78000, A.B.R. Class 2 'Mogul' for 5 in. gauge

by: **DON YOUNG**

FFESTINIOG STEAM 125 1863-1988

Part 1 — Introduction

Railwaymen in the UK still argue today as to the merits of the British Railways "Standard" Classes of steam locomotive as introduced by Riddles in the early 1950's, including the basic question as to whether they were really necessary? My own opinion for what it is worth, and I will elaborate in a moment, is that most of them fulfilled an important need, that they were cut off in their prime, and that they should have been allowed to continue until main line electrification had been fully programmed, thus by-passing the 'diesel era' completely, save for secondary routes.

There is no doubt that the 2-10-0's of Class 9 transformed freight haulage, and if allowed, could have taken care of all but the fastest passenger expresses. In truth though, very similar engines had proved themselves in Europe for all of 30 years, so the Class 9 in reality was a catching-up exercise.

The 'Pacifics' of Classes 6, 7 and 8 were a mixed bag and all were capable of further development. DUKE OF GLOUCESTER, the sole example of Class 8, could I reckon with advantage, have incorporated more features from the successful Peppercorn A1's. By the time of her introduction, the LNER/ER had almost 25 years experience of trying to roster a lone engine, the rebuilt No. 10,000, none of it good.

The Class 7 'Britannias' undoubtably made a name for themselves, though only in East Anglia was their introduction essential. I experienced them on the Liverpool Street service, where they were a definate improvement on anything previous. In East Anglia of course they took over from 4-6-0's of Classes B1 and B17, but in other regions they were matched against GWR 'Castles' and SR 'West Countries', engines of at least equal potential that were available in number and had already established a reputation.

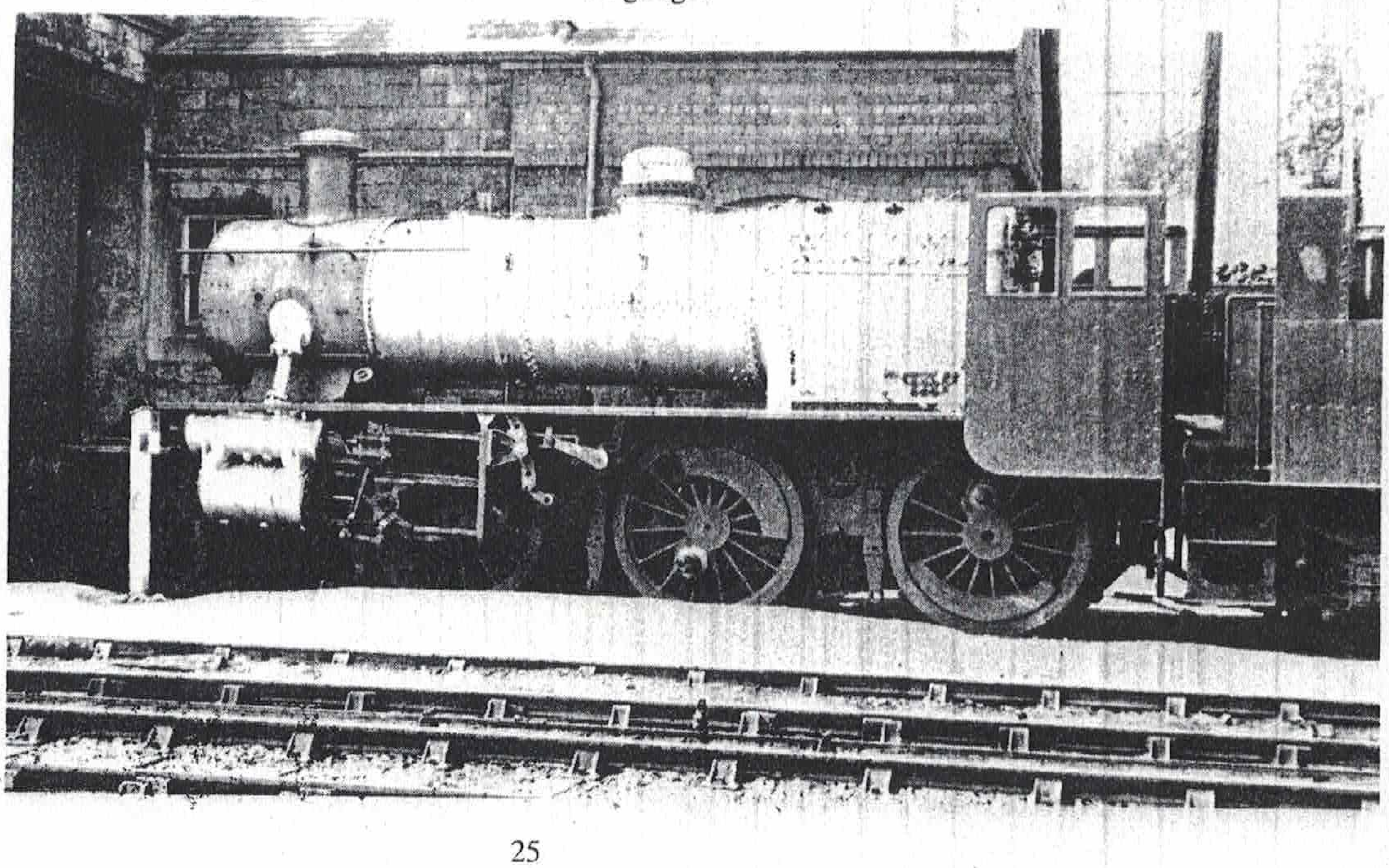
What need was there in the 1950's for a lightweight 'Pacific', one that was under-powered? The Class 6 engines could with advantage have been built as a 2-6-2, or even a 2-8-2, when a very useful power unit would have resulted, plus there would not have been direct comparison with the 'Britannias'. This also leads to the thought of a 2-8-2 passenger version of the Class 9 with larger coupled wheels, similar to the design which Riddles discarded in favour of the 2-10-0 wheel arrangement. There was much work awaiting a decent Class 6 engine in the 1950's, from passenger work on the Highland, fish trains and other fast freight.

The Class 5 evolved of course from the famous Stanier 'Black Fives', so their success was guaranteed, though being designed at Doncaster, there was a little of the B1 class 4-6-0's incorporated, like the 6 ft. 2 in. coupled wheels. Though the Class 5's were widely distributed, only the SR 'King Arthur's' were of sufficient age for their replacement to be considered, and this only happened gradually.

Class 4 was designed and manufactured in three distinct varieties, the first a 2-6-4T that was almost pure LMS and had evolved first through Fowler, then Stanier and then Fairburn into a most useful power unit. The 4-6-0 version was a brand new engine and an immediate success, taking over duties from the older 4-4-0's. It was not, however, a suitable substitute for 4-6-0's of Class 5, like the 'Manors' which were temporarily displaced on the Cambrian, this never being the intention of such a design. I was involved with the 'Mogul' version, developed from the Ivatt 2-6-0 of the end of the LMS era, the BR design being much the prettier. All three versions of Class 4 were a godsend on the Southern Region, where they displaced among others the ageing Drummond T9's.

The Class 3 was available as either a 2-6-0 tender engine or 2-6-2 tank; I only had experience of the latter, particularly 82014 at Eastleigh. I rated this engine very highly, as did her regular crews.

Class 2 was also built as either a 'Mogul' tender engine or 2-6-2T, both being developed from the earlier Ivatt engines on the LMS. Some of the tank engines were destined for the Isle of Wight in the early 1960's and only a last minute decision deprived us of modern motive power. Once the draughting had been sorted out, the tender engines could perform far above their modest proportions, and this is what captivated me into designing 78000, the first of the class, in 5 in. gauge.



I spent a day at Bridgnorth photographing a GWR 15xx 0-6-0 Pannier Tank then in pieces. Luckily my camera wandered to take in this LMS Ivatt Class 2 'Mogul' being restored

Now apart from her size, in other ways 78000 is unique among all of the Standard classes, for instance being the only example where running boards are attached to he mainframes; the boiler supports all the rest. Both the inclined cylinders and chimney shape show the personal touch of E. S. Cox, my hero then as now, and both of us 'Mogul' fans, witness the Horwich 'Crab'. I did, however, manage to besmirch the honour of my hero with just a single dimensional error on 78000 back in 1972, one that seems to have multiplied problems in builders minds over the years; this series will settle things once and for all I trust. I have never been one to duck my responsibilities, and having recently written in the Southern Federation Newsletter on the subject, I now feel the place to air 78000 is LLAS, where hopefully she will gain a lot more fans, though she has been very popular since introduction. At least now I can add a few more castings to the basic set as the series progresses, for 78000 was my first attempt as a castings supplier, thanks entirely to the patternmaking skills of Norman Lowe. Let us now look at the 5 in. gauge engine in more detail.

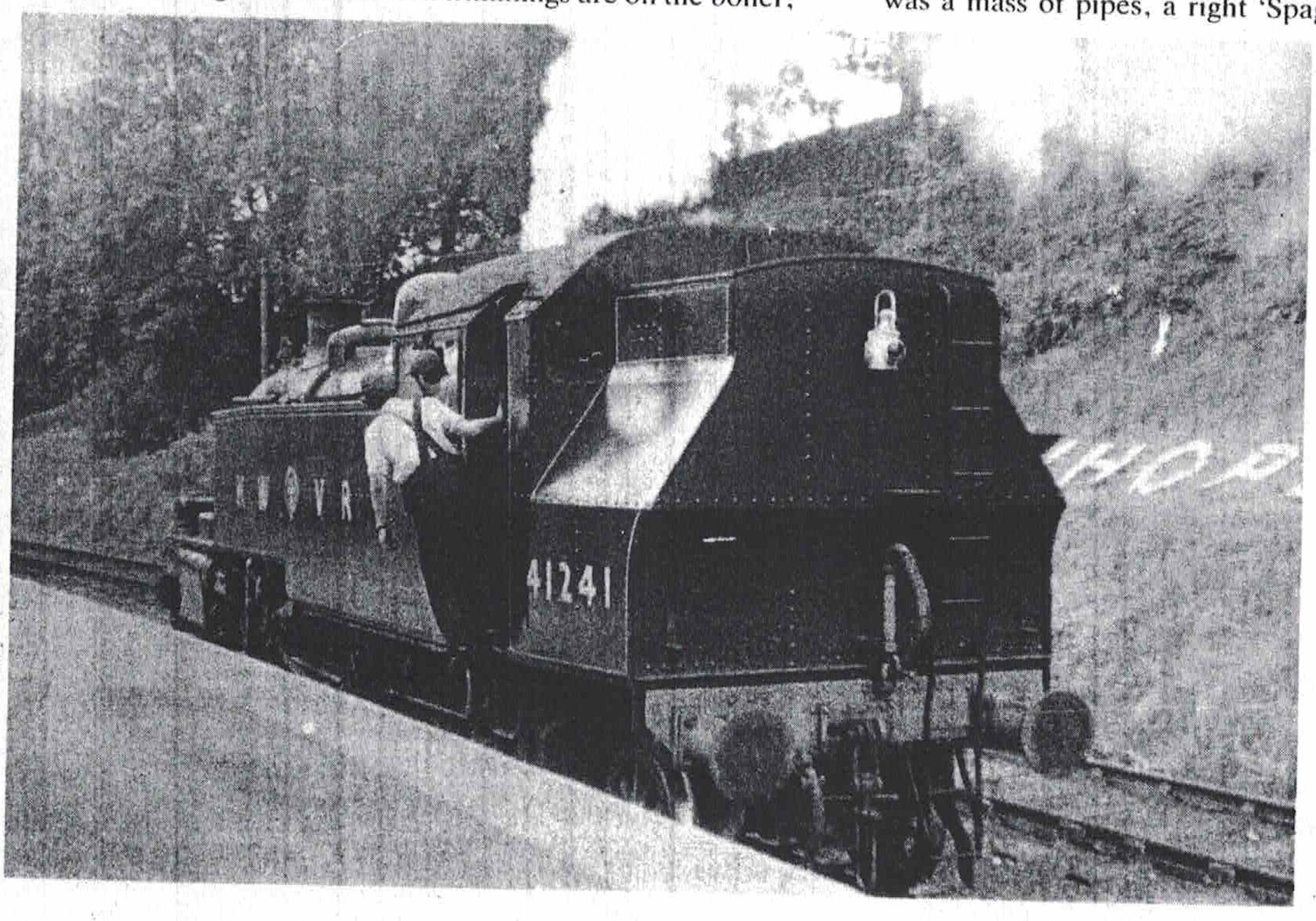
The mainframes are 30⁵⁄₁₆ in. overall, a massive 4⅝ in. deep and ⅛ in. or 3mm thick, a good start to any engine. From my work on the Class 4 'Mogul' full size, I was very much aware of the use of fabrications for frame stretchers, drag box and the like, so this too is a feature of 78000. The coupled wheels are 5¼ in. diameter with correct 'V' rim as are the 3³⁄₁₆ in. diameter pony truck wheels. Although my K1/1, also a 'Mogul', predates 78000 by all of eight years, this is the first time I have specified piston valve cylinders using cast cylinder blocks, ones which have led on through BLACK FIVE and E. S. COX to DONCASTER, and I am talking here of their introduction back in 1972. The cylinders are the same 1⁷⁄₁₆ in. bore that my FISHBOURNE was bored to, but with a 2⅛ in. stroke, which reflects the modest proportions of the whole engine.

The boiler is the heart of any engine and 78000 is no exception. The barrel is 4½ in. diameter at the smokebox end, increasing to 5 in. at the throatplate. The firebox is extremely deep, measuring 6⅜ in. x 4 in. on the outside, the grate being a sloping one. Even with the great depth of firebox, the ashpan is still spectacular and will permit many hours of running. All the modern trimmings are on the boiler, like 'pop' safety valves and top feed check valves, and the smokebox contains the very necessary Ell draughting. 78000 uses my prototype sliding regulator valve, one that proved so successful that it now graces nine of my other designs; it is of course operated by the external regulator rod that is a feature of all the Standards. The early BR tenders were of a unique construction and for the smaller engines which often ran tender first, were equipped with tender cabs for the purpose, though ours will get in the way on the track and will have to be made removeable for running.

What is perhaps most impressive about 78000 is its modest 'dry' engine weight of only 95 lb., so it is an engine that can be contemplated by our more senior builders.

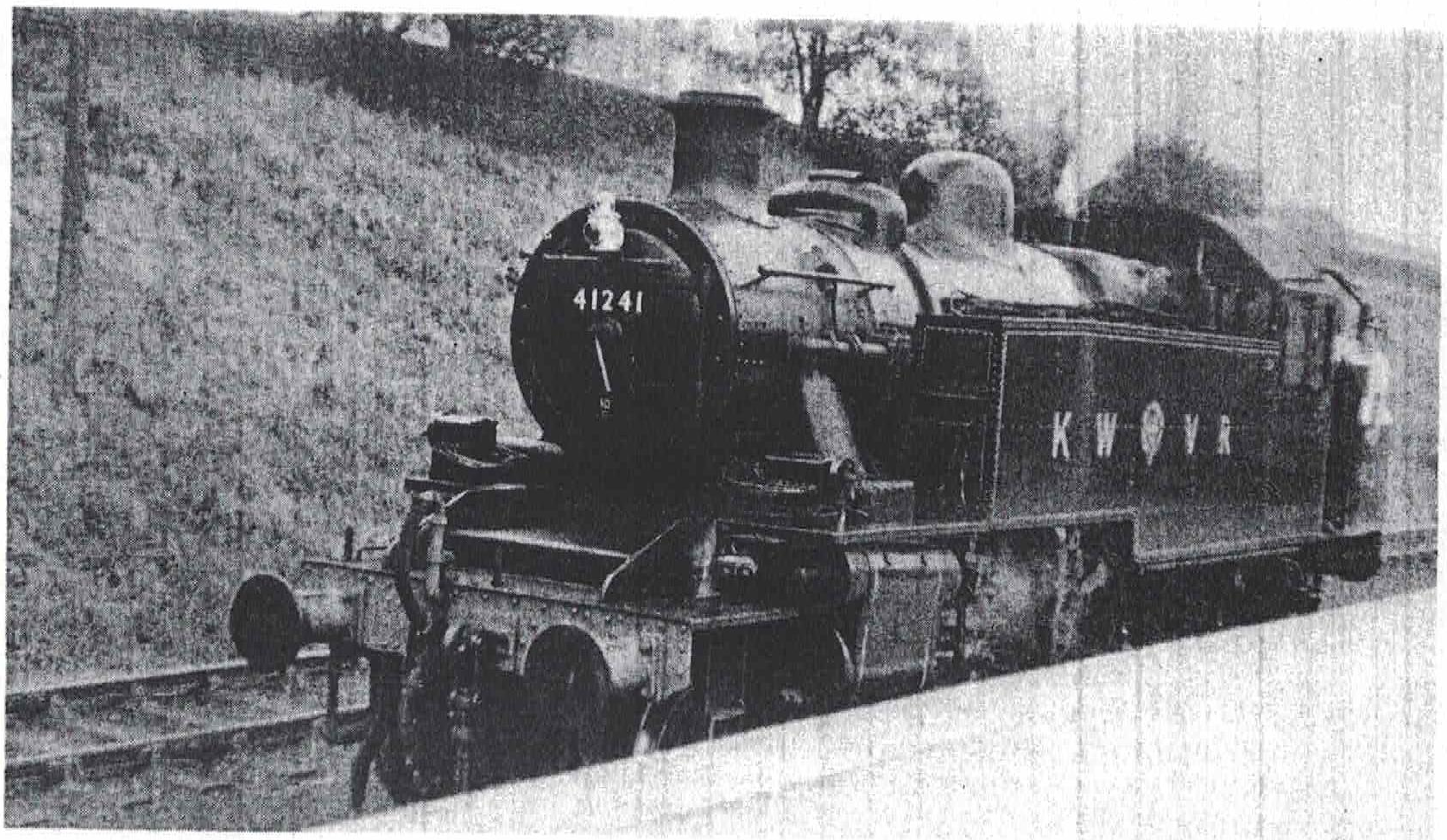
Earlier I had thought about delaying laying the ghost until we reach the valve gear on Sheet 6, but by then we shall be deep into construction, whereas now there is time and space in which to discuss things more fully.

I began corresponding with E. S. Cox back in 1964 with the publication of his book on the Standard Steam Locomotives, using my practical experience of working on them as an opening. Look into the cab of 78000 and you will see that very little is visible, the backhead as instance is almost bare. If I were designing 78000 today, then she would sport a pair of water gauges, just like POM-POM, whereas JERSEY LILY too only had the single gauge. This though is not my point, for on the RH side, adjacent to the water gauge, is a pair of handwheels, ones that go forward to the injector steam valves in front of the cab. Now traditionally, injector steam valves were located high up, either inside or in front of the cab on the boiler top, never in the ideal spot to maintain them. E. S. Cox had the right idea to mount them ahead of the cab so that they could be reached on the running boards; in practice it did not work out quite like that. The lower injector steam valve was only about a foot above the running board, so one virtually had to stand on ones head to get at it, so instead one used a ladder, and standing same on a greasy shed floor was not without its problems; nobody though had thought to tell Mr. Cox of this failing. That pedestal in the cab to the left of the firehole contained the drivers brake valve as depicted on the top; it also housed the cylinder drain cock operating valve and steam sander; it looked clean on the outside, but inside was a mass of pipes, a right 'Spaghetti Junction''! Normally



In 1972 I spent a day on the Keighley and Worth Valley Railway taking photographs and measurements of the DERBY 4F preserved there for my 3½ in. gauge version. By chance there was a steam service between Oxenhope and Haworth that day, 41241 providing the motive power

I worked on sister engine 41242 when at Eastleigh, when I guess she was shedded at Bournemouth for the Somerset & Dorset line, hence my interest in 41241



though, both injector steam valves and those in the pedestal should have given years of service with little or no attention, but the engines I worked on at least had very poor body castings, quite soft and riddled with blow-holes, so their maintainance was a constant fight.

Later on in our correspondence, I was able to raise bigger matters. E. S. Cox had written in that particular book about the work of Bill Harvey at Norwich in altering the valves of the 'Britannias', rather it was the front valve head, to allow for valve spindle expansion in service, which led to a saving of water such that the engines could now reach Norwich from Liverpool Street without having to take water at Ipswich. I was able to tell Mr. Cox that I had set the valves that way on the 76026 that I had helped erect at Doncaster, for this was the practice as we knew it at The Plant, so we too had deviated from the design on paper. The topic moved on to valve travel and I made the point that there seemed no good reason to exceed 6 in. in full gear, whereas engines such as the LMS 'Duchesses' exceeded 7 in.; my point found favour with the great man. Thus it was that I designed and built my K1/1 with a 17/32 in. full gear travel, and after increasing the lead as I have written elsewhere, her performance was a revelation, one I have been able to share with builders of my, piston valve, engines. 78000 was the first engine I put said specification into, at least that was the idea, in appreciation of what that correspondence with E. S. Cox had led to, only I got it wrong!

