# Black Five

## The fabulous Stanier Class 5MT 4-6-0 in 5 in. gauge

By: DON YOUNG

**Part 6 — Bogie completion; Coupled Wheels and Cylinders**

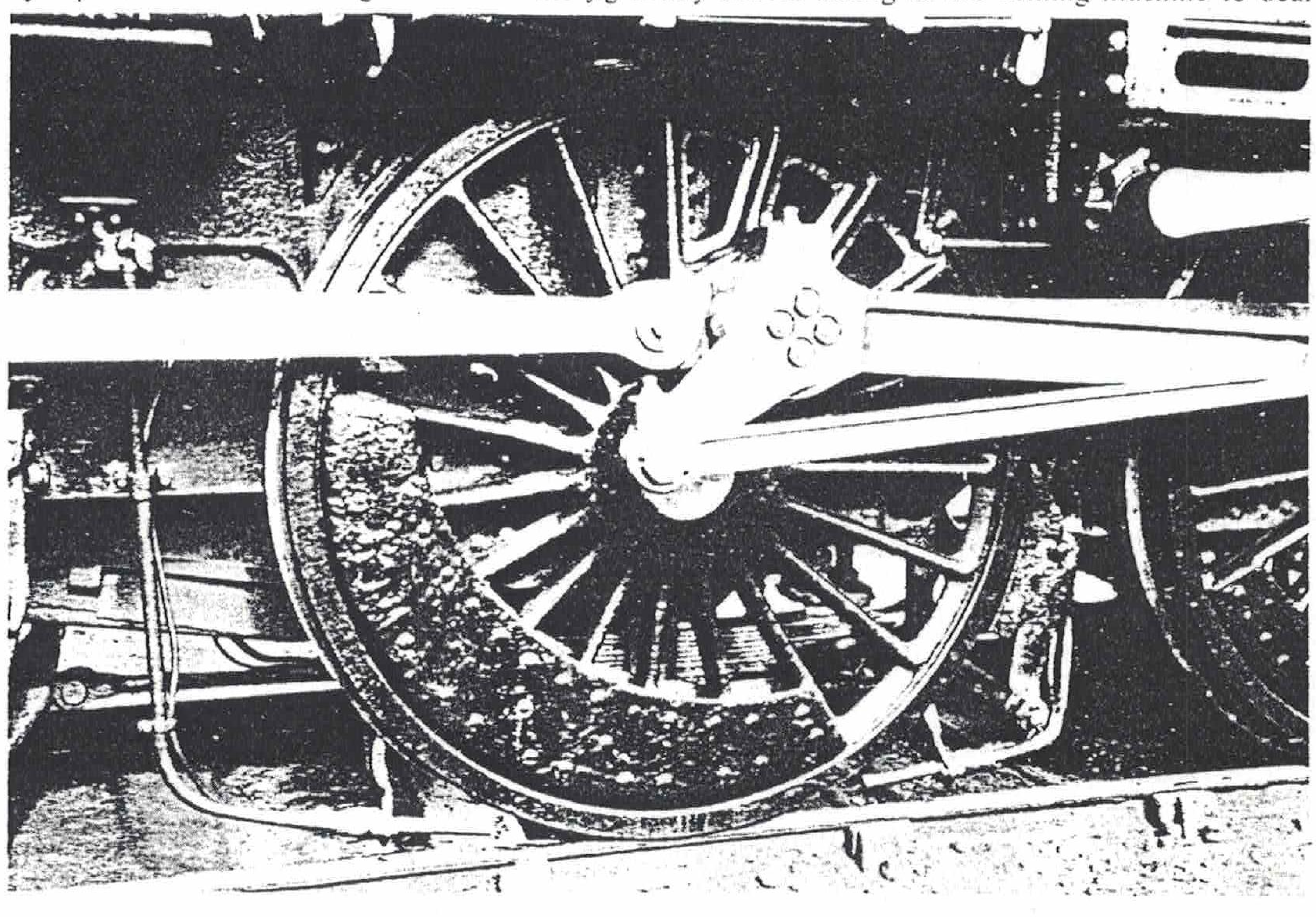
With such a bewildering variety of parts to choose from, I am going to ease my way into this session gradually, taking the wheels first.

**Coupled and Bogie Wheels**

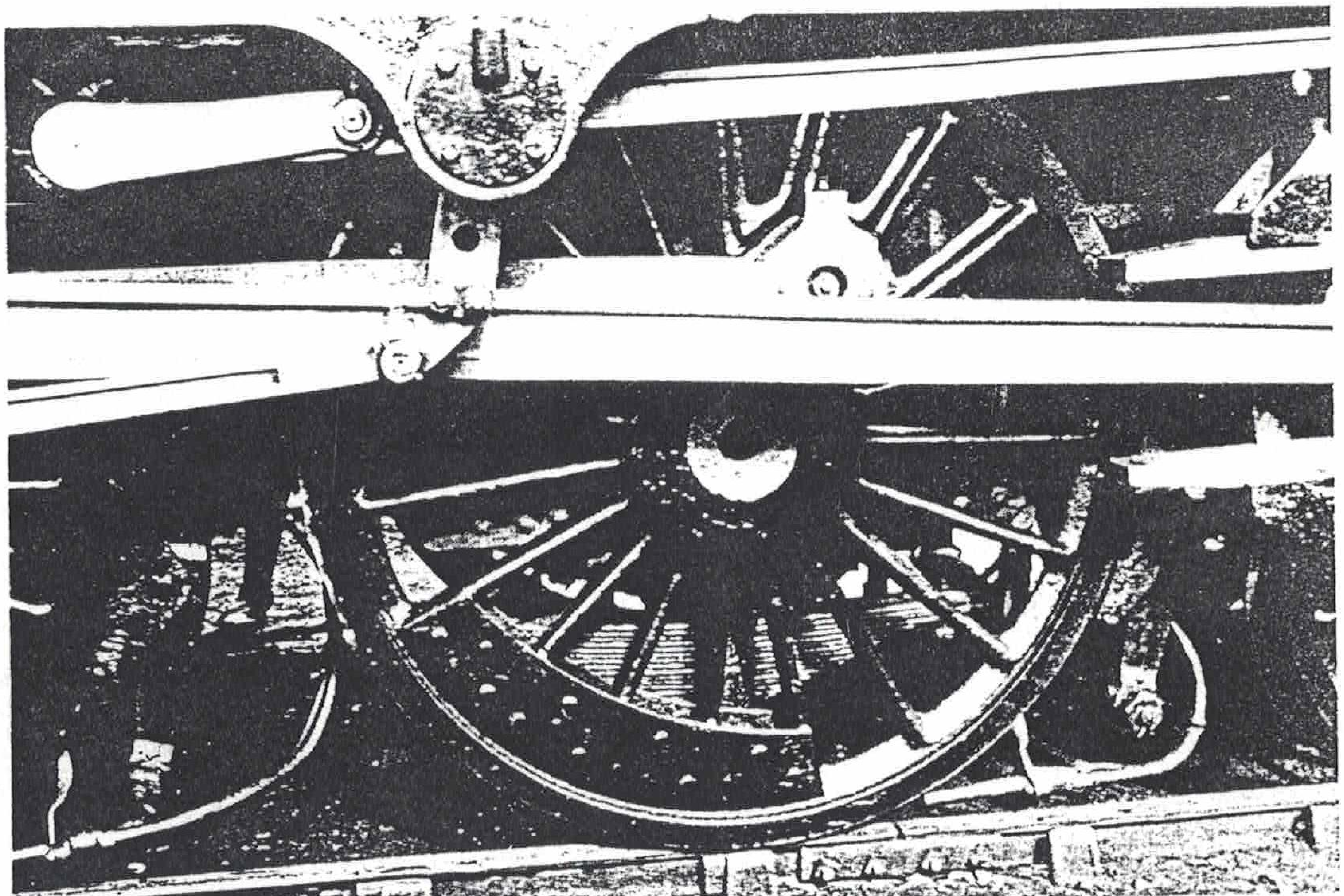
In pre-254V plus days, machining any wheel that was over 6 in. diameter which required bolting to the faceplate, took an awful long time to achieve. Now with the luxury of an 8 in. independent 4 jaw chuck, setting up time is minimal, with only a roughing and finishing cut necessary to bring to size. Take the first coupled wheel and chuck in the 4 jaw, setting to run true and in this respect the flange is likely to have been well fettled, so concentrate on getting in inside of the rim running true. As always, assess machining allowances and relative position of the spokes before making a start, as nothing is worse than cutting into the spokes when facing off the front of the wheels later on. Follow the Myford instruction and run the lathe at near top speed in back gear for a few minutes to get oil circulating properly to the bearings, then reduce speed to a minimum in back gear to take a heavy first cut right across the back of the wheel, winding up the speed as you come to the centre boss; take a second and finishing cut. Turn the flange down to 6 11/16 in. diameter and radius the corner with a file; with the chuck guard in place as it must be, this is not quite so easy as in ML7 days, but with an 8 in. flat file fitted with a handle, you will succeed. Centre, drill through, bore out and ream to ¾ in. diameter, then bring all six wheels up to this stage.

The next requirement is a worn or broken drill of around 13/16 in. diameter, one with a taper to suit your headstock, which for me entails a visit to the local scrapyard, where such things are put aside. Saw away immediately behind the flutes, clean both drill end and taper adaptor in the headstock, then very lightly tap home before turning down to a good fit in the wheels. You will have to remove the 4 jaw chuck to machine the mandrel; replace it with the faceplate, one that will dwarf the wheel!, indeed my ambition now is to design an engine with wheels that will utilise the faceplate to the full!! We now want a couple of screws to attach the wheel to said faceplate, through the spokes, and I prefer ¼ in. countersunk screws with washers both back and front, as this will allow the tool to pass without clobbering any projecting bolt head. Face the tyre to 9/16 in. overall thickness, then withdraw the tool 1/16 in. to face across the crank boss. With a knife edged tool, take a very light cut at the inside of the rim so that the balance weight side plates will fit snugly, making a note of the reading when the final cut was taken so that you can repeat same on all the other wheels. Change to a round nosed tool to machine the tread, so that you can deal with both root radius and flange at the same time, leaving a few thous oversize for a final cut later on; bring all six wheels up to this stage. Leave the last one in place and take a final cut along the tread, leaving the tool at this setting and dealing with the other wheels similarly, then set the tool over 30 deg. and produce the wee chamfer.

To deal with the crankpin holes, we require a simple jig, the base of which is a 2½ in. length from, say, 1½ in. x 5/16 in. BMS bar. Scribe on the centre line then grip in the machine vice on the vertical slide and at ¾ in. from one end, drill through at ½ in. diameter; move on 1.250 in. by the cross slide micrometer collar and repeat. Check that a length of ¾ in. diameter steel bar is a good fit in the wheel, and you can lightly knurl it if needed to obtain a better fit, then chuck in the 3 jaw, face and turn down to ½ in. diameter over a 5/16 in. length to be a press fit in the base; part off at ⅞ in. overall. Scribe the centre line along each of the crankpin bosses on the wheels, bring up the jig, align and then clamp the jig firmly before taking to the drilling machine to deal



By a stroke of good fortune, I caught up with No. 5407 at Carnforth just a few days before typing the manuscript, thus the driving balance weight is featured here for the benefit of members of the RCA (Rivet Counters Association).



No. 5407 was not in steam when I saw her at Carnforth, therefore I consider myself very fortunate that she was so well positioned for photographing the balance weight details. I didn't bother counting the number of rivets holding the balance weight plates on the driving wheels, but for the coupled wheel depicted there are 12 of them, three in a triangular pattern between each spoke.

with the ½ in. crankpin hole in the wheel; repeat. Tidy up the wheels with files and emery cloth and we must next deal with the balance weights.

Check the diameter to which you machined the inside of the rim, then scribe four circles at said diameter, which will be around 5⅝ in., on a sheet of 3mm steel, sawing out roughly to line. Drill a ½ in. hole through the centre of each, chuck a ½ in. bolt in the 3 jaw, mount the four discs and complete with a retaining nut; clean up to size, then produce a wee chamfer on the outside face of each. Cut out a cardboard template for both driving and coupled wheel balance weights, checking against the actual wheel castings, then scribe onto the discs and cut them out, finishing them in pairs. If you are building a specific engine then you will have photographs of same by you, which will show any rivet heads that are visible for securing the side plates; drill the required number of ⅛ in. holes. Offer the side plates up to a wheel, crop the rivets off to length and lightly peen them over. Mix up some Isopon P38 and feed into the space between the side plates with a spatula, filling all the voids, allow to cure then file away any excess; this will hold the side plates firmly in position.

After all that, the bogie wheels will come as light relief, so chuck in the 4 jaw to run true, face across the back and turn the flange down to 3¹³⁄₁₆ in. diameter, radiussing the corner with a file. Centre, drill and ream the bore to ½ in. diameter then check that a length of ½ in. steel rod is a nice fit therein, lightly knurling if needs be. Chuck the rod in the 3 jaw, face and turn down to ⅜ in. diameter over a ¼ in. length, screwing 26T or similar. Part off at 1¾ in. overall, reverse in the chuck and repeat, making up two nuts to suit; bolt a pair of wheels back to back. Grip the pair in the 4 jaw with the flanges running true, then face across to size and turn the thread to within a few thous of finished size; remove the outer wheel of the pair and replace by another. Leave the last wheel bolted as a pair, change from 4 to 3 jaw chuck and reverse to complete the fourth wheel, taking a final cut over the tread and then repeating for the other wheels, then chamfer at the outer end of the tread to complete.

## THE BOGIE

With the wheels out of the way, the next move is to complete the bogie we started in the last session, though first a few words on its really classic design. Basically there are two types of bogie, the Adams variety where the load is transmitted through the centre, and the de Gleghn where a ball and socket almost immediately under the mainframes takes the load, side thrust only being absorbed at the centre. Also on the Adams bogie, the side thrust is transmitted from the bogie frames to the buffer by means of horizontally mounted leaf springs, whereas the Stanier bogie does so via spring bars and coil springs by means which will become clearer as we machine and assemble the piece parts, so let me hurry on.

### Bogie Frames and Horn Gap Stay

I never cease to enthuse over the Stanier bogie, it really is a classic, the frames being a perfect example, for although they lack the curves of a late Victorian engine, they are well proportioned for the stresses they have to endure. In Reeves latest Catalogue, what we require appears in the sheared mild steel listing, so it is worth purchasing the 2⅝ in. x ⅛ in. or 3mm section rather than trust in the 2½ in. width being exact. Saw out two 9¾ in. lengths, file a bottom edge to arrive at a datum, then square off one end which will be the front; carefully mark out to drawing. Tidy up the second piece and bring together as a pair, drilling about four ³⁄₃₂ in. holes for copper or aluminium rivets to hold them in place for machining. Deal with the remaining holes first, including the specified countersinks, and those with rivets fitted will have to be opened out later on when the frames have been separated. Drill a row of ⅛ in. holes along the top of the horn slots, open out until they begin to break into one another, then saw down the sides of the slots, grip firmly in the bench vice and break out the surplus metal with a 'Mole' wrench. Next grip in the machine vice on the vertical slide and with a large diameter end mill, clean the slots up to 1 in. width, using a piece of barstock as your gauge. Still at this setting, mill away the ³⁄₃₂ in. of metal at the bottom of the openings, then change to a smaller end mill to deal with all four edges for the horn gap stays, checking these with a micrometer. Saw out the profile and file to line, in fact a lot of the profile can be milled if you like, there being enough straight edges to make this worthwhile. Separate, remove all the burrs and sharp edges, then open out the temporary rivet holes to final size.

The horn gap stays are from 6mm, or ¼ in., square steel bar, so saw off four 2¼ in. lengths. Just tidy up the ends and starting a full 3/32 in. from one of them, mill a slot first to the frame thickness and then open it out to ½ in. width, a tight fit over the projection. Move on to the second slot, first making it ⅜ in. wide and depth to match the frames, then open it out gradually until it too is a tight fit over the frames; mill the ends to length and radius to drawing. Offer up to the bogie frames, drill through and secure with 8BA hexagon headed bolts.

**Bogie Horns, Axleboxes and Keeps**

The bogie horns are cast in sticks, one stick for each hand, and each wants cutting in half as a first step. Check for flatness as sometimes they are a bit curly, teaching them manners with a wooden mallet, then rubbing a file over the frame fixing surface. Sit this flat face on the bottom jaw of your machine vice, add little pieces of packing to come clear of the webs and clamp firmly; mill the working surface to size. Use the side teeth of the end mill to deal with the edges to arrive at ⅝ in. overall, then turn the casting through 90 deg. to deal with the frame fixing face, including the 3/32 in. lug which fits into the horn gap. The positions of the ribs are critical, so check the rivet heads will come clear of them before cutting into individual horns and squaring them off to the 1 11/32 in. dimension. Fit a pair of horns into a frame gap, clamping in place, then use a couple of 2BA bolts between the working faces, opening out the nuts to bring the lugs in good contact with the frames; drill through and rivet.

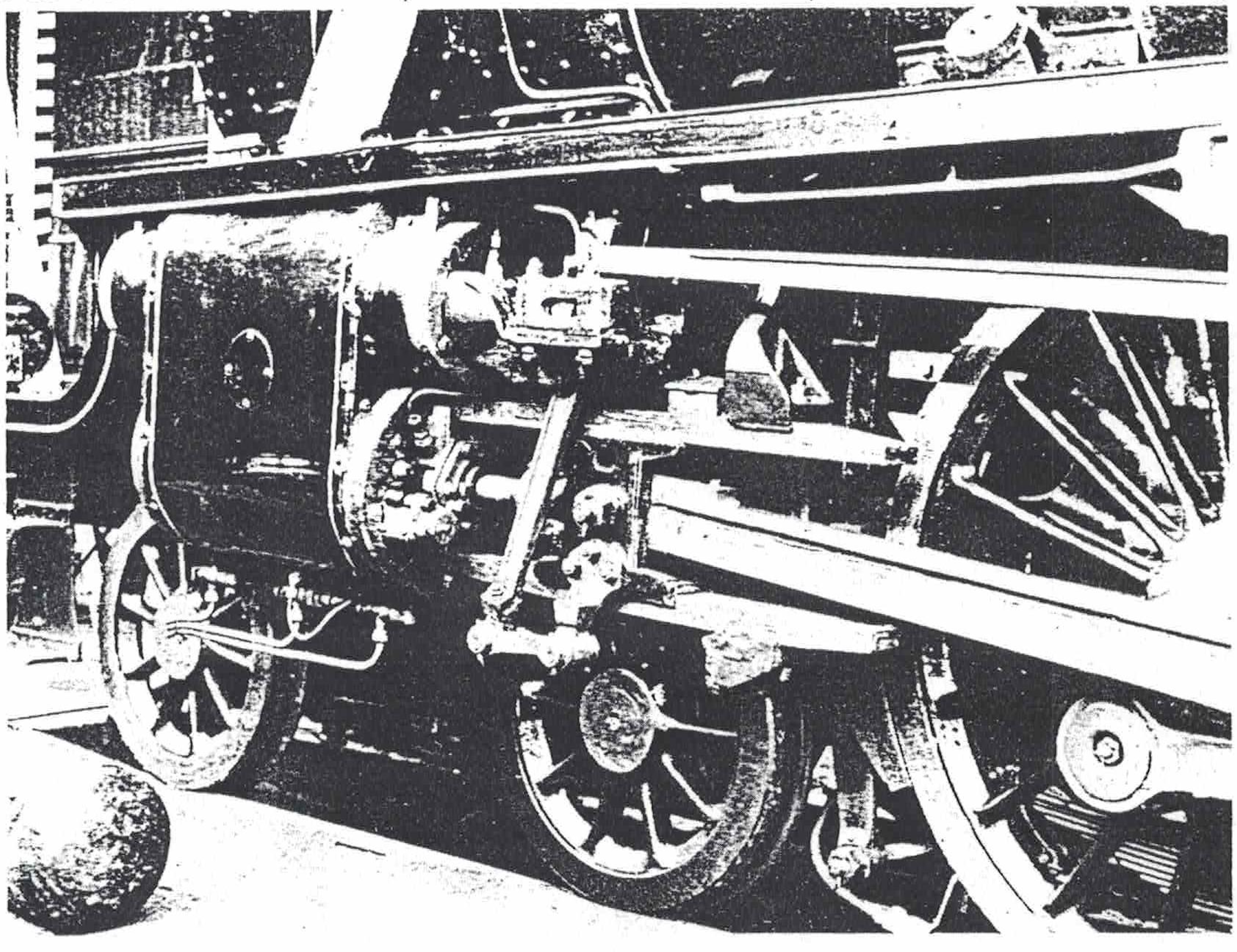
Bogie axleboxes and keeps are also supplied as cast gunmetal sticks, so for the former, first arrive at the required 1 in. x 15/16 in. section. Grip in the machine vice on the vertical slide to mill a ⅝ in. wide slot to ⅛ in. depth along the full length of bar, taking note of those ⅛ in. and 3/16 in. flange dimensions, then rotate the bar through 180 deg. and repeat, only this time instead of going straight to ⅛ in. depth, check against the horns to arrive at a tight fit. Saw into individual axleboxes and square them off to identical length, stamping them in pairs for subsequent machining, the next step being to mill the ⅝ in. wide slot for the keep to ⅝ in. depth. Take the keep material and mill to ⅝ in. square, a tight fit in the slot, then saw into individual pieces and square them off to 15/16 in. length to match the axleboxes. Mark off for the keep pins and drill right through, making the keep pins from 1/16 in. steel rod to suit. Mark the axle centre on the front face of one axlebox, then cut four 1 3/16 in. lengths from ⅝ in. x 3/16 in. BMS flat. Fit a piece in each axlebox slot, then chuck as a pair in the 4 jaw and set the axle centre to run true. Centre, drill through to ½ in. diameter, then bore out to the 9/16 in. diameter axle material as your gauge to be an easy running fit. Turn on the 1/16 in. raised face to 1 in. diameter, then reverse in the chuck to deal with its partner. Mark out the top of each axlebox for the depression to accept the end of the equaliser, setting the first one up in the 4 jaw. First centre and drill the No. 60 oil hole, then use a ball nosed end mill to produce the spherical radius, when of course you will make the ball end to suit. Complete by turning on the 1/16 in. raised face as shown, which just leaves the final fitting.

