steaming into a new age,** by Colin Garratt and published by Patrick Stephens at £12.95.

This book started for me as a running commentary with Colin Garratt as expert guide, probably a legacy from his now famous film shows, which did not greatly impress me, as I do not like being lectured to. However, I am glad that I persevered, as for me the interest grew page by page, culminating in pen-portraits of some of "the railway people" of China that I found totally fascinating, revealing too. Whilst some of the opinions expressed by Colin are greatly at variance with my own, no longer are they so abrasive to me as when I picked up his books in earlier years, for now that I have got to slightly know the author I can at least understand his viewpoint, plus his standard of photography means his books are worth looking at for that reason alone. I certainly enjoyed CHINA'S RAILWAYS, and though it obviously will not be everyone's cup of tea, pun intended!, a single sentence on the jacket for me sums the book up to perfection — I quote. "Railway enthusiasts and many others too will find much to entertain them and, perhaps, to speculate on in this book".

ONE MAN'S LOCOMOTIVES by Vernon L. Smith. Publisher: Trans-Anglo Books, PO Box 6444, Glendale, California 91205, 181 pp, $33.85.

Available in the UK from Candon Steam Services at £23.00 and £2.10 p & p.

Rare indeed is the practical, hands-on railwayman who can combine a fascinating life story with the substantial writing skills required to present it effectively. Vernon Smith has that magic touch and his ONE MAN'S LOCOMOTIVES is clearly the best work of its kind in many years.

The author's half century with locomotives began as a 16 year-old shop helper on maintenance of the standard gauge 0-6-0s which hauled out the overburden and the direct-shipping ore from open-pit iron mines in northern Minnesota. Within a few months he was a pit locomotive fireman and at age 18 had a regular engineer's assignment.

Home study of engineering and drafting fundamentals led in 1934 to work with Differential Steel Car Company as a daytime draftsman and evening student in mechanical engineering.

1937 brought Smith into the design department of Lima Locomotive Works while the Southern Pacific 'Daylight' 4-8-4's were underway, along with 10 huge Texas types for Kansas City Southern and a group of heavy Pacifics for Boston and Maine. A major assignment at Lima in which he took particular pride and satisfaction was as 'elevation engineer' on the design and construction of the heavy Class O-20 5000-series Northerns for the Soo Line — strikingly handsome 4-8-4's much admired in the U.S. midwest for their

POM-POM A Great Central 0-6-0 in 5 in. gauge

by: DON YOUNG

Part 7 — Conclusion

All good things must come to an end and I feel a little sad today as POM-POM approaches the end of the series, though such sadness is leavened by the thought of completed engines reaching the track in years to come, with all the excitement this will bring, so let me hurry on with description.

Brake Gear

For POM-POM I have the luxury of a cast brake block ring in iron, so first grip in the 4 jaw and bore out to 5⅜ in. diameter to match the coupled wheels, facing across and then relieving by 1/32 in. to leave the actual block thickness at 5/16 in. as shown. Now grip by the bore in the 3 or 4 jaw to face the opposite side, then saw into individual shoes. Square each shoe off to drawing, then mark off and drill the No. 30 hole before profiling around same by sawing and filing. To complete, we have to either saw and file, or mill, the 5/32 in. slot to accept the brake hanger; make this slot a very tight fit over the hanger so that it cannot 'trip' in the off position and dig into the wheel tread. I see that I have failed to detail the brake shoe pin, but it is simply a miniature version of the trailing beam end, which latter I will describe in a moment.

Brake beams for the leading and driving axles are easy, so start each by squaring off a 5¾ in. length of 3/16 in. steel rod. Chuck a length of 5/16 in. steel rod in the 3 jaw, face, centre and drill No. 13 before parting off four ⅛ in. slices. Press these collars on to the beams in the positions shown and silver solder them for additional security, chucking in the 3 jaw to remove all excess spelter. Assemble all the pieces made thus far and that includes the brake hangers and their brackets from the previous session, to drill the brake beam ends 1/16 in. diameter for split pins; clamp the brake shoes hard against the wheel treads.

Take lengths of 5/16 in. x ⅛ in. BMS flat for the pull rods, drill each piece No. 11 at 3/16 in. from one end, then offer the first pair up to the leading brake beam ends, mark off and drill the second hole at the driving beam. Likely anyhow you will have to start with ⅜ in. wide material. It is not a problem, for after radiussing the ends over a mandrel with an end mill, you will have to transfer to the machine vice on the vertical slide to mill the central portion down to 7/32 in. width; assemble to the brake beams. Now take the intermediate pair of embryo rods, attach to the driving axle beam, then drill through No. 11 at the trailing brake hangers, completing as before.

For the trailing beam ends, chuck a length of 3/16 in. steel rod in the 3 jaw and part off two 1 in. lengths. Turn up collars as for the other pair of beams, press them on and braze up, then rechuck to tidy up the head. Chuck the 5/16 in. rod again, this time drill No. 11 and then part off to the dimensions shown for the spacers. The rear pull rods are the same shape as those we have already completed, but before tackling same we have to deal with the brake shaft and its trunnions.