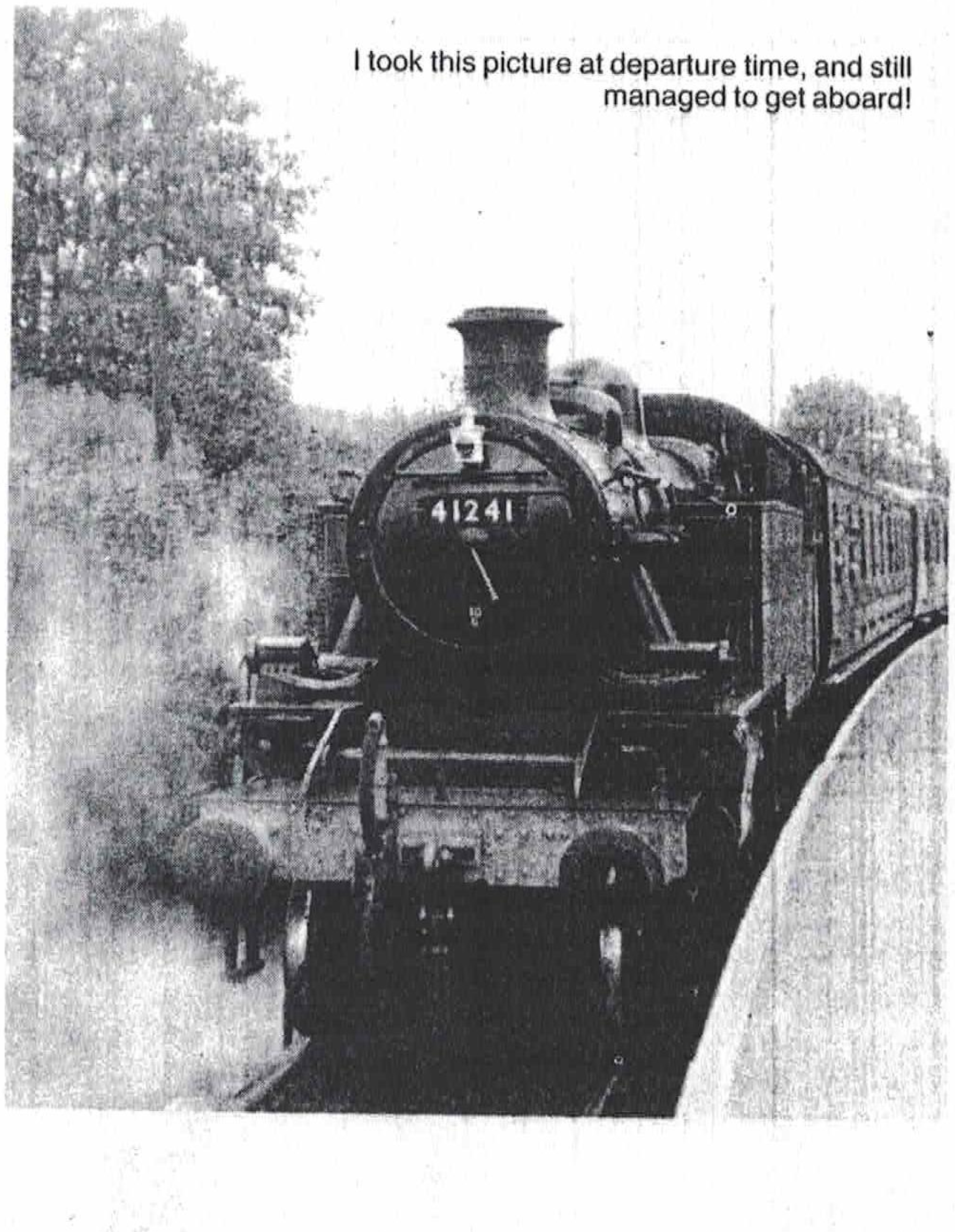
I lay out every valve gear to as large a scale as possible on my drawing board and for 78000 it was four times full size for 5 in. gauge; the larger one can draw anything, the less the error, and so it should have been. I started with a return crank throw of ½ in. and this just about gave the figures I was looking for with the expansion link swing not too great. However, one thing one must always look for in a valve gear is the effect of wear, for even a thou' here and there can make a great deal of difference to valve movement, so I then drew over the top the effect of an increased throw of 9/16 in.; it all fell into place. Unfortunately when I transferred from the layout to the detail drawings, instead of adding 1/16 in. to the ½ in. throw, stupidly I subtracted it, so the specified throw became 7/16 in. A number of engines were built like this, including I am sure the Gold Medal winning 78019 by the late Fred Palmer, which incidentally goes as well as it looks; superbly! But there were also queries, and everytime I got out the large scale layout and convinced myself that all was well, that is until Eric Coward sent me a layout identical to mine, and it was only then that the penny dropped; I felt about 2 in. tall and could have walked out under my office door without opening it!

Of course when one makes such a fundamental mistake, it throws doubt into builders minds and things that are right become suspect, for that idiot of a designer cannot know what he is doing!

You see, even with the correct valve travel of 17/32 in. the valve only opens to steam by 7/64 in. and of course the port is 5/32 in. wide. Said port though is sized for exhaust steam, and only about 15% opening is required for the incoming steam at boiler pressure; this phenomenon was something that continually dogged the late maestro LBSC and in 78000 I got my fair share of the flak!

If you build her as she is now drawn and dimensioned, I promise you a performance that will give you every satisfaction.

I took this picture at departure time, and still managed to get aboard!



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Part 2 — Progressing the Tender

If it took two sessions before I made progress on the tender for POM-POM, for No. 78000 I am going in at the deep end, and base over apex! Reason for this is that for the Class 2 and I believe only one other design, the tender body is not fully detailed or dimensioned, the idea being that the builder lift said dimensions off my full size drawings; now I shall have to do just that to provide a proper description. At least I can make a start on the chassis, which continues on Sheet No. 3. I must say I regard tenders as a necessary evil, for they are not the most exciting things to either draw or make, and with my very short arms, I have to clamber over them at the track to get to the controls; that for No. 78000 is happily a bit shorter than most.

Tender Frames

Unlike POM-POM and several other tenders I have described in LLAS, that for No. 78000 has but the outside frames, making construction that bit easier. I am sure that a few of you are going to squeeze the frames out of $3\frac{1}{2}$ in. x 3mm steel flat, reducing the downward projection at the hornstays from $\frac{3}{8}$ in. to $\frac{5}{16}$ in. and modifying said hornstays to suit, the alternative being to hack them out of 4 in. x 3mm section. Reeves have a cold rolled pickled steel for some of the wider flat sections and this I have found superb for frames as it does not 'banana' when the horn gaps are cut. Mark off the frames on one piece of your chosen section, using the top and rear edges as your datum, then drill about four No. 41 holes roughly equi-spaced along the length of the frame, those for horn fixing being ideal, then bring up the second frame, clamp together and drill though. Use either copper or aluminium rivets to hold the frames firmly together, just hammering them over and not worrying about the rivet heads. Although the temptation is to first profile the frames to see what they look like, it is best to drill all the holes first as that way there is more metal to sit on the drilling machine table. Drill a row of $\frac{1}{8}$ in. holes along the top of each horn gap, when you can saw down each side of the gap, grip in the bench vice with the holes level with the vice jaws and either break out the excess metal with a "Mole" wrench, or better use a wee chisel. Now you can carry on and complete the outer profile with saw and files.

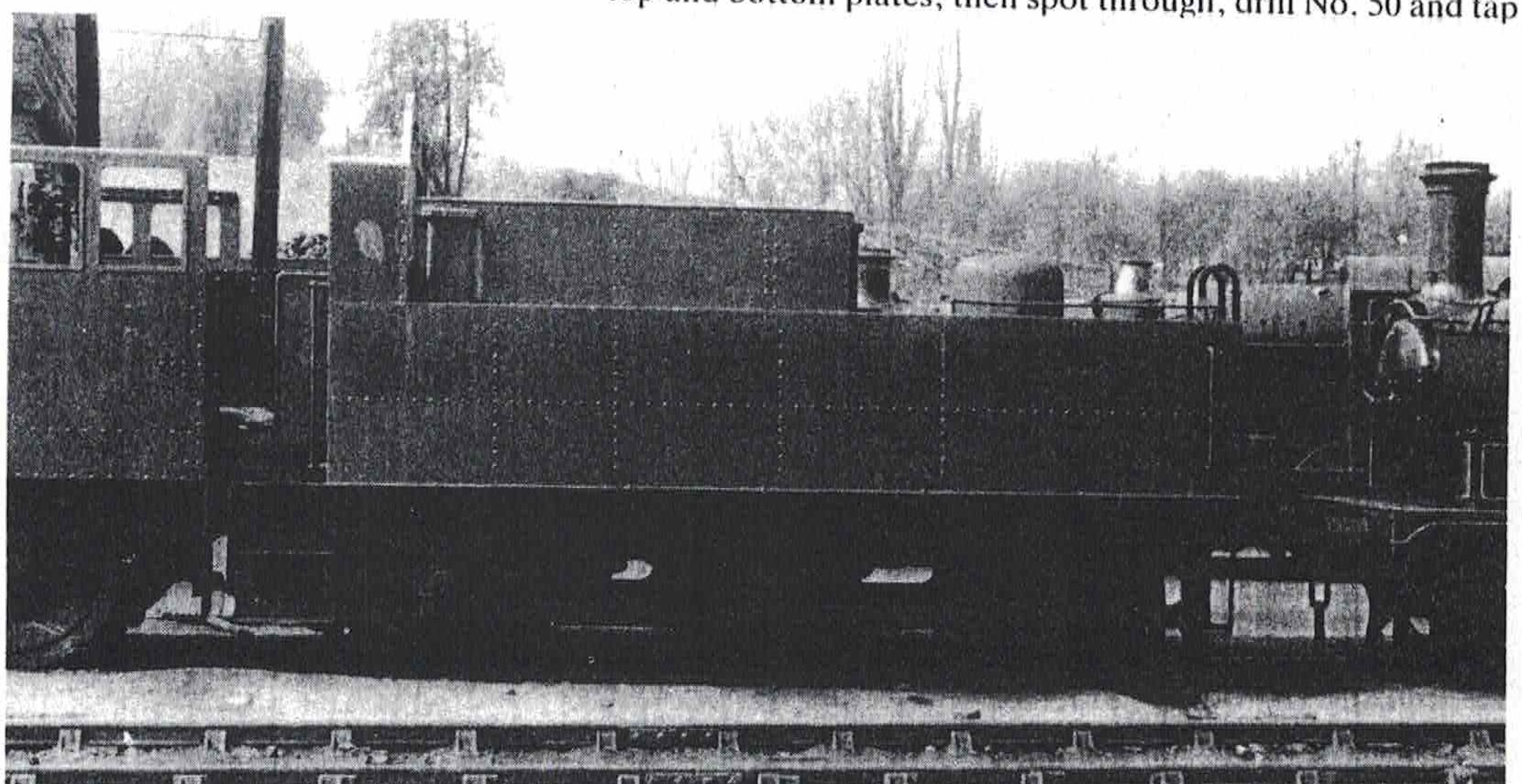
The frame cut-outs are lozenge shaped with large corner radii, and drilling $\frac{13}{16}$ in. diameter holes through $\frac{1}{8}$ in. plate is not to be recommended. You will, however, be able to drill $\frac{1}{2}$ in. holes, then elongate with a square file until a hacksaw blade enters before sawing out as close to the line as possible, completing with files.

Along the top edge is fitted an $18\frac{1}{4}$ in. length of $\frac{1}{2}$ in. x $\frac{1}{2}$ in. x $\frac{1}{16}$ in. brass angle and the first decision is whether it is to be secured with rivets or bolts; it depends if you think you will have to remove it during construction. I must say I favour its fixing with $\frac{3}{32}$ in. diameter snap head copper rivets and they want to be at roughly $\frac{3}{4}$ in. pitch. Fit the heads outside and hammer down into countersinks in the frames.

Front Frame Box Stretcher

At least I don't have to refer to box 'castings' with this tender, for this is where I learnt the superiority of steel fabrications, ones we can emulate in miniature and get the same advantages of a clean finish with the minimum of machining. Start by cutting two $6\frac{1}{2}$ in. lengths from 2 in. x $\frac{1}{8}$ in. BMS flat and square off the ends to about $6\frac{15}{32}$ in. overall, as a pair. Mark on the lightening holes, drill a few holes, then grip in the machine vice and mill them to line, using a $\frac{1}{4}$ in. end mill initially and completing with an $\frac{1}{8}$ in. one. Next mark off and drill the $\frac{1}{4}$ in. drawbar hole and move to the RH side to drill through at $\frac{15}{32}$ in. diameter, tapping the top plate only at $\frac{1}{2}$ x 32T.

Next cut and square off two 2 in. lengths from 1 in. x $\frac{1}{8}$ in. BMS flat, to fit inside the ends of the top and bottom plates, then cut front and back plates from the same material to fit. The front plate requires the $\frac{7}{8}$ in. x $\frac{7}{16}$ in. slot to accept the drawbar and at the back plate I suggest you cut another $\frac{7}{8}$ in. wide slot but this time $\frac{11}{16}$ in. deep to allow access when brazing up the drawbar pin bosses, they being turned up from $\frac{1}{2}$ in. steel rod. To complete the fabrication, we require two partition plates at 2 in. centres, being $1\frac{3}{4}$ in. lengths from the 1 in. x $\frac{1}{8}$ in. BMS flat. Try assembling and clamping the pieces together and if there is any problem, use 8BA brass round head screws to hold the pieces firmly in place. This means you drill No. 44 holes at $\frac{1}{16}$ in. from the edge of the top and bottom plates, then spot through, drill No. 50 and tap



I have no idea why I turned my camera to record the tender fitted to the BR Class 2 seen at Bridgnorth, in the days of Gerald Nabarro and the first public share issue, but it sure is useful now!

8BA into the edges of the mating pieces. Use a ¼ in. bolt, plus a few washers, to correctly assemble the drawbar pin bosses, then mix some flux to a stiff paste and apply liberally to every joint. Lay on the brazing hearth and get the 2943 burner going fiercely. Heat up the whole fabrication as quickly as you can, feeding in spelter which can be Easyflo No. 2 as soon as it runs; the success of this job depends on getting it done quickly. Quench or pickle, remove any excess flux and rub with file or emery cloth, then dry out and apply a coating of zinc from an aerosol can to prevent rusting. Either clamp in the machine vice, or bolt directly to the vertical slide, to machine the ends to 6⁷⁄₁₆ in. overall.

Rear Frame Box Stretcher

As my note suggests, this is very similar to the front stretcher, so I will run quickly through the sequence. For the top and bottom plates, cut 6½ in. lengths from 1¼ in. x ⅛ in. BMS flat and square them off at 6¹⁵⁄₃₂ in. overall. The end plates are 1¼ in. lengths from 1 in. x ⅛ in. BMS flat and the partition plates 1 in. lengths from the same material. That leaves the front and back plates again from the 1 in. x ⅛ in. section and fitted to place, the back one containing a ¼ in. square and the front a No. 2 hole. Cut the lightening holes in top and bottom plates, then braze up, zinc coat and machine the ends to match the front stretcher.

Front Beam and Rubbing Plate

This is a 9¹⁄₁₆ in. finished length from 1⁷⁄₁₆ in. x ⅛ in. section BMS, the bottom corners being snaped to drawing, followed by the ⅞ in. x ⁷⁄₁₆ in. slot, which is as far as we can go until the rubbing plate is made.

The base of the rubbing plate is 2¼ in. x 1⁷⁄₁₆ in. from ⅛ in. or 3mm plate, with a slight radius in each corner and slot to match the front beam; mark off and drill the 12 No. 41 holes. The rubbing surfaces start as 1⅞ in. lengths from ⁵⁄₁₆ in. square steel bar, being clamped together and filed to profile as shown. I suggest you then just clamp them in place on the base and braze together. Offer up to the front beam, drill through and rivet, countersinking the back of the front beam. I have shown no fixing for the beam to its stretcher, full size they are rivets, but a dozen 6BA round head screws will more than suffice.

Rear Buffer Beam

The rear beam is from the same 1⁷⁄₁₆ in. x ⅛ in. section, but only 8¼ in. long; mark off and drill the pair of ⅝ in. holes, clamping the beam to a block of hardwood to ensure a clean hole, then deal with the ¼ in. square to suit the rear stretcher, again fixing as I suggested for the front beam.

Frame Stay

Some builders I know experience awful problems in bending up a frame stay from black steel flat, yet I have always found it a relatively simple operation. Let me repeat the method given for POM-POM so that builders can avoid having to resort to fixing ⅜ in. x ⅜ in. x ⅛ in. steel angle at the ends. Take a 9 in. length from the 2 in. x ⅛ in. section and at a full ⅜ in. from one end, scribe across. Set this bend line level with the top of the bench vice jaws and hammer over to form the first flange. At, say, ½ in. from the other end, scribe another bend line and estimate what you think the length over flanges will be after bending, then produce the bend and check your dimension. Likely it will be in error, but you will now know the order of said error, so saw away the redundant end, scribe the bend line in its correct position to give an overall dimension in the order of 6¹⁵⁄₃₂ in. and bend up. Now all you have to do is machine the ends as for the other stretchers to arrive at 6⁷⁄₁₆ in. overall. Whilst the frames cannot be finally assembled until you can erect axles and axleboxes, which will have to await the next session, you can try clamping the frames to the stays and stretchers and check things out with rule and engineers square.

Wheels and Axles

I predict here and now that no matter how popular No. 78000 becomes, and she has sold well since introduction in 1972, I shall never have need to order another tender wheel from the foundry. Reason is that my previous iron supplier, Poole Foundry who closed in 1985 with a full order book due to environmentalists, spent the whole of the last week of their operation casting wheels from the two patterns of mine then still in their possession, the other one being FISHBOURNE bogie wheels. From the sackfuls of castings I received it would appear they had no other work that week!

Chuck the wheel by its tread in the 3 jaw, all of them that I have checked run perfectly true, to face across the back, turn the flange down to 3¹³⁄₁₆ in. diameter and radius the corner, though I should first ask that you check the machining allowances provided and proceed accordingly. Do this in back gear; now change to direct drive to centre, drill and bore or ream the central hole to ⁹⁄₁₆ in. diameter.

Next find an old drill of about ⅝ in. diameter and with shank to match your headstock mandrel, sawing away behind the flutes. Clean the mandrel and fit the drill shank, then turn down to ⁹⁄₁₆ in. diameter to be a tight fit in the wheels. Fit the faceplate, mount a wheel on the mandrel, and secure to the faceplate with a couple of countersunk screws through the spokes; 2BA ones should be fine. Face the tyre to ⁹⁄₁₆ in. overall thickness, measuring from the faceplate, then pull the tool out by ³⁄₃₂ in. to deal with the boss. I have an ordinary tipped turning tool to deal with wheel treads that has a ³⁄₃₂ in. radius ground on its corner, which allowed me to deal with tread and flange at the same time. Turn the first wheel down to about 3¹⁷⁄₃₂ in. diameter, deal with the rest to be similar, then take a final cut on the last one mounted to come close to 3½ in. diameter; the exact size is not important, only that the wheels be of the same diameter. To ensure this, leave the tool setting well alone and mount each wheel in turn to apply the final cut. Now mount each wheel again to deal with the flange corner radius with a file, then set your tool over 30 deg. to machine a chamfer over ¹⁄₁₆ in. length at the outer end to complete, save for any cleaning of the spokes with a wee file.

The axles start life as squared 7½ in. lengths of ⅝ in. diameter bright steel bar. Chuck in the 3 jaw to centre, then reverse and centre again, mounting between centres and using the 4 jaw chuck as the means of driving the axle, rather than a carrier and driving plate.

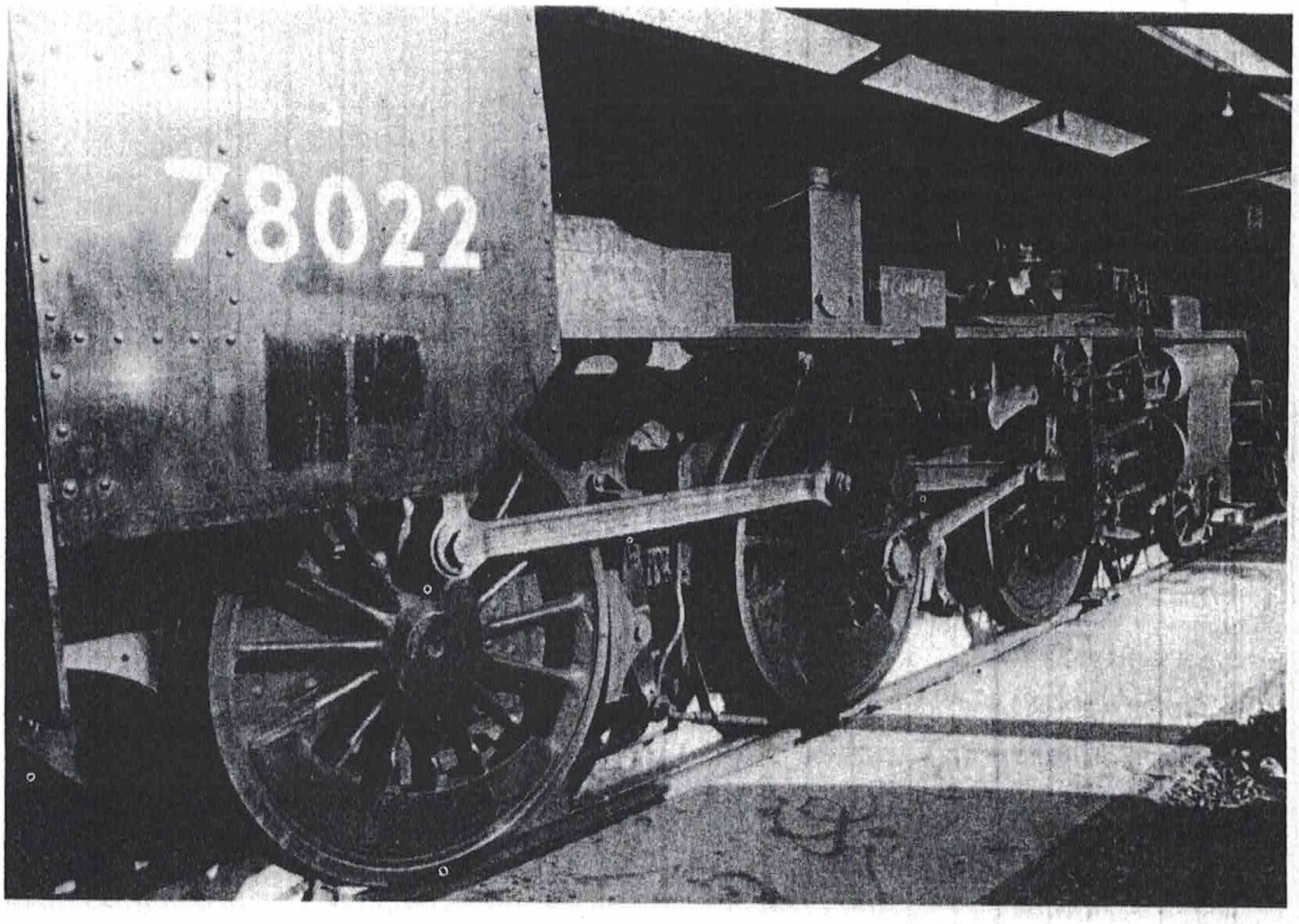
Incidentally, I do possess both a suitable driving plate, it was supplied new with my ML7 nearly 40 years ago, and a carrier, so why not specify same? I found out a long time ago that this set-up could lead to tool chatter, and changing over to the 4 jaw chuck and evenly tightening the jaws on to the bar gave a better drive without distorting the bar.

Starting at the outer end, reduce to a bare ½ in. diameter over a ¾ in. length to be an easy fit in the axlebox, only the latter will have to await the next session. I now recommend Permabond A118 as the means of securing wheels to axles, so turn down the next ²¹⁄₃₂ in. length to ⁹⁄₁₆ in. diameter, to give a clearance of the order of .002/004 in. Over the centre ⅝ in. length, turn down to ½ in. diameter and I find a round nosed tool best for such an operation. Still with the round nosed tool, set the top slide over about 2 deg. and starting from the centre, begin to turn on the taper. It does not matter about the land being exactly ¼ in. long, a ¹⁄₃₂ in. either way will not notice, but once you have the correct setting, deal with the other end of this axle and the remaining pair without disturbing same. Now you can complete all axle ends as described, chamfer the entrances to the bores as recommended by Permabond, clean, apply the A118, fit the wheel and allow to cure.