The axleboxes are a tight fit in their horns, so first ease this until they slide freely from top to bottom, then radius the side flanges as shown so that the axleboxes will tilt and allow the bogie wheels to follow any irregularities in the track.

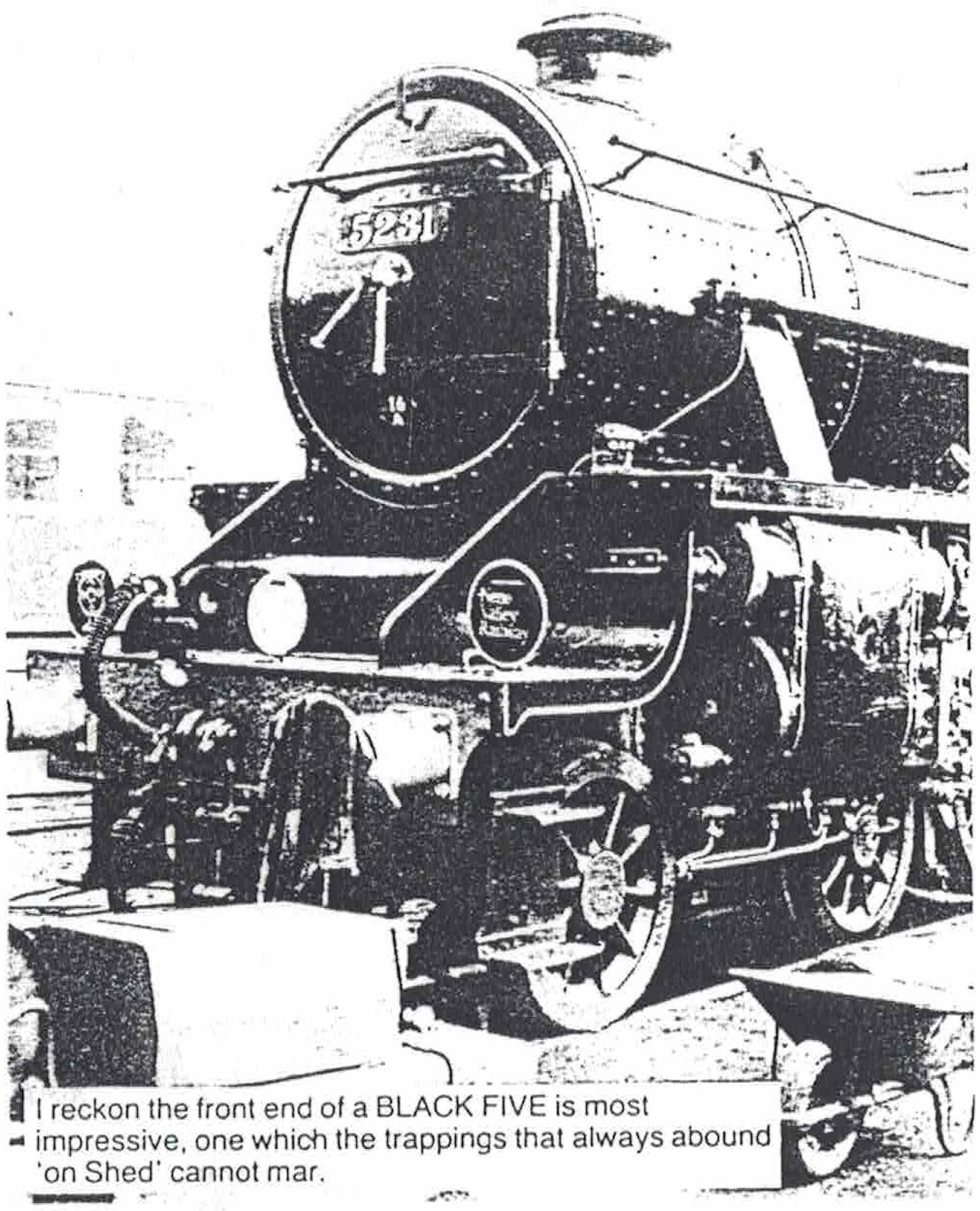
I am not going to describe turning up either the bogie axles or the front and rear stays, both being straightforward, which brings me on to the bogie half centres.

**Bogie Half Centre and Buffer**

Chuck a bogie half centre in the 4 jaw to skim across the top face, then grip in the machine vice on the vertical slide with the working face facing the 3 jaw chuck. Use the side teeth of an end mill to arrive at the 1 7/32 in. overall height, then relieve the central portion by ⅛ in. as shown. Next deal with the rubbing surface, which is 25/32 in. deep, followed by the ⅛ in. thick lug which stands out by 5/16 in. If you have a ball ended end mill with which to deal with the lower face of the lug then so much the better, otherwise use a plain one. Mark off for the two slots to accept the spring bars, drilling an 11/32 in. hole through the centre of each, then change to an ⅛ in. end mill and open them out to line, completing



Photographs of cylinders on their own convey little, though there is an exception later on in this session, so Tom Goulding has taken a wider and more interesting view of No. 5231 on the Nene Valley Railway. Immediately LLAS No. 48 appeared, I had a frantic phone call from Tom telling me that No. 5025 belongs to the Strathspey Railway, which is in Allan Garraway territory; I should have known this!




I reckon the front end of a BLACK FIVE is most impressive, one which the trappings that always abound 'on Shed' cannot mar.

with a square file later on. For the idea is to fully machine the half centres at a single setting, this for accuracy, so swivel the vertical slide base through exactly 90 deg. to bring one of the side faces towards the chuck. Mill right across, then feed in by $\frac{5}{32}$ in., checking the flange of the mating bogie bracket with a micrometer so that you get an exact dimension, then mill the $\frac{5}{8}$ in. wide slot, making a note of the reading at which the final cut was taken. Use the side teeth of the end mill to arrive at the $1\frac{7}{8}$ in. dimension over the side flange, then swivel through exactly 180 deg. and repeat. Next mark out for the $\frac{5}{16}$ in. hole for the spring rod socket, centre and drill through one side, then swivel and repeat, when the two holes will be in exact alignment.

Assemble bogie half centres and brackets to the bogie frames, fitting the end stays, taking care to eliminate clearances as mentioned in the note on the drawing. Try a piece of 1 in. wide commercial bar in the buffer slot, the wheelsets in their respective horns and satisfy yourself that the alignment is correct before spotting through from the frames, drilling and tapping for 6BA screws.

The buffer makes such an awkward casting that it is best fabricated in two parts. The lower piece is a block of gunmetal, machined all over to be $2\frac{1}{2}$ in. long, 1 in. wide to suit the bogie half centres, and $\frac{23}{32}$ in. deep. Mark off for the two slots, grip in the machine vice on the vertical slide and first drill through to $\frac{11}{32}$ in. diameter. Use an $\frac{1}{8}$ in. end mill to open out into slots, then make up a slotting tool from $\frac{3}{8}$ in. square silver steel, hardening right out, chuck in the 4 jaw and engage back gear to hold the tool firmly, then wind the carriage along to complete the slots to drawing.

Make the top flange initially 2 in. x $1\frac{1}{2}$ in. x $\frac{3}{16}$ in. thick from a lump of gunmetal, a front cylinder cover casting is ideal for this, then attach to the block with a couple of 8BA countersunk brass screws to silver solder the parts together. Chuck the block truly in the 4 jaw to face across the top flange to $\frac{5}{32}$ in. thickness, then centre and drill through to $\frac{1}{2}$ in. diameter, producing a bell mouth at the entrance to the hole. Next grip by the block in the machine vice, first to clean away any excess spelter, then to reduce the flange to the $1\frac{7}{8}$ in. x $1\frac{3}{8}$ in. overall dimensions. To complete, set the vertical slide over 30 deg. and mill on the chamfers as shown.

The keep plates are from 12mm x 4mm brass strip, so grip these in turn in the machine vice at the same 30 deg. setting as used to complete the buffer, then saw and square off to $1\frac{1}{2}$ in. lengths, mark off and drill the four No. 34 holes. Offer up to the bogies centres, using either feeler gauges or shimstock to arrive at the .005 in. clearance, then spot through, drill and tap 6BA for hexagon headed screws.

**Spring Rod, Socket, Washer and Bar**

For the spring rod sockets, chuck a length of $\frac{3}{8}$ in. steel rod in the 3 jaw, face and turn down to $\frac{5}{16}$ in. diameter over an $\frac{11}{32}$ in. length. Leave the outer $\frac{5}{32}$ in. at the $\frac{5}{16}$ in. dimension, then with a round nosed tool, reduce the next $\frac{3}{16}$ in. to $\frac{1}{4}$ in. diameter as shown; part off at a full $\frac{15}{32}$ in. overall. Reverse in the chuck, face off to length, then centre, drill and 'D' bit $\frac{5}{32}$ in. diameter to $\frac{1}{8}$ in. depth.

The spring rod starts as a 2 in. squared length from $\frac{5}{16}$ in. steel rod, so chuck in the 3 jaw with 1 in. projecting and with a round nosed tool, turn down to $\frac{5}{32}$ in. diameter, a snug fit in the socket, starting to form the bulbous portion at the centre, this to hold the side control spring in alignment; reverse and repeat.

The spring washers are plain turning from $\frac{1}{2}$ in. steel rod, the only point to watch being that they be a nice sliding fit on the spring rods, with no binding. That brings us on to the spring bars, which in metric terms are 10mm x 4mm section, though most of us are going to have to mill them to the imperial equivalent of $\frac{3}{8}$ in. x $\frac{5}{32}$ in. Mark off and drill No. 22 holes to start forming the end slots, opening out carefully with a key cutting file to the spring rods as your gauge.

I have specified the side control springs as being from 16 s.w.g. wire, which 16 years on seems a little on the light side to me, though no builder has ever complained that the front end of his BLACK FIVE noses into a curve, neither has one given me the slightest cause for concern when I have been given the opportunity to sample one. Even with a 16 s.w.g. spring each side, it is going to be a battle to erect the bogie!

Fit the spring rod sockets to the bogie centres and bring them together over the buffer. Slide in the spring bars, thread the side control springs and their washer over the spring rods, compress and insert between the spring bars. Push the spring rod sockets through the half centres to engage the spring rod ends, then take the whole up to the bogie frames and bolt in place, this time brushing a drop of Nutlok or similar onto the threads as our assembly is semi-permanent.

**Equaliser Springs**

Our leaf springs are a mixture of $\frac{3}{8}$ in. wide x $\frac{1}{32}$ in. thick spring steel and Tufnol and again no builder has yet fed back information as to whether I have got the mixture right. However, as the first BLACK FIVE's built to these drawings have been running for more than 13 years now, I am guessing my specification is not too far out. For the top leaves, cut two $3\frac{7}{8}$ in. lengths from the spring steel and at $\frac{5}{32}$ in. in from each end, centre pop, file off the pip until a wee hole appears and gradually open this out to No. 27. Make the bottom leaf 1 in. long from the same material, then fill in with evenly graduated lengths of Tufnol, holding them securely in place in the spring buckle with a 5BA cup pointed socket grub screw, or of course its metric equivalent. Erect them using 4BA x $1\frac{1}{4}$ in. long steel bolts and that leaves only the guard irons to complete a rolling bogie. I have not detailed said guard irons as such things are best made to place, but a glance back to the G.A. in LLAS No. 44 shows what they look from the front view. First cut one out on a piece of card or plastic to arrive at the shape, then lay on the sheet of 2.5mm steel, mark off, saw out, complete the profile and bend up to place, securing to the bogie frames with three 3/32 in. snap head iron rivets.

**Bogie Bolster, Pivot and Socket**

The bogie bolster is quite an involved fabrication, one that adds massive strength at a critical point in the chassis, thus is well worth the time spent in emulating properly. For the base, saw a 5⅜ in. length from 2⅜ in. x ⅛ in. or 3mm steel flat, scribe on the centre line and grip in the machine vice on the vertical slide. Right at the centre, drill and ream through to ½ in. diameter, then move out 2 in. each side of same, to drill and ream ⅜ in. diameter for the balls which we have already made. With a little care, it is possible to produce the ⅝ in. end radius over a mandrel with an end mill, otherwise fit the balls and use these as your filing aid, completing the base to drawing.

The end flanges are 2⅜ in. lengths from 1 in. x ⅛ in. BMS flat, the main cross members 3 29/32 in. lengths from the same material. Grip the latter as a pair in the machine vice on the vertical slide to reduce to ¾ in. width over the central portion, with a nice sweeping radius at the ends. The next requirement is two ⅝ in. lengths from ¾ in. x ⅛ in. BMS flat, when these piece parts can be erected onto the base, using a few 8BA brass screws to hold in place for brazing. Ahead of this though, cut the four webs, again from ¾ in. x ⅛ in. BMS flat, then braze up, allow to cool, pickle for a few minutes if you like to remove any remaining flux, then wash thoroughly, dry and apply a coating of zinc from an aerosol can. With any luck at all, the base will still be nice and flat, though it is worth chucking in the 4 jaw just to take the lightest skim right across. Bolt to an angle plate attached to the vertical slide and mill the side flanges to 4⅛ in. overall, arriving at the dimension with vernier calipers so that it can be repeated for the remaining frame stays, this being vitally important.

Because the pivot has to accept heavy side loading as your BLACK FIVE enters a curve at speed, the ideal is to turn it up from a lump of 2¼ in. diameter steel bar. The alternative is to make the upper portion from a gunmetal casting, the piston blank for E. S. COX being suitable for this, and braze it to a length of ½ in. steel rod; in either case turn to the drawing dimensions. Cut webs from ⅛ in. or 3mm steel, which if made a push fit will hold themselves in place whilst you braze up, then true the large upper flange and use a knife edged tool to scribe on the bolting circle at 1 15/16 in. diameter. Mark off and drill the eight holes at No. 34, offer up to the bolster, spot through, drill and tap 6BA for hexagon headed bolts, the same applying to the ball fixings.

That leaves just the socket, and if you are able to obtain PTFE or nylon rod for same, so much the better, as it will reduce wear on the bogie brackets. Chuck in the 3 jaw, face and produce the indentation to suit the ball, which really requires a form tool, then turn the 5 deg. taper on the outside before parting off a ¼ in. slice; repeat. Now for the next major assembly, the cylinders.

## THE CYLINDERS

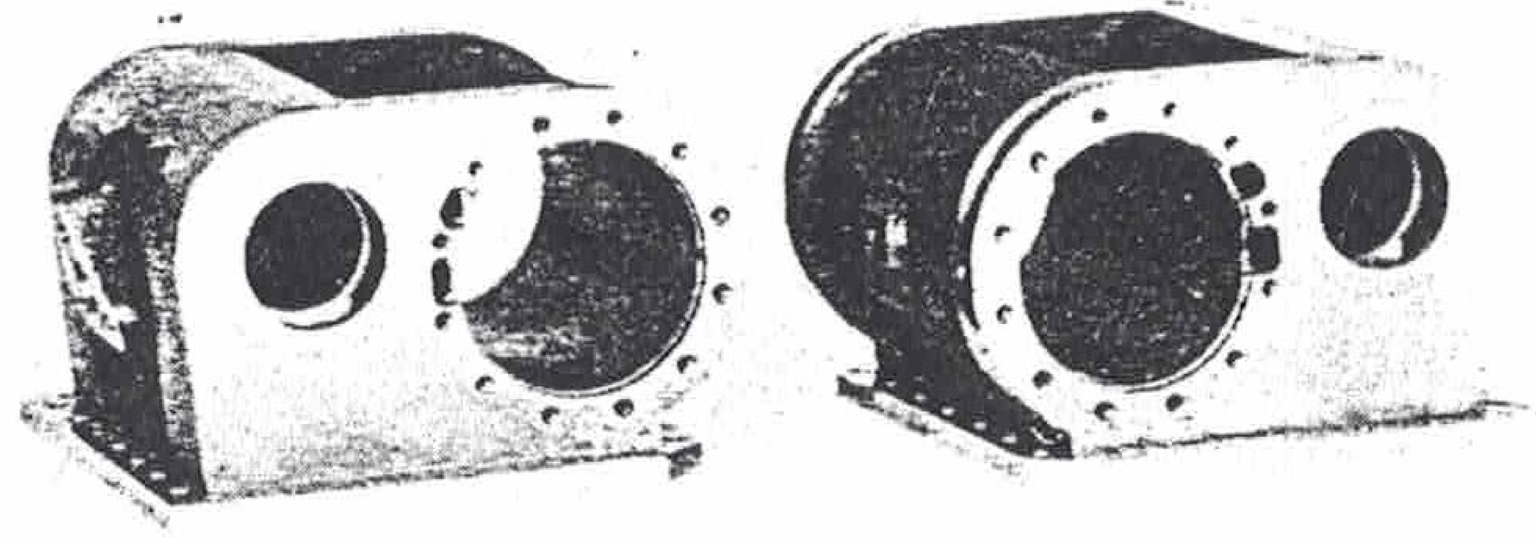
The BLACK FIVE cylinders represent Phase 2 of my development of piston valves which started with the BR Class 2 No. 78000, then went further with the advent of E. S. COX and thus far reached its ultimate for DONCASTER, all four of which have now been featured in LLAS, so you have the full story! The main advance over the Class 2 is the casting in of the steam belts for the valve liners in the steamchest bore and also the exhaust exits from said liners, which will make life that much easier when we come to start machining in a moment. The ⅞ in. diameter piston valves mean that eight 3/16 in. square ports can be adopted and still leave plenty of land, giving an equivalent slide valve port of 1½ in. x 3/16 in., which is very generous indeed for a 1⅝ in. diameter cylinder, ensuring a good performance.

**Cylinder Block and Flange**

Blocks can be supplied either cast in iron or gunmetal to builder's choice, and if your BLACK FIVE is going to earn its keep in revenue earning service, then iron is to be preferred; for occasional running choose gunmetal. First assess the machining allowances and take special care with those 'cast in' features, for I have yet to invent a 'putting on' tool! Rub a file over the outside face of the casting to get it nice and flat, then drive a wooden bung into both the main and steamchest cored holes to mark out; lay on the surface plate and scribe around for the bolting face. Chuck in the 4 jaw, take a facing cut, check against your scribed lines and adjust if required, then machine down to line. Next rub a file over what is going to be the rear face of the block, find the centre of the main bore and scribe a circle at 1⅝ in. diameter. Cut a piece roughly 3 in. square from ⅛ or 3/16 in. steel plate, bring this up to the bolting surface just machined, then chuck the whole in the 4 jaw and set with the main bore running true, checking that the bolting face is square to the chuck body. Drill out the wooden bung, then change to a boring tool, taking a fair first cut to get under the skin of the casting. Now it is a case of trundling the tool back and forwards through the main bore until you reach both 1⅝ in. diameter and your very best surface finish; face across the end of the block and stamp it 'rear' for future identification. Move to the steamchest bore, finding its centre and scribing on the circle at 1¼ in. diameter, next setting this to run true; bore out and clean up the steam belts if there is any uncertainty of them not being 1 7/16 in. diameter and 5/16 in. long. Next, reverse in the 4 jaw chuck, to clean up the front face to 3 5/16 in. overall.

Use a strong-back to bolt the block down through its main bore to an angle plate, attaching the latter to the vertical slide table; turn the steam entry boss towards the 3 jaw chuck. Mill the facing, then centre and drill 5/16 in. diameter into the steamchest bore. Turn the exhaust cavities towards the chuck and clean them up with an ⅛ in. end mill to the 13/16 in. x 5/16 in. dimensions. Back to the centre line and in the steamchest wall and angled downwards so that the union will come inside the cylinder cleading, spotface, centre and drill No. 30 into the steamchest bore, following up with a 5/32 x 40T tap to at least 5/32 in. depth. Turn the bottom of the block towards the chuck and mill in three positions for the drain cocks, then centre, drill and 'D' bit 5/32 in. diameter to 3/16 in. depth, tapping 3/16 x 40T. At the back of the centre boss, mill the face, centre and drill No. 55 into the 3/16 x 40T tapping. Follow up at No. 30 to 3/16 in. depth and tap 5/32 x 40T. For the end drain cocks, we have to drill No. 50 from the main bore into the tappings, when we must clean up all the burrs produced in both the main and steamchest bores. We need two unions for the centre drain cock, made from 7/32 in. A/F hexagon brass bar to the dimensions shown, and do remember to drill through the steamchest liner when inserted, otherwise it won't drain! To tidy up this area, the 3/32 in. o.d. thin wall copper tube comes down around the outside of the main bore and requires a 180 deg. bend underneath to come back to the second union.

I believe these cylinders belong to Brian Apthorpe, at least they bear the hallmark of his superb workmanship.



For many years now I have specified brass for the cylinder flanges as this material is invariably nice and flat. Lately though its acquisition seems to have become more difficult, judging by the number of queries received, and of course steel is perfectly acceptable here as an alternative. Mark it off to drawing and drill all the holes, countersinking those specified, then drill and tap the ¾ x 26T exhaust connection. Chuck an odd end of 1 in. A/F hexagon bar in the 3 jaw, face and turn down to ¾ in. diameter over a ⅜ in. length and screw 26T; use this bolt to attach the cylinder flange to the mainframes to use as a drill jig. Mark back from the frames to relieve those bottom corners, sawing and filing to line, then offer up to the cylinder block. Check as many dimensions as you are able, then spot through a couple of holes, drill No. 43 into the block and tap 6BA, securing with countersunk screws. Bolt in turn to the mainframes, when you will be able to carry out further checks before removing to drill and tap the remaining 6BA holes.

