Derby 2P — An LMS 4-4-0 in 3½ in. gauge

by: DON YOUNG

Part 4 - Chassis completion and Boiler

Judging by the progress of 2P builders who started their locomotives with this series, I am still just about in the lead, and after this session will have extended same again, so no real harm has been done by the GEORGE interruption.

Seat Boxes

Our first job is to tidy up the valve gear by addition of the reverser, same sitting on the L.H. seat box, as good a point to restart as any. The vertical plates are 1 29/32 in. high x 1.6mm thick to arrive at 2½ in. long x 1½ in. wide, either folding up from a single piece or joining a pair with ¼ in. x ¼ in. x 1/16 in. brass angle at the corner. Cut the top plate 2½ in. x 1½ in. from 2.5mm steel sheet, clamp to the vertical plates and braze the joints, then rivet on a length of ¼ in. x ¼ in. x 1/16 in. angle as shown, this to bolt to the cab side later on and complete a very stiff structure. Mark off and drill the four No. 34 holes, offer up to the frames to spot through, drill and tap 6BA, the box attaching to the inside of the frames. Except for handing, both boxes follow the same instructions up to this point, when we complete the L.H. one by drilling a further three No. 34 holes in the top plate to accept the reverser stand.

Reverser

I see from Reeves latest Catalogue that 3/8 in. x 3/8 in. x 1/8 in. section angle is no longer available in either brass or steel, so first job for the stand is to reduce a 1¾ in. finished length from ½ in. wide material. Offer up to the seat box to spot through, drill and tap 6BA in three positions; now for the bearings. Chuck a length of 5/8 in. diameter bar in the 3 jaw, face, centre and drill No. 11 to 5/16 in. depth before parting off a 3/16 in. slice. Face again, centre and drill 9/32 in. diameter to about 3/8 in. depth, tap 5/16 x 40T and then part off at 3/16 in., running the tap through again. Grip the pair of bearings in the machine vice, as usual attached to the vertical slide, to mill the 1/8 in. slot to a bare 5/32 in. depth to be a tight fit on the ends of the reverser stand; braze up.

For the reverser screw, chuck a length of ¼ in. steel rod in the 3 jaw, face and turn down for 3/16 in. at one end to 3/16 in. diameter before parting off at 2⅛ in. overall. Reverse and turn down to 3/16 diameter again to leave 1⅜ in. of the original bar, a length that fits neatly between the bearings on the reverser stand. Back to the chuck to reduce further to 1/8 in. diameter to leave 3/16 in. length of bearing, then reduce the end 1/8 in. to 3/32 in. diameter and screw 7 BA. Although a L.H. thread is specified, plus the screwing tackle is standard equipment from Reeves, it is permissible to use a R.H. thread and indeed a less course one than Whitworth, though a two-start square thread is the ideal. For that specified, rechuck by the end of the ¼ in. portion, fit the die into the tailstock die-holder and screw down, removing to the bench vice to complete.

The front bearing is plain turning from hexagon brass bar; face, turn down, screw, then centre and drill No. 11 to at least 7/16 depth. Before parting off, remove the bearing with the screw in place to check for binding, altering the screwed length if found necessary, then part off to complete. The nut is not identified on the drawing, sorry about that, but it is immediately above the reverse wheel on the drawing. First square off an 11/16 in. length of 5/8 in x 3/8 in. BMS bar, centre pop for the screw and set up in the 4 jaw for the pop mark to run true; centre, drill and tap. Cross drill No. 23 into the tapped hole, then chuck a 3/8 in. length of 5/32 in. steel rod in the 3 jaw, face, turn down to 3/32 in. diameter over a bare 1/8 in. length and screw 7 BA. Fit a brass nut over the delicate threads and press the rod into the nut as shown, adding a wee drop of silver solder if needs be to keep it in place, then tap out the nut again. To complete, cut the 1/8 in. slot with an end mill, erect and check the nut slides freely along the stand without binding.

For the reverser wheel, chuck a length of 1¼ in. diameter bar, it need not be brass, face and turn down to a 3/8 in. diameter spigot over a 1/16 in. length, then centre and drill No. 31 to 3/8 in. depth. Turn down the periphery to 1⅛ in. diameter and part off at ¼ in. overall, then chuck again and lightly face off. At 7/16 in. from the centre, drill No. 40 and tap 5BA, turning up the handle from 1/8 in. rod to suit; erect.

Set the reverser in mid gear, in the centre of the screw, ditto the valve gear, measure the centre distance and transfer to the reach rod to drill and ream the rear pin hole before completing the profile.

Buffers and Couplings

The buffers are genuine LBSC and employ castings that were standardised more than half a century ago. For the stock, chuck the casting by its square in the 4 jaw, set to run true and turn down the spigot to 5/16 in. diameter, screwing 40T. Screw hard into the beam and if not correctly orientated, even with four chances, ease the flange a few thous at a time until all is well; turn off the excess spigot, and mark for the appropriate hole to avoid duplication. Bring all four stocks up to this stage, then chuck a length of 5/8 in. diameter bar, face, drill 9/32 in. diameter and tap 5/16 x 40T; screw an embryo stock into same. Face off to length and turn the specified profile, then centre and drill No. 2 to 7/8 in. depth. Follow up at 3/8 in. diameter to 11/16 in. depth and 'D' bit to 3/4 in. depth.

Take next the buffer head casting, chucking by said head. Centre and bring the tailstock into play to turn down to 3/8 in. diameter, an easy fit in the stock. Drill No. 2 to 9/16 in. depth, then reverse in the chuck and turn the head to shape. Fit the stock to its beam and on the bottom centre line, drill No. 41 at 5/16 in. from the outer end. Either drill two further holes and file the slot, or mill same, then drill and tap the head 7 BA at 3/16 in. from the inner end to suit. The peg is from 3/32 in. steel rod with screwdriver slot for tightening, but before doing so, fit the 18 s.w.g. buffer spring. In conclusion you should just be able to close the buffer in your hand by exerting maximum pressure; fit same for keeps to both engine and tender.

The front coupling is not meant for passenger hauling, but simply for appearance, starting from 5/8 in. x 1/8 in. BMS flat. Mark it off to drawing, drill the No. 30 hole to start forming the slot, but before completing same, chuck in the 4 jaw to reduce the end 1/8 in. to 3/32 in. diameter and screw 7BA; now you can saw and file to your hearts content.

Lubricator

This lubricator is another genuine LBSC item, of a slightly different pattern to that used on DONCASTER, so I must run through the description again. Incidentally, one reader rightly asked that each series carry its own full description and I must say that my rule in avoiding needless repetition is that the relevant description appeared in the current year, then every builder and reader of course, has access to same.

The body, or tank, I have shown developed, so cut to size and

bend up over a wooden or metal former. I would not braze the joints for the moment as it is easier to locate the angle for the fixed pawl later on, but do drill the 7/32 in. holes for the bearing and clack at this stage.

The stand is a 1 1/8 in. finished length of 3/8 in. square brass bar. Grip in the machine vice, to first drill the No. 41 fulcrum hole, then move up 7/32 in. to drill and tap the 7/32 x 40T hole for the bearing. Next mill the 1/4 in. recess to 1/16 in. depth at the fulcrum before moving on again and removing 3/32 in. of metal around the bearing. Still at this setting, drill a pair of No. 55 holes as the lubricator ports, the L.H. one only to 1/16 in. depth, but the other to around 3/16 in. depth. Turn the bar over to drill and 'D' bit the spring pocket at the back of the fulcrum, 3/16 in. diameter to 1/8 in. depth. To complete, chuck in the 4 jaw, centre, drill and tap 7/32 x 40T to a bare 7/32 in. depth at the base.

The cylinder is a 19/32 in. finished length of 7/16 in. 5/16 in. section brass; mark the centre of the bore and chuck in the 4 jaw to run true. Centre, drill No. 31 to a full 1/2 in. point depth and 'D' bit 1/8 in. diameter. Follow up at 3/16 in. diameter and 'D' bit to a bare 5/32 in. depth, tapping 7/32 x 40T. The ram is a plain 21/32 in. length of 1/8 in. stainless steel rod, cross drilled 1/16 in. from one end at No. 48; a wee flat filed on will help the drill enter the rod correctly.

For the gland, chuck a length of 7/32 in. brass rod, face, centre, drill and ream 1/8 in. diameter to about 3/8 in. depth. The thread into the cylinder wants to be fairly tight to avoid the gland working loose, so open the die out when screwing, then before parting off, cut four slots with a Junior hacksaw for adjustment. After parting off, use these screwdriver slots to screw the gland through the die again to clean up the threads.

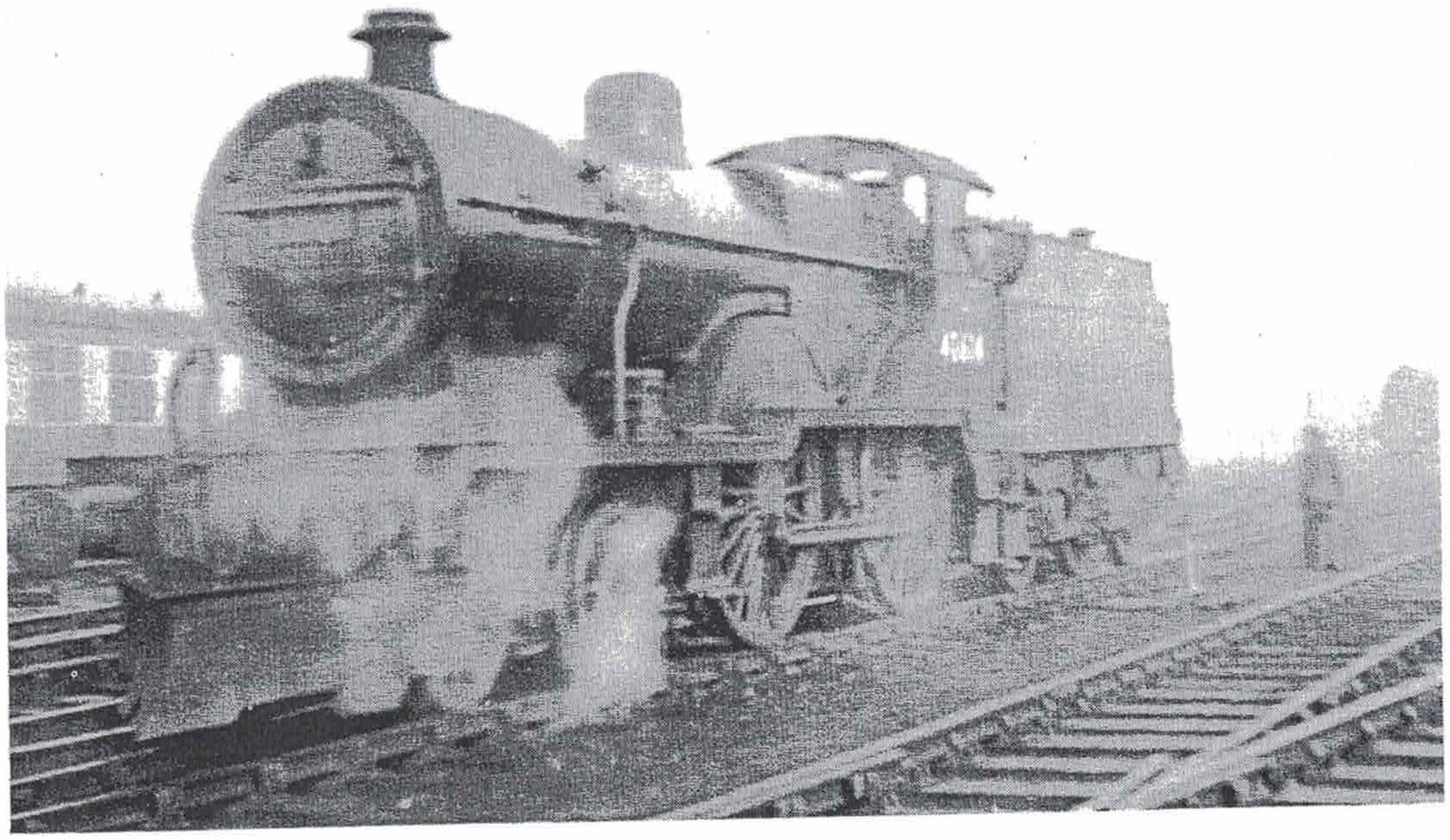
The fulcrum pin is of sufficient length to merit making from 3/32 in. steel rod, screwing both ends 7BA, fitting a nut at the outer end and peening over. We now have to complete the cylinder, so grip in the machine vice, centre, drill No. 48 to 1/8 in. point depth and tap 7BA for the fulcrum pin. Move downwards by 7/32 in. and carefully drill No. 52 into the bore. Rub both cylinder and stand working faces on a sheet of 'wet and dry' or 'crocus' paper laid on a flat surface, this is to clean them up, then erect the fulcrum pin, the spring being tensioned to avoid the cylinder being blown off its seat.

Bearing next, plain turning from 5/16 in. brass rod, and with a nut from 5/16 A/F hexagon brass bar to secure it to the tank wall. Screw into the stand and align the bottom hole in the latter to that in the base of the tank.

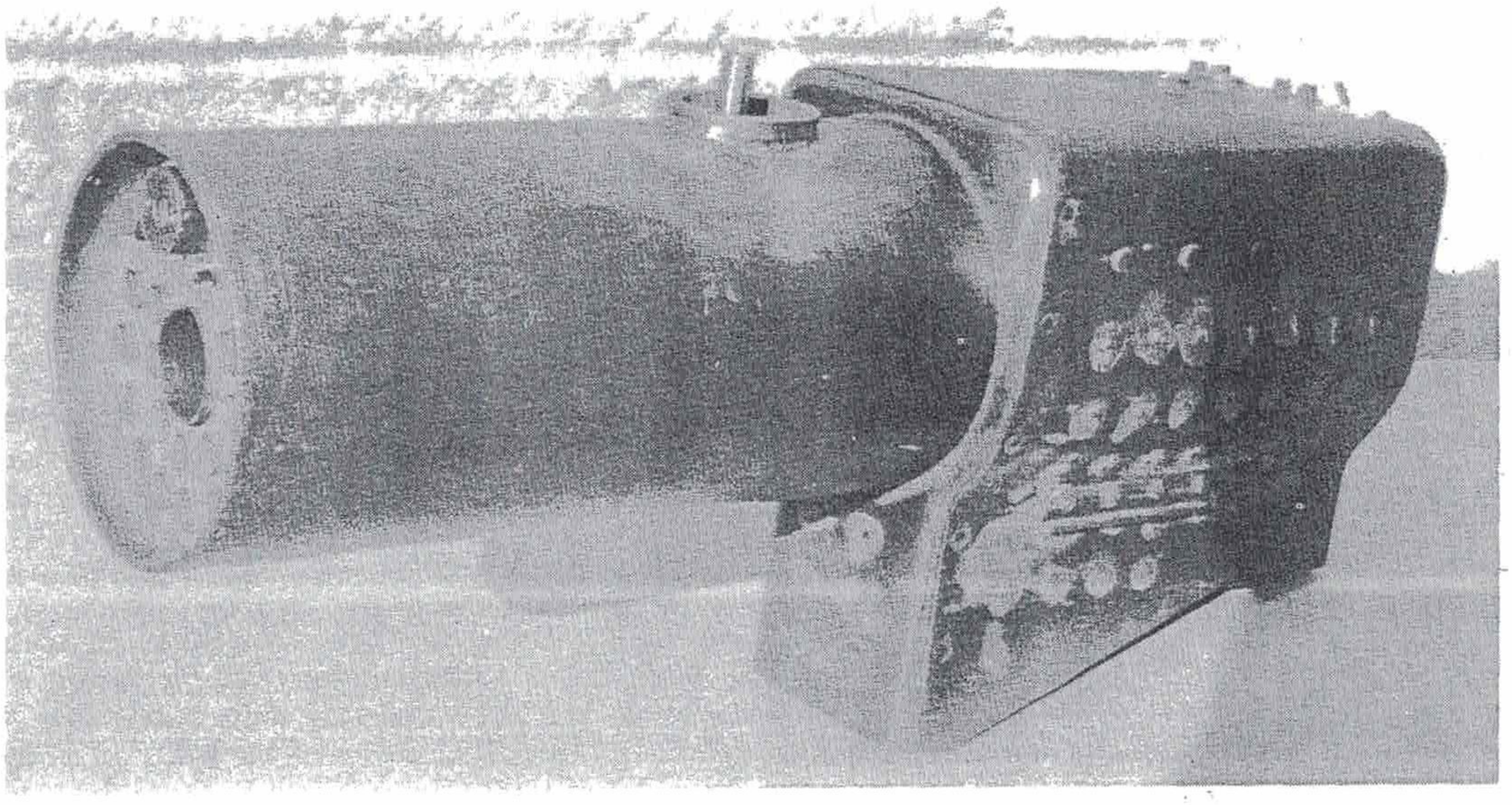
For the clack body, chuck a length of 3/8 in. brass rod in the 3 jaw, face and turn down over a bare 3/16 in. length to 7/32 in. diameter, screwing 40T; part off to leave 7/16 in. length at 3/8 in. diameter. Reverse in the chuck, lightly face then drill and ream right through at 3/32 in. diameter. Follow up at No. 12 to 9/32 in. depth, finishing with a 3/16 in. 'D' bit to 11/32 in. depth; tap the outer 7/32 in. at 7/32 x 40T. Screw hard through the tank into the stand and mark the position of the outlet union to face aft when erected. Chuck the 7/32 in. brass rod again, screw 40T for 3/16 in. length, then centre deeply for the pipe nipple and drill No. 50 to 3/8 in. depth. Start parting off at 7/32 in. but only reduce to around 9/64 in. diameter, then move on a full 1/16 in. and part right off. Mike the spigot just formed, drill the clack body to be a press fit and silver solder in the union, tap the body again and remove any stray spelter. For small fittings such as these, I used to keep a small amount of pickle, around 1/2 pint, in a plastic bucket in the workshop, just dropping them in after they were cool and leaving for about 30 minutes, when they could be polished to look the part.

For the cap, chuck a length of 5/16 in. A/F hexagon brass bar in the 3 jaw, face and turn down to 7/32 in. diameter over an 1/8 in. length and screw 40T. Centre and drill No. 40 to a full 1/8 in. depth then part off to leave an 1/8 in. head. Seat an 1/8 in. ball, which means sitting it on the seat and with a brass drift, giving it one sharp blow with a hammer, follow up with a light compression spring just to stop the ball floating on the heavy cylinder oil, then fit the cap to complete. The oil delivery clack is a variation on this theme, for which I can dispense with description - hooray!

Crank assembly next, starting with a 17/16 in. length of 3/32 in. stainless steel rod, screwed 7BA for 3/16 in. at one end only; do this in the lathe using the tailstock die holder. Next chuck a length of 3/8 in. brass rod in the 3 jaw, face, centre, drill No. 48 and tap 7BA before parting off a 3/16 in. slice. Mark on the 1/8 in. throw, centre, drill No. 53 and tap 9BA, though before doing so, check that you have suitable crankpin material. In my earlier years I was a keen cyclist, so much so that I even traded in a Myford ML7 for a Rudge machine - mad fool! This particular cycle was an early model fitted with stainless steel spokes, ones that suffered from fatigue breakages, very dangerous that!, so in replacing them with mild steel ones, I have a supply of 15 s.w.g. stainless steel wire to last me for life. The alternative of course is 1/16 in. wire/rod, 10BA tapped hole in the crank and a No. 50 clearance hole in the ram.



40634, snowplough fitted, at Kingmoor shed, Carlisle. Photo by Alan Rimmer



I got three lots of 2P photographs mixed up, those from Steve Titley, Peter Niblett and Norman Lammas, so trust I am rightly attributing this boiler to Peter Niblett, though I think anyone would be proud of it!

Ratchet wheels are not worth making individually; professionally they are made in long sticks, shaped, drilled and parted off before hardening, and if the dividing is not absolutely accurate, then a lot of work goes straight into the scrap bin. The driver arm starts as a 1¾ in. length of 5/16 in. square brass bar; mark off and drill the pair of No. 41 holes at 1¼ in. centres as a first step. Roughly saw out the slot to accept the ratchet wheel and either file or mill it to width. Next saw and file, or mill, the bottom section and we can move on to the pawls.

Back in 1960 I ran into a lot of trouble with the 'Curly' springs that the late maestro used to specify, especially the pusher variety. I solved the problem on my 02 by use of an electric lamp socket bayonet pushing on the end of the fixed pawl, the cable clamping screw being used to fix the bayonet to the tank. I was still unhappy with this arrangement and from work I did an automatic oil strainers at work, came up with the flat spring idea, one that had already been invented independently by Arthur Grimmett; as he was then using it commercially this was rather embarrassing. I have now progressed to the non-return clutch as specified for DONCASTER, which of course builders too can adopt, but the flat spring pawls have stood the test of time, material being a Reeves standard. Use a sharp chisel to mark each side of the spring steel, break the piece off and grind the ends square, then centre pop deeply and rub the 'pimple' off with a file, repeating until a wee hole appears, one you can open out in stages to No. 44. Erect the ratchet wheel using a No. 43 drill, sit the moving pawl on the drive arm, spot through, drill and tap 8BA to about 3/16 in. depth. Before securing the pawl with a cheese head screw, ease the No. 44 hole with a swiss file to form a wee slot, this to give some adjustment for wear over the years, when the pawl will last the life of the engine.