Brake Shaft and Trunnions

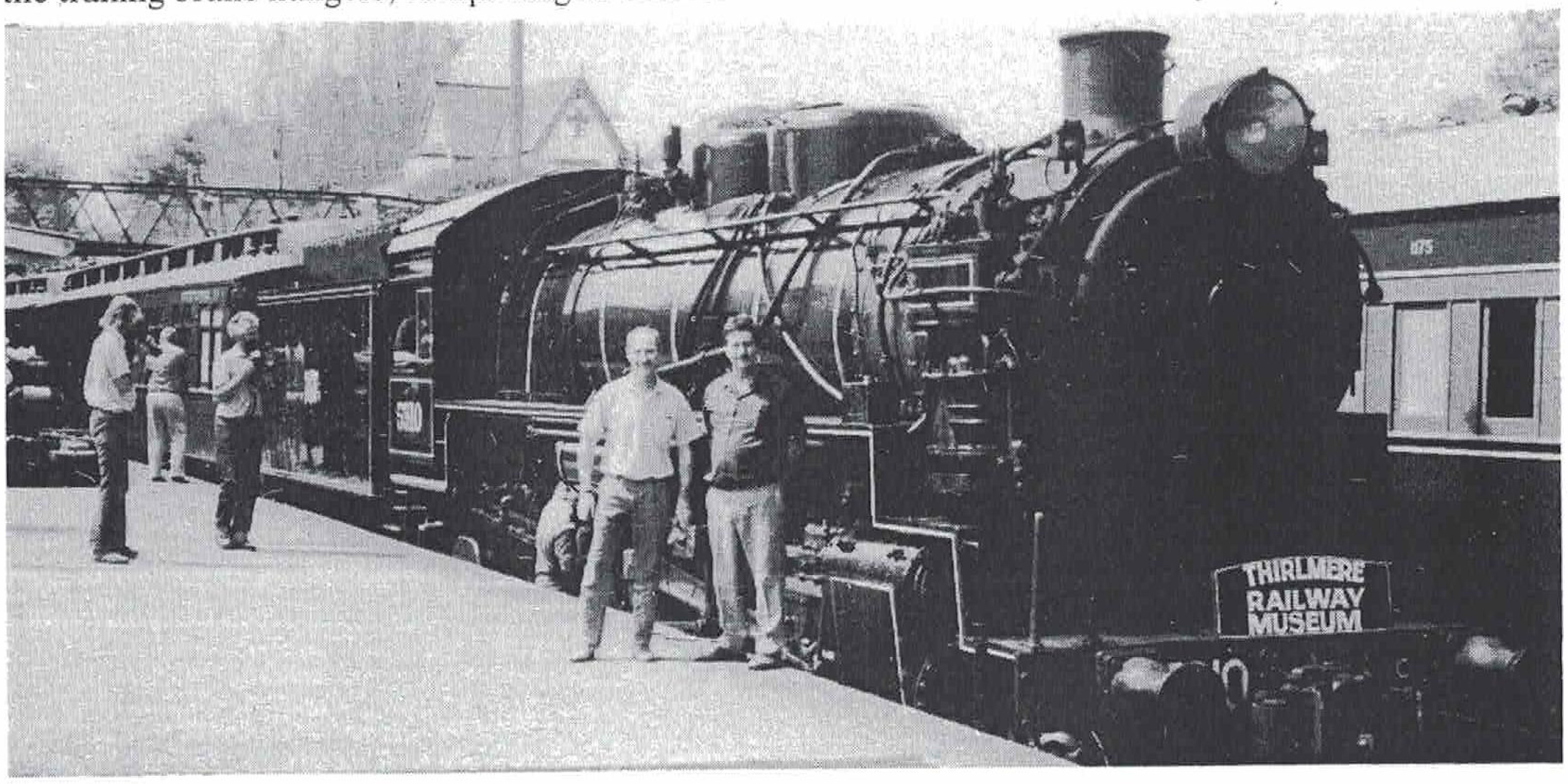
The shaft itself is a 4⅛ in. finished length from ⅜ in. steel rod; chuck in the 3 jaw and turn each end down to 5/16 in. diameter over an ⅛ in. length. The brake cylinder arm requires quite a bit of machining, so start with a 1 9/16 in. length from ½ in. x 5/16 in. BMS bar. Mark off and drill a ⅜ in. hole at 9/32 in. from one end, then move on 1⅛ in. and drill a second hole at No. 22. Turn the bar over and drill another No. 22 hole 3/16 in. back from the first to start forming the 5/32 in. slot, one you will now complete with saw and key cutting file. Back to the machine vice to reduce the main part of the arm to 5/32 in. thickness, then grip with a 'Mole' wrench to radius the ends over mandrels with an end mill, completing with files. If this arm is too slack a fit over the shaft, just squeeze the ⅜ in. hole lightly to hold it for brazing. The brake arms are from ½ in. x ⅛ in. BMS flat, drill the four pieces together, then radius the ends and complete with files; assemble and braze up.

The trunnions are from 1 in. x ⅛ in. BMS flat. Offer up to the frames and drill through the three No. 34 fixing holes, then bolt together as a pair to mark off and drill the 5/16 in. hole before profiling to drawing; erect and you can complete the rear pull rods.

Brake Cylinder

All the components detailed save for the push rod are common with No. 78000, so if I remember then I can avoid duplication of description.

Cylinder body first, so take the gunmetal casting and check the machining allowances, then rub a file across the top face to be flat before chucking truly in the 4 jaw. Face across the bottom, clean the flange up to 1¼ in. diameter, then bore right through to 13/16 in. diameter, taking the same care as with the cylinders. Reverse in the chuck, carefully clean



Those elusive photographs that should have accompanied the Phil Davis Australian Bi-Centennial Rail Tour were located at the printers and I trust POM-POM builders will excuse their being used hereabouts. Here we see the Baldwin 2-8-2 No. 5910 that Ray Cross has previously photographed for us at Maitland across the top face to 7/8 in. overall length and scribe the bolting circle at 1 3/16 in. diameter, marking off and drilling the six No. 34 holes. On to the machine vice to mill the wee flat in way of the steam entry, then centre, drill and 'D' bit 3/16 in. diameter to 5/32 in. depth, tapping 7/32 x 40T. To complete the body as far as we can go, drill No. 31 from the steam entry tapping into the bore as shown.

For the bottom cover, first chuck the gunmetal casting by its periphery to clean up the chucking spigot, then rechuck in the 3 jaw by the latter. Face right across to clean up, then turn on the 1/16 in. spigot to be a tight fit in the body. Clean up the flange to 7/64 in. thickness and tidy up the rest of the casting before centering and drilling 5/16 in. diameter right through into the chucking spigot, the last operation but one being to part same off. Rechuck carefully by the periphery, scribe on the bolting circle at 1 1/16 in. diameter, mark off and drill the six holes at No. 44, at the same time drilling through No. 41 as shown to vent under the piston; very important this. Offer up to the body, spot through, drill and tap 8BA for hexagon headed screws.

The piston is from 7/8 in. diameter brass bar, so chuck in the 3 jaw, face and turn down to around 27/32 in. diameter over a 1 3/8 in. length. Centre and bring the tailstock into play before turning down to 5/16 in. diameter over a 13/16 in. length, a nice sliding fit in the bottom cover. Start parting off at 1 3/16 in. overall, but only reduce to around 1/2 diameter, then move back 1/8 in. and form the groove at 1/8 in. width down to about 9/16 in. diameter, this dimension not being critical. Now concentrate on the piston itself, getting it a nice sliding fit in the body, then drill the end No. 10 to 1/4 in. depth before parting right off. Reverse in the chuck, face lightly, then centre and drill No. 41 to 1/2 in. depth. Follow up at 3/16 in. diameter and 'D' bit to 5/16 in. depth, tapping the outer 5/32 in. at 7/32 x 40T. Drill the 3/32 in. angled hole to complete the drainage arrangement, then drill No. 53 into the crown of the piston as shown and press in a length of 1/16 in. stainless steel rod to be 1/16 in. proud.

The bugbear of steam brake cylinders is that they easily become waterlogged; I realised early that water will always be present and decided to use it to advantage, though part of my solution was arrived at by accident. To help drain excess water, an 1/8 in. ball is provided in the centre of the piston, and we shall have to make the wee ball retainer to keep it there in a moment. Water tends to lift this ball when steam pressure has dissipated after a brake application, the water drains through and out via the vent hole in the bottom cover. That gets rid of excess water, but we need its presence for another feature to work. When I first detailed such a piston, it was with the idea of packing the groove with graphited asbestos yarn. In the event said packing was omitted by mistake, yet the brake operated perfectly, and when I stripped it down later to rectify my mistake, it was to discover the groove was full of water, and that still does the trick today. Anyhow, for the ball retainer, chuck a length of 7/32 in. brass rod in the 3 jaw, face, centre and drill No. 48 to 3/16 in. depth. File a wee screwdriver slot, then screw the outside 40T over a 3/16 in. length before parting off a 1/8 in. slot. Normally one would have to destroy the seating in the ball retainer to prevent malfunction, but the lift of the 1/8 in. ball is so slight that no problem will ever arise in service.

Just the push rod to complete, except for a pin to connect same to the brake shaft which we already know how to manufacture, so chuck a length of 5/16 in. stainless steel rod in the 3 jaw, face, centre and drill No. 22 to 1/4 in. depth before parting off a 5/32 in. slice. Next chuck a length of 5/32 in. stainless steel rod and radius the end as shown, then part off at 15/32 in. overall and silver solder to the boss; erect the completed brake gear and check its operation, though the final proof wil have to await the first steaming, not long ahead now!