### Cylinder Covers

Covers next, and for the front ones, chuck by the periphery in the 4 jaw and clean up the chucking spigot; rechuck by the latter in the 3 jaw. Turn the outside down to 2¼ in. diameter and face across then concentrate on turning the 1/16 in. spigot down to 1⅝ in. diameter, a tight fit in the bore. Scribe on the bolting circle at 1 15/16 in. diameter, then face across the back of the casting to ¼ in. overall thickness, finally parting off the chucking spigot. Mark off and drill the 12 No. 30 holes, offer up to the block in the position shown, to spot through, drill No. 40 to 3/16 in. depth and tap 5BA.

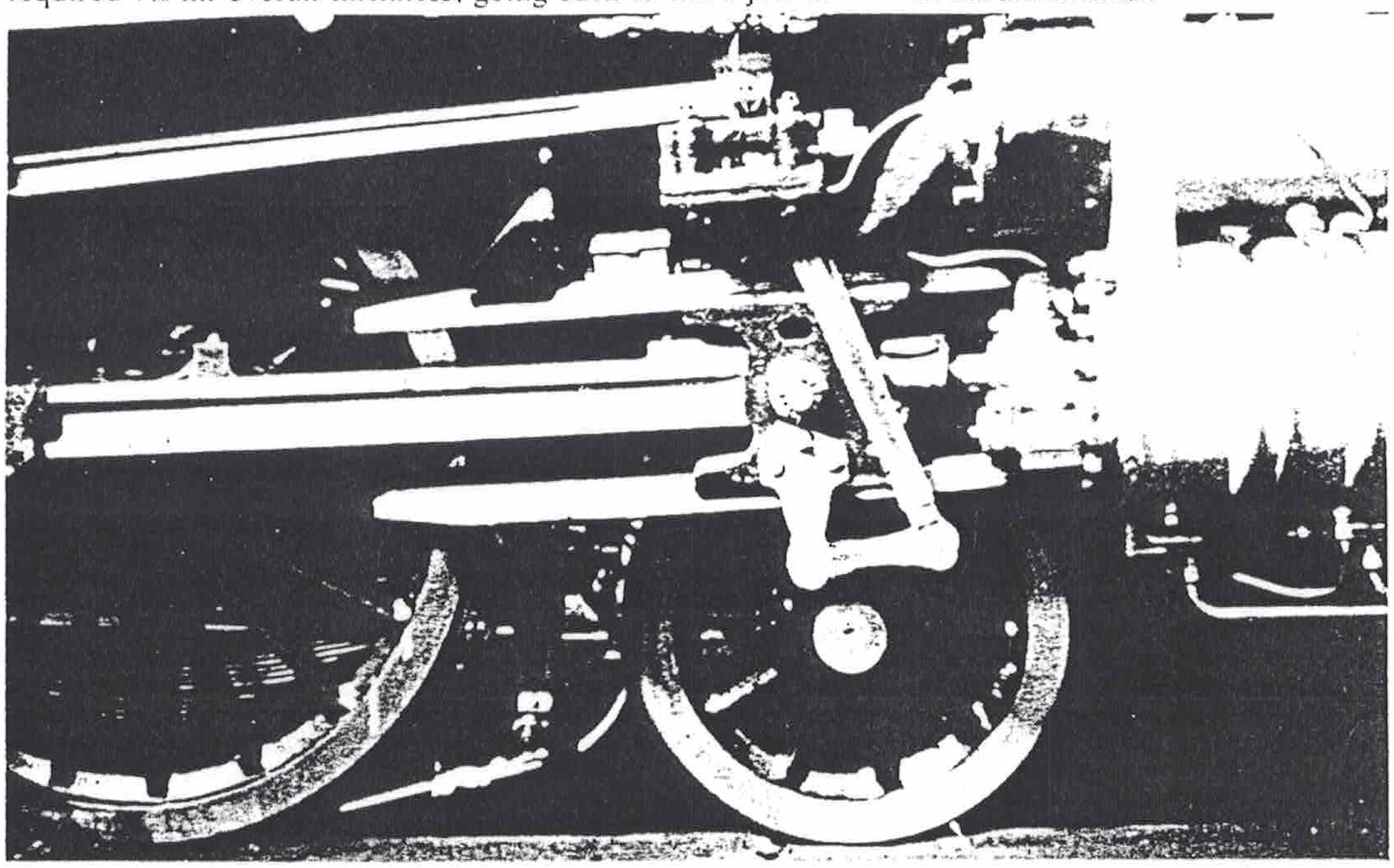
For the rear cover, chuck by the periphery and clean up the chucking spigot, then rechuck by the latter and turn down to a little over 2¼ in. diameter, facing across, then part off the chucking spigot, at the same time cleaning up the slide bar boss. Chuck again by the outside of the casting, centre and drill through at ¼ in. diameter, following up with a 7/16 in. drill and 'D' bit, one with the corners slightly rounded, to 9/64 in. depth; just take a final skim across the slide bar boss. Chuck a length of ½ in. steel rod in the 3 jaw, face and turn down to ¼ in. diameter over a ¾ in. length, a very good fit in the central bore of the cover. Further reduce to 3/16 in. diameter over a ¼ in. length and screw 2BA; fit the cover over the spigot. Turn the outside down to 2¼ in. diameter, then concentrate on getting the spigot a very good fit in the bore. Scribe on the bolting circle, then face off to the required 9/16 in. overall thickness, going back to the 3 jaw to complete the centre portion in way of the 2BA nut. Drill the fixing holes, offer up to the block, to spot through, drill and tap 5BA; secure with hexagon headed bolts. Clamp or bolt the complete assembly to an angle plate and attach same to the vertical slide, poking a length of ¼ in. silver steel rod through the rear cover. Bring an end mill up to this, rotating same until it just touches, then move back .250 in. and mill one of the side faces; repeat at the other side. For the top and bottom slide bar fixing faces the dimension to move is .500 in., which will then ensure perfect alignment.

Remove the cover and file flats at the top of the bore as the start of the steam passages, then centre pop and drill No. 11 into the steam belts. Back to the angle plate, chuck the No. 11 drill in the 3 jaw and align the block so the drill passes cleanly along one of the passages. Change to a 3/16 in. end mill and elongate the passage to the required ¼ in. x 3/16 in. section, dealing with the other three passages similarly. Don't forget to relieve the cylinder covers in way of the passages, or you will have a red face at your first steaming!

### Piston, Rod and Gland Plate

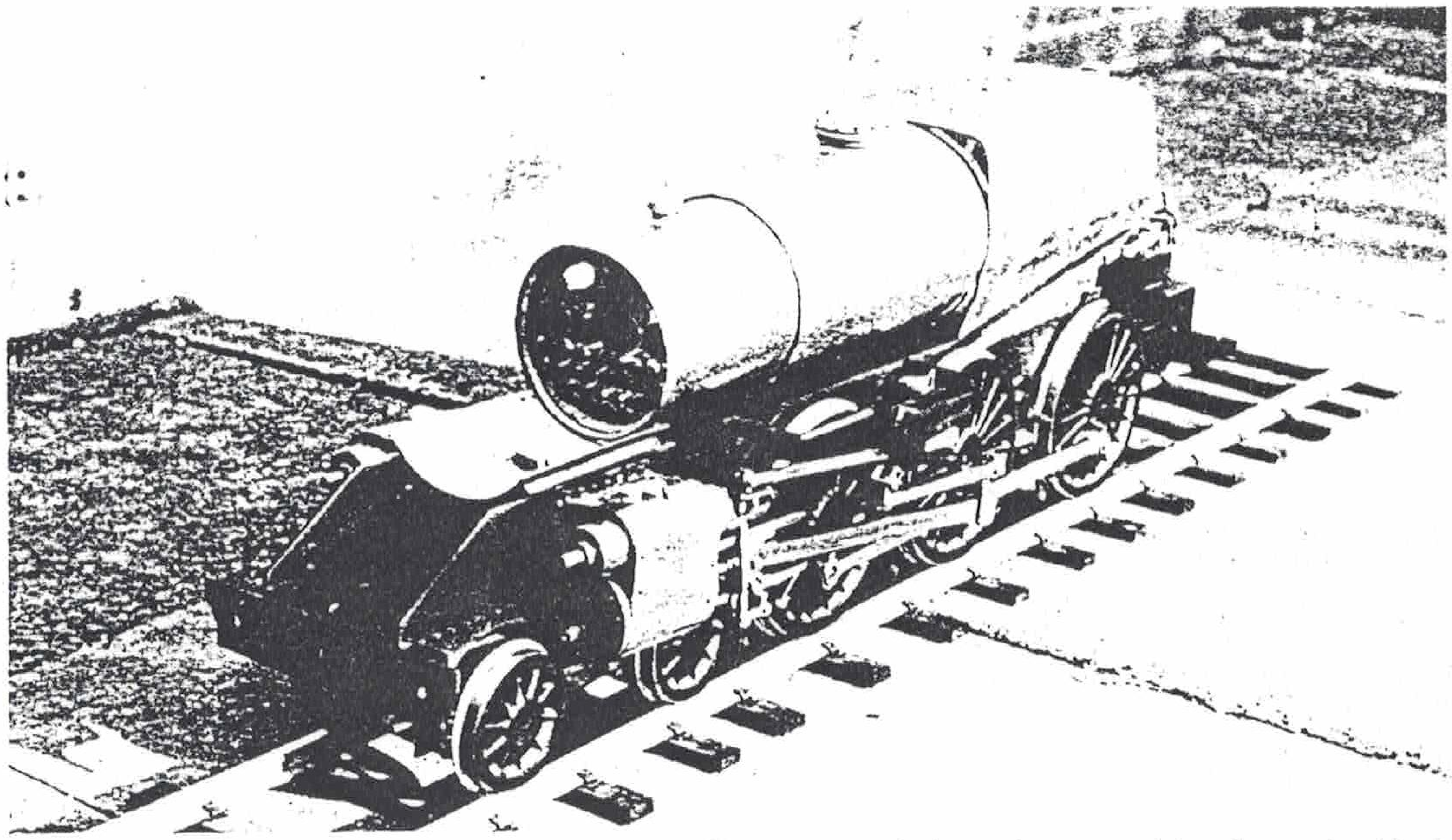
For a bit of light relief, let us deal with the pistons and their rods next. Chuck a piston by its outside in the 4 jaw and clean up the chucking spigot; rechuck by the latter in the 3 jaw. Face and turn down to about 1 21/32 in. diameter, then with a parting off tool, form the packing groove to ¼ in. width and 7/32 in. depth. Centre and drill 7/32 in. diameter to ⅝ in. depth, following up with a 6.3mm drill to ¼ in. depth; tap the rest of the hole ¼ x 40T then part off a full ½ in. slice. Chuck a length of ¼ in. stainless steel rod in the 3 jaw and check with a d.t.i. that it is running perfectly true, changing to the 4 jaw if necessary; face across and screw ¼ x 40T over a ¼ in. length with the die well opened out. Screw the embryo piston as far as you are able onto the piston rod, then face the former off to ½ in. thickness, which will pull the piston hard onto the rod; turn the outside down to 1⅝ in. diameter, a tight sliding fit in the bore.

For the gland plates, one way is to chuck a length of ¾ in. square brass bar truly in the 4 jaw. Face, centre, drill and ream ¼ in. diameter to ½ in. depth, scribe on the ¾ in. bolting circle; part off a 3/32 in. slice and repeat. Fit the piston and rod assembly, drill the gland plate No. 44 as shown, offer up to the rear cover, spot through, drill and tap 8BA. The 'O' rings want to be from PTFE or 'Viton' grade, the piston packing PTFE impregnated yarn, which brings us to the steamchest.



I was trying to show the rear steamchest cover with its valve crosshead guides in this view and only later did I realise how useful it was in showing the cylinder connections that would otherwise be hidden by the cladding. The left of the two unions is the steamchest drain going down to the drain cock in the centre of the block, whilst immediately alongside is the oil connection to the main bore.

Peter Millar in Durham sent me this picture of his BLACK FIVE, which due to his incapacity has been passed to professional builder Terry Barry for completion.



**Steamchest Liner**

Our material requirement is two 4⅛ in. lengths of 1½ in. diameter continuous cast iron or bronze bar. Chuck truly in the 4 jaw, face, centre and bring the tailstock into play, then turn down to 1⅜ in. diameter over a ¾ in. length. Rechuck by this end in the 3 jaw, holding only ⅝ in. length, then face across the other end, centre and bring the tailstock into play again. Face off to 3³¹⁄₃₂ in. overall, then turn down to about 1¹⁷⁄₆₄ in. diameter over a 3⁵⁄₁₆ in. length to match the block. Ease the last ¹⁄₁₆ in. or so to just enter the steamchest bore in the block, then withdraw the tool and bring it back to within .0075 in. of its original setting; turn the full length at this setting. Bring up the fixed steady, release the tailstock and drill right through to about ¹³⁄₁₆ in. diameter. Bore right through to within a few thous. of ⅞ in. diameter, further opening out the end ⁷⁄₁₆ in. to ¹⁵⁄₁₆ in. diameter, followed by the central steam entry belt and then the far 1³⁄₃₂ in. length to exactly the same diameter; run a ⅞ in. reamer through the bore. Use a parting off tool to reduce the outside diameter to 1⁵⁄₃₂ in. in way of the ports, getting both the ³⁄₁₆ in. dimension and the 1⅜ in. distance between them very accurate. Sit on the angle plate with a bolt down through the centre, attach to the vertical slide and drill No. 15 holes to start forming the square ports, getting them exactly opposite each other. I know of no better way to complete the ports than with a square Swiss file, poking it right through a pair of ports and concentrating on the one closest to you to get it to size, then turning through 180 deg. to deal with its partner; we are ready to insert the liners.

**Fitting the Liners**

To achieve this successfully, we need a few simple aids, starting with an 8 in. length of ⅜ in. screwed rod, any thread you like that you have a couple of mating nuts by you. Next chuck an odd end of the continuous cast bar that you used for the liners in the 4 jaw, face and turn down to 1⅜ in. diameter over a ½ in. length. Further reduce to ¹⁵⁄₁₆ in. diameter, an easy fit in the liner, over a ¼ in. length, then centre and drill ⅜ in. diameter to ½ in. depth before parting off a ⁷⁄₁₆ in. slice. For the front end we need an odd end of bar that is roughly 1⅝ in. diameter, a piston blank being ideal. Grip in the 3 or 4 jaw, face and turn down to 1¼ in. diameter, an easy fit in the steamchest bore, over an ⅛ in. length, then centre and drill ⅜ in. diameter to ½ in. depth before parting off a ⅜ in. slice. Enter the steamchest liner at the back end of the block, fit the ends and feed in the screw, tightening the nuts to draw the liner into the block. Use a ¼ in. drill followed by an ⅛ in. end mill and square file to extend the exhaust cavities from the block through the liner, remove all burrs, likewise with the steam entry hole, then run the ⅞ in. reamer through the liner bore by hand, when you will remove only a whisker of metal, most of it in way of the ports.

**Piston Valve**

Cast iron is a material totally compatible with itself, therefore both liner and piston valve material can be purchased with confidence from Reeves. With gun-metal/bronze, one must avoid the same mix where rubbing contact is involved, the easy answer to which is to buy your liner material from Reeves, that for the valves from DYD, purely as an example. Chuck a length of 1 in. diameter bar in the 4 jaw, and you need a 2½ in. length as a minimum so the bar remains undisturbed throughout the machining process. Face the outer end, centre quite lightly and bring the tailstock into play, then working from the outer end, first establish the thickness of the heads very exactly by means of a parting off tool, reducing to about ⅝ in. diameter and checking with a vernier caliper, then with a round nosed tool, complete turning the central portion down to ⁷⁄₁₆ in. diameter. Next bring both heads down to ⁵⁷⁄₆₄ in. diameter, then concentrate on the first ¹⁄₃₂ in. or so of the outer head, so that it will just enter the liner. Withdraw the tool, advance to .0005 in. of the original setting and turn both heads to your very best finish. If you have a magnifying glass by you then take a look at your best finish and you will see that it looks like a ploughed field, with ridges and valleys. Drill No. 10 to 2 in. depth and part off the completed valve.

Very rarely do I disagree with what I have set down on a drawing when I come to describe manufacture later on, but I do so most vehemently when it comes to my note on the fitting of piston valve for BLACK FIVE! For I am an advocate of plain bobbin heads both in cast iron and bronze, rings in any material including PTFE not finding favour with me, thus as soon as these notes appear in print, so will that which is contradictory on the drawing be deleted; my apologies.

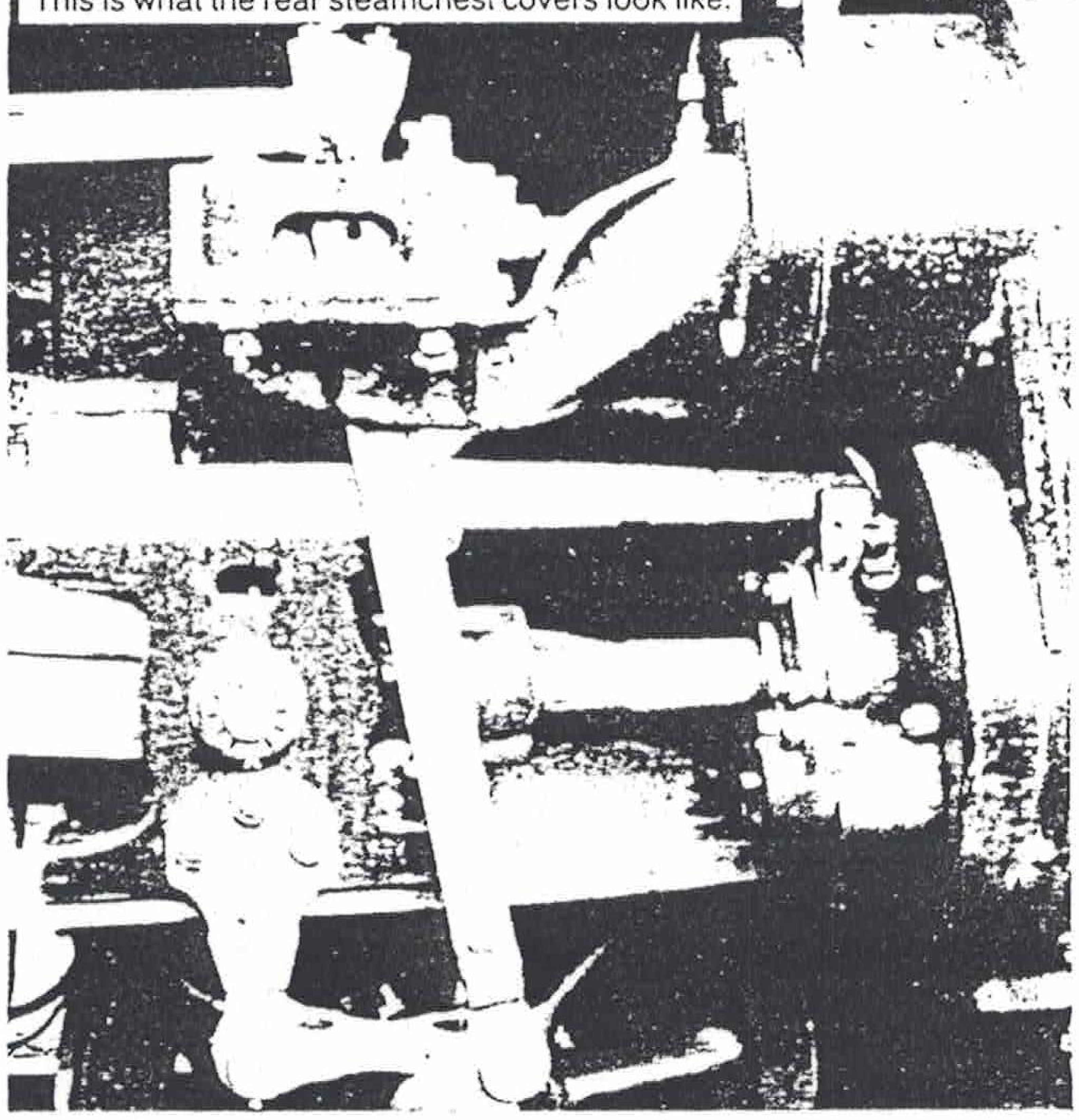
Nearly 30 years ago now, I was given a very small amount of molybdenum disulphide powder, the most wonderful 'cure-all' that never ceases to amaze me. I was on my way to Frank Lockwood's funeral when the speedometer on my Bentley began to show distinct signs of stress and whilst normally I would stop and do something about it, the occasion demanded that I press on regardless. The local garage was unable to solve the problem on their own, for who has ever heard of two drive cables failing simultaneously, but finally the problem was diagnosed as a frozen bearing in the odometer drive: it had seized solid. That speedometer had faithfully recorded 134,000 miles being the original and I was loath to fit a new one, so the wee shaft was driven out of the bearing and given a rubbing of the miracle molybdenum disulphide powder: nothing else was touched. Steve at my local garage was extremely sceptical as to my solution, but he put the head back together and 25,000 miles later it is still perfect, so he is now as convinced as I am.

