Hunslet

by **DON YOUNG**

PART 1

1975 was 'sink or swim' year for yours truly, yet just three weeks before giving up a secure position in the marine industry to try and make a living from model engineering, it seemed to me at the time that I was squandering my chances of success on a fortnight's holiday in North Wales. But there was a deeper feeling that I was doing the right thing, and so it proved.

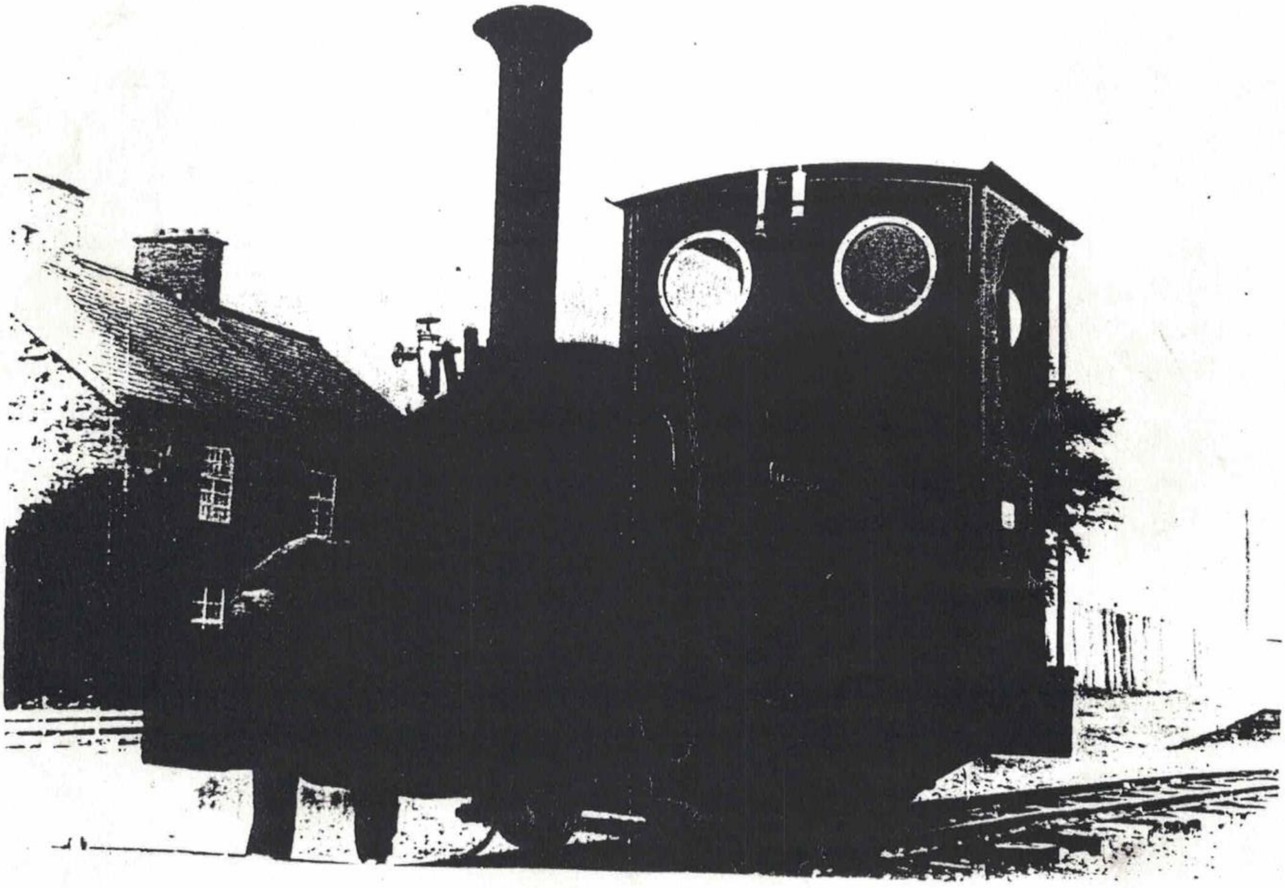
Until 1975 I admit to being not much impressed by the diminutive HUNSLET's, as seen on the Llanberis and Bala Lake Railways, for MOUNTAINEER was still the apple of my eye, but on this visit, George Barnes, who is Manager of the B.L.R. chose to convert me, spending a whole Sunday afternoon in the process, culminating with a footplate trip on MAID MARIAN. This laid the egg and five days later it hatched, for on the following Friday evening the Festiniog Railway had their end of season outing behind the part Bob Harris owned BRITOMART. I watched and filmed this trip from many vantage points, even remaining to open the gates at Penrhyn for the return trip, and as she trundled by in the semi-dark I was hooked.

As soon as things settled down on my return home, I managed to put in nearly 16 hours a day on the drawing board, and in just 17 days HUNSLET materialised. Those who followed the earliest issues of the drawings soon proved that this maximum effort on my part was not without its mistakes, for which I apologise, but 2,000 sets later the drawings are now 'as fitted,' thanks to builders tolerance and assistance, and all will be well with this series.

I did not return to North Wales until 1977, there were no funds for such luxuries as holidays, and as soon as I saw George Barnes again he suggested a HUNSLET Rally, to be an annual event. Reluctantly I agreed it was worth trying in 1978, though there was virtually no chance of a complete 5 in. gauge HUNSLET being present, but in the event I was almost proved wrong, for two were close to completion, these by Jack Coulson and Mike Bamber, and there was a superbly completed 7¼ in. gauge version by Bernard Kay, called BOADICEA and built from my humble drawings. There were also people, hundreds of them, and possibly the largest crowd ever to assemble at Llanuwchllyn Station.

Three days later the 2nd HUNSLET Rally was fixed for 1979, but as the printing deadline came too soon, as will always be the case!, this report will have to wait until the next issue.

This will almost certainly be the strangest introduction to a series that I shall ever write, and HUNSLET is like that all the way through. For a description of the 'Alice'

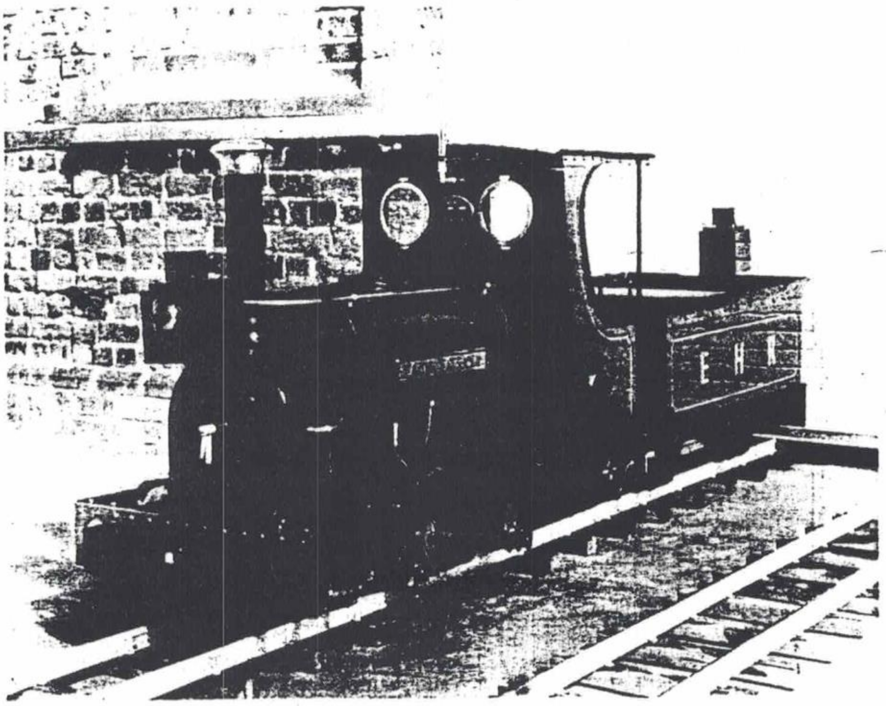


MAID MARIAN at Llanuwchllyn.

Class of Locomotives that HUNSLET belongs to I would refer readers to 'Slates to Velinheli' written by D. C. Carrington and T. F. Rushworth for the Maid Marian Locomotive Fund and obtainable from the Bala Lake Railway; nothing I could write would approach this little masterpiece. The very latest information I have is that nearly all the 8,000 copies so far printed of 'Slates to Velinheli' are gone, and there are no immediate plans to print a third edition, partly because there is a need for additional material in the light of fresh discoveries, though attempts will be made to satisfy readers requests. But the really exciting news is that Douglas Carrington will be telling us about the HUNSLET's in a future issue, so this gap in my story will be more than adequately plugged by a noted authority on the subject; great! I shall also be trying to persuade George Barnes to set down something about operating a Railway with 'Alice' Class Locomotives, so suffice it for the moment to say that he is overjoyed with their performance.

HUNSLET is a Locomotive that would not have appeared from my drawing board without some persuasion. I would never have picked her out on my own, and so uncertain was I of her reception that I did not bother to have my pencil originals traced. Less than a year later I was being embarrassed by my pencil originals literally falling apart! Bringing this strange tale up to date, we have a series about a Locomotive already being built in large numbers, a series too far behind to help a lot of those builders, in fact they will be helping me! At long last I have woken up to the fact that so far I have only touched the tip of the iceberg, and am convinced that this series will show many more model engineers the sheer practicability of choosing Narrow-gauge prototypes. For what is an extremely diminutive engine in two-foot gauge becomes the reverse when reduced to 5 in. gauge, the scale being 2½ times that of a standard gauge prototype. A perfect example of this is in the use of the same Cylinder castings for HUNSLET as for JERSEY LILY, just like Cinderella the shoe fits perfectly, yet the prototypes bear no comparison.

A happy Editor poses with his flock at the 1st Hunslet Rally, and hopes that the next issue of LLAS will provide proof of their further progress! Photograph by Len Hough.



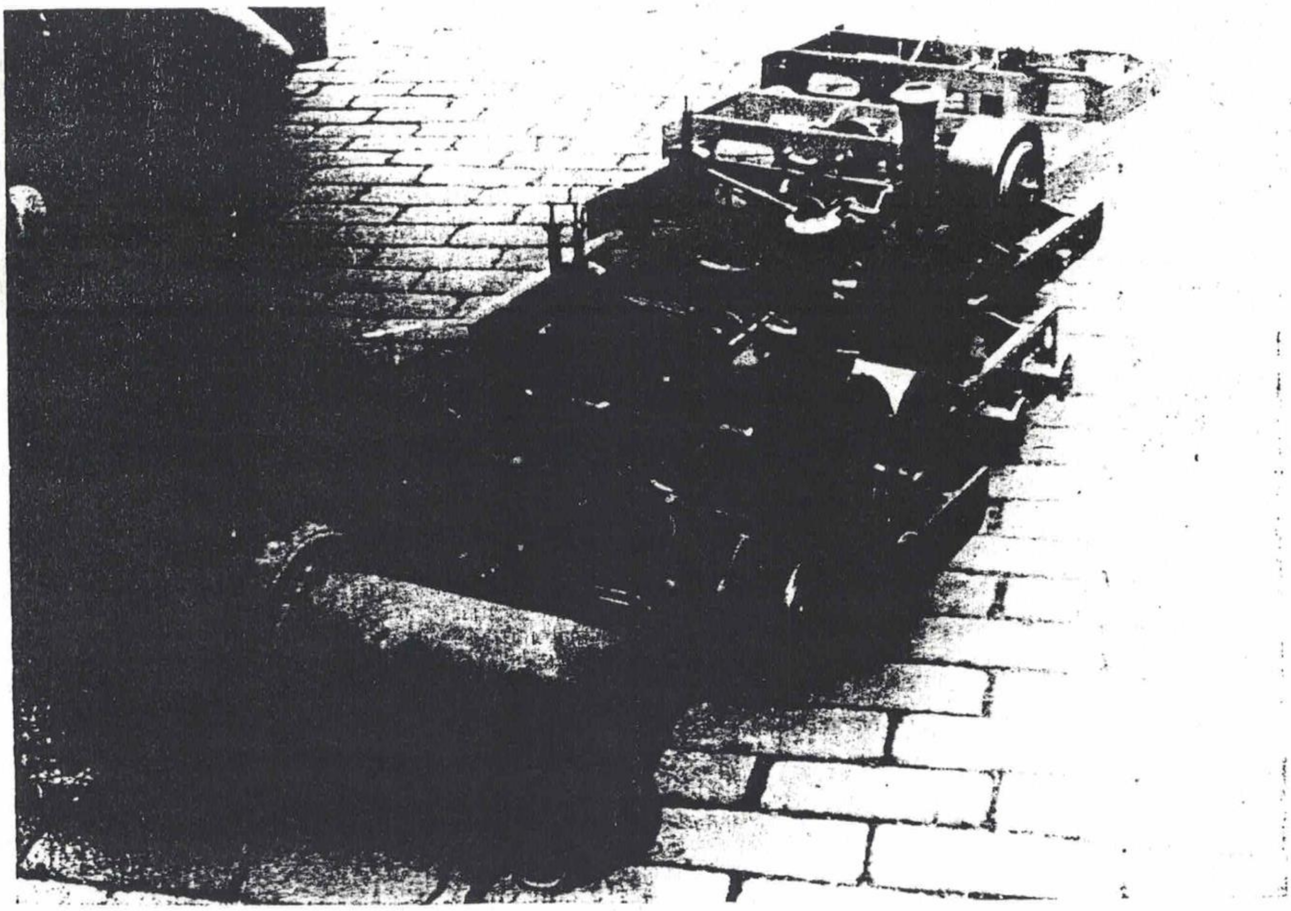
A completed 7¼ in. gauge JOHN HUNSLET poses outside the Milner Locomotive Works at Higher Kinnerton, Chester.

Now another amazing aspect of the 5 in. gauge HUNSLET is that her popularity is virtually worldwide, in the countries where model engineering is practiced, in fact the one notable exception to date is New Zealand, which is a wee bit baffling after the following for MOUNTAINEER over there. Another surprise has been the warm reception she has received in the U.S.A., and I look forward to many of my American friends, or rather I should say all my friends who have helped me over the years, joining to make L.L.A.S. truly international. So from this, the next version to be introduced is the 4¾ in. gauge HUNSLET, which involves nothing more than regauging the wheels, an instruction that will not overtax my pen!

Obviously with the 4¾/5 in. gauge HUNSLET going so well, the possibilities for exploitation in other gauges were realised. For 2½ in. gauge it is mainly a question of halving dimensions, a simple task for any builder, and one we are always pleased to advise on if asked. Thus far there has been a lack of interest in this gauge, but if these remarks help to rectify the matter, then it will be simply to add a few notes at a suitable stage in the proceedings. Several HUNSLET's are being built in 3½ in. gauge, and here builders are sorting things out perfectly well for themselves, though again I can make reference if the need arises. By far the most amazing enquiry to date was if my humble drawings could be scaled up to produce a full size 2-foot gauge Locomotive, this really set me thinking! Anyhow, I could find no fundamental objection to this, so I hope this exciting project does come to fruition, and can be reported upon in these pages, when it can represent the LARGE side of L.L.A.S.

Moving back down the scales, it was however the 7¼/7½ in. gauge bracket where yours truly felt there was real potential for the HUNSLET, but there were already two successful designs available, as complete Locomotives, and there has been unwritten agreement over many years between designers not to encroach, which ruled out the possibility. Then out of the blue came Milner Engineering with news that their 7¼/7½ in. gauge HUNSLET was to be broken down to an alternative castings/materials/boiler/machining service to allow model engineers the choice of building their own Locomotives to the Milner design, as against purchase as ready-to-run, so here was opportunity to fill the gap and from an unexpected quarter. After discussion with John Milner, and close inspection of the drawings, it was agreed as a first step that I would help promote this design overseas, as this is where we both feel the greatest potential lies, though it has yet to be realised. So in L.L.A.S. I can fulfil my dream of describing a 7¼/7½ in. gauge HUNSLET, by kind permission of Milner Engineering, allying her construction with my own 4¾/5 in. gauge version.

Now there are advantages, and pitfalls, in trying to describe Locomotives in one series of varying gauges, but I hope to show very shortly now that it can be done sensibly to avoid confusion; if not then I will quickly be out of a job! The way I am going to tackle the series is to use my set of 4¾/5 in. gauge HUNSLET drawings to provide this aspect of the information. John Milner in his turn will be supplying stage-by-stage building photographs, so the combination should be beneficial to all builders, readers too of course, and provide the right sort of blend. So let us advance the story of the pair of HUNSLET's by next looking at the mainframes.



A collection of 5 in. gauge DON HUNSLET'S on the platform at Llanuwchllyn on the occasion of the 1st Hunslet Rally in September 1978. Photograph by J. Sydney Scott.

The Mainframes

Starting with the 4¾/5 in. gauge version, or maybe it will be a brighter idea if I call her the DON HUNSLET, with JOHN HUNSLET for the bigger gauges, the first requirement is two 28½ in. lengths of 4in. wide steel flat. For thickness I have specified 5/32 in. or 4 mm., and this is the minimum for such a powerful machine, the alternative being 3/16 in. and simply adding 1/16 in. to such items as axles and brake shaft lengths, leaving the frames at the specified spacing. Square off the front and bottom edges on one frame, mark out, then join together as for GLEN. The 'hump' in way of the cylinders means a lot of sawing, or milling, but the rest is easy. JOHN HUNSLET frames, 45¼ in. long and 7 in. x 1/4 in. section, can be supplied fully profiled, with outline to suit either deep or shallow (as DON HUNSLET) style buffer beams; these require only cleaning up, which immediately makes life a lot easier! Running the GLEN series alongside that for HUNSLET also makes life a lot easier for me, for wasteful duplication can be avoided, and I can press on a lot quicker.

Horns

The horns specified for DON HUNSLET are possibly the best illustration of my uncertainty of her popularity, for to be authentic there should be separate horn cheeks. But in saying this I am being a little bit less than fair to myself, for my solution was a practical one, using the casting available from the 7¼/7½ in. gauge RAIL MOTOR, for like the Festiniog Railway, I do believe in standardisation. Also the horns serve the dual purpose of providing the spring rod guide, as well as looking after the axleboxes. There is some validity in the criticism as to the amount of machining allowance, rather on the generous side, but really there is no harm in having a good 'dig' at an iron casting, to see what it is made of and there is a saving of time over separate horn cheeks and spring rod guides.

For machining these horns, and they are cast in pairs, I much prefer milling; using my faithful Myford ML7 of 1949 vintage, and fitting the vertical slide to the cross slide table. As with nearly all machining operations, especially if the builder has a more sophisticated workshop than I, so my descriptions will assume that basic equipment only is available to the builder, and the Builders Corner that I am hoping to establish as a regular feature can tell of the possible alternatives. Of one thing you can be certain in my humble descriptions is a very minimum of jigs and special tools, the sole aim being to build Locomotives.

Back to those horns, to clean the inside face of a casting with files, so that it sits flat on the vertical slide table; bolt in place through the centre slot, bridging the gap with 1½ in. lengths of ½ x 3/16 or ¼ in. bar, drilled centrally for the bolt. Chuck an end mill, about ½ in. diameter, and check you can machine all round the casting without resetting, at the same time checking that the horn is horizontal; you can do this latter by measuring up from the lathe bed. Next check the machining allowance, approximately 1/8 in. all over, and machine the outer face of the horns that sticks through the frames. Mill around the two straps to start with, then move them one at a time, and complete this face. Next mill all around the periphery at the frame fixing flange to arrive at the 2 5/8 in. overall width, and square off the top of each horn. We can now concentrate on the spigot to suit the frame slots, keeping them symmetrical, and finishing at a very tight fit in the frames; you can always ease this slightly later on with a file. Move into the slot and complete as much as possible to size, the dimension to each frame fixing spigot being far more important than the 1¼ in. slot dimension. These spigots must be equal, otherwise there will be trouble when the horns are separated and fitted, so check this with a micrometer. Move the straps and bolts again to complete the slot as far as possible, and if you fear for the vertical slide when milling the slot, pack the horns off the face by about 1/8 in. Reverse the casting and mill the inside face to the required 1 in. overall thickness, blending in the flat that appears on the spring rod guide boss with files to improve appearance.

Cut the horn casting in halves, fit the machine vice to the vertical slide, grip each separate horn at the top and mill across the feet, to arrive at the 3 in. dimension. If you have an end mill of sufficient length to reach the unmachined top corners of the slot, then tidy these up, the alternative being to file them to size. Still at this setting though, mark off, centre and drill through at the top for the spring rod at 19/64 in. diameter, then ream to 5/16 in. diameter, using a drop or two of paraffin as tool coolant; this will ensure a good surface finish. Cut the horn stays from 1 in. x ¼ in. steel flat, each 2 5/8 in. long to suit the horns, drill the four No. 27 holes and clamp to the bottom of the horn. Spot through, drill the horn No. 34 to ¼ in. depth, that means right through on the inner pair, tap 4BA and secure with ½ in. long hexagon headed bolts.

I should have said before separating the horns, that they must be stamped in pairs, one pair for the leading coupled axle and the other for the drivers. The hornstays keep the whole assembly nice and rigid for assembly to the frames, otherwise the bottoms tend to 'toe-in'; get each horn a firm fit in the frames. Incidentally, there is nothing original in this part of the description, or indeed most of what I write, for I am simply following the full size practice I learnt at Doncaster Plant, so I hope students of the full size steam Locomotive will find my notes on building in miniature of assistance.

Drill through the twelve 5/32 in. holes in the frames into the horns and secure either with snap head soft iron rivets, or use 3BA bolts and nuts, preferably with heads one size smaller than standard for neatness These bolts must be a good fit in their holes, otherwise builders could well repeat the 'Pacifics' saga!

Horn Cheeks

Turning now to the 7¼/7½ in. gauge JOHN HUNSLET, there is very little we can do at this stage except make a start on the horn cheeks, or guides as they are called on the Milner drawing, though the horn stays can be completed. The reason why we cannot make the same progress as for DON HUNSLET is because for the larger engine the axleboxes are the 'masters' rather than the horns, and the horn guides are fitted to suit, as is normal construction where the horn is not a complete horseshoe. The horn guides are finished 3 in. lengths of 1¼ in. x 1 in. BMS bar, the horn stays being 3¾ in. lengths of ¾ in. x ¼ in. bar, drilled for ¼ B.S.F. bolts 3/8 in. from each end.

Dumb Buffers

Although dumb buffers cannot be fitted at this stage, this is the last item shown on the DON HUNSLET Sheet I appearing with this instalment, so if you feel these are worthwhile, and they certainly add a further authentic touch, then make them to the sizes shown from oak or other hardwood. They will be secured to the beams with woodscrews later on, and I guess a coat of clear varnish would do them no harm. I could not bring myself to detail alternative spring buffers, as to me these would be completely out of character, though I am sure that any builder wishing to fit them can work something out that is pleasing to himself, and of course the length of the dumb buffers can be varied to individual taste, so there is plenty of choice.

From now on we shall be taking giant steps forward, and I guess there is enough already on paper to keep new builders quiet in getting things organised while I prepare Chapter 2.

Hunslet

by **DON YOUNG**

Part 2 — Chassis (Continued)

I reckon the Chassis Arrangement shown hereabouts tells the story much better than yours truly of the sheer simplicity of HUNSLET; large pieces, and not too many of them. With four years additional experience since the design was prepared, I would make but one change, this from mechanical to hydrostatic lubrication, but we can discuss this feature a little later on when we come to the details. Enough of the preamble, on with the construction of DON HUNSLET, starting again with the Buffer Beams.

Buffer Beams

These are finished 14 in. lengths of 2¾ in. x 3/16 in. bright or black mild steel, with alternative metric section 70 mm. x 5 mm. The only comment on profiling is for the bottom corners, which can be left square, or radiused to drawing, this to individual preference. Mark off and drill all the holes, then cut the top and bottom stiffeners from ½ in. x ½ in. ⅛ in. steel angle and rivet to place with 5/32 in. soft iron snap head rivets. Next cut eight 2¾ in. lengths from the same angle material for frame attachment.

Anyone possessing vernier calipers which will measure to 7⅝ in. is in clover here, but for those of us who are less fortunate, a jig to represent said calipers is required for ease of construction. Take a 9 in. length of 2 in. x ⅛ in. gauge plate and mill a recess along one face, about 1 in. deep and 7⅝ in. wide; this latter dimension need not be exact to the last thousandth of an inch, for if all the requisite pieces are made to gauge, then the frames will be parallel to each other, and that is our goal.

Position one of the inner pieces of angle, clamp in place, spot through from the beam, drill and tap 2BA, then secure with hexagon headed bolts, preferably one size smaller than standard for neatness. Take the second inner angle and position this using the gauge, or vernier calipers of course, before fixing in turn to the beam. Erect the frames, check for squareness, then drill through the No. 11 fixing holes. Remove the inner pieces of fixing angle, clamp to their outer partners, and drill back through the No. 11 holes. Erect the inner pair once more, then the frames, and finally the outer pair, bolting right through the three items; now you can spot through, drill and tap the outer pair of angles and secure to the beams with 2BA bolts. File out the square for the draw hook, to a piece of ⅜ in. square bar as a gauge, and fit the dumb buffers to complete the beam assemblies.

Frame Stay

Initially the frame stay ran through the boiler, for I forgot to scallop the top to clear the barrel. a rather fundamental error! Now it is rather a fancy shape, and some builders have created this from ½ in. o.d. tube. which is a very bright idea. Whichever method is preferred, cut the end flanges and clamp to place for brazing, then mill or file the flanges to suit the frame gauge.

Inside Motion Plate

The inside motion plate has caused builders more problems than any other single component, not in manufacture, but in positioning, though thanks to sterling work by Gordon Rowley of Ilford, who produced numerous calculations, I now know where it SHOULD be located. I did think that I had missed some vital point however, that is until John Milner told me the same was true for the 7¼ in. gauge JOHN HUNSLET, so although the inside motion plate can be made at this stage, it must not be fitted until later on in the proceedings. This poses one other wee problem for DON HUNSLET, for the position of the lugs for the spring hangers cannot be located until the motion plate is erected. Those are the problems, now for the easy bit, actually making the motion plate!

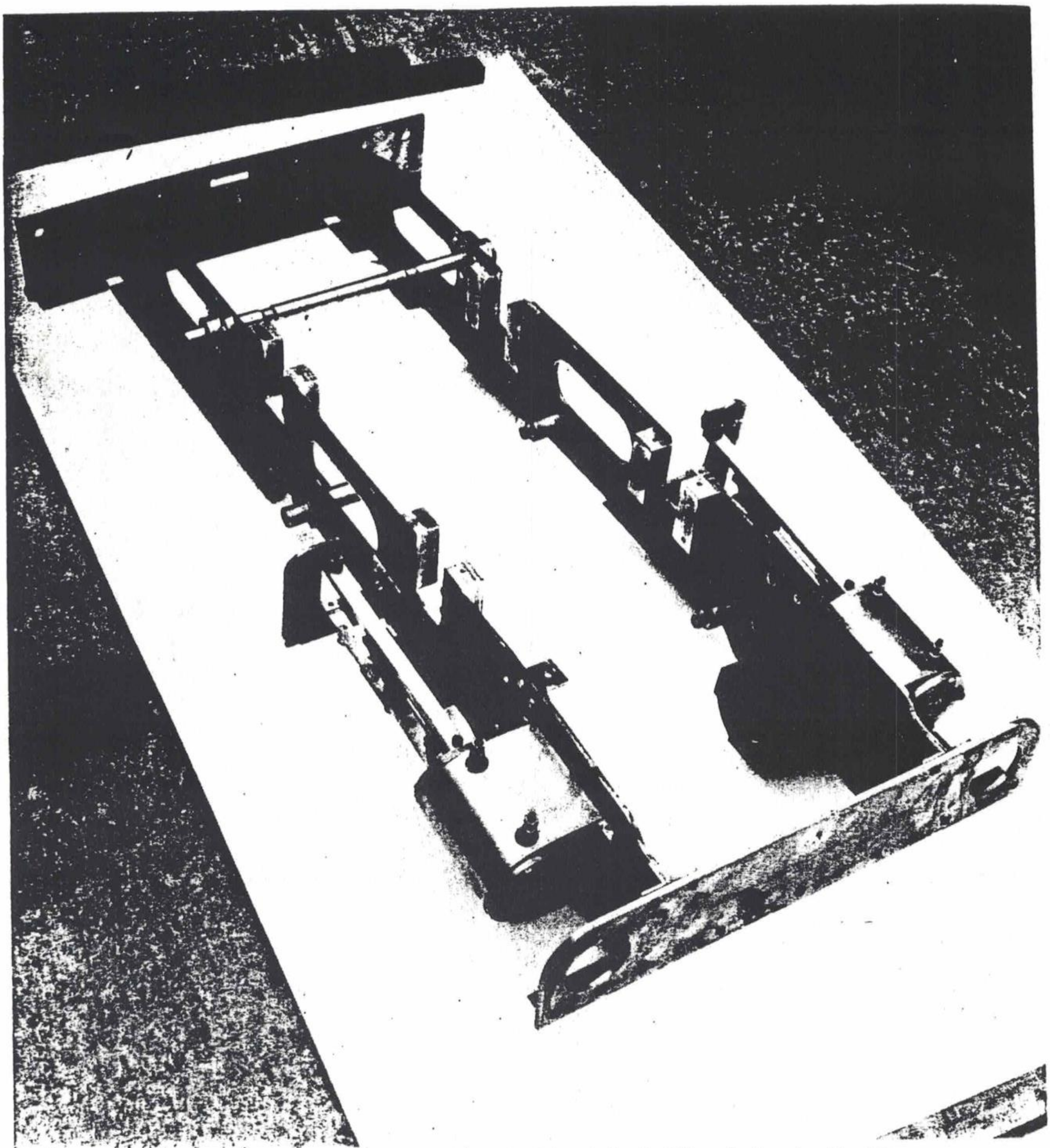
Cut the main portion a full 7⅝ in. long from 4 in. x 5/32 in. section mild steel, black or bright, then cut the side flanges to suit. Cut the top corner pieces to drawing, then fit all the pieces made so far together with a few 8BA screws, to hold firm for brazing; unless you wish to follow Jim Jedlicka's example with his **TUG** and weld up as he described. Tidy up the end flanges to the frame gauge, then saw and file, or mill, the cut-outs to mate with those in the mainframes. Carefully mark off the hole centres for the valve spindle guides, then drill and ream these to size; the tapped holes will have to await the guides themselves. Cut the four lugs for spring hanger attachment, but do not fit them for the moment, in fact my earlier instruction for brazing should have mentioned the use of a higher melting point spelter, like B6 alloy, so that the lugs can be attached with Easyflo No. 2 without destroying the earlier joints. Lay the motion plate aside for the moment, whilst I bring JOHN HUNSLET up to this stage.