For the fixed pawl support, square off a ¼ in. length of ¼ in. x ¼ in. x 1/16 in. brass angle, drill the hole and make up the fixed spring. Assemble ratchet and drive arm to the tank, bring up the fixed pawl assembly and clamp the angle to the tank; you can use a single rivet if you wish to hold for brazing, which latter completes another stage. Erect the internals again, this time packing the ram gland with PTFE or graphited yarn, when you can have a trial run with oil.

I have shown a couple of ¼ in. brass rod spacers, ⅛ in. thick to mount the lubricator off the front buffer beam, attachment being through same by medium of 6BA countersunk screws. Only the lid to complete, folded up like a mini tank to fit over the top, the filler tube being very much optional and if fitted, requires a plug to prevent muck getting inside, for we are in front of the smokebox and in a very vulnerable area.

THE BOILER

Dealing with one sheet of the Drawing set each session means often I can have a complete change of subject during same, so now I can put on my boilermaking cap, only it doesn't fit very well! I must say though that I have been very pleasantly surprised by the boiler performance of both the DERBY 4F and 2P, they really can make steam; use it well too! One should never change a successful formula, and the only difference for the 2P is its more pronounced sloping grate, thus giving greater firebox depth at the front end, slightly less at the rear. Tubes are usually set out in a diamond pattern, but these fitted much better on two radii about the centre superheater flue, which again seems to work well, so let us make a start.

Decision time!

Nowadays unless you have a number of boilers under your belt and full equipment by you, I would recommend your first step be to ask for a quotation for a complete boiler from one of our regular advertisers in LLAS, when you will have a guaranteed end result. Maybe you will find that your purse will not extend to same, marvellous investment though it be, in which case your next step is to purchase the complete boiler kit from Reeves, plus the necessary silver solder. The kit will include flanged plates, a veritable boon, saving the hard labour of a set of formers, ones which I have found in practice never get used twice. Those without the luxury of a boiler purchase, but with a boiler kit, follow me.

Barrel first, so chuck by the bore in the 3 jaw, get the outer end running true but do not support it, then with a thin parting off or knife edge tool, square off the end in the chuck, keeping clear of jaws, etc. File off any rag, make sure there are no burrs in the bore, then reverse and repeat. Before removing from the chuck, fit a scriber under the toolpost and traverse right along the barrel just to make a mark, this will be our top centre line.

Next turn up the dome bush from the casting provided, remembering that it also includes sufficient metal for the flange on the dome itself, then centre pop and scribe a circle at 1½ in. diameter on the top of the barrel. Drill around inside this circle ⅛ in. diameter pitched closely together without the holes running into one another, then open out gradually until they do just that, breaking out the redundant piece in the middle. To hold round work like a boiler barrel on my bench, the front of the bench is a large piece of angle, it also stops the little bits falling off on the floor!, and I then nail a block of wood down behind the barrel to stop it rolling about, when a round file eases the hole until the dome bush fits.

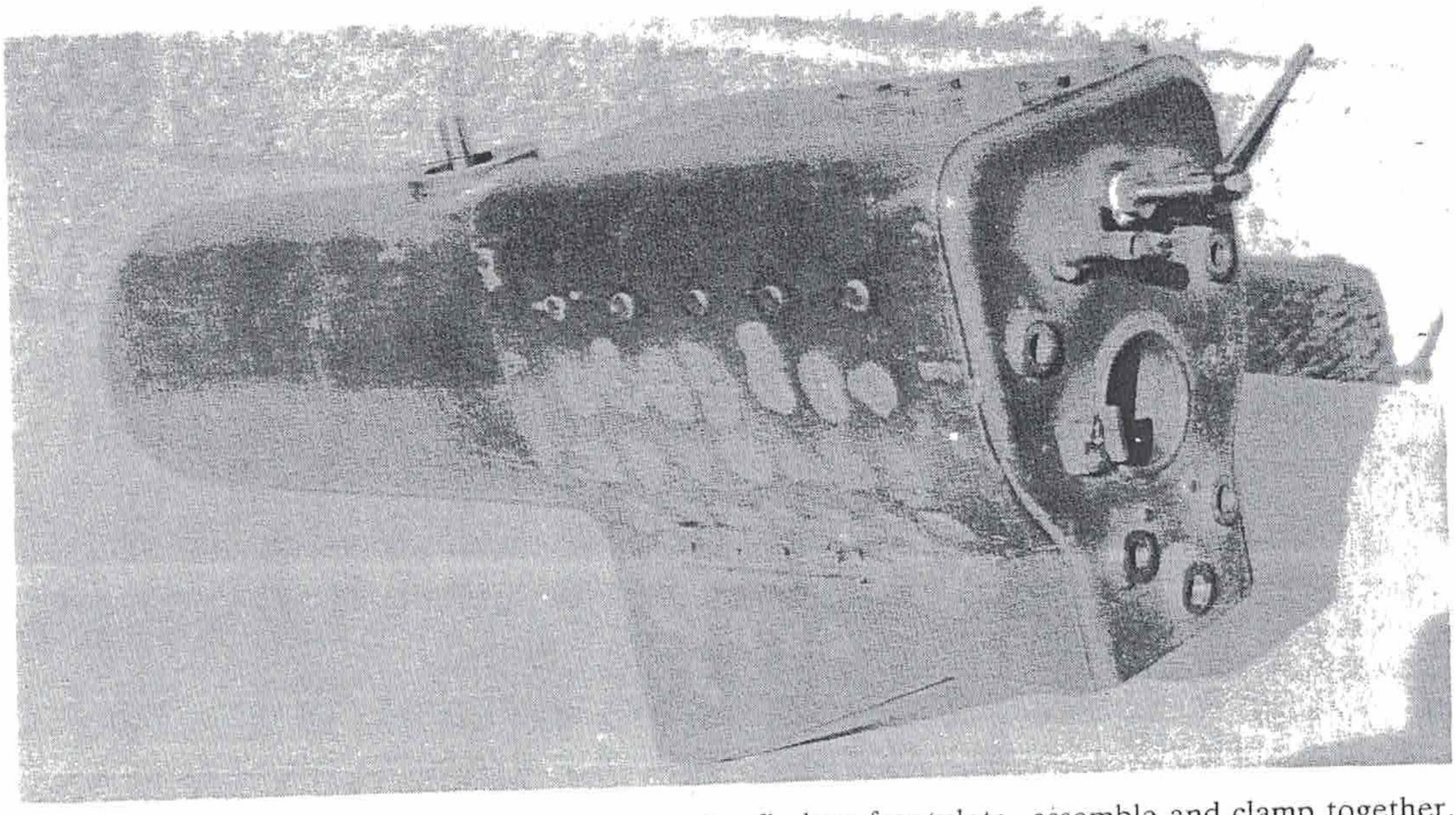
Professional boilermakers very rightly prefer a double flanged joint at the throatplate to the one with joint strip that I have shown, so if your boiler kit has such an object then the next part of my instructions can be ignored; you simply file the flange to suit the barrel.
Those still with me, cut a ½ in. 1.6mm copper strip to fit inside the barrel, a good fit therein so that no other fixing is required for silver soldering, the next subject for discussion.

Brazing Equipment
Equipment first, the most vital being the propane torch and its relevant fitments - gas bottle, regulator, hose and nozzles. You can never have too many of the latter, they are all useful in their turn, but for the jobs we have to tackle in a moment, Sievert Nos. 2942 and 2943 are most relevant, other manufacturers alternatives equally acceptable of course. Next in line is the brazing hearth, something to set the boiler up high enough so that you can work on it comfortably and using firebricks for packing both to hold things in place and to conserve heat. Another vital piece of equipment is the pickling tank, a small plastic dustbin complete with lid is perfectly satisfactory as long as you do not let the hot metal touch the sides.
Although there are proprietary liquids available for pickling, a weak sulphuric acid solution is as good as any, the only problem being that of transport. Reeves make mention of this in their Catalogue, so if this cannot be your source of supply then try locally. New battery acid is ideal, a pint usually suffices in about eight gallons of water, which reminds me to repeat again, always add acid to water, NEVER ADD WATER TO ACID. Before testing the effectiveness of our pickle, we must assemble some tools and of course the actual spelter.
Silver solder we can buy in sticks, wire or flat, the grades required being B6 and Easyflo No. 2, or other manufacturers alternatives of course which do comply with the relevant British Standard Specifications. Now the Easyflo No. 2 specified is a cadmium bearing alloy, which means it is a cumulative poison and as far as I am concerned, there is only one place for its safe use, outdoors and after dark. The after dark instruction is equally as important, for that way you can bring the copper up to the required dull red for the Easyflo to melt correctly, but without boiling off the harmful cadmium, that metal being present anyhow to help the spelter flow freely. We of course also need the correct fluxes for our spelters.
A lot of tools around the brazing hearth can be a nuisance and for a start I will mention just two. The first is a pair of old pliers to hold the sticks of silver solder as they shorten, the second a 'J' bent up from black steel strip. The idea of the latter tool is to be able to pick up the hot metal safely and securely and then lower it into the pickle, so it wants a handle at least two feet long for your hands to be clear of any spitting acid; we are ready.

The first braze
Put the barrel with its joint strip into the pickle for at least 10 minutes, when it should emerge a nice clean salmon pink; wash off in clean water. The dome bush can also be pickled, when it too will be bright salmon pink once copper has begun to dissolve in the acid; no matter. Mix flux to a fairly stiff paste, one that will easily apply to the joints without running all over the place, then stand upright in the brazing hearth. Fit the No. 2942 nozzle, get a nice blue flame going, a fairly diffuse one which means the gas regulator wants to be at its second notch, and play the flame all over the barrel. Remember it is after dark, and as soon as you see the copper just start to glow as you move the flame, come up to the joint strap, bring it up to a red glow, feeding in B6 spelter as your progress around the joint; if all is well then the spelter should overtake the flame and run right round. Lay the barrel down, fit the dome bush and deal with it likewise. Allow to cool for a few minutes, then pick up the barrel with your 'J' shaped tool and lower it carefully into the pickle; leave for 20 minutes, then wash off and inspect your workmanship. At any and every stage, if there are places where the spelter appears not to have penetrated fully, rectify before proceeding any further, otherwise you may well be wasting both your time and precious funds.

The Outer Wrapper
Next take the flanged throatplate, ease the hole to fit over the projecting joint strip and it wants to do so for a full ¼ in., mark on the vertical centre line to match the barrel if it is not already there and rub a file over the flange to slightly roughen it, then pickle and wash off. Offer up over the joint strip and carefully peen the latter over as shown, taking care not to deform the, softened, barrel in the process. Pickle again, wash off, flux the joint and silver solder the throatplate to barrel and joint strip, feeding in more B6 spelter to do so. As at every stage, allow to cool then pickle, wash off and inspect.
The outer wrapper is a 17½ in. length of 6¼ in. wide x 2mm thick copper sheet, first job being to mark on the top centre line to match the rest; only lightly at this stage. Scribe further lines 1 9/16 in. on each side of same to indicate the start of the top bends, then grip a long length of ⅞ in. diameter steel bar horizontally in the bench vice. Clamp the outer wrapper sheet to same and pull round to form the first top bend, then deal with the second, checking against the throatplate and backhead to see that all is well; you may well have to adjust the top centre line as a result of this. If possible, it is best to bend up the outer wrapper with the material in the as supplied condition, probably half-hard, as this way you will get clean bends without dents and the like, which will happen if the sheet is annealed. Pull the wrapper around the boiler barrel itself to form the waisting below the boiler centre line, then use a ⅜ in. steel rod to get the reverse bend to complete to a good fit over the throatplate flange. On the top centre line, drill a 3/32 in. hole through wrapper and throatplate flange, securing together with a 7BA bolt and nut. Move out about 1 in. on either side and repeat, then remove the first bolt and replace it with a 3/32 in. snap head copper rivet, head inside and countersinking the outer wrapper. Grip a one foot length of around 1½ in. square steel bar horizontally in the bench vice, sit the rivet head on same, and we need another simple tool.
Chuck a 4 in. length of ¼ in. steel rod in the 3 jaw, face, centre and drill No. 39 to ¼ in. depth. Sit this tool over the projecting rivet shank, give it a couple of blows to bring the surfaces in close contact and rivet over. Rivet length is important to properly fill the countersink, but if you use ⅜ in. long rivets, you will quickly learn to crop them off correctly. At about 1 in. pitches, carry on around the throatplate joint until within ½ in. of the bottom, but clear of where the foundation ring is to fit. At this stage you can bring up the backhead as a further check, and cut away some of the surplus material at the bottom edges of the wrapper, but unless you are supremely confident, leave some excess material for the moment for final trimming later on. Again tackle this joint as a separate silver soldering operation, pickle, clean and inspect.

The Firebox
Flanged plates mean already we are well on the way with our firebox, but let us add the finishing touches to these first. The front plate is likely centred for the tubes, in which case it is matter of drilling the seventeen holes to 23/64 in. diameter, 9.4mm is better, and reaming them out at ⅜ in. diameter. If you drill a couple of ⅛ in. pilot holes first, you can bolt direct to the smokebox tubeplate and deal with them as a, matched, pair. Next grip the smokebox tubeplate by the inside of its flange in the 3 jaw and turn down to a tight fit in the barrel,



The firebox shows a lot of neat workmanship; note the myriad of backhead bushes

cleaning off the end of said flange to length. Change to the 4 jaw and set ⅛ in. off centre to drill and bore out the flue hole to 1 in. diameter to suit said flue tube. Mark back onto the firebox tubeplate to drill and file to line, or the flue finally as your gauge, making it a tight fit.

At the firebox backplate we need the firehole ring, so chuck the provided material by its bore in the 3 jaw, face and turn down to 1¼ in. diameter over a 5/32 in. length. Reverse in the chuck, reduce to 21/32 in. overall and then turn a spigot over a 3/16 in. length at this end, to fit the backhead. Mark a 1¼ in. hole on the firebox backplate in the position indicated, drill and file to suit the ring, then lay on a block of wood or lead and peen over as shown.

The firebox wrapper is a 13½ in. length of 57/16/5½ in. wide x 2mm thick copper sheet; bend up in similar fashion to the outer wrapper. The first law with any pressure vessel is the less holes in same, the less likelihood of leakage, so hold the firebox together with just sufficient rivets, none of them in way of the crown girder stays, and trim off the bottom edges to drawing.

Crown Girder Stays

When I started making contribution to 'Model Engineer' just about 20 years ago now, how time flies!, Martin Evans was just embarking on his 'girderless' boiler designs; it was the first topic on which we disagreed. Oh, there is the greatest merit in not having girder stays between inner and outer fireboxes, they are difficult to fit properly and if not so then they are worse than useless, but Martin's argument in favour of same went against all my training. This said that bending stresses were to be avoided at all costs in pressure vessels, stays had to be in pure tension, in fact designers in full size went to great lengths to achieve this with ball ends and the like in what were called 'breaking zones'. When Martin stated that his stays would accept bending stress, then his argument was lost on me. I view sloping tubestacks in the same light, in our boilers they are integral and act as stays, which means again they should be in tension in such duty. To my mind, we have to deviate sufficient in making our boilers from the ideal, without deliberately designing in what I view as bad practice. I do accept though that the pioneer girderless boiler, that for SIMPLEX, has proved one of the most popular over nearly 20 years now, and I have heard of no problems with same, except that the design is not accepted under Australian Rules.

Back to the firebox, and for the front section of foundation ring, cut a 2 9/16 in. length from ⅜ in. x ¼ in. copper bar and fit to the throatplate. Ease away 1/16 in. of metal in the centre to accept the firebox frontplate, assemble and clamp together. Fit the smokebox tubeplate and slide in a few tubes to check they are nice and level, then use inside calipers to establish the depth of the crown girder stays; they will be between 1⅜ in. and 1 7/16 in. deep according to me. Fold them up from 1.6mm sheet and rivet back to back, then mark off and drill the five 7/32 in. holes as clearance for the cross stays; they must be a clearance, so open out to ¼ in. if you are uncertain of your marking out. Try the girders in place as a check, then remove the firebox and sit them on top of same. I would clamp them in place using the tube holes and firehole ring, rather than drill any holes in the firebox wrapper, when you are ready for the next braze.

Pickle for about 15 minutes whilst you prepare, then wash off, flux all the joints including the firehole ring, and stand in the brazing hearth. Warm up, then concentrate on the girder stays first, apply B6 spelter, then deal with the backplate and firehole ring. Bring the front tubeplate uppermost and if you are at all worried about damaging the metal around the tube holes, change to lower melting point Easyflo No. 2. The thing to avoid when brazing is any greenish tinge in the flame, as this indicates that copper is being burnt. Allow to cool, pickle, clean and inspect very thoroughly as usual.

Take each firetube in turn, chuck and face off, removing any burrs, then still in the lathe, use emery cloth to burnish and roughen the end. Reverse in the chuck, face off to length and deal with this end similarly. The flue you will have to clean up with files and emery cloth, when we are ready to insert them in the firebox.

As early as LLAS No. 7, Jack Coulson told us that the best way to locate tubes in the firebox tubeplate was to turn a spigot on them and leave the mating hole to match, in which case our tubeplate would simply be drilled out to 23/64 in. diameter. You can of course do likewise, but in 1975 when the 2P appeared, I was still fitting plain tubes, so you can do just that. Take a taper pin of size that fits the bore, grease it, insert and tap down until the tube is firmly trapped in place. Now tap the taper pin sideways to release it and proceed. Again the flue is too big for such methods, but if you followed my instruction of a tight fit there will be no problem. Wind the Easyflo No. 2 spelter around a tube and cut into complete rings, sliding one over each tube end and allowing it to fall to the firebox tubeplate, then slide on the smokebox tubeplate over the tube ends; pickle and wash off. This time the flux wants to be fairly runny so that it penetrates the whole area of the tubestack, when you can stand the firebox in the brazing hearth with the tubestack facing skywards, checking with square and straight edge that it is just so to the firebox. The

2942 nozzle with diffuse flame is required here, directing the flame inside the firebox where there is most metal to be warmed, then outside, until the silver solder melts and flashes right through the joints, which you will be able to see from underneath, feed in more spelter as indicated. When all is well, first allow to cool, then knock the smokebox tubeplate off and anneal the tube ends; pickle, wash off and inspect.

Boiler Bushes

A boiler should not be left too long between stages of silver soldering, otherwise the copper will oxidize, cleanliness being a vital part of successful boilermaking. The second rule is sufficient heat; you should be able to start applying silver solder about five minutes after applying heat to the job. For most builders it is helpful to have a companion with you during brazing, for apart from the confidence this provides, two torches are usually better than one, your partner applying pre-heat whilst you get on with the job in hand.

Having taken a wee break to make these points, we may as well do something useful with it and make the boiler bushes, these from drawn gunmetal or phosphor bronze bar. For the small bushes, chuck the ½ in. rod, face and turn down over a ⅜ in. length to 7/16 in. diameter. Centre, drill to 7/32 in. diameter and tap ¼ x 40T to 7/16 in. depth; part off at 11/32 in. overall; reverse and face to complete. Except for the bar size and dimensions, the larger and steam pipe bushes are identical. For the regulator bush, chuck a length of ⅝ in. diameter bar, face and turn down a 7/16 in. length to 9/16 in. diameter before parting off at 19/32 in. overall. Reverse in the chuck; face, centre and drill right through at No. 22. Follow up at 11/32 in. diameter to 5/16 in. depth; 'D' bit to ⅜ in. depth and tap ⅜ x 32T to complete.