If you do not have any powder by you, then it is available in 'Rocol' anti-scuffing grease and the like, so coat both heads liberally with same, enter in the liner and drive right through with wooden mallet and dowel; real brute force will be required here. Clean off the heads of any stray metal, coat again and drive through repeatedly, when the heavy fit will gradually become a push one and this will ease further in service to a tight running fit, one that with proper lubrication will last the lifetime of your BLACK FIVE and beyond. At conclusion, you will see that the liner has acquired a mirror finish, particularly in way of the ports where some distortion naturally occurs in forcing the liner through the block. Now look at the piston valve heads under a magnifying glass and you will see an amazing transformation from hills and valleys to a smooth and even surface: you in turn will be convinced!

After that high drama, it is a bit of an anti-climax for the valve spindles simply to chuck a length of 3/16 in. stainless steel rod in the 3 jaw, square off to 5¼ in. overall for the moment and screw 40T over a 2⅝ in. length. For the mating nuts, chuck a length of 5/16 in. A/F hexagon brass bar in the 3 jaw, face, centre, drill No. 22 and tap 3/16 x 40T, parting off ⅛ in. slices, lightly chamfering the outside face to look nice.

### Steamchest Covers

We are at last coming to the end of a marathon session, one that will keep any BLACK FIVE builder quiet for the next three months!, so let me hurry on to the front steamchests, which are extremely straightforward. Material requirement is the same as for the liners, so chuck truly in the 4 jaw and turn down to 15/16 in. diameter over a 19/32 in. length, with a radius at the outer end as shown. Turn the next 5/32 in. down to 5/8 in. diameter then part off at a full 1⅝ in. overall. Rechuck in the 3 jaw by the 15/16 in. spigot, face off to length and scribe on the bolting circle at 1 5/32 in. diameter, then


This is what the rear steamchest covers look like.

turn down the outside to 1⅜ in. diameter. Centre, drill and bore out to 15/16 in. diameter and 21/32 in. depth and of course this recess need not be flat bottomed as drawn as it serves no useful purpose, then mark off and drill the six No. 44 fixing holes, countersinking the outer face. Offer up to the cylinder, spot through, drill No. 50 and tap 8BA for 1 in. long screws.

If the front steamchest was easy, the rear steamchest cover is patently not so, but we shall win! The first requirement is a length of 1½ in. diameter cast bronze or gunmetal, so chuck in the 4 jaw and set to run fairly true then face and turn down to 1⅜ in. diameter over a 1 in. length. Next reduce the outer ¼ in. to 15/16 in. diameter, a nice sliding fit in the end of the steamchest liner. If your preference is for a soft packed gland then part off at a full 15/32 in. overall, rechuck by the 15/16 in., spigot, in the 3 jaw, face off to length, centre and drill through at No. 11. Follow up with a 9/32 in. drill, 'D' bit to 9/32 in. depth and tap 5/16 x 40T. For those of us who prefer 'O' rings, and for gunmetal cylinders I would now use them on the main piston, centre, drill No. 13 to 1 in. depth and ream 3/16 in. diameter. To form the groove for the 'O' ring, follow up with a 5/16 in. drill and 'D' bit, one with the corners taken off to give a wee radius, to ⅜ in. depth. Part off at a full 27/32 in. overall, rechuck by the 15/16 in. spigot, turn on the taper boss and face across the back of the cover. Next chuck a length of ⅜ in. brass rod in the 3 jaw and turn down over a ⅜ in. length to .314 in. diameter, a heavy press fit in the cover, then centre, drill and ream 3/16 in. diameter also to ⅜ in. depth; part off a 9/32 in. slice and press into the bore.

Extruded brass bar is one of the nicest materials there is to work with and yet it does not appear in any of our regular suppliers lists, though it is available, so you will just have to shop around. The section we require is 1⅛ in. x ⅜ in. and 1 foot will take care of our immediate needs. Square off each end of the bar and mark a valve crosshead guide support on each end. Our datum is going to be the guide bolting face which is ¼ in. below the centre line, so saw away metal to expose this and then mill to line. Turn the bar over to reveal the underside, then mill the flange down to ⅛ in. thickness, leaving the web at 5/32 in. thickness as shown. The guide face is of course 1¼ in. long, so immediately beyond this, use the side teeth of your end mill to remove .031 in. of metal on the inside face; deal with the outside face to arrive at the required 3/16 in. thickness over this portion. Next job is to deal with the profile, so mark it out and still attached to the parent bar, grip in the machine vice on the vertical slide, when you will be able to mill most of same, completing with files. Scribe a line across at 2 in. from the end, saw from the parent bar and mill to line.

We now have to accurately locate the guide supports on the steamchest cover, so first arrive at a 1⅛ in. squared length from 1¼ in. x ½ in. BMS bar. Find the centre by the 'X' method on one of the 1⅛ in. faces, chuck truly in the 4 jaw to centre, drill No. 13 and ream 3/16 in. diameter. Mark off and drill No. 44 in the four positions shown for the tapped holes for the guides, then fit to the cover using the valve spindle as alignment. Bring up the guide supports, clamp them to the location block in the correct position, to spot through, drill No. 50 and tap 8BA: secure with hexagon head bolts. Maybe it is not a good idea to expose the actual valve spindle to heat, so replace with a length of 3/16 in. silver steel rod, then silver solder the joints to complete, or nearly so! For our last job in this session is to mark out for the six No. 44 holes in the cover and drill through. Offer up to the steamchest liner and use an engineers square from the cylinder flange to set it nice and square, then spot through, drill No. 50 and tap 8BA for hexagon headed bolts.

Next time we shall progress the frames to a stage where the cylinders can be bolted in place, in fact it promises to be another marathon session!

# Black Five

## The fabulous Stanier Class 5MT 4-6-0 in 5 in. gauge

by: DON YOUNG

### Part 7 — Progressing the chassis

If anyone had told me 25 years ago that today I would be in the middle of a BLACK FIVE construction series, I would not have believed him! For it was exactly 30 years ago whilst recovering from tonsilitis, that I set our kitchen table in front of the fire at Dentonbury and started to draw up a 5 in. gauge BR Standard Class 5 as therapy, with the idea of building an example once FISHBOURNE had been completed. I had no problem with the chassis, for LBSC had published an article on cylinders for the big 4-6-0 in 'Model Engineer' and Wilwau produced castings for same. Towards the end of my six weeks period of convalescence, I drew up the boiler, it came together nicely on the drawing board, but when I stood back to survey it from a distance came realisation that it was way outside the scope of my five pint blowlamp; it almost led to a relapse! So that was the end of the Standard 5, though 14 years on I was able to pick up the pieces with the Stanier BLACK FIVE and this time arrive at a more authentic design, though describing her is a different matter!

Just before I continue description though, I have to apologise once again to my Scottish readers. For on Page 19 of LLAS No. 48 I ascribe No. 5025 to the Nene Valley Railway, whereas her rightful home is the Strathspey Railway, Allan Garraway's home territory. It was, however, photographer Tom Goulding who put me wise to my error, though I should have known better, for Allan has appeared on TV driving 5025 and I made remark to him then that the regulator was not in its usual position with him at the helm; up in the roof!

### Front Buffer and Drag Beams

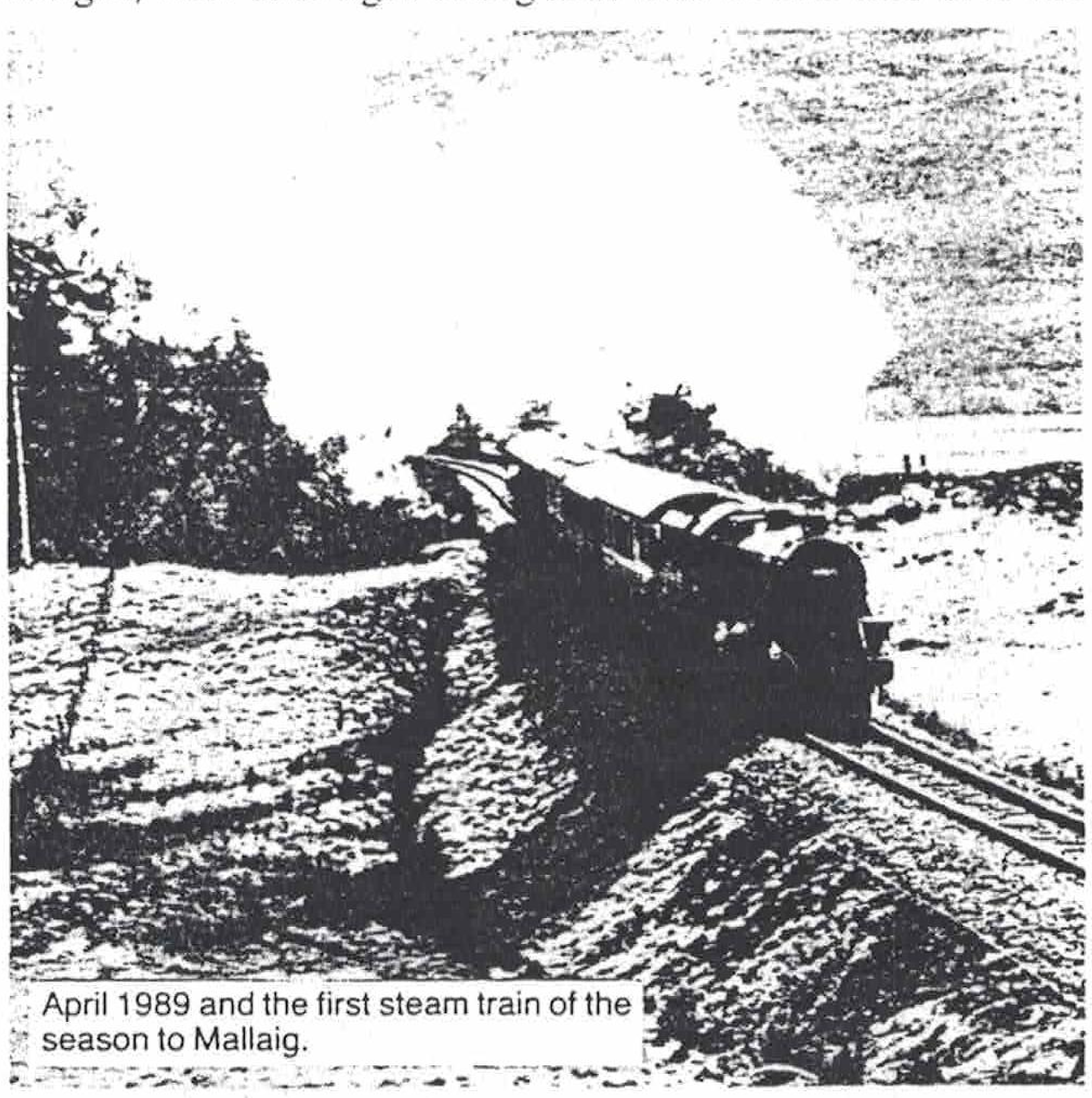
Let us ease into this session gently with the front buffer beam, so square off an 8 1/8 in. length of 1 3/4 in. x 1/8 in. BMS flat, the nearest available section, and mill down to 1 5/8 in. depth. Mark off the end scallops, saw and file these to line, then mark off and drill the specified holes, many of them will be established from the mating parts. That means we are left with the 5/16 in. holes for the buffers, a 1/4 in. square one for the front coupling hook, and four rows of four apiece for the fixing angles which are drilled 1/16 in. diameter. Although the original intention was to use 1 5/8 in. lengths from 1/4 in. x 1/4 in. x 1/16 in. brass angle for fixing, with double heading becoming more prevalent, it would be a good plan to mill the angle from 1/4 in. square steel bar and after riveting in place, either braze or weld for additional security. First though offer each piece of fixing angle up to the mainframes to drill through the five No. 44 holes, then space said mainframes 4 1/8 in. apart before spotting through the beam into the angles and drilling through.

The drag beam is even more interesting, with piece parts attached to each face, and in a definite order. Start with a 9 1/16 in. squared length from 1 1/2 in. x 1/8 in. BMS flat and first mill down to 1 3/8 in. depth; mark off and snape the bottom corners, then mark off and drill the specified holes. We already have a rubbing plate from the tender, so offer up in the centre of the drag beam, drill through the 14 No. 34 holes, then mark off and cut out the 1 1/2 in. x 1/2 in. opening for the drawbar. Next saw two 1 3/8 in. lengths from 1/4 in. angle, this and the 3/8 in. section can be from brass. Offer the 1/4 in. angle up to the top edge of the beam, to drill through at 1/16 in. diameter and rivet in place, countersinking the rear face of the beam. The 3/8 in. brass angle fits over the outside of the mainframes, the dimension over which depends if 1/8 in. or 3mm thick frame steel was employed, so first drill 3/32 in. diameter from the frames, then offer up the beam and drill through. We now need two pieces each 1 1/2 in x 1 3/8 in. from 1/8 in. thick steel sheet, with one edge chamfered 30 deg. as shown. Offer up to the beam, drill through, countersink and rivet, not forgetting the 3/8 in. angle. We must now space the mainframes 4 1/8 in. apart, starting I suggest at the front end and working back logically.

### Leading Stay and Gusset

Nothing to me is more irritating than great thick stays which bear no relationship other than in the lightening holes to the prototype. Plate stays such as those depicted on Sheet No. 6 are easy to make, amazingly robust, and totally authentic; well worth spending a little time over. The only proviso is that you use flanging quality steel, not BMS, otherwise the flanges will crack and the end result be useless.

For the leading stay we require a flanging block 4 3/8 in. x 4 in. that is 3/8 in. thick; steel is preferable here. Just lightly radius the edges around which the stay is to be flanged, then saw said stay from 1.6mm material to be oversize by about 1/16 in. all round. Clamp to the flanging block, grip in the bench vice and hammer over each flange in turn, a bit at a time, until the stay is fully formed. You can of course snape those front corners before you begin flanging, it makes the job that bit easier, though if you are at all worried about the end result, then deal with the corners later on. Remove from the flanging block and braze up those back corners, which will add a little strength, then mark off the lightening holes. Drilling 1/2 in. diameter holes in the corners to start forming these lightening holes is fraught with danger in such a thin section, unless you clamp the stay very firmly to a large block of wood, then grip with a 'Mole' wrench. Saw the metal away between the holes, then file to line. The next job is to reduce the flanges to a uniform 3/8 in. as shown, so bolt to the vertical slide through the lightening holes and tackle with an end mill. Pack the stay away from the vertical slide table, use vernier calipers to assess the dimension over flanges, then take light facing cuts with an end mill over the



April 1989 and the first steam train of the season to Mallaig.

pair of side flanges to arrive at 4⅛ in.: we are on our way! The 4½ in. dimension you will have to check to place later on, so take a light facing cut across both flanges for now and if the final dimension is slightly greater then we have allowed for, then fit a shim on final assembly and nobody will ever know.
Bend the gussets up from 1¾ in. a 1/16 in. strip, checking against the front buffer beam and mainframes to be a good fit, cut away at the inner corner, then grip in the machine vice on the vertical slide to arrive at the ⅜ in. deep flanges. To complete, saw from the parent material and arrive at the 35 deg. slope. Clamp in place, then drill the 3/32 in. fixing holes, plus of course the leading stay is also attached to the front buffer beam.

### Horizontal and Motion Plate Stays

Moving back, we next come to the horizontal stay, though as this is squeezed between the smokebox saddle and motion plate stay, we had better deal with the latter next.
The flanging block wants to be 3 15/16 in. x 3 1/16 in. from either 5/16 in. or ⅜ in. thick steel, so file a wee radius all around, mark out and saw the stay from 2.5mm thick steel, then flange over the block. Next saw two 2⅜ in. long x ⅜ in. wide strips from the same material, radius a face to match the stay, then clamp in place and braze up, dealing with the corners at the same time. This time only one radius on the whole of the lightening holes requires use of a ½ in. drill, the rest are drilled only ¼ in. diameter which is a lot easier, though you will need an 'abrafile' to saw them out before filing to line. Bolt to the vertical slide table, packing the flanges clear of same, to mill the front face of the flanges to a uniform ⅜ in. depth, then use the side teeth of the end mill to arrive at the 4⅛ in. dimension. The overall depth of stay at 3¼ in. is not critical and can be left 'as flanged', though if there are any nasty blemishes then clean them up with the side teeth of the end mill. Reverse the stay on the vertical slide table to tidy up the flanges on the back edge to give a 2 3/32 in. overall dimension.
Although each piece part as we make it should be assembled between the frames, no 'drill or tap from' holes should be tackled at this stage, for although we can check with an engineers square across the horn gaps and at other locations to check alignment, the critical phase comes when we try the axles in their respective axleboxes, when they must turn sweetly.
For the horizontal stay, we can use the same flanging block as for the leading stay, the fourth edge being reverse flanged. So mark out, deal with the first three flanges as for the leading stay, then scribe on the bending line for the fourth flange, set it flush with the top of the bench vice jaws and hammer down. This time all the lightening holes are started with a 5/16 in. drill, the rest following previous practice. Bolt to the vertical slide table, dealing with each flange in turn, then add the machine vice to mark off and drill the 15 3/32 in. holes: again erect but do not spot through the holes.
There now comes the long gap in supporting the frames over which I was so critical, right back to the weighshaft stay.

### Weighshaft Stay

This stay is again flanged up from 2.5mm steel sheet, but do take care at the top to provide clearance for the boiler with the radius as shown. If you experience any problem dealing with this top flange over a block, then cut the flange separately from ⅜ in. wide strip and braze it in place. The rear flange extensions in any case will have to be brazed in place; cut these latter 9/16 in. wide initially and trim them down after bolting to the frames, to make sure there is plenty of metal around the tapped holes. This time the lightening holes are a right mixture of different radii in the corners, though I suggest they all be drilled ¼ in. diameter in the first instance, after carefully marking out of course, and then filed to line, after which machining follows the pattern set for the motion plate stay a little earlier.

### Driving Axle Stays

These are a natty pair of stays from 2.5mm steel sheet, so first make up the flanging blocks from 5/16 in. BMS flat, mark and saw out the stays, flanging over the blocks, then braze up the corners. This time the lightening holes are plain ½ in. slots and though it is tempting to mill them out, it is far easier to drill ½ in. holes at each end, saw out the surplus and then file to line. Bolt to the vertical slide table to reduce the flanges to 11/32 in. depth, then arrive at the 4⅛ in. dimension to match the other stays, tidying up the top and bottom flanges only if there are blemishes remaining from the flanging operation. Although it is feasible to drill for and bolt this pair of stays together at this stage, I much prefer leaving such things until the horns are attached, then have a major session on the drilling machine.
I am sure that builders are looking in dismay at the growing number of 3/32 in. holes which are going to be filled later with 7BA bolts, this size no longer being popular. However, they are so much simpler to make than say 6 or 8BA bolts, as the shanks are 3/32 in. diameter, which means that commercial steel rod can be employed, each end being screwed 7BA for the bolt head and nut respectively. You then chuck a length of 8BA hexagon steel bar, face, centre, drill No. 47 and tap 7BA to about ½ in. depth, parting off 3/32 in. slices for the bolt heads and 7/64 in. ones for the nuts. After the bolt heads have been fitted, lightly peen over to prevent them unscrewing, then chuck by the shank in the 3 jaw to clean them up and provide a wee chamfer to look like the real thing. For the nuts, you can either apply said chamfer before parting off, or fit them to a screwed adaptor to deal with as for the bolt heads.

### Cab and Support Brackets

A total of six brackets are required next, bent up from 2½ in. x 1.6mm flanging quality steel strip, exactly as we dealt

BLACK FIVE's 44871 and my favourite 5407 at Fort William in September 1991. Note that both tenders are coaled in excess of the loading gauge!

with the gussets for the front buffer beam at the beginning of this session, tackling the lightening hole before sawing from the parent material. I would delay fitting them until the side running boards and cab are ready for erection, which is some way ahead yet, though we are winning!

### Cross Tie

Moving backwards, the next item we come to for holding the frames the specified 4⅛ in. apart are the pair of cross ties which attach below the trailing axle hornstays. I doubt very much if ½ in. x ⅜ in. x 1⁄16 in. section 'T' bar is commercially available, in which case it must be milled from ½ in. x ⅜ in. BMS bar: an interesting exercise.
Later on we shall require about a 15 in. length of about 1½ in. x 1½ in. x ¼ in. bright steel angle that is perfectly square on which to machine the side rods, with holes at about 3 in. pitch in one of the faces of a size to match the tee slot bolts for attaching to the vertical slide table. Cut the cross ties 6 in. long initially and either bolt or clamp the extremities to the length of angle, bolting in turn to the table; mill one side of the 'T' section, then reverse and complete before sawing and squaring off the 4⅜ in. long central section. Drill the four No. 34 holes whose position is specified and that is as far as we can go for the moment, the remaining eight holes being drilled back from the hornstays.