John Hunslet

The frame profile drawn for DON HUNSLET is the 'B' type for JOHN HUNSLET, the 'A' type having beams the full 6 in. depth of the frames. So the requirement for JOHN HUNSLET beams is two 21¼ in. finished lengths of ¼ in. steel plate, either ½ in. or 6 in. wide to suit the chosen frame profile. The rear beams are extremely simple, with a minimum of holes, and a full length of 1 in. x 1 in. x ⅛ in. angle rivetted, or bolted, to the top outer face.

Some of the full size 'Alice' Class had large holes cut in the front buffer beam to allow withdrawal of the pistons without the need to remove the beam, and this JOHN HUNSLET faithfully reproduces, though for builders of this fine machine, it can be classed as an 'optional extra,' particularly as a 2 7/16 in. diameter hole in ¼ in. steel plate is not the easiest to produce! I suppose the best way to achieve this is with a heavy duty tank cutter, which drills about ¼ in. diameter pilot hole and then uses this as a fulcrum for trepanning with a small cutter to the finished size; this tool will leave a razor sharp edge, so take care. Apart from this the 'B' type beam closely follows that for DON HUNSLET. though the full depth 'A' beam has a piece of the 1 in. steel angle attached to the bottom front face, which gives massive stiffness. I suppose those builders with aggressive tendencies will fit the 'A' type beams to be able to mow down the opposition without fear of self-inflicted damage!

The dumb buffers, or buffer blocks as called up on the drawing, are from mahogany and steel faced, for an even better battering ram effect; these again can be finished to individual choice. Attachment of the beams to the frames is identical for both versions, so there is no need for repetition, particular details being frame spacing at 11⅜ in. and the use of more 1 in. angle for attachment. There is a lot more of the same section angle to be fitted to the mainframes, but I recommend this to be left until they are needed to attach the relevant components, like the running boards.



Frames and Cylinders erected on this JOHN HUNSLET under construction by Milner Engineering, Chester.

Guard/de-railing Bar

Quarry Locomotives often had to contend with debris between the track, which could derail them, though a simple beam under the mainframes prevented them coming to any great harm, and they could be quickly put back on the rails again. This safety feature can be put to the same good use in miniature, components being of the simplest to manufacture for both versions, but again should not be erected at this stage.

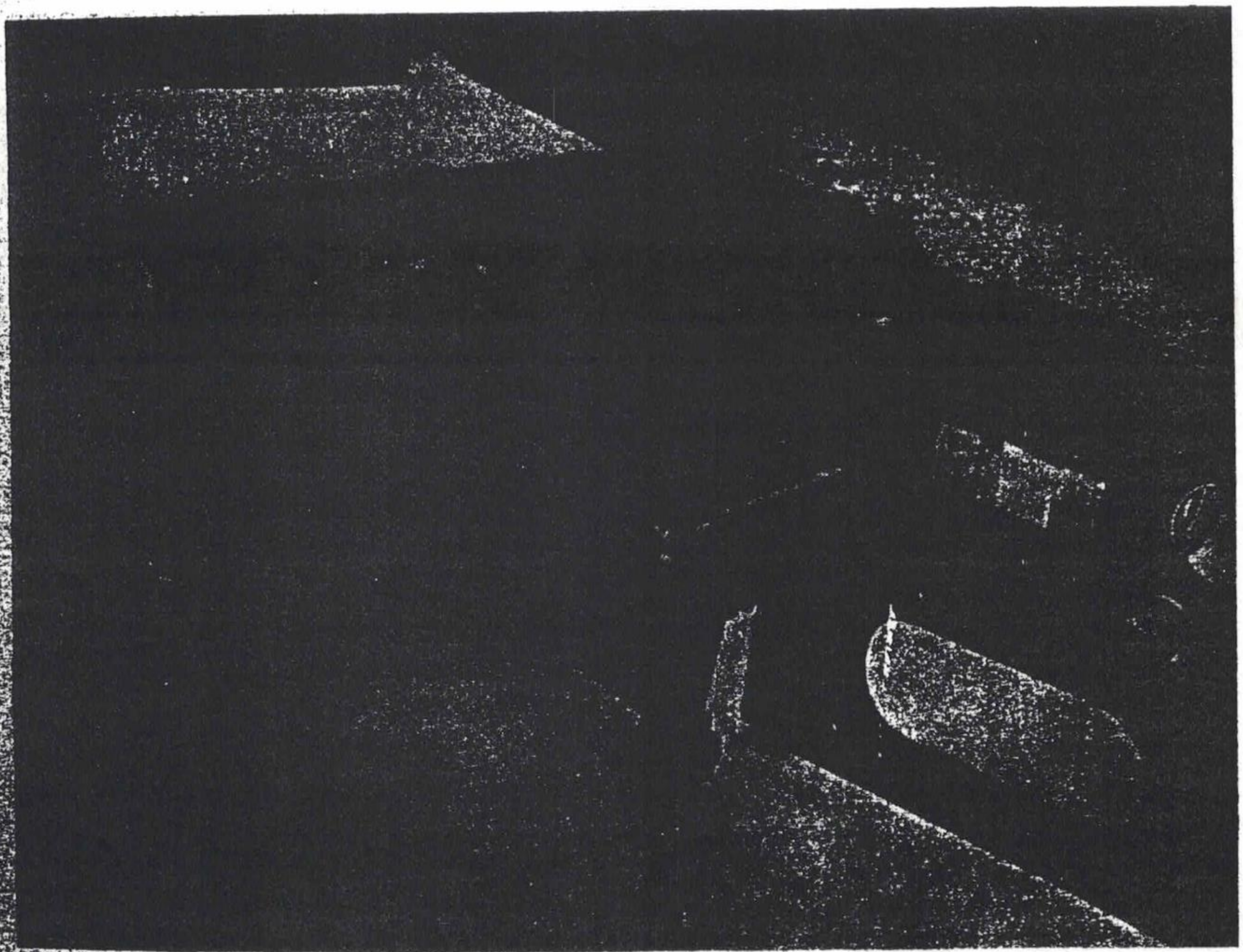
Motion Stretcher Plate

John Milner and yours truly should have got together in our description of the various components, for what I term the inside motion plate, on JOHN HUNSLET is referred to as the motion stretcher plate; it all adds up to the same thing! Having said that, John's detail is much simpler than mine, involving an $11\frac{3}{8}$ in. finished length of 4 in. x 3/16 in. steel flat, scalloped at each end to $1\frac{1}{4}$ in. radius, a simple saw and file job, with $\frac{3}{4}$ in. lengths of his favourite 1 in. angle in each corner, on both sides of the stretcher, to give 8 bolt fixing to the frames. Again, this latter should be left until much later on in the proceedings. The valve spindle guides, at last some agreement!, are positioned at $5\frac{3}{8}$ in .centres, but all we can do for the moment is mark them off, then

drill and ream to ½ in. diameter.
There is no frame stay immediately above and behind the driving axle on JOHN HUNSLET, though any builder who feels a need for same can always scale up that for DON HUNSLET.

Axleboxes

Reverting back to DON HUNSLET, we come to the axleboxes. When the popularity of the design became appreciated, then new and better patterns were produced for the axleboxes, removing the criticism of too generous a machining allowance, and enabling castings to be made in either iron or gunmetal, to builders choice.
Chuck in the 4 jaw, clean up the outside face, then reverse and turn down to the finished 1 5/32 in. thickness. Back to the machine vice and vertical slide set-up on the lathe, to mill one of the side faces, and produce a 3/16 in. deep step as one sliding face on the axlebox. Rotate through 180 degrees, tidy up this face to give 1⅝ in. overall width, then mill the second step to a tight fit in the chosen pair of horns as a gauge; the castings can now be separated into individual boxes and stamped for identification.
Grip one of the boxes in the machine vice, top towards the headstock, and with a length of ½ in. diameter bar in the 3 jaw, use this latter as a guide along one of the side flanks to set the box square. Mill across the top face, mark off and drill ½ in. diameter to ¼ in. depth for the spring rod/oil pocket, completing with a 'D' bit; the No. 55 oil holes will be the last job after boring out for the journal. Reverse in the vice, packing out if necessary, for now we have to mill out the cast-in slot for the keep, also mill the two side legs to length. I invariably fabricate keeps from any odd scraps of brass that have accumulated, and find no difficulty in holding the pieces together with wee home-made clamps for silver soldering, when it is a simple matter to clean them up to size with files. However, enough builders have encountered problems here to warrant specifying an alternative, which is a piece of ⅞ in. square brass bar. Whichever method is preferred, use said square brass bar as a gauge when milling the slot, keeping it central by 'miking' over the flanks, and finishing to a tight fit. Complete fitting the keep, then clamp the whole firmly together to drill and fit the keep pins.
We now have to hold the boxes together in their correct pairings to bore out for the axle, for which two 1⅝ in. lengths of 2 in. x ¼ in. BMS flat is the first requirement, to represent the horn faces. If your 4 jaw chuck has large enough jaws to grip the whole assembly rigidly for boring, then plug the half hole in the casting, mark off and scribe on the axle circle, set up and bore to size, producing the raised face at the same time. Then take the inner box of the pair, set it up in the 4 jaw, poke a length of ¾ in. rod in the bore, set this running true with a d.t.i., and complete this raised face. Fit each axlebox to its horn and all is well.
Whoa!, for I have left those without capacity to bore using the 4 jaw stranded. The answer here is the faceplate, with angle plate bolted to same. One piece of the ¼ in. packing wants to be to the size specified, to fit between angle plate and boxes, but the other needs to be about 4 in. long, and drilled to suit the slots in the angle plate face, so it can be used as a clamp for



Clean castings and good workmanship are very evident on this JOHN HUNSLET.

bolting the boxes rigidly in place. Then it is a case of judicious use of a wooden mallet to set the boxes running true, just nip all the bolts and use light taps to move things in the right direction. This will take time, but you only have to do it twice, and the second time will be much easier! Those with solid keeps should remove them and mill a simple slot to accept the felt pad, which will help look after lubrication on the occasions you forget.

John Hunslet Axleboxes

After all that, the larger axleboxes are easy, having no separate keep, though this feature could I feel be adopted with advantage if the builder is so inclined. Take. the inidividual iron castings, chuck in turn in the 4 jaw and face off to thickness and length in turn. To produce the side flanks, use the same machine vice and vertical slide set-up as for DON HUNSLET, only this time there is no fiddling job of fitting them to a horn, so the ¼ in. step can be milled to rule, to leave 2½ in. over flange and 2 in. over step. Find the centre of each box for the journal by the 'X' method, that is by scribing from corner to corner, scribe a 1 in. circle and set this running true in the 4 jaw. Now you simply centre, drill through the ream, or bore, to size; if the latter, then use a 13 in. length of 1 in. diameter silver steel as your gauge, and get it a tightish fit. To complete, drill the spring rod and lubricating well holes, followed by the oil ways, then cap off the oil well with the retaining washer.

Assembling So Far

For DON HUNSLET we need two 9⅜ in. lengths (remembering what I said about thicker frames!) of ⅞ in. diameter bright steel as the finished axles, which can have the axleboxes threaded to them and inserted in turn into the horns, easing the boxes as necessary. Check for squareness across the frames, and when all is well, fit the frame stay to help hold things square; you can also poke a length of ⅜ in. rod through the weighshaft holes as an additional check.

For JOHN HUNSLET there is little more to be done, so set the frames down on a large surface plate, this can be a well supported sheet of glass. The datum edge is the bottom of the frames, so set them upright, then check all over for squareness. Thread the axleboxes over the length of silver steel rod, clamp the horn guides to the axleboxes and erect in the frames. Use slivers of 1/16 in. packing between the axlebox flanges and horn gap in the frames to centralise, then clamp the horn guides in turn to the frames. Check for squareness of the silver steel 'axle' across the frames, remembering that this is the vital check as the axleboxes were bored individually, so be prepared to juggle with the packing pieces until the axle turns freely. When satisfied, spot through, drill and tap the horn guides ¼ BSF and secure with hexagon headed bolts. Fix the hornstays in turn and another large slice is complete. Incidentally, thread types are taken directly from the Milner drawings, and I agree that British Standard Fine is the best thread for this sort of work, though if not available to the builder, then use NC or NF in lieu, it will make not a scrap of difference to the performance of your HUNSLET.

Axle Driven Feed Pump

We now come to a feature used only on DON HUNSLET, this being the feed pump. If complete reliance is to be placed on this as the sole method of feed, other than the hand pump, then fit a pair of them side by side; here is plenty of room. Personal preference would to repeat JOHN HUNSLET and rely on injector feed, but I will put the case for this in another place. Back to the pump, whose design was produced as far back as 1967, when I considered all the features necessary to arrive at a trouble free unit. The prototype that I made and fitted to my 5 in. gauge RAIL MOTOR No. 1 has run for 7 years without need of the slightest attention, it delivers every time and can be heartily recommended. Its positive action relies on minimum clearance volume, the reason why the plain ram was adopted that could approach the end of the bore very closely. Having said that, American practice in the 19th Century was to use pumps of a large clearance volume, dispensing with bye-pass on the delivery side and controlling flow at the suction side of the pump. In theory this is not a practice to be recommended, though it worked, and worked well judging by the thousands of Locomotives so fitted.

The feed pump stay is bent up from 2¼ in. x 5/32 in. flat, though manufacture will have to wait the completion of the cylinders to gauge the dimension over flanges. On to the pump itself, where the body is a gunmetal casting. First grip in the 4 jaw and face across the bolting surface. Reverse in the chuck face, centre, drill and ream through the bore at ⅜ in. diameter, then bore out to ½ in. diameter to 7/16 in. depth for the gland. Fit the angle plate to the vertical slide and bolt the pump, down through the bore, to the angle plate; turn so that the inlet face is towards the chuck. Face with an end mill, centre and drill into the bore at No. 30, follow up with a 7/32 in. 'D' bit to ⅜ in. depth and tap ¼ to 40T to 3/16 in. depth. Rotate through 180 degrees, mill the top face, centre, drill into the bore at No. 31, 'D' bit at 7/32 in. diameter to ⅜ in. depth, tap ¼ x 40T to ⅛ in. depth and then put an ⅛ in. reamer through the remains of the No. 31 hole. With a square swiss file, produce slots to take delivery from the end of the bore to the outlet passage, and break up the ⅛ in. hole at the inlet so that the ball cannot inadvertantly seat when lifted and cause the pump to fail. Bolt the body directly to the vertical slide, mill the outlet facing, drill at No. 30, follow up with a 3/16 in. 'D' bit to a full 3/16 in. depth and tap 7/32 x 40T.

The inlet elbow and retaining cap over the delivery ball valve require no description, save the instruction that both balls lift at least 1/32 in.; the pump ram and gland are also straightforward items. Fit both to the body, spot through the gland stud holes, drill the body No. 48 and tap 7BA. Use 3/32 in. stainless steel rod for the studs, together with commerical brass gland nuts, then pack the gland with PTFE or greased water packing.

Eccentric Sheaves and Straps

We are now back on common ground, except that an extra sheave and strap is required to drive the pump on DON HUNSLET. Staying with the latter for a moment, chuck a length of 2 in. diameter steel bar in the 3 jaw, face and centre the end, and bring the tailstock into play before turning down for at least 3 in. length to 1⅞ in. diameter. To produce the groove, a special 5/16 in. wide parting off type tool will be very useful, ground perfectly square so that the groove can be produced at one pass, although you can rough it out initially with a thinner parting off tool. Start from the outer, tailstock, end and rough out all the sheaves, including a plain portion at the end which will become our gauge for the straps. Change to the form tool, run the lathe in back gear, very slowly, feed on plenty of cutting oil and turn the outside, plain piece, to size; caliper dimension will suffice. Make a note of the cross slide micrometer collar reading at completion of the cut, then repeat for the 5 sheaves themselves; part them off. Rechuck and clean up to thickness, to remove the parting tool marks, then mark off the 7/16 in. throw on one of them, chuck in the 4 jaw and set to this mark, the drill and bore out to a tight fit over the axle. Loosen two jaws only, and tighten the same pair over the next sheave; carry on and complete the quartet. The feed pump sheave is only 5/16 in. throw, so mark this off and then repeat the procedure. Back to the machine vice and vertical slide set-up to drill for and tap 4BA for the securing screws, themselves cup point socket grub type.

Grip the eccentric straps, by the bore, in the 3 or 4 jaw chuck and face across one side. Now split with a Junior hacksaw, grip in the machine vice, and mill across the mating faces until the bore is roughly circular. Clamp the pair together, drill through top and bottom at No. 34, clean up the lugs in way of these holes and secure with 6BA bolts and nuts. Grip by the outside in the 4 jaw, set to run true, face to thickness and bore out to suit the gauge. To complete, mill across the rod face to the finished dimension and clean up the rest of the profile with files, then drill the oil reservoir and No. 60 oil hole into the bore. Mate eccentric sheaves and straps, relieving if necessary until they will turn, albeit a little stiffly; this will soon wear off in service.

To complete the DON HUNSLET feed pump drive, a short eccentric rod is required, made to drawing from two pieces of ⅜ in. x ⅛ in. BMS flat, brazed up, then drilled for fixing to the strap, also to the ram, this latter hole being phosphor bronze bushed for preference. The lubricator drive fork, if fitted after my earlier remarks, is a length of ⅜ in. x ⅜ in. x ⅛ in. steel angle, tapped 6BA to accept the lower strap bolt.

John Hunslet Eccentrics

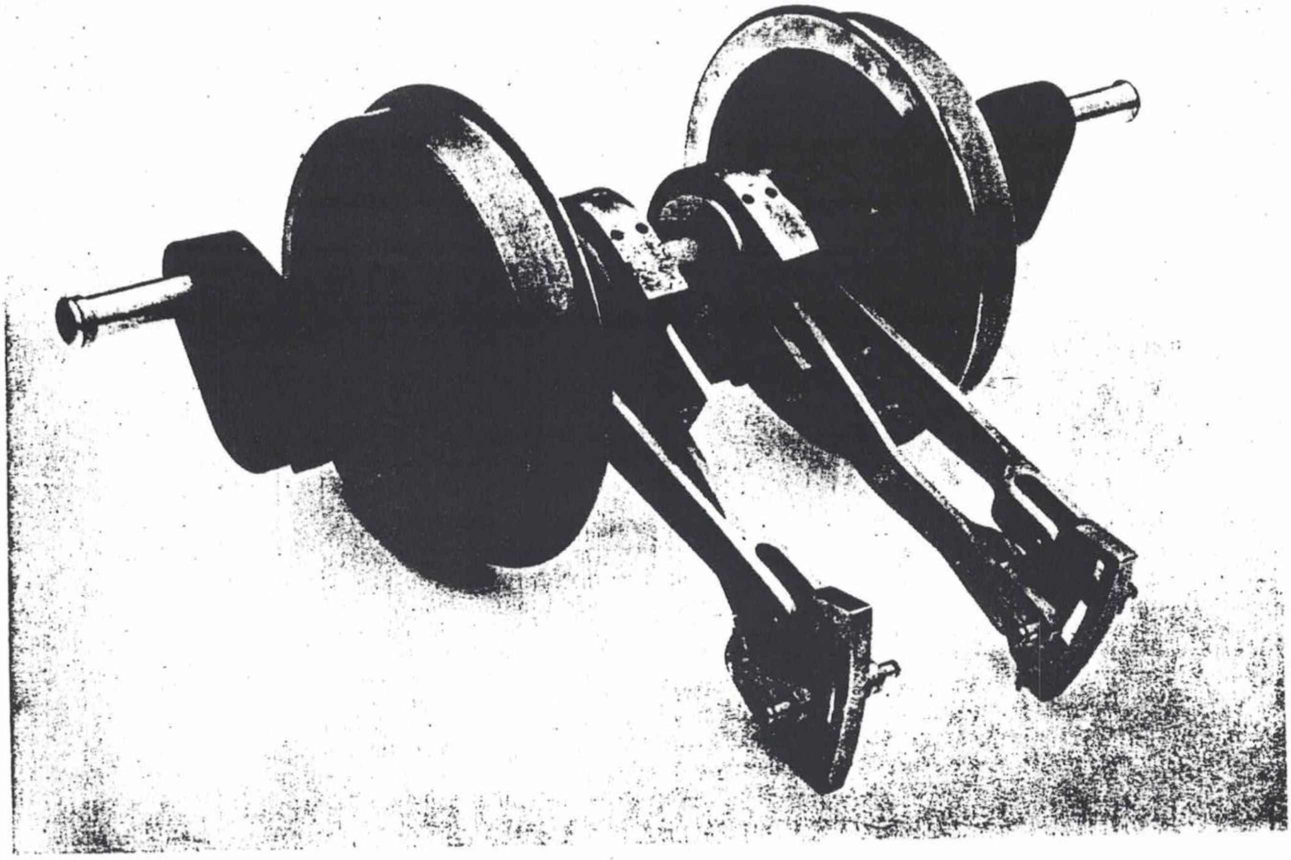
Surprisingly JOHN HUNSLET eccentric sheaves, except for being much fatter, are remarkably similar to those for DON HUNSLET, though having a throw of only 5/16 in. Manufacture is exactly the same, using 2¼ in. diameter steel bar, which is dead size for the outer flanges. Two 2BA screw fixing is used to secure to the axle, inserted through the less meaty portion of the sheaves, which I personally do not favour, though with an overall thickness of 1 in. there is little to complain about!

The eccentric straps are iron castings; first turn or mill them to thickness and then mill the lug to size for fixing the eccentric rods. Next concentrate on the bolting faces, the 13/16 in. dimension from the lug on the forward piece being important. Mill the back portion to suit, then drill and tap for the ¼ BSF socket head cap screws. Chuck the complete assembly in the 4 jaw, set to run true, and bore out to gauge.

Wheels

Wheel turning is one of the most pleasing jobs, at least in my book, and very little instruction is necessary for the HUNSLET, as there are no crankpins to worry about. For DON HUNSLET, two profiles are given, the lighter of the two being to conform to U.K. track standards, so there will be no problem running through frogs and check rails, this being 'scale' for 5 in. gauge rather than for the Locomotive itself. The castings have plenty of machining allowance on them, so if you intend running on your own track, and it is of Narrow-gauge proportions, then use the heavier profile, even wider tread if you like, making the necessary corrections to horns and axleboxes to suit.

For both versions, chuck by the tyre, face across the back and finish turn the flange, taking note of the machining allowances, then centre, drill through and bore out to size, or ream. Assembly to the axles can be through the medium of Loctite No. 636 in both instances, which will be more than strong enough!, though we have not reached this happy stage yet, so on we go. If you can obtain an old drill with taper to suit the headstock mandrel, saw it off behind the flutes, tap it home, and turn down to a tight fit in the wheel seat. Fit the face-



Driving axle assembly for JOHN HUNSLET — we shall be reaching the valve gear in Part 3.

plate, slide on a wheel and 'dog' over the flange, to turn the front face and then the tyre. The JOHN HUNSLET tyre is specified with a 2 deg. 40 min. taper, a worthwhile refinement, so for all wheels, turn to nominal size, resharpen the tool if necessary, and then take a final cut across all of them at the same setting, so their diameters coincide. Incidentally, it was common practice full size with disc wheels to have a couple of holes in their webs to reduce 'ringing.' Any builder can repeat this feature, and then use said holes to bolt directly to the faceplate for turning, this being much easier than using dogs.

John Hunslet Axles

These are 14 11/16 in. finished lengths of 1⅛ in. diameter bright mild steel, turned down to 1 in. diameter for 3 31/32 in. at each end (3 27/32 in. for the 7¼ in. gauge engine). We can now move outside the frames and deal with those flashing fly cranks, one of the most distinctive features of our HUNSLETS.

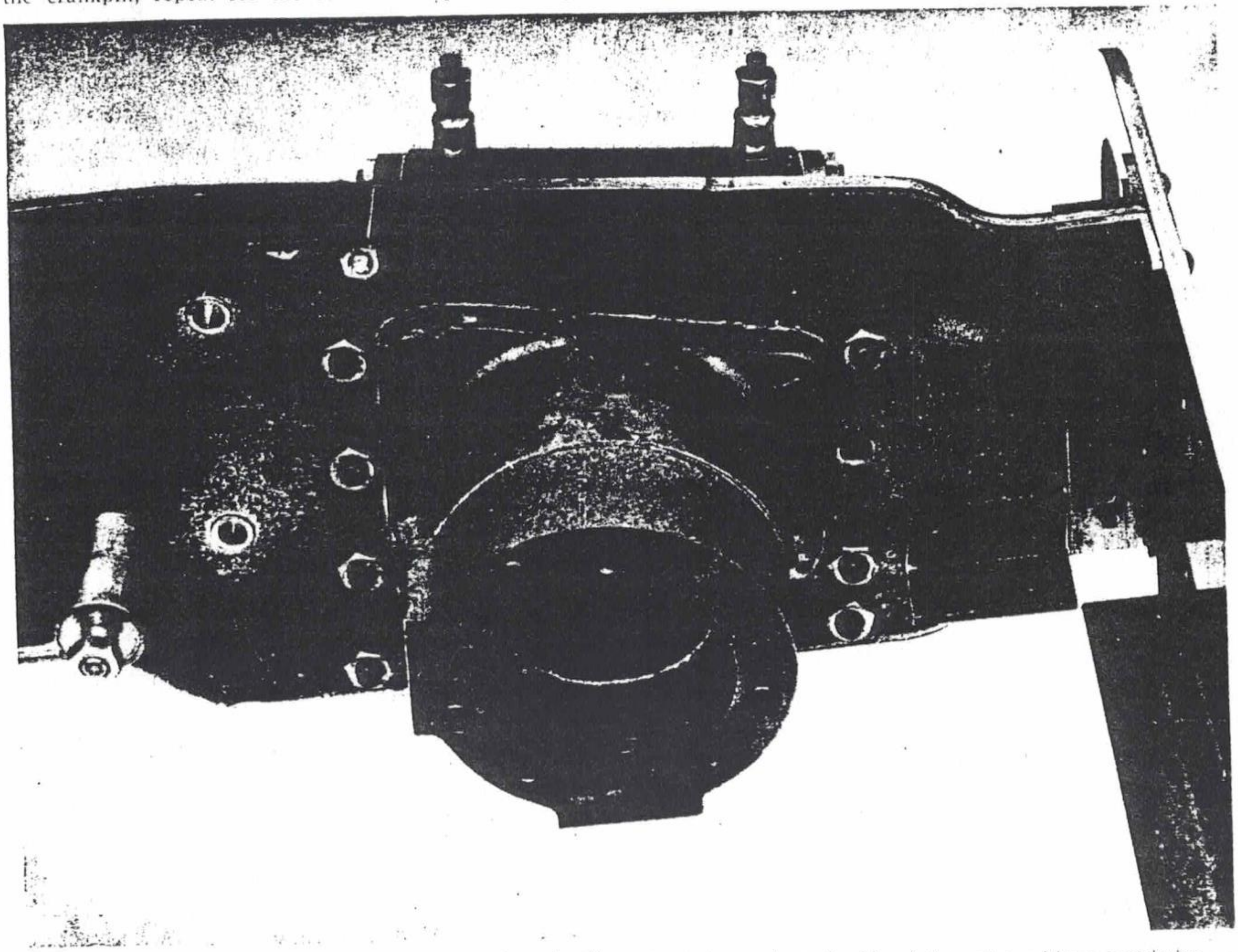
Fly Cranks

For DON HUNSLET the first requirement is four 2 5/16 in. lengths of 1½ in. x ½ in. BMS bar. Mark the centre line along one of the 1½ in. faces on all pieces, and centre for the axle end, then grip in the machine vice, on the vertical slide. Centre at the axle end position, drill, bore and ream to ¾ in. diameter, or finish boring to a tight fit over the axle. Advance the cross slide by 1.562 in., centre, drill and ream to 7/16 in. diameter for the crankpin; repeat for the other three pieces. Rough out the profile at the axle end with a hacksaw, grip a length of ¾ in. rod in the machine vice, you can mill two flats on this mandrel to assist holding it firmly, grip the crank with a 'Mole' wrench, fit an end mill of about ¾ in. diameter in the 3 jaw, and rotate the crank on its mandrel around the end mill to produce a nice clean radius. The side flanks can now be marked on and milled to line, but the outer, crankpin, end will almost certainly have to be radiused by filing, otherwise the 'Mole' wrench will spoil the finished profile if the milling technique is used. Grip a ⅜ in. nut in the 3 jaw, bolt the crank to same, and turn away to leave the 1/32 in. raised boss to complete.