Erecting the Firebox

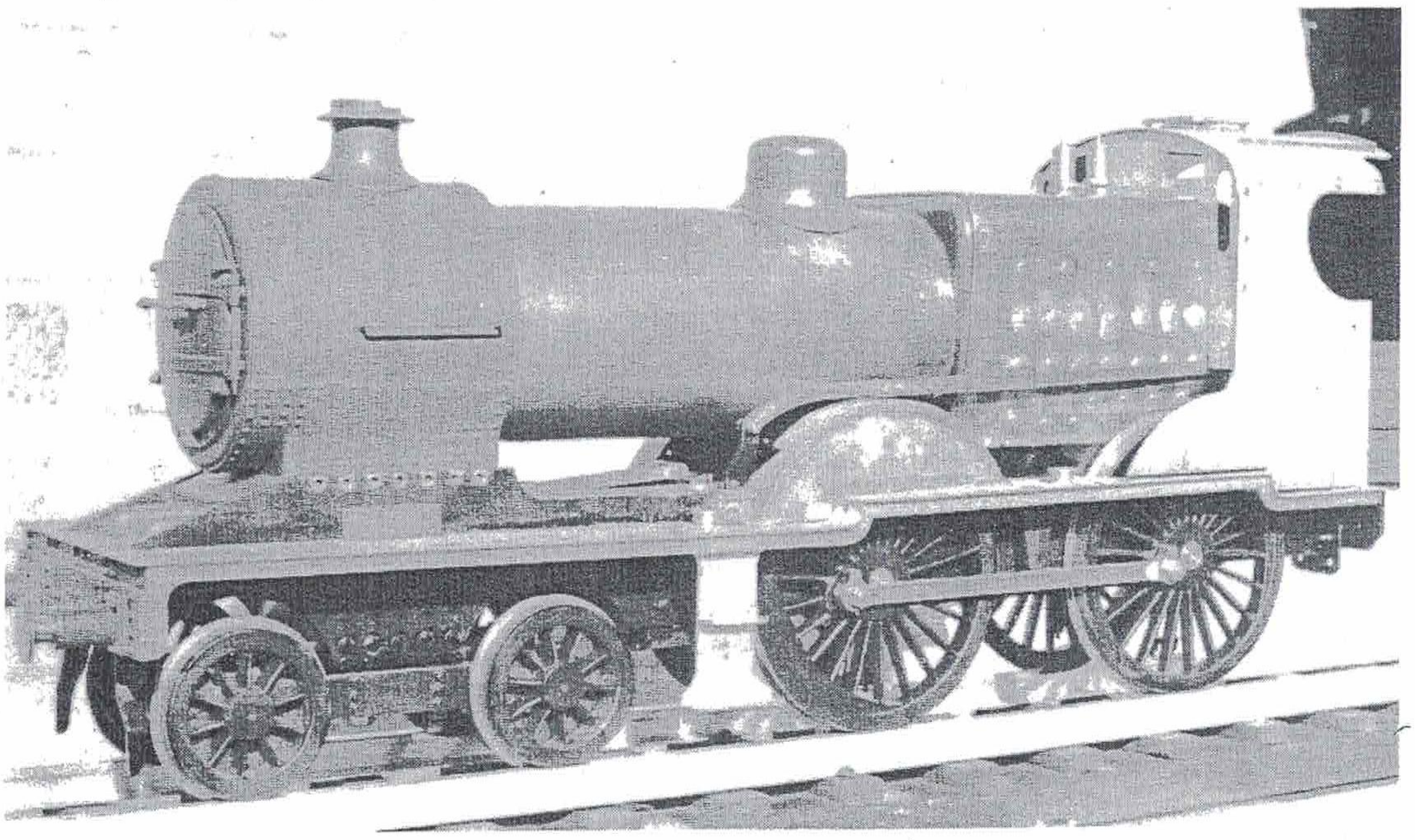
Slide the firebox into the outer shell and the first job is to mark off and trim the outer wrapper bottom edges to their final size. Hold the firebox hard against the front section of foundation ring, but before attaching to same we have to make sure that the crown girder stays are in intimate contact with the outer wrapper. An aid to this is to drill the pair of ½ in. holes in the wrapper for the safety valve bushes. Next make up wee horsehoe shaped cramps from ¼ in. ⅛ in. BMS flat, drilling and tapping for a 4BA bolt, in fact you can never have too many of these wee homemade cramps, they are invaluable. Insert them through the holes to clamp to the crown girder stay flanges firmly in place, then add another pair over the throatplate/foundation ring/firebox tubeplate. Drill right through this combination in two positions at about 1 in. centres, this for 3/32 in. snap head copper rivets, heads inside, hammering down into countersinks in the throatplate.

Next job is to fit the side sections of foundation ring; each side is in two pieces with joints scarfed to be a close fit; again secure with rivets at about 1 in. pitch. The smokebox tubeplate requires some work ahead of fitting, the fitting and brazing of the steam pipe and longitudinal stay bushes. The ½ in. holes will not be a problem if the tubeplate is securely clamped to a block of hardwood, but I suggest you ease out the 11/16 in. one with a round file. Pickle the plate and bushes and silver solder together with B6 spelter, then pickle again, wash off and inspect. The backhead requires similar treatment, eight bushes is quite an array!, so mark off for them, drill, fit and braze up; this will save us time later on.

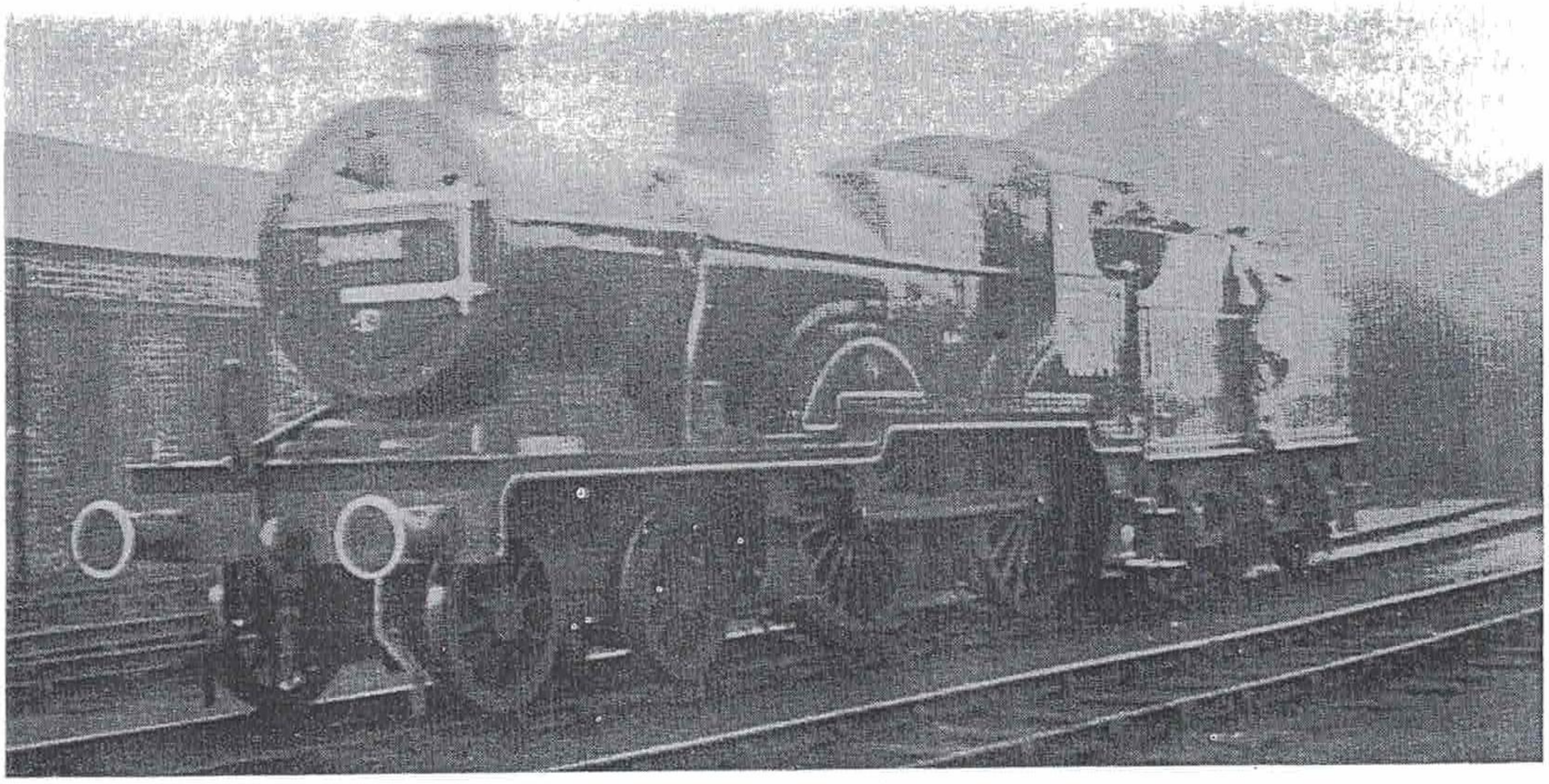
Ease the smokebox tubeplate into the barrel and use ordinary lead pencils to align the tubes with their holes, getting them to project through the plate by about 3/32 in. Pickle the whole assembly, flux the girder stay flanges, foundation ring and smokebox tubeplate. Lay the boiler on its back with the firebox projecting out of the hearth, weighting it so that the boiler does not crash to the ground, then play the No. 2943 burner on the top of the outer wrapper, only inverted it will be on the bottom if you see what I mean. If the girder stay flanges are in proper contact, then the heat will transfer and the whole area start to glow dull red, when you feed in Easyflo No. 2 spelter, although you can if you like feed in pre-cut lengths before applying the torch. Move next to the foundation ring, starting at the front and working back along each side in turn, then sit the boiler on its rear end to tackle the smokebox tubeplate joint to the barrel and then the tubes. If the silver solder stops flowing freely at any time, stop, pickle, wash off, reflux and start again, never try to press on regardless. Allow to cool well before pickling this time as the acid has a nasty habit of boiling up the tubes and spitting forth.

Fitting the Backhead

Offer the backhead up and scribe back through the firehole ring, drilling out the centre and then filing to a good fit over the spigot. Cut another 2 9/16 in. length from the ⅜ in. x ¼ in. copper bar for the rear section of foundation ring and simply fit it to place, then clamp the backhead over the firehole ring. Drill the 7/16 in. hole for the manifold bush, then scallop the backhead flange to suit, when you can stand the inside of the



Again I am going to attribute this 2P to Peter Niblett, this time with absolute confidence as I have his photocopy of same in front of me!



40644 at Hurlford captured for us by Alan Rimmer, Thank you to the 1,000's who wrote in praise of his 'Privileged View of Steam' for which he has been created an honorary member of LLAS

firehole ring on a bar to peen over the outer spigot, when with any luck at all, the rear section of foundation ring will become trapped and require no other fixing. Before the final braze we have to fit the pair of safety valve bushes.

Pickle the boiler yet again and this time drain all the acid away as the vessel is nearly a complete one, then wash off and apply flux around the backhead, the top bushes, plus the rear section of foundation ring, not forgetting the firehole ring. Stand the boiler on its front end, pack securely, then heat up around the backhead joint, starting at the bottom corner and working right round. Take in the manifold bush as you pass, those for the safety valves too, then continue on round. Next concentrate on the firehole ring, where for some obscure reason heat can dissipate alarmingly, then turn the boiler over and complete the foundation ring.

This time allow the boiler to cool for all of 15 minutes before carefully lowering into the pickle, then out again after a well earned cuppa for washing and a final inspection; now for a first test of your workmanship.

Make up and fit temporary plugs to all the holes, a wooden bung will suffice at the dome, and fit a cycle valve stem to one of the plugs. Apply about a dozen pumpfulls of air, no more, and completely immerse the boiler in water. Any 'misses' will show as tell-tale trails of air bubbles, but do make sure that you get rid of all trapped air first, or you could have a needless scare.

Where a Club Boiler Inspector is involved, his advice/ instructions should be adhered to at all times; if my guidance is sought at any time then I will support said Inspector. As a general rule though, if you have an external leak, as against a pure 'pin-hole', then reheat and deal with it. Leaks inside the firebox are not so easy to rectify and if they do not affect the strength of the boiler then the rule is to leave them well alone and simply seal them with the same medium as we shall use for the firebox stays in a moment. Another place where reheat is to be avoided if at all possible is at the smokebox tubeplate. If you have a weep at one of the tubes, it is far better to use the taper drift to expand it, as once reheated, a weep is liable to become a crack, one which will defy nearly all efforts to rectify. I have been told many times that the average boilermaker finishes up with a colander rather than a pressure tight vessel. Well, the first boiler that I tackled completely on my own back in 1959, with the dreaded five pint paraffin blowlamp, that for my FISHBOURNE, took just 21 hours to reach the stage we are now at and was perfectly air-tight; if I can do it then so can you. I would add that I used the same equipment for my K1/1 boiler, that it proved barely sufficient, and I finished up with a weep at a superheater flue at the smokebox end, another in the firebox, so I have experienced at least some of the problems.

Staying

Let us commence staying with those five cross ones above the firebox. Mark off and drill No. 12 holes at both sides, then feed in full 5 in. lengths of the 3/16 in. copper rod. If there is any problem at the girder stays, use the side teeth of the drill to correct same. We need a wee tool to form the countersink to accept spelter at the stay ends, so chuck a length of 1/4 in. silver steel rod in the 3 jaw, set the top slide over about seven deg., the exact figure is not too important, and turn down until the smaller end of the taper is at 5/32 in. diameter. Now file away half of the metal to form a cutting edge and we can harden the tool. Lay on a sheet of steel, hold over a gas ring or similar and allow to 'blue', dip in water or quenching oil. Rub the flat surface bright on a carborundum stone, heat again and quench when the colour reaches dark straw; use this tool to countersink the holes. These stays must be secured with Easyflo No. 2, the excess length of rod will help concentrate the heat, when no damage will result to the rest of the boiler, though if you prefer, you can deal with these cross stays at the penultimate stage of brazing the boiler; when the crown girder stays were attached to the outer wrapper.

Longitudinal stays next, for which the end fittings are our first requirement. Chuck a length of 3/8 in. A/F hexagon bronze bar in the 3 jaw, face and turn down to 5/16 in. diameter over a 5/16 in. length and screw 40T; part off at 15/32 in. overall. Grip a 5/16 x 40T screwed adaptor in the 3 jaw, fit the embryo blower union to same, face and turn down over a 1/4 in. length to 1/4 in. diameter and screw 40T. Next centre deeply for the pipe nipple and continue at No. 41 into the main bore to complete, only I forgot all about the main bore in my haste! Before parting off, centre, drill No. 22 to 5/16 depth and tap 3/16 x 40T and you will not have a scrap blower union as I have!! We must assume for the moment that the blower valve exists, as it will in the next session, so that I can complete this part of the description; the end plugs at least you will have no problem in machining. Take the 3/16 in. copper rod supplied for the longitudinal stay; it is 14½ in. long, chuck in the 3 jaw, face and screw 40T for 5/16 in. at one end. Screw into an end plug, screw this in turn into the smokebox tubeplate and assess the excess length protruding at the backhead end. Add 1/16 in. to your established dimension, cut the stay off at this, face and screw. Final assembly will have to await fitting of the firebox stays, then we shall do no harm to the liquid jointing compound with which we shall annoint the threads, but let me complete the description. Enter the stay onto its end and screw the latter hard into the smokebox tubeplate. Engage the other stay end onto the protruding thread at the backhead, then enter the bush and again screw home.

Blower stay material is now only available as 3/16 in. o.d. x 18

s.w.g. copper tube, as against 16 s.w.g. back in 1975, but this is of no consequence. Deal with it exactly as for the solid stay, using the blower union and valve as the end fittings.

Firebox Stays

Carefully mark out the centres of all the stays to be fitted to the outer wrapper, throatplate and backhead, using an automatic centre punch at a light setting to avoid denting the soft copper, then drill a single hole through one row at No. 34. Poke another drill in the hole and use as a sight to drill the rest in that row.

A veritable must when dealing with firebox stays is a new set of taps, carbon steel ones are perfectly satisfactory, so that you avoid tearing the soft copper as you tap out the holes. A further very useful aid is a proprietary brand of tapping compound, any good one will do. Dip the new taper tap in the compound and tap the hole in the outer wrapper, easing the tap forwards and backwards to break off the swarf so that it does not jam the tap. Once through the outer hole, remove the tap and remove any and all swarf. As when drilling the row of holes, use the No. 34 drill as a sight when tapping. Next run the plug tap through the outer hole, then back to the taper one to deal with the inner firebox shell.

For a bit of variety, I would fit each row of stays as the holes are tapped, problem being that the 4BA screwed gunmetal stays that were specified back in 1975 are no longer available in 1986 from Reeves. The alternative then were 4BA phosphor bronze screws from Whistons, but as they no longer advertise in LLAS and I do not have their latest list, I am uncertain if they can supply today; in other words, readers to the rescue! At least 4BA commercial brass full nuts are still available, so screw in the stay, fit the nut inside the firebox and tighten it up, then crop off the excess on the outside to be about 1/16 in. proud - not flush. Now it is a question of dealing with the whole firebox one row at a time until all 76 of them have been inserted, when it is back to the pickle again for at least 20 minutes.

The medium for sealing the stays is 'Comsol' and its relevant flux, both available from Reeves, and this time we only require a small burner, though one fitted with a neck tube to allow us entry into the firebox. Far less heat is required, so lay the boiler on its side, flux the outside face that is uppermost, and the inner one below, then deal with each stay head in turn, to a pattern so that you do not miss one. Pickle, wash off and deal with the opposite faces in like manner, then deal with throatplate and backhead to complete.

Dome

After the boiler, the dome will be easy! The tube is a 1 1/32 in. square length from 1 1/8 in. o.d. x 16 s.w.g. copper tube, the flange being turned 5/32 in. thick from the casting we have already dealt with. For the top plate, scribe a full 1 in. circle on a sheet of 3mm thick copper and saw roughly to line. Centre pop and drill, say, 5/16 in. diameter in the centre, chuck a 5/16 in. nut in the 3 jaw and bolt the disc to same to turn the periphery to suit the dome tube, a tight fit therein. Rechuck the periphery and bore, or drill, out to 1 1/32 in. diameter; turn the wee bush, and its plug, to suit. Assemble the bits, minus dome plug of course, pickle, wash off and flux for Easyflo No. 2, then braze up. pickle again, wash off and inspect, then chuck by the tube in the 3 jaw to face across the flange at the bottom as it is bound to 'banana' . With a knife edge tool, lightly scribe on the bolting circle, space it out for the ten 6BA screws and drill through at No. 34. Offer up to the dome bush, spot through, drill No. 43 to 3/16 depth and tap 6BA. For the fixing screws, chuck a length of 3/16 in. phosphor bronze rod in the 3 jaw, face and turn down over a 9/32 in. length to .11 in. diameter, screwing 6BA. Part off to leave an 1/8 in. thick head and produce a screwdriver slot with a Junior hacksaw; nothing more sophisticated is required here as the end result is well hidden by the dome cover.

Hydraulic Test

The tender hand pump does not arrive on the scene until Part 6, the ultimate, of this series, but for testing I must assume its presence. Fit screwed plugs to all the tappings but one, coupling the hand pump to the latter. Fill the boiler completely full of water, removing the dome plug to do so, and instead of replacing same, couple from here to a master presure gauge. Immerse the pump in a container of water and press the boiler to 40 p.s.i.g.; checking round for leaks and any sign of movement of the plates, then go on up in 40 p.s.i.g. increments to 160 p.s.i.g., this for a working pressure of 80 p.s.i.g., at which point your Club Boiler Inspector will give you a pat on the back! If a firebox stay does weep, just try caulking it with a wee hammer, but don't worry if you cannot cure it, for this will happen anyhow at the first steaming.

THE STEAM CIRCUIT

We cannot complete the steam circuit for lack of some of the details, but can at least make a good start, plus I can add another note of controversy. The experts of boilermaking, people like Alec Farmer for whom I have the greatest respect, tell me to orientate the smokebox tubeplate as shown on the boiler itself. Reason for this is that a fillet builds up between the barrel and tubeplate in the 'V' gap. Now I maintain that with the flange facing outwards, it is easy to directly heat it, the barrel too from the outside to achieve full penetration of the silver solder, and that in this lies the strength of the joint, a fillet being immaterial. All the other joints in the boiler rely on full penetration for their strength, so why not this one?

Having dared to disagree with Alec on one feature, I have wholeheartedly adopted another of his in the coaxial superheater element, though the purists will tell me that it is less efficient than the spearhead type. True enough on paper, as the spearhead has much greater heating surface, but in practice the coaxial wins hands down because it can be kept clean and unblocked by ash and char. Whether your superheater be merely flue type, or the alternative radiant, I can safely leave to you the builder, the sole proviso with the radiant type being that your cylinder lubrication be 100% certain. Let us make said superheater.

First requirement is the outer sheath of specified length from 1/2 in. o.d. x 22 s.w.g. stainless steel tube. Cut the end plug also from stainless steel and weld it in place; silver solder will not do here as it will surely melt. Make another disc for the other end of the outer sheath, but bore this one out to 5/16 in. diameter for the return pipe; all joints at the smokebox end can be silver soldered with safety. The return tube can again be from stainless steel, with copper as a suitable alternative. If you are worried about the return tube sagging over such a long length, then wind a course spiral of 16 s.w.g. copper wire around same to hold it central, say at 1 1/2 in. pitch and tack it in place, when your superheater will be even more efficient. I have shown a 90 deg. scarfed joint down to the steamchest as an ordinary bend will tend to flatten at such a tight radius; leave this pipe overlong at the moment to be fitted later. That leaves just the feed from the superheater flange down to the outer sheath, the former item we do not have this session, but once made, assemble the whole and braze up.

That leaves just the steam pipe assembly. For the end fitting, chuck a length of 3/4 in. diameter drawn gunmetal bar, face and turn down over a 7/16 in. length to 1/2 in. diameter, screwing 32T. Centre and drill through at 1/4 in. diameter, following up at 5/16 in. diameter to 5/16 in. depth. Part off at a full 11/16 in. overall, reverse in the chuck and face off. To form a 5/16 x 32 T thread on the end of the steam pipe we need 18 s.w.g. material as a minimum, so square off a 4 3/8 in. length, screw one end and then braze to the end fitting - end of another session.