THE SMOKEBOX

If the boiler is the lungs of any engine, the cylinders its heart, then the smokebox can well be its Achilles Heel. There ued to be an oft quoted statement that nature cannot be scaled, but I have always thought on the opposite track in that the same principles apply in miniature as in full size, thus the success of my designs owes a great deal to the work of S. O. Ell and his team at Swindon in the area of draughting. When I mentioned this in an earlier article, both Alan Rimmer and Gerry Collins stepped forward with information, the latter with a whole chapter from WORLD RAILWAY LOCOMOTIVES written by Sam Ell and published by Hutchinson in 1958. I asked the publishers for permission to publish Ell's piece which was entitled "The Testing of Locomotives", but sadly my request has been ignored thus far. Alan on the other hand is beginning to think as I did some 25 years ago now, so it will be interesting to compare his results with those of DYD builders; on with the action.

Smokebox Platework

I love using the mandrel and end mill technique, so would use it to shape the smokebox front plate. Cut same from 1/4 in. steel plate, file roughly to line and drill a 1/2 in. hole through at the centre, then profile with an end mill before completing the parallel portion at the bottom with files. Chuck in the 4 jaw, face across to provide a sound seating for the door, then bore out to 4 3/8 in. diameter. The back plate could also be from 1/4 in. steel plate, though I feel it looks much better flanged up from 2mm copper sheet as detailed. Make up the former from 1/2 in. thick hardwood as we shall only be using it the once, cut the copper 5/16 in. bigger all round except at the bottom, heat to a bright red and quench, then start forming the flange, annealing every time the metal hardens, that way the former will last out the job. File the flange to match the front plate, then chuck in the 4 jaw to bore out to size, and if you use a knife edged tool you will be able to save the centre portion for another day.

Joint ring next, first chucking by the periphery to face off, then to bore out to a very tight fit over the end of the boiler barrel. Rechuck by the bore, face off to length and turn on the spigot to match the smokebox back plate.

The smokebox shell starts as a 20 in. length of 3 3/8 in. x 1.6mm section steel strip, which of course you will have to cut from wider material, though perhaps some kindly person will shear it for you. If your boiler barrel is still unlagged, and I have yet to describe this process, then put the shell around this initially, checking against the front and back plates. Splay out the bottom, check between the frames and saw away the excess, then join the three pieces together with a minimum number of 6BA countersunk screws, tapping into the front and back plates. Bring up the joint ring and silver solder the whole assembly to be air-tight, then check over the end of the boiler barrel, when very likely the fit will have eased.

Chimney and Petticoat Pipe

There is always excitement in seeing the chimney in place on top of the smokebox, so let me deal with this next. On the top centre line of the smokebox shell, scribe on a 1 3/8 in. diameter circle, drill around the inside of this, break out the middle and file to line.

The petticoat pipe is a gunmetal casting, yet another of my standards, so first grip by the bore in the 4 jaw and turn down the outside to 1 5/16 in. diameter as shown, facing off to length and then tidying up the bottom radius. Rechuck by the outside parallel portion, clean across the bottom face and then bore out to 1 in. diameter. Set the boring tool over by 2 deg. and start opening out from the chuck until you arrive at the choke in its correct position, then radius the bottom flare with files, polishing finally with emery cloth. For the flange, cut a 1 3/4 in. square from 1.6mm brass, find the centre by the 'X' method, chuck in the 4 jaw and bore out to a fit over the petticoat pipe. Now bend the flange to match the inside of the smokebox shell, easing the hole to again fit over the petticoat pipe, then locate it 3/8 in. from the top as shown and silver solder together.

The chimney is an iron casting requiring little machining. It is a good plan to first bed the bottom flange to match the smokebox shell, gripping by the chucking spigot in the bench vice, then chuck by the bore and clean up said chucking spigot. Rechuck by the latter and clean up the outside to your heart's content, then bore out at the base to accept the petticoat pipe, allowing for the 1/16 in. of smokebox shell. Set the boring tool over 2 deg. once more, in fact it is good practice to do these taper turning operations consecutively, and bore out the chimney to match said petticoat pipe. To complete, tidy up the base of the chimney with files before parting off the chucking spigot. At this stage the petticoat pipe is rather a rattling fit in its hole in the smokebox shell, which is the way we want it, to allow some adjustment to the blast nozzle later on.

Smokebox Door and Fittings

Before going into the dark confines of the smokebox, we must add the smokebox door and its adornments. Chuck the gunmetal door casting in the 4 jaw to clean up the chucking spigot, then rechuck by the latter in the 3 jaw. Turn to diameter, face, then concentrate on the profile before centering and drill No. 27. Fashion the centre boss as you part off and we must give attention to the hinge.

Chuck a length of 5/32 in. steel rod, face, centre and drill No. 51 to 1 5/8 in. depth, taking it in easy stages to avoid drill breakage. Lay alongside a 1 1/2 in. length of 5/8 in. x 1/16 in. steel flat on the brazing hearth and join together with a high melting point spelter, then complete fashioning the hinge to drawing, bedding to the door. Although it is perfectly feasible to rivet the hinge to the door, I much prefer silver soldering, Easyflo No. 2 or similar specification being all that is needed.

The hinge blocks are from 5/32 in. square steel bar, so chuck truly in the 4 jaw and turn down to 3/32 in. diameter over an 11/32 in. length, screwing 7BA. Cross drill No. 51 at the 5/64 in. dimension before parting off, and if you feel particularly brave then you can radius the outer end over a mandrel with an end mill, otherwise file on the radius.