JOHN HUNSLET builders are blessed with excellent iron castings for their fly cranks, the profile of which would clean up nicely with files. I would recommend the same technique be used by producing the two holes, packing up the sloping flanks in the machine vice, and throw specified at 1.65 in. Fixing to the axle is by ¼ in. square key, excellent engineering practice, but possibly beyond the amateur builder, though as always Milner Engineering can provide the necessary machining service. My experience with Loctite products is that this would be a more than adequate alternative, and this would be my recommendation, as for the wheels. Leave this operation for the moment however, as we have yet to make and fit the crankpins.

Crankpins

For both versions these are simple turning jobs. On JOHN HUNSLET the outer lip is integral as it should



Circular steamchests are rather unusual, though they do allow steam to reach each side of the valve without restriction — a JOHN HUNSLET feature.

be, but as there was no restriction here, I used a slightly larger and separate collar, plus another between the coupling and connecting rods, all secured with 3/32 in. spring dowel pins. The crankpins themselves can either be a press fit in their respective cranks, and JOHN HUNSLET has a half-and-half 2BA fixing for additional security, or reliance can be placed on Loctite once more.

Coupling Rods

For DON HUNSLET the coupling rods only require profiling, being made from 1¼ in. x 7/32 in. (30mm x 60 mm) section BMS flat. First mark off, drill and ream two ½ in. holes at 8¼ in. centres to start forming the slots for the brasses, then mark on the rod profiles, using the two holes at datum. Bolt a piece of ¼ in. plate, size about 10 in. x 2½ in. to the vertical slide, drill through at 8¼ in. centres and ⅜ in. diameter and bolt the embryo rod in place. Set it horizontal, then mill as much of the profile as you can, using the side teeth of an end mill; remove and deburr.

Next fit the machine vice to the vertical slide, mark off for the cotter slots and oil reservoirs, drilling as specified on the drawing. If you are adept with a 1/16 in. end mill, form the slots for the cotters this way, otherwise use Swiss files, to the cotter material as a gauge. Grip by the ⅝ in. wide portion of the rod, as close to one end as you can get, and mill away as much of the cut-out for the brasses as you can; repeat at the other end and then finish with files.

The brasses start life as ½ in. square bronze or gunmetal bar, four off finished to ⅝ in. length and the other four to ¾ in. Chuck each in turn in the 4 jaw and reduce to 5/16 in. thickness. Tin each pair of faces, clamp together and reheat, so that you can machine together in pairs. Back to the machine vice and vertical slide to mill a 7/32 in. wide groove, or 6 mm., to 1/16 in. depth in the shorter, top, face; it will be ⅛ in. deep on the front portion of the brass.

Rotate through 180°, pack off the back of the machine vice onto the just machined surface, and repeat the dose to a tight fit in the rod end. Mill the front and back edges to arrive at the 7/16 in. dimension, but don't worry about either the cotter groove or the radius at the back as yet. Back to the 4 jaw, to centre and drill to ⅜ in. diameter, then profile the outer and inner flanges to drawing, the latter only applying as a lip at the back of the rear brass, all the rest being removed. File the ¼ in. radius on the back of one brass, checking the fit as you go, then fit the front half and hold firmly in place by wedging packing between the front of the brass and the end of the slot.

At this stage, chuck two 1½ in. lengths of ¾ in. diameter steel bar, odd ends of axle material, and turn down for ⅝ in. length to ⅜ in. diameter, a good fit in the brasses. Clamp the axleboxes on one side of the engine hard down onto their hornstays, fit the stepped dowel pins, and the almost completed rod end. Now concentrate on the back brass at the other end of the rod, filing on the radius until it takes up the same centre as that between the axles. Fit the mating front brass, use a Swiss file down through the cotter hole to mark the brass, then file the groove to drawing. The cotter starts life as a 1½ in. length of ¼ in. x 3/32 in. gauge plate, and you simply reduce it as shown until it can be driven home with equal amounts protruding above and below the rod.

Connecting Rod

The connecting rods for DON HUNSLET are very similar to the coupling rods, are initially 9¾ in. lengths of 1¼ in. x ⅜ in. BMS bar, but require an additional operation to reduce the thickness over the major portion to ¼ in.; 1/16 in. off each side. This can be dealt with at the same time as the profiling, the rods being inclined slightly to produce the taper. Big end brasses are as for the coupling rods, except they use the full ⅜ in. thickness; there is no problem over centres, so fit the cotter at this stage.

Small End Brasses

For the front half of the brasses, chuck a length of ½ in. bronze rod, face, centre and drill 7/32 in. diameter to ½ in. depth. Turn down for ½ in. length to 15/32 in. diameter, then turn a ¼ in. wide groove down to 11/32 in. diameter to suit the rod. Part off to leave 1/16 in. flanges at each side, then back to the machine vice to mill away exactly half of the brass; you can check this by micrometer. For the back half of the brasses, start with ⅜ in. square material, first drilling the 7/32 in. hole and then milling away exactly half of it. Now concentrate on the top and bottom surfaces, milling away until a fit in the rod is obtained, with gudgeon pin half holes coinciding; a rather tricky operation, though the loss of material is small if you fail first time. The holes could be drilled initially at 13/64 in. and finally opened out when the brasses come together if this would be easier on your nerves! Next mark on the 15 degree slope at the back, saw roughly to line, then back to the machine vice to complete by milling, including the ¼ in. wide slot for the wedge.

I should have said earlier that the hole for the adjuster bolt be drilled No. 50 before completing the slot; apologies. Make the wedge from ¼ in. x 3/16 in. bar, bronze or steel, a tight fit in the brass, assemble the whole, then drill from top and bottom of the rod at No. 50, to break through, tapping the wedge 8BA. Open up the rod to No. 44 as clearance for the 8BA bolt; do this in the machine vice and at the same time spotface for the bolt head and nut, as there is limited clearance here in the crosshead.

John Hunslet Rods

The JOHN HUNSLET coupling and connecting rods are fabricated from steel bar and flat, and I would very much recommend builders to purchase the complete and nickel plated rods, when only the brasses have to be made and fitted.

Both coupling and connecting rod big end bushes are fitted with wedges, as per the gudgeon pin end on DON HUNSLET, in lieu of cotters, brasses being made up in pairs, bored to size, and then slots milled for the wedge. The same techniques can be used for arriving at the correct centres to coincide with those for the axles, only this time instead of filing a radius, it is a simple matter of milling a little off the front of a brass; the leading brass to increase the centre distance and the driving to shorten same. Wedges are made up and fitted in exactly the same way, only with wedge bolts at 2BA you can spot through onto each end of the wedge, before drilling No. 27 as the tapping size. The small end brasses are plain phosphor bronze bushes, a press fit in the rod ends, and six oil nipples turned from ⅜ in. brass rod completes the rods.

Slide Bars

The slide bars for both versions are commercial section BMS bar, ¼ in. x ¼ in. section and 5¼ in. long for DON HUNSLET; ⅜ in. x ⅜ in. and 9¾ in. long for JOHN HUNSLET. By way of a little extra authenticity, the JOHN HUNSLET bars have ¼ in. x 1/16 in. recesses cut across at the ends of the crosshead stroke, which means wear is even along the slide bar and tight spots do not occur when adjustment is made after some length of time in service.

Crossheads

We now come to the penultimate item in this particular session, the crossheads, and again DON HUNSLET will take the lead, and curiously yet again there is more work involved, this one being a fabrication.

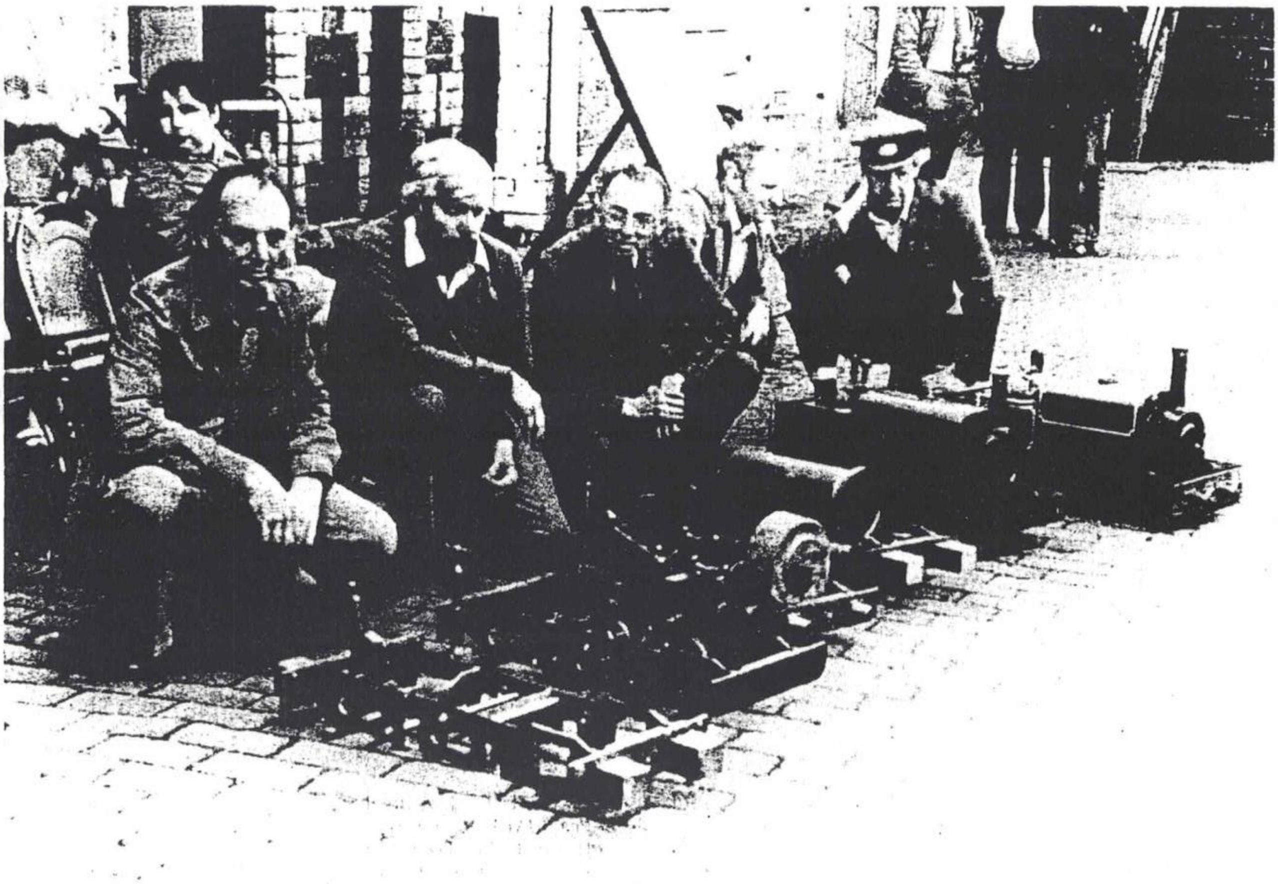
Start with two 1⅝ in. lengths of 1 in. x ⅝ in. BMS bar, and mill 1/16 in. off the width to arrive at 15/16 in. x ⅝ in. section for the centre of the crosshead. Find the centre at one end by the 'X' method, centre pop and chuck to run true, then centre and drill 5/16 in. diameter to 13/16 in. depth. Try to select a drill that produces a smaller than nominal sized hole if you can, as the piston rod should be a tight fit. Next turn the boss to drawing. Mark off for the gudgeon pin hole, chuck again in the 4 jaw, centre and drill through at No. 13. Open out to ½ in. diameter to ½ in. point depth, then bore out to 9/16 in. diameter, before running a 3/16 in. reamer through the remains of the No. 13 hole. You can now mill the ⅜ in. wide slot to accept the connecting rod either to the shape as shown, or take it right across from top to bottom, to give more clearance. The back profile can be milled over a mandrel, or filed to line, the latter being the easiest solution.

Top and bottom slippers are from ¾ in. ¼ in. bronze bar for preference, milled to drawing, clamped in place, and brazed up. Alternatively you can braze the slippers on first, and then mill to drawing.

For JOHN HUNSLET, extremely good iron castings are provided, needing a minimum of machining. Tidy up the outside, machining only the boss faces to arrive at a datum, then mark off for the gudgeon pin. Grip in the machine vice, drill right through at 27/64 in. diameter, then open out the outer flange to 31/64 in., finishing with ⅜ in. and ½ in. reamers respectively; this will ensure both holes are in perfect alignment. Use these holes to bolt the crosshead to an angle plate, attached to the vertical slide, and mill the outer faces of the slippers first, to get them parallel, before dealing with the .63 in. wide slot to 5/64 in. depth. All that remains is to chuck again in the 4 jaw, to centre, drill and ream to ⅜ in. diameter for the piston rod.

Gudgeon Pins

The gudgeon pins for both versions are simple turning and screwing jobs, requiring no description, and having written Part 2 in one day, I reckon builders will be kept quiet longer than that, hopefully until the next issue appears!



DON HUNSLETS pose with their builders, from left to right Frank Yates (Don Thorne went into hiding), Alex Bradley, Tom Pomfret, Wm. Turnbull and Jack Coulson. This scene made up for all the poor weather; thank-you.

Owing to lack of space, we regret that the North Wales feature has to be held over until the next issue.

Hunslet

by : DON YOUNG

Part 3 — Cylinders

Cylinders Introduction — DON HUNSLET

This being my first excursion into the realms of the balanced slide valve, I took out an 'insurance policy' in the shape of making provision for ordinary 'D' valves should problems arise. Hence dimensions are shown for an exhaust port, which is nothing but an empty space with the balanced valve, plus there was retention of the boss immediately above to facilitate an alternative exhaust passage should the need arise. This then was a deliberate mistake from the outset, and there is one other subtle point in the design, which one or two builders have remarked upon, this being an increase in clearance volume to my norm. With small clearance volume, compression pressures can be produced in excess of that of the incoming steam, and on several of my designs this is negated by opening the steam port rather earlier than previously accepted practice. This time the valve gear precludes same to a degree, so I have taken the other way out and increased clearance volume instead. Even so, when working really hard, it is not unknown for valves to unseat, which indicates to me that the piston could stand another 1/64 in. off each side to further reduce compression, the alternative being to reset the valves with slightly more lead. For having sampled the sharp exhaust from balanced valves, there is everything to be said for their retention.

Cylinders Introduction — JOHN HUNSLET

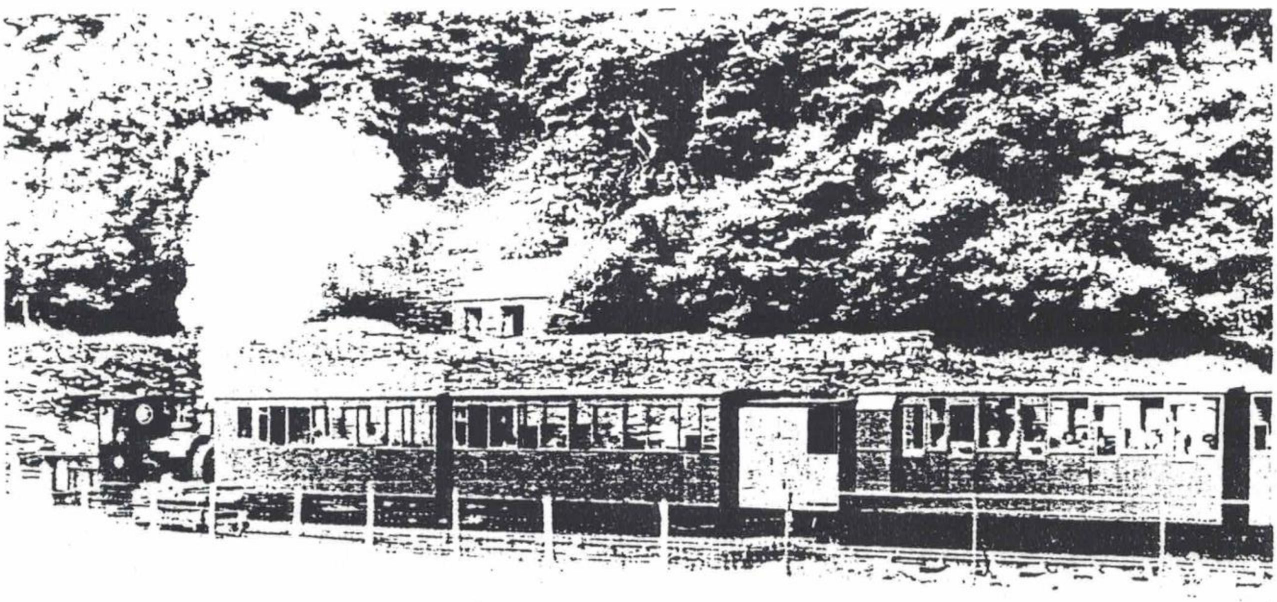
By utilising JERSEY LILY cylinder castings, DON HUNSLET started off at a very slight disadvantage in that the valve gear could not be 'straight line.' So, starting from scratch, JOHN HUNSLET has the edge in being able to employ a separate port block, there being no large cut-out in the frames, and of course the port faces are closed to the centre line of the engine. But this does increase the length of the passages, so as ever it is a case of swings and roundabout.

Comparing the two designs, it is a case of adaptation versus realism, but I am a terror with the pencil, and have doodled several times to open out the exhaust on JOHN HUNSLET, though it must be admitted that for the intended duty, the specified arrangement is perfectly adequate.

DON HUNSLET Cylinder Block

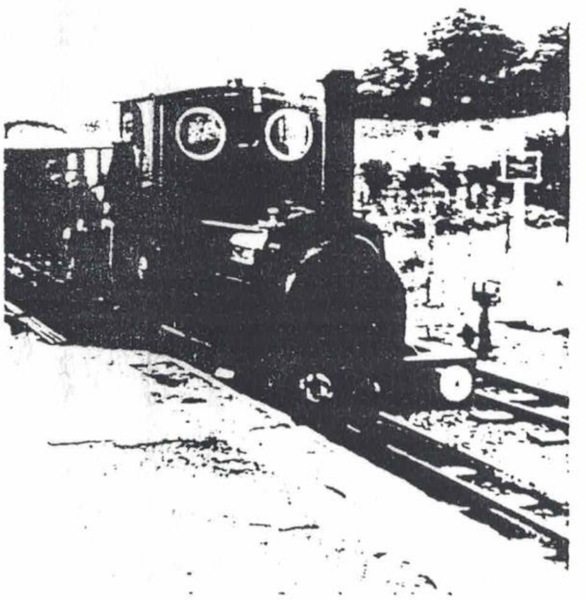
With balanced slide valves there is much to be said against the use of cast iron, which I need not go into here, though there is merit in cast iron cylinder blocks, allied to pistons fitted with rings, for this is where wear will occur on a really hard worked engine. So I have arranged that blocks only will be available in both cast iron and gunmetal, so that builders have the choice.

Take a block, clean it up with files and then mark out to assess the machining allowances. Next file one of the end faces at the cylinder cover both flat and square to the rest of the casting. Erect the vertical slide, bolt an angle plate to same, then sit the just cleaned-up surface of the cylinder block on the angle plate and bolt down through the bore, using a clamping bar or large washer at the head end of the bolt. Set square across the lathe axis and then fly cut the port face down to line. To do this, use for preference an Arrand high speed counter-balanced fly cutter, a most useful tool for the SMALL LOCOMOTIVE builder, who like me does not want to waste valuable time making jigs and tools. Change to the 3 jaw chuck and grip a large diameter end mill, with which to machine around three edges of the bolting flange: the top edge must be left until later, when it can be blended in with the top edge of the frames. Now mill the bolting flange face all around, to a tight fit in the frames; you know the



14.00 departure from Llanberis on Sunday, 2nd September, 1979.

saga of the exhaust boss, and there is now sufficient confidence for me to instruct builders to mill it off, when the job becomes a hundred times easier! Our boats are burnt, the exhaust port disappears, so mark out for the steam ports only, drill a row of 5/32 in. holes to 9/16 in. point depth along the centre of each and mill to line with a 5/32 in. end mill. Never use an end mill of equal size to the port width, as it will wander at the very least at the extremities, and cause me correspondence! To cover this point, and to stop those letters, let me explain how to overcome any problem in this area, though the first instruction must be to rigidly adhere to drawing.
The width of a steam port is meaningless as such: basically it consists of two edges, steam and exhaust, and that is all you have to concern yourself with. So if either edge be displaced from drawing, to correct the deficiency, what you have to do is imagine the valve sitting on top and



A very sprightly 'Holy War' hits Llanuwchllyn platform — not literally!

then displace the mating edge by the same amount, then you are back to Square One.
Fit a hardwood bung in the cored cylinder bore, at the cleaned up end, and scribe a circle at the relevant diameter; mine would be at 1¾ in. for I love big cylinders! Chuck truly in the 4 jaw, and do take care with that finished port face, to bore out to size and face as much as you can for the cover. This is the back cover face and will be perfectly square with the bore; the front cover face does not have to meet this requirement, but do remember to machine the blocks as a pair. You can either reverse in the chuck and turn the front cover face first, or go back to the vertical slide and mill this, and the remainder of the back face.
Offer up to the frames, drill through the sixteen No. 11 fixing holes, mark off the top edge, and either saw and file, or mill, to line. You can now cut those tapered packing pieces to accept the cleading, from 3/16 in. brass plate, and screw them in place. The passages will have to await the fitting of the covers, to locate those 6BA tapped holes, but I can describe them now for continuity. Incidentally, Merlin Biddlecombe who has just finished machining a set of these cylinders has made two useful suggestions. One is to use a smaller number of larger bolts, say 10 off at 4BA, and the other is to re-orientate the bottom one clear of the drain cock tapping; thank you Merlin.
Back to the passages, where the first job is to file flats between said tapped holes to give landing for the 3/16 in. drill. Bolt through the bore to the vertical slide and angle so that the 3/16 in. drill will break through into the port; this can best be done by eye. Drill holes at the extremities of the passage, then change to a 3/16 in. end mill and open out into a slot. That completes DON HUNSLET cylinder blocks as far as we can go for the moment.

JOHN HUNSLET Cylinder and Port Blocks

Mark off carefully, using those cast-in passages as datum, then chuck in the 4 jaw and face off the bolting flange. Find the centre of the bore, transfer this down to the bolting flange, and drill the 5/16 in. holes as shown. Bolt to the frames, with cylinder centre lines coinciding, mark off and drill the remaining fixing holes. You can now mark off and mill the bolting flange edges, using the 5/16 in. holes to bolt the casting to the milling machine table or vertical slide.
To bore the cylinders, I would recommend the use of faceplate and angle plate; bolting face to the latter and again using the 5/16 in. holes for attachment. Set to run true and bore out to size, using an internal micrometer to arrive at 2.284 in. diameter. Face across for the back cover, then recess the bore to drawing for the cover spigot, finally reversing on the angle plate to deal with the front cover spigot and facing.
Both versions need drain cock tappings, so back to the angle plate and vertical slide, to mill across the bosses provided, mark off, centre, drill, 'D' bit and tap to drawing. Centre pop and drill back from the bore into the tapped holes to complete the exit arrangement.
There are many proprietory liquid jointing compounds now available, and I would use one of these for both cylinder and port block sealing to the frames in lieu of a compressed asbestos fibre (CAF) gasket. In olden days the concoction would be boiled oil and red lead, but nowadays a liquid joint is less abnoxious!
Mark off the port block, and again machine the bolting face first, with cast-in ports as datum. Drill the four 5/16 in. fixing holes, offer up to the frames, drill and tap the latter 5/16 in. B.S.F. to suit, or any other thread form you like. Clean up the edges then chuck in the 4 jaw, set the raised port face to run true, then clean up the rest of the casting before machining across the port face to finished thickness. Bolt to the vertical slide, or milling machine table, to clean up the steam and exhaust ports to drawing dimensions. I would suggest leaving the ½ in. exhaust passage until the bottom of the smokebox is in place, then it can be marked off and drilled from the latter, although being square with the top edge of the bolting flange, this could be used as the datum instead, to get another job out of the way.

Front Covers

For both versions, chuck in the 3 jaw and machine across the outer face. JOHN HUNSLET is tapped centrally at 5/16 x 32T for a haxagon plug, and DON HUNSLET could, with great advantage, follow suit at 7/32 x 40T. Then all you have to do is chuck the requisite screwed adaptor, fit the cover, and complete machining to drawing. Use a knife edged tool to scribe on the bolting circle, mark off and drill, then offer up to the block, spot through, drill and tap the latter to suit.

Back Covers

Again for both versions, chuck by the gland boss in the 4 jaw, face across, turn the spigot to a tight push fit in the bore, turn the periphery to size and clean up as much of the bolting face at the back as you can reach. Scribe on the bolting circle, then centre, drill and ream right through for the piston rod. Reverse in the chuck, poke a length of piston rod material into the bore, and set to run true with a d.t.i. Face off to overall thickness and bore out for the gland, completing with a ½ in. 'D' bit in the case of DON HUNSLET. If you have a parting off tool which can be ground to half-round form at the cutting edge, undercut the outer face as shown for DON HUNSLET; if not, then leave well alone and simply clean up the boss. The slide bar facings will have to await completion of the cylinders, so simply bolt to the cylinder, block at this stage, then turn up the piston rod glands.

Piston and Rod

Chuck the piston blanks and rough out to drawing, leaving a few thous. for final machining. Centre and drill through at tapping size for the piston rod, followed up with a tight, clearance drill for half depth; tap out the remainder. Cut the piston rods to length, plus about ¼ in., chuck in the 3 jaw and check to see if running true; if not, transfer to the 4 jaw. Face and screw, then fit the piston and complete machining to drawing, when all will be concentric. For cast iron DON HUNSLET cylinder blocks, machine the pistons to accept rings as available from A. J. Reeves & Co. Ltd., to give .002 in. axial and .005 in. radial clearance in the grooves; two per piston. Erect the pieces made so far, check all is well, when we can progress to the steamchests.

DON HUNSLET Steamchest and Cover

First chuck the steamchest in the 4 jaw and machine to finished thickness, keeping the valve spindle boss in its rightful position. Move to the vertical slide and angle plate, clamp the steamchest to the latter, then mill the top and bottom faces to an overall height of 2½ in., again keeping the valve spindle boss in the correct position. There is a second boss on these steamchests, which we can use as a chucking spigot, so chuck in the 4 jaw and clean up said spigot, and the front face, before gripping same in the 3 jaw.

Centre the valve spindle boss, then bring the tailstock into use before machining the boss to size and facing across to give the correct overall steamchest length. Change to the tailstock chuck, drill through at No. 13, then 'D' bit at 11/32 in. diameter to ¼ in. depth before tapping ⅜ x 32T; ream the remainder of the No. 13 hole to 3/16 in. diameter. Reverse in the chuck, centre and drill through the chucking spigot at 11/32 in. diameter and tap ⅜ x 32T. Countersink the end of the tapped hole, and use the tailstock as support when parting off, then lightly countersink the entrance to the remaining threads, so the taper tap will enter and remove any burrs. Drill and tap the ⅜ x 26T steam entry hole, but leave the 7/32 x 40T one for oil delivery until the decision is made as to mechanical or hydrostatic lubrication. To complete the steamchest, mark off and drill the eighteen No. 29 stud holes for fixing to the cylinder block, in fact you can now offer up to drill and tap the latter to suit. The studs are made from ⅛ in. stainless steel rod, screwed 5BA each end, with corner studs having sufficient thread length to hold the steamchest firmly in place for valve setting when the cover is removed.