Derby 2P — An LMS 4-4-0 in 3½ in. gauge

by: DON YOUNG

Part 5 — Smokebox, Regulator, Cab lay-out and Mountings; Grate and Ashpan

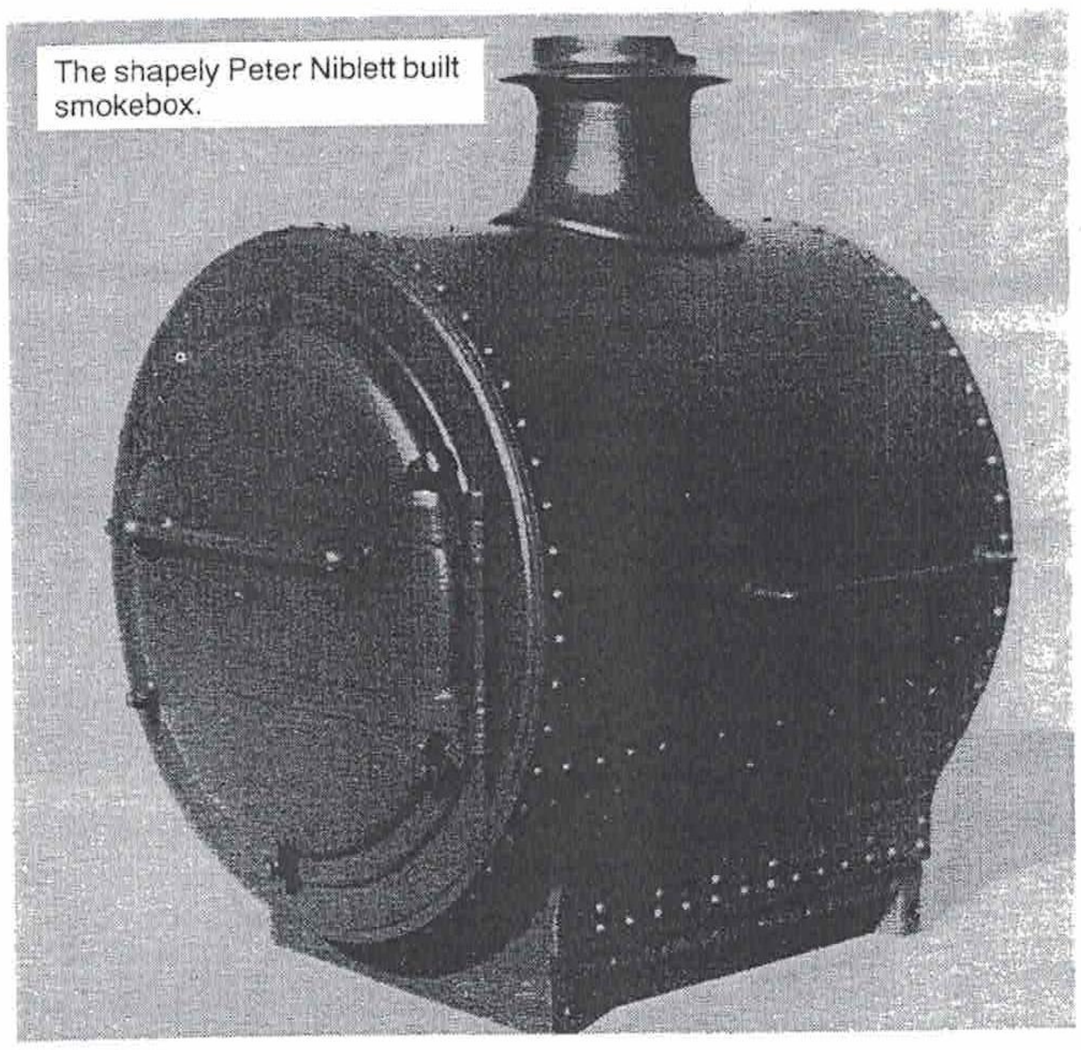
Apologies to all DERBY 2P builders who are following the series for the long break in transmission, especially as there are many more of you than GEORGE builders thus far; I should have been more considerate. The only plus is that the GEORGE boiler fittings are of a later standard than those depicted on Sheet 5 hereabouts by a matter of 10 years, so builders may wish to use my later items. Let me quickly get back into the swing of things, starting with the smokebox.

The Smokebox

The smokebox shell is 4⅜ in. o.d. x 16 s.w.g. and 4 7/16 in. long, so if you are unable to roll this up and braze the seam, then the answer is to use the rolled smokebox service as available from Reeves. Chuck the smokebox shell by its bore truly in the 4 jaw, fit a knife edged tool under the toolpost, turn to bring one of the chuck jaws into contact with the tool, by hand of course!, then lightly scribe a line along the shell; repeat at the other three positions. As we have some of our own brazing to do at the smokebox, it would be as well to keep the shell joint towards the top, well clear of your efforts. On the top and bottom centre lines, measure back 2 11/16 in. to centre pop and drill the bottom hole at 13/32 in. diameter as shown. At the top we require a hole at 31/32 in. diameter, so scribe a circle to this diameter, drill a row of, say, ⅛ in. holes around the inside of same, break the holes into one another to remove the redundant piece and then file to line.

Although the boiler joint ring lists all its dimensions, it is really a case of make to place, and the material can be steel. Chuck the ring in the 4 jaw and set to run true, then face the outside and turn the bore to a light drive fit over the end of the boiler barrel. Rechuck by the bore in the 3 jaw, face the other side to the required 3/16 in. thickness, then turn down the periphery to a push fit in the smokebox shell.

The front ring again can be from either gunmetal or steel to your preference and is simply turned to drawing in the same manner as the boiler joint ring just dealt with. When you had the ring in the 4 jaw chuck, if you lightly scribed on the centre lines, then it is a simple matter to mark out to drill and countersink the pair of No. 34 holes; erect to coincide with the centre lines on the smokebox shell.



The shapely Peter Niblett built smokebox.

The smokebox saddle is a fabrication from 3mm thick material and brass will be easiest here. I recommend you make the front and back plates first, as a pair, so that you can get the scallop to suit the smokebox shell, then saw and file away ⅝ in. of material at the back plate to come to drawing. The other point to watch is that these end plates are a very tight fit between the frames, so that you can just ease them with a file after fabrication. Now cut side plates 3¼ in. long and ¾ in. deep, erect to the frames and clamp the four pieces together. If there is a problem here, then use lengths of ¼ in. x ¼ in. x 1/16 in. brass angle rivetted in each corner. Looking at the sequence of brazing, I reckon it will be best to tackle the saddle first and ease its fit to suit the frames. Now take a ⅜ in. bolt, down through the bottom hole in the shell, bring up the saddle and use a strongback to hold it in place, securing with a nut. As well as brazing the smokebox shell to the saddle, deal also with the front and boiler joint rings, then you will have an airtight smokebox; very important that.

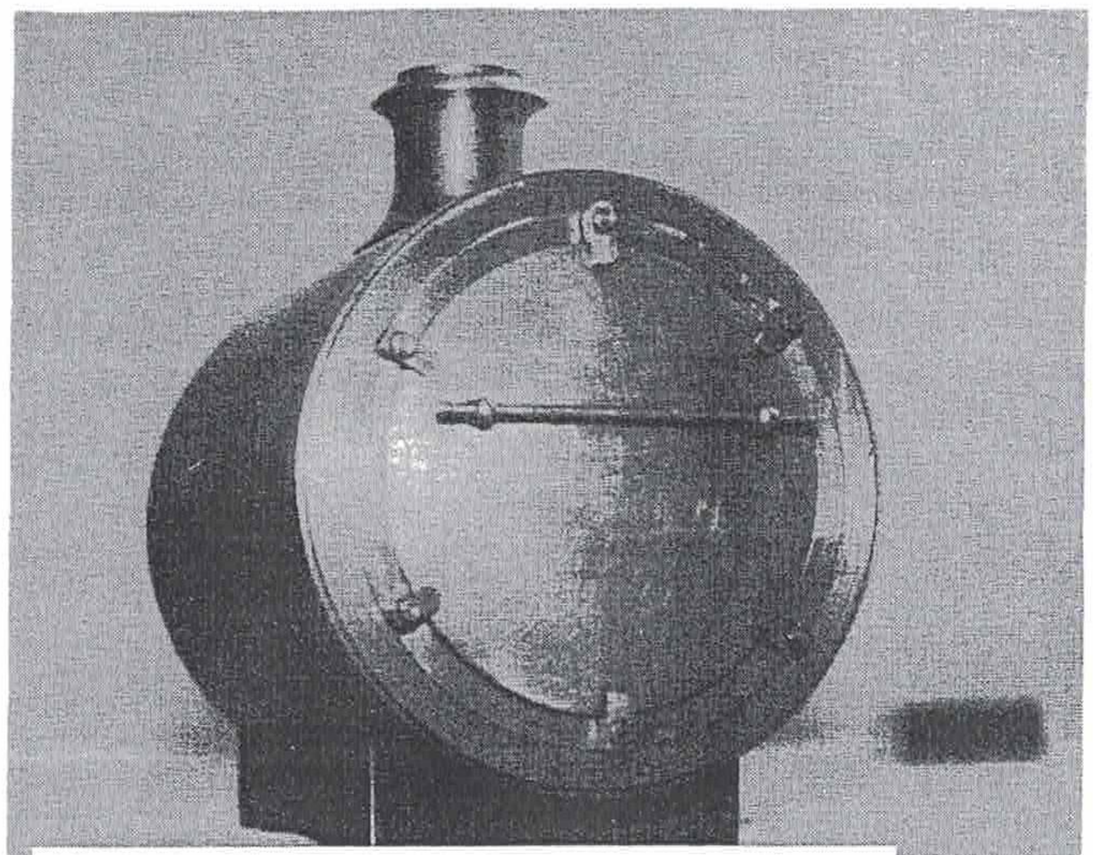
Boiler Erection

It would be as well to erect the boiler at this stage to check that all is well before we move inside the smokebox, so take two pieces each 2 9/16 x 1 1/16 in. from 1.6mm copper and fold to leave the bottom flange a little over 3/16 in. wide. Fit the boiler to the smokebox and erect the latter in its correct position, then block up the firebox at the back until your spirit level or rule tells you all is in order. Bring up an expansion bracket and locate it 1¼ in. back from the throatplate, then mark on the positions of the firebox stay heads, drilling clearance holes in the expansion bracket. You now know the fixing holes want to be located midway between the holes just drilled, so mark off and drill, when you will not be too far away from what I have dimensioned. The clearance holes in the expansion brackets are No. 34, from which go on and drill the outer wrapper No. 43 to tap 6BA, using new taps so the soft copper does not tear; make 6BA cheesehead screws from 3/16 in. bronze rod and fit the expansion brackets to place, using a little liquid jointing compound on the threads.

Fitting out the Smokebox

For the blastpipe flange, chuck a short length of ¾ in. diameter brass bar in the 3 jaw, face, centre and drill ⅜ in. diameter to 3/16 depth. Before parting off an ⅛ in. slice, use a knife edge tool to scribe on the bolting circle at 19/32 in. p.c.d.; drill the four No. 34 holes. The blast pipe is a 2⅛ in. finished length from ⅜ in. o.d. x 16 s.w.g. copper tube, the top end being screwed ⅜ x 32T over a ¼ in. length. Fit the flange over the bottom end of the blastpipe, braze up, pickle and clean, then chuck lightly by the blastpipe in the 3 jaw to face the flange to be perfectly square; erect to the exhaust flange on the cylinders.

We may as well complete the exhaust to the chimney as the next step, so take the petticoat pipe and first grip by the bell mouth in the 4 jaw and set to run true; after removing any flash at the joint. Lightly face off to length and if this is then greater than the 1⅜ in. specified then you can simply bore the chimney to suit, then turn the outside down to 29/32 in diameter with a round nose tool. Grip by this freshly machined portion to first bore right through to 1 1/16 in.



Proper dogs for this door; but I am wrong, it is the Steve Titley arrangement.

diameter, taking care to arrive at this dimension, then face off the bell mouth to give you the datum. Now set the boring tool over 2 deg. and open out the top of the petticoat pipe until you arrive at the choke, which is 5/8 in. up from the bell mouth; use files to clean up the latter both inside and out.
For the petticoat pipe flange, cut a 1½ in. square from 1.6mm brass sheet and find its centre by the 'X' method; chuck to run true, then centre, drill and bore out to a good fit over the petticoat pipe. Bend the flange to fit inside the smokebox shell, ease the fit over the petticoat pipe, but still a tight one so it does not move during brazing, then set the flange 1⅛ in. up from the bell mouth as against the ¼ in. down from the top, I have shown this in case you have varied the overall length; braze up, pickle and clean.
File the top of the chimney flat, it will then be to size, and braze on a short length of 1 in. diameter bar as a chucking spigot; chuck by same in the 4 jaw to run true, though you may wish to grip same in the bench vice in the first instance to get the base of the chimney matching the smokebox shell. There is very little required to clean up the outside profile, so next bore through to ¾ in. diameter, before opening up at the bottom to 29/32 in. diameter over a length to suit the petticoat pipe. Now set the tool over 2 deg. to bore out the chimney to match the petticoat pipe, in fact you bring the latter up to check same.
We now have to align the chimney with the blastpipe, so take a length of, say, ½ in. steel rod and turn down over a 1 in. length to a good fit inside said blastpipe. Erect the petticoat pipe and chimney to the smokebox and if the fit between them is a push one then they will stay in place whilst you fit the alignment rod and check with calipers that chimney and petticoat pipe are central. Mark off on the smokebox shell at the four corner positions and at 1½ in. p.c.d.; to drill through at No. 41 and countersink, then bring up the petticoat pipe and drill its flange to suit, securing with 7BA countersunk screws and nuts; you can use 8BA here if you do not have 7BA screws by you.

Smokebox Door and fittings

Before we attend to the steam circuit, let us tidy up the external bits and pieces, starting with the smokebox door. Tidy up the periphery of the door with a file then chuck by same in the 3 jaw to clean up the chucking spigot; rechuck by the latter. The only important job is to face the joint to be air-tight, after which you can clean up the front of the door to your hearts content. Centre and drill through at No. 29, then part off the spigot. Mark off and drill the door No. 34 in two positions for the handrail stanchions, then the pair of No. 43 holes for the locating spigots, only do not fit the latter until the crossbar has been drilled to suit.
Said crossbar is a 4⅛ in. finished length from ⅜ in. x ¼ in. BMS bar; offer up to the front plate to spot through, drill and tap 6BA, securing with countersunk screws. For the dart/handle, first chuck a length of ¼ in. steel rod in the 3 jaw, face, centre and drill No. 31 to 5/16 in. depth, parting off a 3/16 in. slice. Next chuck a length of ⅛ in. rod, and this may be stainless, to ease the outer end before screwing 5BA over a 9/16 length; part off at 15/16 in. overall. Press on the sleeve, then cross drill No. 53 and press in the 1/16 in. handle; the rod is ¾ in. long. Now you can erect the door to the crossbar and spot through the pair of locating holes, drilling the crossbar No. 41, or even opening out to No. 39 if you wish, then the door will position itself correctly every time.
I hear many courageous tales of builders fitting the correct dogs for securing the door, it all started with Steve Titley as far back as LLAS No. 2, but for the beginner my way must be best.

Steam Circuit

We have to return to the boiler to fit it out, starting with the regulator. Clean any flash from the joints on the gunmetal casting, then chuck by the main part of the body in the 3 jaw, face, centre and drill No. 30 to ⅜ in. depth. Open out to 9/32 in. diameter and 'D' bit to 5/16 in. depth, then tap 5/16 x 32T. Chuck an odd end of ½ in. rod, face and turn down to 5/16 in. diameter over a ¼ in. length, screwing 32T; screw the embryo regulator body to same. Just clean up the outside of the body with a round nose tool, then face off to length, centre and drill through at No. 13. Follow up at 11/32 in. diameter and 'D' bit to 15/16 depth, but of course face off to length as the first step. My drawing instruction now is to tap the body ⅜ Whitworth (LH) and as the screwing gear is available from Reeves, this is a possibility; if not then use RH screwing tackle and to about 9/16 in. depth. On the top centre, drill 9/32 in. diameter into the bore and tap 5/16 x 40T for the feed pipe, the latter being a simple detail that is self-explanatory, then run the tap through the bore again to remove any burrs. The flat face at the top fits to the inside of the boiler barrel, so first check the 9/16 in. dimension and then file the radius to suit said barrel.
For the regulator valve, chuck a length of ⅜ in. stainless steel rod in the 3 jaw, face and then turn down to 7/32 in. diameter over a ½ in. length. Set the tool over 45 deg. and turn on the actual valve to drawing before screwing the next ⅝ in. length to suit the regulator body; part off at 17/16 in. overall. Reverse in the chuck, face, centre and drill No. 12 to ⅜ in. depth. The regulator spindle starts life as a 10 in. length from 3/16 in. stainless steel rod, so chuck in the 3 jaw, face and turn down over an ⅛ in. length to 3/32 in. diameter, screwing 7BA. The next 3/16 in. of rod has to be turned into a 5/32 in. square, or filed is the operative word, and an easy way to do this is to file one flat until the dimension over the rod reduces to .172 in., then move opposite and file the second flat to the required 5/32 in. If you are unhappy about filing, then grip in the machine vice on the vertical slide and lightly mill to the dimensions.
We are now ready for assembly, but must do this carefully so that all goes together correctly. Screw the regulator valve into the body and just enter the steampipe assembly at the smokebox end. Get the regulator body into the boiler, that bit is not difficult!, but then engage it on the steampipe end, screwing the steampipe hard into the smokebox tubeplate and not letting the regulator body turn; it should now be in the position as shown on Sheet 4. At 5/16 in. ahead of the dome bush and 5/32 in. each side of the centre line, drill the boiler barrel at No. 34 and countersink. Spot through one hole onto the regulator body, then remove from the boiler to drill and tap 6BA; assemble again with a 6BA screw and deal with the second hole. To seal the screw heads, I use an electric soldering iron with Bakers fluid as flux and simply tin the

immediate surface. The steampipe assembly can now be removed, liquid jointing compound applied to the threads and then reassembled for keeps. Slide the regulator spindle in from the backhead and engage the valve, then really you will have to await the boiler fittings to make sure the regulator handle is clear of same, though for now we will assume it can be checked. Cut the spindle to length as indicated, remove the valve and attach spindle to valve either with a 3/32 in. pin, or by brazing. Now you will find I have got it wrong, for the valve/spindle assembly wants to be introduced into the boiler ahead of the regulator body being permanently fitted, otherwise it is difficult to get into the boiler.

For the regulator spindle gland, chuck a length of 7/16 A/F hexagon brass or bronze bar, face and turn down over a 7/16 in. length to 3/8 in. diameter, screwing 32T. Centre and drill No. 11 to 11/16 in. depth, then part off to leave a full 1/8 in. head, one you can lightly face.

That leaves the handle, for which first chuck a length of 5/16 in. rod; face, centre and drill No. 24 to 5/16 in. depth, parting off a 3/16 in. slice. The actual handle is a 1½ in. length of ¼ in. x 1/8 in. BMS or stainless steel flat; first chuck in the 4 jaw to turn the circular portion over a 7/16 in. length. Scallop the other end to match the boss, checking the overall length comes out at 1½ in., then file the flanks before brazing together. With the regulator valve fully closed, the regulator handle wants to be roughly in the position shown on the cab layout, so file the square to arrive at this, completing the boiler part of the steam circuit.

Superheater flange next, so chuck a length of gunmetal bar in the 3 jaw, if it is the continuous cast variety it can be ¾ in. diameter, otherwise oversize, to turn if necessary, face, centre and drill 5/16 in. diameter to 3/8 in. depth; part off a full ½ in. slice and rechuck to clean to length. Grip in the machine vice on the vertical slide, mill a wee flat at the bottom, then centre and drill 5/16 in. diameter into the bore, using an end mill if there is a problem when the holes meet. Mark off and drill the pair of fixing holes, No. 29 at 17/32 in. centres, then assemble to the steampipe flange, bring up the superheater and check it is nicely central before brazing on the flange.

There is now a length of tube projecting down from the superheater, one which requires connection to the cylinders, so at 5/8 in. behind the blastpipe hole in the base of the smokebox, drill another hole, this time at 9/16 in. diameter. For the actual connection, chuck the 7/16 in. A/F hexagon bar again, face and turn down to 3/8 in. diameter over an 1/8 in. length, screwing 32T; part off at 11/16 in. overall. Chuck a 3/8 x 32T screwed adaptor and fit the embryo steam connection to it, then face and turn down to 7/16 in. diameter over a 3/8 in. length, screwing 26T. Centre and drill through at No. 2, then use a 90 deg. Rosebit to deal with the nipple seating. For the nipple, chuck a length of 3/8 in. brass rod, face, centre and drill No. 2 to 5/16 in. depth. Chamfer the end to suit the connection just made, then part off at ¼ in. overall, reverse in the chuck and open out to 5/16 in. diameter over a 5/32 in. length. The nut is from 9/16 in. A/F hexagon brass bar, so chuck in the 3 jaw, face, centre and drill 5/16 in. diameter to ½ in. depth. Follow up at 13/32 in. diameter to 9/32 in. depth, 'D' bitting before tapping out at 7/16 x 26T and of course you can use 32T screwing tackle if you have this by you.

Screw the steam connection into the cylinder, lower the boiler and superheater into place and saw off until the end of the steampipe is level with the top of the steam connection. Fit the nipple, not forgetting the union nut, then braze up.