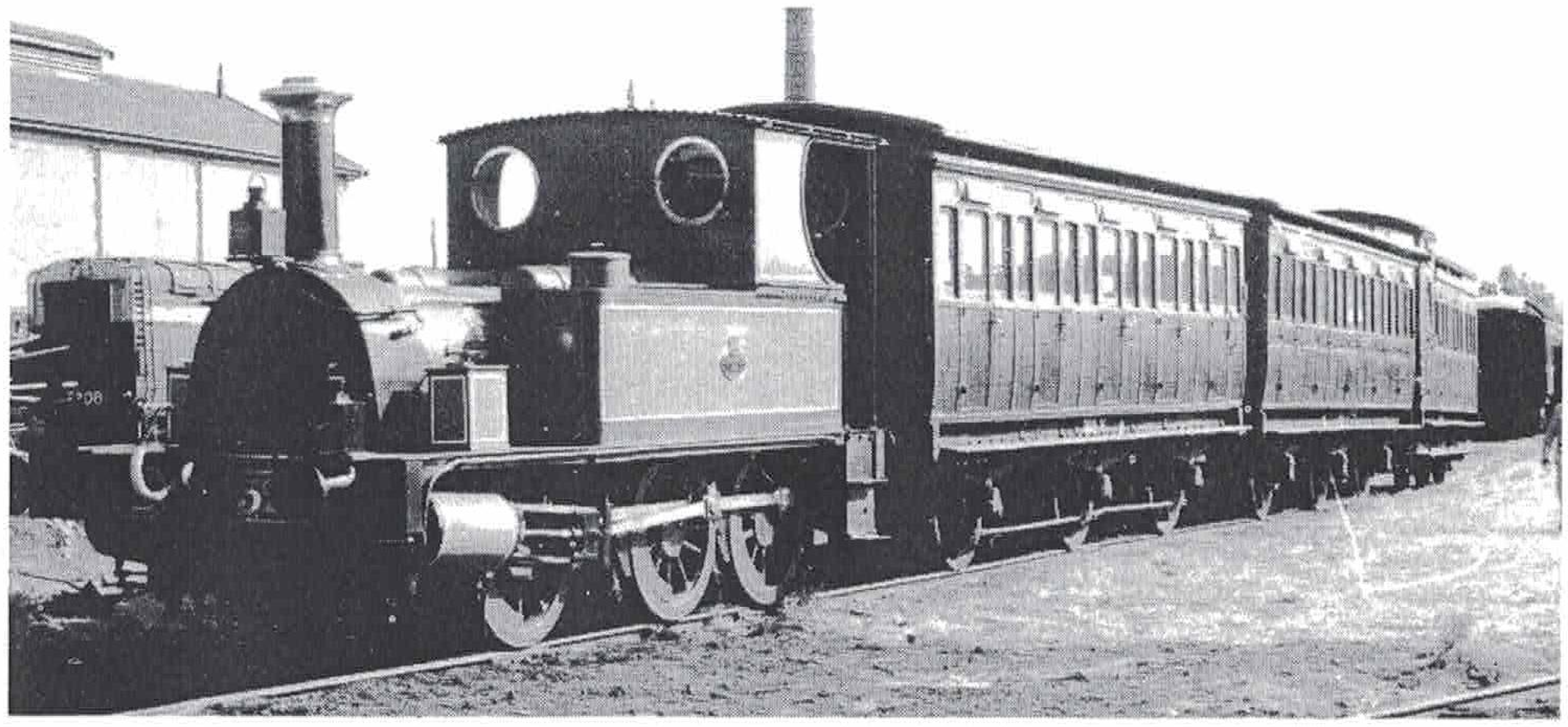
Crossbar next and although its shape looks a bit fancy, it is arrived at very simply. Cut two 2 5/16 in. lengths from 7/16 in. x 3/16 in. BMS flat and two pieces 1 in. long from 7/16 in. x 1/8 in. section, clamping firmly together with the 5/8 in. slot at the centre; braze up. Now it is a case of shaping the ends to drawing, though before completing same we should make up the brackets for inside the smokebox. Bend these up from 1/4 in. x 3/32 in. strip, drilling for a 3/32 in. iron rivet, but do not attach them as yet. Instead we must turn our attention, literally, to the dart which is from 7/16 in. rod, mild or stainless steel as you prefer. Chuck in the 3 jaw and turn the first 1/2 in. down to 1/16 in. diameter, then move on and turn the next 9/32 in. down to .110 in. diameter, screwing 6BA. Move on again, this time in about 3/8 in. increments, to turn the next 1 23/64 in. down to 9/64 in. diameter; part off to leave a full 5/32 in. of the original material. Shape this as shown to pass through the centre of the crosbar, then make the hinge pin the same way as we made brake gear pins a moment ago and assemble the door. Fit the crossbar, then the dart, securing the latter with a 6BA nut and some washers, this to position the crossbar, when you can drill through and rivet the brackets into place.

The smokebox door handle is a mighty affair, yet elegant at the same time, and I am much inclined to turn it from 1/4 in. steel rod, rather than fabricate. Chuck in the 3 jaw and turn on the taper portion a little at a time, though filing is much quicker, then turn on a spherical end and part off. File two flats on this end to arrive at the 5/32 in. dimension, then drill No. 35 and file out to the 7/64 in. square, dealing with the dart to be a match.

The handwheel too calls for some fancy turning, so start by chucking a length of 7/8 in. diameter steel bar in the 3 jaw and turning down to 13/16 in. diameter over a 1/2 in. length. Next turn down the outer 3/32 in. to 3/16 in. diameter, then start parting off at a full 3/16 in. overall. Now you can shape the rim and remove a whisker of metal towards the centre boss to start forming the spokes. Before parting off, centre, drill No. 43 to 3/8 in. depth and tap 6BA. Chuck a 6BA bolt, screw the embryo handwheel to same, then carefully turn the front face to look really pretty. Grip in the bench vice by the 6BA bolt, mark off for the spokes and drill four 3/16 in. holes to start forming them, completing with files; fit this and the handle to the dart. To retain the handwheel we need a wee collar and although I am much enamoured by 1mm spring pins, on

This picture by David Jones in Queensland was sent in ages ago and has been waiting for space to be published; I hope you like it

This Phil Davis masterpiece can only have been taken at the Thirlmere Railway Museum. Note the closeness of the driving and rear coupled axles, which much make problems for the ashpan, otherwise I would be tempted to add this 'different' engine to my lists



reflection I would now modify my instruction to making the collar a press fit on the end of the dart.

COMPLETING THE STEAM CIRCUIT

This whole session is about completing unfinished business, and thus far our steam circuit ends at the superheater flange on the smokebox tubeplate; we must next get steam into the cylinders.

Superheater and Flange

There should be an odd end of that lovely bronze we used for the balance pistons left over for the superheater flange, so chuck in the 4 jaw, face and turn down to 1¼ in. diameter over a ¾ in. length. Centre, drill ⅜ in. diameter and 'D' bit to ⅜ in. depth then part off a ½ in. slice. Chuck again to clean up the parted off face, then scribe on the bolting circle at 1 in. diameter. Next chuck a length of 7/16 in. bronze rod in the 3 jaw, face, centre deeply to form the countersink for the pipe nipple, then carry on at ¼ in. diameter to ⅝ in. depth. Screw the outside 26T over a 5/16 in. length, then start parting off at ⅜ in. length, but only reduce to 11/32 in. diameter before moving on another ⅛ in. and parting right off; repeat. Mark off on the flange for the two unions, drilling ¼ in. diameter into the central hole, then follow up at 9/32 in. diameter to 5/32 in. depth, fit the unions and silver solder together. Mark off and drill the four No. 30 holes, then rechuck and lightly face across the joint face to be perfectly flat. Offer up to the steampipe flange, spot through, drill and tap 5BA to 3/16 in. depth, making up ⅞ in. long studs from ⅛ in. stainless steel rod and securing with commercial brass nuts.

The superheater is of the coaxial type, far easier to clean than the spearhead ones that I used to specify, thus more efficient despite the smaller surface area presented to the gases. Whether you choose a radiant type extending into the firebox, or flue type, I will leave to builders, which decides the length of stainless steel outer sheath. Square the tube off to chosen length, turn up an end plug from stainless steel and have it welded in place, silver soldering will not suffice here. Insert in the flue tube and centralise using paper as packing, then mark off for the feed pipe from the superheater flange, drill the sheath at 5/16 in. diameter and cut the supply pipe to length. The element nipples can be from brass if you like, so chuck a length of 7/16 in. rod, turn down to 25/64 in. diameter over a 1 in. length, then centre and drill ¼ in. diameter to 1 in. depth. Follow up with a 5/16 in. drill and 'D' bit to 3/32 in. depth, then set your turning tool over to 30 deg. to form the cone, part off; repeat for the other three nipples. Chuck the ½ in. stainless steel rod again, turn down to fit the sheath over a ¼ in. length, then centre and drill 5/16 in. diameter to ¼ in. depth before parting off an ⅛ in. slice. I should have said at the outset that both supply and return pipes can be either copper or stainless steel to choice, and I much prefer copper here for its ease of bending to connect to the cylinders. The problem with copper is that it can sag inside the sheath, the answer being to form a coarse spiral from 20 swg copper wire and just tack it to the return pipe; this spiral will also greatly increase the efficiency of the superheater. Now you can assemble all the pieces and silver solder them together at the smokebox end, Easyflo or similar being quite suitable here. Don't forget the pipe nipples and even more importantly the union nuts, the latter from ½ in. A/F hexagon bar.