Talking of the cover, chuck by its spigot, face across, then mill the edges to suit the steamchest, finally gripping in the machine vice to either fly cut or mill across the outside. Centre and drill the ⅜ in. outlet hole, then offer up to the steamchest and drill the stud holes.

JOHN HUNSLET Valve Chest and Cover

After DON HUNSLET, these are easy! First chuck the valve chest in the 4 jaw and face off to finished thickness, cleaning up the inside at the same time if you wish, and I should have said for DON HUNSLET that this particular operation is one for files, and patience. Mark off for the valve spindle, set up on angle and face plate, check to run true then face, centr... ream through at 5/16 in. diameter. Contin... out to ½ in. diameter for the gland, itself a ... job. Rotate so the steam inlet boss comes ... across, reset as necessary, then drill and tap ... Drill the eight fixing holes, countersinking ... to hold the chest in place for valve setting ... attaching to the port block until the valve ... and fitted, so you can check alignment. The ... cover is from ¼ in. steel plate, a 3½ in. dis... tapped to drawing.

Book Review

'AMERICAN NARROW GAUGE' by John K...

(with Donald Duke), published by Golden W...

San Marino, California 91108 at $26.95

'American Narrow Gauge' proved one of the mo... ing books I shall ever have the honour to revi... ally it is a picture book, with short introductory ... nothing out of the ordinary. But it scores th... enthusiasm and technical ability of camerama... Krause, and his choice of subject and locations. It ... enthusiasm that shines through the pages and ... involved Donald Duke, the publisher, in helping ... it together, so one finds Donald as much a Narro... enthusiast as he is a successful publisher; this is ... evidenced by the sheer quality of the book itself. The largest section is rightly devoted to the Denve... Rio Grande Western, a prince among Narrow-gau... roads, so it is amazing to learn that John Krau... based, not in Colorado, but in New York! This ... seem a serious obstacle to obtaining any prope... graphic record, as we are talking in time of th... 1940's, but incredibly John's record is the most ... I have ever seen. As witness of his dedication, ... the Cumbres Pass are taken both in summer and ... though snows could last from mid-October to July ... one considers the isolation of this territory, the... no road access, the results become even more in... The scope of 'American Narrow Gauge' is enorm... covers common carrier railroads from New Mex... Alaska, Virginia to Hawaii. It is particularly ... mended to those who have yet to experience th... of Narrow-gauge, the 'unconverted,' running along ... blasted out of the mountainside and over spindly ... bridges, providing what was then an essential servi...

Should any LLAS reader not be able to obtain 'Ame... Narrow Gauge,' or any of the following listed bo... direct from the publisher in the U.S.A., then we shall ... pleased to place a bulk order for same when quantit... required are known. Simply send us your order witho... deposit, to reach us by 18th July, and we will do th... rest.

Other titles available : —

Rio Grande Glory Days	$12.95
Iron Horses to Promontory	$16.95
Santa Fe	$17.95
Super Power Steam Locomotives	$14.95
The Ulster and Delaware	$16.95
The Missabe Road	$18.95
The San Gabriels	$20.95
Chicago and Illinois Midland	$29.95

(Prices current 1.1.80 — May be subject to change — Carriage extra at cost).

Hunslet

by: DON YOUNG

Part 4 — The Valve Gear

On JOHN HUNSLET there is provision for lubricator drive from the valve spindle, but neither of the components calls for any comment, save an interesting use of circlips, a feature well worthy of consideration on my own humble designs for the future.

DON HUNSLET Valves, etc.

We can now move on and virtually complete DON HUNSLET cylinders, starting with the valves. Grip in the machine vice, on the vertical slide, to fly cut the working face, then mill both the cavity and outside edges to drawing. Chuck in the 4 jaw, with packing pieces to protect those newly machined surfaces then face off to finished thickness and bore out for the balance piston; the surface must be to a high polish for the 'O' ring. To complete, bolt directly to the vertical slide through the centre hole and mill around the spigot for the buckle. Treat the buckle itself as a small version of the steamchest, and complete by filing the inside to a close fit over the valve, though not too tight so it will seize. Neither valve spindles, or the front spindle guide, call for comment, except that a flat must be filed on the front spindle to prevent its acting as a pump in said guide, and causing all sorts of problems.

Cast stick is provided for the balance pistons, there being a surplus for other uses, so chuck in the 4 jaw and first turn down to 1 3/8 in. diameter over a 1 in. length. Rough out the rest of the profile, then face, centre and drill to 5/8 in. diameter to 3/4 in. depth. Complete the outer profile, obtaining a good finiish in the 'O' ring groove, and about .005 in. clearance between the 15/16 in. spigot and the mating bore in the valve. Part off, reverse in the chuck and face to thickness, then countersink the bore and shown. I have yet to be entirely convinced as to the area to be in contact with the steamchest cover, there is something to be said for an 1/8 in. land all round, this to slightly increase the loading, but in any case the countersink will give a clear exit to exhaust when the port is fully uncovered. Turn up the valve spindle gland from 1/2 in. A/F bronze bar, when you can assemble your cylinders complete whilst I bring JOHN HUNSLET towards this happy stage.

JOHN HUNSLET Valves, etc.

The valve for JOHN HUNSLET is a bronze casting requiring a minimum of machining. Tackle the working face, steam edges and cavity as for DON HUNSLET, then chuck in the 4 jaw and face off to thickness, before milling the grooves for spindle and nut in the back face. Nuts are made for 1 1/4 in. lengths of 3/4 in. x 1/2 in. BMS bar, ends turned square, then chucked in the 4 jaw to centre, drill and tap 5/16 x 32T for the valve spindle, this latter being a 11 1/2 in. length of 5/16 in. stainless steel rod, screwed 32T for 1 1/4 in. at one end only. To complete the nuts, drill 1/4 in. holes at 3/4 in. centres to 3/8 in. depth, and these cylinders too can be laid aside for the moment.

Lubrication

To all HUNSLET builders I would recommend our Hydrostatic Lubricator Kit, as opposed to mechanical feed, it being superior in all respects. Let me describe the kit, its installation and operation in support of this claim.

First item is the Steam Cock, which requires a 3/16 x 40T tapping at the manifold. From here a 3/32 in o.d. thin wall copper tube takes steam, condensing as it goes, to the bottom of the Oil Tank, located conveniently below the footplate. The oil tank is fitted with a filler plug and drain valve; it will require filling at about 8 hour intervals, so you get a fair run for your money! Oil leaves the tank at the top, via a 5/32 in. o.d. tube, to the base of the twin Sight Glass Unit, located conveniently in the 'cab', above boiler centre line. From the top of the sight glasses, feed is by 1/8 in. o.d. tube, diagonally along the boiler down to the steamchests, where 3/16 x 40T Cylinder Connections are fitted; for both versions entry is most convenient at the back of the chests. Prime the sight glasses with a brine solution, fill the oil tank, and light up. The steam cock can be left open as steam is raised, at initial light-up, and oil allowed to pass through into the delivery pipes to prime them. When ready, regulate the oil in the sight glasses to one drop every 2/3 minutes, when feed will be almost constant no matter what the regulator opening. Try to feed more oil, and it will simply build back in the glasses, continuing to reach the cylinders at the correct rate; this is a built-in design feature, so HUNSLET'S can be driven in your best suit, that I promise! For stops of up to 10 minutes, simply leave things well alone; for more lengthy stops just close the steam cock.

Valve Gear

We now come to one of the most interesting parts of HUNSLET, the valve gear, made more so by a comparison between the two versions. The major difference is the use of launch links with related small (5/16 in.) eccentric throw on JOHN HUNSLET, as against locomotive links with relatively large (7/16 in.) throw on DON HUNSLET. I prefer locomotive links wherever possible, and my thoughts stem directly from experience with Bulleid valve gear on his 'Pacifics', where a small originating movement is translated into much greater movement at the valve, so any wear in the valve gear is magnified at the valve. The same set of circumstances applies to launch links, though to a much lesser degree, another reason being that launch links need much more careful design to produce smooth harmonic motion of the valve, and errors in design cannot be so easily nullified at the setting stage, so yours truly tries to opt for the easy solution! The valve gear drawing as originally supplied to me by Milner Engineering from which to pen these notes left something to be desired, but this has now been sorted out, and with the generous bearing surfaces that Narrow-gauge allows, the comment on wear does not apply in any importance. Part of the fun of engineering is the number of alternative solutions available, a classic example of this being the vast number of valve gears produced over the years, from gab to Caprotti; on with construction.

Valve Spindle Guide

A glance at both drawing details shows that the same bronze casting as specified for JOHN HUNSLET will do admirably for DON HUNSLET, a real bonus! so let me deal with the larger engine first for a change.

Chuck by the nominal 1 in. spigot, face across the bolting flange, then centre, drill and ream through at 1/2 in. diameter.

Tidy up the flange with flies, then grip by said flange in the 4 jaw chuck and complete the profile. Offer up to the stretcher plate, align with a length of ½ in. rod, then spot through, drill and tap the flange in two positions at ¼ B.S.F. I forgot to mention the important feature of the oil reservoir, drilled in the top face ¼ in. diameter x 3/16 in. deep, and carried on at 1/16 in. diameter into the bore.

For DON HUNSLET, grip by the spigot, face and then reduce over ¼ in. length to ¾ in. diameter, a tight fit in the motion plate. Centre, drill and ream through to ½ in. diameter, then grip by the ¾ in. spigot and carefully complete the profile. Saw and file the flange to drawing, mark off and drill the two No. 11 holes, then offer up to the motion plate, to drill and tap at 2BA.

Intermediate Valve Spindle

Continuing with DON HUNSLET, cut two 7 in. lengths from ½ in. diameter BMS rod. First grip in the machine vice, on the vertical slide, with the bar held along the lathe axis, so the vertical slide is at 90 deg. to its usual position, this to mill the 15/32 in. x 13/32in. section for ⅞ in. at one end, leaving small flats at the original ½ in. section. Next mark off carefully for the No. 13 hole and cross drill same right through, then back to the previous set-up to produce the ¼ in. slot with an end mill. Complete this end by radiussing the forks with end mill and mandrel.

Grip in the 3 jaw chuck and next face off to the 6 ⅝ in. dimension given, then reduce for ½ in. length to ¼ in. diameter, screwing the outer ¼ in. at 40T. Leave a 5/32 in. collar at ½ in. diameter, and reduce to 5/16 in. diameter, to leave 2¼ in. of the original bar in conclusion.

The dog-legged valve spindle connector is a result of my overlooking the presence of the brake gear; for existing engines it was thought better than specifying a 'putting-on' tool to extend the intermediate valve spindle!, and in truth the final solution is thought the best. So take a 1 ⅝ in. length of ¾ in. x ½ in. BMS bar and first reduce the width from ¾ in. to 11/16 in. Next mark off and drill the No. 11 and ¼ in. diameter holes, then mill away to produce the step; radius the ends over an end mill to complete. You can now assemble all the pieces made so far and check alignment, though still only clamp the inside motion plate in position, as it may yet require final adjustment in the fore and aft plane.

For JOHN HUNSLET we are already on our way with the front half of the spindle complete, so next chuck a length of ⅝ in. square bright steel bar in the 4 jaw and set to run as true as possible, with about 3½ in. projecting. Centre and bring the tailstock into use, before turning down to ½ in. diameter over a 3¼ in. length, a snug fit in the valve spindle guide. Change to the tailstock chuck and drill 5/16 in. diameter to ½ in. depth, to suit the front portion of the spindle: on completion these will be joined with a 5/32 in. taper pin.

Next saw off to leave 1 11/16 in. of square bar, then mark off, cross drill and ream ¼ in. diameter for the die block pin. All that remains is to produce the .378 in. wide slot, shaping the bottom to clear the expansion link, and then radius the fork ends. You may now erect the valve chests, valves, nuts and spindles, plus the stretcher plate, to achieve correct alignment. When satisfied, drill and tap the port blocks to accept the valve chests and covers; a big step forward.

Eccentric Rods

The one drawback is using very wide eccentric sheaves is a need to offset at least one eccentric rod to compensate, and this is very apparent on JOHN HUNSLET, though personal preference would be either to put all the offset in the back gear rod, or make the pair identical. Also I much prefer, as an amateur builder, to braze or weld the complete fork ends onto the rod portion, and fashion them by milling, rather than use the fabricated fork end as shown on the Milner drawing, though the latter is the economic solution for a professional builder. So, using my humble technique, braze or weld 1⅞ in. lengths of ¾ in. square bar onto pieces of 1 in. x 3/16 in. flat and fashion the fork ends to drawing before producing the set(s). I will go into more detail for DON HUNSLET, as the description will suffice for both versions, save in actual dimensions. Braze 1⅛ in. lengths of ½ in. square bar onto 2¾ in. lengths of ½ in. x 5/32 in. flat, although you can use ½ in. square bar throughout and mill away to drawing if you wish. Mark off and cross drill at 5.5 mm diameter, then in the other face, drill ¼ in. diameter at the end of the slot. I would now saw out the slot and finish with a piece of ¼ in. material as the gauge, rather than go to the bother of milling, but it can be dealt with as for the valve spindle fork ends. Radius over an end mill and complete the profile.

At the strap end, cut a full 1 in. length of 5/16 in. x 3/16 in. BMS flat, face the ends, then attach to the end of the rod with one 8BA temporary screw. Check the dimension over centres of the rod, and correct as necessary, then stick the fork end into a potato, to stop the spelter melting, and silver solder the flange on. Grip in the machine vice, on the vertical slide, and face across the flange, including removal of the temporary screw head; if now slightly short you can always add a shim. Drill the No. 34 fixing holes and tap the strap to

Eccentric Rod and Sheave detail of 'Dolbadarn' – for once my camera worked!

suit, remembering to hand the rods, so the expansion link will fit.

Die Block & Expansion Link

As previously stated, it is in the expansion link that the main difference between DON & JOHN HUNSLET occurs, though manfacturing technique at least is similar. For DON HUNSLET, two 2 $\frac{5}{8}$ in. lengths of 1 in. x $\frac{1}{4}$ in. chrome vanadium steel is the first requirement, each carefully marked out to drawing. Drill the two $\frac{5}{16}$ in. holes for the eccentric rod pin bushes, and two at No. 42 for the rivets to attach the link trunnions, then saw and file the complete profile; you can radius the ends over a mandrel if you wish, then blend the rest in to suit. Drill a row of 9/32 in. holes along the centre line of the slot for the die block, bolt through the pin holes to the vertical slide and rough out the slot, with a $\frac{3}{16}$ in end mill. Various jigs have been described over the years to assist in machining the curved slot, but after spending several evenings producing a quite sophisticated version, it was only to find that my small end Mill tried its best to cut a straight slot in the type of material specified, so I lost not only valuable time, but the material as well! From this point on the fitter in me took over, and in one evening I had a completed pair of expansion links, plus a resolve to make them all this way in future; now to describe the operations.

Grip carefully in the bench vice and first file the relief at each end of the slot. Next concentrate on the convex curve and file this to line. The concave curve is far more difficult, but by first getting it close to line, and then easing a bit at a time until a stub end of $\frac{5}{16}$ in. silver steel rod enters, only patience is required. With Walschaerts valve gear it is easy to check the accuracy of the slot by setting the link vertical, winding from full fore to full back gear, and measuring the movement at the valve spindle; with the pair I made for my 5 in. gauge L.N.E.R. Class K1/1 'Mogul' this movement was no greater than .002 in. on the dial test indicator, which I suggest is more than satisfactory!

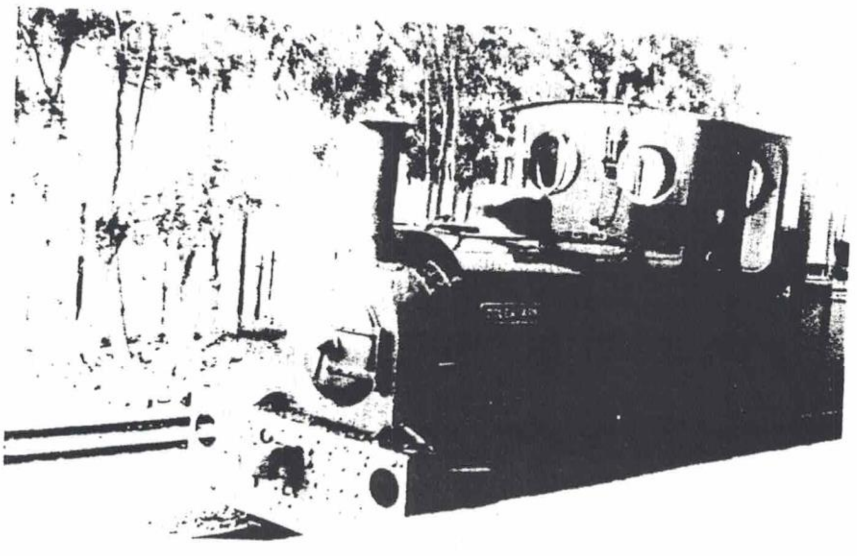
Several builders have reminded me of the lack of a detail for the die block; to be candid, I thought this was self-explanatory, for the limit of travel is when an eccentric rod strikes the intermediate valve spindle, and if the die block strikes the end of its slot at the same time, this is the ideal, although through the medium of the reverser, when the gear is completely assembled, there is a working clearance. This means the die block is 13/32 in. long, $\frac{1}{4}$ in. thick, and with a $\frac{3}{16}$ in. reamed hole in the centre. Keep this reamed hole central whilst filing the flanks to a close fit in the expansion link.

By close fit I mean a quite tight one, when initially it [illegible] struggle to reverse the engine. This tightness will [illegible] disappear as any irregularities in the filed surfaces [illegible] moved, when you will have a die block that will last [illegible] of hard service. Drill a No. 47 oil hole, do the same [illegible] expansion link itself, then you can decide whether the [illegible] needs to be hardened; it is by no means essential. If the [illegible] cision is to harden, then lightly stone the slot afterwards [illegible] regain the fit for the die block. Turn up and press [illegible] bushes, and we can move on to the link trunnions.

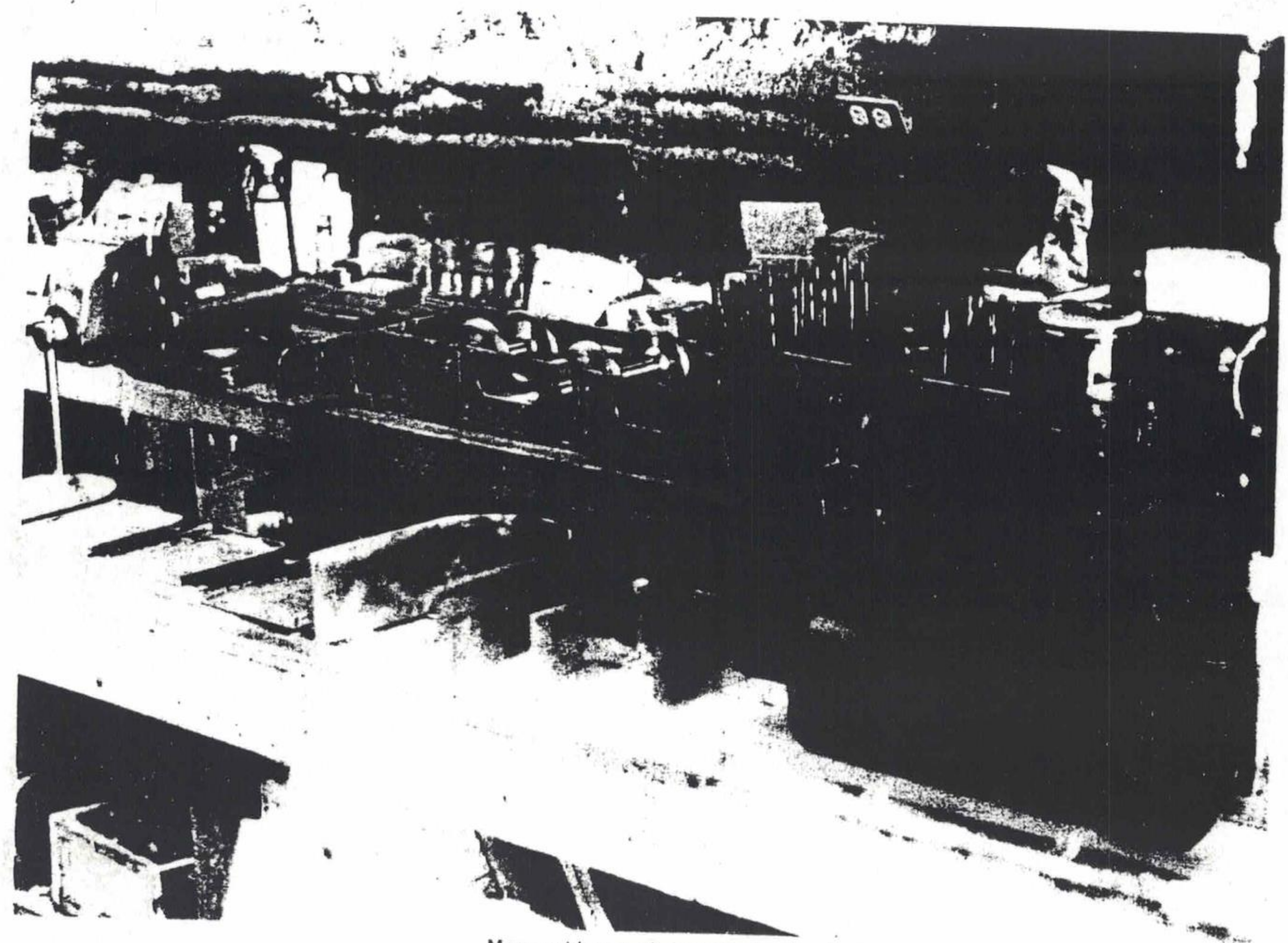
Take two pieces of $\frac{5}{8}$ in. x $\frac{5}{16}$ in. BMS flat and in the [illegible] of the $\frac{5}{8}$ in. face, about 7/32 in. from one end, drill through [illegible] 7/32 in. diameter. Next part off a 1 $\frac{1}{2}$ in. length from [illegible] steel rod and make a collar from $\frac{5}{16}$ in. rod, drilled [illegible] diameter, and parted off $\frac{1}{4}$ in. thick to suit the expansion link slot. Insert same, slide in the 7/32 in. rod and fit one of [illegible] pieces of flat trunnion material over the pin; clamp in place and drill through from the No. 42 holes in the link. Mill [illegible] the relief for the intermediate valve spindle, radius over [illegible] mandrel, finish the profile and complete by cutting to length. Assemble the trunnion again, locate in place with 3/32 [illegible] rivets, but don't hammer them down as yet. Everything [illegible] now positively located, as the collar ensures the pin in centre in the expansion link slot. Adjust the trunnion pin to give the required $\frac{9}{16}$ in. protrusion, then braze to the trunnion, taking care not to braze the collar to the link. Saw away the surplus 7/32 in. rod and file flush, then rivet the assembly permanently together, turning up the collar for the trunnion pin.

For the JOHN HUNSLET expansion links we need two [illegible] lengths of 1$\frac{1}{2}$ in. x $\frac{3}{8}$ in. BMS flat; I very much doubt if [illegible] can obtain chrome vanadium steel (gauge plate) in this section. With a minor alteration in shape, the eccentric link pin holes can be opened out to $\frac{3}{8}$ in. diameter and bushed; this [illegible] recommended. Even with this slightly larger link, I am still specifying completion of the slot with files, as being the simplest and quickest method. Link trunnion pins are plain turning, and the trunnions themselves are best made in two pieces. First take lengths of $\frac{1}{2}$ in. x $\frac{1}{4}$ in. BMS flat and drill the pin holes $\frac{3}{16}$ in. diameter; before counterskinking, radius over a mandrel.

Erect to the link, with the pin facing inwards into the slot for the moment, and hard against the back of same to give the required $\frac{1}{16}$ in. offset. Drill the $\frac{3}{16}$ in. holes from the link before sawing to length, flush with the back edge of the link. Cut four $\frac{5}{8}$ in. lengths $\frac{1}{2}$ in. x $\frac{5}{16}$ in. BMS bar as the second piece of each trunnion, this acts as packing and gives the necessary clearance for the intermediate valve spindle. Drill



Alice Class Hunslet 'Dolbadarn' of the Llanberis Lake Railway.



More evidence of Jim Harrison's dream materialising – DON HUNSLET frames.

the packing piece from the trunnion, countersink all holes as specified, then rivet the pins to the trunnion, and the latter to the links to complete the assembly, though it might be prudent to make up and fit the die blocks first!

That completes the 'operating' part of the valve gear, now we have to add the 'control' bits and pieces from expansion link back to the reverser.

Weighshaft Assembly

For DON HUNSLET we have to return briefly to Sheet 2, which appeared in the February 1980 issue, this for the weighshaft itself, being a plain length of $\frac{7}{16}$ in. steel rod, and its trunnions. These latter are from odd ends of $1\frac{1}{4}$ in. diameter gunmetal bar, though steel is satisfactory here, with $\frac{1}{4}$ in. thick flange, a spigot of $\frac{5}{8}$ in. diameter and thickness of the mainframes, then drilled and reamed centrally to accept the weighshaft. Offer up on the inside of each frame, clamp in place, spot through the No. 27 holes, drill the trunnion No. 33 and tap 4BA for hexagon head bolts. The weighshaft is flush with the outside of the L.H. frame, and projects through the R.H. frame, to have the reverser arm fitted at its extremity; locate positively by making up and fitting two collars to drawing dimensions. We can now move back to Sheet 3. For the lifting and reverser arms, simple brazing jigs are required. Take two lengths of $\frac{3}{4}$ in. x $\frac{3}{8}$ in. BMS bar, grip one in the machine vice, on the vertical slide, and drill through at 11.0mm. Advance the cross slide by 1.625 in. and drill at 5.5mm; press in lengths of $\frac{7}{16}$ in. and 7/32 in. rod respectively and we have the lifting arm jig. The only variations for that for the reverser arm are 1.750 in. centres and the 7/32 in. pin reduced with emery cloth to a sliding fit in the 5.5mm hole in the arm itself; correction, this latter instruction applies to both jigs.

Turn up the bosses and fit to the jig, then drill a 5.0mm hole in a length of $\frac{5}{8}$ in. x $\frac{3}{16}$ in. BMS flat, and radius the end. Slip over the jig, estimate the position of the scallop to mate with the boss, then saw and file this to shape, trying on the jig as you go to check the fit. When all is well, coat the jig with marking off fluid, this to prevent the silver solder inadvertantly adhering, pack the arm up $\frac{1}{4}$ in. from the jig, heat up and braze. Remove the arm from the jig whilst it is still hot, or you may have a problem! then complete the profile. For the lifting arms, make pins and collars to drawing, pressing the former into the arms, with a touch of silver solder as insurance if you like. To localise heat in this sort of situation, otherwise the boss may drop off, use the potato trick as described a few lines back.

A similar jib is required for the lifting links, and with their plain end bosses, only a simple length of $\frac{1}{4}$ in. x $\frac{3}{16}$ in. BMS bar has to be scalloped at each end to complete for silver soldering. Assemble the complete weighshaft, connect the lifting links to the expansion links, then set with the die blocks in mid gear; spot through from the lifting arm and drill the weighshaft $\frac{1}{8}$ in. diameter for spring dowel pins. Still in mid gear, set the reverser arm vertical, and drill for another $\frac{1}{8}$ in. pin; we must bring JOHN HUNSLET up to this stage.

The weighshaft, though on JOHN HUNSLET it is called a reversing shaft, is so similar to that for DON HUNSLET that one of us must have cribbed! What it does mean is that I can move quickly on to the suspension of the link, for here there is a difference, the superiority being with JOHN HUNSLET, for the link is suspended on both sides. Lifting links are plain lengths of $\frac{5}{8}$ in. x $\frac{1}{8}$ in. BMS flat, drilled $\frac{1}{4}$ in. diameter at 3 $\frac{1}{2}$ in. centres, with ends radiussed, and at the end of the lifting arms are turned pins. Spacers complete the assembly and setting is as described for DON HUNSLET.

Reverser and Reach Rod

Anyone who has driven a LARGE LOCOMOTIVE fitted with pole reverser will have experienced the large forces in play when notching up, and no doubt heard the 'kick' in the latch if there is any clearance in the latch block or sector plate slots. Equally in miniature, for a valve gear to function correctly, the 'control' portion must be rigid, and the reach rod is the important link in this chain; I much prefer this to have forked ends. At the reverser end, this means the pole has to be spaced away from the stand, to allow one tongue of the fork to fit between, and this means use of two sector, or quadrant, plates as shown for DON HUNSLET. Why all this preamble? Well, on JOHN HUNSLET the reach rod, only it is called the reversing link, is a plain length of $\frac{1}{2}$ in. x $\frac{3}{16}$ in. BMS flat, and one of the quadrant plates is the stand itself. If any JOHN HUNSLET builder would like to follow my humble recommendation, all it needs is an extra quadrant plate, an extended pole fulcrum, and of course said reversing link with forked ends; let me continue construction with DON HUNSLET.