Combined Blast Nozzle and Blower

In my haste to complete the exhaust system, I omitted the most important part, the combined blast nozzle and blower, so let me make amends before going any further. For the body, chuck a length of 7/8 in. diameter brass bar, face, centre and drill No. 5 to 11/16 in. depth. Follow up at 11/32 in. and 'D' bit to ¼ in. depth, tapping 3/8 x 32T, then part off at a full 9/16 in. overall. Chuck a 3/8 x 32T screwed adaptor, fit the embryo body to same and first with a parting off tool, deal with the blower belt ¼ in. wide to 9/16 in. diameter. Turn on the upper nozzle to leave the 1/16 in. thick flange for the blower nozzles and turn this to suit the 7/8 in. o.d. x 18/20 s.w.g. tube, though the latter can of course be made from solid bar. The connection is from 7/32 in. brass rod, so chuck in the 3 jaw, face and screw 40T over a ¼ in. length. Next centre deeply for the pipe nipple and drill No. 46 to 7/16 in. depth. Starting parting off, but when you arrive at around 5/32 in. diameter, move on 1/16 in. before parting right off. Mike this spigot and drill the blower tube to suit. Screw the body onto the blastpipe, orientate the blower union for ease of assembly and braze up, pickle and clean.

Grate and Ashpan

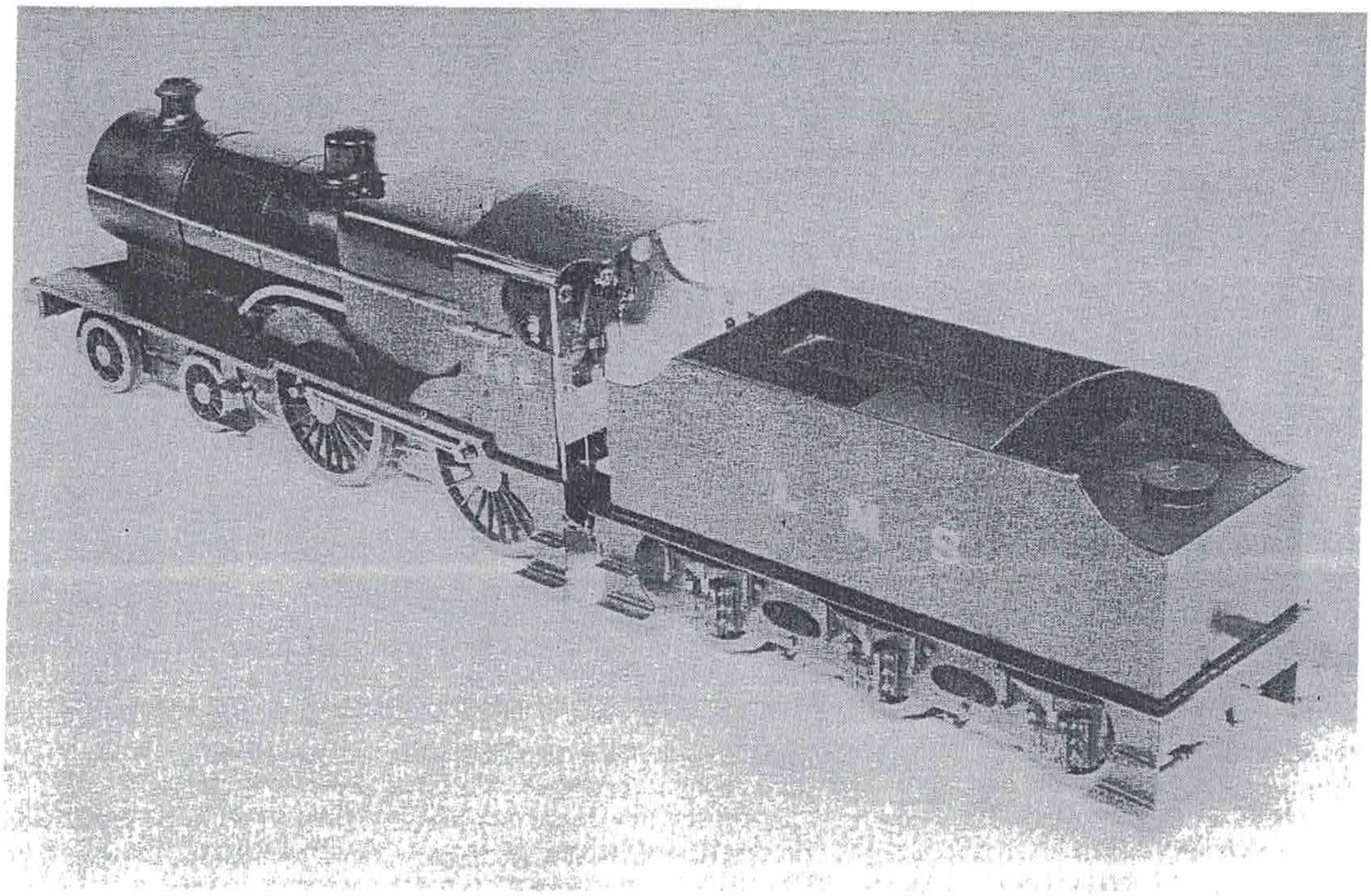
Before we can permanently erect the boiler and seal the smokebox with soft setting asbestos cement the grate and ashpan must be dealt with, in reverse order.

Cut a side of the ashpan to drawing from stiff cardboard and try it to place before transferring to 1.6mm steel sheet, and if you have a big enough piece of material, it is a good idea to form both sides and the bottom in one piece, otherwise make in three pieces and fix together with lengths of ¼ in. brass angle. The front is filled right in and again is attached with the brass angle, though leave a space at the top to fit over the firebox. There are two air entry slots, the first being at the base of the main portion of the ashpan, the 7/8 in. dimension. Above this the ashpan bottom is sheeted in, over the rear coupled axle, until we reach a second air entry slot right at the back of the ashpan. As well as allowing air to enter, these slots also allow ash removal, the back one by gravity and the one in the base by raking out. Although this ashpan is remarkably deep and will allow for hours of running with a minimum of attention, keeping the air entry slots clear will make life a lot easier at the track. Attach that rear portion of ashpan floor with the brass angle and braze up the whole assembly when we can turn our attention to the grate.

Burning Welsh steam coal, providing the ash is not allowed to build up right under the bars, the grate can happily be made from mild steel; it is anthracite that loves to eat mild steel bars! There are six bars, each bent up to drawing from ¼ in. x 1/8 in. section material and then drilled in the two positions shown at No. 30 for the 1/8 in. rods; drill one bar as a master and then use as a jig for the remaining five bars. For the spacers, chuck a length of ¼ in. steel rod, face, centre and drill No. 30 to about 1 in. depth, parting off 3/16 in. slices and deepening the hole as you proceed. When you have six spacers of this thickness, make another four that are only 1/16 in. thick. The lugs to attach to the ashpan are again bent up from ¼ in. x 1/8 in. strip and I suggest you make a 'dry' assembly in the first instance to check the lugs fit the ashpan correctly, then peen over the rod ends. Erect grate and ashpan and check that the top of the grate is at least level with the top of the foundation ring, then drill through and rivet the lugs to the ashpan.

The dumping pin hole I have shown in the frames is 3 in. forward of the rear coupled axle and ¼ in. up from the bottom edge of the frames, so drill No. 10. Bring up the ashpan hard against the foundation ring, over the firebox extension, and drill the ashpan walls No. 10. some builders prefer a tube across the ashpan to positively align the dumping pin as it is fitted, and indeed I have specified same on occasion, but I reckon in this instance it is not really necessary as you can see what is happening.

For the dumping pin, square off a 3½ in. length of 3/16 in. rod, taper one end for ease of entry into the No. 10 holes, then slit with a saw and splay slightly so that the pin is trapped when



Bob Gray in Birmingham built this fine 2P; note the very clean lines.

fitted. For the head at the other end, chuck a length of 5/16 in. steel rod, face, centre and drill No. 12 to ¼ in. depth before parting off an ⅛ in. slice. Braze this to the pin, then chuck and clean up the head.

Front Running Board

Before we move into the cab, there is the front running board to be dealt with ahead of the smokebox. Cut a piece 3½ in. x 2⅞ in. from 1.6mm sheet, and at 11/16 in. from one edge, grip in the bench vice, soft clams please, to make a 90 deg. bend; I use a wooden mallet to get a nice sharp radius. Take a length of ¾ in. x ½ in. BMS bar and fit to the first bend, clamping in the vice to produce the second, reverse bend to drawing. Trim off the excess length and as this running board will be frequently removed for access to the mechanical lubricator, I suggest you attach a wee piece of ¼ in. brass angle that locates against the inside face of the front buffer beam.

THE CAB

We now come to the area that will take our attention for much of the time on the run, the cab, though don't bury your head in it and miss the signals, or you will be in trouble! Of all the fittings inside, the only one that is vital is the water gauge, for the water level must be kept above the bottom nut at all times; if you lose steam pressure then all you do is stop; lose the water and you are likely to need a new boiler. Often on 3½ in. gauge, there is difficulty in seeing the pressure gauge when mounted traditionally in the roof of the cab, so I have shown it lowered for ease of reading, though you can locate it to your choice. The only point is that there must be water between the boiler steam and the actual pressure gauge, which means a 'U' tube to trap same. Moving left from the water gauge, we come immediately to the injector steam valve, then on the centre line and starting at the top is the turret, for which the whistle valve is our only control. My whistle valve levers are made so they pull out rather than push in, so you fit a length of cord from same to the back of the cab roof, which you simply grab and pull to warn of your coming. Next down is the regulator handle, which we have already dealt with, and below this the firehole door, my own pattern that goes back 20 years now and has not yet been found wanting. Below the door is the blow-down valve, this for emptying the boiler after every run. Each side of the blow-down valve are the feed check valves from tender hand pump and injector; I am not too proud of their positions as it is below the boiler water level and prone to foreign bodies, though the hand pump should be rarely used, except perhaps when filling the boiler at the start of a run. The axle driven feed pump is higher up on the left and in the ideal position; above and slightly to the right is the blower valve, which completes our journey over the backhead.

There is very little we can do with the cab structure this time, but we can at least make the spectacle plate, which lets us complete another large part of the engine. Mark the spectacle plate off on stiff cardboard and offer up to the boiler — the fit I have shown is too good and will have to be eased to clear any stay heads. When satisfied, transfer to 1.6mm sheet, brass for preference and cut out, including the cab windows. As the latter are extremely tiny, I suggest you cut them from mica and superglue directly to the spectacle plate. The spectacle plate is located ¼ in. behind the centre of the rear coupled wheels, which brings us neatly to the area between the cab front and the smokebox.

Lagging and Cleading

Reeves do a suppressed asbestos woven cloth which is 1/16 in. thick and ideal for our application, so cut four pieces to suit the barrel, cutting away at the dome, and wire each to place with the old 15 amp fuse wire, when there should be just room for a single layer over the firebox.

It was just about 25 years ago now that I discovered .015 in. thick brass shimstock was ideal for boiler cleading, we used vast amounts of it as shims on steam turbines, its great advantage being that it was totally resistant to dents. Reeves now stock this material, only it is roughly .014 in. thick, so cut a piece 14 in. x 8 in. when the joint will be approximately on the bottom centre, so cut a circle out for the dome to place. I fit my cleading with a simple Spanish windlass, a length of string tied at the ends, a file tang or similar through the loops, and you just turn the file to tighten the string, though only try to place as yet, for we have a cleading type of throatplate to make.

Make up a hardwood former to represent the lagging at the throatplate, then take a sheet of 0.7mm copper and beat it over the former, sawing vertically in halves with a Junior

hacksaw. Now if you are able, form a reverse flange at the barrel to sit under the cleading for that portion; if not then cut to a tight fit to said barrel. Now you can offer up the cleading over the barrel once more and this time use the Spanish windlass to bring it into good contact with the lagging. With an electric soldering iron, heat the joint and feed in soft solder to hold the cleading firmly together. The boiler bands, three of them, are lengths of 5/32 in. wide brass strip and sold as flat brass banding; use a 3/16 in. wide if that is the only alternative. Wrap it round the cleading and produce a 90 deg. bend at each end to leave approximately a 1/4 in. gap; drill each of these wee lugs at No. 44. Refit the band and tighten with an 8BA bolt; repeat.

If you have difficulty with the brass shimstock over the firebox, revert to the 0.7mm copper sheet; it is a simple box. When the splashers are available then you can cut the bottom edges to suit, but fix either to the frames by means of spacers, or use lengths of 1/4 in. brass angle on the outside. There are two boiler bands over the firebox, the first masks the throatplate joint and both can be bolted directly to the lagging, or the 1/4 in. brass angle if this is used. There must be a 1/16 in. gap between the cleading and the spectacle plate to allow for expansion and left like this it looks horrible. So take a length of 3/16 in. x 3/16 in. x 1/32 in. brass angle and form it to suit the cleading, rivetting to the spectacle plate with 3/64 in. copper rivets.

Firehole Door

After being such a coward with GEORGE, I had better describe the firehole door for DERBY 2P as the first backhead fitting. Scribe the actual door, 1½ in. diameter on a sheet of 1.6mm brass and saw roughly to line. Drill the hole in the centre No. 41, chuck a 7BA nut in the 3 jaw and bolt the door to same to carefully clean up to line. Mark on and drill the three air holes also at No. 41 and we are ready to deal with the fitments.

The catch is simply bent up from 1/4 in. x 1.6mm brass strip and rivetted to the door; the hinges require a little more attention. Chuck a length of 3/16 in. brass rod in the 3 jaw, face, centre and drill No. 41 to 3/4 in. depth, parting off two 3/16 in. slices. Sit on lengths of 3/16 in. x 1.6mm brass strip and silver solder together, then trim and rivet to the door in turn, using a long 7BA bolt both for spacing at 1/2 in. and for alignment. The baffle is a smaller and simpler edition of the door and the spacer straightforward; use a 3/32 in. copper snap head rivet to fix baffle and spacer to the door.

For the hinge block, chuck the 3/16 in. rod again, face, centre and drill No. 41 to 5/8 in. depth, parting off a 1/2 in. slice. Sit on a length of 1/2 in. x 1/8 in. brass strip to silver solder together, then saw off to length and drill the pair of No. 41 fixing holes. Hinge pin next, so chuck a length of 3/32 in. rod, face and taper one end for ease of alignment, then part off at 1 in. overall. Chuck a length of 5/32 in. rod, face, centre and drill No. 43 to 5/32 in. depth before parting off a 1/16 in. slice. Press this onto the end of the pin, braze up, then chuck and clean up the head. Assemble the hinge and door to the backhead, with the door nice and central over the firehole, then spot through, drill and tap the boiler 7BA and make cheese head screws from 5/32 in. bronze rod in the same way as we did for the boiler expansion brackets.

You will be surprised how you can bend up 1/4 in. x .015 in. spring steel strip to drawing for the catch spring without it breaking, centre pop deeply at the two positions, file away the pip until a wee hole appears and open this out in stages to No. 41. When the catch is properly positioned it will just catch the door and hold it at its outer limit; a push with the shovel will fully close it. When you have this condition, spot through, drill and tap the boiler 7BA and make a further couple of bronze screws.

Originally I fitted a short length of chain to the door to open it, but it always seem to get in the way, so now I hook the pricker over the catch to open the door and use the shovel to close it.

Hand pump

We have been using hand pumps to test the boilers for DERBY 2P and GEORGE, so it is about time we made one! Grip by the main part of the body in the 4 jaw and clean up the chucking spigot; rechuck by same. Face the outer end then centre, drill and ream 1/2 in. diameter to at least 1 3/4 in. depth before facing the end flange and parting off. Grip in the machine vice on the vertical slide to first mill the foot to size, then grip by the foot to deal with the flange profile. With the foot hard against the base of the machine vice, mill the top face at the outlet union, then centre and drill No. 31 into the bore. Follow up at 7/32 in. diameter and 'D' bit to 3/8 in. depth, tapping the outer 1/8 in. or so at 1/4 x 40T; run an 1/8 in. reamer through the remains of the No. 32 hole. To complete the outlet passage, file from the end of the casting into the 1/8 in. hole so that the ram will not lock.

Turn the casting over 180 deg. to deal with the inlet passage, milling the flat to be 3/8 in. below the ram bore, then centre and drill 1/8 in. diameter into the bore. Follow up at 7/32 in. diameter and 'D' bit to 5/16 in. depth, then open the hole out towards the mouth of the bore with a triangular file as this is not the ball seating. The inlet seating is in fact a separate part, so chuck a length of 5/16 in. A/F hexagon brass bar in the 3 jaw, face and turn down to 1/4 in. diameter over a 3/16 in. length. Next centre to drill No. 31 to 3/8 in. depth and ream at 1/8 in. diameter before parting off to leave a 3/32 in. head; screw this into the body with a 5/32 in. rustless steel ball above.

The outlet connection is again from the 5/16 in. A/F hexagon brass bar, so chuck, face and turn down to 1/4 in. diameter over a 1/4 in. length, screwing 40T. Centre deeply to form the pipe nipple seating, then drill No. 30 to 5/8 in. depth before parting off at a full 1/2 in. Chuck a 1/4 x 40T screwed adaptor and fit the embryo connection to same, to face to length, turn down to 1/4 in. diameter over an 1/8 in. length and screw 40T. When the upper ball lifts, it must not reseat on the outlet connection, so mill or file slots to break up said seat, then erect.

The outlet connection boss on the body extends to become the anchor point for the pair of links, so either mill down to leave an 1/8 in. thick lug, or leave as cast and bend the links instead; in either case drill the No. 41 fulcrum hole. The material for the ram has a wide choice and though I have specified stainless steel, you may use brass, bronze, or a plastic. Part off your chosen material to 1 13/16 in. overall, cross drill at the end for the 3/32 in. pin and then slot for the lever, the latter a roughly 2 in. length from 1/4 in. x 1/8 in. section brass bar. The links are from 3/16 x 3/32 in. section brass, when you can drill all the holes and assemble with 3/32 in. brass rivets as pins, simply peening the ends over. All that remains is to close the open end of the bore, either by a 2.5mm brass plate, or more simply a stepped plug that presses into the end of said bore. We had better deal with the two odd items detailed in this vicinity, starting with the water gauge elbow.

Water Gauge Elbow and By Pass Valve

Although the main body of the water gauge elbow can be made from round stock, it is much easier to make from 3/8 in. square bronze bar, so chuck truly in the 4 jaw, face and turn down to 1/4 in. diameter over a 5/16 in. length and screw 40T. Centre and drill No. 30 to 19/32 in. depth before parting off at 23/32 in. overall. Screw the body hard into the boiler bush and then drill the side facing aft at No. 30 as shown. Next chuck a length of 3/8 in. rod, face and centre before drilling 7/32 in. diameter to 7/16 in. depth and tapping 1/4 x 40T; part off a full 5/16 in. slice. Clamp the two pieces together for silver

soldering, run the tap down the threads to remove any excess spelter after pickling.

The by-pass valve is rather archaic and very definitely LBSC in style, so is worth making for that alone. Chuck a length of 3/8 in. brass rod for the body, face, turn down to 1/4 in. diameter over a 1/4 in. length and screw 40T. Next centre and drill No. 43 to about 1 1/4 in. depth, then drill No. 30 and 'D' bit 1/8 in. diameter to 5/8 in. depth; follow up with a 5/32 in. 'D' bit to 7/32 in. depth and tap the next 7/32 in. at 5/32 x 32T, a Whitworth thread. Part off at 1 1/4 in. overall, reverse in the chuck to centre and drill No. 30 to 1/2 in. depth, then follow up at No. 21 to 3/16 in. depth. Scallop the end of the body as shown, it just makes it look pretty, then run a 3/32 in. reamer through the remains of the No. 43 hole.

For the connections, chuck a length of 1/4 in. rod, face and screw 40T over a 3/16 in. length. You can either spigot the connections into the body or carry on to my detail, in which latter case part off at 1/4 in. overall after centering deeply for the pipe nipple and drilling No. 41 to 3/8 in. depth, then scallop the connection to suit the body; clamp in place and braze up. Now drill No. 41 from the connections into the body and remove any burrs.

Locate the body hard against the LH frame and you can either clip the body, or the pipes, to same to keep it stable. The operating handle or bar wants to come just clear of the cab floor so as not to be too obtrusive, so measure off and cut your 5/32 in. stainless steel rod to length. Chuck in the 3 jaw, face and turn on the actual valve, 3/32 in. diameter and 1/8 in. long including the 60 deg. taper. Screw the next 1/4 in. or so at 32T and we must decide on the means of operating. I much prefer the bar type of handle and wonder why I drew otherwise. Chuck a length of 1/4 in. steel rod in the 3 jaw, face, centre and drill No. 23 to 5/16 in. depth before parting off a 3/16 in. slice. Press this onto the end of the spindle and then cross drill No. 53 for the bar handle, a 1/2 in. length of 1/16 in. rod pressed into place. We must now silver solder a length of 5/32 in. o.d. thin wall copper tube into the bottom end of the body and I suggest this be only 3-4 in. long and then fitted with a plain or double union, as it is not too easy to thread a long pipe right through from by-pass valve to pump delivery. The gland nut is from 5/16 in. A/F hexagon brass bar, so chuck in the 3 jaw, face, centre and drill No. 22 to 3/8 in. depth. Follow up with a 7/32 in. drill and 'D' bit to 1/4 in. depth and tap 1/4 x 40T before parting off at 5/16 in. overall. If you rechuck the nut and lightly face and chamfer the end, this will give it a touch of class and applies to all union and gland nuts. Pack the gland with PTFE braid and erect to the engine.