Cylinder Connection and Blower Union

Both these items are simple turning from hexagon bronze bar and call for no description on my part, when we can complete the steam circuit to the cylinders and run ⅛ in. o.d. thin wall copper tube towards the blast nozzle; now for the exhaust.

Blast Nozzle and Blast Pipe Top

The latter again is simple turning, so we can turn our attention to the blast nozzle. Yet again there should be sufficient bar left over from the balance pistons to cover this item, so chuck in the 4 jaw, face and turn down to 1¼ in. diameter over a ¾ in. length. Rough out the profile, then centre and drill 13/32 in. diameter to ¾ in. depth before boring out to 45/64 in. diameter over a full ¼ in. depth and tapping ¾ x 26T; part off at a full ⅝ in. overall. Chuck an odd end of ¾ in. diameter bar in the 3 jaw, face and screw 26T over a ¼ in. length, screwing the embryo body to same. Face off to length and complete the profile, then set the boring tool over to deal with the actual nozzle. The blower belt I have shown from 1 in. o.d. x 16 swg copper tube, but if this is not to hand then it can be bored out of 1¼ in. diameter bar; perhaps yet another odd end of the bronze? For the union connection, chuck a length of 7/32 in. brass rod in the 3 jaw, centre deeply and drill No. 41 to ⅜ in. depth. Screw the outside 40T over a 7/32 in. length, then start parting off at ¼ in., but only reduce to around 5/32 in. diameter before moving on another 1/16 in. and parting right off. Mike the diameter of the spigot, drill the blower belt to suit, press in, assemble the whole and silver solder together. Just those three No. 70 holes to complete and I have never found any problem with these using my Woolworths 6/10d (34p) hand drill of 1956 vintage; it is simply a question of patience.

The blast pipes are from 9/16 in. o.d. x 18 swg copper tube, scarfed together and fitting into the blast pipe top. The bottom flanges are 1 in. diameter and 5/32 in. thick from either brass or bronze bar, drilled through at 9/16 in. diameter and then eased to suit the blast pipe. Mark off and drill the fixing holes in each, then silver solder together. Now comes the tricky bit of bending the blast pipes for the nozzle to come upright, though with the tube now well annealed it is that much easier. Bolt the flanges down to the steamchest cover, make a ¾ x 26T nut to fit over the blast pipe top so that it will not distort, then insert a length of 9/16 in. diameter bar into the top and pull carefully, checking as you go by alignment with chimney and petticoat pipe. When upright, use calipers around the petticoat pipe to the alignment bar, get it perfectly central, then drill through both smokebox shell and petticoat pipe flange at No. 41, countersink the shell and secure with 7BA screws. I am assuming in this instruction that the smokebox has been permanently fixed to the cylinders, by screws passing into the steamchest cover, which will be the case very shortly, as we now have to erect the boiler.

BOILER ERECTION

Expansion Brackets

Bend up the expansion brackets from 2.5mm copper to drawing, then sit the boiler in the frames to be level, taking time over this as a boiler that slopes looks really horrible. Offer up the expansion brackets and if my drawings are correct, then scallops are required as shown to clear the stay heads. Drill the brackets No. 34 in four positions, offer up to the firebox, spot through, drill No. 44 and tap 6BA. The securing screws are from 3/16 in. bronze rod, so chuck in the 3 jaw, face and turn down to .110 in. diameter over a 1/4 in. length, screwing 6BA. Part off to leave an 1/8 in. thick head, one which requires a simple saw cut as the screwdriver slot, for it will be hidden under the boiler lagging. Anoint the threads with liquid jointing compound such as 'Osotite' and erect.

Grate and Ashpan

I am a great believer in cardboard template, they being much cheaper than metal if one is spoilt and we shall be using quite a lot of them before this session is over. The first one we require is for the ashpan, so cut it out and fold up to fit over the bottom extension of the firebox. Lay on a sheet of 1.6mm steel, scribe around, saw out and fold up, silver soldering the joints. Note the dotted line at the front which indicates it is plated in, the only air opening is at the back of the ashpan; simple I know, but I have seen too many ashpans with air entry back and front, accompanied by complaints that the fire does not burn as brightly as it should. Offer the ashpan up to the firebox, and if I remember what Dave Johnson told me, I have specified the hole for the dumping pin in about the worst possible position! No problem at all, for with the boiler erected you will be able to find a suitable position for the pin over the centre couple of inches of the ashpan, so drill No. 30 through both ashpan and firebox extension. The dumping pin is bent up from 1/8 in. steel rod, with a saw cut at the end and just slightly splayed out so that the pin does not come out on the run and cause a premature halt to the proceedings!

The grate starts with eight 5 1/4 in. lengths from 3/8 in. x 1/8 in. stainless steel flat; clamp them together and drill through No. 30 at 1 in. from each end. Next chuck a length of 3/8 in. steel rod, face, centre and drill No. 30 to about 1 in. depth, first parting off ten 7/32 in. long spacers and then another four at 3/32 in. thickness, deepening the No. 30 hole as necessary. Bend up the four support legs from the same 3/8 in. x 1/8 in. section material, check to place against the ashpan, then thread lengths of 1/8 in. steel rod through bars, spacers and legs, peening well over so the assembly is rigid. Mark off and drill the four holes in the ashpan, erect grate and ashpan to the firebox, position the grate so that its top is at least level with the top of the foundation ring, then drill through the legs and secure with either bolts or rivets as you prefer.