### Drag Box

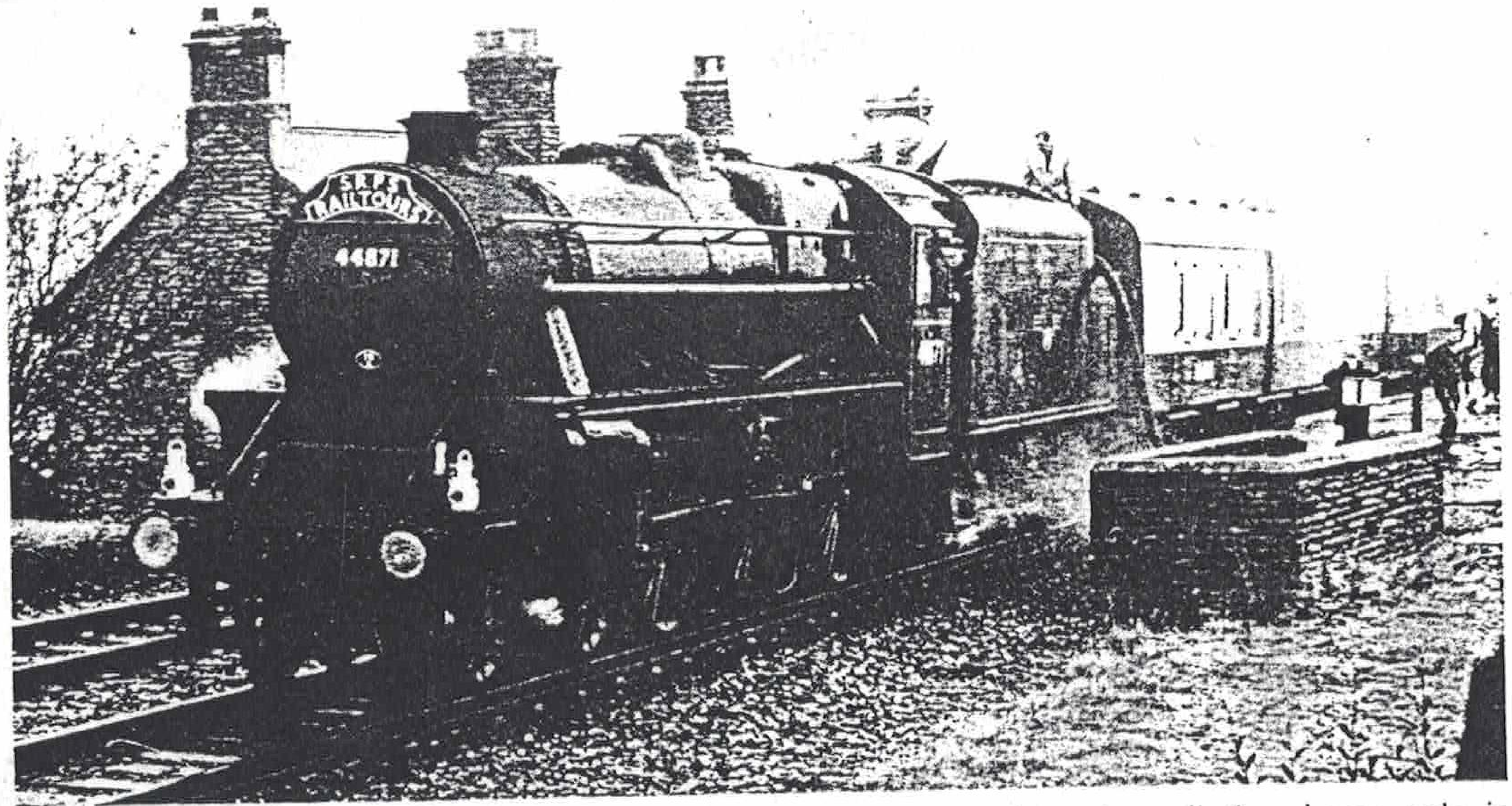
Having already tackled the box stretchers at each end of the tender frames, this one is so similar that I can quickly run through description of its manufacture, with reference back to LLAS No. 46 for any builder who is tackling the engine first.
Start with the back plate, which is a 4⁵⁄32 in. length from 1⅜ in. x ⅛ in. BMS flat, marking the central cut-out from the drag beam and completing to the 1½ in. x ½ in. dimensions. The side flanges are 3⅞ in. lengths from the same material; clamp together as a pair to deal with the three lightening holes. Top plate next, which is 3²⁹⁄32 in. x 3⅞ in. from either ⅛ in. or 3mm thick steel sheet, these being the finished sizes in all cases. The bottom plate is 3²⁹⁄32 in. x 3¹⁵⁄16 in. from the same material, being shaped at the front end to accommodate the steam brake cylinder. Again clamp together as a pair, first to deal with the ¾ in. wide lightening holes with a 5⁄16 in. end mill, then to drill plain 5⁄16 in. holes for the drawbar pin, with a ⅜ in. one ahead of this for ease of piping up the steam brake cylinder. To complete provision for the drawbar pin, chuck a length of ¾ in. diameter steel bar in the 3 jaw, face, centre and drill 5⁄16 in. diameter to 1 in. depth, parting off two 5⁄32 in. and one ¼ in. slices. For assembly, we require a 5⁄16 in. spacer, say from ½ in. steel rod and drilled centrally at 5⁄16 in. diameter. So that the spelter will not inadvertently adhere to same, give it a few minutes in the acid pickle, leave in the fresh air to rust, then assemble top and bottom plates with a 5⁄16 bolt. You can either attach the back plate and side flanges with a few 8BA round headed brass screws, or use cramps; now to complete the structure, all of which is from ⅝ in. x ⅛ in. BMS strip.
First cut two 3⁷⁄16 in. lengths, offer up to the side flanges and drill the ⅜ in. plain hole, then slide into place at the ⅞ in. centres shown. Just ahead of the drawbar pin bosses is a plain closing plate which is ⅞ in. long; square this off and push into place. That leaves only the front closing plate, a 3²⁹⁄32 in. length from the BMS strip and again simply pushed into place. Easyflo No. 2 is the best spelter here, so mix some of the appropriate flux to a stiff paste and thoroughly coat all the joints to be dealt with. Lay on the brazing hearth, bring rapidly up to a dull red, apply the spelter, allow to cool, then pickle for a few minutes only, wash off thoroughly, dry and remove any excess flux with something like a discarded toothbrush, then coat all over with zinc from an ozone friendly aerosol can. Remove the 5⁄16 in. bolt and spacer, bolt to the vertical slide table through the lightening holes, then use the side teeth of a large end mill, first to arrive at the 4⅛ in. dimension over flanges, then to square off the back plate; end of our first fabrication exercise this session, though there is more to come.

### Horns and Hornstays

The horns are cast in pairs and although we have supplied them to order in cast iron, as the price is exactly the same as in gunmetal, there is little point in deviating from the drawing specification, other than to say that I would not like to fabricate them! First assess the machining allowances and because it is such a compact item they are not as generous as you have become used to, so please take care. Just rub a file over the spigot that projects through the frames, to make sure it is nice and flat, then bring this face up to the back of the machine vice, so that you can mill the inner edge of the working face. Reverse in the machine vice, so that you can mill the spigot to arrive at the required ⅞ in. overall width of the working face, then mill the frame fixing face to leave the spigot at 7⁄32 in. thickness and ⅛ in. proud. Turn the casting over to bring the working face towards the chuck, milling right across until the spigot is exactly 5⁄16 in. thick, a micrometer dimension. If you have drilled the 3⁄32 in. rivet fixing holes already in the frames, then offer the horns up to same and assess the best position before, taking back to the machine vice and dealing with the top faces, otherwise mark the holes on the horn itself, drilling through and then milling the top edge to suit. Saw into individual horns, grip as a pair in the machine vice and mill the bottom, hornstay, face to arrive at the 1²⁵⁄32 in. dimension, stamping the pair of horns for identification. With the side teeth of the end mill, deal with the outer edge at the bottom to arrive at the ¾ in. dimension, again it wants to be a micrometer one, then mill the 7⁄64 in. recess to 7⁄64 in. depth as shown.
Clamp a pair of horns to the frames, the bottom of same coming flush with the bottom edge of the frames, then use a couple of ¼ in. x 1 in. long bolts, opening out the nuts to hold the frame spigot hard into place. Deal with one hole at a time, lightly spotfacing the horn with a pin drill and inserting the rivet from inside. Although standard practice is to hammer the rivets into countersinks in the frames and indeed it can be the method employed, to emulate the full size BLACK FIVE's you will need a rivet snap in order to finish with a domed head on the outside, which calls for careful cropping to length. If all your machining has been as accurate as it should, then with your vernier calipers you will be able to check the distance between horn cheeks at almost exactly 1¼ in. along their full length.
The hornstays start as 3 in. lengths from 1⅛ in. x 5⁄16 in. BMS flat and if you have to arrive at this section from the nearest available commercial bar, then reduce the thickness to 9⁄32 in. at this stage. Carefully mark off and start milling away 7⁄64 in. of material to expose the four spigots, checking them to place as you approach the finished sizes. Once satisfied, and these are vitally important as our horns are not of horseshoe pattern, then complete the profile; mark off and mill out the 1¼ in. x ½ in. cut-out to allow the spring gear to pass through. To complete, mark off and drill the four No. 34 holes, offer up to the horns, spot through, drill and tap for 6BA hexagon steel bolts.

### Axleboxes and Keeps

These axleboxes are really massive and played a major part in the success story of the BLACK FIVE's. Ours can either be in cast iron or gunmetal and I have no personal preference in the matter, sales also being roughly 50/50. The first thing to arrive at is the overall section of 1⁹⁄16 in. x 1⁵⁄32 in., keeping the cored portion nice and central, and I still reckon the best way of achieving this is to simply chuck in the 4 jaw and turn down to size. I must say though that having spent hours winding the cross slide with such castings




SRPS special on its way to visit the Keighley & Worth Valley Railway in October 1989, here seen taking water at Appleby on the Settle and Carlisle line.

on the ML7, it is a luxury today to be able to set the power cross feed on the 254V plus and sit back, though the old 'piecework' instinct still comes into play and I invariably crank up the speed a bit towards the end of the cut!

Mark off for the bores, to establish the top edge of each axlebox, then grip in the machine vice on the vertical slide to mill to line, dealing with the 7/8 in. square oil reservoir to 3/16 in. depth at the same setting. Next job is to mill the 7/8 in. wide slot right along each side face of the casting, so turn one face towards the chuck, first produce a 3/4 in. wide slot to 5/32 in. depth in one face and then open out gradually to 7/8 in. width, a tight fit over the horns, keeping the flanges of equal thickness. Make a note of the micrometer collar settings when the final cuts were taken, rotate the casting through 180 deg., this time milling a full width slot to 1/8 in. depth, then deepening it a little at a time until it either just pushes into the gap between the horns by about 1/8 in., or the vernier caliper reading over the slots comes within a few thous of that you measured between the horns earlier on.

The keeps are from 7/8 in. square brass bar, a lovely material to work with, so first reduce the section to 7/8 in. x 11/16 in. and then square off six 15/32 in. lengths to match the axleboxes. Before separating the casting into individual axleboxes, you might wish to drill and ream the 5/32 in. holes for the spring pins, though these can of course be left until later on.

The next operation is to mill the 7/8 in. wide slot in each axlebox to accept its keep, the latter being a light push fit therein. Pack the top of the axlebox away from the back of the machine vice, so that you can mill the full depth as a single cut and try the keep in place, then mark off and drill the keep pin holes No. 52 as per drawing, cutting 1 1/4 in. lengths from 1/16 in. mild or stainless rod to hold the keeps in place. We now have to bore the axleboxes in pairs, which calls for a simple jig. The main part of the jig is two 2 1/2 in. lengths of 2 in. x 1/4 in. BMS flat, so mark the centre line on one piece and clamp together as a pair. At 3/16 in. from each end and on the centre line, drill through at No. 24 for a 4BA bolt. Leave another 3/16 in. of metal, then drill a row of 5/16 in. holes, opening out with an end mill into a slot. Take a pair of axleboxes, holding them back-to-back so that the milled slots in same coincide, then slip one of the pieces just made over the side faces and resting on the slots, aligning properly and then holding together with 4BA bolts which want to be about 2 in. long. Take the whole assembly first to the machine vice, using end mills in sizes up to 5/8 in. diameter to remove metal at the keeps, as this will make the next step so much easier.

The next step is to transfer the whole assembly to the 4 jaw chuck and set for the bore to run true, then simply bore through until the chosen axle is a sweet running fit, the surface finish obtained your very best. Relieve the front face by 1/64 in. to drawing, then reverse in the chuck and deal with the outer face of its partner.

Separate the axleboxes and at the bottom we still have the jagged edges from sawing them apart, so first tidy them up and then mark out as shown. With care, that 3/16 in. radius can be achieved using the mandrel and end mill technique, indeed I first tried it successfully on my K1/1 approaching 30 years ago now, and the engine still sits unfinished below where I am typing this evening!; oh, that somebody else would take over the role of scribe!! Complete the bottom profile with files, then mark off and drill the three No. 60 oil holes from the reservoir, removing any burrs.

Offer each axlebox up to the selected pair of horns and begin easing in to a nice sliding fit, remembering that you will likely have to remove a little metal from the horn faces as well as the axlebox, as horns do have a tendency to 'toe in'. Once you are satisfied with the fit of each axlebox in its pair of horns comes the moment of truth, for now you can slide in the axles we turned up several session back and check that they turn sweetly, indeed making sure that they do so. Once you have reached this happy stage, and checked squareness of the frames in as many other places as possible, there follows the marathon session of drilling all those 3/32 in. diameter holes from the frames, tapping where specified, and bolting the whole together.

There follows one final job on the axleboxes, for although they will slide sweetly from top to bottom of the horns, try to lift one independent of its partner and the axle will jam solid. Just imagine your brand new engine on the track and you hit a low joint; the wheels won't drop into same and the result will be derailment; disaster! The remedy is to relieve the side flanges on each axlebox until each can be lifted by 5/32 in. independent of its partner and the axles still turn sweetly; onto the springing.

**Spring Connector and Buckle**

The upper portion of the spring connector is straightforward, so chuck a length of 5/16 in. steel rod in the 3 jaw, face, centre and drill No. 22 to 1 in. depth, parting off a 7/8 in. slice. For the lower portion, start with a length of 7/8 in. x 1/4 in. BMS bar, scribe on the centre line and at 13/64 in. from one end, drill through at No. 11. Transfer to the machine vice, first to remove 1/32 in. of metal from one face over a 3/4 in. length, then saw away metal at the end to reveal the 3/8 in. lug, one which you can now radius over a mandrel with an end mill. Back to the machine vice to complete the profile with a 5/16 in. end mill, using the side teeth of same, then relieve each side face above the No. 11 hole by 1/32 in.

as shown before sawing from the parent bar. Square off the sawn face and scallop to suit the upper portion, arriving at the ⅝ in. dimension, then clamp the two pieces together to braze up. Allow to cool, remove all excess spelter and polish, then store in oil to stop rusting.

Erecting the spring connectors to the axleboxes requires only a plain 1¼ in. length of 5/32 in. steel rod, though it is important to watch that the 1¼ in. slot in the hornstay is a continuation of that between the pair of horns, so that the pin cannot accidentally jam and cause mayhem.

The spring buckles are from 9/16 in. x 7/16 in. section steel bar, an awkward size that will have to be arrived at from the nearest commercial section. Start by drilling the No. 13 hole for the spring pin, then radius over a mandrel with an end mill. Transfer to the machine vice to deal with the 7/32 in. slot to accept the connector, then ease the outer face of the lugs exposed by 1/32 in. with the side teeth of the end mill. Mark off, centre, drill and tap the 6BA for a socket grubscrew to about 5/16 in. depth, then drill a 13/32 in. hole to start forming the pocket for the spring leaves. Open out with a small diameter end mill to 7/16 in. width to suit the spring leaves and then to 19/32 in. depth, finishing the corners with a file again to the spring leaf material as your gauge.

We know how to make up leaf springs from those on the tender and bogie and of course we already have the spring grippers and special washers by us. There is no doubt though that you will have to experiment with the Tufnol/spring steel mix to ensure that your BLACK FIVE both sits and rides properly; maybe one day a builder will be kind enough to tell us the magic formula so that I can pass it on through these pages.

### Spring Hanger and Bracket

The base of the spring hanger bracket is a length of ¾ in. x ⅛ in. BMS flat, so first clamp to the frames to drill the four 3/32 in. and single No. 22 holes, marking the base out from these holes and then profiling to drawing. Next the channel section, from BMS bar and first mill two 5 in. lengths down to 15/32 in. x 7/16 in. Still in the machine vice, mill a ¼ in. wide slot centrally the full length of each piece, sawing and squaring off 12 11/16 in. lengths. An ordinary 4BA steel washer can represent the raised boss, so clamp the channel to the base, drill the No. 22 hole, then bolt together to trap the washer and braze up. This time the finished bracket will be painted the same red as the inside of the frames, so clean them up and zinc spray for the moment, then lay aside, as it is a bit premature to rivet them to the frames.

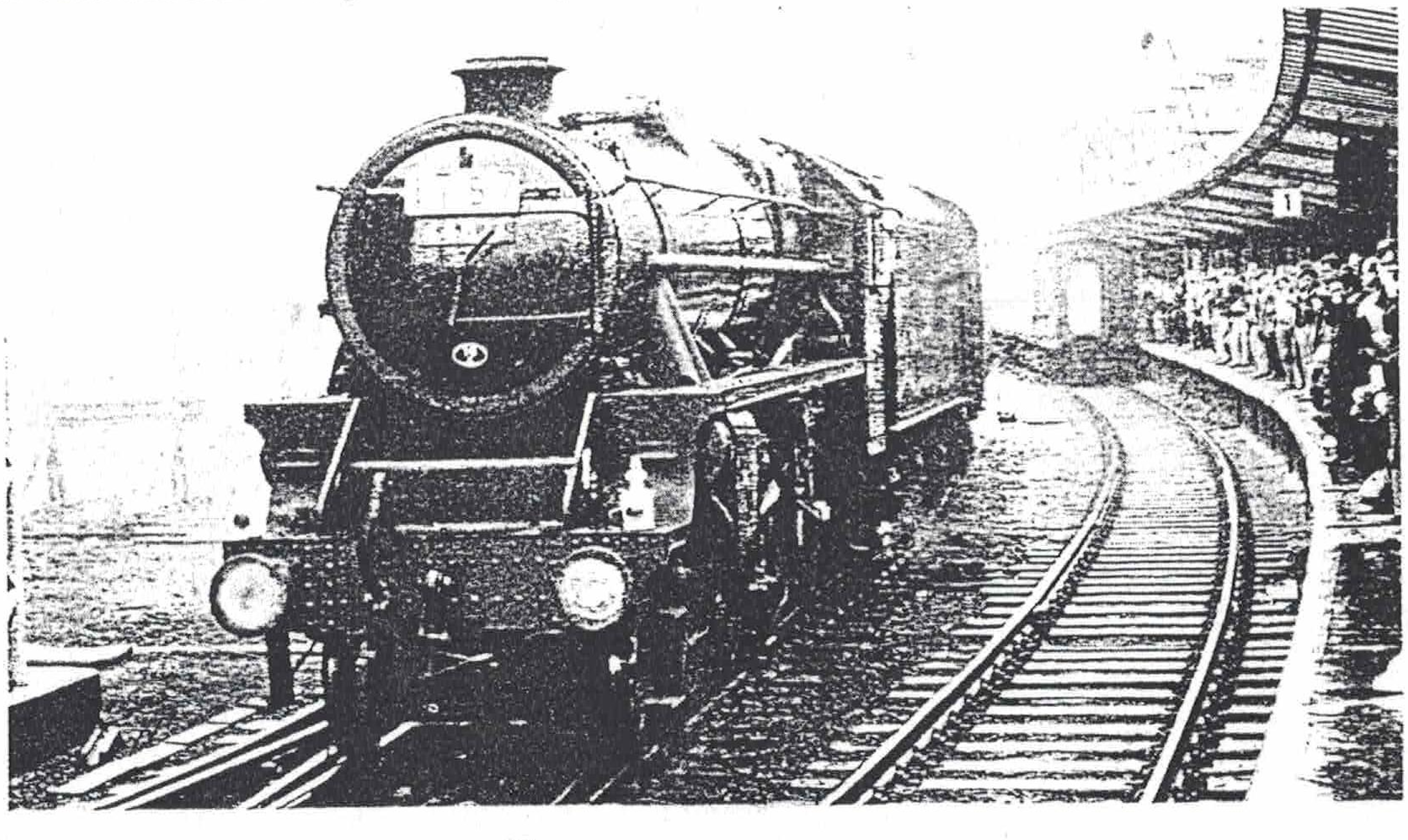
On to the spring hanger, for which first chuck a length of 5/32 in. steel rod in the 3 jaw. Face and turn down to .110 in. diameter over a 3/32 in. length, screwing 6BA, then turn the next 1⅝ in. down to .142 in. diameter, screwing the outer 1 in. at 4BA and part off at 111/16 in. overall. For the upper portion, chuck a length of ¼ in. steel rod in the 3 jaw, face, centre and drill No. 22 to ½ in. depth, parting off a ⅜ in. slice. Drill No. 28 into the bore for the pin and press it in to arrive at the 1⅝ in. dimension, then braze up and clean. The pin projects into the No. 22 hole in the upper portion, so chuck by same in the 3 jaw and use a 5/32 in. end mill to clean up the hole.

The spring buckles are attached to their connectors with plain ½ in. lengths of 3/16 in. rod, which with advantage can be silver steel, the spring hangers being hung from their brackets with headed pins as we have already made for the tender brake gear as example. Now you can bring those cross ties up to the trailing hornstays, to spot through and drill the No. 34 holes, when you can tap the additional 6BA holes in said hornstays, completing another large slice of engine.

### Slide Bars

Thankfully the BLACK FIVE slide bars do not exhibit that massive 'T' section that was such a feature on the later BR Standard classes, thus are fairly simple to machine from ½ in. x ¼ in. section chrome vanadium steel; gauge plate in other words. Obtain the correct section if at all possible as it is ground to size and has a superb surface finish; saw and square off four 5 in. lengths. Mark off for the No. 30 hole, grip in the machine vice to centre and drill this, then use an end mill to reduce the first 5/16 in. length to 5/32 in. thickness as per drawing. In the past, I had great difficulty in milling the tapered ends of slide bars, it was a real hit and miss affair, but with the Myford swivelling vertical slide it is simply a matter of setting the slide over, taking a cut and checking it out, and when the first slide bar end is complete to drawing, simply leave the setting alone and repeat for the other three slide bars; no need to worry about calculating angles.