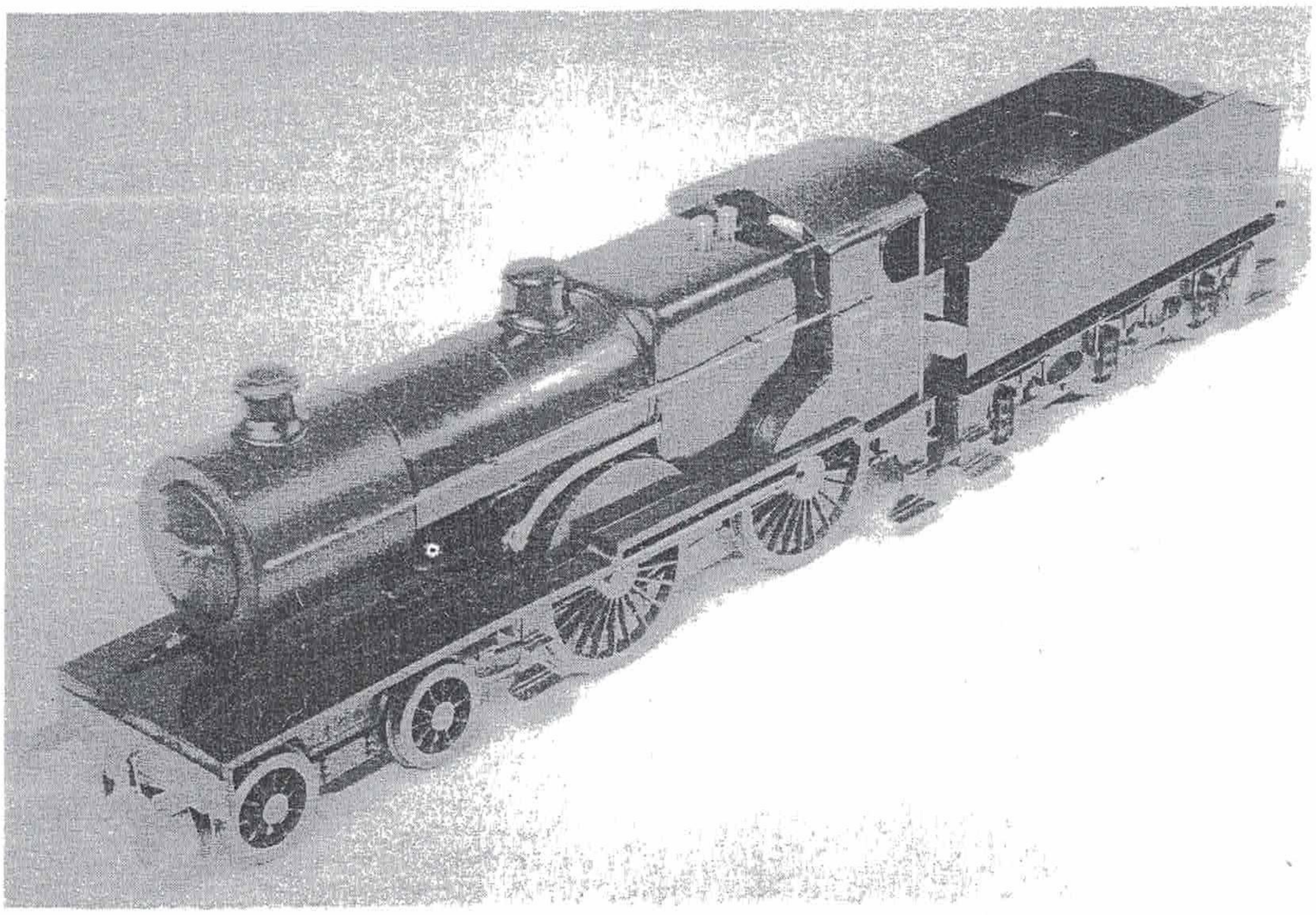
Blow-down Valve and Water Gauge

The blow-down valve fitted to GEORGE is a little neater than that detailed for DERBY 2P, but in any case the same description can be used to arrive at the finished article.

The water gauge for GEORGE though is now thought much superior to that detailed hereabouts some 12 years back, though it is still worthy of brief description. For the top fitting, chuck a length of 5/16 in. bronze rod in the 3 jaw, face and screw 40T over a 3/16 in. length. Now centre and drill through at No. 10 to suit your 3/16 in. o.d. gauge glass, checking the fit before parting off at 9/16 in. overall. Reverse in the chuck, clean up and then tap 7/32 x 40T to about 1/8 in. depth. For the boiler connection, chuck a length of 3/8 in. bronze rod, face and turn down to 1/4 in. diameter over a 1/4 in. length, screwing 40T. Leave a full 3/32 in. at the full diameter, then use a round nose tool to reduce to around 7/32 in. diameter, but before parting off at 1/2 in. overall, centre and drill No. 30 to about 5/8 in. depth. Mike the spigot and drill the body to suit, then pickle, flux and silver solder.

For the top cap, chuck the 5/16 in. bronze rod again, face and turn down over an 1/8 in. length to 7/32 in. diameter, screwing 40T, then part off to leave a 1/16 in. thick head. Next chuck a length of 3/16 in. square brass bar truly in the 4 jaw, turn down over an 1/16 in. length to around 3/32 in. diameter and part off to leave a 5/32 in. thick head. Drill the cap to accept this spigot and silver solder together. That leaves the gland at the top, in fact make a pair of them, using the description from the by-pass valve gland nut.

For the bottom fitting, chuck the 3/8 in. bronze rod again and turn on the 1/4 x 40T spigot as for the top fitting, then leaving the full 3/32 in. flange, use a round nose tool to reduce over a 1 1/4 in. length to around 21/64 in. diameter before parting off at a full 1 1/4 in. overall. Chuck a 1/4 x 40T screwed adaptor and screw the embryo bottom fitting into same to first face to length and then turn down to 5/16 in. diameter up to the flange. Next centre and drill through at No. 31, following up



Another view of Bob's 2P, an engine I was hoping to see in steam at Bellany Green.

at 3/16 in. diameter and 'D' bitting to 7/16 in. depth and tapping the first 3/16 in. or so at 7/32 x 40T; ream the remains of the No. 31 hole to 1/8 in. diameter.
Screw hard into the boiler to orientate the gauge glass connector and drain valve union, turning these up from 5/16 and 7/32 in. rod respectively, then mike the spigots and drill the body accordingly; braze up. After pickling and cleaning, check all the threads with tap or die as required and poke the reamer through the bore again. The valve stem comes next, from 1/4 in. A/F hexagon brass bar, so chuck in the 3 jaw, face and turn down to 7/32 in. diameter over a 3/16 in. length, screwing 40T. Centre and drill 7/16 in. depth at No. 40, follow up with a 5BA tap and then part off to leave an 1/8 in. head, one which you should chamfer to drawing.
The valve is from 5/32 in. stainless steel rod, so chuck in the 3 jaw and in about 1/4 in. increments, turn down to 1/8 in. diameter over an 11/16 in. length and screw 5BA; part off at a full 1 in. overall. Reverse in the chuck and you can use a couple of 5BA brass nuts as support, to turn the actual valve to a 90 deg. point as shown. The collar is from 1/4 in. rod, so chuck, face, centre, drill No. 40 and tap 5BA to about 3/16 in. depth before parting off an 1/8 in. slice. Screw this onto the end of the spindle, not forgetting to fit the valve stem first, then cross drill No. 53 and press in a 5/8 in. length of 1/16 in. rod as the handle.

Blower Valve and Clack
Commercially I would not sell a blower valve today without a captive spindle, which rules out the detail for DERBY 2P and as a much better alternative exists from GEORGE, we can use this in lieu. The only alterations is that you only turn the spigot down to 5/16 in. diameter instead of 1/4 in., but still screw 40T, but this time you have also to drill and 'D' bit the bore to 5/32 in. diameter and 1/4 in. depth to tap 3/16 x 40T for the blower tube, the rest is as per LLAS No. 30.
You can also make a prettier version of the clack from GEORGE, but as this item is not open to danger, I will describe the detail. For the body, chuck a length of 5/16 in. bronze rod, face and turn down to 7/32 in. diameter over a 7/32 in. length and screw 40T. Centre deeply for a pipe nipple, but do not drill from this end, instead part off at a full 11/16 in. overall. Chuck a 7/32 x 40T screwed adaptor, fit the embryo body, face to length then centre and drill through at No. 31. Follow up with a 7/32 in. drill and 'D' bit to 3/8 in. depth and tap the outer 3/16 in. at 1/4 x 40T, then run an 1/8 in. reamer through the remains of the No. 31 hole. Change to 3/8 in. bronze rod, face, turn on the 1/4 in. spigot over a 3/16 in. length and screw 40T. Centre and drill No. 30 to about 5/8 in. depth, then leaving a full 3/32 in. flange, reduce with a round nose tool as for the water gauge and drill the body to suit, silver soldering together.
I have heard so many tales about clacks leaking, with Schraeder valve and plastic seat alternatives, but it all boils down to an imperfect seat, one which I have found can easily be corrected. I simply use a taper reamer, one for instance that has been used for making drain cocks, twirling the reamer around in the hole with my fingers; it just removes the last burr and polishes the seating.

Safety Valve
For these we require a length of 1/2 in. A/F hexagon bronze bar, so chuck in the 3 jaw, face and turn down to 5/16 in. diameter over a 5/16 in. length before screwing 40T, or if you are going to fill the boiler by removing a safety valve, then use the courser 32T. Part off at a full 1 1/32 in. overall and repeat, then fit a screwed adaptor of the correct thread. Turn the outside to drawing and if you make a little profile gauge you will be able to get the pair identical, then centre and drill through at No. 13. Follow up at 9/32 in. diameter and 'D' bit to 5/8 in. depth, screwing the top 3/16 in. or so at 5/16 x 40T, then run a 3/16 in. reamer through the remains of the No. 13 hole.
For the adjuster, chuck the 5/16 in. bronze rod, face and screw 40T over a 3/16 in. length, then centre and drill No. 40 to the same 3/16 in. depth before parting off an 1/8 in. slice. File the four steam escape slots and they want to be to drawing sizes to clear the exhausting steam, then ease into the body by removing the burrs.
The spindle is from 3/16 in. stainless steel rod, so chuck in the 3 jaw and reduce in 1/4 in. increments to 3/32 in. diameter, an easy fit in the adjuster and over a 1/2 in. length. Part off to leave a 3/32 in. head, reverse in the chuck and use a drill point to form the indent for the ball. I had to smile about what I said for GEORGE about stainless steel springs, for we have now started to buy them commercially for some of our safety valves and find them unsurpassable; I should keep my big mouth shut! For the moment, you will have to wind your spring from 20 s.w.g. bronze wire and although you can check the operation of the valve hydraulically, final setting will have to wait your first steaming; not long ahead now.

Safety Valve Cover
To set off the safety valves, there is a wee cover, which although I have seen as castings, are best machined in this instance from 3mm brass sheet. Scribe out and first drill the pair of 9/16 in. holes, for which you will have to clamp firmly to a block of hardwood, then saw out and file to line, adding a wee radius all round the top as the finishing touch.

The Turret
According to me, we have reached the last item for this session, one where we can exercise our machining skills to the full; pity the end result will be largely hidden in the cab.
Chuck the 5/16 in. bronze rod again for the body, it should be faced off by now!, then centre and drill No. 43 to 1 3/8 in. depth. Follow up with a 3/16 in. drill and 'D' bit to 3/4 in. depth, then part off at 1 7/32 in. overall; reverse in the chuck. Drill 3/16 in. diameter to 3/8 in. depth and tap the outer 5/32 in. or so at 7/32 x 40T, then run a 3/32 in. reamer through the remains of the No. 43 hole.
We know how to make boiler adaptors from the water gauge and clacks, and this one is a repeat; screw hard into the boiler to orientate the turret body fore and aft. As I have not fully described union connection manufacture this session, I will do so now. Chuck a length of 7/32 in. bronze rod in the 3 jaw, face and screw 40T over a 5/32 in. length. Centre deeply and drill No. 41 to 3/8 in. depth, then start parting off at 7/32 in., but only reduce to around 5/32 in. diameter before moving on 1/16 in. and parting right off; the fourth connection is 3/16 x 40T but all the rest follows. Mike the spigot and drill the body to suit and when all four are fitted, pickle, flux and silver solder together.
For the end cap, chuck a length of 5/16 in. A/F hexagon rod, face and turn down to 7/32 in. diameter over a 5/32 in. length, screwing 40T. Centre, drill and 'D' bit 1/8 in. diameter to 3/16 in. depth, then part off to leave a full 3/32 in. head. The spring wants to be 1/8 in. o.d. and of sufficient length and strength to hold the 1/8 in. ball firmly on its seat; nothing is more annoying that a blowing whistle valve!
We now come to the fulcrum block, so chuck a length of 3/8 in. square brass bar eccentrically in the chuck to produce the 5/32 in. long spigot to 7/32 in. diameter; screw 40T. Centre and drill 1/16 in. diameter to 1/2 in. depth, then part off a 7/16 in. slice; reverse and clean up. Mark off and cross drill No. 53 for the fulcrum pin and we had better make the lever next. The lever is marked off on 2.5mm brass, cut to shape and drilled to drawing, when you can slot the fulcrum block to accept same. The push rod wants to be .010 in. shorter than the length between ball and lever, so that expansion doesn't cause the whistle to blow. Use a 1/16 in. brass snap head rivet as the fulcrum pin, peening over and that is as far as I can go for the moment.

Derby 2P — An LMS 4-4-0 in 3½ in. gauge

by: DON YOUNG

Part 6 — Conclusion

Valance and Side Running Boards

Looking back at Sheet 1 it will be noted that the valance is not straight, being raised in way of the coupled wheels to clear the coupling rod. We shall do well to deal with this raised portion first, so cut pieces 9⅛ in. x 1⅝ in. from 1.6mm steel or brass for the centre section side running boards. Mark off and saw away to clear the coupled wheels, then mark off and drill the 11 No. 44 holes specified; nine of them for the valance and the other pair for attachment to the top of the sandbox. Offer up to said sandbox, spot through, drill and tap 8BA and you may attach either with round or countersunk head screws; this is all the support this running board will require. At 1/16 in. from each end of the running board, rivet on 9/16 in. lengths of ¼ in. x ¼ in. x 1/16 in. brass angle, this for attachment to the other sections of running board; first though we need the valance.

Cut a 9 in. length of the ¼ in. brass angle and attach centrally to the centre section side running board with 8BA screws, the outside edge of the valance being 1/16 in. from the outer edge of the running board; tap the valance to place. Turning to the valance detail, the front and rear sections are ⅜ in. below the centre section, so cut roughly to length to overlap the centre section and add a filler from ⅛ in. x 1/16 in. strip, brazing the joints and then completing to profile with files. At the front, braze on a 1 in. length of ½ in. x 1/16 in. brass strip and then profile to drawing; it is important that the ends are a good fit between the buffer beams.

For the front section side running boards, cut pieces 12½ in. x 1⅝ in. from the 1.6mm thick material and fold at the rear to suit the valance and centre of running board, trimming to a fit before cutting away for the splasher. Mark off, drill the 14 holes at No. 44 and attach to both valance and sandbox, then drill another couple at No. 44 and attach to the angle at the centre section. The rear section starts life as a 3½ in. length from the 1⅝ in. x 1.6mm strip; fold to suit the valance, cut away for the splasher, drill the specified holes and attach to valance and rear buffer beam. At the rear end of the valance, mark off and drill the pair of No. 44 holes, countersink and then spot through to drill and tap the rear buffer beam 8BA.

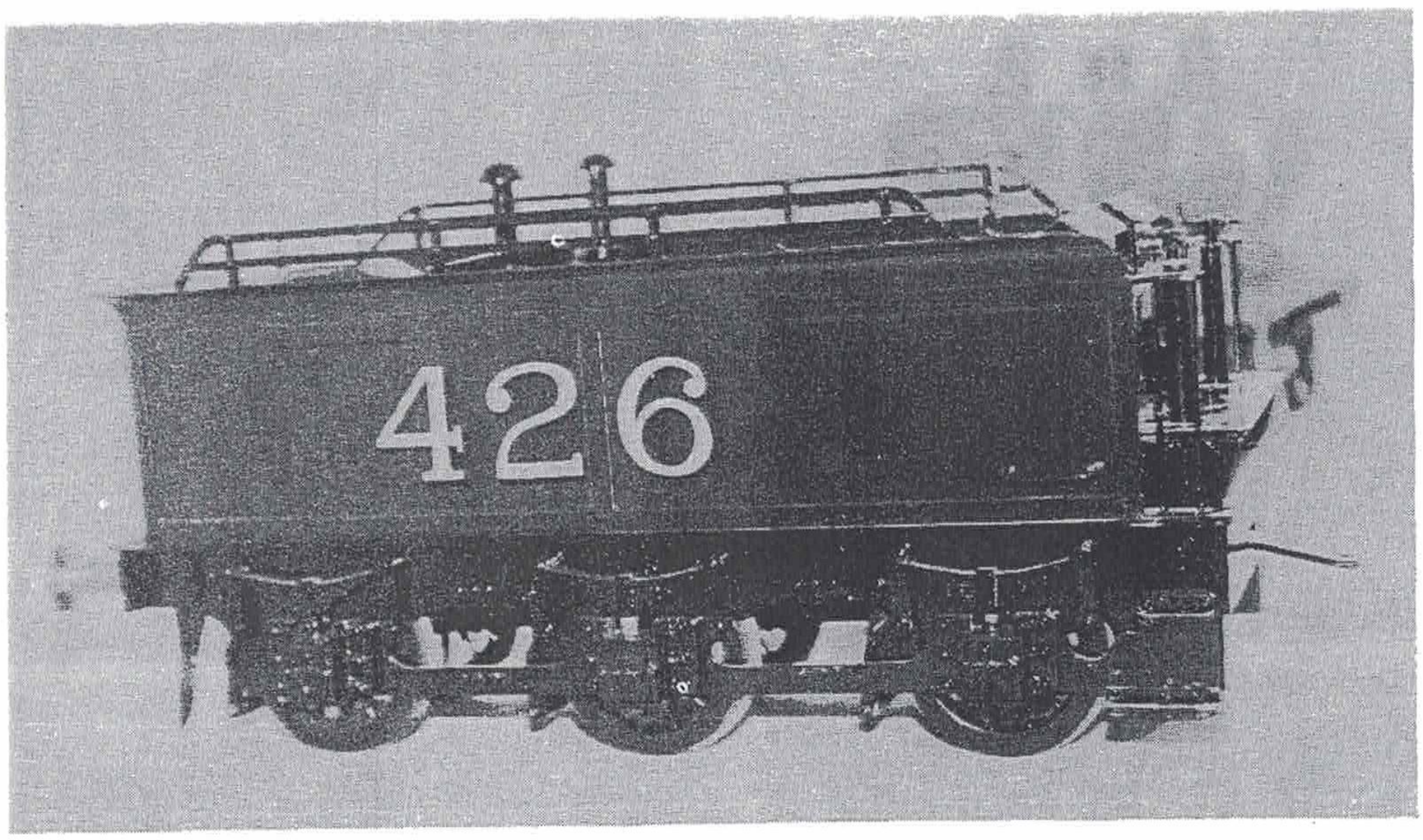
Neither side running board or valance is attached at the front end I would drill from the running board in two positions where there is the double thickness of buffer beam and attachment angle, tapping 8BA and securing with countersunk screws.