Horns and Hornstays

Although my description of the horns on the Frame Plan is somewhat sketchy, thanks to Norman Lowe I have been able

I should have sent some castings to John Stephenson in Hull via their Sea Fisheries Association exhibition trailer when it was at Bembridge on the Isle of Wight, but the VAT man called that morning and I forgot! My 'reward' for sending them by post was this shot of No. 78022 undergoing repair.



to supply correct profile gunmetal castings from the outset. Norman has provided a spigot that sits inside the horn gap and this gives an overall working surface width of ⅝ in.; the casting itself shows the correct length required. These horns are cast in threes, so first rub a file over the working face to make sure it is flat, then sit on the bottom jaw of the machine vice with the spigot towards the chuck; use wee pieces of packing to grip over the webs in the casting. Face off the spigot with an end mill, then concentrate on the frame fixing face; rotate the casting through 180 deg. and arrive at the ⅝ in. width. Now sit the frame fixing face on the bottom jaw of the machine vice, again use packing to apply the top jaw and machine the working surface to size. As with all castings, assess the machining allowance before proceeding, it can save you money! Saw into individual horns and face the ends.

With this type of construction, it is perfectly feasible to fit the horns to the frames ahead of making the axleboxes. Radius the spigot at the top corner to match the frame slot, then take a pair of ¼ in. bolts and nuts, the former want to be about 1 in. long, and open the bolts out to hold the horns firmly in the horn gaps; clamp the horns additionally to the frames. Drill through from the frames No. 41, in fact you can with advantage drill the horns first and transfer the holes to the frames rather than the reverse, as this makes sure the rivet heads are clear of any web. We need 3/32 in. snap head rivets to secure the horns, heads outside and driving down into countersinks at the back of the frames.

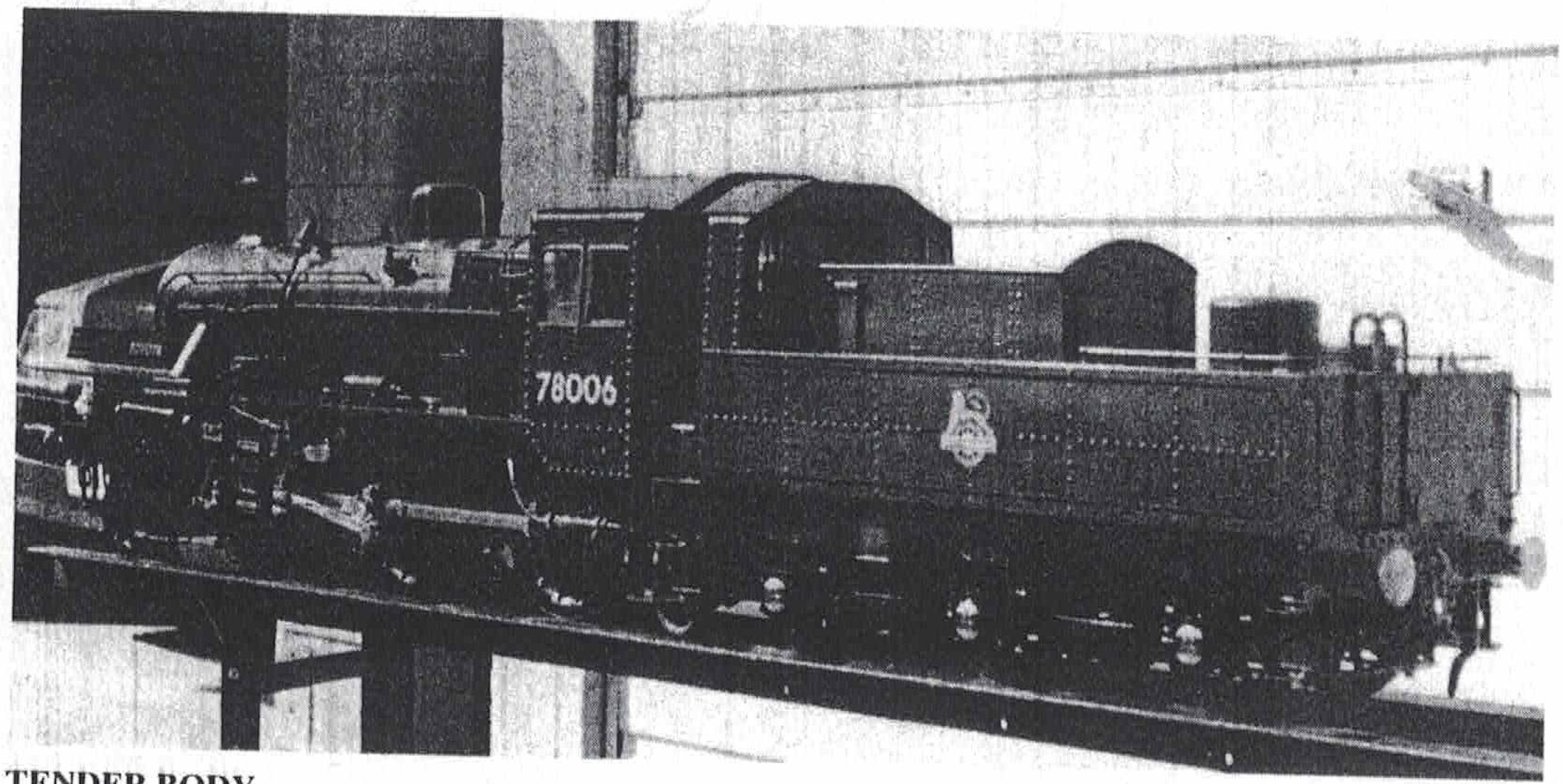
I said earlier that the hornstay section could be reduced slightly if 3½ in. wide material were used for the frames, and although this is perfectly OK, they can be left ¼ in. square with the reduced stand-out. Take a length of the ¼ in. square bar, grip in the machine vice and mill a ⅜ in. wide slot to ⅛ in. depth to be a tight fit over one of the frame extensions. Erect, scribe lines at the other frame extension, then carefully mill out the slot, checking to place as you go. When satisfactory, saw off to length, tidy up the ends to drawing, offer up to the frames and drill through at No. 41. Actually 7BA bolts are less easy to obtain in 1988 than they were in 1972 when this sheet was produced, so you may vary the drilling to No. 44 for 8BA bolts, that way I may gain a few friends!

Axleboxes

Although the axleboxes are not detailed, they are so simple as to cause me no problem in describing them. The tender axlebox cast stick that I supply for DONCASTER will be suitable for the Class 2 tender and first we want to produce the required section of 1⅜ in. x 1⅛ in. over the length of bar, sawing into 1⅛ in. lengths and squaring them off to be a uniform 1 in. thickness. Grip one embryo axlebox in the machine vice, as always on the vertical slide, to mill a ⅝ in. slot centrally in one of the 1⅛ in. faces to ⅛ in. depth; rotate the axlebox by 180 deg. and deal with the second slot to be identical, checking against the chosen pair of horns. In conclusion, the fit is bound to be very tight, a fit that you will have to ease with files, remembering that the horns are likely to 'toe-in'. Find the centre of one axlebox by the 'X' method, which means scribing from corner to corner, centre pop and set to run true in the 4 jaw, then centre and drill through to ½ in. diameter; repeat for the other five boxes. Now you can erect the frames, checking with engineers square, and the axles, that things are in alignment; drill and tap the stays and stretchers. If one of our suppliers cannot supply the wee aluminium 'Timken' axlebox covers, then I will do so, they being fixed in place with a couple of 8BA countersunk screws. The spring plates I would now make from 1 in. x ¼ in. BMS flat, the length being 1⅜ in. as for the axlebox. At ⅝ in. from one of the 1⅜ in. edges and on the centre line, centre pop and set to run true. Make a ball ended end mill from an odd end of silver steel rod and use to form the spherical radius, then turn on the boss roughly to drawing. Finally mill the two end slots to fit between the horns and this can be an easier fit than for the axleboxes.

Brake Shaft Bearing

Just the brake shaft bearings before we move on to the tender body and having had a brake shaft seize on me at that time, my specification now as then are for bearings turned from a non ferrous material, ¾ in. brass bar being ideal. Although in 1972 I specified Loctite for fixing, today I reckon a press fit will be just as quick.



Right up to press day I was short of pictures to illustrate my No. 78000 series. Then out of the blue came a packet of photographs from Mr. G. Ross of Harwich of his No. 78006, one of a pair of Class 2 'Moguls' he has built.

TENDER BODY

The Ivatt/Riddles/Cox tender is merely a later development of the traditional horseshoe pattern, and although I have shown the bunker floor raised above the soleplate as per prototype, for simplicity they could become one and the same. In any case the construction is quite straightforward, so let me make more progress before space runs out.

No tender well this time, just a couple of strum boxes, which makes the soleplate a straight 21⅞ in. x $9\frac{1}{16}$ in. piece from 1.6mm brass sheet. On the frame detail I say rivet the ½ in. x ½ in. x $\frac{1}{16}$ in. brass angle to the frames and bolt to the tank, but some builders may wish to reverse this specification, riveting the angle to the soleplate at this stage and then later bolting to said frames.

In a way it is fortuitous that I have described construction of the tender body for POM-POM in this issue, for I can refer No. 78000 tender body builders to the general notes on fixing the sheets together by means of the ¼ in. brass angle. The side sheets are 19⅞ in. long and 3½ in. high, the rear end plate being $8\frac{15}{16}$ in. x 3½ in., all from the 1.6mm brass sheet. This indicates that the side sheets extend the full width of the soleplate, which is the variant of the BR3 tender I prefer, though another version of the same 'standard' tender body has the soleplate slightly extending.

The strum boxes are ⅝ in. square and extend 1½ in. below the soleplate and it would be nice if square brass tube were available for this, otherwise it will have to be folded up from 1.6mm brass sheet. In either case a 3mm thick bottom plate has to be fitted, tapped centrally at $\frac{7}{32}$ x 40T for a ¼ in. A/F hexagon brass plug. Centrally on the front face of the strum box at ⅞ in. up from the bottom, fit a ½ in. o.d. x $\frac{5}{32}$ in. bore x $\frac{3}{32}$ in. thick flange, drilling into the bore of course as this is the injector suction. The mating flange on the pipe is identical and securing is by means of 4 in. No. 10BA hexagon bolts on a $\frac{11}{32}$ in. p.c.d. Space is very tight here, which rules out a union connector, or we could not get the pipe clear of the brake hangers.

I have shown the tank top finishing $\frac{5}{16}$ in. short of the front of the side sheets and of course this can be varied if you like to come flush with same, when the bunker recess becomes 11⅛ in. long x 5¾ in. wide. The top plate also requires work to be done at the back to represent the water scoop dome and the filler. The former is a huge 2⅝ in. diameter and projects 1¾ in. above the top plate. Although 2⅝ in. o.d. x 16 s.w.g. copper tube is in some manufacturers lists, it does not appear in any of the model engineers suppliers lists I have by me, which is not surprising. Either roll up from 1.6mm strip, or you will probably prefer to reduce the dome to 2½ in. diameter, in which case you can use a mixture of commercial copper tube and a gunmetal cylinder cover.

By 1972 I was back in the marine industry, where it was important to know the fuel, oil or water levels in enclosed tanks, for which simple gauges actuated by floats on pivoted arms were employed; one of these with the arm cut down and recalibrated seemed a better solution then than peering into a tank.

The filler tube is 1¾ in. o.d. x 16 s.w.g. and stands ½ in. proud of the tank top. With an open ended tube, I prefer to sit them on the tank top, sweat in place and then drill and file away the unwanted centre. It is not so easy with an item such as the water scoop dome, but if a level gauge is not going to be fitted, you simply leave the tank top in place and nobody will ever know! The filler lid can be hinged, but it is far easier to turn it up from another cylinder end cover, with a spigot to fit the filler tube and then sweat on a wee 18 s.w.g. handle as shown.

I should have said at the outset that the tank top is $8\frac{15}{16}$ in. wide and sits down inside the top of the side sheets, again using lengths of ¼ in. brass angle. A tender hand pump can be fitted under the filler, sited athwartships, though I prefer to rely solely on injectors. With a hand pump, one should provide a means of fairly easy access for servicing, and to make a section of tank top removal means also that the step and handrails have to be portable, whereas they are better permanently fixed in place.

The sides of the rear ladder, that's a better description than steps(!), are bent up from $\frac{3}{16}$ in. x $\frac{1}{16}$ in. steel strip or cut from sheet as you prefer and are then drilled No. 52 for $\frac{1}{16}$ in. steel rod as rungs, being brazed together. Lugs project from the rear sheet and tank top, again $\frac{3}{16}$ in. x $\frac{1}{16}$ in. strips, and the ladder is fixed to same with 8BA bolts. Five handrail stanchions are required, which can either be 3½ or 5 in. gauge ones, and this will determine whether the handrail be $\frac{3}{32}$ or ⅛ in. diameter. That solves another problem in that the vertical grab rails want to be the same diameter as the handrail, to be a match.

The Bunker

If the decision over handrails was easy, the one on how far the bunker should extend upwards is not, as is equally the tender cab, this in the cause of safe driving. The big problem is that the tender cab also forms the front coal bulkhead. You will see Robin Butler's solution on page 13 of LLAS No. 33, one which is eminently practical. It was also entirely predictable that Robin should head the cavalcade, ready for the off once more, for apart from stops to take water, he was on the go all day at Balleny Green!

Those of us making a bunker as per drawing I reckon should start and make up another fabrication on the lines of the tender body itself. Start with the bunker floor and you can now begin to take all measurements to place, for the bunker has to fit inside the tender body and to the cut-out you have made in the tank top. I also recommend you use pillars to locate the bunker floor above the soleplate, so chuck a length of 3/8 in. brass rod, face, centre, drill No. 42 to 1/4 in. depth and tap 6BA. Part off at a full 1 1/2 in. overall, reverse to face off to length and tap this end identically. Make six of these pillars and you can support the floor along its length. The bunker side plates are roughly 4 1/2 in. high and of course they help close in the tank space. Use lengths of 1/4 in. brass angle to join to the bunker floor and another two lengths to secure the sides to the tank top, underneath for neatness.

The way I would use drawings produced for my own use when building was to cut a piece out as a paper template and transfer to metal and this is the ideal way to deal with the bunker back as it saves worrying about the actual radius at the top. Again use lengths of brass angle to secure to bunker sides and floor. Those stiffening angles at the back of the bunker down to the tank top add a bit of realism and again are 1/4 in. brass angle. Don't worry about their final length initially, but saw and file a notch so that they can be bent to a 90 deg. angle, checking against the job and then brazing the joint. Now you can saw off the excess and shape to drawing, securing to place with 1/16 in. countersunk copper rivets.

We now have rather a mess to deal with at the front end, for both water space and bunker are wide open; if we look back at the front elevation of the tender as published in LLAS No. 35 things should become clearer. We first need a piece of the 1.6mm brass to go right across the tender between the side sheets and be the full 3 1/2 in. height; this will completely blank off the water space and part of the bunker. The coal opening I have suggested at 2 1/8 in. width and 1 1/4 in. depth, but of course you can vary this; secure the front water bulkhead with 1/4 in. brass angle and by this time you will be using 8BA countersunk screws as fastening. Ahead of the bulkhead is a stool which is 7 3/4 in. long, width to extend from the water bulkhead level with the edge of the front beam, and 1 7/16 in. high. You can either build this up from wooden planks or make a metal box and secure with more brass angle.

Our next job is to seal the water space and those strum boxes mean we must support the body on wooden blocks for the initial heating. Pour in some Bakers fluid, swish it about so it gets to all the joints, then light your propane torch with a very diffuse flame; very little heat is required here. Warm the whole body as evenly as you can and feed in some tinsmans soft solder. When it melts, swill it all around to seal the joints, and this indicates you wear protective gloves. Allow to cool, wash out with hot, soapy water, dry and then fill again with cold water to check for leaks. Bad ones will require reheating, but an odd weep will be sealed by the gloss white paint that we shall now pour in and swish around, draining off the excess.

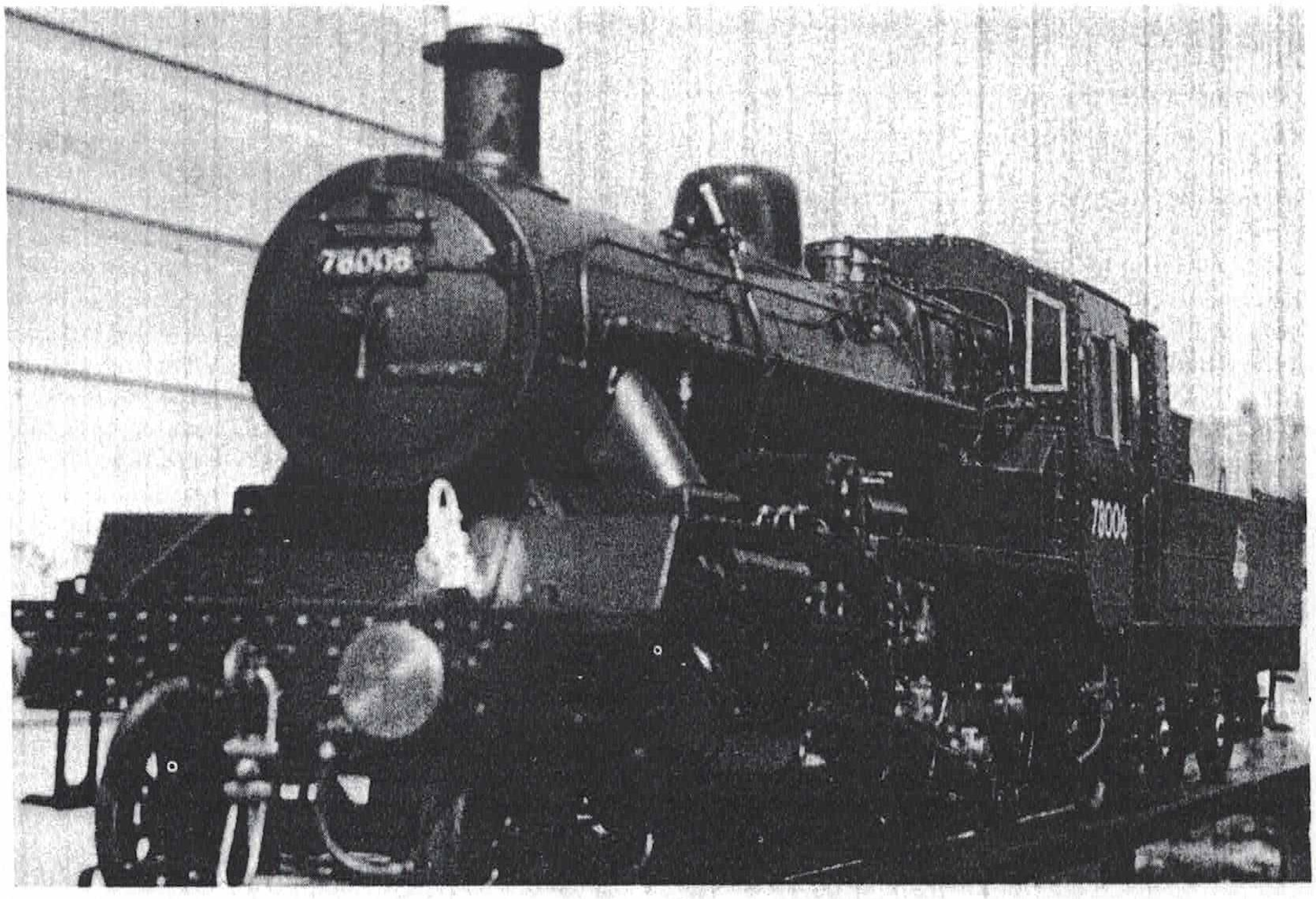
Tender Cab

The back is a piece 9 1/16 in. x 5 1/8 in. from the 1.6mm brass sheet and if you are able to use the full size drawing as your template so much the better, to mark off, including the coal opening and windows, sawing to line. The main portion of the roof is 2 9/16 in. wide and matches the cab back, being secured with odd ends of the 1/4 in. brass angle and the sides are cut 1 5/8 in. wide to match. For the times when the tender cab will be fitted, I suggest you use yet more brass angle along the cab sides and back, securing with a few 6BA countersunk screws, or plain dowels if you like.

At the front of the main portion of the cab roof there is a skirting which is 3/4 in. high at the centre and to this is fitted an extension which comes under the engine cab roof, keeping the firemen snug and dry; you will have to check this against the engine when completed, a little way ahead yet!

The coal doors are 3 3/4 in. high and 1 in. wide, with a 1/4 in. strip fitted to the R.H. one to act as a stop. I have said all I am going to say about wee brass hinges in this issue, so make and fit them as POM-POM. I am going to leave my wee drawing error in respect of the hasps for posterity, knowing it will give amusement. Cut 1 in. lengths from 3/16 in. x 1/16 in. strip and drill centrally at No. 51 for a pivot pin, a snap head brass rivet, drilling the R.H. door to suit and peening over. Bend up the clips from the same material and if you fit them as I have drawn the coal door will never open, not that it ever will in anger! If, however, you turn the L.H. ones upside down, then the hasps will swing free and the doors will open. Actually I was being very clever back in 1972 in indicating this was a non-working feature.