From now until the end of this session, I am in trouble as many of the piece parts I want are detailed on Sheet No. 7, one of them being the crosshead. For although we can offer up the slide bars to the rear cylinder covers to spot through, drill and tap the latter 5BA, there is no way we can properly align the slide bars without being able to check that the crossheads slide sweetly between same, and of course we need to meet this condition ahead of positioning the motion plates which come next.



October 1989 and No. 44871 at Carlisle prior to working the special to the K&WVR; Inspector MacLennan is leaning from the cab. For the record, the reporting number attached to the front of the smokebox is the same as the 'Last Steam Train on BR' that ran on 11th August, 1968.
All the BLACK FIVE photographs used this time were taken by Graham Ellis of Mull Railway fame, hence their Northern flavour.

### Motion Plates

The motion plates are gunmetal castings supplied as a pair and for goodness sake make the first operation separating them as the joining piece will have distorted between casting and arriving on your doorstep. Next rub a file over them and assess the machining allowances. Grip in the machine vice, carefully packing up from the jaws to be clear of all the cast detail, then mill the frame fixing face. Although you can finish profiling the flange at this setting, because of the closeness of the fixing holes to the edges of the flange the wisest plan is to delay same until you have checked the position when erected over the slide bars, so just clean them up for now. Next grip this flange in the machine vice to deal with the slide bar faces, using the side teeth of a large diameter end mill, then mark off and drill the No. 30 holes for slide bar fixing. Back to the previous setting, in fact it would be best not to disturb same, to tilt the vertical slide table by two deg. to mill the girder face, and as the motion plate is angled at two deg. to the vertical when bolted to the frames, deal with the upper face at this setting, then it will match the side running boards.

Mark off and drill the four No. 44 holes for the girder fixings, then offer the motion plate up over the ends of the slide bars, locating axially from the dimensions shown on the frame fixing flange; clamp in place. Spot through the No. 30 holes, drill the slide bars No. 40 and tap 5BA, then drill back from the frames through the motion plate at No. 34 in the twelve positions.

### Weighshaft Stay, Bearing and Cap

On E. S. COX, this stay is a gunmetal casting, though it serves a different purpose and is not connected to the motion plate as on the BLACK FIVE, thus a fabrication in this instance is far more precise, being relatively easy to arrive at, so now I have to prove said statement!

For the base of the stays, square off two 2 7/16 in. lengths from 1 3/4 in. x 1/8 in. BMS flat. Mark on the profile, including the lightening hole, clamp together as a pair, then saw and file or mill to line. Three pads have to be added to the front face of the stays, which immediately hand them, two for the weighshaft bearings and the other for the expansion link bracket. The latter is a 1 1/4 in. length from 5/8 in. x 1/8 in. BMS flat, each corner being lightly radiussed, secured to the base with a couple of 1/16 in. countersunk iron rivets to be well clear of the six No. 44 holes to be drilled later after brazing up. The seatings for the weighshaft bearings are 13/16 in. and 5/8 in. lengths respectively from 1/4 in. x 1/8 in. BMS flat, each secured for brazing by a single 1/16 in. rivet in the positions as shown. Next comes the frame fixing flange, a squared 1 19/32 in. length from 1 in. x 1/8 in. BMS flat. Profile the rear edge to drawing and this time make no allowance for drilling the fixing holes as their location has to be very accurate, then attach to the base with a couple of 8BA brass round head screws to hold the pieces together for brazing. Top flange next to accept the running board, this being a 2 1/16 in. length of 7/16 in. x 1/8 in. BMS flat, again attached with a couple of 8BA round head brass screws, location being 3/16 in. back from the front edge of the frame fixing flange as shown. To add the finishing touch, we need a length of 7/32 in. wide x 1.6mm thick steel strip to fit around the outer profile of the stay, being both cut away in way of the expansion link bracket facing and with the corners rounded to resemble a casting. It may be possible to clamp this strip in place for brazing, but if not then use another couple of 8BA screws to teach it manners. Braze up using Easyflo No. 2 as your spelter, clean thoroughly and then zinc spray.

Very little machining is required, so first grip by the base in the machine vice and mill 1/64 in. of metal from the frame fixing flange, which should then bring all the dimensions to drawing. I see in my hurry that I have forgotten to mention the wee 1.6mm web between the base and frame fixing flange at the back, and of course brazing in this web could well distort the flange from being exactly square with the base, in which case give the fabrication a tweak in the bench vice to square it up ahead of milling the flange. Check also that the frame fixing flange is exactly square with the top one for attaching the side running boards, taking a light facing cut if there is any error, when you can mark off all the holes accurately from the two datum, drilling all ten at No. 44 as per drawing. Clamp the stays to the frames, locating them from the dimensions given, to drill through the nine 3/32 in. holes from the frames.

Weighshaft bearings and caps next, for which we require two lengths of 3/8 in. x 1/4 in. BMS bar. Square off one end of each piece and clamp together in perfect alignment, to mark a pair of holes at 11/16 in. centres, giving 3/32 in. of metal at the outer end. Drill right through at No. 50, separate and tap one piece at 8BA, then open its partner out to No. 44 and bolt together. Next find the centre of the bearing, grip in the 4 jaw to bore out to 13/32 in. diameter against a length of silver steel as your gauge, getting it a really good fit. Use the end mill and mandrel technique to remove as much metal as possible in forming the 9/32 in. outer radius, then saw into individual half bearings, mill the end lugs to be 1/8 in. thick and complete the profile with files; the 1/64 in. relief to trap the weighshaft bearing shells should be left until final assemble on the engine.

Bolting flanges next, which are 13/16 in. and 5/8 in. lengths respectively from 1/4 in. x 1/8 in. BMS flat and will have roughly 1/32 in. of metal removed by milling to arrive at the dimensions shown on the drawing, so make allowance for this when cutting out the ribs from 1.6mm strip to place; braze up. Mill the bolting faces on the pair of inner bearings and erect using that length of 13/32 in. silver steel rod, checking as fully as you are able with engineers square across the frames, then spotting through, drilling and tapping the bearings 8BA. Now it is a question of milling the flanges on the pair of outer bearings until they slide into place, and if you make a mistake on any of these flanges then shims will provide the necessary correction.

### Expansion Link Brackets

This is the part that I know many BLACK FIVE builders have been waiting for me to come to, thinking I will have my work cut out! I know that some of you favour castings for this and the motion plate girders which come next, but the extremely thin metal sections rule this out, plus in any case castings would distort badly when machined, whereas fabrications are so much more stable.

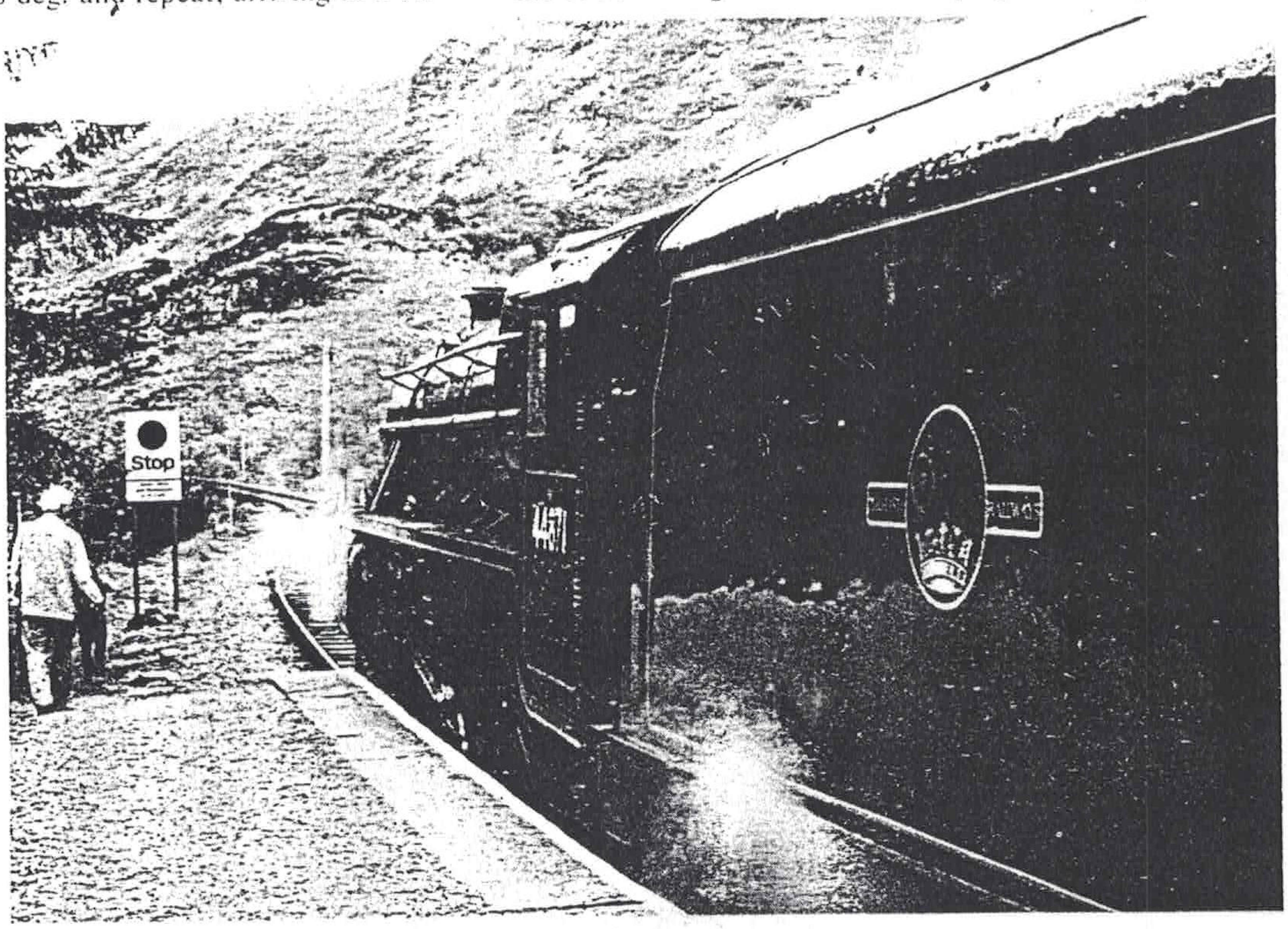
Starting point for each bracket is two 4 1/8 in. identical lengths from 2 in x 1/4 in. BMS flat, which should accommodate the required 3/32 in. set without cracking. Mark out both pieces individually, as they differ above the trunnion bearing, then clamp together as a pair to drill a 3/8 in. hole at the trunnion bearing centre, then mill out the three 1/4 in. wide lightening holes. From now on, each plate has to be treated individually, so first remove 1/16 in. of metal right across the inner faces of each to leave the stiffening rib only along the top edge. Now bring the outside of the plates in turn towards the chuck and remove 1/8 in. of metal to reveal the inner profile, then deal with the outer profile similarly, when you should be able to remove about 3/16 in. of metal before you start running into trouble; saw away the remaining surplus metal and then file flush with the machined surfaces. Mark off the bend lines on each plate, remembering to allow 3/32 in. for the rear end flange that attaches to the weighshaft stay, grip in the bench vice and bend as close as you are able to drawing. Next job is to chuck a length of 7/8 in. diameter steel bar in the 3 jaw; face, centre and drill 3/8 in. diameter to 1 1/2 in. depth, parting off two 1/16 in. and one 7/8 in. slices, and these dimensions do want to be accurate. The thin slices are of course the trunnion bearings facings and the 7/8 in. one to accurately locate the two plates that distance apart; secure the whole lot with a 3/8 in. bolt and then check alignment of the pair. Make the end flanges 1/8 in. thick initially to allow for some machining, so cut and square off 1 1/4 in. lengths from 1 in. x 5/8 in. wide BMS flat respectively and clamp into position. There is a 1/16 in. thick stiffening plate located 1 21/32 in. ahead of the rear, machined flange, which leaves just the three fancy pieces to complete the top of the structure, all of which are made to place, plus the one web at the centre of the front flange at the top. Braze up, not forgetting the trunnion bearing facings, clean thoroughly and zinc spray, then remove the 3/8 in. bolt and check for any distortion, gently squeezing in the bench vice to remove same if it does occur. Everything radiates from the trunnion bearing holes, so insert a length of 3/8 in. rod into same, then chuck in the 4 jaw and set with a d.t.i. for the rod to run true. You can now either bore out to 7/16 in. diameter to a short length of silver steel rod as your gauge, or bore out to within a few thous. of finished size and complete with a 7/16 in. reamer. The next operation requires the 7/16 in. silver steel rod anyhow, chucking same in the 3 jaw and assembling the expansion link bracket over same, then bring the machine vice up to same and grip firmly, when the reamed holes will be in alignment with the end flanges we are just about to machine to size. With the side teeth of a large diameter end mill, tackle each in turn, using the vernier calipers first to arrive at the 1 15/16 in. dimension to the front flange and then the 4 5/16 in. one overall. The 3/8 in. deep cut-out in the front flange to clear the radius rod is central and 9/32 in. wide, so may be safely tackled at this stage, though I should simply clamp the brackets to the weighshaft stay at this point, rather than tap the mating holes.

**Motion Plate Girder**

And so we come to the last piece part this session, with the promise that things get easier from now on! Start by arriving at two 3 7/8 in. square lengths of 19/32 in. x 13/32 in. section BMS bar, which means milling from the nearest available commercial section. Grip in the machine vice, on the vertical slide, to mill a 15/32 in. slot centrally in one face to 11/64 in. depth, making a note of the micrometer collar readings when the final cuts were taken, so that you can rotate the bar through 180 deg. and repeat, arriving at a 1/16

The ROYAL SCOTSMAN steam special at Glenfinnan in April 1989.

in. thick central web. This latter has now to be punctured with a series of four 1/4 in. wide lightening holes, so still at the same setting, mark off and drill 1/4 in. holes at the extremities of same, then open out into slots with a 7/32 in. end mill. Make the end flanges from 1/8 in. thick BMS flat, clamping in place, followed by the four 1/16 in. thick webs at the rear end, and this time there is no handing to worry about. Just an extra couple of webs roughly half way along the length of the girder, made to a push fit which will retain them for brazing; do just that, then clean and zinc spray. Back to the machine vice to deal with the rear flange to match that on the expansion link bracket, including the cut-out to clear the radius rod, then it is simply a matter of removing metal at the front flange until it fits snugly between said bracket and the motion plate. Again I would leave the fastenings until you are able to erect the expansion link and check that it is exactly vertical, when the whole lot can be bolted together to form a very rigid assembly.




This shot of No. 44871 at Glenfinnan symbolises the readiness of a BLACK FIVE to tackle anything that lies ahead, both the grade and mountain scenery being spectacular.

# Black Five

## The fabulous Stanier Class 5MT 4-6-0 in 5 in. gauge

by: DON YOUNG

**Part 8 — Rods and Motion**

So many 'missing items' are contained on Sheet No. 7 that by the end of this session, and it will be quite a short one, what has been a heap of bits lying about the bench will be transformed into an almost completed chassis, so let me hurry on.

**Coupling Rods**

Where to start is the problem and as the first priority is to wheel the engine, let me get the coupling rods out of the way ahead of this. That decision made, it immediately puts the ball into the builder's court as to whether to fit plain rods as detailed, or fluted ones as per Sheet No. 1; I would recommend the former.

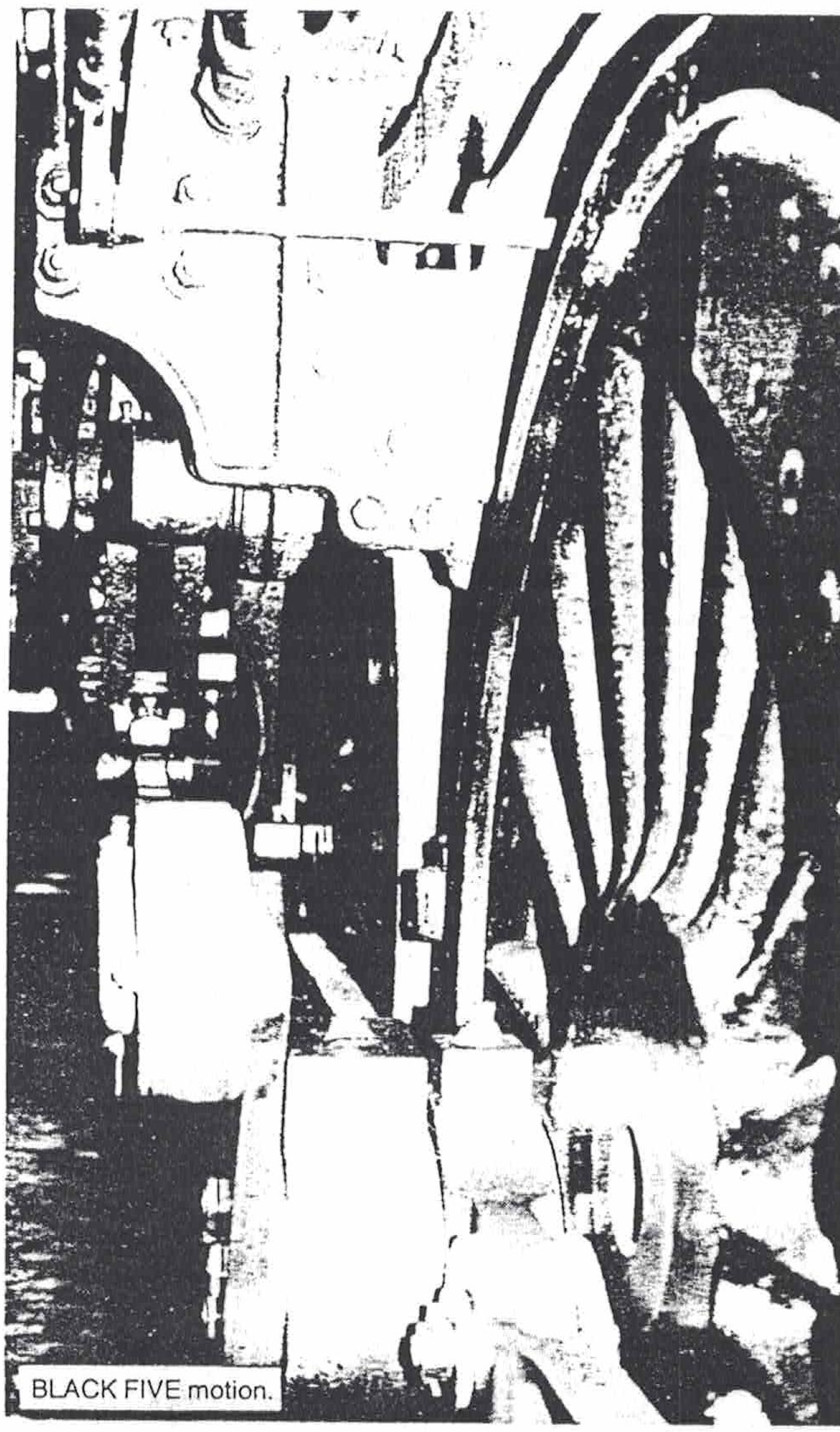
For the front section, the requirement is two 10 in. lengths from 1¼ in. x 3/8 in. BMS. Coat with marking off fluid and scribe a line right along a full ½ in. up from the bottom edge, followed by vertical lines at 7 7/16 in. centres. Pack the axleboxes hard down onto their hornstays and clamp a coupling rod blank to the outer face of them, using the scribed lines as 'cross hairs' for alignment, though before we go any further we require some drill bushes. Chuck a length of 1 in. diameter bar in the 3 jaw, face and turn down to a good fit in the axlebox bore over a 1 1/8 in. length. Centre and drill ¾ in. diameter to 1 3/8 in. depth, then part off at 1¼ in. overall to give the first, stepped, bush. The second is identical, save the bore is at 9/16 in. diameter, that for the rear section being drilled ½ in. diameter; insert a bush in each axlebox on one side of the engine. The frames really want to be separated to make life easier, then you drill through from the front pair of bushes into the rod, when of course rod and axle centres coincide and your BLACK FIVE will run run sweetly with no binding of said rods.

From the drilled holes, coat the rod again with marking off fluid and carefully mark it out to drawing, drilling the third hole to 5/16 in. diameter for the knuckle pin. We already have our length of steel angle, to which we now bolt the embryo rod, taking it up to the vertical slide table. As the base line is along the back of the rod, deal with the front face first, using the side teeth of an end mill that wants to be at least ½ in. diameter. The extra length of bar is so that when you come to one of the bolts holding the rod to the angle, use a clamp over the excess length and remove the bolt to mill its face. When complete, and the faces at the knuckle will have to be milled later, turn the rod over, supporting with pieces of packing so that you can mill the back face between the two bosses to arrive at the specified 11/64 in. thickness. Next mark the profile on the rod and saw away as much surplus metal as you are able. The plain rods have a pleasing fish-bellied shape, though it will require careful setting up on the steel angle to mill the shape to line, after which radius as much of the bosses as you are able over a mandrel with a end mill, before completing this part of the rod with files and polishing with emery cloth. That leaves the knuckle end, for which grip in the machine vice on the vertical slide and deal with each side in turn to arrive at the 11/64 in. thick tongue. Again radius as far as you are able over a mandrel with an end mill, completing to drawing with files and drilling the oil holes.