The stand is a 4 $\frac{1}{8}$ in. length of 3 in. x $\frac{1}{8}$ in. BMS flat, marked off as shown, the pole pin hole being $\frac{1}{4}$ in. diameter. Clamp to the R.H. frame, spot through the No. 11 holes, drill No. 25 and tap 2BA for hexagon head bolts. Either roll the sector, quadrant, plates or racks, call them what you will, from $\frac{3}{8}$ in. x $\frac{3}{16}$ in. BMS flat, or cut them from plate, drilling the No. 30 holes, but leave the slots to accept the latch for now.

For the pole, start by turning up the bottom boss, then cut the pole itself from $\frac{1}{2}$ in. x $\frac{3}{16}$ in. BMS flat. You can either turn the handle integral with the pole, or make it separately with a wee spigot on the end to suit a hole drilled in the top of the pole. Cut the lug to accept the extension spring, lay on a sheet of absestos millboard, pack to the correct position, and then braze up.

I suggest the latch starts life as a length of $\frac{1}{2}$ in. x 3/32 in. steel strip, to which the end bosses are brazed, and then sawn and filed to final shape. The latch block is from a length of $\frac{1}{2}$ in. x $\frac{3}{8}$ in. BMS bar; square off the end, then mark on and drill the two 3/32 in. holes, countersinking for rivets. Grip in the machine vice, on the vertical slide, and cut the $\frac{3}{16}$ in. slot to a good fit over the pole, using an end mill or slitting saw. The 3/32 in. slot to accept the latch is best dealt with by a single saw cut and then opened out with a key cutting file to the latch as a gauge.

Turn up the pole pin and rack spacers, assemble the pieces made so far and locate the latch block just clear of the rack; drill through the 3/32 in. holes and secure with soft iron rivets. Now you can cut slots in the racks to accept the latch, the number of these being to your choice, though both designers seem agreed on a total of 7 slots.

The catch is as a component easier to make than describe, for much of it is saw and file to eye, and to fit the parts already made and assembled, but let me try. Take a length of $\frac{3}{4}$ in. x $\frac{3}{8}$ in. BMS flat and first drill two No. 43 holes at $\frac{7}{16}$ in. centres at a full $\frac{1}{8}$ in. from one end. Grip in the machine vice, and mill a $\frac{3}{16}$ in. slot to a full $\frac{1}{4}$ in. depth. Now cut away metal to leave the trigger, and complete with files. As a guide to this sort of component, if it looks good in your eyes, then that is what really matters. Use 3/32 in. hard brass snap head rivets as pins, pressing them home, then fit the tension spring to give a nice positive action. The extra adornment of the drain cock operating lever on DON HUNSLET is a smaller, and much simpler, edition of the pole and sector plates, the latter requiring $\frac{1}{4}$ in. x $\frac{1}{16}$ in. long spacers for correct alignment.

Set the engine in mid gear and the pole vertical, then measure the centres for the reach rod. Braze $\frac{7}{8}$ in. long blocks of $\frac{7}{16}$ in. square bar on the ends of an approximately 6$\frac{5}{8}$ in. length of $\frac{3}{8}$ in. x $\frac{3}{16}$ in. BMS flat, drill and ream the two 7/32 in. holes at the correct centres, then fashion the fork ends as for the eccentric rods; no need for repetition here. Make up the reach rod pins, assemble and we are nearly ready to set the valves, so let me do likewise with JOHN HUNSLET.

The stand is from 4 in. x $\frac{1}{8}$ in. BMS flat, attached to the running board with a piece of 1 in. x 1 in. x $\frac{1}{8}$ in. steel angle, the quadrant plate being cut from the same material; turn up the spacers to suit. The pole is a plain length of $\frac{1}{2}$ in. x $\frac{1}{4}$ in. steel with a $\frac{1}{4}$ B.S.F. thread turned on the upper end to accept the handle, this latter being silver soldered to place for additional security. Erect with a 2BA bolt, then mark off and cut the $\frac{3}{16}$ in. slot in the pole to accept the catch, only I call it a latch! This latter starts life as a length of $\frac{5}{8}$ in. x $\frac{3}{16}$ in. bar, cross drilled initially for an $\frac{1}{8}$ in. pin, and then cut away to leave a $\frac{1}{4}$ in. thick spigot to match the pole. Now you can cut the slots in the quadrant plate and stand to accept said catch, which latter can then be snaped for ease of entry.

The release trigger, my catch! is of slightly varying form to that on DON HUNSLET, but can be tackled in like manner. Catch release arms are plain lengths of $\frac{3}{8}$ in. x $\frac{1}{16}$ in. brass strip, drilled to drawing, and polished for effect. Erect all the pieces and then fit a tension spring from the trigger down to a 6BA bolt located in the pole; its exact position depends in large part on a suitable available spring.

Reach rod length is determined as for DON HUNSLET, drill the length of $\frac{1}{2}$ in. x $\frac{3}{16}$ in. bar to suit and secure with 2BA bolts.

Outside Motion Plate and Slide Bar Blocks

Just these two pieces to make and we can move into the Erecting Shop, to greatly advance our HUNSLET'S, so let me hurry on.

Verily this designer, who by virtue of drawings appearing in LLAS, lives in a glass house, should not throw stones. For in being slightly critical of the JOHN HUNSLET reverser, I should be even more caustic with the DON HUNSLET outside motion plate and slide bar block, for in this JOHN HUNSLET is both simpler and superior. For instance the motion plate is just that, $\frac{3}{16}$ in. thick, and frame attachment is by pieces of the 1 in. steel angle. For DON HUNSLET, that awkward to fit top plate could well be omitted, although it does add strength, especially to the running board; attachment to the frames could be by $\frac{5}{8}$ in. x $\frac{5}{8}$ in. x $\frac{1}{8}$ in. steel angle in lieu of the integral flange, this fits in very neatly. Similarly on JOHN HUNSLET the slide bar block has single stud to pass through the motion plate, being turned integral, so there is only one hole for slide bar attachment, and this also is worthy of consideration. Really there is little more to say about these components, and what little there is can be dealt with at the erection stage, which follows immediately folks!

Erecting the Motion, etc.

We can best start with the cylinders, where just a little more machining is required -- to the back covers. First offer the cylinders up to the frames and drill the sixteen No. 11 holes; these will come in very useful right now. Bolt a piece of $\frac{1}{4}$ in. steel plate to the vertical slide table, about 4 in. square, then drill four No. 11 holes to match those in the corners of the cylinder bolting flange; fasten in place. Set horizontal with the piston rod facing the chuck, using a dial test indicator along said rod for maximum accuracy. Clamp the slide bars to the crosshead, slip this assembly over the end of the piston rod and judge the amount of metal to be removed from the slide bar facings on the back cover boss. Mill this away, a little at a time, until the slide bars fit correctly; you can always use a shim in case of being over generous in your machining. Spot through, drill the cover No. 33 and tap 4BA, securing with hexagon head bolts, then release the crosshead and check it slides freely.

Erect this assembly to the frames, try the outside motion plate, first adjusting the blocks by filing if necessary, then check the axial position of the motion plate itself, shortening the slide bars a touch if this is indicated. Drill and tap the outer ends of the slide bars 4BA, then drill and attach the plate to the frames.

Moving inside, we can now check alignment of the motion plate and valve spindles, and when satisfied, drill and secure; JOHN HUNSLET builders may delay steamchest fixing until this stage, and remember to hit $\frac{1}{16}$ in. gaskets where specified. Wheels and axles are assembled, so we can next give attention to the fly cranks. Fit one to each axle, then the second to the driving axle, and for quartering I recommend you use a scribing block to check one crank and an engineers square for the other, this by eye, which is plenty accurate enough for 4-coupled Locomotives. Apply Loctite to the fourth crank, slip it in place, followed by the coupling rods, and check for tight spots before the Loctite starts to cure to a permanent fit. If you do have trouble, heat to around 200°C and tap the offending fly crank off, though I have never found this operation as easy as the manufacturers claim! Erect the rest of the motion, take 'bumps' at the ends of the piston stroke as described for GLEN, and we are ready to set the valves; at this stage I wish I had specified Joy gear!

Looking ahead

Your DON HUNSLET is finished, painted and ready for the track, those words should set builders dreaming! but one feature is missing, Name and Works Plates. This was a problem that had worried me for some time, so finally I plucked up courage and discussed it with Alec Farmer of regular LLAS advertisers A. J. Reeves & Co (Birmingham) Ltd., their etched plate service being both well known, and comprehensive. To my relief, back came Alec one Sunday evening, requesting rubbings from actual plates for complete authenticity, and with the aid of George Barnes, General Manager of the Bala Lake Railway, these were duly obtained.

My real interest was in MAID MARIAN and HOLY WAR as then at Llanuwchllyn, but to this pair Reeves have added JONATHAN, DOLBADARN, ELIDIR and SYBIL. I have a sample of each, can vouch for their excellence, will be pleased to supply either HOLY WAR or MAID MARIAN from stock, and those for the other four Locomotives to order. Thank you Alec for solving yet another problem for me.

As with all things though, there never seems to be a perfect solution, and having sorted out the above, only this morning (3rd July) came a letter from Ray Cross in New South Wales saying that all the lads at the track, the Lake Macquarie Live Steam Locomotive Co-op Society, know his engine as

HUNSLET and that is the name that will adorn his tanks! Soon now we shall be packing our bags for the annual pilgrimage to North Wales and we look forward to seeing as many LLAS readers as can make it to Llanuwchllyn on Saturday 6th September, on the occasion of the 3rd HUNSLET Rally; hope the weather is fine for us!

Book Review

'A MANUAL OF STEAM LOCOMOTIVE RESTORATION AND PRESERVATION'
by D. W. HARVEY

Published by DAVID & CHARLES @ £4.95

E. S. Cox paid tribute to the remarkable practical know-how of Bill Harvey in his book 'British Railways Standard Steam Locomotives', this for transforming the **'Britannias'** at the Norwich depot from good into outstanding Locomotives, being supremely economical. Whilst most other Shed Masters were more than content that their stud of Locomotives met the required availability for traffic, Bill Harvey wanted, and achieved, much more. I have only come to know Bill through correspondence recently, and in this I am lucky in that we were both Doncaster trained; I can tell readers that his letters are full of sound practical sense, and the same comment applies to his book currently under review.

From my apprenticeship days at Doncaster I learnt two things which stood me in good stead in other industries. The first was not to be frightened of weight, but to apply simple principles, like that of the lever, roller and wedge, for safe movement. The other is that all mechanical engineering in its practical form is common sense; do something foolish and one courts disaster. This manual, and to my mind it would be better titled THE MANUAL, is full of practical common sense on every aspect of Steam Locomotive Maintenance and should be compulsory reading for all involved in this activity. Compulsory reading should also be extended to those who drive and fire preserved Locomotives, to foster a true regard for machinery in their care. For all readers of LLAS I would recommend this book as compulsive reading; the photographs and diagrams alone being extremely useful.

There are but two aspects of maintenance where I feel that Bill has not stressed a point sufficiently, and I qualify that statement with one brief year's Shed experience as against a lifetime. The first is correct 'gapping' of piston rings when renewing, where the allowance should be .001 in. per inch of bore, plus .001 in., this gap to be achieved at the MINIMUM bore position. I once took it for granted that a worn cylinder bore is barrel shaped, so getting the correct gaps at each end of the bore was sufficient. The result was a Locomotive failure, because the bore was not barrelled as I thought and the engine seized solid, and I have always remembered since to check the whole of the bore with calipers, or the rings themselves.

My second point is how vital it is that hornstays be securely fixed at all times. I noted in the early days of the Wight Locomotive Society that their preserved 02 Class 0-4-4T FISHBOURNE was being driven well notched up at low speeds, a bad practice for her continued wellbeing. Besides needlessly hammering all the bearings, plus trying to displace the horns in the frames, if the hornstays worked loose then frame cracking became a probability. As the 'kick' tended to loosen the hornstay bolts, there was every chance of this happening, so I feel this must be watched very carefully. Having said that, the Isle of Wight is extremely well catered for in THE MANUAL, with pages of useful tips on the Westinghouse brake which reigned, and still reigns, supreme.

Summing up, if this book had been available to me at Eastleigh in 1953-4, it would have saved my having to learn common sense the hard way at times; thank you for a very readable book Bill, on a subject of which I **thought** I had some knowledge!

D.Y.

Hunslet

by: DON YOUNG

Part 5 — Setting the Valves; Boiler and Smokebox

No matter how much you read about valves and valve gears, and that includes what yours truly will have to say on the subject in LLAS, without a shadow of doubt, builders of both DON and JOHN HUNSLET will learn more in one evening actually setting their valves than by days of study. Let us start by setting down the points of adjustment for Stephenson link motion; full size practice first.

Eccentric sheaves were almost universally machined in pairs, split so they could be assembled over the axle and then bolted together, and firmly orientated by a large square or rectangular key in both axle and sheave assembly. This meant that the angle of advance was pre-determined at the design stage, and fairly rigorously adhered to, though I have known the use of a stepped key to correct a machining fault. The first point of adjustment was in length of eccentric rod, this by placing shims between the flange on the rod and the mating surface of the eccentric strap. This procedure was resorted to if there were slight inequalities in valve events, in fact just a few valve gears were deliberately designed with fore and back gear eccentric rods of differing lengths. The other point of adjustment of this type of valve gear was between intermediate and valve spindles. The small valve spindle entered its larger partner, 'pennies' which are circular shims were used as spacers from the bottom of the hole in the intermediate spindle, positioned the end of the valve spindle, and the two were then held firmly together with a flat cotter.

Turning now to DON and JOHN HUNSLET, the first point of adjustment is by altering the angle of advance, eccentric sheaves being individual and retained on the axle by the medium of a grub screw. The facility exists for adding shims to lengthen individual eccentric rods, but only on the rarest occasion will it be used. For JOHN HUNSLET, adjustment of the valve spindle length is at the valve itself; for DON HUNSLET it is at the other end of the valve spindle, where it passes through the connector. Now we must turn theory into practice.

Remove the steamchest covers and firmly secure the steamchests; concentrate on each side of the engine in turn. Drop into full fore gear, turn the engine to front dead centre on one side; if you have a d.t.i. against either the piston or crosshead this can be determined quite accurately as the point at which the needle stops moving, then remove the back of the strap on the side being set, loosen the set screw and holding the front half of the strap hard against the sheave, advance until the front steam port just opens to steam; you will see a line appear. Nip up the set screw and turn to back dead centre to see the result, then adjust the valve on its spindle to centralise it over the ports. Do the same in full back gear, you will certainly get a slightly different result, then return to full fore gear and go right through the procedure again, gradually equalising out any error.

For me this is only the start of valve setting, for your HUNSLET will spend little time in full gear, most running being either in the first or second notch from mid gear. If you will be running mainly on continuous track, then concentrate on these two notches in fore gear only, getting equal leads at these shorter cut-offs at the expense of back gear. For up-and-down running, try and equalise any error, and here the facility to add shims to lengthen an eccentric rod just might come in useful. From this exercise you will discern that feature of Stephenson link motion in that shorter cut-off is accompanied by increasing lead, indeed you can go right to mid gear and check this if you like. Now for the actual figure for lead. With a 'constant lead' valve gear like that on GLEN this is designed in at .030 in., and for DON HUNSLET in the first notch from mid gear this figure should be repeated; from this all else is determined.

Springing

I should have said at the outset of valve setting that the driving axle be packed at its 'nominal' running position; now it can be released and we can provide the means to control the axle position when running. There is considerable difference here between DON and JOHN HUNSLET, so I will take them through one at a time, starting with the $4\frac{3}{4}/5$ in. gauge DON HUNSLET.

Spring Hanger Brackets

For the larger of the two types, start with a length of $1\frac{1}{8}$ in. x $\frac{5}{8}$ in. steel bar; you will have to arrive at this section by pre-machining. Mark off and drill the No. 11 hole, then drill and tap the OBA hole for the brake hanger pin. Grip in the machine vice and mill the $\frac{5}{16}$ in. slot, then fashion the upper profile; complete by sawing off to length. The smaller brackets are from $\frac{5}{8}$ in. x $\frac{1}{2}$ in. bar, machining operations being so similar, and simple, that there is no need for repetition. Offer up to the frames, spot through, drill and tap as specified and secure.

Brake Hanger Pins and Spring Rods

These are plain turning exercises which require no description on my part, save that the backnut used when adjusting the latter in the spring buckle, and depicted on Sheet No. 2, has caused a lot of correspondence in the past.

Spring Hanger

This is rather an awkward item to make, though it does add a lot of realism, and is thus well worth spending time on. At least the end boss should cause no problems, so with this out of the way we can concentrate on the hanger itself.

Take a length of $\frac{5}{8}$ in. x $\frac{1}{2}$ in. steel bar and at a full $\frac{1}{4}$ in. from one end, cross drill in the centre of the $\frac{1}{2}$ in. face at 5/32 in. diameter, this to start forming the hook portion. Next saw away as much metal as you can around the $\frac{3}{16}$ in. diameter spindle portion, then chuck in the 4 jaw and turn to size. Now it is a matter of sawing and filing the rest to shape, a little at a time. You can mill the top radius first over a 5/32 in. mandrel, but this does take both skill and courage, and being a forging full size, the file will I am sure give equally realistic results. Braze on the boss, to give the finished lengths as shown, and we can move on to the springs themselves.

DON HUNSLET Springs

Working leaf springs are quite effective on such a mighty machine as DON HUNSLET, and really look the part, so let me hurry on to deal with the buckles. Material section is $\frac{7}{8}$ in. x $\frac{1}{2}$ in. BMS, so chuck very carefully in the 4 jaw, face off, turn down the $\frac{1}{2}$ in. diameter portion, and a small flat left by being slightly out of truth will not worry here. Turn down the $\frac{3}{8}$ in. diameter portion, then centre and drill No. 33 to at least $1\frac{1}{4}$ in. depth. Follow up with a 9/32 in. drill to $\frac{1}{2}$ in. depth, 'D' bit to about $\frac{10}{16}$ in. depth, then tap 4BA and $\frac{5}{16}$ x 32T as indicated. Drill a $\frac{7}{16}$ in. hole to start the buckle, then mill round and complete with files until your leaf spring material enters the slot; part off to complete.

Cut the top spring leaf 4 in. long from the $\frac{5}{8}$ in. x 22 s.w.g. spring steel; cut two $\frac{5}{8}$ in. lengths from $\frac{1}{8}$ in. steel rod and file a flat on each to sit on the ends of the leaf. Poke the leaf through a large potato and silver solder the 'gripper' on; the potato will prevent the spring losing its temper, except at the very end, and this is supported by a second 'top' leaf immediately underneath. Cut the remaining leaves from 'Tufnol' and spring steel as specified, assemble in the buckle and erect. Final adjustment, including possible substitution of some spring steel leaves for tufnol ones, will have to await completion of DON HUNSLET, still a few instalments ahead yet!

JOHN HUNSLET Springing

Again the springing is far simpler on JOHN HUNSLET, another lesson for this humble designer! and can be quickly dealt with, though let me say a few words on the main features first. 'Springs' are cast dummies in aluminium and are connected directly to the axlebox through the medium of a $4\frac{1}{8}$ in. length of $\frac{3}{8}$ in. steel rod, the spring being drilled $\frac{3}{8}$ in. deep to accept same. A measure of location is provided by a 25/64 in. diameter guide hole in a $6\frac{3}{4}$ in. length of 1 in. x 1 in. x $\frac{1}{8}$ in. steel angle. This angle has two other holes in its upper face, at $5\frac{3}{4}$ in. centres, this to accept the spring bolts, these latter being of the commercial variety $\frac{5}{16}$ B.S.F. and 3 in. long. These bolts pass up through the angle, the working springs being retained between the underside of the head of the bolt and the angle above it, being 17/32 in. o.d. x 12 s.w.g. x 2 in. free length. For perfection of action, these springs have to be fairly closely matched, so I recommend you ask Milner Engineering to supply same.

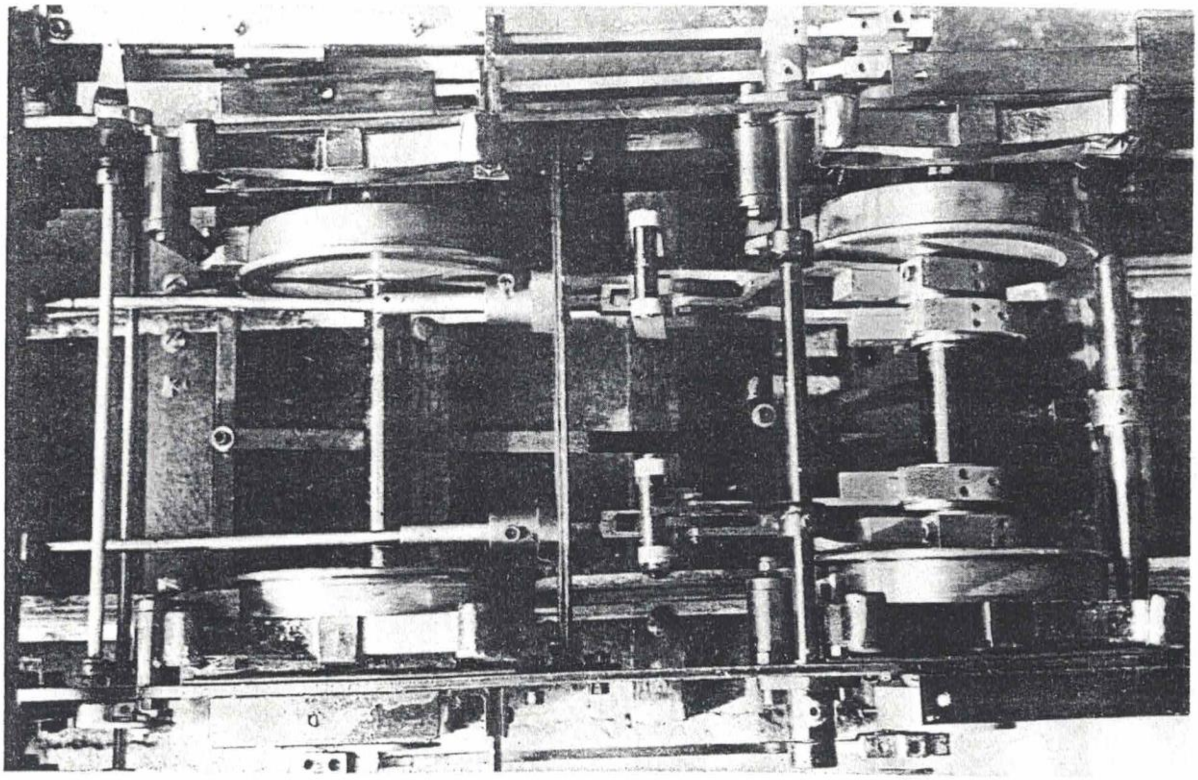
Connection from the spring bolt to the ends of the dummy spring is by simple stays, bent up from $\frac{3}{4}$ in. x $\frac{3}{16}$ in. steel flat. That's all there is to the springing; I was able to describe features and manufacture in the same breath. Just one last point before we leave the chassis; the 1 in. x $\frac{1}{8}$ in. angle used to suspend the springing is specified rivetted to the frames, but for the moment at least, 2BA bolts should be substituted.

THE BOILERS

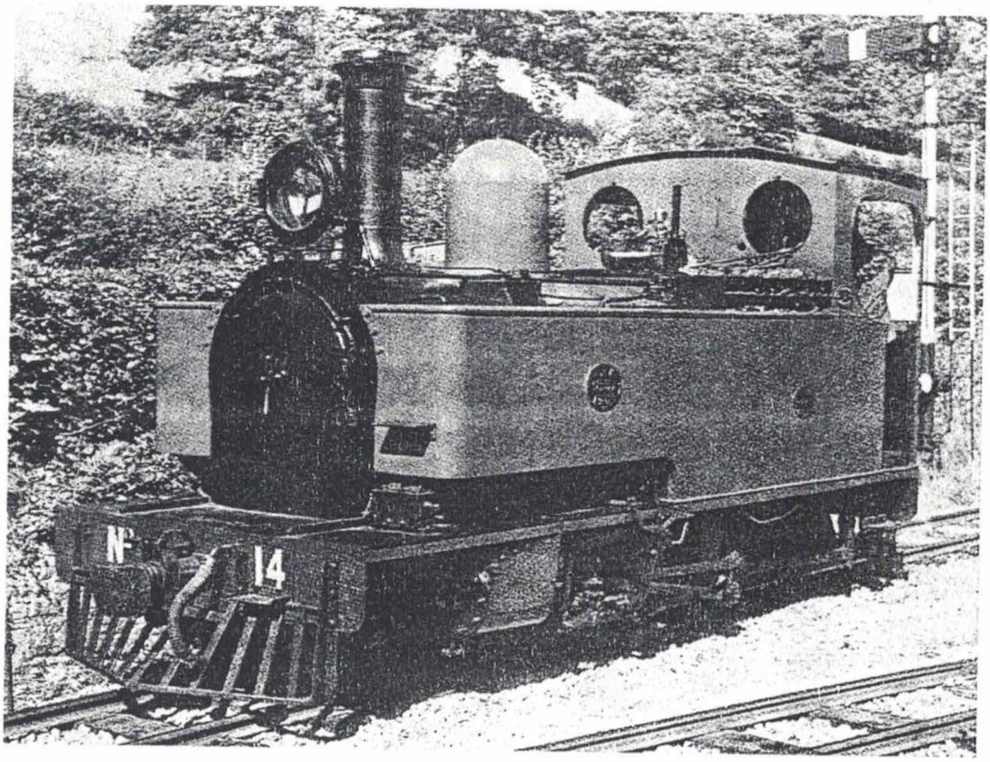
THE JOHN HUNSLET steel boiler is so obviously designed to be professionally built and welded that my sole recommendation is to order it complete and tested from Milner Engineering. This will remove all onus from Model Engineering Society boiler inspectors in identifying materials, plus weld preparation, penetration and excellence. The boiler will be tested and certificated, the design being approved by Commercial Union, and all that then will be required is a further hydraulic test to satisfy Club Rules before going into service.

That takes care of the boiler design from the safety aspect, but I cannot leave the subject without a few words on steaming potential. There is no doubt in my mind that the fantastic success of the full size HUNSLET'S on the Bala Lake Railway is mainly the result of the excellent boiler proportions. This was achieved by virtually turning a conventional firebox sideways, so one does not see what one expects, hence the question 'Is the boiler big enough to steam the cylinders?' The answer is an emphatic YES both in full size and miniature, and turning the firebox sideways means there is a greater area available for the tubestack, and the boiler steams very freely. A feature of the JOHN HUNSLET however, is that the firebox is longer than scale, taking advantage of the space available. But this increase in grate area has not been complimented by a corresponding increase in free gas area through the tubestack, so the full potential of the larger grate is not realised. It is still a very good boiler, but it would be even better with an additional row of tubes.

This JOHN HUNSLET chassis is under construction by R. L. Hudson of Norwich and is the first of a series of photographs taken by Paul Bullock of Great Yarmouth.



A different sort of 'Hunslet', this is No. 14 of the Welshpool & Llanfair Railway, ex Sierra Leone Railways No. 85 of 1954, this photograph appearing by courtesy of John Davis



Some time back John Milner was talking to me about introducing a copper boiler variant, though to my mind it will have limited appeal, particularly in the light as to what has happened to the cost of said metal in recent months! In any case, construction will be closely akin to that for DON HUNSLET to which I can now give attention.

DON HUNSLET Boiler

Whilst to my mind steel is the obvious material with which to construct the JOHN HUNSLET boiler, equally copper is both ideal, and reasonably economic, for DON HUNSLET. I strongly suspect that many of these Locomotives will earn their keep at fetes and exhibitions, for which duty any sizeable 0-4-0 is well suited, and with that in mind the superheater may be classed as an 'optional extra'. This will probably be the simplest boiler that builders will ever construct, as indeed it was full size, providing care is taken at each stage, particularly with the silver soldering. For this the boiler must be perfectly clean all the time, which means pickling both before and after silver soldering at each sequence. Failure to observe this, with consequent 'misses', will lead to deep trouble. With all long barrelled boilers there is the problem of differential expansion when heating, infinitely more so on re-heating. At the initial heat, all moves smoothly, and the stresses on cooling are low. But re-heat, especially at the smokebox tubeplate end, to cure a local 'miss', and stresses build up such that either the silver solder cracks on cooling, the smokebox tubeplate will distort; even the throatplate can distort in extreme cases. With clean copper and Easyflo No. 2 the chances of even a pin-hole weep are very remote, and clean copper is the first requirement for any successful boiler, no matter what its shape. For those of a nervous disposition, the obvious answer is a complete and certificated boiler from Reg Chambers; for those of us who gain pleasure from making our own boilers, a kit from A. J. Reeves & Co (Birmingham) Ltd will set us on our way with least damage to the pocket; on with construction.