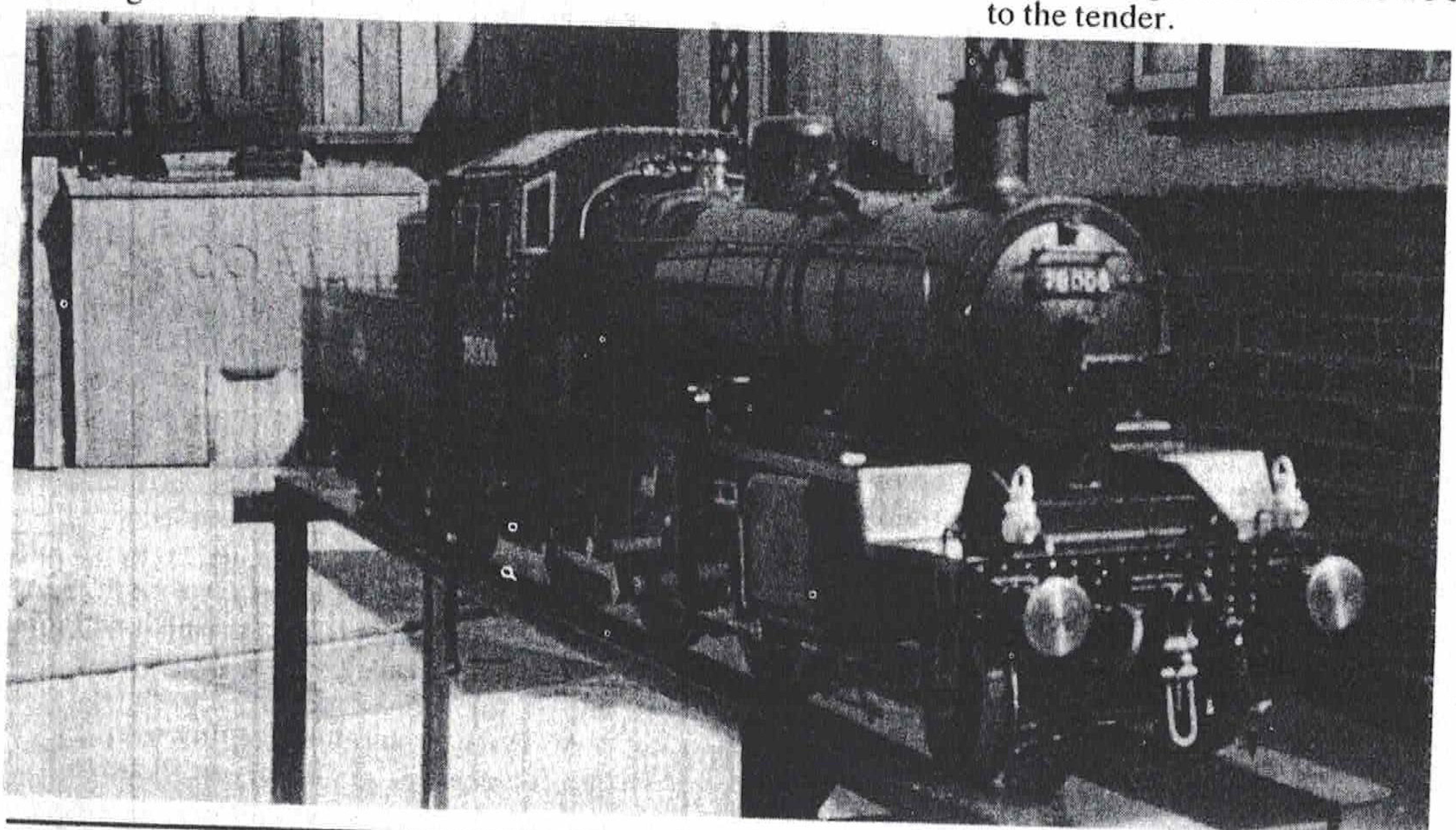
The lockers are 2 3/4 in. high, 1 3/8 in. wide and 1 1/4 in. deep.



The daintiness of a Class 2 allows for higher boiler mountings than on most modern steam locomotives, the BR 'Standards' among them, but to my eye No. 78006 benefits hugely from the taller chimney and dome.

They are very neat in that the outer door section opens first and through 180 deg. when the second and inner hinges come into play and the whole folds back towards the coal door.
When I wrote about fitting glass to the spectacle plate on DONCASTER, it brought forth the query as to whether a glass hammer had to be used to fit them! I should have said 'glass', for a variety of clear plastic materials are now employed by builders to achieve the finished item, held in place with brass frames. The window protectors are bent up from 3⁄16 in. x 1⁄16 in. strip, or cut from sheet, being 'U' shaped and standing 3⁄16 in. clear of the 'glass'; sweat in place.
I am approaching the end of what has been a long, hard session for me, but enjoyable nonetheless, for I like a challenge.

Steps
Steps on BR Standard locomotives were extrememly functional and as the one at the front of the tender is the means of access to the footplate, it is wider at 1¼ in. as against the 1 in. width at the back; both are 3 3⁄16 in. high and from 1.6mm brass. The draughtsman went so far as to vary the lightening hole size from ⅝ in. at the front to ½ in. at the back, a real weight-saving exercise! We must clamp our pieces to blocks of hardwood to successfully tackle said holes. Now it is simply a question of bending up the actual steps from either 1.2 or 1.6mm strip and brazing them to the backs. Secure the completed step to both soleplate and beam with pieces of ¼ in. brass angle and next time we can add the finishing touches to the tender.



I can always tell if a builder is pleased with his completed locomotive by the pictures I receive and this one sums up for me how proud Mr. Ross is with his No. 78006; let it be the inspiration to those who are following.

Through Don's letter box

Dear Don, I feel that I must congratulate you on the content of the latest issue of LLAS; I was particularly impressed by the photographs of the big 'do' at Blenheim in my native New Zealand. On page 36, down on the LH side, is a friend of mine watering his little 5 in. gauge F class 0-6-0, an engine he has been running for many years and one that still performs very well.
I have had the pleasure of driving Gerry Gerrard's 5 in. gauge MOUNTAINEER and it is a really magnificent locomotive. It is a pity that we could not have seen the 'A' in all its glory, instead of only a portion, for they were indeed beautiful locomotives, very English in appearance with plenty of polished brass. They were a four-cylinder de Glehn and were built to coincide with the Wellington-Auckland Main Trunk Railway. As a young boy, I found them a joy to watch. We actually lived away from the Main Line and it was only when I visited my grandmother that I could watch the Auckland expresses passing through, hauled by one of these magnificent 'A's'. Approaching my vantage point, there was a very deep cutting, on a steep grade, and the first indication I had of the approaching express was the billowing exhaust, and being a compound there was plenty of it! On going through the station, invariably the fireman used to put on more coal, which made for a memorable spectacle; to my young eyes anyhow! The exhaust was from memory very muted, very different from the manner in which the 'K's' and 'Ka's' used to tackle the same grade in the years to come.
A preservation group near here recently re-commissioned a Ww tank locomotive, which is a 4-6-4. The ceremony went off very well, with a member of the Cabinet doing the honours. We had set up our portable track nearby and did some lucrative locomotive running that day. Before returning south, the Ww was used on the Hutt Valley, so it was able to run on its old track for a short distance.
Many years ago I was a passenger on a train hauled by this particular locomotive, in fact it was on its delivery trip to the North Island. I recall that we stopped at a small wayside station for lunch and to take on water. While the driver and firemen went to lunch, I looked after the locomotive for them. On their return, I mentioned that I reckoned I had earned a cab ride, they agreed, so we set off at a very leisurely pace as we had ample time to catch the north-bound rail ferry. A few miles north of our lunch stopping point was a road bridge over the line and shortly before we arrived there, a tourist bus pulled up and disgorged its passengers, who wasted no time in leaning over the parapet of the bridge, to watch and admire the vintage train slowly wending its way up the valley. Just as the funnel came level with the bridge, I saw the driver give the fireman a wink as he opened the regulator and dropped the engine into full forward gear. Never before have I seen such a flurry of skirts and looks of amazement as we shot under that bridge; we all laughed about that episode for many a mile along the way!
Recently we had my little RAIL MOTOR running on our track in the Park, though it is a run I would sooner forget. I may have mentioned before that for a portion of its length,

78000, A.B.R. Class 2 'Mogul' for 5 in. gauge

by: **DON YOUNG**

Part 3 — Completing the Tender; the Boiler

Last time we left a completed tender body sitting on frames with wheels and that is about all, so now we have to add the finishing touches to that chassis, starting with the springing.

The spring hangers are from ⅝ in. x ½ in. BMS bar and the first instruction is to reduce the section to 19/32 in. x 7/16 in.; we need a total of about 9 in. of bar. Grip in the machine vice to mill the ⅜ in. wide slot to 7/32 in. depth as shown, leaving 1/16 in. at the outside, then turn the bar through 90 deg. and mill as much material away to the 7/18 in. dimension as you can, when you will have to complete with files. Chuck in the 4 jaw to part off to leave the ⅛ in. flange, clamp to the frames and drill through No. 51 in the three positions indicated. Complete profiling the flange with files, if you make the hanger in one piece as I have described you will not be able to countersink the lower hole as detailed, said will require a two-piece construction. In any case we have to close the slot furthest away from the axle with a piece ⅜ in. x 5/32 in. from 1.6mm steel, this being brazed into place as shown to retain the leaf spring, and remember this hands the spring hangers, when you can rivet them in place.

Spring Buckle

Start this time with ½ in. square steel bar and reduce one side only to 7/16 in., parting off into ⅞ in. lengths. Chuck one of them truly in the 4 jaw, face and turn down to leave 11/16 in. of original bar with a spherical end to suit the spring plate; centre, drill No. 44 to ⅜ in. depth and tap 6BA. Drill a 5/16 in. hole to start forming the spring housing, open it out with a ¼ in. end mill to start forming the slot, one you will have to complete with files against the actual spring material as your gauge.

Leaf Springs

Looking back at the side elevation of the tender on Sheet No. 2 you will see the leaf springs I have specified as being made from ⅜ in. x .012 in. spring steel, which means a total of around 40 leaves, say groups of four of identical length. Whilst more recent practice is to use a mixture of spring steel and Tufnol, my personal preference after 20 years of use is the multi-leaf as specified here. The top spring leaves, 24 of them in total, want to be 3⅛ in. long and if you reduce the groups of four by 3/16 in. per step, you will arrive at a decent looking spring, one you can now firmly clamp with a 6BA cup point grub screw and forget about it for life; such is springing at its simplest.

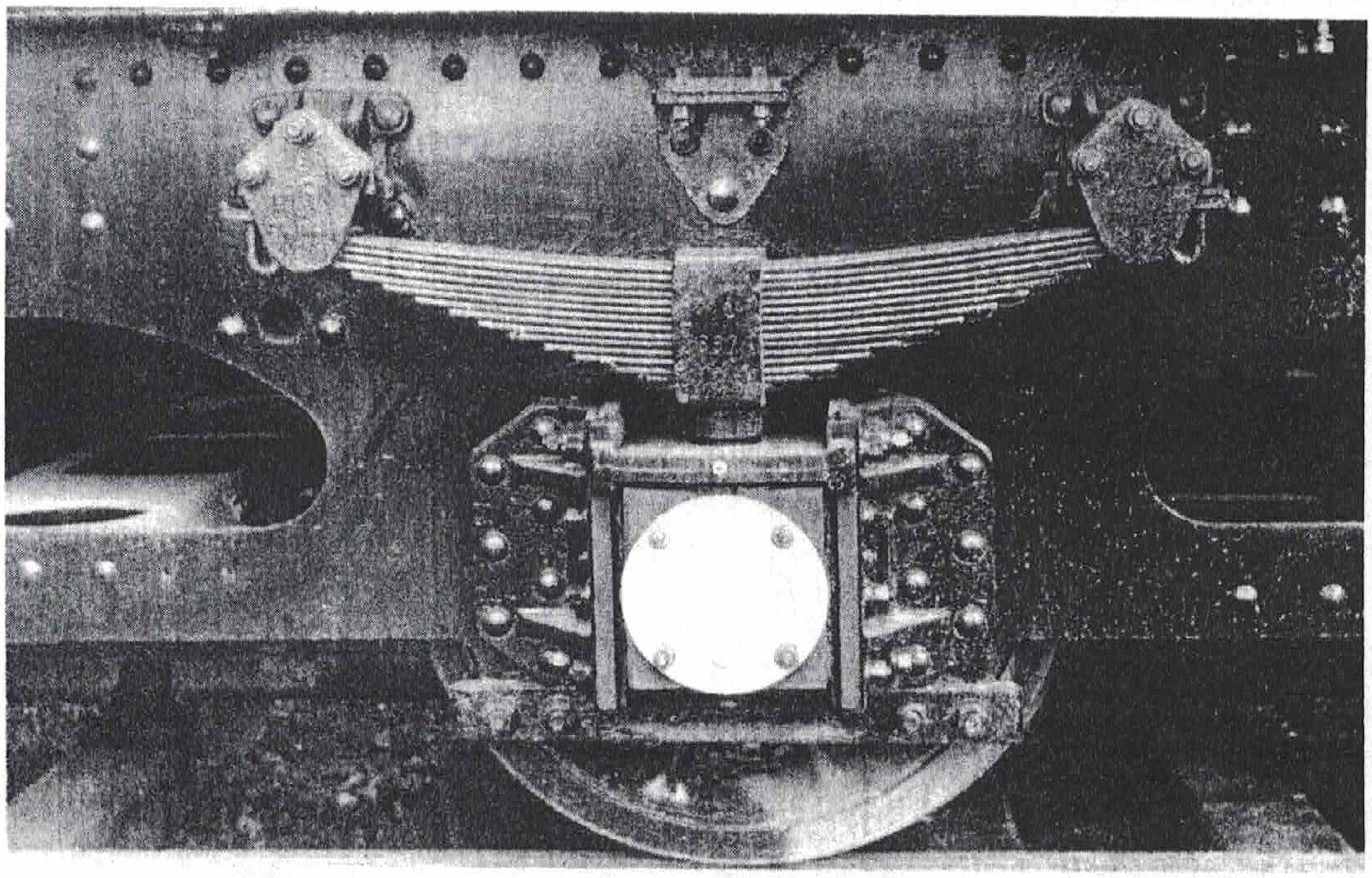
BRAKE GEAR

The brake gear is entirely conventional, even though there are a few more parts than LBSC used to detail, this in the cause of authenticity. I should have said at the wheeling stage that it does no harm to have ⅛ in. side play on all three axles to avoid the tender derailing, and the brake hangers require the same flexibility to follow the wheels, otherwise there is no point in providing side play.

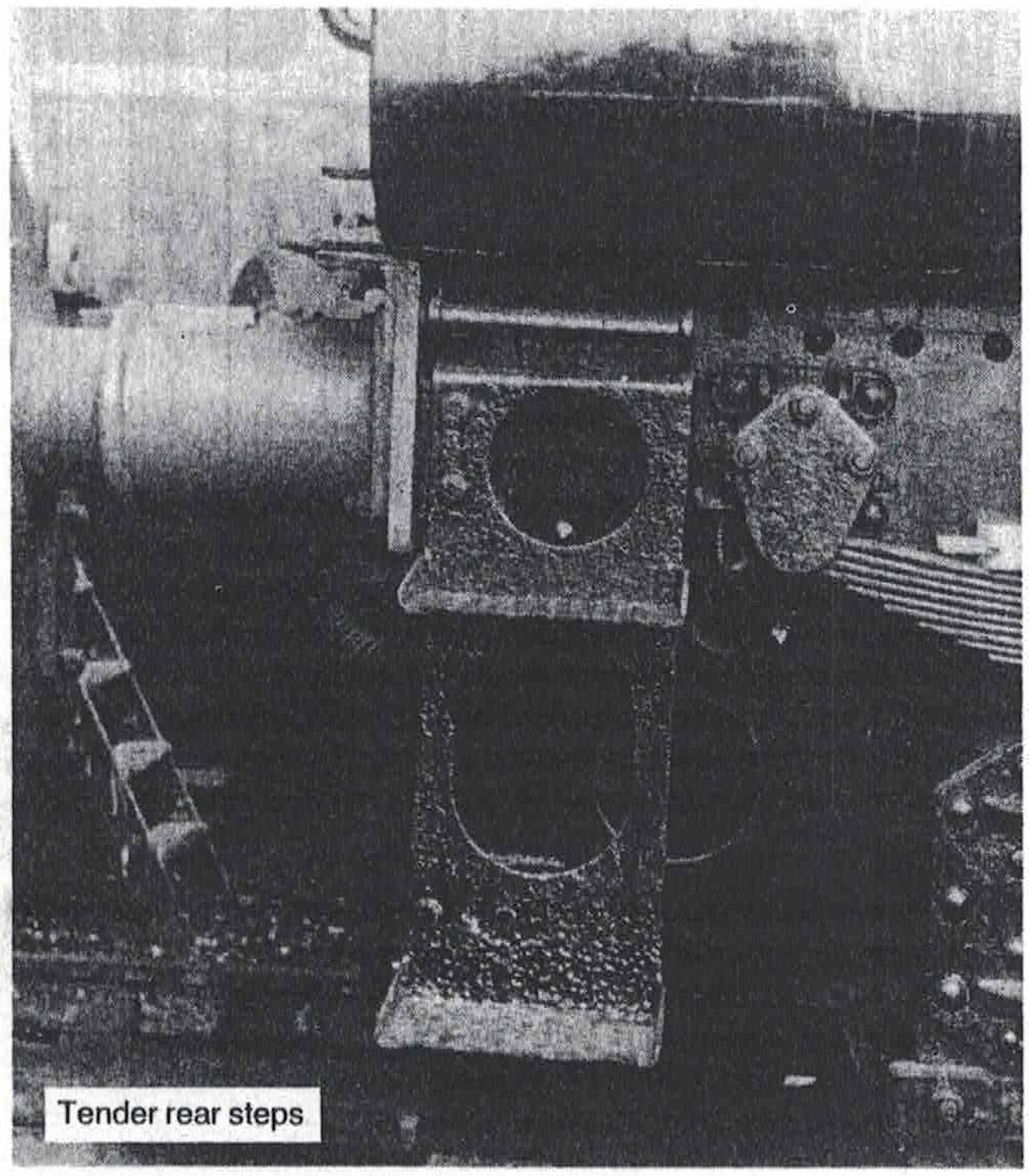
Brake Hanger, Hanger Pin, Shoe and Pins

The brake hanger pins are plain turning from 7/16 in. steel rod, so chuck a length in the 3 jaw, face and turn down to 5/32 in. diameter over a ⅜ in. length, lightly tapering the end with a file for ease of assembly. Reduce the next ¼ in. length to 9/32 in. diameter and radius the shoulder as shown, then part off at 15/16 in. overall. Reverse in the chuck, gripping the 9/32 in. portion, to reduce over an ⅛ in. length to 3/16 in. diameter and screw 40T.

The brake hangers are fabrications, indicating a simple brazing jig. Take a 2½ in. length of say, ¾ in. x 3/16 in. BMS flat, mark on the centre line and grip in the machine vice, on the vertical slide. At ¼ in. from one end, centre and drill through at No. 23. Move on 1 in. on the cross slide micrometer collar to centre and drill No. 31, then move on another 1 in. to complete with another No. 23 hole; press in ½ in. length of 5/32 and ⅛ in. silver steel rod. Next chuck a length of 5/16 in. steel rod in the 3 jaw, face and turn down to 9/32 in. diameter over a length, centre and drill No. 22 to about



I visited the mid-Hants Railway workshops at Ropley on several occasions to photograph BR Class 4 'Mogul' No. 76017 during her general refit. Although the tender differs slightly from that attached to No. 78000, builders should find the details to be useful



Tender rear steps

1 in. depth and part off 1/4 in. slices until you have 12 of them. The centre portion is from 3/8 in. x 1/8 in. BMS flat, so first mark off and drill the No. 30 hole, scallop the ends to fit the bosses which have now been assembled over the jig, then complete the profile. Find a couple of 4 or 5BA washers that between them add up to 1/16 in. thickness, this to correctly assemble the hanger on its jig, before doing so, liberally coat the jig with marking off fluid so that the spelter will not adhere. Mix some flux to a stiff paste and coat the joints, then heat up rapidly and apply some Easyflo No. 2 or similar. Allow to cool, wire brush off all excess flux and to protect brake gear parts from rusting I simply apply one coat of black undercoat, to represent a steel finish, for brake gear full size remains unpainted.

The brake shoes are best made from 1 1/4 in. x 3/8 in. BMS flat, so mark one off on the end of the bar and scallop to fit a tender wheel, and this includes a radius on the inside to match the root radius on the wheel flange, otherwise you will finish up with a square corner. Next drill the No. 30 brake pin hole, then saw away from the bar and profile to drawing. The last operation is also the most important, that of providing the slot to accept the brake hanger. We know how to rough out a slot with a couple of hacksaw blades in the frame and if you do not want to use a wee end mill to complete, then a key cutting file is just as quick. Use an odd length of 1/8 in. rod as a temporary pin, fit the brake hanger pin and erect the hanger to same and in conclusion, the brake shoe must follow the wheel as it rises and falls, but not be too loose a fit that it can 'trip' when the brake is off and jamb up.

We have a total of 20 brake gear pins to make, so let me describe the six for the brake shoes, when only the dimensions vary for the remainder. Chuck a length of 1/8 in. steel rod, face and lightly taper the end, then part off a 9/16 in. length. Check that this gives you sufficient length when assembled for the head to be fitted and vary the length if necessary, this applies to all the pins, then make all six of identical length. For the heads, chuck a length of 3/16 in. steel rod, face, centre and drill No. 31 to about 1 in. depth, parting off 3/32 in. slices. Press them onto the plain ends of the pins and silver solder, then rechuck, tidy them up and remove any excess spelter. Complete with a No. 57 cross drilled hole for a 3/64 in. split pin. Lest the quantities of pins listed confuse builders, and they certainly had me reaching for my correction pen early this Sunday morning, they are sufficient also for the engine, and that includes our next item, the brake beam.

Brake Beam

The main portion of the beam is from 1/2 in. x 1/8 in. BMS flat, 5 3/16 in. finished lengths with a No. 22 hole in the centre, then shaped to drawing. There are two ways of fixing the ends, the first of them requiring a 3/32 in. drilled hole into the ends of the beams to about 1/8 in. depth. Now chuck the 5/32 in. steel rod in the 3 jaw and turn down over a 3/32 in. length to a tight fit in the 3/32 in. hole and braze up. The other and one I have come to prefer over the years starts with the 5/32 in. rod in the 3 jaw. Face and lightly taper the end, then part off a 9/16 in. length. Grip this in the bench vice, saw down to 3/16 in. depth with the pair of hacksaw blades and file the slot to a tight fit over the beam end, then braze up. It may just be possible to assemble the pieces made so far without separating the frames, but much easier to do just that.

Brake Shaft

The frames must be separated to fit the brake shaft, though its manufacture will not delay us unduly. Start with a squared 6 11/16 in. length of 7/16 in. steel rod, chuck in the 3 jaw and turn down to 3/8 in. diameter over a full 1/4 in. length, an easy fit in an end bearing; reverse and repeat.

The main arm is from 1/2 in. x 3/16 in. BMS flat, so mark on the centre line and grip in the machine vice. At 1/4 in. from one end, centre and drill out to 7/16 in. diameter, then move on 1/2 in. to centre and drill No. 22. It is just possible to radius the large end with an end mill over a mandrel, but just as easy to saw out and profile completely with files. If the 7/16 in. hole is too easy a fit over the shaft, just squeeze it gently in the bench vice so that it will not move during brazing, though we still have a second arm to produce ahead of this.