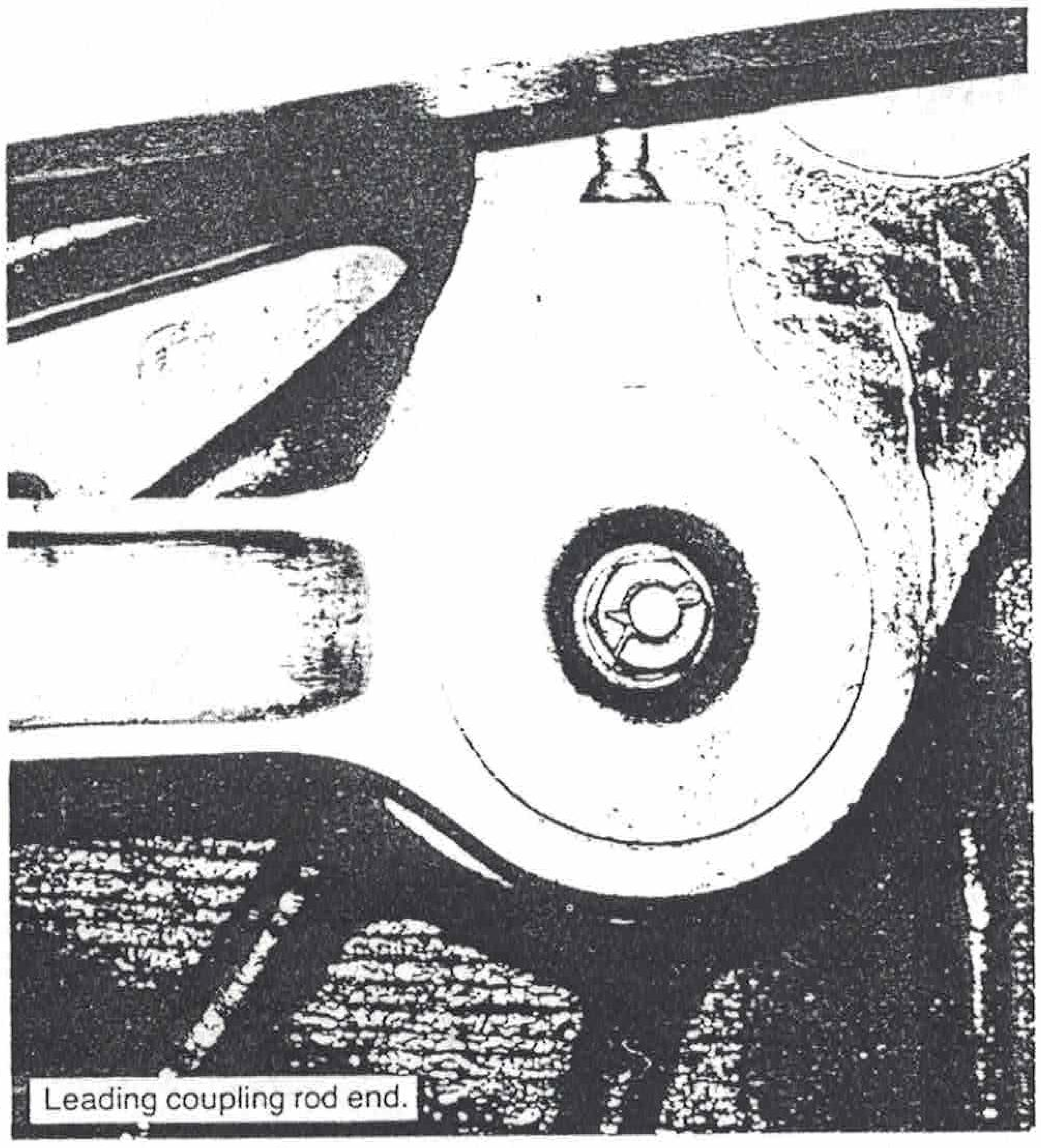
Before we move on to the rear coupling rod, we require the knuckle pin bush, so this would be a good point at which to take a break in the proceedings to deal with all of the bushes as listed in the table, and also the oil plugs alongside. Press all three bushes into the leading coupling rods, drill the No. 60 oil hole and then press in the oil plugs.

The rear coupling rods start as 8½ in. lengths from 1 in. x ½ in. BMS bar, thus a fair amount of swarf will be generated before they are completed! Start at the knuckle pin end by drilling and reaming through at ¼ in. diameter, following up with a 3/8 in. drill and 'D' bit to 3/32 in. depth. Cross drill no. 18 to start forming the slot, sawing down to same and completing with a 5/32 in. end mill against the front section as your gauge. Grip in the machine vice on the vertical slide to remove 1/16 in. of metal on each side at the knuckle, then radius over a mandrel with an end mill.

Next chuck a length of 7/8 in. diameter bar in the 3 jaw, face and turn down to a good fit in a leading axlebox over a 1 5/8 in. length, further reducing to 7/16 in. diameter over the outer 3/8 in. length to be a good fit in the leading coupling rod bush; part off at 1½ in. overall. The next stepped dowel is the same fit in the axlebox over a 1 5/8 in. length, but the outer 3/8 in. is then reduced only to 19/32 in. diameter to suit that bush in the front coupling rod; erect. Assemble the knuckle joint with a plain length of ¼ in. silver steel rod, although you can of course turn up the proper knuckle pin and its cap, then align to drill back from the trailing axlebox, after which complete the rear coupling rod as for the front ones.



BLACK FIVE motion.



Leading coupling rod end.

**Crankpins and Caps**

Crankpins next, the leading and trailing ones being plain turning. When you have turned up the driving pair, grip in the machine vice on the vertical slide and use a 3/32 in. end mill to deal with the ⅛ in. wide slot to 3/32 in. depth; the tappings will have to await the return crank.

For the leading crankpin caps, chuck a length of ¾ in. diameter steel bar in the 3 jaw, face and turn down to 11/16 in. diameter over a ½ in. length, adding the light chamfer as shown; part off a 3/32 in. slice and repeat. Mark off and drill the No. 44 holes, following up with 5/32 in. drill and 'D' bit to 1/16 in. depth for the socket head screws.

For the trailing crankpin caps, silver solder an ⅛ in. length of ⅜ in. A/F hexagon steel bar to a ¾ in. disc of 1.6mm sheet, then grip by the former in the 3 jaw to turn said disc down to 19/32 in. diameter and 3/64 in. thickness. Centre and drill through at No. 11 before tapping 7/32 x 40T to complete. Fit the leading and trailing crankpins to their respective wheels and one of the pair of wheels to its axle.

**Return Crank and Crankpin Setting Jig**

For the return crank, start with a length of 1 in. x ¼ in. BMS bar. Grip in the machine vice on the vertical slide and first mill the ⅛ in. wide key to suit the driving crankpin. use this as your datum to move on 1.460 in. by cross slide micrometer collar, to drill at Letter 'D' for the return crankpin, then ream through at ¼ in. diameter. It is permissible to drill a 3/16 in. hole at the crankpin end, which will allow you to radius this end over a mandrel with an end mill, after which plug said hole and file to match the key. The other end is much easier, after which saw out and complete the profile with files. The return crankpin is from ¼ in. silver steel rod, followed by a plain washer, after which the whole can be silver soldered together. Mark off, drill and counterbore the four No. 44 holes, offer up to the crankpin, spot through, drill and tap 8BA for socked head screws.

To correctly orientate the driving crankpins, we require the simple setting jig, and the crankpin should be set ahead of brazing in the return crank pin, as we shall be using the ¼ in. reamed hole for alignment. The base is a 1½ in. length from 1¼ in. x ¾ in. BMS bar, so grip in the machine vice on the vertical slide to first drill and ream the ¼ in. hole at ¼ in. from one end. Move on .625 in. to drill the second hole at ⅝ in. diameter.

Next chuck a length of ⅞ in. diameter steel bar in the 3 jaw and turn down to ¾ in. diameter over a 1½ in. length to be a good fit in the wheel boss. Further reduce the outer ¾ in. to ⅝ in. diameter to be a press fit in the jig and part off at 1⅜ in. overall. The other pin is a plain 1¼ in. length of ¼ in. silver steel rod, so sit the jig in a driving wheel seat, bring up the crankpin and return crank assembly, and fit same orientated as per the view immediately above these details on the drawing: assemble a driving wheel to its axle.

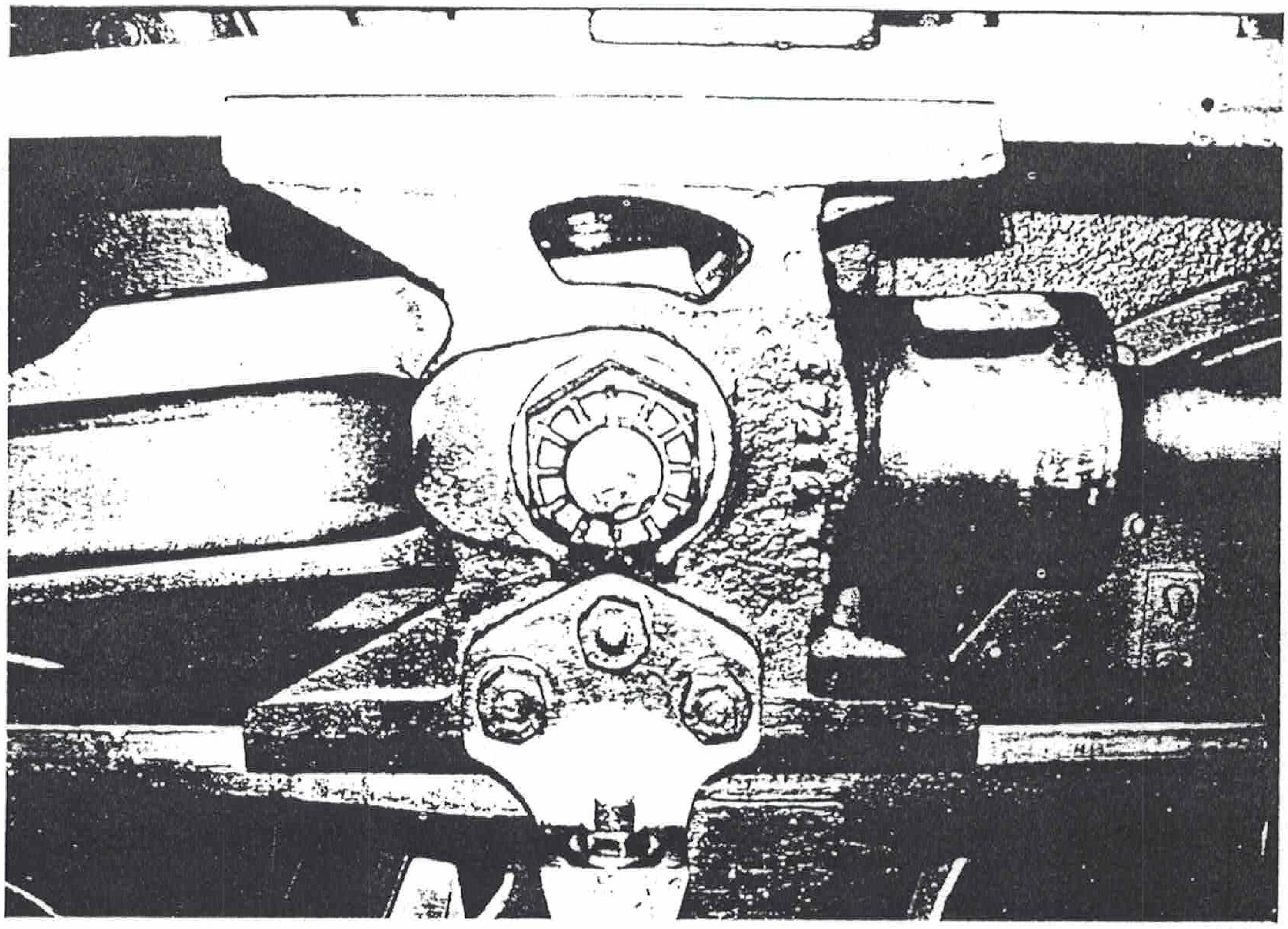
There are many ways of quartering wheels, and I reckon mounting between centres in the lathe and using the scribing block and engineers square is as good as any of them, after which push home the second wheel and allow to cure. Bring all three axles up to the engine, fit the coupling rods at one side, then bring up the leading coupled wheel on the other side, slide it home and use the front coupling rod to check it out, then deal with the trailing coupled wheel to complete the wheeling. We now have to ease the coupling rod bushes so that the wheels can rise and fall independently of each other, so stand the appropriate drill upright in the bench vice, fit the rod bush over same and drop a length of 1/16 in. rod down one flute so that it jams. This will allow you to pare a few thous of metal from the bush, don't overdo it, but keep trying in place until each wheel will lift about 5/32 in. independent of all the others, then you will have no problem at the track.

**Connecting Rod**

For the connecting rods, start with two 14 in. lengths of 1¼ in. x ½ in. BMS bar, first drilling the ½ and 11/16 in. diameter holes at 12 in. centres. Bolt to the length of angle and set over, using the side teeth of a large end mill to remove 7/64 in. of metal along the top face. Next use the side teeth of the end mill to start profiling the rod, then change to a Woodruff key cutter to deal with the flute. Turn the rod end for end to deal with the other edge and to complete the fluting, then turn over, add pieces of packing to support the centre of the rod, and mill down to 17/64 in. thickness, removing 1/64 in. of metal at the big end boss. Completing the big end of the rod is the same as for the coupling rods, but the small end is somewhat different. Sixteen years on from when the detail was originally drawn, I now suggest an alternative solution to arrive at the oil reservoir. First radius over a mandrel with an end mill, then mill the 1¼ in. length of reservoir to 11/32 in. up from the centre line, using a small end mill to produce the actual reservoir and drilling No. 60 through rod and bush, the latter to be inserted at this stage. Cut a top plate 1¼ in. x 17/64 in. from 1.6mm sheet, silver solder in place, then drill and tap 8BA for the oil plug to complete.

**Crosshead**

The crosshead will allow us to complete another large chunk of the assembly, so starting with the centre, first arrive at the required 11/16 in. x ⅝ in. section. Chuck in the 4 jaw and set to run true, to turn on the piston rod boss, then centre and drill Letter 'D' to ⅞ in. depth. Next cross drill and ream 3/16 in. diameter for the crosshead pin, following up with an 11/32 in. drill and 'D' bit to ¼ in. depth. Along the top and bottom faces, we have to mill a 9/32 in. wide slot to 3/32 in. depth, then turn the crosshead through 90 deg. to continue the slot to accept the small end of the connecting rod, checking this to place. Complete the profile with saw and files and we must move on to the slippers. By fabricating the crossheads, we can make the slippers from bronze to be more compatible with the slide bars, so first arrive at the ⅝ in. x 9/32 in. section. Deal with the 9/32 in. spigot next to be a good fit in the centre, then turn over and mill the ½ in. wide slot to 3/32 in. depth to be a nice sliding fit over the slide bars. Saw and square off to length and then silver solder to the centre. Check for any distortion and take a light cut over the slippers to correct any error, using shims under the slide



This shot concentrating on the crosshead and connecting rod small end shows every minute detail, as I have come to expect from the photographic work of John Michael Foster; remember the massive contribution he made to my DONCASTER series in the way of illustration?

bars to compensate. Turn up the crosshead pin from ¼ in. silver steel rod and erect rod and crosshead to the slide bars. Enter the piston rod into the crosshead and check that the crosshead slides sweetly between the slide bars, adding shims if required to achieve this. Turn to back dead centre, remove the cylinder front cover and push the piston until it strikes the back cylinder cover, marking where the piston rod enters the crosshead and checking that the piston rod is not striking the small end of the connecting rod and giving a false impression. Turn to front dead centre, replace the front cover and push the piston forward until it strikes the front cover, again mark the piston rod at the point of entry to the crosshead. Divide the distance between the two scribed lines, make a third, and bring this up to coincide with entry to the crosshead, when you can drill for and fit a couple of ⅛ in. taper pins, only do not drive them home at this stage.

**Valve Crosshead, Guide and Pillar**

There is a lot that can be said in favour of bronze valve crossheads, so first arrive at the 11/16 in. x 11/32 in. section and then chuck truly in the 4 jaw to centre and drill No. 12 to ⅜ in. depth. Saw and square off to ¾ in. overall, then chuck again to centre and drill the No. 13 hole. Transfer to the machine vice on the vertical slide and complete by milling the 7/32 in. slot to accept the combination lever. Although you can drill for and fit the 3/32 in. taper pin at this stage, I much prefer to wait until you are ready for valve setting, when you can roughly centralise the valve before drilling through the valve spindle.

For the valve crosshead guides and there are eight of them, first saw four 2¾ in. lengths from ⅜ in. x ⅛ in. chrome vanadium steel strip. Grip each piece in turn in the machine vice to mill the 5/32 in. x 3/64 in. step, saw and square off to length, marking in pairs, then clamp together to drill the two No. 44 holes. Although you may harden out the guides to the instructions provided with this material, experience now is that they will give a marvellous service life in the 'raw' state. The guide pillars are plain turning from 5/32 in. steel rod, the ¼ in. central portion to be left a little on the full side at the outset and then reduced a thou or two at a time until the crosshead is a nice sliding fit.

**Weighshaft, Bearing and Arms**

Where to go next and those weighshaft bearing blocks on the stay have been looking a bit bare for some time now, so let us check them out. There is absolutely no need to split the bronze weighshaft bearings, so chuck a length of ½ in. bronze rod in the 3 jaw. Face, centre, drill and ream 5/16 in. diameter to ⅝ in. depth, then use a parting off tool to deal with the ¼ in. wide groove to 13/32 in. diameter, checking the fit again in the bearing block; when satisfied, part off at ⅜ in. overall and repeat. The weighshaft is a plain 8¾ in. length of 5/16 in. silver steel rod and in 1992, no way would I cut it as assembly is simplicity itself in a single piece. That means the couplings are complete dummies, so treat them accordingly and I would merely sweat them in place.

For the reverser arm, we require a simple building jig, so take a 2 in. length of, say, 1 in. x ¼ in. BMS flat and drill 5/16 in. and 5/32 in. holes at 15/16 in. centres, fitting ¾ in. lengths of plain rod in each hole; coat the jig with marking out fluid so that the spelter will not adhere. Turn up the two end bosses from ½ and 5/16 in. steel rod respectively, slip one over each jig pin, then fashion the central portion from ⅜ in. x ⅛ in. BMS flat, packing up 1/32 in. from the jig base. Silver solder together, clean up and spray with zinc. Offer up to the weighshaft in the position shown, to drill through and secure with an ⅛ in. taper pin.

Although lifting arms are usually fabricated, those on BLACK FIVE will look so much better if machined from ⅝ in. square steel bar, for which we require two 2 in. squared lengths. Mark on the centre of the 5/16 in. hole and set in the 4 jaw for same to run true, then centre, drill and ream to 5/16 in. diameter. Next turn to 33/64 in. overall thickness, then turn the raised boss starting at ½ in. diameter, its stand out being 5/64 in. Next radius the whole end to 17/32 in. and complete with files to the shape as shown. On to the machine vice and vertical slide and with the 5/16 in. reamer in the 3 jaw, align it with the hole in the lifting arm. Now move on 1 19/32 in. by micrometer cross slide collar to drill the No. 23 hole. Turn the bar over to drill a 15/64 in. diameter hole to start forming the slot, dealing with this as a separate entity before going on to tackle the 7/32 in. one at the end, as this makes the assembly so much more rigid. Now it is a matter of roughing out the profile, radiusing the ⅜ in. end over a mandrel with an end mill and then filing the side flanks to drawing. Although the lifting arms can be pinned to the weighshaft at this stage, it is better to wait until the radius rods have been made and fitted, which will provide a check on their positioning.

### Drop Arm

There are two distinct patterns of drop arm on the BLACK FIVES and this to me is the sturdiest of them, being the MK2 version. Start with a length of 5/8 in. x 3/8 in. BMS bar, drilling and reaming the 3/16 in. hole and marking out around same. You will be able to mill out the 3/32 in. thick bolting flange, dealing with the front face at the same setting to arrive at the 11/32 in. overall thickness, then turn over and mill around the hole to 3/16 in. thickness, but the rest you will have to file. Still attached to the parent bar, radius around the 3/16 in., hole over a mandrel with an end mill, then complete the lower profile. Mark off and drill the trio of No. 44 holes, then cut from the parent bar and file the flange to drawing. Offer up to the crosshead after drilling and tapping the 8BA oil hole, and mention of 8BA tappings reminds me that I should have specified one on the crosshead centre, though dealing with it now presents no real problem. It is tapping from the lower pair of holes where the problem occurs, for there is hardly any metal here, so make up dummy bolts and silver solder the whole to the crosshead, which indicates this could best be carried out when the slippers were attached.

### Union Link and Combination Lever

The union link is quite straightforward, being from 3/8 in. square steel bar. Grip in the machine vice, to drill and ream the pair of 3/16 in. holes at 7/8 in. centres, then turn over to drill No. 6 holes to start forming the slots. Deal with one of these and radius the end over a mandrel whilst still attached to the parent bar, then saw away, add a piece of 3/16 in. thick packing to stop this fork end being squeezed whilst you deal with its partner. Use a 'Mole' wrench to hold the union link to radius the other end, then mill and/or file the remaining profile to complete.

The combination lever is a right pig and will be heavily loaded initially whilst the piston valves bed in, thus I would strongly advise it is milled out of 5/8 in. square chrome vanadium steel bar. First grip in the machine vice on the vertical slide to drill those three 3/16 in. holes, which must be a reamed finish. Use the upper portion as your datum, so mill this to arrive at the required 7/32 in. thickness, then pull the end mill back by 19/64 in. to deal with the outer face of the hole at the union link end. Turn the bar over to arrive at the 3/16 in. thickness at the bottom, then set out by trial and error to arrive at the tapered back portion, this I am afraid being rather 'hit and miss'. Turn the bar over again and this time pack the tapered portion out from the base of the machine vice, when you will be able to mill the front to arrive at the 5/32 in. thickness, taking care not to mill away the wee oil boss at the bottom. Next bolt to your length of steel angle that you used a while back for the coupling and connecting rods, packing up carefully so that the tapered length is parallel to the angle, then mill on this length of profile and deal with the flute with the smallest of Woodruff key cutters. Some of the rest of the profile you can arrive at over a mandrel with an end mill, but the remainder is just filing. Complete with the three 8BA tapped oil holes, continuing at No. 60 into the three bores. The valve gear pins and collars at least are plain turning, and I would use 3/16 in. silver steel rod for the pins, brazing on separate heads and then cleaning them up to drawing; erect the pieces made thus far.