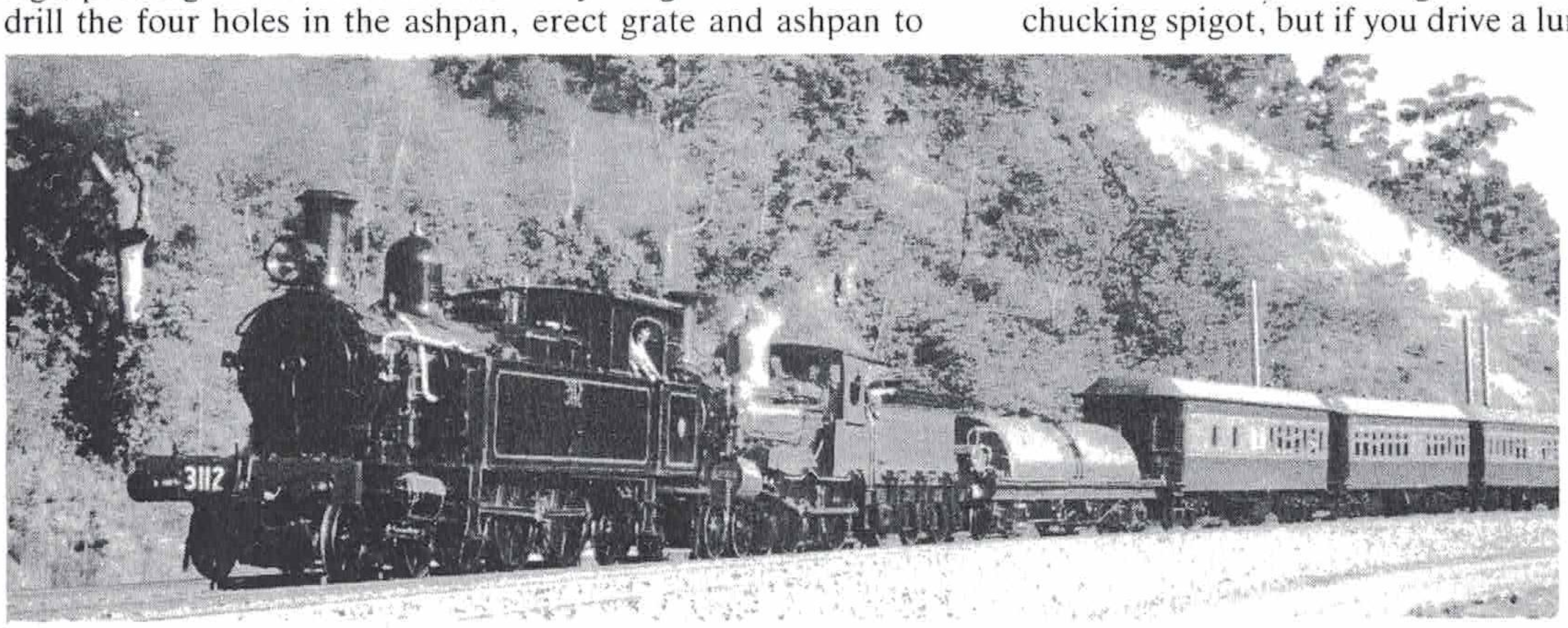
Lagging, Cleading and Dome Cover

I note that Reeves have now changed over to glass cloth as lagging material for boilers and I do hope that not too many POM-POM builders are allergic to the stuff, so handle with care so as not to find out the hard way! Cut into pieces that fit neatly around the boiler barrel, cutting clear of such obstacles as the dome and hold in place with fine copper wire, the old 15A fuse wire I reckon to be the ideal; build up to the diameter of the boiler joint ring. Now deal with the firebox to match the barrel and we must refer back to Sheet 1, indeed much of our remaining time will be spent on this first sheet. To clead the firebox properly we need the splashers and cab in place, but at least I can describe the process.

First part we need is the joint between barrel and throatplate, indeed it is much akin to said throatplate and best made from very thin gauge copper, 0.7mm thick. Make up a hardwood former and flange the copper over same. Cleading for the barrel is from 11 1/2 in. wide x .015 in. thick brass shimstock, length to pass right round the barrel with about a 1 in. overlap on the bottom centre line. Make up a couple of Spanish windlasses, which are simply loops of string with an odd end of rod passed through the ends of the loops and then wind up, this to wrap the cleading closely around said barrel, or rather on top of the lagging, when you can solder the seam with an electric iron, just so that it does not spring apart. Boiler bands are from 3/16 in. wide brass strip, with the ends turned over at 90 deg. and drilled No. 44 for long 8BA bolts to draw them firmly onto the cleading, with about a 3/16 in. gap in conclusion. Cleading over the firebox is roughly 5 in. wide, but do remember that the boiler will expand through the cab front and allow 3/32 in. for this. A close inspection of Tom Greave's fine photograph of No. 64441 on Page 22 of LLAS No. 36 shows that the cleading drops vertically to the running board, not being waisted in to match the firebox, but this is something I can safely leave to builders. Just a single boiler band is required at the throatplate joint, the bottom ends being splayed out as for those on the barrel, but this time attached to the splashers.

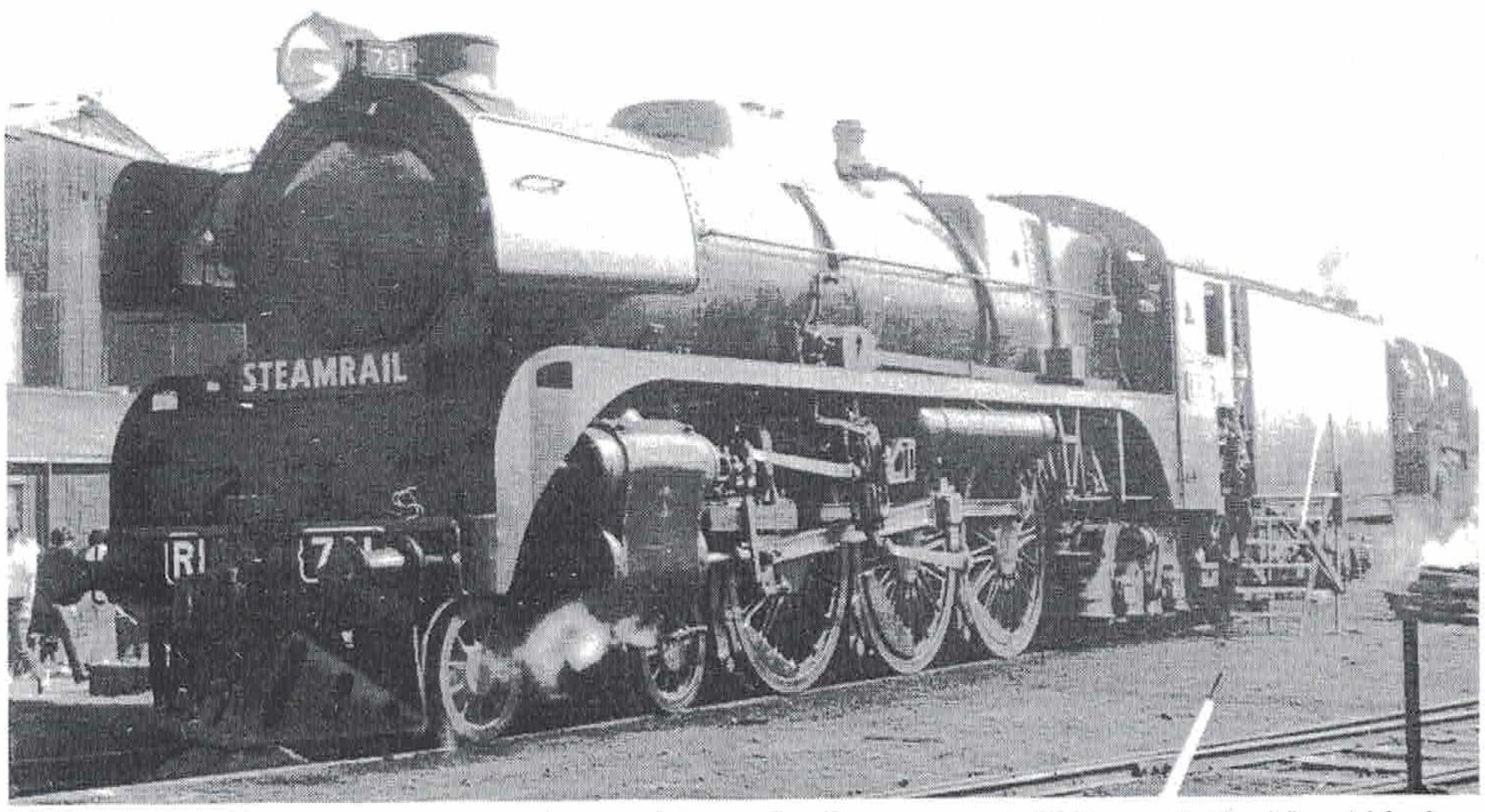
I must admit that I was very unhappy when I first saw the dome casing detail on the Works drawing, for it differed from that for JERSEY LILY simply in height, and such did not seem to warrant another pattern. Then as I came to look at more and more POM-POM photographs it was to discover a wide range of dome covers, a bewildering array in fact as Tom's illustrations show, and in particular note the exact copy of that for JERSEY LILY fitted to the POM-POM on Page 19 of LLAS No. 36. So really it is a case of you pays your money and takes your choice, so I will content myself by describing the drawing detail.