Splashers

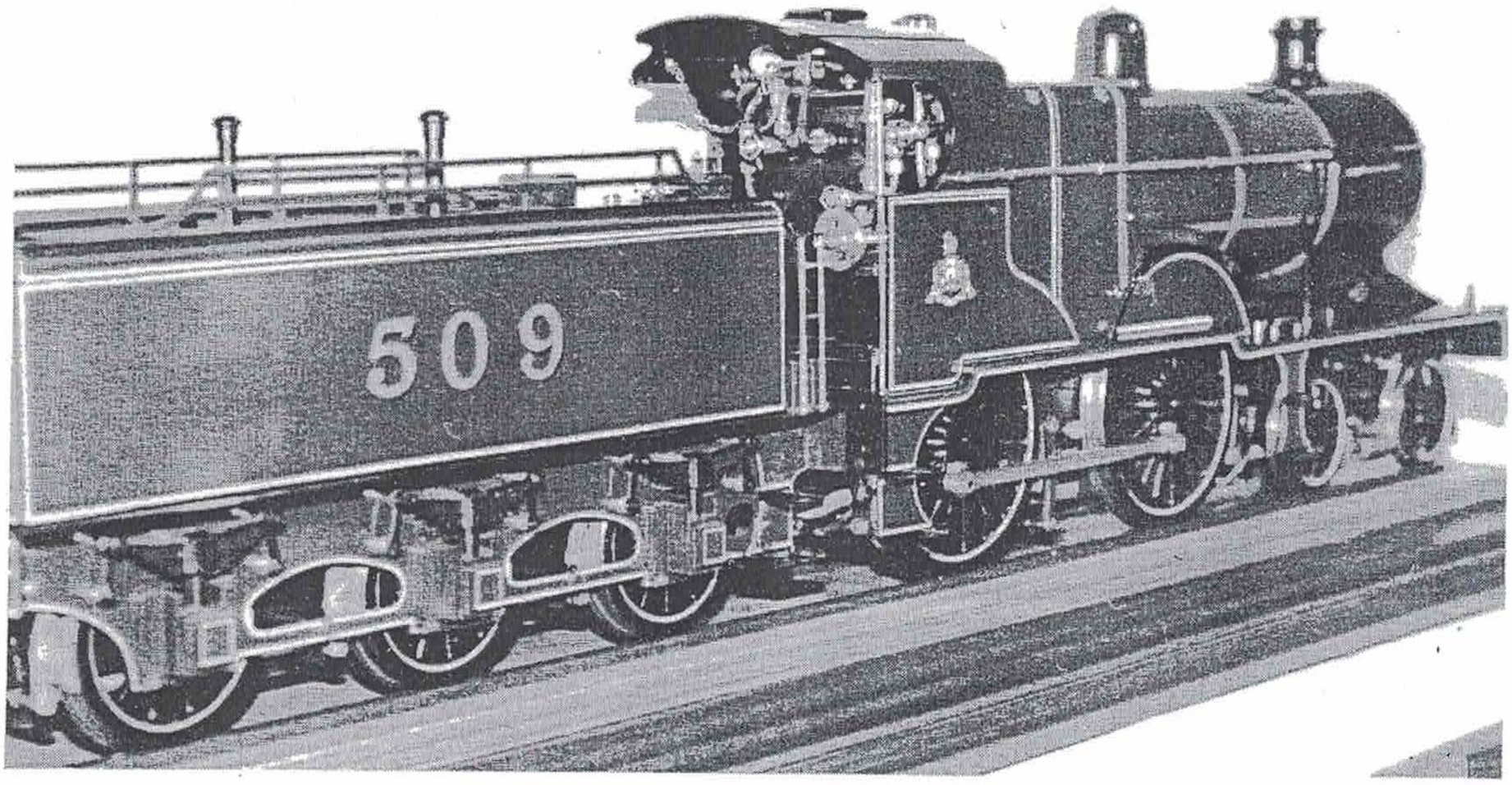
I am a great believer in using stiff card or plastic as templates ahead of cutting metal for the superstructure on locomotives; you can get things looking better that way. Years ago all duplicate books were provided with a stiff plastic backing sheet as well as carbon paper and this I found ideal for templates; pity like a lot more things it is no longer available. Mark off on your chosen template material, cut out and trim to place before transferring the front plate onto 1.6mm brass; saw out and file to line. The top of the splasher is a 6¾ in. length of ¾ in. x 1.2mm brass strip; if you do not possess bending rolls, then pull around a piece of 4 in. o.d. tube. Bend out the tabs at the ends to attach to the running boards. Dealing with the joint is not easy, for if short lengths of ¼ in. brass angle are used to rivet the top to the front, there is likely to be an interference when erected over the coupled wheels. I would grip in the bench vice; hold an end tab with pliers and use an electic soldering iron to apply the soft solder from the top down one side of the splasher, then deal with the other side likewise. Trim up the tabs, mark off and drill the No. 44 holes, then offer up to the running board, drill through and secure with 8BA screws and nuts, though of course the splasher top has also to be cut to match the boiler cleading.

Cab Side/Splasher

If a template was useful for the splasher, it is virtually essential for the cab side/splasher, a lovely area of metal which for marking out wants to be approximately 6½ in. square. Using a plastic template, it can be bent over at the top to match the spectacle plate, when you can mark off and cut your 1.6mm thick brass in the flat and bend the top to match the spectacle plate to place. Now we have several things to



This superb DERBY 2P tender, with trimmings, by Norman Lammas, has been awaiting publication for several years now; the engine in the background is now almost complete.



Steve Titley's 'brass engine' looks even better professionally painted. She now resides with the Wills family of whitemetal kit fame and has not been steamed since painting; I can understand why!

add, starting with a length of ¼ in. brass angle for fixing to the spectacle plate. Before rivetting to the cab side, offer up to the spectacle plate and relieve in way of the glass. A word about rivets and to join two pieces of brass together one would naturally assume the use of brass rivets. As I found out the hard way nearly 40 years back now, hard is the operative word, for a brass rivet will resist attempts to hammer it down into a countersink and likely leave you with a mess, including blemishes on the metal being joined. The answer is soft copper rivets, which it is a joy to use, and after hammering down into a countersunk you merely file flush for a neat job.
Next job is the splasher top and to be accurate it should be a continuation of the spectacle plate, complete with radius to match the cab side. This I felt was far too difficult for beginners, so cut a 3¼ in. length from 1 in. x 1.2mm brass strip and this time it can be fitted with short lengths of ¼ in. brass angle, after bending out the tab. The 1 in. width is nominal, so if you are not using commercial strip, check the measurement to the cleading and cut from plate to the correct width. The cab opening has a surround from ¼ in. x 1.6mm brass strip, so cut and bend to place. Drill the No. 30 hole at the bottom for the cab stanchion and continue upwards into the top, then clamp the strip firmly in place for soft soldering the joint. My way is to apply the electric soldering iron to the strip and as the surround heats, feed in cored solder, one that has its own flux. It is also a good plan to sweat on the stanchion, so cut a full 5½ in. length from ⅛ in. steel rod, drilling the running board to accept the bottom end. I have assumed the cab side has been bent in at the top; now rivet on the ⅜ in. x 1.6mm doubler strip. At the bottom there is a 2¼ in. length of ¼ in. brass angle to be rivetted on at the inside face for bolting down to the running board; clamp in place, and drill for 8BA screws at the spectacle plate and splasher end.

Cab Roof
Cut a piece a full 5½ in. x 5 in. from 1.6mm steel or brass plate and roll to a radius to match the spectacle plate and cab sides; trim off the excess. Mark off and shape the rear corners to drawing, then cut 3⅞ in. lengths from 3mm x 1mm section brass, or similar, and sweat to the sides of the cab roof to add the finishing touch.
I see I have omitted the step detail in way of the front sandbox, but these are the same 2½ in. high as the tender steps detailed on Sheet 6. The top and bottom portions are identical at 1⅜ in. wide and the back waists in to ⅞ in. at the back.

THE TENDER
Introduction
Before cutting any metal for the tender, go back to Sheet 1 and familiarise yourself with the assembly, as only the piece parts are shown on Sheet 6. This is a simplified version of a 3,500 gallon standard LMS tender, the fully detailed tender in this style, but for 5 in. gauge, having been described in LLAS Nos. 12 & 13 for E S COX. All this raises possibilities, as will the notes by Peter Niblett in "Builders Corner" describing making his 2P. Allied to POM-POM which begins a series in this issue, there is the thought of a 5 in. gauge 4F, but before imagination runs away with me we had better make the tender as detailed for the DERBY 2P.

Frames and Beams
My detail specifies material section as 2⅜ in. x 13 swg., though it is more likely that builders will more easily avail themselves of the 2.5mm thick steel flat; things have altered in the past 12 years! Deal with them as a pair exactly as for the mainframes and although in many ways the tender is not so precise, take the same care with them. The only new feature is the cut-outs between the axles, remnants from the days when the tender frames were baulks of timber with horn-plates bolted to them; why they survived so long is a mystery. Mark them off, drill, say, a ½ in. hole at each end and then saw away as much material as possible, of course inserting the saw blade through the ½ in. holes.
The front buffer beam is a 5⅞ in. finished length from 1¼ in. x 1¼ in. x ⅛ in. square root and corner steel angle which is bright finish, though black angle will do at a pinch, just as long as the faces are square to each other. First mark off the ¼ in. recess at the ends of the top face and mill or saw these to line, then mark off for the frame slots. If you fit two new blades in your hacksaw frame then the resulting slot will be slightly greater than the frame thickness, so use a couple of worn blades and then file to the frames as gauge with a key cutting file; deal with the pair of slots in this way.
Next job is to drill all the specified holes, including the ⅜ x 32T tapped one for the hand brake, then cut 1 in. lengths from the 1¼ in. angle, reducing one face to 1⅛ in. width and the other to 1 in. Fit an odd scrap of frame steel to a slot, bring up the angle just cut and clamp firmly in place to drill through the four 1/16 in. holes and fit soft iron snap head rivets, heads inside, hammering down into the countersinks; repeat for the other slot. File out the drawbar slot to size and it looks like I have omitted another detail, that of the drawbar bottom support; I will describe it fully.

Grip a 1 in. length of 1 in. x ¼ in. BMS bar in the machine vice, on the vertical slide, and mill the end square. Offer up to the underside of the top face of the buffer beam and drill through at No. 11 for the drawbar pin. Now offer up to the vertical face of the beam below the drawbar slot, spot through, drill No. 43 to ¼ in. depth and tap 6BA; secure with a pair of countersunk screws.

To make the component look better, the inner edge may be radiussed, in fact, looking back to Sheet 2 I now see the detail appears as being common with the rear engine buffer beam!

All this brings us neatly on to the tender rear buffer beam, a 5⅞ in. finished length from 1 in. x 1 in. x ⅛ in. steel angle; same proviso as for the front beam. End relief and slots are as for the front beam, the fixing angles being ¾ in. lengths of the 1 in. steel angle with one face reduced to ⅞ in. width. Drill and tap for the buffers, which already exist and can be fitted, when we can give attention to the rear coupling, which requires a 3/16 in. square hole in the beam.

Rear Coupling

Although by no means authentic, this coupling must be fitted at all times when passenger hauling to avoid a break-away. Chuck a length of 5/16 in. square steel bar truly in the 4 jaw, face and turn down over an ⅛ in. length to .142 in. diameter, screwing 4BA. Turn the next ½ in. length down to ¼ in. diameter, then file the four faces to 3/16 in. square to suit the rear buffer beam. At ⅜ in. from the end of the 3/16 in. squared length, cross drill No. 22, this for a 5/32 in. split pin, one which is just slightly splayed so it does not come out inadvertantly. Saw off to length, then saw down and file the slot to accept the drawbar, completing with a nice radius at the end.

Compression springs 5/16 in. o.d. x 18 swg., or very similar, are available from Reeves, so crop off to length and grind the end nice and square. Erect to the engine with a large 4BA washer and nut, in fact use a self-locking nut if you are able.

Axleboxes

The axleboxes are cast in sticks of three and first require machining to reduce the overall thickness to around 13/16 in.; I find it easiest to chuck in the 4 jaw to accomplish this. Transfer to the machine vice, on the vertical slide, to mill the side faces in turn to arrive at ⅞ in. width and keeping the cast cover nice and central. On completing the second face, change to a ⅜ in. end mill and mill a slot right along to ⅛ in. depth, widening to 7/16 in. to leave the specified ⅛ in. thick flange at the back; rotate the casting through 180 deg. and repeat. I should have said when dealing with the width of the casting that it wants to be a good fit in the frame slots, then it becomes its own jig. Saw into individual axleboxes and face them all to the same ⅞ in. length. Deal say with the top face first. getting the cover to drawing, then fit a centre to the headstock mandrel and tighten the first casting against same. Lock the carriage and face off to length, then at the same setting, deal with the other five boxes. On the back of one axlebox, find its centre by the 'X' method, centre pop and set to run true. Centre and drill 9/32 in. diameter to ⅝ in. point depth, then slacken two jaws only, replace by another box and tighten the same two jaws; repeat for the other five boxes. To complete the axleboxes as far as we can go for the moment, mark off and drill the oil hole at No. 51 down into the main bore.

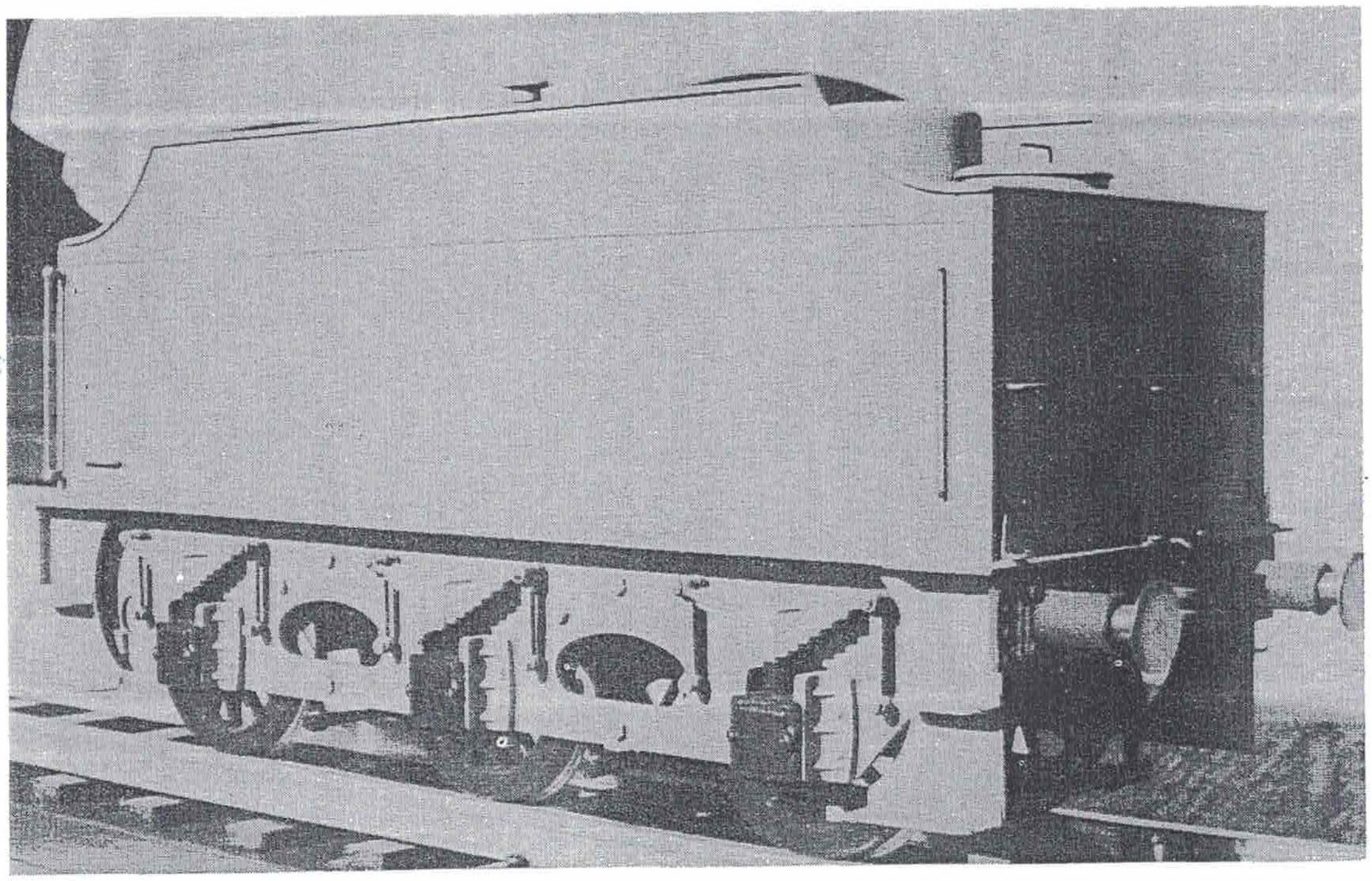
Erecting the Frames

Unlike the mainframes, the tender frames are straight along the top, so clamp to the buffer beams and lay on a flat surface; the lathe bed is ideal for this. Get the assembly to sit squarely on that flat surface, then if you do not have three 5¼ in. lengths of 9/32 in. silver steel rod by you, take the same lengths of 5/16 in. steel rod and turn down to a good fit in the axlebox journals. Offer axleboxes and dummy axles up to the frame slots, this is where the good fit is important, to check that the axles turn OK, then spot through from the frames into the fixing angles, drill them No. 34 and tap 4BA for hexagon head bolts.

To stiffen the assembly, cross ties are required below each of the frame cut-outs and I have assumed you have drilled all the holes in the frames before separating them. Chuck a length of 5/16 in. steel rod in the 3 jaw, face, centre and drill No. 34 to ¼ in. depth, tapping 4BA. Reverse in the chuck and face off to 4 7/16 in. overall, a nice fit between the frames, then centre, drill and tap this end also; erect to the frames.

Horns and Hornstays

The horns are also cast in threes, so grip in the machine vice to mill the working face and as with all castings, first establish the machining allowances. Bring the working surface under



This tender, by Peter Niblett, owes more to E S COX than DERBY 2P, it too having all the trimmings.

the vice jaw and deal with the bolting face, then turn again to first mill the working face to 17/32 in. width, and again to deal the bolting face to 7/16 in. width. Cut into individual horns and face them off to length, tidying with files and we are ready to fit same.
Looking back at Sheet 1, you will note that the horns come flush with the bottom edge of the frames, so fit an axlebox in the slot and clamp a pair of horns over same, clamping in turn to the frames. Now drill back from said frames at No. 42 for snap head iron rivets, dealing with them exactly as we did for the bogie, they being the same casting. We now have to ease the axleboxes with files to suit the horns, after which file the flanks with the dummy axles in place to get the independent rise and fall as for all the others so far fitted.

Wheels and Axles

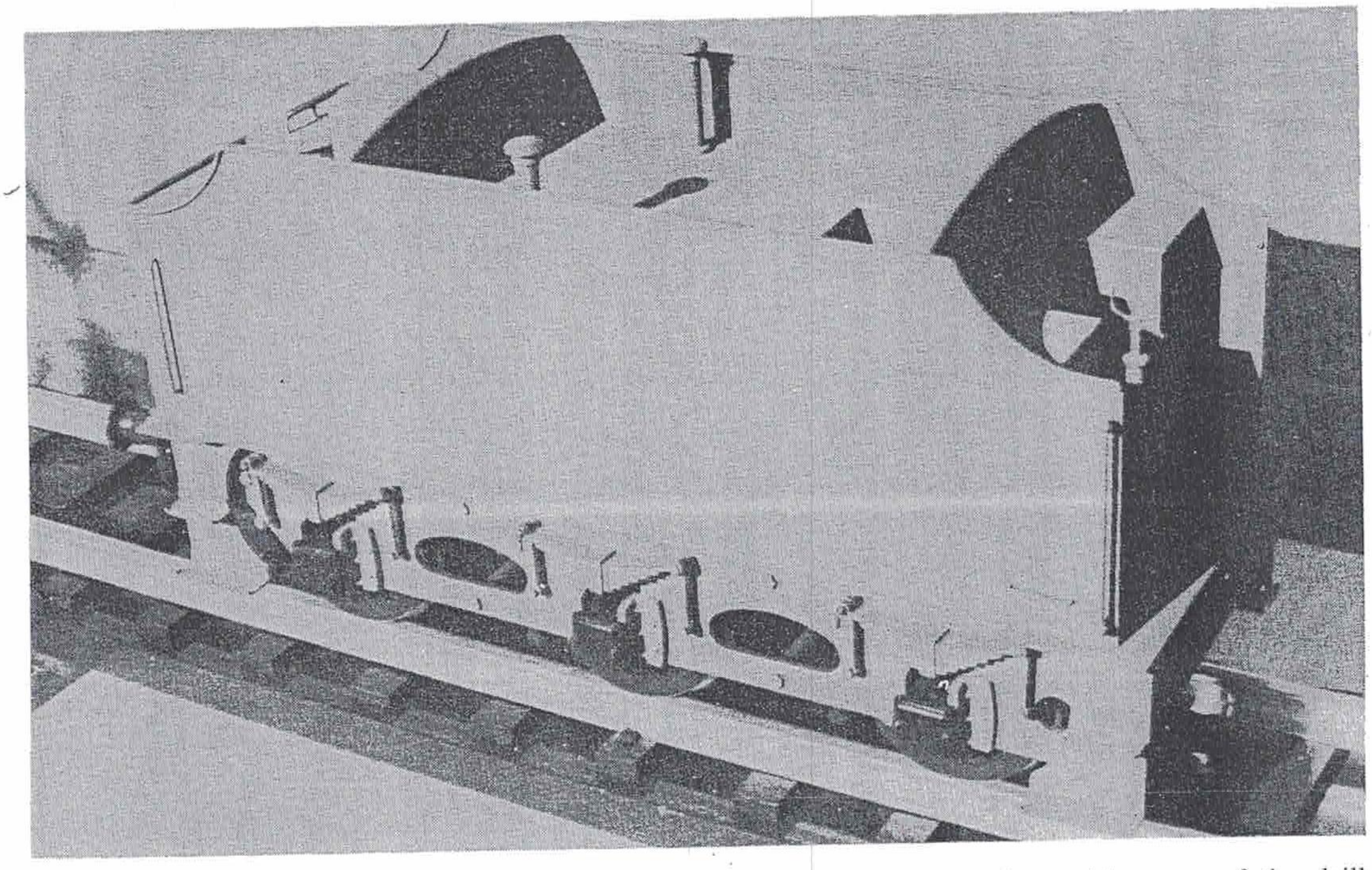
We know how to turn wheels, these six being a slightly larger version of the bogie wheels, so complete these as a first step. Chuck a length of 7/16 in. BMS rod for the axles, centre and turn down to .280 in. diameter over a ½ in. length to suit the axlebox; a fairly easy fit. We also know how to produce fits for either press or glueing the wheel to the axle, so do this over the next ½ in. length, then reverse in the chuck, face off to 5 9/32 in. overall, centre and repeat; fit the wheels and erect.