Barrel/Outer Wrapper

The barrel is a plain 14$\frac{13}{16}$ in. squared length of 6 in. bore x 10 s.w.g. seamless copper tube; not one hole to worry about! If your lathe is of insufficient capacity to grip the tube by the bore in the 3 jaw, and cut with a knife edged tool to square at the chuck end, then wrap a flexible tape around and scribe to this. Drop over your bench vice and open out to grip the bore, not too tightly, then hold with one hand and use a course flat file with the other to square to line.

If your boiler kit does not include flanged plates, then mark formers out on $\frac{3}{4}$ in. thick hardwood; aluminium or steel faced plywood is an ideal substitute. Cut them out 9/64 in. less all round than the outer profile of the boiler plate and radius to drawing. Cut the plates out $\frac{3}{8}$ in. bigger than the former all round, anneal and flange with a wooden mallet. Once the copper becomes stiff, re-anneal, don't bash on regardless!

For those who enjoy boilermaking, but like me don't get enough opportunity to practice the art, the method of barrel/throatplate jointing shown at the bottom is for us. Cut a 1 in. strip from 1.6mm copper sheet to wrap around inside the barrel, close fitting and that means no gap at the joint, with $\frac{1}{2}$ in. protruding. Piddle, wash off in running water and apply flux around the joint; this latter wants to be mixed to a smooth paste of consistency such that it can be spread easily but does not run all over the place, otherwise the expensive silver solder is likely to follow! Fit the 40 oz burner to the propane torch, stand the barrel upright in your brazing hearth and heat all round the joint. This is an operation best done outdoors on a cool, dark evening, so you don't get too hot, and you can see how hot the copper is. When it starts to show a dull red, concentrate on one spot, feed the spelter in, and when it starts to run freely, follow it round with the torch; it all happens faster than I can pen these notes. Pickle, wash and dry when we can attend to the throatplate.

This latter requires a large hole to fit over the spigot we have produced, and I doubt if you can grip the plate in the 4 jaw chuck to bore out to size. Instead, scribe a circle of requisite diameter and drill right around the inside of this at, say, No. 30. Open out carefully until the holes break into one another, then cut out the middle with a sharp chisel. Grip carefully in the bench vice, using pieces of packing to protect the soft copper, and file out the hole to fit the spigot. We now have to tap down the projecting spigot to trap the throatplate, and if you expect difficulty with this, then saw down at about 1 in. spacing to form tabs, which can then easily be tapped over. Pickle, flux, heat and run in more spelter to complete your first really sound joint. Carefully inspect, and if you have any doubts at all, tackle again now; later may be too late!

The outer wrapper is a 24¼ in. length of 4 in. x 3 mm copper, wrapped as the name suggests around the throatplate, and secured with a minimum number of ⅛ in. snap head copper rivets, heads inside and hammered down into countersinks in the wrapper itself. Check as you go with the mating backhead and when complete, trim off any excess at the bottom edges before silver soldering this joint also; we can now turn our attention to the firebox.

The Firebox

The two flanged plates from your boiler kit will give you a tremendous start, so first mark off the firetube centres on the tubeplate before drilling and reaming to ½ in. diameter. For the flue tubes, drill these as large as you can, then use a round file to open them out to a tight fit for the actual flue tube as your gauge. For the firehole, a 1 in. length of 2 in. bore thick wall copper is required. Square off, then turn a spigot to about 2 3/16 in. diameter on each end, to leave ½ in. of original tube in the centre. Cut a hole in the backplate to accept the spigot, stand on a block of lead, and peen over the projecting spigot.

The firebox wrapper is a 19½ in. length of 3¼ in. wide x 2.5mm thick copper. Find the centre, scribe across, and scribe further lines 2¼ in. each side to indicate the start of the bends. Cramp to a length of 1½ in. diameter bar and form one of these bends by hand, then move on and form the second one, only this time check as you go against the flanged end plates. Insert a minimum number of rivets to hold the firebox together, and try to keep these clear of the girder and crown stay areas.

The crown stay is ⅝ in. x ½ in. angle, flanged up from 3 mm copper, rivetted back to back, and providing it is in good contact with the wrapper, no fixing will be necessary prior to brazing. Locate the firebox inside the outer wrapper and measure to find the height of the crown girder stays, the dimension will be around 3¼ in. Flange up from 2.5 mm or 3 mm copper to suit, again rivet them together in pairs, and you should be able to get cramps through the flue tube holes to hold them in place for brazing, this in preference to rivetting to the wrapper. The firebox can now be brazed up, pickled and cleaned, plus thoroughly inspected.

Fitting the Tubes

Take each of the ½ in. o.d. firetubes in turn, face off one end and polish with emery cloth, then reverse to tidy up to length and polish this end also. The flue tubes will almost certainly have to be squared off with a file, but do not 'pinch' them in the vice as this will seriously weaken them; again polish the ends with emery cloth.

Take the smokebox tubeplate, grip by the inside of the flange in the 3 jaw chuck, and turn down to a push fit in the barrel. Tackle the tube holes as for the firebox, then turn up the steampipe bush and braze this in with B6 alloy or similar as a separate operation.

Insert the top three rows of firetubes in the firebox tubeplate, expanding them to a nice fit with a lightly greased taper pin, followed by the pair of superheater flues. Wrap your Easyflo No. 2 spelter around suitable bar, cut into individual rings, drop one over each tube and check that it slides right down onto the tubeplate. Fit the smokebox tubeplate over the outer end of the tubes, check the partial tubestack is square to the firebox tubeplate, mix up and add flux, then braze up, adding extra spelter if necessary until there is a fillet around each tube inside the firebox. Pickle, wash off and throughly inspect, before dealing with the two bottom rows of tubes in like manner. Knock off the smokebox tubeplate, anneal the outer tube ends, then pickle, wash and inspect again.

Erecting the Firebox

Take the manifold bush casting, grip by the outside in the 3 jaw chuck, face across and bore out to 1¾ in. diameter. Continue to 1⅞ in. diameter for ¼ in. depth, turn down the periphery to 2½ in. diameter for at least ⅜ in. length, then part off a 3/16 in. slice for the manifold flange. Face again, then reverse in the chuck and grip by the bore, to complete turning the bush to drawing. Cut a hole in the outer wrapper to 2⅜ in. diameter to suit the bush.

Cut a full 7¼ in. length of ½ in. square copper bar as the front section of the foundation ring and shape to suit the throatplate flanges. Slide the firebox into place inside the outer wrapper, check that the girder stays are in good contact with the outer wrapper, and cut away the inside flanges in way of the manifold bush. Cramp firmly over the foundation ring and drill three ⅛ in. holes for 1 in. long snap head copper rivets, heads inside, and hammering down into countersinks in the throatplate. Next slide in the smokebox tubeplate and engage all the tubes, a couple of ordinary pencils helps a lot in lining up the tubes. You may fit the side members of the foundation ring, machined to 7/16 in. thickness from the ½ in. square bar, if you wish at this stage, although being relatively short then can be left until the backhead is ready.

The girder stays are also very short, so the boiler can be stood upright to braze them in place, feeding in spelter through the manifold bush hole and then dropping the latter in place and dealing with this also. Turn the boiler over and you can deal with the front section of the foundation ring.

The Backhead

The first job on the backhead is to try it in place and tap down the outer wrapper if there are any gaps. Holding it in place, scribe back through the firehole and cut out to a tight fit over the spigot. Turn up the regulator stuffing box and the other seven bushes, drill the backhead to accept same, then braze in with B6 alloy or similar. Slide the backhead over the firehole spigot once more, cut and fit the remaining foundation ring section(s), and rivet these in place before peening over the firehole spigot. Drill the longitudinal stay holes and make up a special 30 deg. countersink bit so you can build up a bead of silver solder. Cut the stays from ¼ in. copper rod to protrude at least 1 in. at each end.

Stand the boiler up on its backhead, packing to give those stay ends clearance, flux the smokebox tubeplate, then deal with tubes, barrel joint and stay ends at the one heat, remembering that this is where you must achieve sound joints first time. Tackle also the projecting stay ends in the throatplate at this heat. Allow to cool and lower carefully into the pickle, for our vessel is almost 'closed' now. Wash out thoroughly and inspect, when we can move on to the last major brazing operation.

Stand on the barrel end and carefully support, as this is rather unstable, then flux and braze the backhead joint, firehole, stay ends and foundation ring, in that order. Pickle, wash very thoroughly, and inspect.

Preliminary Air Test

We can now apply a low pressure air test as a more positive check on the soundness of all the joints, so blank off all the openings, soldering a cycle inner tube valve to one of the blanks, then add about 20 pumpfuls of air and completely immerse, when there should be no tell-tale bubbles. If you do have a wee problem, now is the time to consult your Club boiler inspector.

Firebox Stays

If you have any doubt at all in your ability to fit the 'professional' rivet style firebox stays, then do take the alternative path and fit 4BA screwed stays instead. There are no curved surfaces at all to be stayed, I did say this boiler was easy, so all you have to do is drill the tapping size holes nice and square to the plates and all will be well. Invest in a new set of 4BA taps, taper, second and plug, so that the possibility of tearing a thread in the soft copper is reduced to a minimum, insert the stay and add a 4BA commercial brass full nut on the inside of the firebox. Warm up more gently this time and seal the threads inside and out with 'Comsol' or SX2, obtainable from Reeves. Crop off all the excess longitudinal stay ends, leaving them roughly to drawing, and our boiler is structurally complete; we can begin to fit it out.

The Regulator

Gerry Collins will be pleased to see that there is a Stroudley regulator on DON HUNSLET, it really does fit in well, and being so similar to that for GLEN, I can dispense with description of same. I have shown pear shaped ports in the regulator valve, this to exercise a measure of control, as the steam circuit is opened right out, and DON HUNSLET will need some holding in check!

The steam pipe is of rather extreme length and will have to be fitted squarely into its flange, so I suggest you change my drawing specification for said flange and bore through to 15/32 in. diameter. Turn the end of the steam pipe over about $\frac{1}{2}$ in. length to a tight fit in the 15/32 in. hole and braze up. Poke the pipe through the headstock, square off to length, then use a tailstock die-holder to thread 26T for $\frac{1}{2}$ in. length. Engage the steampipe flange in its bush, about 4 turns, feed the regulator through the manifold bush and engage this over the steam pipe end; screw in. Mark off and drill for the 4BA countersunk head regulator body fixing screws, one at a time, tin over the heads, then remove the steam pipe, annoint the threads with liquid jointing compound and screw home again.

Superheater

The superheater flange is straightforward turning and drilling, and here we can take full advantage of the sheer size of Narrow-gauge in making each superheater element individually removeable for both flue cleaning and element replacement should the need arise. It will also be noted that if you want to compare a 'wet' engine with a superheated one, then the pipework to do so is elementary.

The 'commoning' pipe between the two steamchests arose from a wish to maintain the steam circuit of generous proportions, otherwise from the superheater flange there would only be individual supply to each cylinder. One or two builders have told me how difficult it is to achieve the double bend in the 90 deg. fitting, but this is not the intention. Fit a nipple at one end of each bend, erect, then turn forward a bit. Now all you have to do is mitre the top ends so that a plain length of $\frac{1}{2}$ in. o.d. pipe drops in between; the only reason for doing this is to bring this cross pipe clear of the blast nozzle. Turn up saddle pieces to accept the ends of the superheater elements, then braze up the whole assembly.

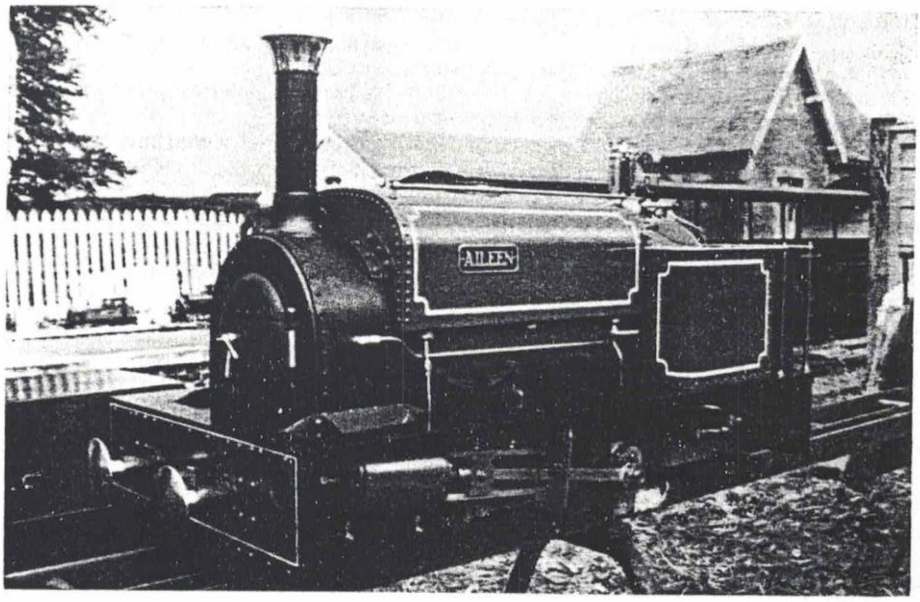
The exhaust pipes are also commercial bends, with flanges as detailed on the steamchest end, and a stub of $\frac{3}{4}$ in. o.d. pipe to couple to the blast nozzle. Before moving on to the smokebox proper, let me progress JOHN HUNSLET.

JOHN HUNSLET Regulator

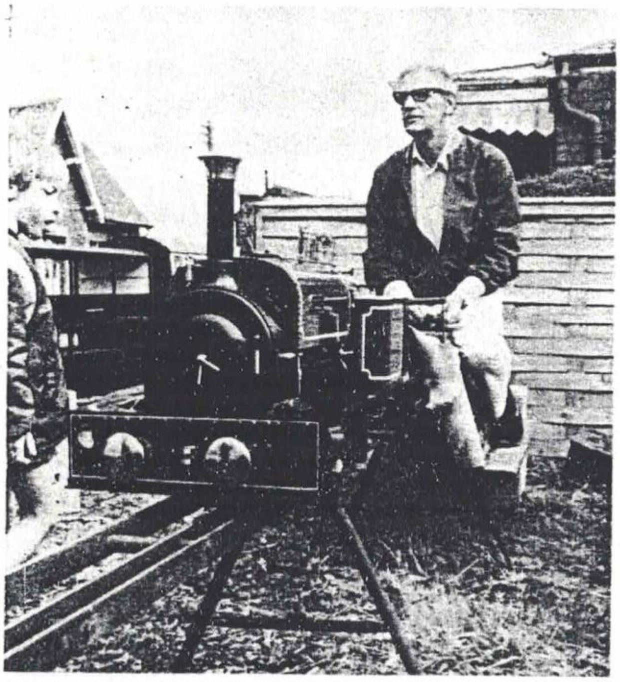
I very much like the design concept of a simple combination of disc-in-tube and Stroudley regulator, but am going to suggest a marked improvement in manufacture so that there is no internal installation work.

For the regulator body, take a 3 in. length of $2\frac{1}{2}$ in. diameter gunmetal or cast iron bar. First chuck in the 3 jaw and square off to $2\frac{15}{16}$ in. overall, then bore out to 1 9/32 in. diameter to $1\frac{11}{16}$ in. depth. Centre the bottom of this recess and drill $\frac{3}{16}$ in. diameter to $\frac{3}{16}$ in. depth, 'D' bitting to $\frac{1}{4}$ in. depth. Reverse in the chuck and turn down for $2\frac{3}{4}$ in. length to 1.64 in. diamter, an easy fit in the boiler backhead. At $\frac{11}{16}$ in. from the inner end, cross drill at $\frac{3}{8}$ in. diameter to $1\frac{1}{2}$ in. point depth; a plain plug will be fitted and brazed in later on. Move back $1\frac{1}{16}$ in. towards the flange and drill a $\frac{1}{2}$ in. hole into the recess on the same axis as the previous hole. Next chuck eccentrically by $\frac{3}{8}$ in. to bore out into the $\frac{3}{8}$ in. cross hole at $\frac{5}{8}$ in. diameter to accept the steam pipe; this latter will be brazed in at the same time as the aforementioned plug. To complete the regulator body, drill two 11/32 in. diameter steam passages at $\frac{3}{4}$ in. centres into the cross drilled hole.

The regulator valve, or disc, is $1\frac{1}{4}$ in. diameter and $\frac{1}{4}$in. thick,



AILEEN poses at Llanuwchllyn during the HUNSLET Rally in 1979. Photograph again by Jan Bonjer; he knows how to drive his camera!



Jack Coulson, builder of this lovely DON HUNSLET which for obvious reasons he has called AILEEN, poses for the camera of Jan Bonjer from Holland at Llanuwchllyn

with a 0.23 in. square hole in its centre. Drill two 11/32 in. holes in same to match the body, and these can be elongated to a pear shape as per DON HUNSLET with advantage. The regulator gland plate is a $2\frac{1}{2}$ in. disc from $\frac{1}{4}$ in. or 6mm brass plate, machined to drawing, and you can turn on a 1/32 in. spigot to 1 9/32 in. diameter to make life easier in mating with the body. Both body and gland plate can be erected to the boiler with common 2BA bolts, four or six in number as you prefer. The regulator spindle is to drawing, except that it has to be about $\frac{3}{16}$ in . longer at $2\frac{3}{4}$ in. overall. The regulator arm is very similar to valve gear components already described, and the handle is plain turning.

We have assembled the regulator and now have a piece of plain $\frac{5}{8}$ in. o.d. copper tube sticking through the smokebox tubeplate. Take a $\frac{5}{8}$ in. male stud coupling, a compression fitting type; if possible one that is threaded either $\frac{5}{8}$ B.S.P. or $\frac{7}{8}$ U.N.C. Chuck this in the 3 jaw and bore right through the body to a full $\frac{5}{8}$ in. diameter, this to accept the steam pipe. Now all you have to do is screw the stud coupling into the prepared tapped hole in the smokebox tubeplate, and tighten up the compression union to complete a very simple assembly; I hope John Milner will approve of my amendment. From here to the cylinders requires a compression fitting tee, main arm for $\frac{5}{8}$ in. o.d. tube and branches at $\frac{1}{2}$ in. o.d.; plus $\frac{1}{2}$ in. o.d. copper pipe to the $\frac{1}{2}$ in. male stud coupling in each steamchest.

The exhaust arrangement on JOHN HUNSLET makes me shudder! My problem is that having said that, suggesting an improvement is not so easy, especially as the design makes the best possible use of commercial pipe fittings. The route is vertically upwards from each steamchest, then through a 90 deg. bend to mate into an inverted 'T', the main leg of which accepts the blastpipe proper. A deflector bar is welded into the tee to help turn the blast upwards, so it is not as primitive as one might think, plus it has the added attraction of ease of access for sweeping the tubes, a most desirable feature. I would much prefer an inverted 'Y' form exhaust arrangement, but this is easier said than done, so I am in grave danger of my criticism becoming purely destructive. I am sure JOHN HUNSLET builders are going to be able to improve on my suggestion of cutting the 2 in. nipples that screw into the steamchests to form a mitred 45 deg. bend, followed by the $\frac{1}{2}$ B.S.P. Unions as already specified, and completed with a fabricated 'Y' from $\frac{1}{2}$ in. nominal bore steel tube; with that I shall tip-toe on!

The Smokeboxes

If we consider the smokebox for DON HUNSLET as a miniature edition of the outer firebox, then very little needs to be said by way of description, in fact astute builder Tom Pomfret had Reeves flange up the front and back plates over the boiler backhead former and is just going to add a piece of packing between smokebox shell and frames. Flange up the plates, then turn up the boiler joint and front stiffening rings from the gunmetal castings, the former to be a very tight fit over the barrel initially as it will distort on brazing. Grip each plate in the 4 jaw, with the former still in place if you like, and bore out to suit said rings. The smokebox shell is 3 in. x $\frac{1}{16}$ in. section mild steel, pulled round the end plates, or separately rolled, and either secured with a few rivets, or you can use 6BA round head screws to represent the snap head rivets in full size and fill the slots with plastic metal after the brazing, which follows immediately folks! As the spelter is required as a high temperature sealant, rather than a pressure joint, use same more sparingly than on the boiler, wash off with hot soapy water, rinse, dry and apply a coating of zinc from an aerosol can to prevent rapid rusting.

The JOHN HUNSLET smokebox is helped by the fact that both front and back plates are supplied as castings. Bore the backplate to accept the boiler barrel, then complete the visible profile to drawing before cleaning up the flange with a file. Face off the front casting so that the door will sit nicely and be air-tight, and tidy up the bore. Fit the small lugs to retain the crossbar, and tidy up this flange also with a file. The smokebox shell or wrapper is $4\frac{5}{8}$ in. wide x 3/32 in. thick steel and can be rolled to suit the end plates. Cramp in place and starting from the top centre line, drill for rivets a pair at a time, fitting same as you go, and countersinking these in way of the chimney base. Incidentally, before rivetting up the smokebox assembly, it would be as well to check that it fits between the frames!

For both versions, cut the hole on the top centre line to accept the chimney, our last item in this session.

The Chimney

The beauty with both HUNSLET's is that you can make the chimney as tall or as short as you like; one builder at least of DON HUNSLET simply squared off a 12 in. length of the $1\frac{1}{2}$ in. o.d. copper tube because he could not bear to cut it! So it is really a case of arriving at a height of chimney which pleases you, my $7\frac{5}{8}$ in. dimension being taken as purely nominal. JOHN HUNSLET uses $2\frac{1}{2}$ in. o.d. steel tube, and I would much recommend its extension into the smokebox as per DON HUNSLET, for the purpose of fitting a petticoat in the cause of greater efficiency.

The DON HUNSLET chimney is a composite casting, in iron, for the reason that I am not in favour of polished brass caps, though no doubt I am going to have to modify that view! Grip by the chucking piece and tidy up the base to fit the smokebox shell, then grip by the bore in the 3 jaw chuck, set to run true and take a skim along said chucking piece. Now you can carry on and profile to drawing, bore out to suit the chimney tube, and that means a reduced bore in the top cap to suit the spigot that I should have said earlier be turned on the tube. Complete the base with files, part off both chucking piece and into separate components, in reverse order, and here we can take a breather.

For JOHN HUNSLET the base and cap are separate castings, which first require boring out to size, and then gripped by said bore to complete.

Hunslet

by: DON YOUNG

Part 6 – Smokebox, Boiler Erection, Brake Gear and Boiler Fittings

Petticoat Piece

Continuing with the smokebox for DON HUNSLET, the petticoat piece is the next item required. Looking through my 'standard' castings for petticoats, I find that if the outside diameter is reduced from $1\frac{3}{4}$ in. to $1\frac{5}{8}$ in. then that produced for the 5 in. gauge BLACK FIVE is suitable, and as the intention is to braze this piece to the bottom of the chimney tube, then the reduction in diameter is considered acceptable. Grip said casting by the bore in the 4 jaw chuck, set to run true, and clean up the outside; you may well arrive at a finished diameter slightly in excess of $1\frac{5}{8}$ in. which is all to the good. Transfer to the 3 jaw chuck and grip by the just machined outer surface, to bore through to 1 11/32 in. diameter, this to match the chimney tube bore; machine the flare as shown. The final machining operations are a little tricky, by reason that we cannot properly grip the casting, but there is always a way out. Grip a length of either $1\frac{3}{8}$ in. or $1\frac{1}{2}$ in. diameter bar in the 3 jaw and turn down to a tight fit in the petticoat piece bore. If you achieve the correct 'light drive' fit, then you can tap on the casting with a wooden mallet and proceed; otherwise soft solder the pieces together. Now you can part off to length and bore out to suit the chimney tube.

Blast Nozzle

Moving down we come to the blast nozzle, but before doing so I must tell readers that my criticism of the exhaust arrangement for JOHN HUNSLET has rebounded before it appeared in print. For today (Sunday, 26th October) I called at the Island Steam Centre at Havenstreet seeking information on the privately preserved 0-6-0T which is called AJAX. (I was told that she is of 1915 vintage and built by Barclay, like a tank!) though parts of the smokebox shell have succumbed to rust. Today she was not in her usual place at the back of the Shed, being alongside the platform, and for the first time I could gaze through those gaping holes into the smokebox interior – to see a perfect example of a JOHN HUNSLET exhaust arrangement; after that I almost took an interest in a 1954 North British 'diesel' newly arrived!

Tip-toeing on, blast nozzles are of similar construction for both version, so a single description will suffice. The main body is turned from 1 in. diameter brass bar for DON HUNSLET and 1 in. A/F hexagon bar for JOHN HUNSLET neither calling for comment. The sleeve over the 'blower belt' is a $\frac{7}{16}$ in. length of superheater flue for D.H., and for J.H. a $\frac{5}{8}$ in. length of either 1 in. o.d. x 16 s.w.g. copper tube, or machined from 1 in. brass bar. Add the steam connection to this sleeve and the whole assembly can be silver soldered together. To complete, four holes are required from the blower belt to produce the necessary draught when stationary; specified No. 70 for D.H. and No. 50 for J.H. Small holes such as these I find easiest to produce using a hand drill, it being far more sensitive than a 'power tool'. I would also recommend that for JOHN HUNSLET these holes be drilled initially as small as No. 65, especially if a petticoat piece be fitted, for this should generate ample smokebox vacuum, plus you can always open out the holes if necessary; making them smaller is not so easy!

Correct alignment of chimney with blast pipe and nozzle is fundamental in the cause of free steaming of the boiler, so must be properly attended to. For both versions, take an appropriate length of $\frac{3}{4}$ in. diameter bar, sufficient to project from the chimney top, for D.H. reduce one end to a close fit in the blastpipe and for J.H. to suit the 0.386 in. diameter blast nozzle. You can now either turn up two nominally $\frac{1}{4}$ in. thick discs of outside diameter to suit the chimney bore and a central hole to slide over the $\frac{3}{4}$ in. alignment rod, this to positively centralise the chimney, or use internal calipers to achieve the same end. When satisfied, secure the chimney to the smokebox shell.

Smokebox Door, Hinges, Crossbar, Dart and Handles

We can now move on to complete the air-tight integrity of the smokebox, to make sure the vacuum induced by the blast is not wasted, starting with the door. In both instances this item is a casting, iron for J.H. and gunmetal for D.H. Grip by the chucking piece provided and first machine across the back to ensure a proper fit to the smokebox front plate/ring. next tidy up the outer profile by turning, or with files and emery cloth, for D.H. turning the centre boss to drawing; the 3 in. No. snap head rivets are 'dummies'. Centre and drill through for the dart before parting off said chucking piece. For the hinge blocks, chuck a length of $\frac{5}{16}$ in. square steel bar truly in the 4 jaw and turn down for $\frac{5}{16}$ in. length to 0.140 in. diameter before screwing 4BA. Cross drill No. 22 and saw off to length before radiussing the end as shown. Now you can fashion the hinges themselves from the same $\frac{5}{16}$ in. square bar, again radiussing the end and milling down to $\frac{1}{8}$ in. or 3/32 in. thickness over the main portion which lays snugly against the door; rivet in place. On JOHN HUNSLET, attachment is by bolts top and bottom, whilst DON HUNSLET employs the traditional hinge pin, plus a 'non-traditional' spacer, so the end result looks similar.

The dart for DON HUNSLET is turned from $\frac{5}{8}$ in. diameter steel bar, whilst that for JOHN HUNSLET can use 1 in. diameter bar, or more conveniently have the end portion welded to a length of $\frac{3}{8}$ in. steel rod. For the handles, turn up the centre bosses, make the handles themselves by chucking lengths of rod in the 3 jaw and 'turning' on the taper with files, then braze together before completing by tapping the outer boss and filing a square in its inner partner.

The crossbar is the last piece to complete this particular assembly; reason for the fairly involved shape for DON HUNSLET is to remain clear of the blast. Start with $\frac{1}{2}$ in. x $\frac{3}{8}$ in. BMS bar and first drill four 7/32 in. holes before filing into a slot to accept the dart. Next mill away the ends to give the $\frac{1}{4}$ in. step to fit inside the stiffening ring, easing the corners to sit in the brackets so that the dart slips in easily when the whole is assembled. For JOHN HUNSLET the crossbar is simply bent up from two pieces of $\frac{1}{2}$ in. x $\frac{3}{16}$ in. BMS, rivetted together.

Blower Union and Steam Connection

The steam connection for DON HUNSLET is plain turning from $\frac{3}{4}$ in. A/F hexagon bar, steel can be used if gunmetal is not readily available, and the blower elbow we can supply as a finished fitting for those who do not wish to produce the item; I guess Milner Engineering can likewise provide this service in respect of JOHN HUNSLET.