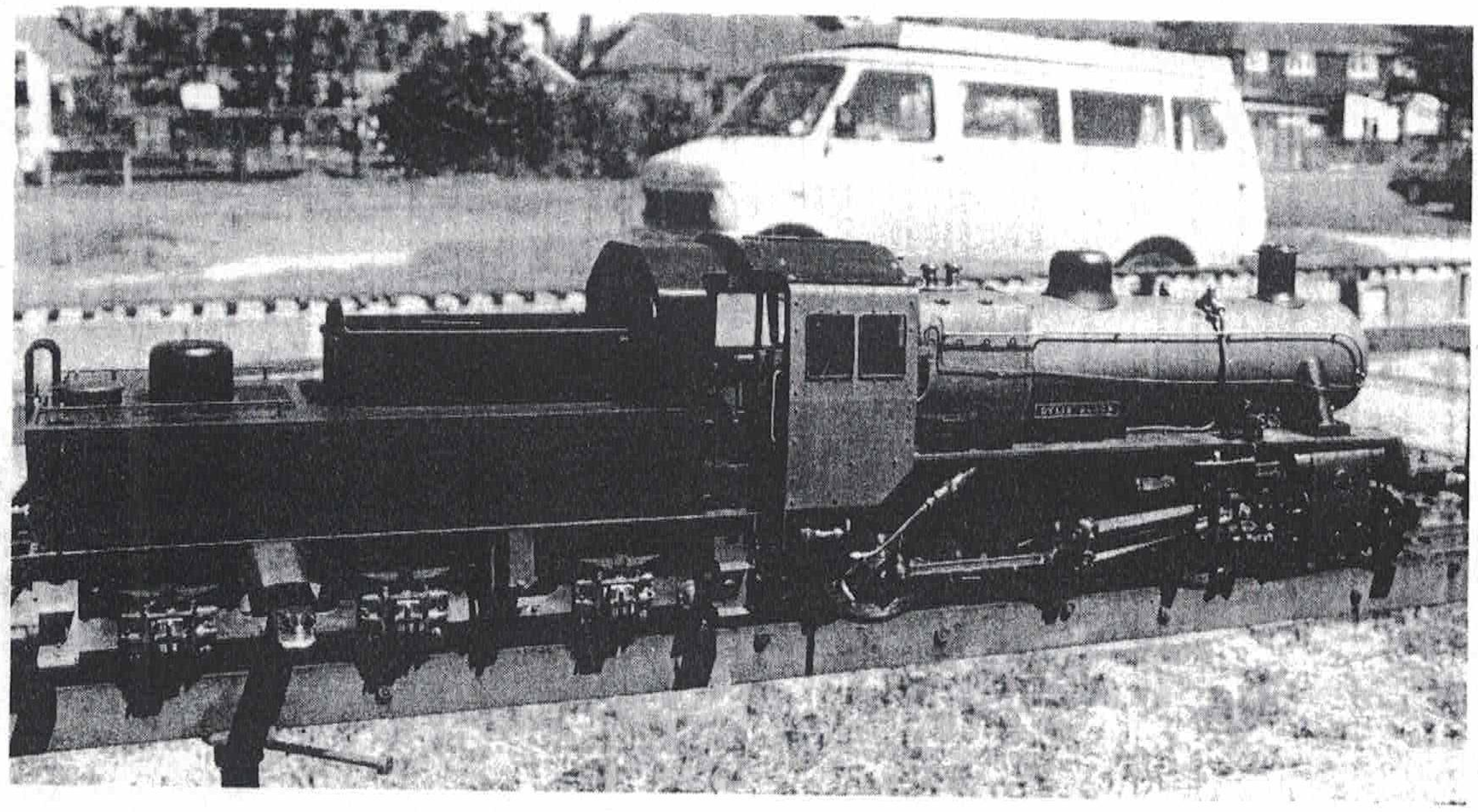
This second arm, for the handbrake, is from 1/2 in. x 3/8 in. BMS bar and requires a bit of fashioning to look right in conclusion. Start this time by drilling a 1/4 in. hole at a full 3/16 in. from one and, then move on 7/8 in. to drill the second at 7/16 in. diameter. Now you will be able to radius around the 1/4 in. hole over a mandrel with an end mill to produce the shape as shown, when the dimension over the end wants to be between 11/32 and 3/8 in. Before sawing away from the parent bar, first cross drill No. 11 to form the bottom of the slot, roughly saw down and complete the slot with an end mill, then grip in the machine vice and mill the flanks to give the 1/8 in. arm, completing with files. The two arms being at 90 deg., it is easy to set them up for brazing, after which clean up and paint.

Brake Block

I was obviously stuck for a description of this piece part back in 1972, for many builders call their brake shoes brake blocks, though I guess there will be no confusion as to its use. Again the second item called up is for use on the engine, so we may as well make the pair at this time. Start with a length of 5/16 in. square steel bar and at 5/32 in. from one end, drill No. 22, when you can radius it to drawing over a mandrel with an end mill, at all times removing the corners with a file to make life easier for the end mill. Grip the parent bar in the machine vice and reduce the section to drawing, keeping the radiussed end nice and central, then mark off and drill the other pair of No. 22 holes before sawing away from the parent bar and radiussing this end also, but using files. Only the slot remains and this is a job for the pair of hacksaw blades and key cutting file, using the front brake beam as your gauge, it being secured to same by a brake pin using the centre pair of holes.

Pull Rods

The first operation when measuring off for the lengths of pull rods is to clamp the brake shoes firmly to the wheels, same being at their normal running height. Also there are two types



Dick Black's lovely 5 in. gauge Class 2 at the DYD Rally at Yeovil. I asked John Plowman to take this shot with the tender cab and bunker in place

of pull rods ends, the first a plain boss from 1/4 in. steel rod and drilled centrally at No. 22, which indicates turning in the 3 jaw, and the other a forked end which requires a more detailed description.

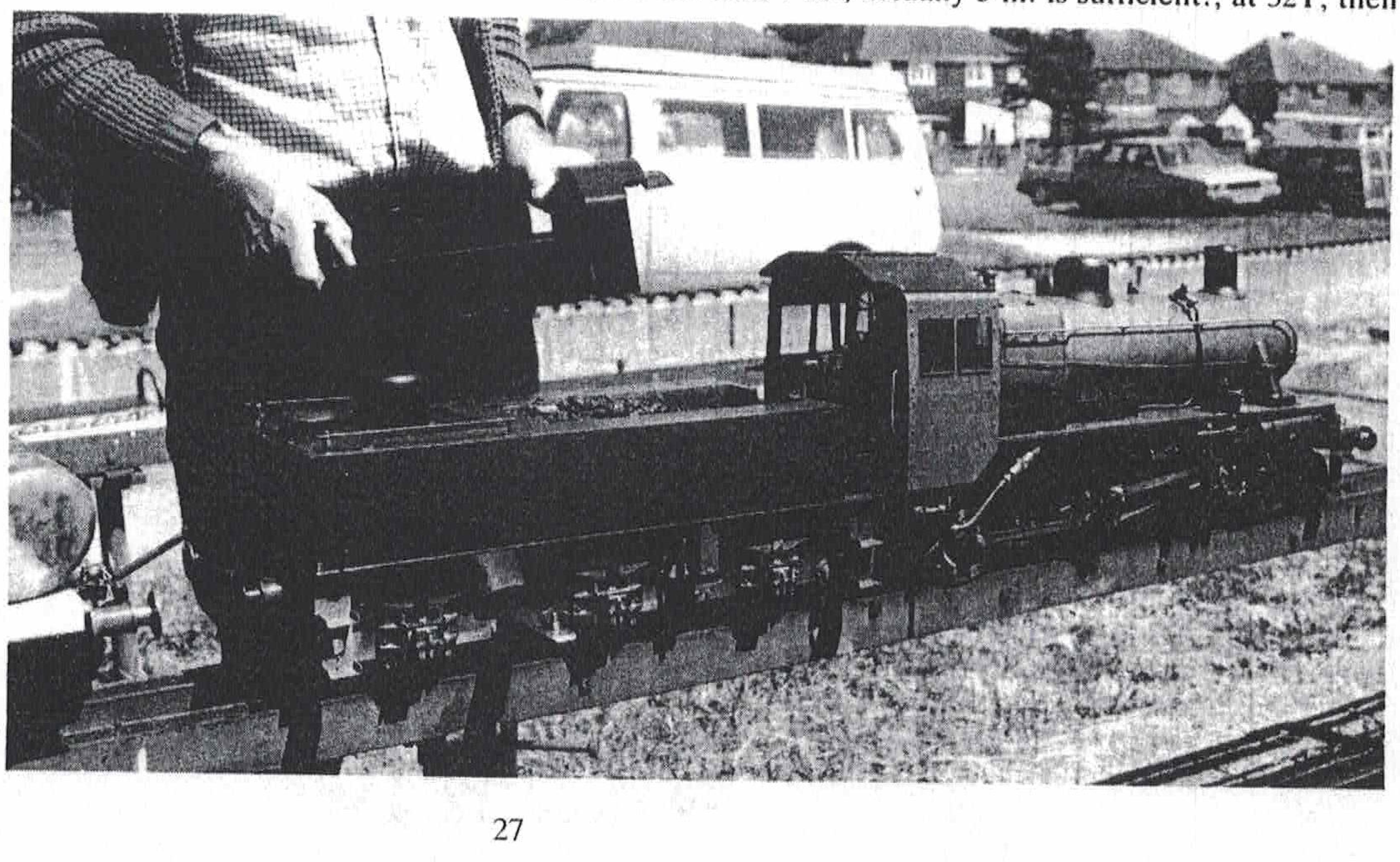
Start with a length of 3/8 in. square steel bar and first reduce to 3/8 in. x 5/16 in. section. Mark off and drill a No. 22 hole at 5/32 in. from one end and radius over a mandrel with an end mill as shown. Next cross drill No. 11, and here I am dealing with the larger of the two patterns of fork end, to saw down and end mill the slot. File the flanks, saw away from the parent bar and radius the end, drilling the second No. 22 hole in the intermediate pull rod end before forming the slot. The smaller pattern of fork end is from 1/4 in. square steel bar, using the same techniques as described, but to the alternative dimensions.

As for the brake hangers, simple brazing jigs are required and I suggest you make a separate one for each rather than a single length of bar with a series of drilled holes as that way leads to mistakes! The actual rod if from 1/8 in. diameter steel, either scalloped at the ends to suit the boss or fork end, the alternative being to turn on a spigot and drill the end fitting to suit; braze up, clean and paint. Assemble the whole with brake pins, check its operation, and we have but the handbrake to complete.

Handbrake

The column is turned up from 5/8 in. A/F hexagon brass or steel bar to choice, so chuck in the 3 jaw, face, centre and drill No. 19 to about 2 in. depth. Bring the tailstock into play to turn the outside to profile with a round nosed tool, the main portion being 9/16 in. diameter. Change to the tailstock chuck to drill 7/32 in. diameter to 3/32 in. depth and 'D' bit to 5/32 in. depth and of course you must leave about 1/8 in. of hexagon at this outer end to form the square later on. Part off at a full 4 in. overall, reverse in the chuck, gripping by the 9/16 in. portion, to face off to length, turn down to 1/2 in. diameter over a 1/4 in. length and screw 32T. Centre this end also and drill 5/16 in. diameter to 2 15/16 in. depth, finishing to 3 in. depth with a 'D' bit or end mill, otherwise drill to 3 1/8 in. depth and leave the plain drilled hole. Screw hard into the front beam to correctly orientate and mark on the front centre line for the 9/32 in. slot; grip in the machine vice and mill this. To be absolutely realistic, it requires for the slot to be surrounded by half round beading, 1/16 in. section, but this can be omitted as being very much an optional extra.

For the brake spindle, chuck a length of 5/32 in. steel rod, and free cutting stainless steel will come in very handy here, to face and turn down to 1/8 in. diameter over an 1/8 in. length. Screw the next 7 in., actually 3 in. is sufficient!, at 32T, then



Dick then obligingly removed the 'top structure' to show how his Class 2 takes to the track, something I was able to sample and will report on in the next issue part off at a full 8 23/32 in. overall, reverse in the chuck and in about 3/8 in. increments, reduce over a 15/16 in. length to 1/8 in. diameter. Chuck a length of 1/4 in. brass rod and turn down to 7/32 in. diameter, an easy fit in the top fo the column, over a 1/4 in. length, then centre and drill No. 23 before parting off a bare 5/32 in. slice. Press onto the spindle in the position shown and silver solder, then rechuck and clean off all excess spelter.

I doubt if any builder can now obtain 13 s.w.g. brass, but 2.5mm is readily available, so mark off and drill the holes as specified, then carefully profile. Fit the brake spindle to the column, bring up the retaining plate and clamp it in place, then spot through, drill the column at No. 55 to 1/8 in. depth and tap 10BA; secure with hexagon head screws and shape the top of the column to match the retaining plate. Actually I was being rather foolish to say that 3 in. of screwed length was sufficient on the brake spindle, for that 7 in. dimension was deliberate so that the brake indicator nut could be fitted, so tap a piece of 3mm brass plate, shape to drawing and check its operation to place.

Brake handle next, a most pleasant piece to make, so chuck a length of 1/4 in. steel rod in the 3 jaw, face, centre and drill through at No. 31, easing with an 1/8 in. reamer or drill to be a tight fit over the end of the brake spindle; cross drill No. 51 before parting off a 7/32 in. slice. Chuck a 1 3/4 in. length of 1/16 in. stainless steel wire in the 3 jaw and radius the ends, then bend to drawing before assembling to the boss and brazing up. Rechuck the boss to remove the unwanted piece of wire with an end mill rather than a drill; erect with a 2mm spring dowel pin.

To operate the brake we still need the nut, so chuck a length of 1/4 in. bronze rod, face and then remove to cross drill No. 29 and tap centrally 5/32 x 32T; it may well take a couple of attempts to get this right, then part off to 3/8 in. overall and assemble to check brake operation. So that the brake nut cannot be completely unscrewed and lost at the track, a wee retainer is required, so chuck a length of 3/16 in. steel rod, face, centre and drill No. 31 to 3/16 depth before parting off an 1/8 in. slice. Press this on the end of the brake spindle and to ensure it never comes off accidentally, cross drill right through at No. 60 and fit a 1mm spring dowel pin.

Buffers

It is sometimes preferable to turn buffer stocks up from castings, but this is one instance where 1 in. square steel bar is much the easier way, so chuck truly in the 4 jaw to first turn on the outer profile. Next centre and drill to 5/8 in. diameter and 1 1/2 in. depth, parting off at a full 1 5/16 in. length, reversing and cleaning up. The separate socket is from 5/8 in. diameter steel bar, so chuck in the 3 jaw, face and turn down to 27/64 in. diameter over a 15/32 in. length. Next centre and drill No. 27 to the same 15/32 in. depth before parting off at 3/4 in. overall. Again reverse in the chuck to centre and drill 5/16 in. diameter to 7/16 in. depth, finishing with a 'D' bit to 1/2 in. depth. There is a wee chequer pattern footstep on top of the stock, positioned as shown, when the three pieces can be silver soldered together to form a neat whole. Rechuck to remove any excess spelter at the socket so the buffer will sit neatly on its beam, then lightly scribe on the 1 1/32 in. bolting circle, marking off and drilling No. 44 and radiussing the corners to complete. BR Standard buffer heads are very distinctive and worth taking time to get them looking right. I can supply suitable castings as alternative to 1 1/2 in. diameter steel bar for the buffer heads, complete with very useful chucking spigots. Chuck by the shank and clean up said chucking spigot, then rechuck by the latter to first turn down the shank to 5/8 in. diameter, a nice sliding fit in the stock. Rough out the head before facing the shank to length, that way you will avoid a costly mistake, then centre and drill No. 33 to 3/4 in. depth. Follow up at 7/16 in. diameter and 'D' bit to 1/2 in. depth, tap the remains of the No. 33 hole at 4BA, then complete the head to drawing and part off the chucking spigot.

Buffer springs must be of sufficient strength that they cannot be fully depressed by hand, then when your train tries to overtake you they will prevent it uncoupling accidentally and cushion any impact. I mention round or cheese headed screws for buffer head fixing, but inexplicably omit the socket head variety, which are completely hidden in such application. Erect the completed buffer to its beam with 8BA hexagon headed bolts and we can move on to the couplings, the last item for the tender.

Coupling

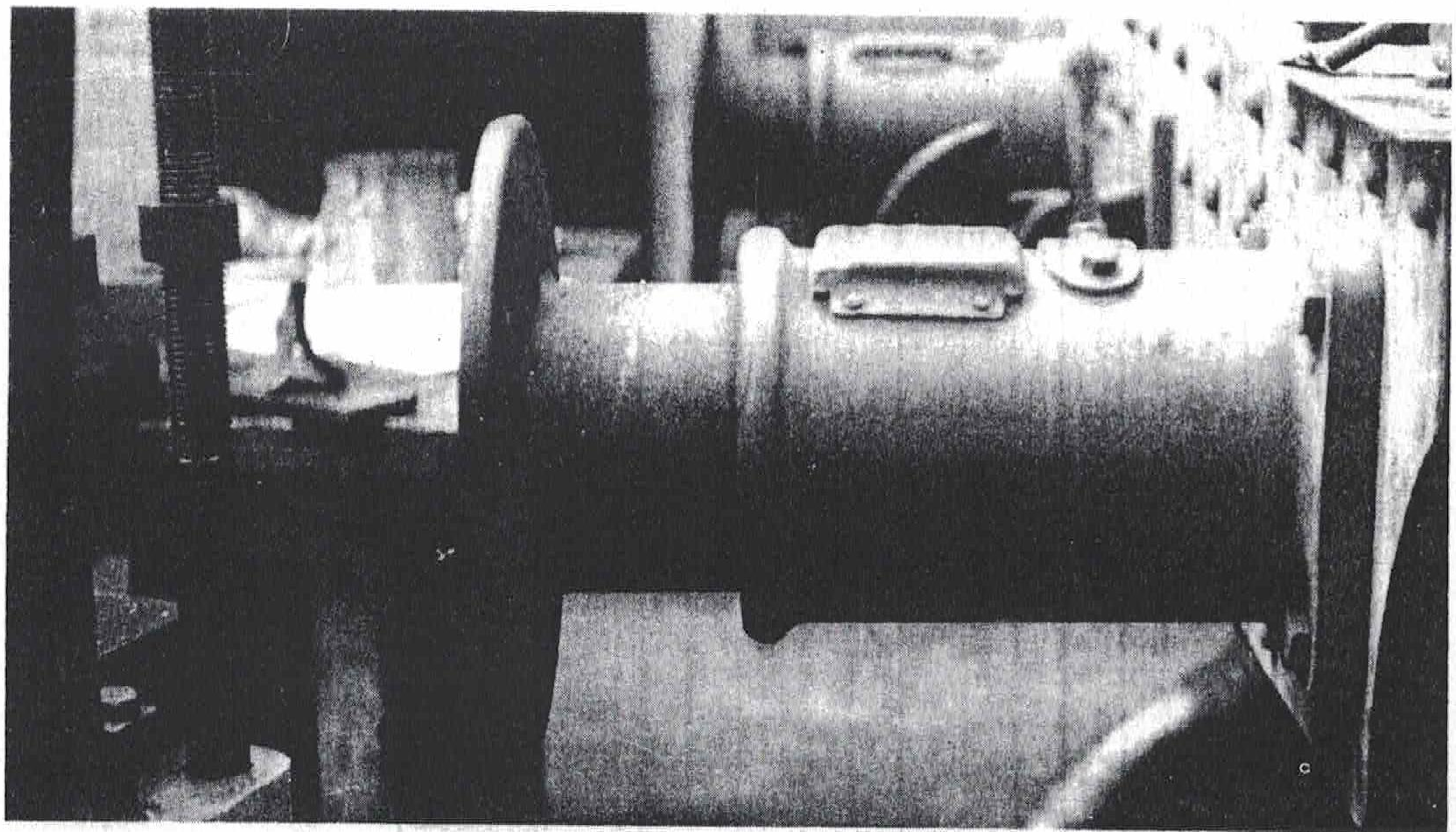
Nowadays I much prefer to see a fork end coupling on the tender, one like I described for DONCASTER, though the Class 2 is not quite in this league for pulling power, brilliant though she is. Start the item as detailed with a length of 7/8 in. x 1/4 in. good quality steel flat and chuck in the 4 jaw to turn on the shank to 7/32 in. diameter, length to drawing, in about 1/2 in. increments and screwing the end 3/8 in. at 40T (or 32T). Saw out to profile and then shape by eye, the most important feature being that the link coupling from the driving trolley fits snugly. For the actual shape I can refer builders to my pictures of No. 41241 as they appeared in LLAS No. 35, where incidentally they stirred up a hornet's nest for me!

When No. 78000 was introduced back in 1972 I was content simply to draw engines and sometimes describe them in 'Model Engineer'; there was no thought of going commerical. It was only when Reeves declined to introduce castings, as at that time I had no thought to serialise the design, that Norman Lowe stepped in and made some patterns, ones that he subsequently offered me and which formed the starting point of my castings supply. My state of mind at that time can best be summed up when some model engineers approached me about the 2-6-2T version, saying they would like to build a tank engine, but only if I declined from producing drawings for same; they wanted to build an unpublished design. I was happy to promise them no 2-6-2T from my drawing board in 1972, and have kept this pledge, though by the requests coming in these past months for one, I am in a cleft stick! In the ensuing 16 years I have lost touch with nearly all the builders of the tank engine version, save for Eric Coward, and I can only make the plea in these pages for the other builders to contact me with a view to allowing me to cover the 2-6-2T. The alternative of course and one very attractive to me, is for one of them to contribute to 'Builders Corner', a feature that has disappeared from LLAS in recent times, and one I for one would like to see reborn.

THE BOILER

Two boilers described in a single issue of LLAS, and for the Class 2 I have no Dave Johnson to do the spadework for me! However, before any boiler is attempted in the future, I am going to strongly recommend breaking off to read Alec Farmer's authoritive MODEL LOCOMOTIVE BOILER-MAKING as insurance against disaster, and in this no way am I abdicating from my own responsibility on the subject.

Remaining with the construction rather than the design of the boiler for a moment, the greatest advance since 1972 has been the provision of kits by our suppliers. It was just after the advent of No. 78000 that I discontinued the Material Lists, and I must say that one particular model engineers supplier, not one of our advertisers I hasten to add, complained bitterly to me about this, for now he had to make his own assessment of material requirement, instead of being able to blame this designer if my list was wrong! Talking of design, this one was very easy and only the inner firebox and tube layout required any thought. The water legs at the side of the firebox I determined at a minimum of 5/16 in., and this is perfectly OK in any area provided the boiler is blown down after every run,



Front buffers on No. 76017; note the wee footstep

as it should be. This gave a neat tube layout with the two superheater flues out on the wings, a position that has become a favourite with me and adopted because I had just completed a year's hard running with a MAID OF KENT, having experienced great difficulty cleaning the 4-in-a-row flues. Also I had read a lot about sizes of firetubes and on my K1/1 had mixed 7/16 and 1/2 in. o.d. as an experiment; finding the smaller ones to give good result, they were adopted for No. 78000.

The only other point is that the two bottom tubes could be omitted if any builder is worried about them blocking in service, though they are well clear of any normal depth of fire, in fact as with the 2P some years back, so I got caught with my sloping grate on No. 78000 at Yeovil, trying to keep the top of the fire level instead of just putting coal through the door and allowing it to shake forward naturally; one day I will learn! Enough of the preamble though, on with construction.