Springing

The neatness of the springing revolves around the lovely cast dummy springs that we will tackle as our next job. Clean them up with a file first, then cross drill the ends at No. 42; there are wee dimples in the casting for the drill to follow. The slots we deal with exactly as for the tender buffer beams, only this time we have about 3/16 in. to go. Transfer to the machine vice with the bottom of the casting towards the chuck and lightly face before centreing and drilling ¼ in. diameter to 3/8 in. depth; use a 9/32 in. 'D' bit to complete the spring pocket.
There is usually some water floating about around a tender and using steel spring plungers many years ago I learnt a lesson the hard way, the tender derailed!, so be warned and make said plungers from 9/32 in. brass rod; you will probably have to reduce fom 5/16 in. diameter as a first step. Face, centre and drill No. 12 to 7/16 in. depth before completing with a 3/16 in. 'D' bit, then part off at 9/16 in. overall, removing any burrs. Reeves do a standard tender axlebox spring that will be ideal for our application, so fit same as a next step.
We now have to anchor the spring, two of the components being easy and the other a bit tricky, so let us get the difficult part over first, namely the spring link. Take a length of 3/16 in. x 3/32 in. steel strip, mark off and drill No. 41 holes at 1 1/16 in. centres. Next chuck a length of 5/32 in. steel rod, face, centre and drill No. 42 to ½ in. depth, parting off two ⅛ in. slices. Caseharden these by heating to a bright red and dropping into a casehardening powder or the like; reheat and repeat. Assemble each side of one end of the embryo spring link, using a stub of 3/32 in. rod, then file down to the hardened surfaces to get a neat end; repeat at the other end. The centre portion you can only reduce by careful filing, the job is too small to attempt milling, after which I recommend you caseharden the completed link and use as a master to produce the other five of them; it makes an ideal drilling and filing jig.
The rest is easy, the pin being from 3/32 in. steel rod. Chuck in the 3 jaw, face and screw 7BA for ⅛ in. at one end, then part off at 17/32 in., reverse in the chuck and screw this end. The spacer is even easier; chuck the 3/16 in. steel rod, face, centre and drill No. 41 to about 1 in. depth, parting off 7/64 in. slices and deepening the hole as you proceed. If your parting off tool leaves a nasty face, then rechuck and lightly face.
Assemble the link to the dummy spring end with a 3/32 in. snap head brass rivet, peening over the end to keep it in place. At the bottom end, fit a 7BA brass nut to the spring pin, push through the frames from the inside, feed on the spacer and then the spring link, followed by another 7BA nut; we are winning.

Brake Gear

There is a brake gear arrangement on Sheet 6 which I trust builders will find useful; let us make a start with the brake hangers. Material is ¼ in. x ⅛ in. BMS bar; first mark off and drill the 3 holes to drawing. We already know how to make and use filing buttons from the spring links, so make up a pair ¼ in. o. d. and 1/18 in. thick and use to deal with the end bosses. At the brake shoe, No. 41, hole the width is also ¼ in., so file from the end bosses to arrive at the finished profile.
The brake hanger pins are simple turning, so chuck a length of ¼ in. steel rod in the 3 jaw, face and turn down to ⅛ in. diameter over a 7/32 in. length, screwing 5BA before parting off at ¾ in. overall, Reverse in the chuck and again reduce to ⅛ in. diameter, this time over a ¼ in. length and screwing the outer ⅛ in. only at 5BA.
The brake beams again are simple turning, so chuck a length of 5/32 in. steel rod in the 3 jaw, face and turn down to ⅛ in. diameter over a ¼ in. length. Part off at 4⅛ in. overall, reverse in the chuck and turn on a second spigot. Slip a brake hanger over the end of a beam, add a 5BA plain washer and then cross drill No. 57 for a 3/64 in. split pin. The beams have to be fitted with collars, we shall see where they fit later on, but for the moment chuck a length of ¼ in. steel rod in the 3 jaw, face, centre and drill No. 23 to about 1 in. depth, parting off ⅛ in. slices and deepening the hole until you have nine spacers.
Brake shoes next and although I specify cast iron as material on the drawing, nowadays I substitute ½ in. x ¼ in. section BMS bar, The length of shoe is 7/8 in., so cut off and square each shoe to length, then scallop the working face with files to suit the wheels. Next mark off and cross drill No. 43 for the brake shoe pin, then saw and file the slot to accept the brake hanger. A word of caution here, for although the shoe must follow the wheel as it rises and falls in the horns, it must not be able to 'trip', otherwise with brakes fully released, the end of the shoe can dig into the wheel tread and slow your progress, likely stop you! So deepen the slot only sufficiently that the shoe can tilt and follow the wheel; do this to place, then press a ¼ in. length of 3/32 in. steel rod as brake shoe pin through shoe and hanger.
Brake pull rods next and although these are of a specified length, this has to be checked to place, so erect the brake hangers and beams to the brake hangers and beams to the brake hanger pins and press the brake shoes hard against the wheels, measuring the distance between the brake beams; make the pull rods to this measured length. The section is ¼ in. x 3/32 in., so treat like an elongated spring hanger, in fact the filing buttons exist from the brake hangers just made. The leading rod is of identical form and this time can be made to drawing length; you need a pair of them.
Before we can erect the brake gear we need the brake shaft and its bearings, so face off a piece of ¼ in. steel rod to 4½ in. overall. There is only a single arm of each type to make, so mark them off on a piece of 3/8 in. x ⅛ in. BMS flat and drill the shaft end at either 7.9mm or 5/16 in. The other end is drilled No. 30 and for the longer arm elongated by 1/16 in. into a slot. As there is only a pair of arms to be dealt with, I doubt if you will have to resort to filing buttons, just file to the best of your ability; it should have improved by this stage in the proceedings. If your shaft holes are ¼ in. diameter, lightly squeeze before assembly to the shaft so they remain in position for brazing, and the arms are 90 deg. to each other, though a wee error here is of no consequence. Braze up and clean, then as with all brake gear parts, I recommend giving them an undercoat only of black paint, then they will look fairly authentic and without rusting.



A tantalising peep into the coal space of Peter Niblett's tender; note particularly the air vents and neat locker.

For the end bearings, chuck a length of 7/16 in. A/F hexagon brass bar in the 3 jaw, face and turn down to 3/8 in. diameter over a 5/32 in. length, screwing 32T. Next centre and drill 1/4 in. diameter to 3/16 in. depth before parting off to leave an 1/8 in. thick head; rechuck and lightly chamfer with a file.

Let us assemble the brake gear, starting at the front end where we first hold the brake shaft in place and screw the end bearings through the 3/8 x 32T tapped holes in the frames. At each side of the brake arm in the centre of the shaft, fit the leading pull rods, the No. 30 ends, holding in place with an 1/8 in. snap head brass rivet that you now cross drill for a 3/64 in. split pin. At the leading brake beam, fit a collar between the pair of leading pull rods, simply pressing into position and using a length of tube as your tool. Fit an intermediate pull rod outside of each of the leading pull rods and follow up with a collar at each side to hold them in position. At the intermediate brake beam, fit the rear pull rod on the centre line, followed by a collar each side, then the intermediate pull rods, completed by another pair of collars. All that is needed at the rear beam is a pair of collars to hold the rear pull rod in place on the centre line. The only problem now is that to erect and dismantle the brake gear, the frames have to be released to allow the brake hangers to come free from their pins and although there are ways around this the brake gear will probably last as long as the tender itself.

Hand Brake

We have erected the brake gear, all we have to do now is provide the means of operation through the hand brake. The column starts life as a length of 1/2 in. A/F hexagon brass bar, so chuck in the 3 jaw, face and turn down to 5/16 in. diameter over a 1/4 in. length, screwing 32T to suit the front buffer beam. Centre and drill No. 30 as far as you are able, then part off at a full 3 3/4 in. overall. Chuck a 5/16 x 32T screwed adaptor and screw the embryo column to same, then centre and bring the tailstock into play at the other end before lightly facing off and turning the profile to drawing; again the shape is not too critical, it just has to look pretty. To complete, drill No. 30 to meet the hole already made from the bottom, trying a length of 1/8 in. stainless steel rod as a check that it is reasonably straight. If you are unlucky, then all you do to retrieve the situation is braze a length of 3/32 in. steel rod to your No. 30 drill and poke it in from both ends until you have a clear path. You simply poke the drill into a large potato and braze the rod to it, said potato ensuring that neither you of the drill loses its temper!

Our brake spindle is 5 1/2 in. long, so chuck in the 3 jaw and screw 5BA over a 7/8 in. length. The collar at the top is from 5/16 in. brass rod, so chuck in the 3 jaw, face, centre and drill No. 31 to 1/4 in. depth. Start parting off an 1/8 in. collar, but before parting right off, radius the collar as shown on the drawing detail. Press the collar onto the spindle to give the 1 1/8 in. dimension at the bottom. For the handle boss, chuck a length of 3/16 in. steel rod in the 3 jaw, face, centre and drill No. 31 to 5/16 in. depth, parting off a 3/16 in. slice and pressing onto the top of the spindle. Cross drill No. 56 at a full 1/16 in. from the top and bend up the handle from 18 swg. wire, stainless steel for preference. Braze both handle and collar to the spindle, then rechuck to clean up the collar. At the bottom end we require a slightly different collar, so chuck the 1/4 in. rod again, face, centre and drill No. 31 to 1/4 in. depth before parting off an 1/8 in. slice. Erect the spindle to the column, press on the lower collar and cross drill No. 60 for a 1mm spring dowel pin.

Brake Nut

I must be slipping, for I cannot find a brake nut detail, though its description without a detail will cause me no bother. Chuck a length of 1/4 in. square steel bar truly in the 4 jaw, face, centre and drill No. 40 to 1 in. depth, tapping 5BA. At 1 1/4 in. from the end, cross drill No. 31, then part off at a full 1 3/8 in. overall. Make a slot to 3/8 in. depth and 1/8 in. width to accept the longer brake arm, then radius the end to complete. Use a 1/4 in. length of 1/8 in. steel rod pressed through nut and brake arm to assemble, then fit the hand brake from the top, remembering that we still have to deal with the tender soleplate, and engage the brake spindle with its nut; now you can check operation of the brake.

Steps

Here I have been ranting and raving at myself for the lack of engine steps and all the time they are on Sheet 5 and have already been described!, thus I only have to describe those for the tender, and they just about match those at the rear of the engine. Cut out the backs to drawing and fit the actual steps as per the engine, then offer up to the respective buffer beams. I have shown wee lengths of 1/4 in. brass angle to attach both the vertical and top faces of said angle, using a couple of 8BA screws in each piece; I think I can safely leave

this to builders, though you may wish to delay fitting the steps until the tender body is made and fitted; it may save an unsightly gap.

Tender Body

This being a 3½ in. gauge engine, the feasibility of using steel sheets and then fibreglassing is marginal and one should think in terms of 1.6mm brass sheet, with maybe 1.2mm for the sides. Start with the soleplate, which is a piece 16⅝ in. x 6⅜ in.; it only requires the addition of a few holes, and thereby hangs a tale. Look at that vast acreage of plate in your hand; surely I could have located the fittings clear of any obstructions — could I heck! With all that space to choose from I managed to get the injector and feed pump suctions mixed up with the intermediate wheels, this for the 4F in 1974 and repeat my mistake a year later with the 2P. This was a period when I had no feedback from builders, they must have thought I had disappeared off the face of the earth, but now it is different and such stupid errors are corrected. Having said this, I still recommend you sit the soleplate on the tender chassis at this stage and check the position of the fittings; you may well find a better spot than I have. When satisfied, chuck an odd end of ¾ in. diameter brass bar in the 3 jaw, face, centre and drill No. 44 to ½ in. depth before parting off two ⅛ in. slices. Hold them in your chosen positions, drill through and tap 6BA for a screw to hold them in place temporarily for soft soldering. Leave the other holes in the soleplate for a while, as we shall be swilling soft solder about to caulk all the joints later on.

Tender sides come next, size being 15 13/16 in. x 4⅞ in.; mark off on one piece and deal with them as a pair. Before we go any further, let us get the coal and water spaces clear in our minds, then we won't have a disaster with expensive brass sheet!

Once locomotive design became established, so did the horseshoe shaped tender, with water at the sides and back, coal filling the space left in the middle. Examples of this tender lasted well into the Grouping, nay even into BR days, being an LNWR Standard, for instance see Frank Pearce's fine article on his 19 in. Goods in LLAS No. 20; this type of tender was also an American classic. Later on as efficiency improved and engines boiled more water for each pound of coal, especially after superheating occurred, the coal space diminished and indeed water was frequently stored under said coal space, as it should be on the DERBY 2P under the wooden floor I have drawn, but this has been omitted to help beginners tackling this lovely engine. The horseshoe part though is still retained by the wing tanks each side of the coal space. The other alteration in more modern tenders is an upward extension of the tender sides, allowing coal to be stored on the tank top, it is all a question of evolution.

Back to business, where the backplate is 5½ in. x 3⅝ in. if 1.6mm material is used, slightly wider if 1.2mm is your chosen material. We can now start assembly on the soleplate which is like a base or building board, so as I should have said at the outset, it wants to be flat. The method of joining the various pieces is by lengths of ¼ in. x ¼ in. x 1/16 in. brass angle, of which you will have need of at least 10 feet. Start by rivetting a length along the bottom of each tender side plate, but don't extend beyond the water space, using 1/16 in. snap head soft copper rivets with heads inside and hammering down into coutersinks on the outside face of the side plate; the pitch wants to be between ¾ & 1 in. Do the same to the base of the back plate, then deal with the rear vertical face of the tender sides, again using rivets and leaving about a ⅜ in. gap top and bottom. Assemble the sides and back on the soleplate, using the ½ in. dimension from the front of the soleplate and the ⅜ in. one from the sides to get the position right, then mark off and start drilling No. 44 holes in the soleplate to come within the pieces of brass angle, countersinking for 8BA screw. Bring the sides and back up again, spot through, drill the angle No. 50 and tap 8BA, then assemble. Next deal with the back plate similarly, attaching it by screws to the two side sheets. For the front water bulkhead, cut a piece 3⅝ in. high to fit between the side sheets, then cut out centrally as shown to be 2¼ in. wide and leaving 1¼ in. of metal at the bottom; locate this 1 in. back from the front of the side sheets. To form the wings of the tank, cut pieces 4¾ in. x 3 9/16 in. then a piece 2⅜ in. x 3 9/16 in. to fill in as a water bulkhead at the back of the coal space.

The aft, coal, bulkhead comes next, being 2 in. deep at its centre and sweeping down each side at a big radius to align with the top of the side sheets; rivet lengths of ¼ in. brass angle to both sides and the bottom as shown. To locate the rear bulkhead, cut a piece 5½ in. x 4⅜ in. as the removeable section of tank top, rivetting further lengths of ¼ in. brass angle to the back and side sheets to support same, in fact this is all the support this piece should need.

If the plume of white escaping steam does not tell the story, then Steve Titley's attire describes the weather as 'cool' at the Southampton track; I can remember when the breeze off the river was decidedly parky!

Let us deal with the filler and tube at this stage to tie up another loose end, so first square off a ½ in. length of 1½ in. o. d. x 18 swg. copper tube and cut a hole in the tank top to accept same; soft solder in place. I can supply a gunmetal casting for the tank lid and if it has some weight then there is less chance of it being lost at the track. Chuck the casting and clean up the chucking spigot, then rechuck by the latter. Reduce to 1⅝ in. diameter over the whole length, then further reduce to an easy fit in the filler tube over a length between ⅛ and 3/16 in.; part off to leave a full 3/32 in. thick flange. To complete the lid, bend up an 18 swg. wire handle, drill the lid to accept same and either braze or soft solder in place.

The fixed portion of tank top is roughly 10⅜ in. long and 5½ in. wide, with a portion removed at the centre towards the front to reveal with coal space. Again use lengths of the ¼ in. brass angle attached to all the upper edges of the mating components, fixing the tank top to the angle with 8BA countersunk screws. Although not strictly a part of the water space, before sealing same we had better make and fit the forward coal bulkhead, which starts as a piece 5½ in. x 2 11/16 in.; cut away at the sides to match the wing tanks and again secure with lengths of ¼ in. brass angle, this time hidden inside the coal space.

Put a goodly amount of Bakers fluid in the tank, plus some tinsmiths solder and begin heating up very gently with your blowlamp; too much heat and the plates will distort. When the solder starts running freely, simply swill it around inside the tank to caulk all the joints. Wash out with warm soapy water, then rinse before filling again and checking for leaks; small ones you can ignore as my specification is to paint the inside of the tank a gloss white, this so that you can see any 'foreign bodies' and of course the paint also acts as a sealant.

Although there is still some work to be done, we should now try erecting our tender body to its chassis, to check among other things that it still sits flat, otherwise you will have to gently persuade it to shape. But four 6BA screws are necessary, tapping the front and rear buffer beams to suit; the front pair can be clear of the water space, but the rear pair have to be inside the tank, so liquid jointing should be applied; we can now fit out the tender.

Fitting out the Tender

I forgot to mention when making the front water bulkhead that a piece needed bending forward to form the coal plate. If like me you have forgotton to do this, simply screw on a 2¼ in. length of the ¼ in. brass angle. Inside, the coal space has to be planked up to the level of the coal plate, for you will never be able to shovel coal out of such a recess. If you are able to obtain 1 in. x ¼ in. wood, then lay a couple of longitudinals on edge along the coal space and nail the top planks crosswise to them.

Moving inside the tank, we first have to drill through the doublers and soleplate at 11/32 in. diameter and tap ⅜ x 32T for the filter fittings, then another pair of ¼ in. holes through the soleplate only for the byepass and hand pump fittings. Talking of the handpump, locate this inside the tank roughly in the position shown below the filler tube and check with the extension handle that you can operate the pump at full stroke, then drill from the pump through the soleplate and secure with 6BA bolts and nuts; brass ones with liquid jointing compound on the threads.

Filter fitting next, so chuck a length of 7/16 in. brass rod in the 3 jaw, face and turn down to ¼ in. diameter over a ¼ in. length. Turn the next ¼ in. length down to ⅜ in. diameter and screw 32T, centre and drill No. 30 to 1 in. depth and 'D' bit before parting off at 1⅛ in. overall. At 3/16 in. from the bottom of the fitting, drill No. 22 into the bore and solder in a short length of 5/32 in. o. d. thin wall copper tube; you can orientate this tube towards to engine by screwing the body into the soleplate before drilling. For the filter fingers, take a piece of 100 mesh bronze gauze, sizes about 1¾ in. x 13/16 in., wrap it round a pencil and seal the seam with an electric soldering iron, checking it is a good fit over the spigot on the fitting. Pinch the top together with pliers, you can trim it up if you like to look neat, then soft solder this seam as well; screw into the soleplate.

The byepass and hand pump fittings are similar, so chuck the 7/16 in. brass rod again and turn down over a ⅜ in length to ¼ in. diameter, screwing 40T. Centre deeply to form the pipe nipple seat, then drill No. 30 to a full ⅞ in. depth and 'D' bit. For the outlet union, chuck a length of ¼ in. brass rod, face and screw 40T over a 7/32 in. length. Centre deeply and drill No. 30 to ⅝ in. depth before starting to part off at 5/16 in. from the outer end, only stop after you have reduced to around 3/16 in. diameter, move on another ⅛ in. and part right off. Mark the spigot and drill the body to suit, then assemble and silver solder.

Pipework

The pipework inside the tender is self-explanatory, so let me concentrate on the connections to the engine. From the filters to the relevant connections on the engine run lengths of 5/32 in. bore rubber tube for preference; if you have to use the plastic alternative then clip it at both ends to prevent air ingress; you must also clip the pipes clear of the moving axles. The pump byepass too can be plain rubber tube, in which case substitute a plain copper pipe connection at the base of the tender body in lieu of the screwed one.

I seem to have missed out description of the plates supporting the pipe connections below the engine drag beam, but the job is self-explanatory, save for the hand pump connection, which can be a ¼ x 26T union nut, with nipple of course. This union nut will then connect to a bicycle pump connector, the male end of same. At the other end of the connector, chuck a length of ¼ in. brass rod, face and screw 26T over a ¼ in. length. Centre and drill No. 22 to ⅝ in. depth and part off a ½ in. slice; braze this to the end of a length of 5/32 in. thin wall copper tube, then check its length to place and add a ¼ x 40T union nut and pipe nipple at the other end attached to the hand pump delivery fitting.

Tender Edging Strip

I have deliberately left this item until last as being very much an optional extra, in fact the tender will look perfectly OK without same. If you are going to fit the 3/16 in. x 1.6mm brass strip all around the tender top edges then carefully fit it to place in the first instance, then tin the underside of same with your electric soldering iron, also all along the edges where it is to be fitted. Now all you do is bring the surfaces into close contact, by use of the electric soldering iron, moving it along as the solder melts, in fact it can be a quick movement as you want the solder to set almost immediately the soldering iron passes.

Painting & Lining

I am about the last person to speak on this subject, in fact Geoff Swift of Ashdown Models should be writing this: there is a hint Geoff!

Strip the engine and tender down to its components/ assemblies and degrease; I always have used turps substitute. Gloss paint will go straight onto steel components and for BR days the inside of the frames are red and the outside black. The same applies to both bogie and tender frames, wheels in all cases being black. The smokebox must be painted with something that is heat resistant and the perfect material I have found to be car exhaust paint. All brass items need careful preparation to aviod the paint chipping off, Ashdown Models will be able to supply a suitable primer, though I have used zinc plate from an aerosol can to provide the key. Lining sheets are available from Ashdown Models in BR colours, as are the emblems — alternatively read Reeves.