Domes are awkward things to hold without the luxury of a chucking spigot, but if you drive a lump of wood into the bore



For 4-6-4T No. 3112, 1988 seems to have been a busy year, for she also appears on Page 9 of LLAS No. 39

The mighty R Class 4-6-4 No. 761 of Victoria Railways; details of this engine appear on Page 10 of LLAS No. 39. Phil Davis wrote to say that my illustration of his article in LLAS No. 39 did meet with his approval, but it would have been so much better if these could have been included; my apologises to all



and dress it with chisel and file, you will in the end be able to chuck it truly in the 4 jaw to carefully top it like a hard boiled egg; clean up the joint. Now chuck an odd end of 3 in. o.d. copper tube in the 3 jaw, by the bore, to face and part off a 7/16 in. slice, assemble the three pieces on the brazing hearth and silver solder together. Now you have to go through the rigmerole of chucking truly again in the 4 jaw to tidy up the outside, drilling the top if you like centrally at No. 44 for an 8BA bolt to secure to the dome plug. To complete, grip very gently in the bench vice to profile the base to match the cleading.

TIDYING UP THE CHASSIS

We now come to the stage of adding the final details to the chassis, starting with the rubbing plates which are attached to both engine drag beam and tender front beam.

Rubbing Plate

The base is from 4mm steel plate, size 1 7/8 in. x 1 3/8 in. with corners radiussed as shown. We now have to add the rubbing surfaces top and bottom and these can best start as 1 7/8 in. lengths from 7/16 in. square steel bar. First remove 5/16 in. of metal for 1/2 in. at each end to produce the 1/8 in. ribs as detailed, then roughly mill on the 1 3/4 in. radius just to remove the majority of the metal before completing in pairs with files. Offer up to the baseplate, clamping in place, then drill and file out the 7/8 in. x 1/2 in. drawbar opening before brazing up. Mark off and drill the eight No. 34 holes, countersinking where shown, then offer up to the respective beams, drill through and tap 6BA.

Buffers

Again the buffers differ from those which adorn JERSEY LILY, so will have to be made from steel bar instead of castings. For the stock, chuck a length of 1 1/4 in. square bar truly in the 4 jaw, face, centre and bring the tailstock into play. Start by turning down to 13/16 in. diameter over a 1 in. length with a round nosed tool, then turn the outer 3/16 in. down to 19/32 in. diameter and form the raised portion before setting the tool over to complete the taper. Now drill 5/16 in. diameter to 1 1/4 in. depth before parting off to leave a 1/16 in. thick flange, one which you now drill in the four corners at No. 44 and radius.

The socket is from 2.5mm steel plate, so cut 1 1/8 in. squares from same and file to match the stocks, though maybe it would be prudent to leave oversize for the moment. Chuck truly in the 4 jaw, centre and drill through to 5/16 in. diameter. Next chuck a length of 3/8 in. steel rod, face and turn down to 5/16 in. diameter over a 7/32 in. length. Centre and drill No. 30 to 3/8 in. depth before parting off at 11/32 in. overall, silver soldering to the plate. Now you can insert the spigot into the socket to tidy up the flange and drill through the No. 44 holes. Castings are available for the buffer heads, which will save some heavy machining from 1 1/4 in. diameter steel bar, so chuck by the shank, clean up the chucking spigot and rechuck by the latter. Turn down the shank to 5/16 in. diameter, parting off to length, then profile the head as far as you are able before parting off, only before doing so, centre, drill No. 30 to 1/4 in. depth and tap 5BA. Rechuck by the shank to complete turning the head, polishing it well to deter the rust bug. Chuck a length of 1/8 in. steel rod, face and screw 5BA for 1/4 in. at one end, then part off at 1 3/8 in. overall, reverse and screw this end over a 3/16 in. length; assemble to the head. Erect stock and socket to the buffer beams with 8BA steel hexagon bolts, then find the strongest spring you can that is 5/16 in. o.d., slip it into the socket, fit the head and secure at the back of the beams with 5BA nuts and lock nuts to be secure. In conclusion it should not be possible to fully depress the buffer by hand pressure alone, otherwise they will be a complete waste of time and effort.

Front Couplings

We already know how to make coupling hooks having dealt with this item on the tender, and as only the dimensions of the shank vary, I can safely leave this to builders.

For the shackle, chuck a length of 1/4 in. steel rod in the 3 jaw, face, centre and drill No. 30 to 5/8 in. depth before parting off a 1/2 in. slice. The shackle loop is bent up from 1/8 in. steel rod, checking against the hook so that it fits snugly and still in the hook, sit on the brazing hearth with that 1/2 in. length of 1/4 in. rod and braze together, finally sawing and filing away the excess to complete. Having made brake gear pins a little earlier, the shackle pin follows, so on to the link and hook.

Being fundamentally a freight engine, at least when introduced, POM-POM did not then have the luxury of screw couplings, but merely a hook to connect to the first wagon. Of course by LNER and BR days, screw couplings were provided, so sadly I cannot refer builders to any photographs of this detail, so instead look at a crane hook if you get the opportunity. Start with a 1 in. length from 5/8 in. x 1/4 in. steel bar and at 1/8 in. from one end, cross drill No. 30 through the longest face; turn over and drill again No. 11 at 11/32 in. from the opposite end. Now really it is a question of removing metal until the end result pleases you, and as the hook will never be used in anger, then do not worry if in conclusion it looks rather flimsy, for that will deter others from using it. Bend up the link from the 1/8 in. steel rod and braze the joint and I see I got something wrong just a moment ago. With a screw coupling, the shackle is assembled to the hook as I have described, but with link and hook it is the shackle pin that passes through the hook, the link then threading onto same, so please be a bit more careful that I have been!

Boiler Fittings

Save for the 'Everlasting' blow-down valve, which latter is an LBSC speciality and I would not presume to tread where the maestro has been, every other fitting has been described in these pages, most of them very recently, so I shall avoid duplication, even though I know this incurs the wrath of some of my readers! Space though is ever at a premium!!

PLATEWORK

Let me at least start the final part of the series with a drawn detail, that of the running board brackets. These are simply bent up from 1.6mm steel or brass sheet, trimmed to size and then drilled to detail. Offer up to the frames, although you can leave this until the running boards exist, to spot through, drill and tap the frames 6BA for hexagon head bolts. Everything from now on is 'make to place'.

The valances can be made either from ½ in. x ½ in. x 1/16 in. brass angle, or alternatively from ½ in. x ½ in. x ⅛ in. steel angle, depending if you want a light or heavyweight engine! I much prefer brass here as one can make the valances longer in the first place, then cut away the top face and turn the side face inwards to form a bolting lug to attach to the end beams. Sometimes the brass will crack when one bends it in a sharp corner, but a drop or two of silver solder will heal the crack and in any case we have to add a piece at the front end, shaped as shown to match the front buffer beam.

Side running boards start as 30 in. lengths of 2¼ in. x 1.6mm steel strip, offered up to place to mark off in way of the wheels. Saw and file to length, attaching to the end beams and the brackets we have just made, when they will be nice and rigid. Although the centre section of running board at the front should be hinged, as only Dave Johnson thus far has thought fit to locate a mechanical lubricator under same, my recommendation is that it be folded up in a single piece and attached permanently to the front beam with lengths of ¼ in. x ¼ in. x 1/16 in. brass angle, and this of course applies also to the side running boards.