Mention of boiler kits earlier reminds me to recommend that the boiler barrel is purchased ready rolled with joint silver soldered, removing the largest obstacle in one go. This boiler has a genuine tapered barrel, both top and bottom, so no funny shapes at the ends and we can turn them. Cut a wooden bung to fit the throatplate end, chuck in the 3 jaw and drill right through the wood, it wants to be at least 1/2 in. thick, at, say, 1/2 in. diameter. Now chuck a length of 5/8 in. diameter brass bar, face and turn down over a 1/2 in. length to a tight fit in the hole just drilled, parting off to leave an 1/8 in. thick head. Reverse in the chuck and deeply centre, tap the bung into the barrel, grip the front end on the inside in the 3 jaw and bring the tailstock into play. With a very sharp tool and I have been known to use a screwcutting one here, pull the lathe around by hand and cut the large end of the barrel to length, then deal similarly with the smokebox tubeplate end, using a file in the bore to remove all burrs. I like to lightly scribe four centre lines along the barrel whilst it is still mounted this way, with a scriber under the toolpost, but same is not possible here, so use a scribing block and just mark on what will become the top centre line. Although the barrel has to be cut away in way of the throatplate, this is better left until we have positioned the latter.

The throatplate is one of those double flanged jobs requiring two flanging plates for the amateur to achieve, but one the professionals arrive at without problem, so from your boiler kit you select this plate, clean up the side flanges and bed the curved top one to fit the barrel. Leave the 7/16 in. hole for the blow-down valve bush for the moment as it is easier to drill this once the front section of foundation ring is in place, then you will not have to worry about filing to a fit. Just clamp the throatplate to the end of the barrel and we can deal with the outer wrapper.

I see Dave Johnson has stolen my thunder with his wooden former for the outer wrapper on his POM-POM, but this is the perfect way for a Belpaire firebox with just about every surface a curved one, so make this up to be 6 in. long. The copper sheet will likely be supplied in the half hard condition, which means it can be pulled around the former without annealing, using a wooden mallet to teach it manners as you go round the tighter corners; in conclusion, check it both against the barrel and throatplate, plus the backhead as well and rectify any errors at this stage. Mark the top centre line on the outer wrapper, get it to coincide with that on the barrel with 5/16 in. overlap as shown, then drill through at 3/32 in. diameter, securing temporarily with a 7BA bolt. You can see the way the backhead projects 1/4 in. past the outer wrapper and the throatplate wants to do the same, so position it carefully, scribe onto the barrel and cut the latter away, leaving enough meat at the outer wrapper joint; be generous about this rather than sparing. The next job is to rivet the outer wrapper to both barrel and throatplate and there are big gaps in the top corners which are left open for the moment. Drill through at around 3/4 in. pitches where there is metal and secure with 7BA bolts, keeping the pieces together with clamps as you proceed. Remember to leave at least 3/4 in. at the bottom corners, otherwise your rivets will foul the foundation ring.

The dome bush is a phosphor bronze casting and includes the flange, so first chuck by the bore in the 3 jaw and turn down the outside to 2 3/8 in. diameter over its full length, facing across to clean up and really getting under the skin of the metal to remove any slight blemishes. Now chuck by the turned outside, face this end and bore out to 1 3/4 in. diameter against your chosen dome tube as gauge. Next reduce the outside further over a 3/8 in. length to either 2 5/16 in. or 2 1/4 in. diameter, no smaller, then scribe a circle at the dome position on the barrel to suit. My workbench has an angle iron front to it, put there to stop small parts falling off and getting lost, having watched uncle Hector Tutton spending hours sweeping the floor after knocking a watch part off his bench!; such happened every other week!! A bonus is that the barrel can be placed hard against the angle and a block of wood nailed behind it, when one can work happily on said barrel, centre popping it around the inside of the circle, then drilling about No. 30 holes and breaking them into one another, removing the surplus piece and then filing to your dome bush as gauge.

Check that it penetrates fully into said barrel at the sides, and being tapered you will have to scallop the bush at the back so that it sits level, increasing the 3/8 in. dimension to 7/16 in. or even longer to achieve full penetration if indicated. Back to the 3 jaw to chuck by the bore, parting off to leave a 5/32 in. thick collar as indicated, plus the 1/8 in. for the dome flange, though this latter wants initially to be at least 5/32 in. thick for reasons that will become clear later.

Although the top feed bushes can be turned up and fitted at this stage, their positions indicate that they can be easier dealt with when we come to the smokebox tubeplate fixing, so place the assembly as it is carefully in the pickle whilst you prepare your brazing kit.

A brazing hearth is essential if only to hold the boiler steady, though using firebricks you can save a lot of heat that would otherwise be wasted. Despite disagreeing with the real experts, I would always use a propane torch, though I have no great preference for the actual spelter; your kit supplier will cover this for us both! Mix some flux to a paste that will adhere to all the joints to be tackled without running all over the place, otherwise the spelter will follow its path and cost you more pennies, nay pounds! Stand the outer wrapper up on its backhead end and pack around so there is no chance of its falling over, then begin applying heat around the wrapper joint. I will always do such jobs on a cool winter's evening so that I can see when the copper just begins to show red, just the dullest shade, when the spelter is held momentarily in the flame, dipped in dry flux and applied to the job, advancing the flame and watching the spelter follow it, hopefully going ahead, Go right around the wrapper joint, then the throatplate to the barrel and finally the dome bush, tipping the boiler over if there is tendency for said dome bush to drop out. Allow to cool then place carefully into the pickle, leaving it whilst you enjoy a cuppa, then take it out, wash off and inspect all the joints, reheating if there are any 'misses'.

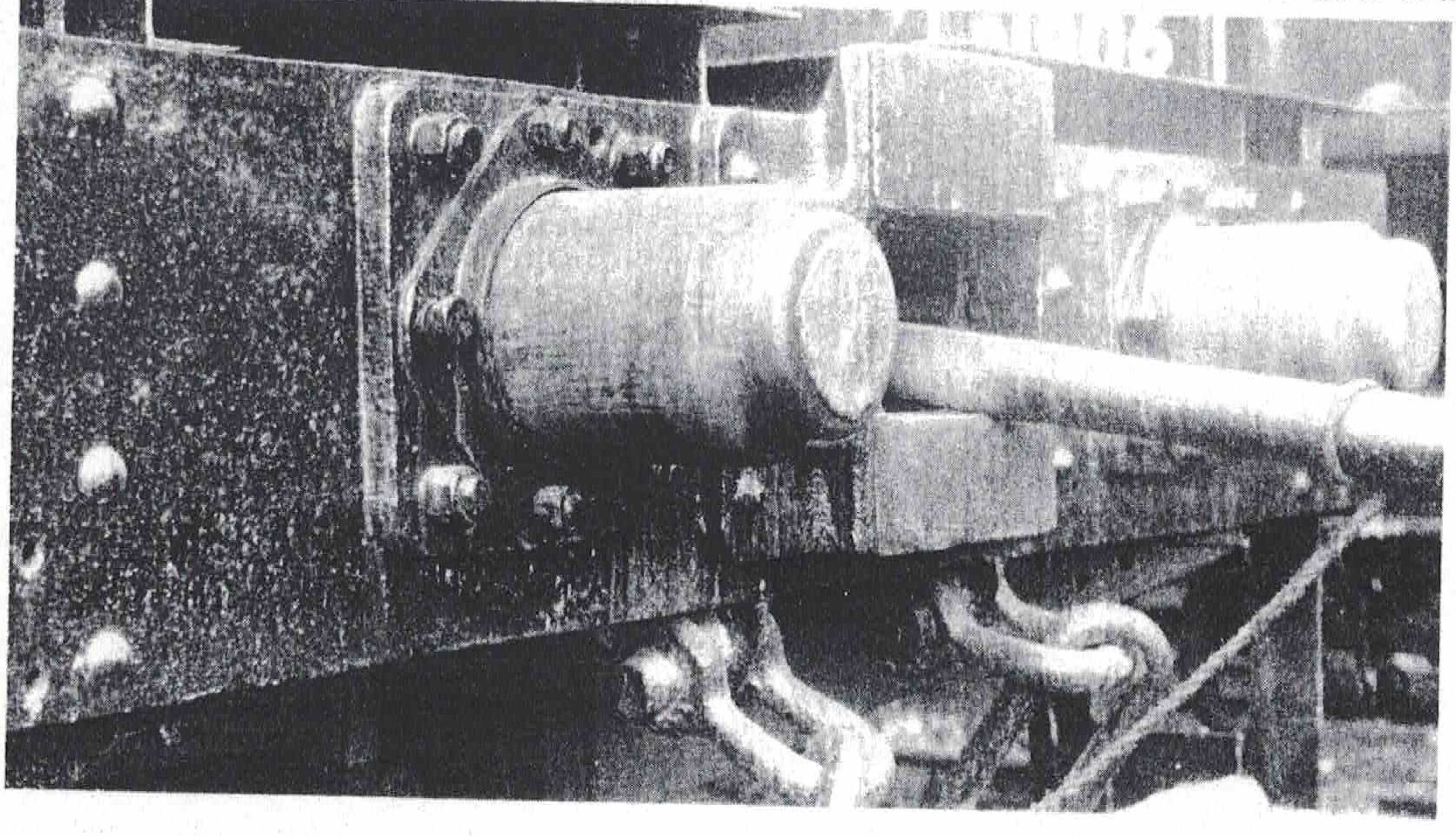
The Firebox

This is a lovely, deep, little firebox, one that will ensure that the boiler makes more than its fair share of steam and masters the cylinders. The two flanged plates first require our attention, so rub a file over the flanges and then concentrate on the tubeplate. This is likely to have already been marked out for you, with maybe the luxury of pilot holes at the tube centres; the 19 firetube ones want drilling out to 27/64 in. diameter and then reaming at 7/16 in. Do this operation in the drilling machine, with the plate clamped firmly to a large block of wood, then you will not damage either the precious table, the copper, or just as importantly yourself! There are now a variety of tools for cutting large holes in thin sheet, Jack Coulson described a home-made one back in LLAS No. 7 and no plumbers kit is complete without a similar tool for cutting holes in water tanks, though I would still stop short at about 15/16 in. diameter and complete with a round file with your flue tube as gauge; that way you can achieve a tight fit.

The backplate requires a hole of around 1 9/16 in. diameter, though this will depend in part on the firehole ring material supplied in your kit, which may vary from the 8 s.w.g. that I have specified. Chuck said material by its bore in the 3 jaw, face and turn down for 3/16 in. at one end, the thickness of the remaining tube not to be less than 2mm. Reverse in the chuck, still holding by the bore, to face off to length and turn on a similar step, one that is 5/32 in. long, when you may anneal the tube, though it is best to try it as supplied before resorting to annealing. Mark off the backplate, scribe on the ring and drill out the surplus centre just like for the dome bush. Remove all burrs and slightly chamfer the inside, then fit the tube, support it on a wooden or lead block and peen well over. If the two end plates do not have centre lines scribed on them, and I will be surprised at such an omission, rectify same immediately, then choose the firebox wrapper material and mark on its top centre line at the starting point.

Whilst boilermakers amateur and professional will make a wooden block former for the firebox wrapper, I have never yet found the need for same, especially for a shape as simple as that on No. 78000. Perhaps a reason for this is that in stripping a horse drawn hay turner many years ago now, it was to find the excellent shaft material it yielded too tough for normal turning, but ideal for bending things like copper sheet over, though I do not want to influence builders choice in the matter. So you either bend the sheet to fit your wooden block, or mark further centre lines 1 5/16 in. each side of the one already scribed on, and bend the top corners over a length of 1 in. diameter steel bar, clamping the ends of the sheet to same to properly hold them. Try against the end plates and correct as found necessary, then complete the bending by hand to those end plates as your gauge. Secure in place with a minimum number of 3/32 in. snap head copper rivets, positioning clear of the crown and girder stays yet to be made and fitted, our next job.

Erect the firebox inside the outer wrapper, you can try a few tubes in place if you like but also check around carefully with calipers that everything is nice and central. One instruction I have omitted is to cut the front section of foundation ring from either 1/2 in. x 5/16 in. or 3/8 in. square copper bar to a fit



To keep the drawbar between engine and tender taut, buffers are fitted to the front beam on BR tenders. Because of the tight curvature on some miniature tracks, this feature is difficult to incorporate in 5 in. gauge and could well lead to derailment. However, the detail is included for authenticity's sake

inside the throatplate and clamp over same to get the firebox in its correct position, in fact you can now drill 7/16 in. diameter for the 'Everlasting' blow-down valve bush. Use your inside calipers to establish the height of the girder stays, along their full length, when the dimension should be very close to 1¾ in.
Leave the firebox in place and bend up said stays from 1.6mm copper sheet, easily achieved in the bench vice, checking to place as you proceed and when satisfied, rivet them back to back. The ends need to be snaped to come clear of the barrel and backhead, a matter of about ⅜ in., then drill the row of holes to clear the cross stays which will be fitted later on, and if you are worried about their position, then you can drill up to ½ in. instead of the ⅜ in. diameter dimensioned. The crown stay is ⅜ in. x ⅜ in. section from the same 1.6mm sheet and riveted together as a pair as before. You may well be able to clamp these stays in place without drilling any holes, if so then so much the better, otherwise secure with just four rivets in the corners, as filling holes with spelter is far more difficult than an ordinary joint. As the bottom of the firebox slopes uniformly, it is as well to trim off the excess at this stage whilst the copper is not too soft, when you can put the firebox in the pickle. All the joints are going to be tackled in one fell swoop, though if the silver solder stops running freely, then you stop too!, pickle again and carry on as before. Flux all the joints, not forgetting the firehole ring, lay on said ring in the brazing hearth, pack securely and beginning at the tubeplate, keeping the flame away from those delicate holes as much as you can, go right round that joint. Now stand the firebox upright to deal with the crown and girder stays, then stand on the tubeplate to deal with the backplate joint and firehole ring; allow to cool, pickle, wash off and inspect.

Fitting the tubes

We are gaining in ways of fitting the tubes, spigotting them as per Jack Coulson, swaging as just described by Dave Johnson for POM-POM, or drifting them in with a taper pin as per yours truly: Alec too has a different assembly procedure here, so take your pick! The important thing is to check that the tubestack resulting is both square to the tubeplate and parallel with the sides of the firebox, with the smokebox tubeplate fitted at the outer end to hold things nicely in alignment; we must deal with the latter flanged plate.
Chuck in the 3 jaw by the inside of the flange and turn to a tight fit in the boiler barrel; this is why it was so important to remove the burrs when squaring off the barrel to length; face the flange to the ½ in. dimension. The steampipe flange is turned up from drawn gunmetal bar, something I can supply if it is not in your boiler kit and I will describe its manufacture, when only the dimensions will vary for all the other bushes yet to be made. Chuck in the 3 or 4 jaw as the material indicates, face and turn down to ⅞ in. diameter over a ¾ in. length then further reduce to 13/16 in. diameter over a 5/16 in. length; part off at a full ½ in. overall. Reverse in the chuck, only this time it will definitely be the 3 jaw, to face off to length, then centre and drill right through to 37/64 in. diameter. Support a ⅝ x 26T taper tap in the tailstock centre, enter it into the bore and make about four full threads, just sufficient that the tap will enter squarely when you come to tap right through later on.
Drill and/or file the tubeplate to accept the bush, then deal with the tube holes as at the firebox end, in fact if it was not marked out as supplied, you should clamp to the firebox tubeplate and put pilot holes through. That leaves a trio of No. 11 holes for the longitudinal stays, which want to be countersunk on the outside to allow a fillet of silver solder to build up, and a last one tapped 5/16 x 40T in the parent copper, though fit a separate bush if you are at all worried about tapping the copper here.
Wind up a spiral of silver solder and cut off individual rings to drop down over each fire and flue tube, then fit the smokebox tubeplate over the outer ends. This time the silver solder wants to be of a lower melting point and I must say Easyflo No. 2 is my favourite here, so mix some appropriate flux to a runny paste and get it right to the centre of the tubestack. This time use a more diffuse flame and keep moving it around so as not to burn any of the delicate tubes, watching for the spelter to melt and looking inside the firebox to see it penetrates fully; cool, pickle, wash off and inspect.

Assembling the Firebox

Turn up the bushes for both safety valves and manifold, then drill and file holes on the top centre line of the outer wrapper to accept them, though initially we shall use these holes for another purpose. Erect the firebox inside the outer wrapper with the front section of foundation ring in place, the first requirement being to get those girder stay flanges in really intimate contact with the outer wrapper and you can use home-made cramps through those three openings you have just dealt with to achieve this rather than worrying about any rivets. When satisfied and of course you can adjust the flanges with your wooden mallet, clamp over the throatplate, foundation ring and firebox tubeplate to drill through for two 3/32 in. snap head copper rivets, heads inside and hammering down into countersinks in the throatplate; use a dolly to support the rivet head and do draw the rivets with the little tool I have described for earlier boilers in LLAS. Perhaps though before riveting the firebox in place it would be as well to mark off and cut away the excess metal on the lower ends of the outer wrapper, taking your cue from the firebox, the 5/16 in. dimension applying. Before moving to the front end, fit the blow-down valve bush.
Enter the smokebox tubeplate and align the tubes with pencils or the like, tapping it home to be flush with the end of the barrel as shown. The three 3/16 copper rod longitudinal stays want to be at least 18 in. long, so that they project well beyond the plates and need to be crimped ½ in. from one end so that they do not fall right through when inserted, this during the brazing operation. Turn up the bushes for the top feeds and fit these to the barrel, then back to the firebox end to fit the side sections of foundation ring.
Bring up a section of rear foundation ring and clamp it to the firebox backplate, this to give us a guide for the side sections. These latter are from 5/16 in. square copper bar and held in place with a couple of rivets, when you can return the boiler to the pickle.
Lay the boiler on its back on the brazing hearth with the firebox projecting, which means it must be packed down to avoid its falling off, then flux around the foundation ring, the blow-down valve bush and the girder stay flanges. Get your torch going with a fierce flame and concentrate first on the outer wrapper in way of the girder stays. If you have done your job properly then the heat will transfer and as soon as you see both wrapper and flanges a dull red, feed in spelter and watch it run through; you will deal with those three bushes as a separate heat.
Now move to the foundation ring, starting at a back corner, watching the colour, feeding in spelter and looking for full penetration as far as you are able and not forgetting that bush; stop and pickle. Now flux the front end, including the top feed bushes, stand the boiler upright and play your flame on the end of the barrel; the boiler must be packed up sufficiently that you can drop those longitudinal stays in later on. Feed spelter into the joint, deal with the pair of bushes, and likely you will then find the whole area is hot enough for the spelter to run freely around all the tubes, just bringing the flame up if there is any stubborness. The steampipe bush could have been dealt with separately; if not then feed spelter in now and then drop in the longitudinal stays; cool, pickle and inspect.

The Backhead

Just the backhead to fit, so first mark off and drill the 3/16 in. holes for the longitudinal stays to protrude, then mark back through the firehole ring and deal with the hole, peening over the ring when fitted. Before this though turn up and fit the water gauge bushes and another for the blower tube if you wish. Make the rear section of foundation ring a decent fit and no other fixing will be necessary, otherwise teach it manners with a couple of rivets. Remove any spelter at the three top bushes and fit these also, then pickle and flux. Stand the boiler on its smokebox end, a hole in the brazing hearth helps here, otherwise pack it securely, then with fierce flame, warm up the whole area before concentrating on a corner of the backhead joint. As you feed around the joint, see if the joint around the firehole ring will run, otherwise deal with it next and thèn the boiler bushes, finally laying the boiler on its back to complete the foundation ring. Allow to cool right out, then pickle, wash out carefully and inspect, and don't miss those longitudinal stay ends as I have!

Preliminary Air Test

Before staying and fitting out the boiler, it is a good plan to check your work thus far, which calls for a low pressure air test. Tap out all the bushes and fit plugs and cut a wooden bung for the dome opening, though a rubber cork is much better if you can find one. Fit a cycle inner tube valve to one of the bushes, apply about 12 pumpfuls of air and immerse the boiler completely, looking for tell-tale bubbles. As air will be trapped initially, make sure this has all gone before starting to worry about your workmanship!, which should be sound! Better than mine in fact, for I have forgotten the regulator spindle bush alongside the dome!

Regulator Spindle Bush

Actually there is no great harm done in leaving this bush until now and dealing with it completely separate from the rest of the boiler, though really the air test should be delayed for its fixing. It is the single most item that has caused problems for builders, not in itself, but because its alignment is critical as if poorly fitted it can 'trip' the regulator valve from its seating, with predictable results.

Chuck the drawn gunmetal bar again and reduce to 3/4 in. diameter over a 1 1/4 in. length, it will be well faced by now! Centre and drill 15/32 in. diameter to the same 1 1/4 in. depth, tapping the outer 1/2 in. or so at 1/2 x 32T; part off a 1 in. slice. Reverse in the chuck, countersink the end and 'D' bit out to 9/16 in. diameter and 5/8 in. depth, or bore to size. Mark on the position of the bush on the boiler barrel, it is 3/8 in. behind the centre line of the dome, and if you have an odd end of wooden dowelling, scallop this to a fit and scribe round. A drill will wander badly unless held square to the tube, but if you open out this way in stages to 5/8 in. diameter then you can complete with a file to the bush as your gauge. Its support is critical, so chuck a length of 1/2 in. steel rod in the 3 jaw, face and screw 32T over a 3/8 in. length, part off at 2 1/2 in. overall and file on two flats. Fit to the bush from the inside, erect to the boiler and clamp the 1/2 in. rod through the dome opening to both align the bush and hold it firmly in place. Mark off for the five 3/16 in. copper rod cross stays on both sides of the outer wrapper to drill through and these want to be at least 6 in. long with crimped end as for the longitudinal trio. Lay the boiler on its side on the brazing hearth, regulator bush uppermost and feed in the cross stays, then flux. For here we need a small concentrated flame, the only place where an oxy-acetylene torch would come in handy, for we only want to heat locally and avoid soaking the whole boiler again, for that way leads to distortion and possible cracked joints. Deal with the regulator bush and the five stays ends on that side, then pickle, flux the other side and deal with these five stay ends in turn, remove the steel rod from inside the boiler.