Boiler Erection

We must now return to Sheet No. 4 for the last time, in order to erect the two major assemblies, the boiler to the chassis. There is just one piece to be made ahead of this, the smokebox bottom plate to act as a closure, and this is best made to place for both versions. Then immediately before the first light-up, not far ahead now, fill the bottom of the smokebox with soft setting asbestos cement, or magnesium silicate; heating engineers will carry one or other of these materials. This will not only complete the sealing of the smokebox, but also make cleaning easy, for after raking out the char, a small paint brush can be used to sweep the smokebox clean. This clears up all the features at the smokebox end, save for coupling from the blower elbow to the union on the blast nozzle, when if not already dealt with, we can fix the smokebox to the boiler. If the fit is the correct 'light drive' one, then this can be the sole means of connection; if in any doubt, apply a high temperature liquid jointing compound and secure together with screws for DON HUNSLET, screws or rivets for JOHN HUNSLET.

Sit the smokebox between the frames and pack the back of the boiler barrel up from the frame stay, to be perfectly level. For DON HUNSLET, fold up the expansion brackets from 3 mm thick copper, hold them in place against the outer wrapper and position the holes to clear the stay heads; drill these with plenty of clearance so that the expansion bracket is in good contact with the outer wrapper. Now position the 4 in No. fixing holes, drill these No. 27, offer up again, spot through and drill the outer wrapper No. 34 before tapping 4BA. The fixing screws must be made from best quality bronze, say from $\frac{1}{8}$ in. phosphor bronze rod, and can be cheese headed for ease of manufacture. Annoint the threads with jointing compound and screw home. I can find no reference to this item on the JOHN HUNSLET drawings, but recommend that 1 in. x 1 in. x $\frac{3}{16}$ in. (or $\frac{1}{8}$ in.) black angle be used, dealt with in similar manner to that described, but welded to the outer wrapper for preference. All the remaining pieces of angle bar can now be bolted, or rivetted, to the JOHN HUNSLET frames, to bring the chassis almost to completion. Only one major job remains, the brake gear, and this is the next assembly to be tackled.

Brake Gear

I guess over the years that brake gear has become my Achilles heel. It all started with a general comment that vacuum brakes were a waste of time on the $3\frac{1}{2}$ in. gauge COUNTY CARLOW I was describing in 'Model Engineer' some 12 years back now. This brought forth protest from Brian Hughes, the designer of a superb vacuum system for train braking, for which incidentally the necessary drawings and castings are available from Messrs. Reeves. As it happened, I am glad I made the statement, for since that initial 'crossing of pens', Brian and I have remained firm friends, and I have come to appreciate his general approach to LOCOMOTIVES both LARGE & SMALL, for apart from being an accomplished builder of SMALL LOCOMOTIVES, he is also a driver on the Welshpool & Llanfair Railway. Anyhow, as retribution for the errors of my ways, I fitted the $2\frac{1}{2}$ in. gauge 'King Arthur' 4-6-0 called ELAINE with full vacuum brakes, it seeming appropriate after experiencing the skill of drivers on the full size 'King Arthurs' when braking for Winchester after the fast run down from Basingstoke.

When it came to HUNSLET, everything appeared to be plain sailing, with the provision only of a simple hand brake, but the jinx struck again, in two areas. Marine engineering in particular has taught me about the problems with long shafts, for one of the exercises of the drawing board for ships is to show the way to remove sections of propeller shaft and other large chunks of machinery overboard. From this, removing the brake shaft from the frames without separating them was simple, or so I thought. The problem arose when Messrs. Whiston ran out of the 4mm. thick frame material that I specified, it being a 'surplus' item, and I then gave builders a concession to use $\frac{3}{16}$ in. thickness in lieu. Maintaining the overall width over frames meant there were no problems with cylinders, motion, etc., but I forgot that the arms on the brake shaft had to be moved in by $\frac{1}{16}$ in. for the offending object to remain removeable, so be warned!

Brake Hanger

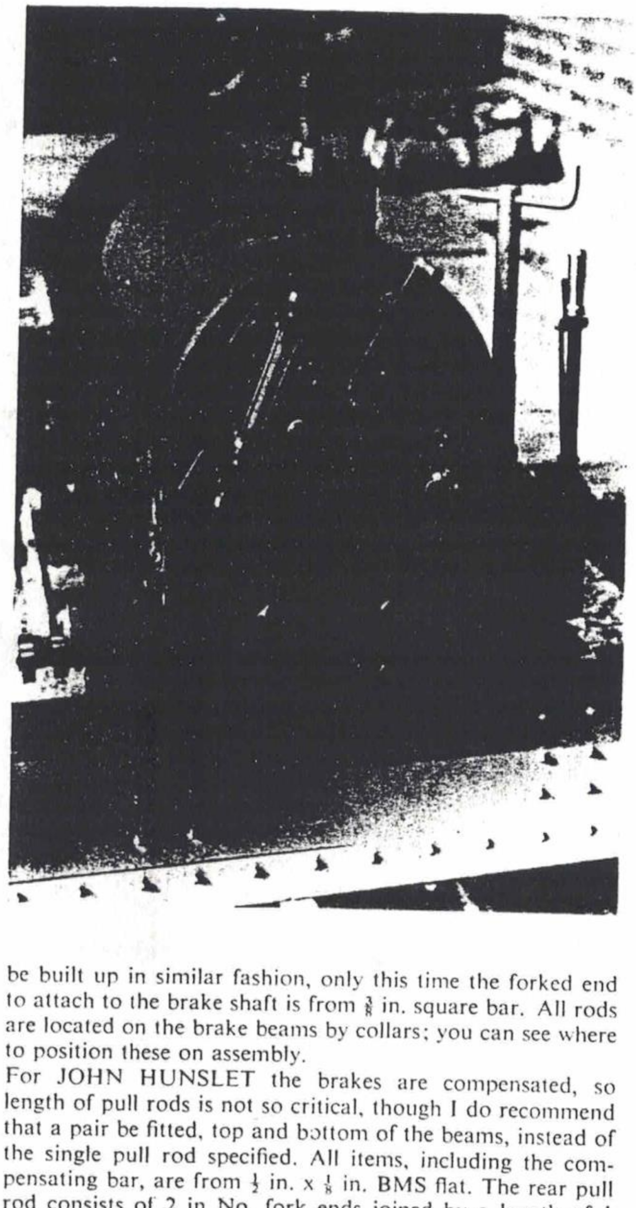
The second piece part which has caused trouble, and still crops up in correspondence, is the brake hanger, as I will explain as I describe construction. For DON HUNSLET, take a length of $\frac{3}{16}$ in. x $\frac{7}{16}$ in. BMS flat, cramp it on edge to a piece of $4\frac{1}{2}$ in. o.d. tube or bar, and hammer around to arrive at the shape shown, removing and giving a extra 'biff' to arrive at the 2 7/32 in. radius. Ah, I thought, this might cause problems to the more precision minded, so I will give finite dimensions to the bottom hole as reference, in the cause of 'belt and braces'. Whilst all this **appears** to tie up on my drawing board, and I have checked same more times than I care to remember, many builders tell me that I am in error. When they include such craftsmen as Ron Kibbey, whose completed chassis graced the back cover of LLAS No. 5, and which I had the great pleasure of inspecting at Llanuwchllyn, then no doubt **I am** wrong. So can I say that what is required here is that all four hangers be identical, and blend nicely with the wheels. On JOHN HUNSLET the problem is completely avoided by straight hangers, with ends radiussed and flanks tapered, hung from plain turned bosses; will I never learn! Incidentally, when George Barnes, General Manager of the Bala Lake Railway remarked on seeing Ron Kibbey's chassis 'Goodness me, a Quarry Locomotive built to Rolls Royce standards', little did he realise how close this was to the truth!

Brake Shoes

Although cast iron is specified on the drawing for the DON HUNSLET brake shoes, a ring casting is not a great deal of help in their manufacture due to the profile, so my alternative is 1 in. x $\frac{1}{2}$ in. BMS bar, as specified for JOHN HUNSLET. For the 5 in. guage version, reduce the thickness to $\frac{7}{16}$ in. then mark out the profile. Drill the 7/32 in. diameter pin hole, then saw and file to outline, including a chamfer to avoid cutting into the radius between wheel tread and flange. To complete, mill the $\frac{3}{16}$ in. slot to accept the brake hanger, to make sure the shoe comes into good contact with the tread, but not so much that the shoe trips when released and jams the wheels solid; this could cause a nasty accident. The brake shoe pin is not detailed, but is turned from $\frac{5}{16}$ in. steel rod, having a head 3/32 in. thick at the original bar size, a shank 7/32 in. diameter and $\frac{9}{16}$ in. long, being held in place with a $\frac{1}{16}$ in. split pin.

Brake Beam and Pull Rods

Brake beams are from steel rod, $\frac{1}{2}$ in. diameter and $7\frac{5}{8}$ in. long for DON HUNSLET; $\frac{1}{2}$ in. square x 7 13/16 in. long for JOHN HUNSLET, the latter being tapped $\frac{1}{4}$ in. B.S.F. at both ends. Pull rods on DON HUNSLET are also circular section, $\frac{3}{16}$ in. for the 'rod', with $\frac{3}{8}$ in. end bosses drilled $\frac{1}{4}$ in. diameter to suit the beams. Erect the hangers, shoes and beams, including the pull rod bosses, then clamp the shoes hard to the wheels, when you can cut the $\frac{3}{16}$ in. rod to a neat fit between the bosses; braze up. The rear pull rods I suggest



be built up in similar fashion, only this time the forked end to attach to the brake shaft is from $\frac{3}{8}$ in. square bar. All rods are located on the brake beams by collars; you can see where to position these on assembly.

For JOHN HUNSLET the brakes are compensated, so length of pull rods is not so critical, though I do recommend that a pair be fitted, top and bottom of the beams, instead of the single pull rod specified. All items, including the compensating bar, are from $\frac{1}{2}$ in. x $\frac{1}{8}$ in. BMS flat. The rear pull rod consists of 2 in No. fork ends joined by a length of $\frac{1}{4}$ B.S.F. screwed rod, this giving the necessary brake adjustment, with locknuts to complete.

Brake Shaft, Bearings and Brake Arm

I had already mentioned the brake shaft for DON HUNSLET, the main portion being $\frac{5}{8}$ in. steel rod, ends turned down to drawing and completed by the two short arms produced as for valve gear components. Ever since I had a brake shaft seizure, due to rusting, I have specified non-ferrous bearings, and those for DON HUNSLET can be turned up from a piece of the 'balance piston and bush material' from the castings set. Offer up to the frames, scribe back and cut the flange flush with the bottom edge of the frames, then mark off, drill and tap the five 4BA fixings.

For the brake arm, start with a length of $\frac{5}{8}$ in. square steel bar. Mark off and drill the $\frac{7}{16}$ in. hole for the brake nut, then mill the $\frac{1}{4}$ in. slot before radiussing over a mandrel with an end mill. Bolt to an angle plate, packing the $\frac{1}{4}$ in. slot, attach to the vertical slide and mill to arrive at the section shown. Turn up the end boss from $\frac{3}{8}$ in. steel rod, scallop the arm to suit and braze up; complete by filing the profile. Attachment to the brake shaft should await completion of the hand brake.

For JOHN HUNSLET the brake shaft is a 15 in. finished length of $\frac{3}{4}$ in. BMS round bar, relieved to $\frac{5}{8}$ in. diameter in two positions. The brake pull lever is separate and attached to the shaft with a $\frac{3}{16}$ in. taper or spring dowel pin, construction being the boss and arm fabrication we have become conversant with. There is the added refinement of a steam brake, the lever for which to couple to the brake shaft being identical to the pull lever, save for a $\frac{1}{4}$ B.S.F. tapped hole in lieu of a $\frac{1}{4}$ in. clear one, a plain turned pin being screwed into same and secured with a backnut. In place of a machined from solid hand brake arm, that for JOHN HUNSLET is fabricated from 2 in. x $\frac{3}{16}$ in. black steel flat, though the machining operations are very similar. The exception is at the shaft end, where instead of direct attachment to transmit the braking effort, there is a lug which engages the steam brake lever, giving independence of operation. The brake shaft trunnions/bearings/bosses, call them what you will, are specified machined from cast iron, and although my fear of siezure is somewhat reduced by provision of a $\frac{1}{16}$ in. oil hole, this can also let in water! so I recommend a brass sleeve, say $\frac{1}{16}$ in. wall thickness, to remove the possibility.

Hand Brake

For me a well proportioned hand brake column provides a lot of pleasure and that on DON HUNSLET I feel to be outstanding, or perhaps I should say upstanding! Chuck a $6\frac{1}{8}$ in. length of either $1\frac{1}{4}$ in. round or square steel bar, face and turn down for $\frac{3}{16}$ in. length to around $\frac{5}{8}$ in. diameter; this spigot is to engage in the cab floor and stiffener which I have specified under same. Reverse in the chuck, face off to $6\frac{1}{16}$ in. overall and centre; bring the tailstock into use and turn the outer profile. Leave the top flange at the original bar size for the moment and change to the tailstock chuck to drill the No. 1 hole. Use a 60 or 90 deg. Rosebit to countersink the end of the hole to accept a $\frac{7}{16}$ in. end mill and use the latter to produce the recess to a full $\frac{3}{16}$ in. depth. Reverse in the chuck once more and drill No. 1 to break into the previously drilled hole. I recommend securing through the cab floor to the stiffener with 4 in No. 6BA hexagon bolts.

The hand brake column flange is from 3mm brass plate; mark off and drill the five holes then tidy up the edges. The brake spindle is straightforward; turn up the collar a push fit over the spindle, locate to drawing and braze up. Chuck in the 3 jaw and face off any excess spelter, checking the fit in the column. Now you can slip the flange over the upper end of the spindle, spot through, drill and tap the column 8BA, and complete the upper flange of the latter to suit.

We almost have a complete brake gear, so moving on to the handle, first turn up a collar from $\frac{7}{16}$ in. steel rod, drilling first to suit the brake spindle and then cross drilling at No. 22 for the handle. Bend the latter up from 5/32 in. steel rod, fit to the collar and braze up, then drill out the centre portion. Slip over the end of the spindle and cross drill again at No. 42 for a 3/32 in. spring dowel pin. The last piece is the brake nut, a $\frac{1}{2}$ in. length from $\frac{7}{16}$ in. bronze rod, cross drilled and tapped 1BA, when the whole gear can be erected and the brake arm pinned to its shaft.

Now for JOHN HUNSLET, starting again with the hand brake column, only this time it is called a stand. The main portion is a length of $\frac{3}{4}$ in. o.d. steel tube, to which a lower end flange and top bush are fitted, plus a wee bracket to attach to the cab for additional support. Brake spindle/screw is as for DON HUNSLET, with a $\frac{5}{16}$ B.S.F. nut at the bottom to prevent the screw becoming disengaged from the brake nut, a useful feature, and a collar pinned on towards the top. The brake nut is a hefty $1\frac{5}{8}$ in. chunk of 1 in. diameter bar, screwed to suit the spindle, the brake handle being a composite of 1 in. diameter centre boss and $\frac{5}{16}$ in. steel rod.

JOHN HUNSLET Steam Brake

The steam brake cylinder is an iron casting; first face off to length and machine the frame bolting face. Next chuck in the 4 jaw and bore out to 2 in. diameter, before drilling and tapping through the integral back cover at ¼ B.S.P. At the rear of the bore, on the bottom centre line, drill and tap 2BA for a wee plug, this latter being drilled centrally at No. 72 as a condensate drain. Offer up to the frames and secure with two $\frac{5}{16}$ B.S.F. bolts. The piston is plain turning from the iron casting, to a nice sliding fit in the bore and then grooved for ⅛ in. square graphited steam packing. There is also need for a self-centring indent to accept the end of the connecting rod to the brake lever, the latter being a 9¼ in. length of ½ in. x ¼ in. BMS flat. Because of the long length of the connecting rod, and also its being in compression under load, a guide is provided, with body from ½ in. square bar and slotted to accept the rod, completed by a ½ in. x ⅛ in. closing plate; locate and bolt to the frames.

BOILER FITTINGS

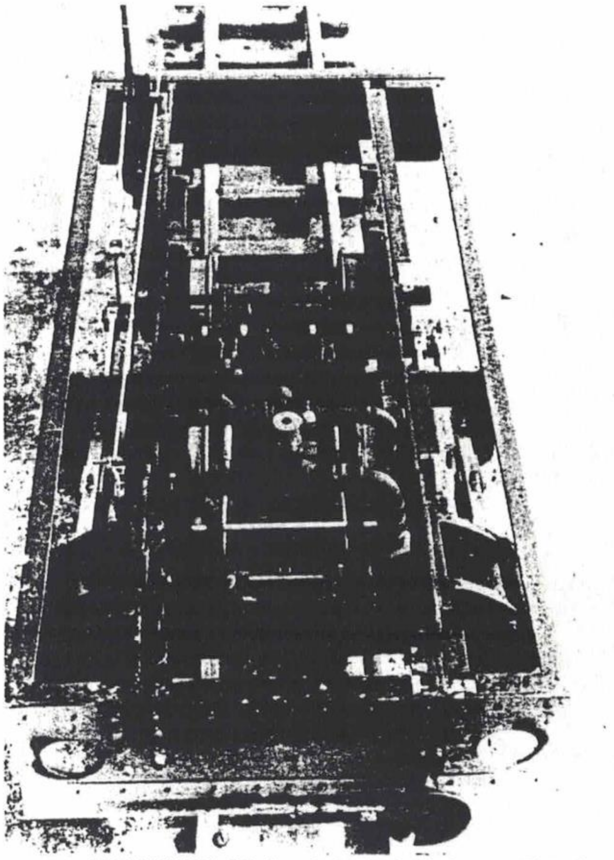
Regulator Stop

Although this item can be bent up from brass strip, it is such a prominent feature that I reckon it is worth making from an odd end of 1¼ in. diameter brass bar, so chuck in the 3 jaw, face across, centre, drill and bore out for at least 1 in. depth to 1 in. diameter, a nice fit over the regulator bush; part off a ⅞ in. slice. Grip in the machine vice, on the vertical slide, and begin milling away the slot for the regulator handle completing with files to place. Cut away half of the tubular section, drill the No. 30 hole, offer up to the bush, spot through, drill and tap for a 5BA x ¼ in. long hexagon brass bolt.

Manifold

Having checked that the regulator is functioning correctly against the external stop, we can now close up the last large hole in the boiler with the manifold. The flange is already partly machined, so complete by boring to a piece of 1⅞ in. o.d. x 16 s.w.g. copper tube as your gauge, then mark off and drill the fourteen No. 29 holes, only they can be No. 30 at this stage. Offer up to the boiler, spot through, drill and tap the bush 5BA x $\frac{3}{16}$ in. deep, making studs to suit from ⅛ in. stainless steel rod. Next part off a full ½ in. length of copper tube and we can turn our attentiön, literally! to the top, closing, plate. For preference I would make this latter from a ¼ in. slice taken from a length of 2¼ in. diameter copper bar, which only then requires finishing to thickness and a $\frac{1}{16}$ in. step turned on to fit the bore of the copper tube. This material may, however be difficult, if not impossible, for some DON HUNSLET builders to obtain, in which case I will supply a disc of gunmetal to order, which again will require simple turning. Cut $\frac{7}{16}$ in. square blocks from copper or gunmetal, machine to fit under the closing plate, hard against the tube, and braze up. This latter operation will have distorted the flange slightly, so chuck in the 3 jaw and face across, try over the studs and if there is any problem, open up the holes to a clearance No. 29, or even No. 28, as it is important that the manifold sits snugly on its bush. Next mark off, drill and tap the six holes indicated to the relevant sizes, when the manifold can be erected.

For a joint, 1/64 in. CAF may be used, though I still prefer good quality brown paper soaked in linseed oil. Lay the chosen jointing material on the manifold flange and gently tap around the periphery and bore, to give a mark which can then be cut out with scissors. The holes can be cut out with a small punch, though with a paper joint all you do is stick it to the flange and poke a scriber through the paper into each hole; even I can do this and get a perfect joint every time!



JOHN HUNSLET chassis by R. L. Hudson exhibits fine workmanship. Photo by Paul Bullock

Fitting out the Manifold

Injector Steam and Blower Valves are of our standard angle pattern; we also manufacture the neat little Whistle Valve and can supply a male Union for the pressure gauge tapping; the pressure gauge too, so all that is required is a short length of 3/32 in. o.d. copper tube, plus the little stay. The whistle is a proprietary one, from a friendly policeman or boy scout, the mouth-piece being cut off and an adaptor made up to suit whistle tube and valve. That leaves one very important feature – the Safety Valves.

Safety Valves

Probably the least used fitting on a well managed LARGE LOCOMOTIVE was the safety valves, yet on SMALL LOCOMOTIVES they are usually kept pretty busy, and I am one of the culprits! It is recommended that for DON & JOHN HUNSLET these be purchased from Don Young Designs and Milner Engineering respectively, not only because they will have been thoroughly tested, but also that their purchase price works out less than that for materials and tooling for their construction by builders.

DON HUNSLET is fitted with a feather, being a prominent feature full size, and one that is pleasing to reproduce in miniature. Start with a 4 in. length of ½ in. square stainless steel bar; first mark off and drill the No. 39 and 27 holes. Use Swiss files to elongate from the latter into a ¼ in. x 3/32 in. slot to accept the spring plate. Clamp the bar to an angle plate, attach to the vertical slide and end mill the section, overall width being $\frac{5}{16}$ in. in way of the slot just formed. Turn the bar over, support with packing pieces and complete the section; now it is simply a question of completing the profile

with saw and files to arrive approximately at that shown, which I think is pleasing to the eye.
For the spring plates, cut two $\frac{5}{8}$ in. lengths from $\frac{1}{4}$ in. x 3/32 in. stainless steel strip; reduce the width to 15/64 in., then drill the No. 42 hole and complete the profile. For the screwed end, chuck a length of 5/32 in. stainless steel rod and reduce to 9/64 in. diameter over a $\frac{5}{8}$ in. length; screw the outer $\frac{3}{8}$ in. at 4BA. Part off at 17/32 in. overall and then slot the plain portion to accept the plate; braze up. I have specified the lower plate without a screwed end and brazed directly to the manifold, but on reflection, if the screwed portion were reduced to $\frac{3}{16}$ in., then the manifold is of sufficient thickness to be blind tapped to suit, and this is now my recommendation.
The feather block is a length of 7/32 in. square bar, cross drilled No. 43 and then slotted to accept the feather. Radius the fork end, then saw off to length, chuck truly in the 4 jaw, face across, centre, drill No. 47 and tap 7BA.
Erect all the pieces, when you will require a tension spring to complete; this is of quite massive proportions in full size as it controls the valve in each column, but ours must place no restriction on the spindles. So choose a heavy spring, as shown on Sheet No. 1, and slot the lower spring plate so that the spring is free to rise and fall as the safety valves open and close.

Water Gauge and Blow-down Valve

The Water Gauges and Blow-down Valve Don Young Designs will be pleased to supply, the latter with a captive spindle in the cause of increased safety, in fact the valve in each of the water gauges is also 'captive'.

Injector(s)

Recently I was asked a very apt question – "Why are axle driven pumps still specified Don, when your injectors are so reliable?" It was only then that I realised that DON HUNSLET and GLEN are both so fitted, whereas 19 of my 29 designs produced to date are specified for injector feed only, so the impression given from this pair is a false one; why is this so?
When I began to put pencil to paper to produce realistic designs for SMALL LOCOMOTIVES back in 1957, having by then gained some experience in LOCOMOTIVES both LARGE & SMALL, a main ambition was to follow full size practice as far as I then thought was possible. Obviously over a quarter of a century the possibilities of improving realism have increased and although personal contribution to this is minimal, I have gained a great deal through other SMALL LOCOMOTIVE builders freely imparting their experiences; to these kind people belongs the credit for improvement of my humble designs.
Turning to injectors, as an almost universal full size feature, these I specified, and on my 5 in. gauge 02 Class 0-4-4T FISHBOURNE, I fitted a pair of the famous 'Linden' horizontal pattern which I had purchased in 1948. Their capacity proved too great for the small boiler and they were replaced by a pair made for me by Gordon Chiverton, my own efforts being a dismal failure. Later on I produced a successful design for a vertical injector and this has been detailed for some of my designs, among them COUNTY CARLOW and JERSEY LILY. The problem then arose that although the design had been proven, not every builder achieved success, which is the reason why commercially produced injectors have been so highly regarded over the years.
At the time that HUNSLET and GLEN were at the design stage, Arthur Grimmett, who was then the world's largest manufacturer of 'traditional' horizontal injectors, was on the point of retirement, and Gordon Chiverton had not then begun manufacture of his fine range, so I envisaged a problem in injector availability, this influenced me to include axle driven feed pumps in my specification. Now that Gordon Chiverton has established himself as the manufacturer of Injectors for SMALL LOCOMOTIVES, the need for axle driven pumps has disappeared, though the builder still has the ultimate choice as to their abandonment.
With DON HUNSLET as drawn, one Injector only is required, a 24 oz/minute Vertical type, with steam valve (already covered), Water Cock and Feed Check Valve to complete the fittings; all of Don Young Designs supply. For JOHN HUNSLET I recommend two Injectors be fitted, both Horizontal type, and one each of 40 and 60 oz/minute capacity.

Firehole Door

That brings me to the last boiler fitting, the firehole door, and as with the others, this is not particularly well illustrated for JOHN HUNSLET, so I recommend larger editions of those shown for DON HUNSLET to resolve any problems.
Mark off the door on a sheet of 3mm brass and cut roughly to line before drilling the three No. 11 air holes, plus one of the same size at the centre. Chuck an odd length of $\frac{1}{2}$ in. rod in the 3 jaw, face, centre, drill and tap 2BA; bolt the door in place and turn the periphery to $2\frac{3}{8}$ in. diameter. For the hinges, chuck a length of $\frac{1}{4}$ in. brass rod, centre and drill No. 30 to about $\frac{7}{8}$ in. depth and part off two $\frac{1}{4}$ in. slices. Lay these on lengths of $\frac{1}{4}$ in. x $\frac{1}{16}$ in. brass strip and braze up, trim off to drawing and rivet to the door.
The hinge pin is best made in two parts, a technique we have used previously, so I can move on to the hinge block. Cut the end plates as a pair from 3mm brass, erecting to the door with the hinge pin; now cut the base from $\frac{1}{2}$ in. x $\frac{1}{8}$ in. brass strip to fit between the end plates, clamp together and braze up. The baffle is dealt with as for the door and the spacer will pose no problem; assemble these to the door with a snap head copper rivet. Drill two No. 34 holes in the hinge block, assemble to the door again and erect to the firehole. Check that the door opens without the baffle fouling the firehole ring, then spot through the No. 34 holes, drill the backhead No. 43 and tap 6BA for home made bronze screws. The catch is bent up from $\frac{3}{8}$ in. x $\frac{1}{16}$ in. strip and rivetted to the door, the small unspecified hole being to suit a short length of chain, this for opening the door.
Bend the catch spring up from $\frac{1}{2}$ in. x 0.015 in. spring steel or hard phosphor bronze, when the $\frac{11}{16}$ in. dimension can with advantage be increased to 1 in. Centre pop for the two No. 34 holes, rubbing away the 'pimple' formed with a file, then drill out to size a little at a time. Offer up to the backhead so that the catch just engages at the extremity of the spring, then check that the door closes properly, bending the spring if necessary to achieve this. When all is well, secure to the backhead with 6BA bronze screws.

Coupling

This coupling is designed for the hard work that DON HUNSLET is very capable of. Chuck a length of $\frac{5}{8}$ in. square BMS bar truly in the 4 jaw and turn down for $1\frac{3}{8}$ in. length to $\frac{3}{8}$ in. diameter; screw the outer $\frac{5}{8}$ in. at 32T and make two nuts to suit. Reduce the next $\frac{3}{8}$ in. to 17/32 in. diameter and mill or file the $\frac{3}{8}$ in. square to suit the beams. Next mark off and drill the $\frac{5}{16}$ in. hole before parting off to length. Mill, or saw and file, the $\frac{1}{4}$ in. slot and complete by radiussing the fork end. Erect to the beam and on reflection the spring could be increased to 14 s.w.g. as DON HUNSLET will pull a house down!, followed by a plain washer and the two nuts to make sure the coupling will not come adrift. The cab really belongs to the 'platework section', and the grate is allied to the ashpan, so as there is not much to describe on Sheet No. 6, our last session, I will call a halt at this juncture.