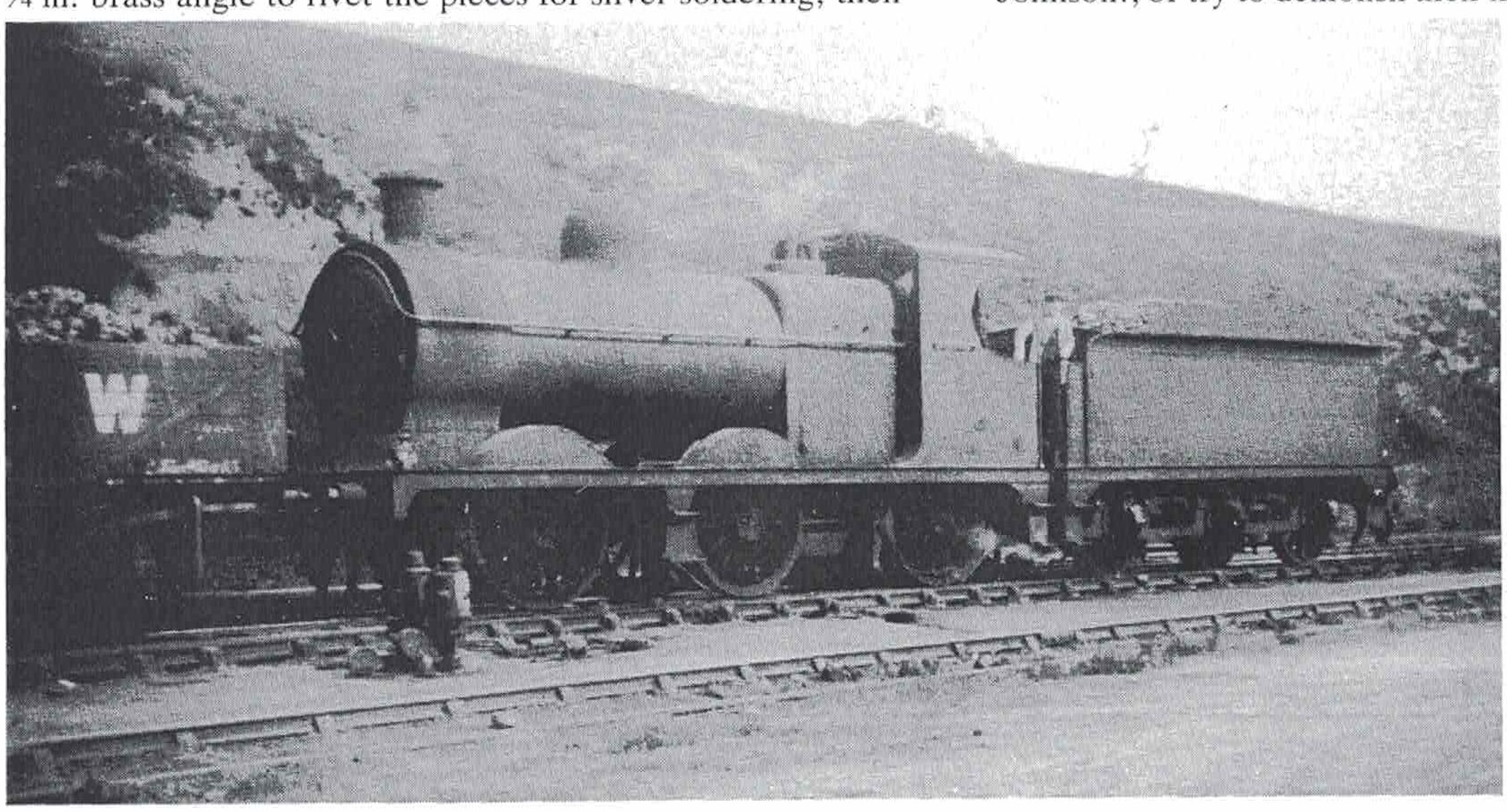
For the splashers, start by marking a 5¾ in. diameter circle on a sheet of 1.6mm brass; saw and file roughly to line. Drill a ½ in. hole through at the centre, chuck a ½ in. bolt in the 3 jaw and bolt the disc to same to clean it up to size; you will need two of these discs. Next cut four pieces each 5¾ in. x 1 in. from 1.6mm sheet to form the bases of the splashers and relieve them to match the running boards. Now mark chords on the discs to be 1 3/16 in. at the centre and saw these out. The final requirement is lengths of ⅞ in. wide x 1.6mm strip to bend round the discs to complete the splashers, or at least the leading pair. Clamp these together, or use short lengths of the ¼ in. brass angle to rivet the pieces for silver soldering, then offer the leading pair up to the driving wheels; sounds odd? The reason for this is that the frames completely blank off the backs of the leading pair, but not quite so at the drivers, and if you are at all unhappy with the unsightly gap at the back, cut more pieces from the discs and match them to the frames before silver soldering together. Attach to the side running boards with some 8BA countersunk screws, initially just a pair of screws at each end, but if there are gaps along its length, then add a few more to close same. Steps we have dealt with at the tender stage, so we can move on to the cab platework.

The spectacle plate is always one of the most pleasing items to make, so cut it out of cardboard to clear the boiler, dealing also with the spectacles, then transfer to 1.6mm brass or steel sheet and cut out. Remember that you have to splay out the bottom corners to form the trailing wheel splashers, but the real beauty of making things to place is that such things become apparent without my having to make reference to them, or more likely omit to make said reference! Deal with the cab sides in like manner, they will be very firmly attached to the seat boxes, but the cab roof needs a little thought and I would turn in the tops of the cab sides to provide flanges to attach the roof. Roll the cab roof to fit both sides and front, add lengths of 3/16 in. brass angle at both ends to complete and bolt to the cab sides.

The cab handrails are a prominent feature and I have found the best way to deal with these is to chuck a 12 in. length of 5/16 in. steel rod in the 3 jaw, with about 2 in. protruding, centre the outer end and bring the tailstock into play. Now I use files to remove metal and arrive at a decent taper, pulling the rod out of the chuck roughly 1½ in. at a time and completing when the required 7⅛ in. is exposed. Tap the bottom foot 8BA for a bolt up through valance and running board, and at the top turn on a 3/32 in. spigot over a 1/16 in. length. The cab opening is lined with 3/16 in. wide strip, some remaining from the boiler bands will do just fine, when you can bring up the handrail, make up the wee collars which will have to be in halves, then soft solder the strip to both cab side and handrail.

There is now an insightly gap between the boiler cleading and the spectacle plate, which we will cover with another length of the 3/16 in. brass angle, running right round as shown and rivetted to the spectacle plate.

Apart from adding the number, and you all seem to have your own ideas on this, POM-POM is basically complete and ready for the track. I will let No. 6012 round off the proceedings, safe in the knowledge that other POM-POM builders will not experience as many teething troubles as Dave 'Jonah' Johnson!, or try to demolish their homes in the process!!



One model engineer who has very much approved of the POM-POM series is Ron Bray in Grimsby. Ron made an earlier attempt to illustrate the series, which was thwarted by the Post Office, but the second time round he has been successful and what better way to conclude the series; farewell POM-POM