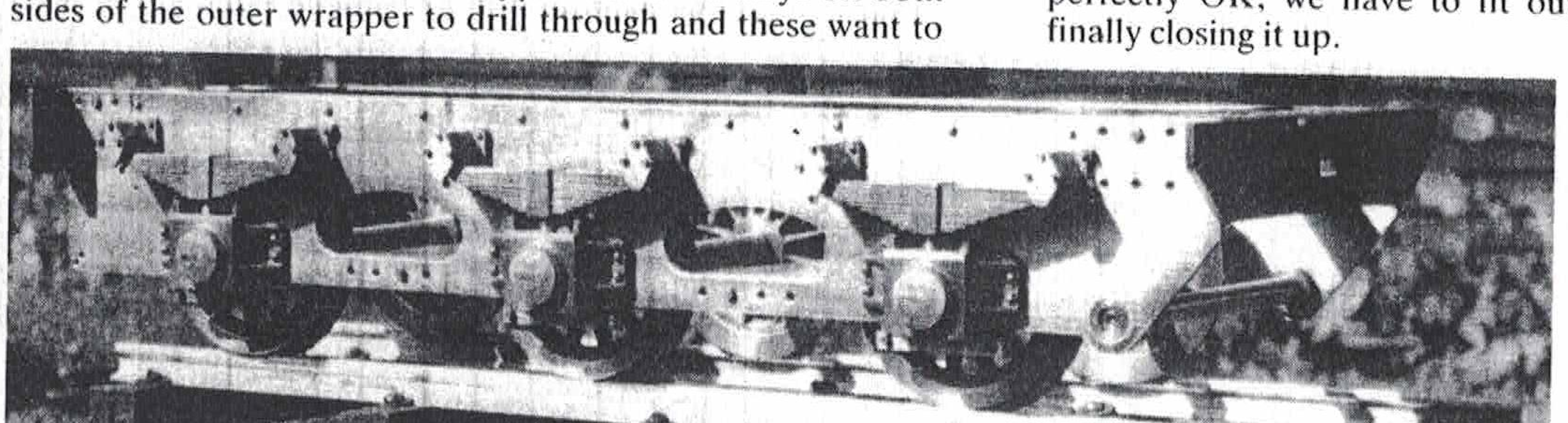
Staying the Firebox

There may well be a blower valve and union detailed on one of the remaining Sheets, but in any case I have described enough of them already in LLAS, Nos. 29 and 32 covering these details for DERBY 2P and describing their manufacture, the connecting tube being 3/16 in. o.d. x 18 s.w.g. copper. The early 1970's was the era of the copper rivet as plain firebox stays, though the amateur experienced difficulties in silver soldering them as strength was required here instead of the pure sealing of screwed stays as my note about alternative 4BA phosphor bronze screws bears witness. I would now put those screws top of the list, so mark off and drill a row of holes at No. 34, then with a brand new set of carbon steel taps, put the taper one through the outer wrapper. Remove it and clean off the swarf, then dip again in the tapping compound and proceed through the inner firebox. Screw in a stay, put a brass nut on the inside and tighten it up, then saw off the head to be at least 1/8 in. proud. Carry on a row at a time until all 85 stays are in place; I was once told this would take weeks but my own experience is that a couple of evenings will suffice. We shall seal the stays with Comsol as available from Reeves, for which we need but a gentle heat, but a nech burner so we can go inside the firebox without the flame extinguishing. Flux one outside face and the opposite inner one, heat up gently and then concentrate on each stay head in turn, in a strict order so as not to miss one of them, then pickle, wash off and repeat the dose, dealing last with the front group of eight and the backhead seven.

Dome

Dome next, so square off a piece of 1 3/4 in. o.d. x 16 s.w.g. copper tube to a full 1 1/2 in. overall. The top plate is from 3mm copper and may be bushed identically to that for the blowdown valve; cut and file to a good fit in the tube, then fit the flange already made and braze up. At this stage you will likely find the flange has bananad, so chuck in the 3 jaw to face across, at the same time scribing on a bolting circle at 2 1/8 in. diameter. Mark this circle into 14 equal pitches and drill through at No. 34, then offer up to the dome bush, spot through, drill No. 44 to 1/4 in. depth and tap 6BA. Screws are best made from 3/16 in. phosphor bronze rod, so chuck in the 3 jaw, face and turn down over a 5/16 in. length to .110 in. diameter, screwing 6BA. Part off to leave an 1/8 in. thick head, one which you complete with a saw cut as the screwdriver slot.

The gasket I have always made from stiff brown paper soaked in linseed oil, though 1/64 in. thick Hallite or similar is perfectly OK; we have to fit out the dome though before finally closing it up.



An extremely well detailed 5 in. gauge BR tender chassis

The Regulator

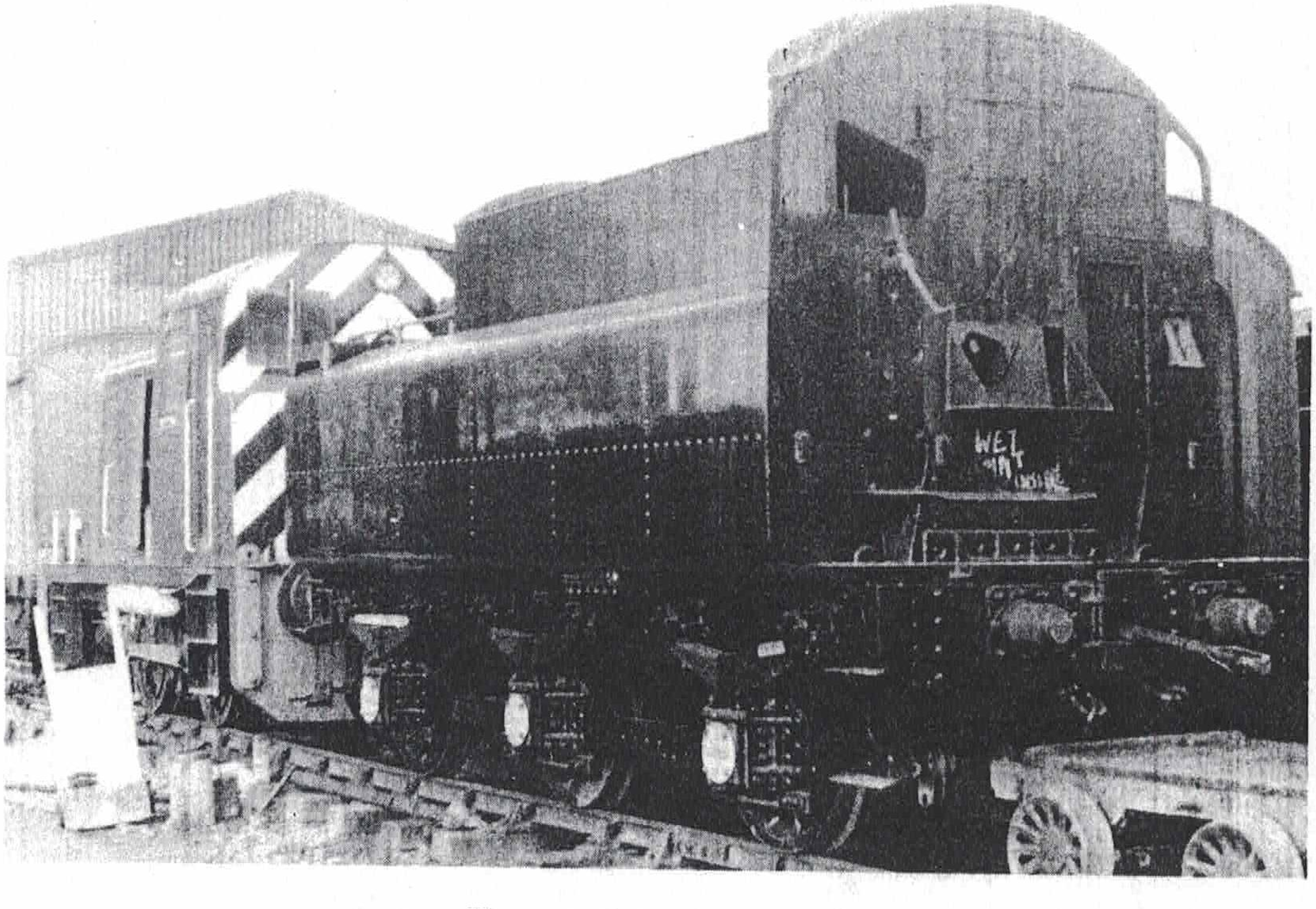
Bill Naunton from Norwich sent me a regulator body for his Class 2 with which he was experiencing difficulty of which more in a moment, but what alerted me was it was a casting as against the fabrication I had always envisaged. Looking through my stocks I found that the casting for MOUNTAINEER is suitable, so can supply same, though it does need about ⅝ in. cut off at the top; still useful material though! Grip in the machine vice to reduce the section to drawing, then centre and drill down 11/32 in. diameter to 2 3/16 in. depth, completing with a 'D' bit; clean off the top. You can chuck in the 4 jaw to deal with the steampipe fixing, so face, centre, drill 25/64 in. diameter into the main bore and tap 7/16 x 26T. Relieve the securing foot in way of the dome bush, the latter could well be scalloped to reduce the amount of relief required here, then file the foot to suit the boiler barrel. The plug at the top is turned up from ⅜ in. rod to a light press fit in the bore and then silver soldered to secure it, which brings us back to the working face. Mark this off carefully and drill three No. 48 holes along the centre of each port, opening out with a 3/32 in. end mill to form the slot and the ends can well be left round, then drill No. 40 in two positions for the guide bolts, tapping 5BA and all holes go through into the bore. Brazing and machining will likely have distorted the working face just slightly and the best way to finish it properly is with a fly cutter. Don't worry if you do not possess such a tool, just grip a round nosed tool eccentrically in the 4 jaw, run the lathe at top speed and take the lightest cut across with the casting still in the machine vice.

The regulator valve I would start from a gunmetal cylinder cover casting, turning it down to about 3/16 in. thickness initially, marking it off and sawing out to profile, milling the long side edges. Grip in the machine vice, deal with the ports as for the body, then drill No. 30 holes to start forming the guide slots, opening out with an end mill. Drill No. 23 for the operating pin, press it in and braze, then fly cut the working face to finish as before. The guide bolts are from 3/16 in. A/F hexagon bronze rod, so chuck in the 3 jaw, face and turn down to ⅛ in. diameter over a ½ in. length, screwing the end 3/32 in. at 5BA. Part off to leave a full 1/16 in. thick head and the spring wants to be of sufficient strength to hold the valve firmly on its face, when a washer both under the head and against the valve will be found useful.

For the steampipe flange, chuck a length of drawn gunmetal bar that will turn to 1¼ in. diameter and do just that over a 1 1/18 in. length. Further reduce the next ½ in. or so to ⅝ in. diameter to screw 26T, the next ⅛ in. to ⅞ in. diameter and part off to leave a full ¼ in. at 1¼ in. diameter. Reverse in the chuck, face off, centre and drill 25/64 in. diameter right through. Follow up at 7/16 in. diameter to about ⅜ in. depth and tap the remainder at 7/16 x 26T. The steampipe, 7/16 o.d. x 16 s.w.g., wants to be of the order of 6½ in. long and screwed 26T for ½ in. at each end, though you will have to check its length to place; erect with the regulator body in position. On the boiler barrel top centre line, drill two No. 34 holes to come within the foot, countersinking them for 6BA screws; spot through one of them and remove the body to drill No. 43 and tap 6BA. Erect again and secure with the screw, then deal with the second tapping in place, tinning over the heads to seal them with soft solder. Remove the steampipe, annoint the threads with jointing compound and assemble for keeps.

Just a couple of items to make to complete this, marathon!, session, starting with the regulator spindle and crank. For the latter, choose a piece of ⅜ in. x 3/16 in. section bronze or stainless steel flat; you will likely have to arrive at said section. Grip in the machine vice to centre and drill through No. 23, then move on 15/32 in., repeat, add another hole close by, form into a slot with an end mill, then profile to drawing. Square off a 2⅛ in. length of 5/32 in. stainless steel rod, press on the crank, braze in place, then chuck the whole assembly to remove all excess spelter.

The regulator spindle guide is from ⅝AF hexagon bar and brass is just acceptable here, though bronze much preferable. Chuck in the 3 jaw and reduce to 7/16 in. diameter over a 13/16 in. length, of course facing the bar initially. Turn the next 5/16 in. down to ½ in. diameter and screw 32T then part off to leave a full ⅛ in. head. Reverse in the chuck and grip by the 7/16 in. diameter portion to face off to length, then centre, drill right through at No. 23 and ream 5/32 in. diameter. Follow up at ¼ in. diameter to 7/16 in. depth and tap the outer ¼ in. or so at 9/32 x 32T and if you do not have this screwing gear by you, vary the dimensions to 5/16 x 32T and turn up a gland nut to suit. The spindle is assembled back from the boiler, tie a bit of string around it so it will not disappear, then feed in the guide to complete by packing the gland with PTFE yarn. Next time we will move on to the engine chassis.



The completely rebuilt tender ready for attachment to No. 76017. This very popular engine on the mid-Hants Railway was once shedded at Eastleigh

What of the Catalogue itself? Perhaps I am growing older and more resistant to change, so initially I preferred the format of the 21st edition with its larger type, especially when I was looking at the new edition for hours on end. Also I must admit to being unhappy with separate price lists, having to cross reference being time consuming. Then I looked again and objectively at the 22nd edition and could not help admire what I saw. Although the type is smaller, it is extremely legible, plus everything is in logical order. The separate price list of course means there can be amendment without destroying the value of the Catalogue itself, which has great merit, as I have discovered with mine these past few months! What really matters is what is in the Catalogue as this is where Reeves excel.

Back this up with a service that seems ever improving, at least such is my experience, plus a staff from Directors downwards who are largely knowledgeable and practicing model engineers, and it would be easy for one such as I to feel intimidated. But such is not the case, for it is a friendly service, one that I have come to both like and respect. Yes, Reeves 22nd edition Catalogue is a new experience, one I can recommend to readers.

78000, A.B.R. Class 2 'Mogul' for 5 in. gauge

by: **DON YOUNG**

Part 4 — Frames and Cylinders

This promises to be another marathon session and as many builders want to make the 'traditional start' with the mainframes, now is the time for them to join the action!

Mainframes

For such a relatively small engine, these frames are of massive depth, requiring two 30½ in. lengths from 5 in. x ⅛ in. (or 3mm) section steel flat, the cold rolled pickled variety for preference. It is more than likely that such section will have been sheared from plate, which is no problem, save that the top, datum, edge will require careful attention both to remove any evidence of shearing and to get it nice and straight, for on this will depend our accuracy in marking out. It is alright stressing the accurate alignment of the axles and coupling rods later on, but this stems from the very first chassis item, the mainframes, so take your time in getting that top edge nice and flat, using your lathe bed to check this out; now square off the front, datum, edge to same and we arrive at the exciting part of marking out.

Your steel should be in pristine condition and any scribed line will show clearly, but one can and will make errors in marking out, so use a proprietory marking out fluid, then you can erase any mistakes with a further coating of the fluid. Start with the axle centres, including that for the pony truck, then build up the frame profile around this, checking back as you proceed to ensure there are no cumulative errors. Next deal with all the holes save those for cylinder attachment, and centre pop them accurately. I have an automatic centre punch which is adjustable for depth of impression, but find for frames I get on much better with a conventional punch and ¾ lb. hammer. Deal with the top and front datum edges on the second frame piece, then match up to the first and clamp firmly together. Choose five or six holes and though specified finally at No.34 drill them right through initially at 3/32 in. diameter and fit copper or aluminium rivets, hammering them right down for minimum interference when drilling the remaining holes. The temptation is to profile the frames first, but resist this for the extra area of plate this provides to support the frames on the drilling machine table, when we must break off to deal with the cylinder flanges.

Cylinder Flange

I chose brass for my first pair of cylinder flanges back in 1964 rather for its flatness than with any thought of corrosion, have repeated said specification over the years, and found it has caused more problems for builders in obtaining supplies than almost anything else, so now can suggest steel as being a suitable alternative. Some builders will also find that 4.5mm thick material is easier to obtain that the specified 3/16 in., in which case add .10 in. to the machined dimension on the cylinder block to compensate, indeed if you round it up to 1/64 in. this will then also compensate for 3mm thick frames and all will be well. Mark off and drill the 46 holes, countersinking 19 of them for attachment to the cylinder block later and tapping the large one at ½ x 26T, then complete profiling the outside to suit.

Back to the Mainframes

To secure the cylinder flange for drilling, first we need a single bolt, made from ⅝ in. A/F hexagon bar. Chuck in the 3 jaw, face and turn down to ½ in. diameter, a tight fit in the hole in the frames, over a 7/16 in. length and screw the outer ¼ in. at 26T. Fit the cylinder flange with same, get it lined up properly and drill a single No. 34 hole right through from same; fit a 6BA bolt. Now you can carry on and deal with the remaining 25 holes.

Those builders possessing a bandsaw will be able to make quick work in roughing out the frame profile, though for me there is more satisfaction in sawing them out by hand. Unless you have the luxury of a milling machine with fairly large table though, completing the frame profile is going to call for careful work with files, the super-critical areas being the horn gaps and the mating edges for the hornstays. I know it is just possible to grip the frames in the machine vice to mill the gaps in the lathe, but really the overhang is far too great, as is the risk of damage to your most precious machine tool. I doubt if any builder has a piece of 1½ in. square steel bar by him, but any section from 1½ in. x ⅜ in. upwards will be OK, so first file one of the frame gap edges to line and then deal with the second with your piece of bar as gauge; that way they will all be the same. Set your micrometer to .625 in. to deal with the other hornstay mating edges, although of course you can make up a simple gauge to emulate same; the rest of the profile is simply filed to line. Separate the frames, remove all those burrs and sharp edges to avoid recourse to the first aid kit, then open out the holes you used for those rivets to their final size.

Full size when No.78000 was being built or repaired, it was moved around the Erecting Shop by overhead cranes, hooks being used under the drag beam and shackles attached to the frames at the front end, to which doubler plates were added for the extra strength they provided; we can next add this feature. This brings me back to E S COX where such feature was omitted from the frame detail and a few builders took me to task over this. Reason was that no lifting holes were shown on the Works drawings in my possession, and early photographs confirmed that none were provided. Even more curious was that when they did appear in later years, their position varied, thus it is likely that this was never an official modification, but added to suit the Works involved in their repair. On No.78000 there is a fixed position, so chuck a length of ¾ in. diameter steel bar in the 3 jaw, face and turn down to 11/16 in. diameter over a ½ in. length. Centre and drill ¼ in. diameter to the same ½ in. depth, then part off two ⅛ in. slices. Use a ¼ in. bolt to attach to the frames, on the inside face, to drill through and secure with four 1/16 in. soft iron snap head rivets.

Main Horns

Full size these were steel castings with integral lugs for attachment of the cross stays, though the late and sadly lamented Fred Palmer did once tell me that on No.78019 these cross stays were not a feature on all the axles, being I believe confined to the trailing one. The ones I fitted though to Class 4 'Mogul' No.76026, however, are remembered as vividly today as when first fitted, so I have retained them for the rigidity they add to an otherwise unsupported position.

Our castings are in gunmetal and those specifically for No.78000, though they have since found other employment as instance on POM-POM, are cast in pairs, and at this point my description of POM-POM overtook these notes, so I can refer builders to Page 21 of LLAS No.38. I said there that there was one important difference between POM-POM and No.78000, this being on the overall thickness of the horn which for our engine wants to be ⅝ in. Other than this only the hornstay tappings vary, and this is our next item.

Horn and Cross Stays

The hornstays are from 1 in. x ⅛ in. BMS flat; saw and square off six 2½ in. lengths. Mark off and drill all the holes, and at this stage I recommend that they all be No.30, particularly those for the cross stays. Saw out and file to line, and if you are very careful then you can radius around the cross stay holes with an end mill over a mandrel. Offer up to the horns, spot through, drill and tap 5BA, when you can deal also with the No.30 oil supply pipe hole at the top of the horn. Erect the horns to the frames exactly as for POM-POM.

⅜ in. x ⅜ in. x 1⁄16 in. 'T' section brass used to be obtainable from Whistons, but as I have not seen their list for some years now, I cannot say if this is still possible. The alternative is to mill from ⅜ in. square steel bar, gripping a long length in the machine vice and dealing with about 1 in. at a time, a bit time consuming I know, but we only want a little over 6 in. of it. The ends at least are definitely from the ⅜ in. square bar, so drill No. 23 at a full 3⁄16 in. from one end, radius over a mandrel with an end mill, then saw and file or mill the slot to suit the hornstay, sawing off and squaring to the ⅜ in. dimension. It is worth making up a brazing jig, the base of which is a length of, say ¾ in. x ¼ in. BMS bar. Grip in the machine vice, drill a No. 24 hole, then move on 2.6875 by the cross slide micrometer collar and repeat. Chuck a length of 5⁄32 in. steel rod and ease with file to a sliding fit in the No.23 holes in the cross stay ends over a ¾ in. length; saw off and press into the No. 24 hole in the jig. Coat the whole jig liberally with marking off fluid, so the spelter will not adhere, then build up the cross stay and silver solder together. Assembly to the hornstays will have to await complete erection of the frames, but then offer up the cross stays and drill right through at No.23, following up with a 5⁄32 in. reamer. For the pins, chuck a length of 5⁄32 in. silver steel rod in the 3 jaw, slightly taper the end, then part off at 19⁄32 in. overall. Next chuck a length of ¼ in. steel rod, face, centre and drill No.23 to about 1 in. depth, parting off six 3⁄32 in. slices. Press them onto the ends of the pins, silver solder together, then rechuck and clean up the head, removing all excess spelter. Assemble to the cross stays, to drill through for a 1⁄16 in. split pin.