Hunslet

by: DON YOUNG

Part 7 - Conclusion

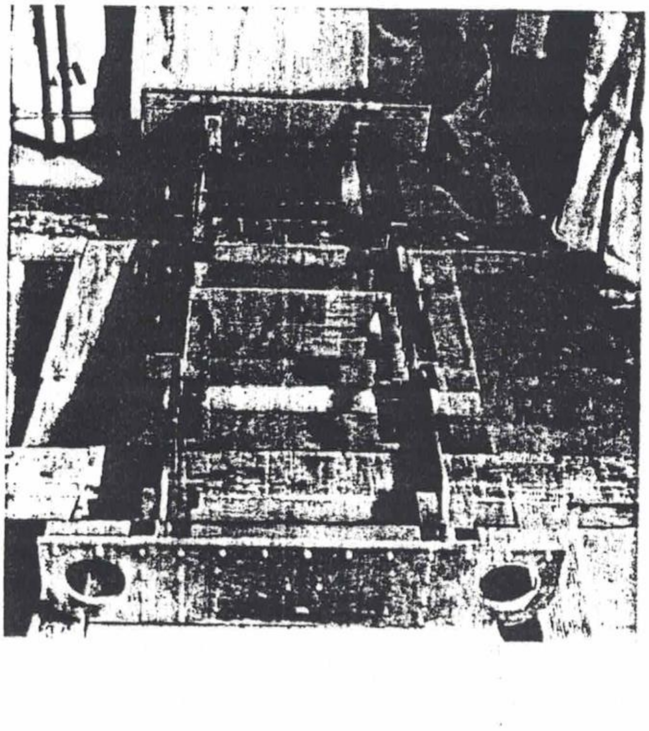
Ashpan and Dumping Pin

We are on the final lap, so let me hurry on and deal with the ashpan next. Cut the side plates first from $\frac{1}{16}$ in. steel sheet and offer up to the firebox wrapper extension; you may clamp these temporarily in place. There is a backward extension on the L.H. side, to mate with the lever guide; this can be cut integral or made separately and brazed into place. You can now site the ashpan dumping pin position on the mainframes, using that given on the ashpan as reference, drilling through both frames and ashpan side plates at 7/32 in. diameter; open out the latter holes to $\frac{3}{8}$ in. to accept a full $6\frac{1}{2}$ in. length of 16 s.w.g. tube. Measure the distance between the two side plates, add 1/32 in. for clearance, and cut a piece $5\frac{1}{2}$ in. long at this width to fold up for the front/bottom plate, shaping to suit said side plates. Next cut a length from $\frac{1}{4}$ in. x 2mm (or nearest available section) strip to accept the hinges, and for the latter I would take a $5\frac{1}{2}$ in. length of $\frac{1}{4}$ in. brass rod, centre and drill No. 30 from both ends to break into one another. You can now braze the whole ashpan up and then mill away the unwanted hinge material, when the remnants will be in alignment. The dumping pin, shown on Sheet 5, is from 7/32 in. steel rod with the head brazed on and then finish turned.

Damper

The damper door is $1\frac{1}{4}$ in. wide and the same thickness as the mating strip attached to the ashpan. Deal with the hinges as on the ashpan, make up the wee lug on the L.H. side, and braze up. Machine the hinges to mate with those on the ashpan and poke a length of $\frac{1}{8}$ in. stainless steel rod through as hinge pin, but don't peen the ends over yet.

Frame Assembly for JOHN HUNSLET. Photograph Crown Copyright, National Railway Museum, York



Erect the ashpan, take a length of $\frac{3}{8}$ in. x $\frac{1}{8}$ in. BMS flat and drill a No. 41 hole at one end, off centre so that it will fit the lug on the damper door; assemble temporarily with a 7BA bolt. Now you can judge the length of this damper lever, both for ease of use at the track, and to check that it does not get in your way; in this the $4\frac{3}{4}$ in. length is personal preference and may be varied. When satisfied, make up the distance pieces, plus lever guide, and assemble. The distance piece that fits to the ashpan, if nutted inside, would foul the firebox, so rivet over instead. Back to the lever to drill some No. 30 holes and then saw out and file to produce the lugs, or hooks, as shown, so that they can be engaged in the rear distance piece to give varying and positive openings of the damper door; complete profiling the lever as shown. The final test is to pull out the dumping pin, when the ashpan should drop cleanly, though Ron Kibbey tells me that this is not quite the end of the story. Ron tells me that damper door opening is restricted by the close proximity of the guard angle across the frames, and feeling the latter was a useful feature, he simply extended the guard support brackets backwards for $\frac{1}{2}$ in. to provide the necessary clearance.

Grate

Having provided the means of collecting ash from the fire, and controlling the primary air to same, we now need to support said fire by medium of the grate. Like MOUNTAINEER previously, HUNSLET's are being built worldwide. It is a cheerful story, though it does pose a few problems, like fuel quality. This is where local expertise comes into its own, and it would certainly increase the general fund of knowledge if LLAS readers could acquaint us with their particular fuel characteristics, and the art of burning same efficiently. For the Welsh steam coal that we in the U.K. are still fortunate enough to be able to purchase, I recommend breaking down into lumps that will pass through the firehole door on your shovel, when the bars should be spaced as specified. My experience with anthracite, and it is not my favourite fuel, is that lumps should be 'bean' size, and not only the bars be respaced to give $\frac{1}{4}$ in. air spaces, but be made from stainless steel to give a reasonable service life. The most exciting coal that I have used is that from the Forest of Dean; it burns brightly with some smoke, giving a good effect with SMALL LOCOMOTIVES, but strangely little sooting of the tubes.

Cut the bars from the chosen material, section $\frac{3}{8}$ in. x $\frac{1}{8}$ in., drill one of them No. 22 at the two positions shown and then use as a drill jig for the remaining bars. Chuck a length of $\frac{3}{8}$ in. steel rod in the 3 jaw, centre and drill No. 22, parting off spacers of the required length, remembering that four have to be $\frac{1}{8}$ in. shorter to allow for the grate support lugs. Assemble the grate with lengths of 5/32 in. steel rod and clamp firmly together, then trim off the grate support lugs to accept the end pieces as shown; braze these in place and then rivet over the ends of the two rods.

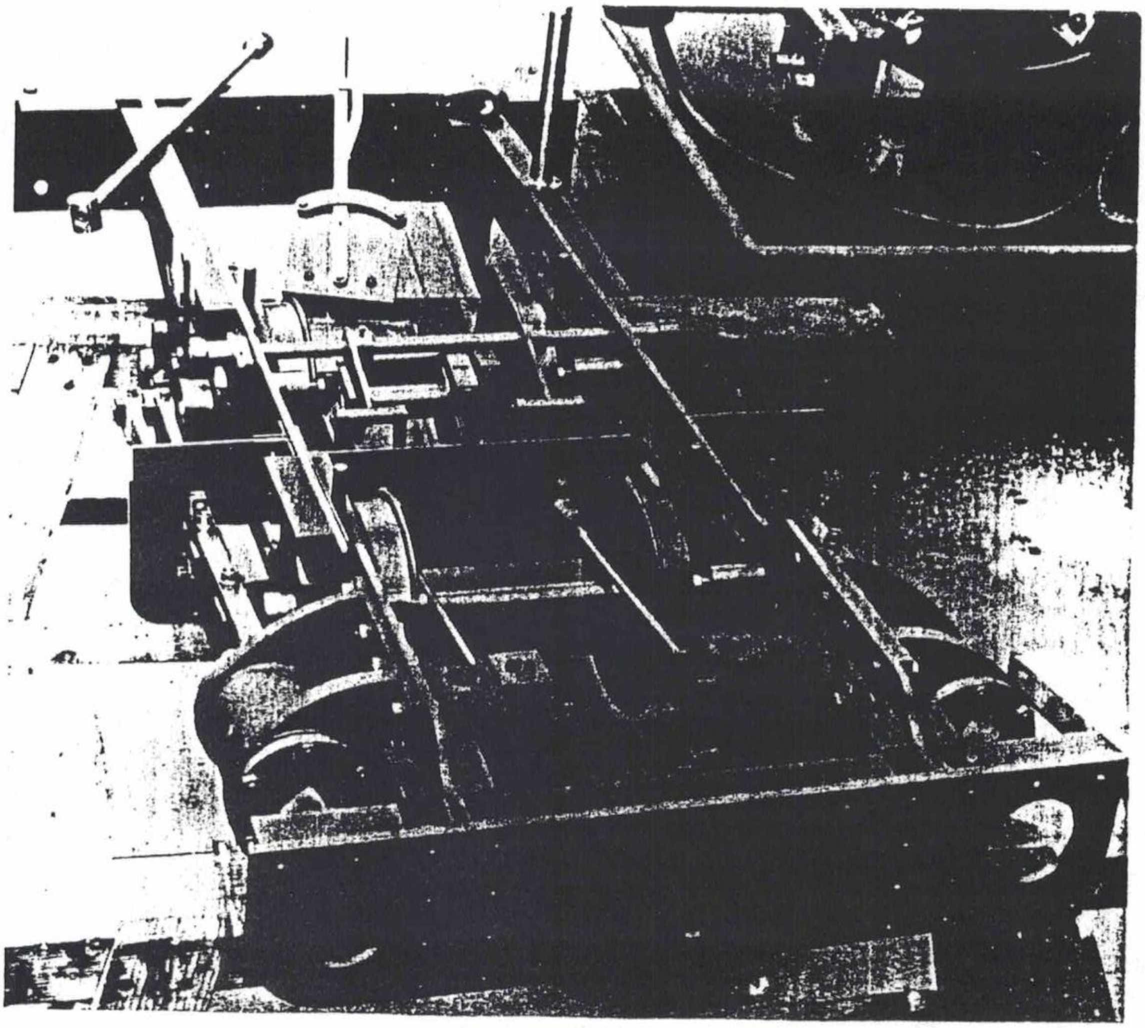
You are now left with an assembly that won't fit to the ashpan by reason of that dumping pin guide tube, and I think you will agree that the latter adds a lot of stiffness to the ashpan, plus it makes fitting the ashpan in place so much simpler. So cut the end pieces to leave a full $\frac{3}{8}$ in. gap, to slip over the guide tube, then drill the four No. 27 holes in the ashpan. Erect, complete with grate, and check that the top of the fire-bars are at least flush with the top of the foundation ring.

Drill through the end pieces of the grate support, from the ashpan, at No. 27 and secure with 4BA bolts, checking again that the ashpan, plus grate, will 'dump' freely.

Lagging and Cleading

Probably the most important single feature on any saddle tank SMALL LOCOMOTIVE is keeping the water cool enough for the injector(s) to function properly, yet this feature is missing from my drawings; a big black mark! Part of the reason for this is not being in favour of the asbestos lagged, brass clad combination in this instance, feeling a more efficient means of preventing heat transfer is called for. I remember in the last days of my full size steam engineering experience that pipes carrying superheated steam at around 850 deg. Fahrenheit were being covered with aluminium foil, the surface temperature of which was markedly reduced over the older asbestos rope lagging. My experience was in marine applications, but I also know that the Central Electricity Generating Board was then engaged in similar experimentation, and this must have advanced somewhat in the interim; no doubt some LLAS readers can fill this gap? The principle as I then knew it was that still air is an extremely good insulator, and if one crushed aluminium foil, as used in the kitchen, a lot of air was trapped, giving good insulation properties. The problem is that I cannot explain to builders how to crush aluminium foil to arrive at a uniform $\frac{1}{8}$ in. thickness around the boiler barrel; it seems almost like a job for the the pastry board and rolling pin! That joke actually rebounded on me shortly after being penned in rough form, for my wife had to retire sick and for a few days I was head cook and bottle-washer, when there was opportunity to experiment with aluminium foil, though not fitting same to boiler barrels! With crushed aluminium foil lagging, I was going to specify heavier steel cleading as stocked by Reeves, only I find on checking their most comprehensive 1981 Catalogue that they have changed over to my standard brass shimstock specification; I am trapped! I must therefore ask builders to try aluminium foil lagging and if your patience fails revert to asbestos, clead with 0.015 in. thick brass shimstock, secured with $\frac{5}{16}$ in. wide boiler bands.

The firebox at least is somewhat easier; lay a 4 in. wide strip of $\frac{1}{8}$ in. thick asbestos on the wrapper, followed by a $3\frac{1}{2}$ in. wide strip of brass cleading, both with clearance holes at the manifold. At back and front of the firebox is a quarter round brass casing, and the only way I reckon this can be tackled is by making a wooden former and tapping the brass shimstock over it. I have used this material in this sort of situation before, for instance to make cylinder outer covers, and found if well annealed it does work well, and gives good end results. I suggest you use a full width sheet and then trim out the section after flanging. Hold in place with the same $\frac{5}{16}$ in. wide boiler bands as for the barrel, securing to the top edge of the frames.



This magnificent example of JOHN HUNSLET, under construction at the National Railway Museum workshops at York, approaches the valve setting stage in 1980. Photograph Crown Copyright, National Railway Museum, York

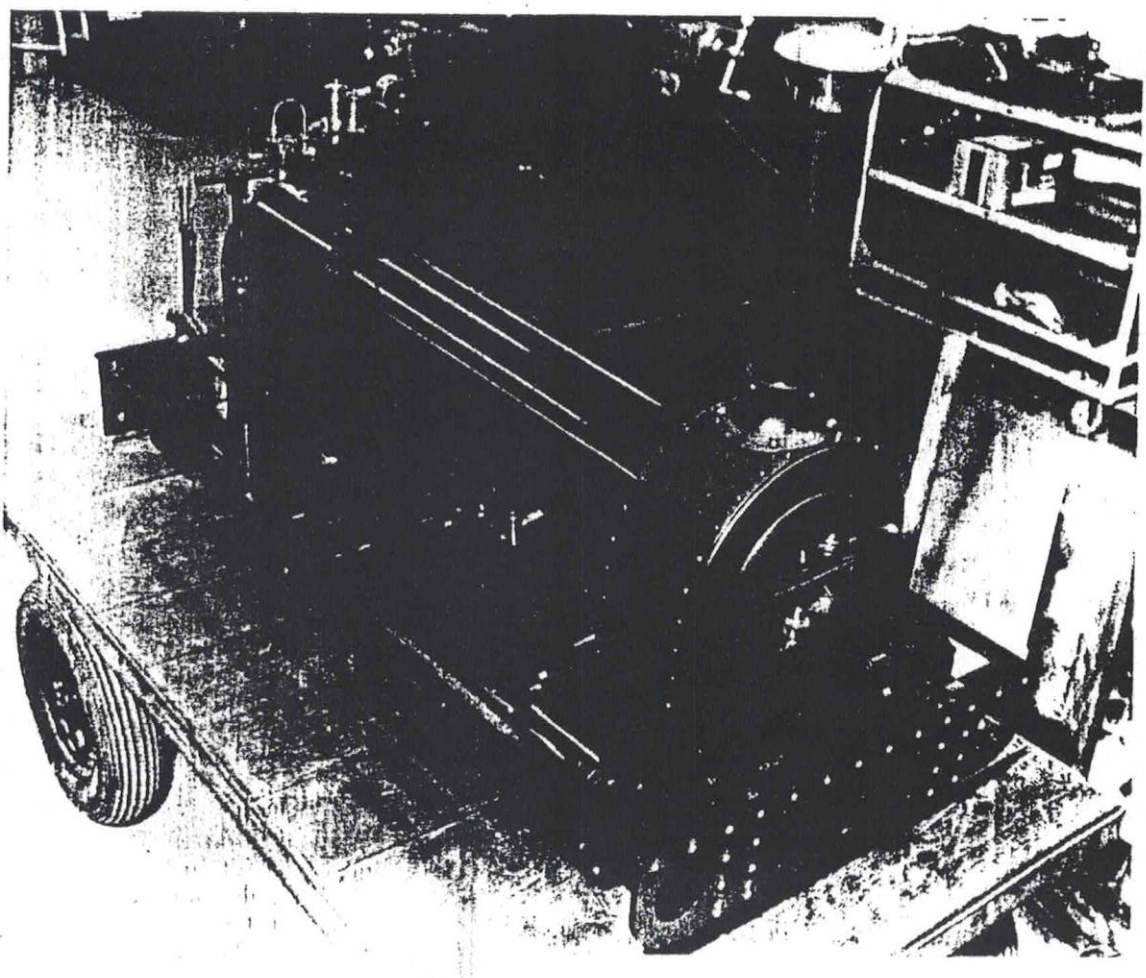
Saddle Tank

We now come to the platework, and we may as well start with the only difficult item, the saddle tank. One or two builders have suggested that a balance pipe between the two tank legs would be of benefit; I certainly have no quibble with this, in fact if the feed pump suction flange and filter is duplicated on the L.H. side, then a pipe could run round under the barrel to form said balance pipe, with a 'T' to the pump suction. Now that we know the connections required, let us think after fabricating the tank.

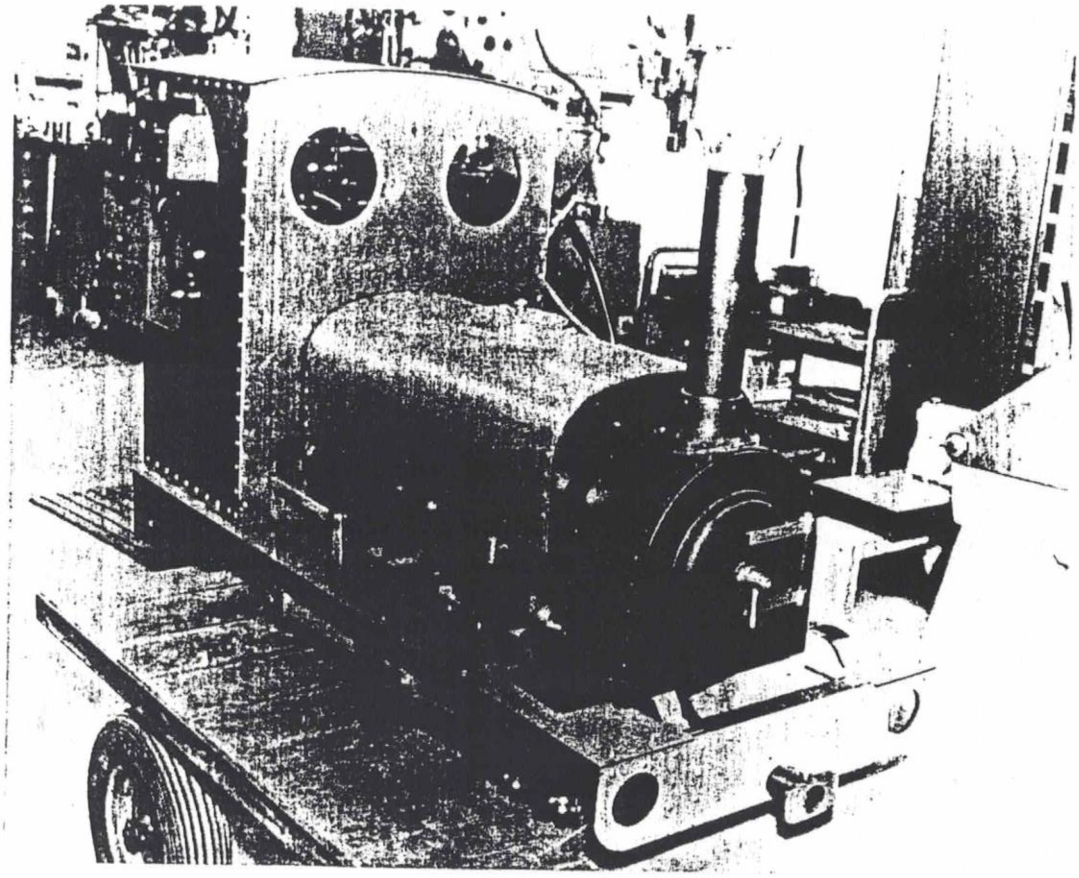
The boiler is intended to be lagged to the 6½ in. diameter of the boiler joint ring, an even ⅛ in. thickness over the barrel. Having established the diameter of the barrel over cleading, the first part of the tank can be rolled to match, giving us a base on which to build. I strongly recommend a brass, or copper, tank if economically viable, for a steel one is rather difficult to coat internally to prevent rust.

The end plates can either be cut now and used as templates when forming the outer shell, the most practical method for us 'amateurs', but for those with 'plate-bashing' skill it is probably easier to roll the outer shell, then stick on the end plates and trim them flush. I am reminded of yet another form of construction, one that uses a wooden former made to the internal dimensions of the tank, the outer shell being beaten down over this former. Whatever form of construction you employ, hold the pieces together with short lengths of ¼ in. brass angle, using rivets or screws for attachment as applicable. To close the bottom legs of the tank we need two strips, each rougly 14 in. x ⅝ in. x ⅛ in. Mention of the word 'close' reminds me that this is exactly what we have now, a closed container, and this is just about impossible to seal by soft soldering, brazing, or even welding; if you do manage to achieve success, as the hot air cools inside the tank it is likely to implode; hardly the desired end result! So cut the 2½ in. diameter hole for the filler, and those using a former have the advantage here in drilling the ring of small holes and chopping out the surplus centre. Now you can either seal all the seams with soft solder from the outside, or feed Bakers fluid and spelter into the tank, warm up and swill the mixture around. Wash out with hot soapy water, rinse, dry and refill to check for leaks.

We can now fit out the tank and first I must make mention of those hank bushes, for they have raised more queries than any other item on DON HUNSLET. These are in fact round nuts, with a spigot that pokes through the plate to which they are to be attached, this spigot is then peened over to fix the hank bush firmly in place, when items such as brackets and handrail stanchions can be easily attached; and removed. Where to obtain such exotic things? My source of supply over many years has been from a "Nut Assortment" purchased from Messrs Whiston; the late John Kendall told me it would be the best investment I would ever make, though at first sight it would look like a heap of rubbish, and so it has proved. The only problem is whether to specify fitting same before or after sealing up the tank. Before and you will have to drill out any solder and re-tap; after and you have the fiddly job of getting them to the right place inside the tank. Turn up all the flanges and fit to place; those suction filters I· roll around a pencil and tack the seam with a soldering iron. The hand pump is a variation on the axle feed pump already described, though much simpler to manufacture as no gland is required. An 'O' ring may be fitted to the ram, though it is far from being essential. Pipe up the hand pump as shown, then drill and tap the two $\frac{3}{16}$ x 40T holes for the drain plugs.



Boiler meets chassis and all is well! Photograph Crown Copyright, National Railway Museum, York

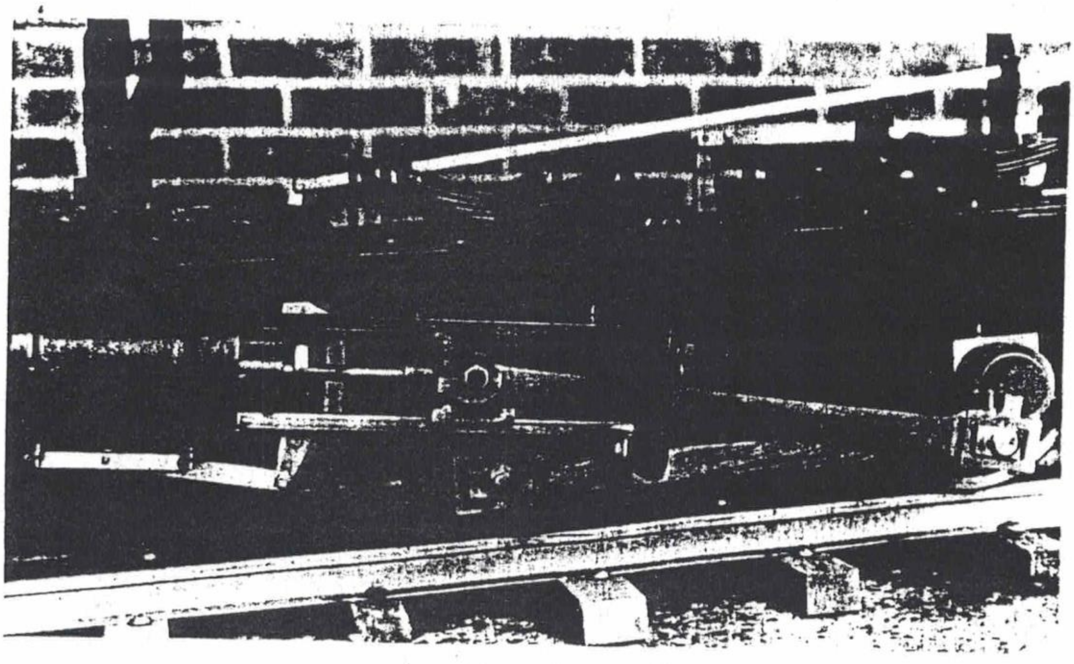


Progress at mid-February 1981, the N.R.M.'s JOHN HUNSLET should be in steam before long. Photograph Crown Copyright, National Railway Museum, York.

Filler Tube and Lid

To complete the tank we need the filler tube and lid, so first cut a $\frac{5}{8}$ in. length from $2\frac{1}{2}$ in. o.d. x 16 s.w.g. brass or copper tube. Chuck by the bore, face one end, then reverse and complete to $\frac{1}{2}$ in. overall. The flange is best turned from 1.6mm brass sheet, so cut a 3 in. square, find the centre by the 'X' method, chuck truly in the 4 jaw and bore out to an easy fit over the tube. Saw off the corners then chuck again, by the bore this time, to complete the periphery to $2\frac{3}{16}$ in. diameter. Bend to suit the top of the tank, then sweat to the tube, and I suggest you leave this whole assembly portable on the tank top, for ease of access.

The lid can be fashioned from 1.6mm sheet, the lip being rolled to a tight fit in the tube and then skimmed after soldering to the top plate; or you can turn from solid. The central ball completes the assembly and I suggest this be screwed 7BA to suit the lid.



Cylinders and motion of R. L. Hudson's JOHN HUNSLET. Photo by Paul Bullock

Valance

We can now complete the platework, starting with the valances. Cut the end pieces from ½ in. angle and bolt to the beams, then cut the main portion from ⅜ in. angle, fashioning the ends to accept same; silver solder together.

Side Running Boards and Side Sheets

The side running boards are 29½ in. lengths of 3 in. x 1.6mm brass strip, cut to clear the cylinders. Fasten to the valances with 6BA raised countersunk head screws, this to represent rivet heads, filling the slots with plastic metal before painting. Use pieces of ⅜ in. brass angle to attach from the inner edges to the frames; this can only be done to place.
On the L.H. side there is a closed coal bunker in way of the firebox, a very simple fabrication; on the R.H. side only the outer side and front sheets are fitted, to close in the reverser/brake column area. The front running board speaks for itself and must be the simplest component to make on the whole engine!

Cab Step

For the cab step, first take a 3¼ in. length of 2⅜ in. x 1.6mm brass and bend to form the ½ in. flange at the top, then bend second ½ in. flange on the back face for attachment to the rear beam; silver solder the corner. Bend up the step from 1.6mm brass, silver solder the corner seams, then rivet to the back plate. Erect the step to come flush with the end of the beam and attach to both beam and side running board to complete.

Erecting the Tank

Sit the tank on the boiler barrel and cut the front supports from ⅜ in. steel angle. Bolt to both tank and smokebox shell, filling any gap around the latter with Isopon P38. The rear supports are bent up from ⅜ in. x ⅛ in. strip, attaching to angle at the front of the bunker and R.H. front sheet; this again can only be done to place. Complete the piping and your HUNSLET is ready to steam, but do be careful, for she can be rather a handful!

Cab

To fit or not to fit a cab, that is the question, and although at the outset I was positive that "no cab" was the answer, by the time I reached Sheet 6 you can see that I wavered by the front view that approximates to MAID MARIAN. I stress approximate, for without actual measurements, and things like roof radius is difficult to establish, I was forced to rely on scaling from photographs. For when I asked for details of the then newly fitted cab on HOLY WAR I was shown a sketch on the back of a cigarette packet! Don't laugh, the end result is superb, but it does illustrate that if you do propose to fit a cab, then there is license to do exactly as you wish, and who can quibble? Certainly not yours truly.

Votes of Thanks

It remains to thank the cast of thousands for making HUNSLET such a magnificent success, a Locomotive that has found favour in almost every country where SMALL LOCOMOTIVE building is practiced. All this has been made possible by those dedicated stalwarts who decided that HUNSLETS would survive the closure of the North Wales Slate Quarries; you have shown that their efforts were worthwhile. A final word for the moment, for I am sure that HUNSLETS will feature again in these pages, is to thank John Milner for permission to describe his 7¼/7½ in. gauge version, with my amendments, just a few of them necessary, but most just my own whim; thanks for your tolerance John, I have read in "Model Engineer" that Roger Marsh says that it is his version of the 7¼/7½ in. gauge HUNSLET that I have been describing in LLAS. This puzzles me greatly, for I can state categorically that I have never seen a Roger Marsh drawing for any of his Locomotives, neither has there been correspondence between us on this particular subject. What I will say is that if my notes have been of assistance to builders of Roger Marsh 7¼/7½ in. gauge HUNSLETS, then I am delighted to have been of service.

John Goulden, Chairman of HMRS, drives Alwyn Kay's 7¼ in. gauge DON HUNSLET past the BBC 'Look N.W.' camera