Frame Staying

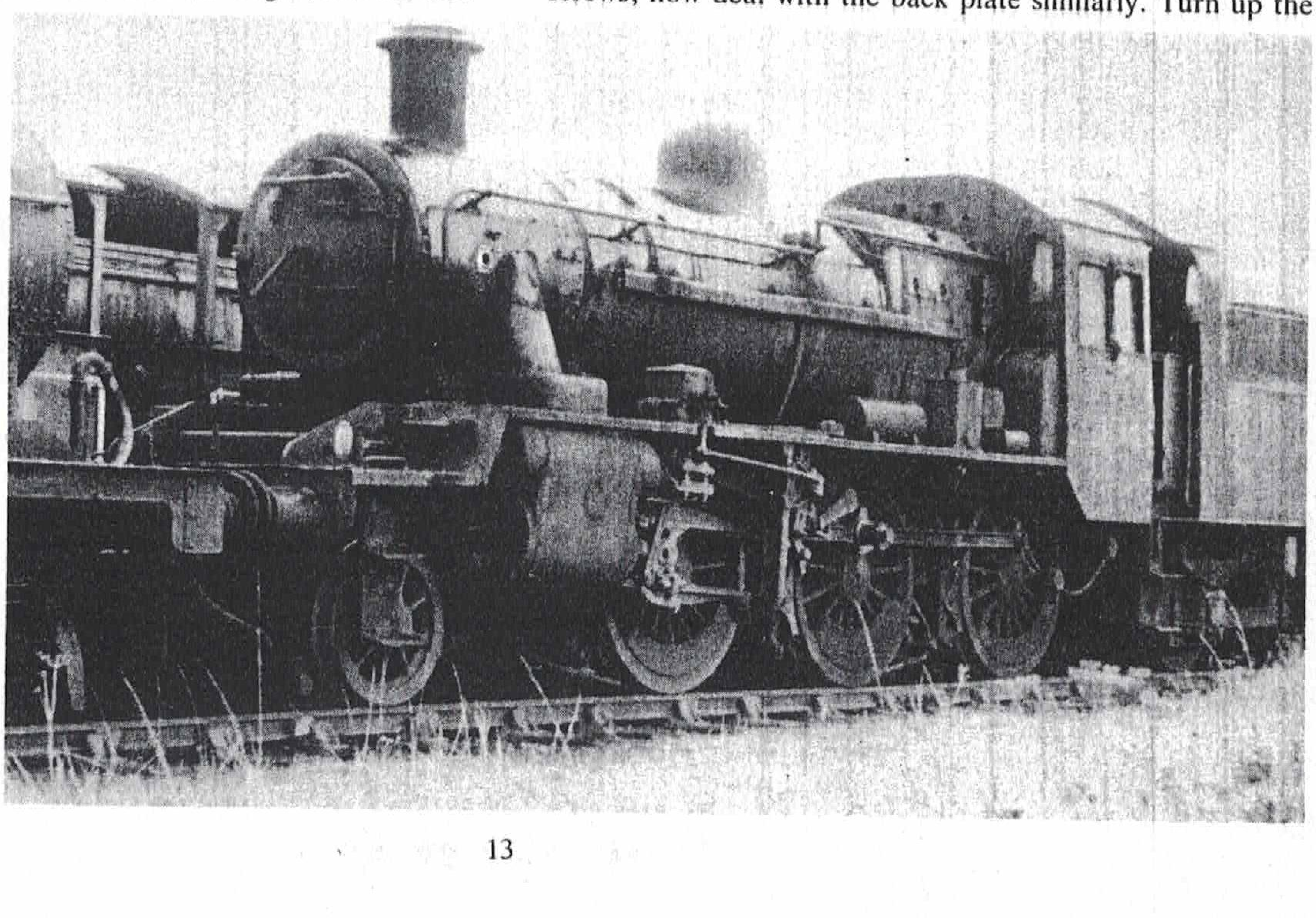
Having dealt with the mainframes, we must now make up the various stays to hold them 4⅛ in. rigidly apart, starting with the drag box.

Drag Box

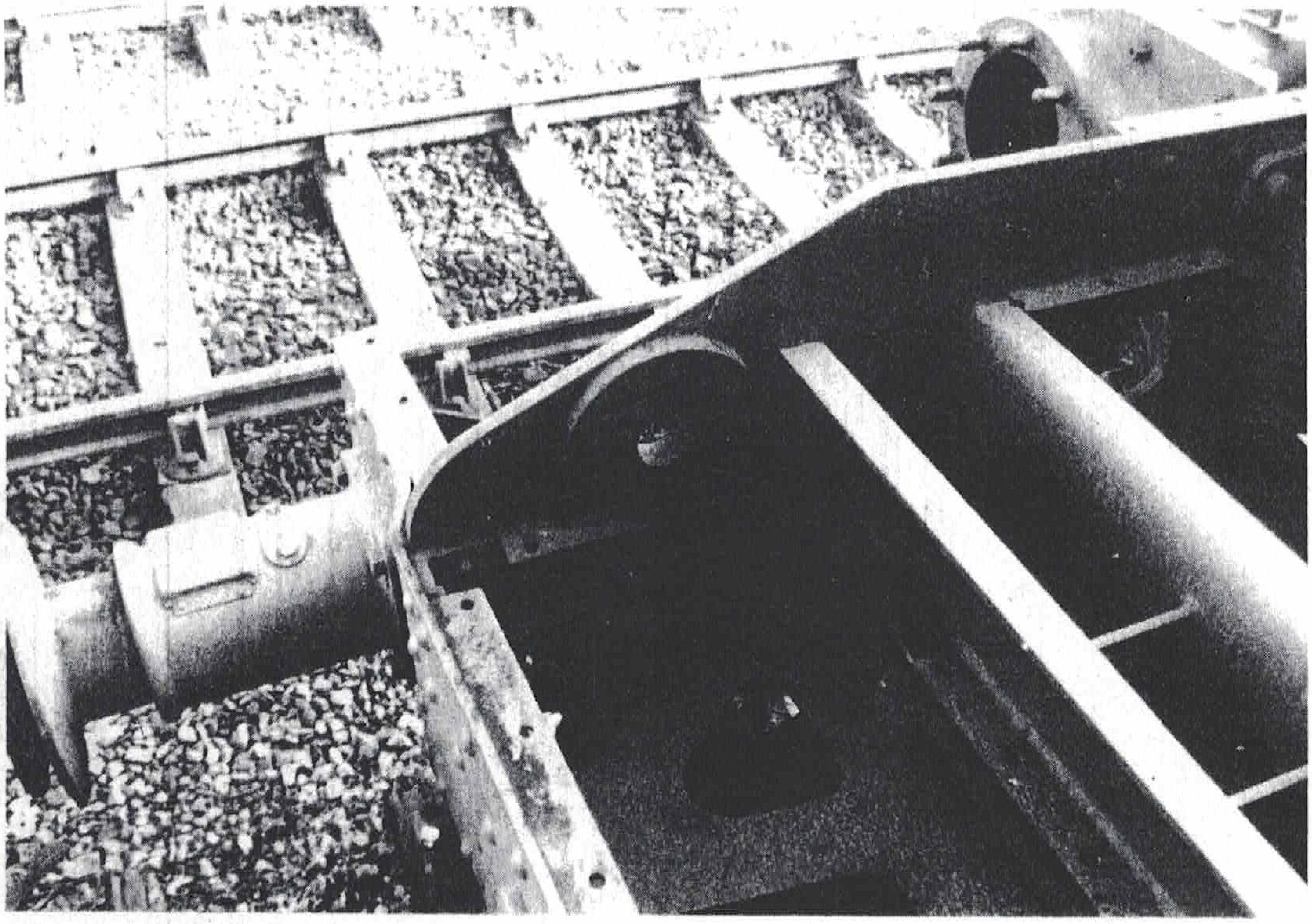
Barely three months into my apprenticeship at The Plant, I was let loose on a huge drilling machine, which had a nominally fixed head and a compound table, somewhat akin to a horizontal milling machine. On this I drilled the drag boxes for the Ivatt Class 4 'Moguls' then building at Doncaster, being greatly impressed with the clean fabrications, which I thought a great advance on the castings which were more traditional, indeed it has had a lasting effect on my own work on the drawing board, and in the workshop when I was able to build instead of describe how to build miniature steam locomotives!

Top and bottom plates first, these being 3 29⁄32 in. x 2⅞ in. from ⅛ in. or 3mm thick steel. Drill the ¼ in. hole for the drawbar pin, bolt together, then drill ⅝ in. holes to start forming the lightening slots, gripping in the machine vice and completing with end mills. The back plate is a 4 5⁄32 in. length from 1⅜ in. x ⅛ in. steel flat; mark off, drill and file out the ⅞ in. x 7⁄16 in. drawbar slot. That leaves the side plates, which are 2⅞ in. lengths from the 1⅜ in. x ⅛ in. flat. Pack top and bottom plates to their correct positions, bring up the side plates, to mark off and drill three No.44 holes in each of the latter, along the joint with the top and bottom plates.

Offer up again, spot through into the edges of the latter plates, drill these No.50 and tap 8BA for brass cheese head screws; now deal with the back plate similarly. Turn up the



The pictures on the next three pages were sent in towards the end of 1988, in good time to appear in LLAS No. 38, when of course No. 78000 had to be held over and this time it is the turn of POM-POM; it will be good when I can get back to running two series in each issue once again. Problem is that I have forgotten who sent them in and where they were taken, this three-month lay-off has done me no good at all! It does not help at all that the smokebox numberplate is missing. At least the photograph is of a BR Class 2 'Mogul' and very soon now our 5 in. gauge engines will be looking something like this, complete with connecting rods of course.



This photograph reminded me to describe the doubler plate around the lifting holes at the front end of the frames. It also shows to good effect the massive horizontal and vertical stays that were such a feature on the BR Standard classes; we have seen them before on E. S. COX.

three bosses for the drawbar pin from ½ in. steel rod and use a ¼ in. bolt to hold them in position for brazing; the bolt wants to be nice and rusty to avoid the spelter adhering to same, the nuts too, and I guess most builders have such things by them. Mix some flux to a stiff paste and apply all round the joints, leaving no gaps to oxidise, then heat very rapidly and feed in spelter, which can be Easyflo No.2 or similar. Quench, dry and clean away all excess flux, then spray on a coating of zinc from an aerosol can to prevent rusting. Either bolt directly to the vertical slide, or use the machine vice, to mill the two side faces to arrive at the correct 4⅛ in. dimension; no other machining should be necessary.

Drawbar, Pin and Retaining Plate

The drawbar is an optimistic ½ in. x ¼ in. section, I doubt if No.78000 will stretch this!, and the length should be checked to place at the track. Drill the holes, then radius over a mandrel with an end mill to complete. The drawbar pin is made the same way as those for the cross stays we dealt with a little earlier in this session, though being a 'one off' it could be turned from ½ in. steel rod. I think around 1972 I must have suffered a drawbar pin coming out on the run, for my RAIL MOTOR No. 1 has a retaining plate as drawn, bent up from 1/16 in. steel strip. Attach to the drag box with a 6BA bolt, tightening so that you can just push it clear of the drawbar pin head with a screwdriver.

Drag Beam

The drag beam is a 9 1/16 in. finished length from 1 7/16 in. x ⅛ in. BMS flat, which indicates 1½ in. wide material as the starting point. Whilst you are milling down to 1 7/16 in. width in the machine vice, you can also relieve the two end faces over a 2 1/32 in. length to 3/32 in. thickness if you like, though this is very optional. Cut the drawbar slot to suit the drag box, mark off and drill the holes as specified, then offer up to the drag box, spot through, drill and tap 6BA in the twelve positions indicated.

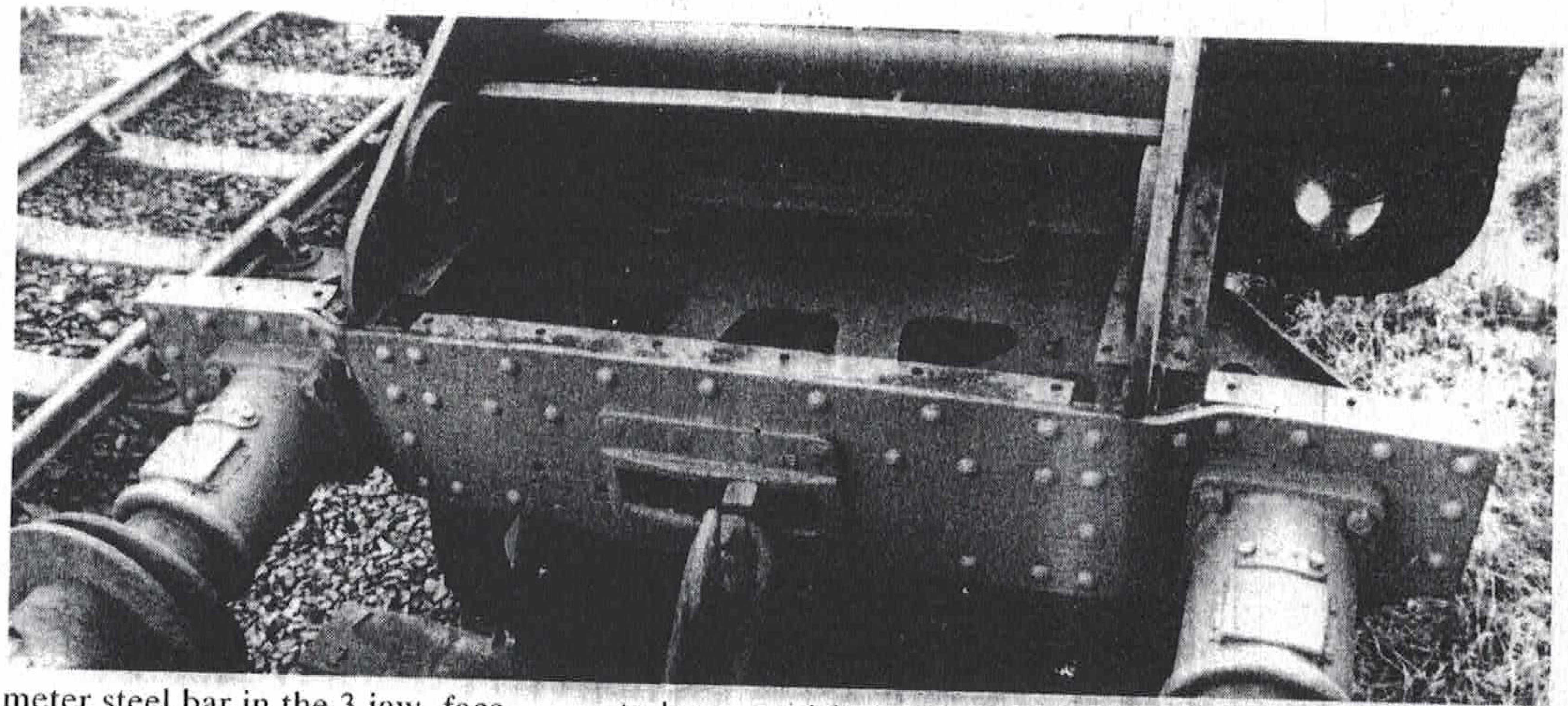
Driving Axle and Motion Plate Stays

Now that we have got the hang of fabricating, the next pair follow, so for the driving axle stay, first cut and square off a 3 29/32 in. length from 2 in. x ⅛ in. steel flat before reducing to 1½ in. width over the central section and radiussing the ends as shown. The bottom plate is simply a 3 29/32 in. squared length from ¾ in. x ⅛ in. steel flat, which brings us to the upright member, the same length but from 1⅛ in. x ⅛ in. flat. To deal with oblong lightening holes such as the ones detailed, I mark off and drill ¼ in. holes in each of the corners, then clamp firmly to the vertical slide table, with pieces of packing between to protect said table from end mill teeth, and simply mill along the faces between the holes to break out the surplus, tidying up the milled edge with a file. Join the three pieces made thus far together with a few 8BA brass cheesehead screws and I should have said for the drag box that once the joints are silver soldered, you file off the screw heads as being redundant. The end flanges are from the 2 in. x ⅛ in. flat, squared off to 1⅜ in. lengths and then shaped to the drawing detail, saw and files being quicker here. Again attach with a few 8BA screws, flux and silver solder together, then quench, dry, clean off all excess flux and zinc spray before milling the end flanges to 4⅛ in. overall.

The motion plate stay, though bigger, is even more straightforward. It is basically a diaphragm plate size 3 29/32 in. x 3¼ in. from ⅛ in. thick steel, hemmed in with pieces of ¾ in. x ⅛ in. steel strip on all four sides. You will enjoy milling the lightening holes then still attached to the vertical slide table, mark off and drill the seven No.34 holes, for fixing to the horizontal stay. Assemble with 8BA screws as before, flux, silver solder the joints, then tidy up and zinc spray before milling the side flanges to complete. I reckon the acid test of frame alignment is to slide the axles into their boxes and have them turn sweetly, which means we cannot fit the stays in this session, for the axlesboxes are detailed on Sheet 5. Most of us though like to see our frames assembly as soon as we can, it gives encouragement for what lies ahead, so you can either use clamps, or drill a few No.50 holes in the stays from the frames and just hold them temporarily together with 10BA bolts.

Pony Truck Pivot Stay

This stay needs just a bit more care, as the pivot must be fairly accurately aligned for the pony truck to work correctly, it being vital to the wellbeing of No.78000 out on the track. Start with a 3 29/32 in. squared length from ⅞ in. x ⅛ in. steel flat, find its exact centre and drill through at ½ in. diameter.



I must admit that I have never before set eyes on a buffer beam that was other than straight, other than after being involved in an accident, so it was a surprise to see that this beam is deliberately bent, seemingly to cater for longer, hydraulic, buffers; it must be a source of weakness.

Chuck a length of 5/8 in. diameter steel bar in the 3 jaw, face, centre and drill 5/16 in. diameter to 3/4 in. depth, in fact you can ream this hole if you prefer. Now turn down over an 1/8 in. length to 1/2 in. diameter, a press fit in the hole in the stay top plate. Cut the end flanges 3/4 in. long from the same section strip, then make up the two vertical webs to be a close fit each side of the centre boss. I say a tight fit very deliberately, for if you leave a gap, then as the silver solder sets, it will pull the boss to one side or the other, in fact a skilled welder will use this very technique to move a boss that has strayed from the upright. You should only need screws to hold the end flanges in place, so flux and silver solder as before, adding a coating of zinc after cleaning up. Mill the end flanges and then poke the drill or reamer through the 5/16 in. hole again, for it will have tightened where it passes through the top flange.

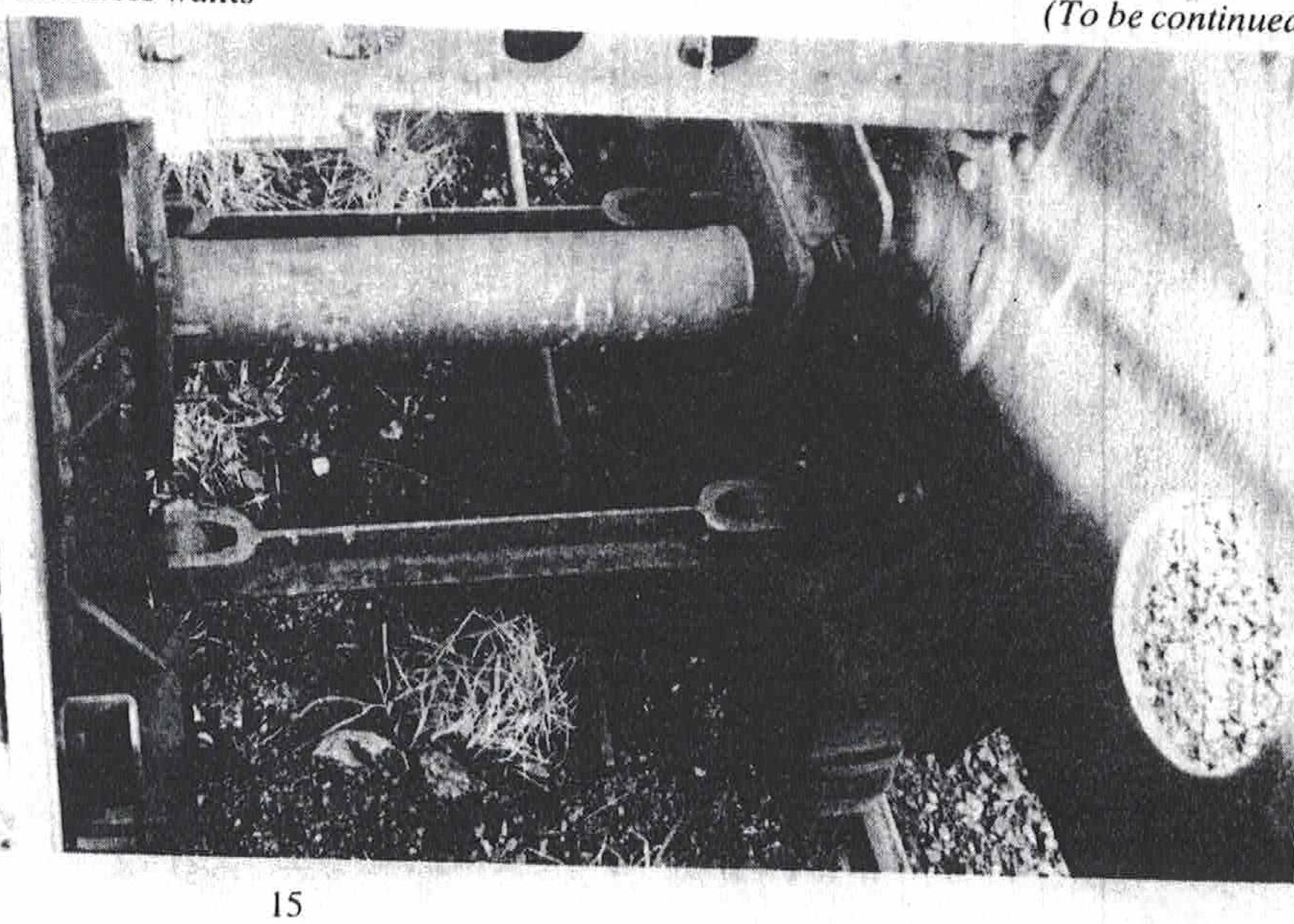
Horizontal Stretcher

We now come to an entirely different form of stay/stretcher, one that causes builders more problems than any other according to my postbag, yet it should not. The first requirement is that the steel be flanging quality, which rules out BMS in favour of black; it is a lovely material to work with. The other problem experienced is in flanging, or rather getting the flanges the correct distance apart, but I have found if you get to know your material first by experimenting with it, it is quickly mastered.

For the stretcher, cut a piece roughly 6 in. x 5 in. from the 1/8 in. plate, mark it off and first scallop the corners to drawing, as they greatly aid the flanging. If you are still unhappy about the flanging, make up a flanging block, or rather a pair of them, each a full 5 in. long and 3 29/32 in. wide; thickness wants to be around 3/8 in. Heat the stretcher to a bright cherry red, grip between the two flanging plates in the bench vice and hammer over, annealing again if the flanges work harden. I must say I much prefer to do the job cold, simply gripping each flange in the bench vice and hammering over. Clean up the mess if you did the job hot, then cut a length from 3/8 in. x 1/8 in. steel strip, and this can be BMS, to fit between the flanges as shown, silver soldering in place.

Check that the base of the stretcher is flat, teaching it manners with a wooden mallet if this is not the case, then drill four holes within the lightening slots area to bolt the stretcher directly to the vertical slide table; no need for packing this time. Go right round the edge of the flanges with an end mill, to arrive at the 7/16 in. dimension, then turn the stretcher over and deal with the 3/8 in. wide edge, just packing those flanges off enough so that the stiffener is not a problem. With any luck, the lightening slots will be marked on this face of the stretcher, if not then transfer same. Drill holes in the corners and ends of each slot, end mill as much surplus material away as you can, then back to the bench vice to complete to line with files. Finally we must mill the side flanges and the one to match the motion plate stay in a single operation, so they are either perfectly square or parallel to each other, so choose the right spot to mount the stretcher on the vertical slide table and go right the way around. Full size that front flange was bolted to the smokebox saddle, but though I could specify holes in the flange, I don't know how to spot through or otherwise transfer said holes to the saddle to match, thus they are omitted. You can of course though, drill through and attach the stretcher to the motion plate stay at this stage.

(To be continued)



Again this picture came as a surprise, for the cross stays I have turned through 90 degrees from the pair depicted here. I seem to remember them 'as drawn' on 'my' BR Class 4 'Mogul' No. 76026, so perhaps the alteration is due to the proximity of the spring hanger brackets.