### Radius Rod

It was late on New Year's Day that I came to describe the radius rod, and after the battle with the combination lever, I decided to call it a day. Overnight I thought of the difficulties that the valve gear was presenting and how it must have taxed those fine craftsmen and artisans at Derby and Crewe, for if an item presents problems of manufacture in miniature, then you can be sure same would be equally the case in full size. Much has been written about the impact of Stanier on coming to the LMS, the transformation in design thought, but 36 years on the drawing board has taught me many times how easy it is to set things down on paper, their translation into 3D a different story altogether! Now the consummate skill of the workforce at both Crewe and Derby is beyond question, it was acknowledged by Rolls-Royce setting up factories in both towns, thus it would have been the quality of the machine tools that would have been put to the test. For excellence of machining was what

I was tempted to give a prize for identifying the engine in this photograph, but had to refrain as we were unable to trim enough off the nameplate, which makes it too easy. Note the roughness of the cast detail on the expansion link bracket as against the pristine machined finish on the actual valve gear components.

distinguished Swindon built locomotives from the general run of things in the UK in the 1920's, indeed it was still true between Doncaster and Swindon products into the 1950's during my own apprenticeship, for Swindon would religiously machine a forging or casting that we would leave untouched. I have never yet seen it recorded how Crewe and Derby coped with such a transformation of machining practices, but they did so and magnificently, which is the basic reason for the improved reliability in service of the Stanier locomotives. With those thoughts in mind, I felt better able to cope with the problems that lay ahead for me in describing the remaining piece parts on Sheet No. 7, for had not others gone before me?

For the radius rods, we require two 8½ in. lengths of ⅝ in. square chrome vanadium steel bar, a metal I had thought unique to DYD valve gear parts, that is until I read a few weeks ago that it was also used full size in the same way, so nothing is new! Mark off and drill the No. 13 and 5/32 in. diameter reamed holes and this time you will have to measure the 7 in. centres accurately, for this is beyond the capacity of the lathes available to us. Clamp to the length of angle bolted to the vertical slide table and remove the 1/16 in. of metal at the front face with the side teeth of an end mill to establish a working datum.

Turn the bar over, pack up 1/16 in. to be level along the full length of bar, then reduce to 7/32 in. thickness in way of the lifting die block slot, which becomes 5/32 in. along the rest of the rod; this will result in a mountain of swarf! Lift the end mill by ¼ in. as you reach the fork end and continue to the end of the bar, some of which will be surplus of course later on.

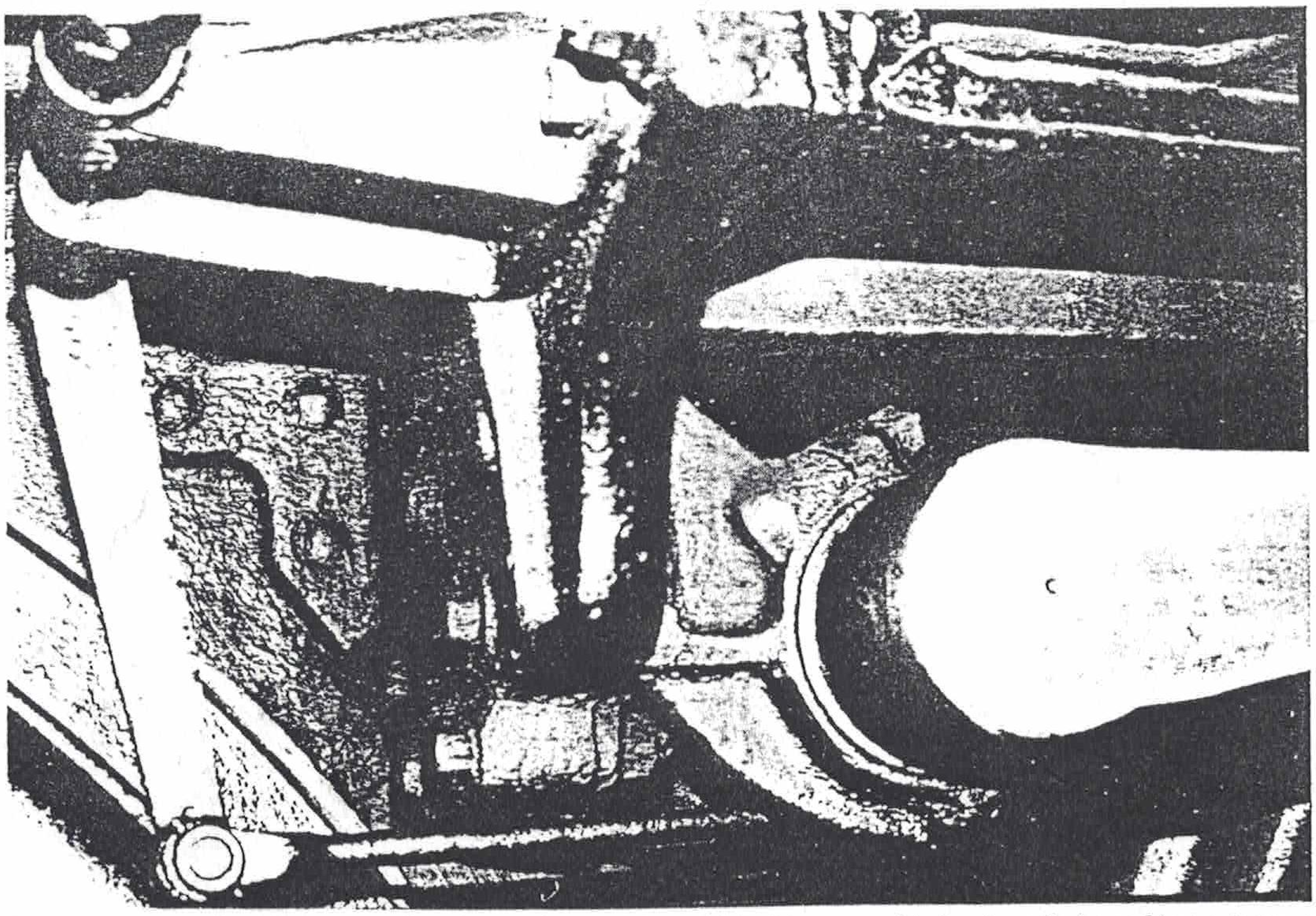
Coat with marking out fluid and scribe the profile on the front face of the rod, then back to the length of angle with the front face uppermost, this time packing up by ¼ in. to be level along its full length. I should have said at the outset when drilling the holes to draw the centre line carefully, for at the oil boss above the lifting die block slot, we are using the full ⅝ in. depth of bar. You can at this stage drill a row of 7/32 in. holes to start forming this slot, but our main purpose for the moment is to profile as much of the rod as possible. There is a very gentle taper from the die block pin hole to the fork end, so use the end teeth of your end mill to arrive at same, setting up by trial and error, dealing say with the bottom edge first. Change to the smallest Woodruff key cutter and deal with the lower half of the flute, then turn the rod end for end and deal with the upper edge, moving on to complete the flute. Carry on and reveal the full profile in way of the lifting die block slot, save at the end, then drill a No. 3 hole to start forming the fork end. Saw away the surplus bar at this end, radius over a mandrel with an end mill, then mill the slot to be a good fit over the combination lever. There is still surplus bar at the other end, so grip this firmly in the machine vice on the vertical slide and with a 3/16 in. end mill, deal with the lifting die block slot against a piece of ¼ in. square bronze bar as your gauge, the actual piece that we shall be using to make the die block. Ease the ends of the slot by filing as shown, then saw away the surplus bar and mill this end to complete the profile. Drill the oil boss No. 50 and tap 8BA, and as for all the other oiling points, turn up a plug from 8BA hexagon brass bar, drilling a No. 60 oil supply hole down the centre of same; I make it you will need at least 14 of these.

Next grip the ¼ in. square die block material in the machine vice to mill down to 7/32 in. thickness, carefully mark out, drill and ream the 5/32 in. hole, then square off to ½ in. length around said hole and drill No. 60 for the oil supply, running the reamer through again to remove any burr. Temporarily erect the radius rod to both combination lever and lifting arm, when you will see that a set is required to align with same, one which you will apply right from the die block pin hole, or rather ¼ in., ahead of same, to the fork end. You can give the rod an initial tweak if you like, but leave the final assessment until the expansion links have been made and fitted, our next job.

**Expansion Link and Bearing**

Even in full size, box type expansion links were a real pain to machine, the set-up to finish grind the slot involved. We are extremely fortunate though in that ours can be fabricated, which makes them quite straightforward by comparison with full size. Start with four 2½ in. lengths of 1 in. x ⅛ in. steel flat, and I would use the chrome vanadium variety for preference, marking out the business part of the link to include the tail. As the oil boss comes within the metal section, mark out same to be integral with the link, then clamp together in pairs. Drill and ream the 3/16 in. pin hole first, then deal with the four for the 8BA fixings, only drill these through at No. 51 only for the moment and assemble with 10BA bolts to machine. Saw around the tail, file and then radius over a mandrel with an end mill, then drill a row of 7/32 in. holes to start forming the slot. Although you can now grip the pair of links in the machine vice on the vertical slide and rough out the slot with a 3/16 in. end mill, I still know of no better way to complete said slot than by filing. Deal with the convex face of the slot first, which you will find relatively easy to deal with, simply filing to line. Turn the link over to deal with the concave face, and this is not so easy, but if you take it a little at a time, using a length of ¼ in. silver steel rod as your gauge, plus a great deal of patience, then you will win! I still shudder today when I think about machining curved slots in links, for it takes me back more than 30 years to the first pair I produced for FISHBOURNE, my 'Isle of Wight' locomotive. First I spent a whole week making up a special jig for machining the slot, feeling that the time spent would be extremely worthwhile. I then had the Toolroom at the shipyard where I then worked, grind me two pieces of gauge plate to the required thickness, and finally invested what was then a vast sum in a special end mill, one which cut the gauge plate like butter. Perhaps you can imagine my feeling of elation as the jig worked perfectly and swarf began to pile up on the lathe bed, this was good!, and how my ego bubble burst as I removed the link with its completed slot, only to find it was straight rather than curved, jig and links being consigned to the scrapbox!!

Slot completed, and it does require easing at each end as per drawing, move on to deal with the outer profile with saw and files. Outer plates next, for which we require four 2½ in. lengths of 1 in. x 3/32 in. BMS flat. Clamp together in pairs, find the centre of one piece, to drill and ream through at ¼ in. diameter. Now use a length of ¼ in. silver steel rod to align the outer plates with the ¼ in. slot in the links so that they will swing truly, checking the vertical distance carefully to both ends of the slot to be identical; clamp together, or rather drill back from the links the No. 51 holes and assemble with 10BA bolts again. This time it is merely a case of profiling the outer plates to match the links, then tidy up at the bottom and drill the No. 11 hole for inserting the die block pin. That leaves just those end blocks, for which cut eight ½ in. lengths from 3/16 in. x ⅛ in. steel flat. Offer up to the ends of the link, drill through the No. 50 holes, then tidy up the profile to drawing, this time assembling as individual expansion links to braze the pieces together. Ahead of this though, we have to turn up the fulcrum pins from 5/16 in. steel rod. For one pin only, the inner RH one to provide drive for the mechanical lubricators as indicated, and I regret at the moment DYD are unable to supply these, turn down to 5/32 in. diameter over an 11/32 in. length. For this and the rest, turn the next 7/32 in. of rod down to 7/32 in. diameter to be a good fit in the bearing that we shall be making as our next piece part. The use of 5/16 in. rod is so that we can now reduce over the next ¼ in. length to a press fit in the ¼ in. reamed hole in the outer plate, so part off to give a 3/32 in. length of same and press home.



John Michael Foster sent in strips of negatives for the BLACK FIVE's rather than prints, which is why I delayed selection from same until I was ready to describe the rods and motion. It would have been better had this view of the attachment of the weighshaft bearing to its bracket appeared slightly earlier in the series, for which my apologies.

To prepare for brazing, coat the slot with marking off fluid so that spelter will not adhere to same and assemble with rusty 10BA bolts for the same reason, then silver solder together, using the very mininmum of spelter and feeding in from the outside face of the link. Wash off thoroughly, then polish and dip in oil to preserve its pristine appearance, whilst we complete machining. First thing is to reduce those end pieces from 1/8 in. to 7/64 in. thickness, which is a simple task in the machine vice on the vertical slide. Next drill and tap the oil boss at 8BA, drilling back from the slot at No. 60 at an angle as the means of oil supply to the die blocks. The bottom pair of fixing holes can now be opened out to No. 44, indeed they could have been so throughout, but as the top ones require special attention at this time, I thought it best to maintain uniformity. Tap the inner link fixing holes 8BA and open the outer ones out to No. 44, countersinking the outer face as shown.

Again I have omitted the die block detail from the drawing, but at least this time I have set down the relevant dimensions, which saves me more than a few queries! Full size, the die block pin was held in place with a taper pin down through the radius rod, and this we can reproduce with a 1mm spring dowel pin, though it will not be very easy to erect. The alternative is to ream the outer die block 5/32 in. diameter as specified, but drill the inner one No. 23 in lieu, which will mean when the pin is pressed home, the inner die block will retain it in position; this is well worth considering. Start making the die blocks as a pair from 1/2 in. lengths of 5/16 in. x 1/8 in. bronze bar, the first operation being to drill No. 23 in the centre. Bolt them together through the No. 23 hole, making up a special bolt for the purpose and progress them as a pair right up to the final fitting to the expansion link slots, separating them only to remove the final whisker of metal, then they will be in alignment. Square each off to 7/16 in. overall length, then run a reamer through the outer die block of each pair to complete.

The expansion link bearing I recommend be made in three pieces and for the first of these chuck a length of 1/2 in. bronze rod in the 3 jaw. Face and turn down to 7/16 in. diameter over a 1 in. length, a nice push fit in the expansion link bracket, then centre, drill and ream 7/32 in. diameter to the same 1 in. depth, parting off two 15/64 in. slices. Next cut a 1 in. disc from 1.6mm brass sheet, clamping in place, then a 5/16 in. length from 3/16 in. brass rod, filing a flat on same to reproduce the oil boss. Clamp the three pieces together and silver solder, then pickle and clean. Chuck by the 7/16 in. diameter portion to turn the flange down to 7/8 in. diameter, which will also deal with the oil boss, then file a flat on the latter and drill No. 41 to about 3/16 in. depth, continuing No. 60 into the bore as the oil supply. I will try to publish a photograph with these notes showing the oil supply arrangement as covered by my note, though as with most things on the BLACK FIVES there is individuality between engines. Mark off and drill the four No. 44 fixing holes, offering up to the bracket, spotting through and tapping 8BA.

Erecting box links is not easy and must be done in definite order. Fit the inner link first, swinging it up out of the way to enter the outer link in the bracket, then bring up the bearings, engaging the link fulcrum pins; bolt the bearings in place. Now bring the links together and bolt through the fixing holes, this before you ever contemplate erecting the radius rods. Bring these latter up now and complete the set to pick up the top of the combination lever, and you may find you have to remove a little metal at the weighshaft bearings to achieve perfect alignment at that end, after which the lifting arms can be secured with 1/8 in. taper pins. Fit the first arm, getting the angle to the reverser arm as close to 75 deg. as you are able, then swing the expansion link and so position the radius rod that no movement is imparted to the combination lever. Repeat this condition on the other side of the engine before drilling for and fitting the second taper pin to secure that lifting arm. But I have been running ahead of myself as usual, for nothing will happen when you swing the expansion links before the die blocks have been fitted! So fit a die block at the bottom of each link, drop the radius rod to align with same and insert the die block pin through the No. 11 hole provided in the links, pressing it home.

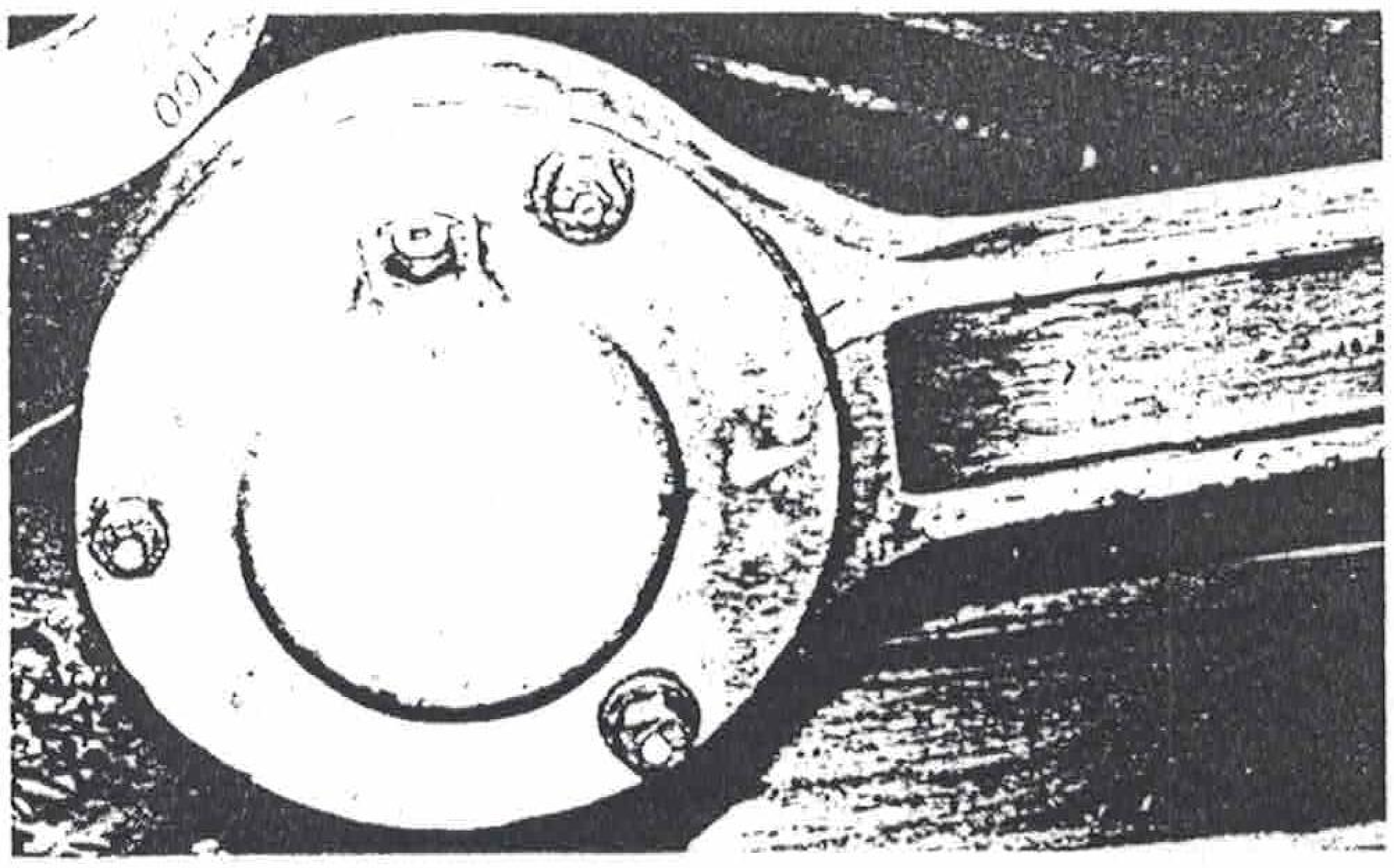
**Valve Setting**

Although no way will I set up a valve gear without the reverser and reach rod being connected, to complete description of the items on Sheet No. 7, I must assume this to be the case, especially as the valve setting details as set down, are so comprehensive on the drawing that I need add nothing to them!

Eccentric Rod

Although I am tempted to give a full description in translating from the dummy eccentric rods to the proper pair, eveything about them says they are akin to smaller versions of the connecting rods that we have already tackled in this session, save for the 1/8 in. set on completion, thus all I need say is that the material requirement is two 6½ in. lengths of ¾ in. x ¼ in. chrome vanadium steel; you can tell me the rest!

We have now reached the happy state in proceedings where the tender has been completed and the chassis is now a rolling one, one where the interesting bits move as you propel your BLACK FIVE along the bench and dream of the day when steam will replace your 'handraulic' drive!; we are winning!!



# 1992, A Proposed New Standard Tank Engine

By: DON YOUNG

In my last "Time for a Cuppa" on Page 43 of LLAS No. 48, I set down some first ideas for new building of a standard gauge steam locomotive in the 1990's. This created sufficient interest for me to take the exercise a stage further, first preparing a specification and then working this through to a General Arrangement in the process of research and development towards the 'production model'. That I have chosen to draw to the scale of 1 1/16 in.=1 foot, for 5 in. gauge, imposes certain limitations that would not occur in 12 in.=1 foot scale, though the basic principles remain, and these I will discuss as the design is revealed.

The first and most important conditions in the specification go hand in hand, these being considerations of loading gauge together with Health & Safety legislation, the latter imposing restrictions in design which were never faced by a CME in Steam days. I came to **1992** fresh from committing the Talyllyn Railway No. 7 TOM ROLT to paper in 5 in. gauge, which gave me some insight into the problems associated with more recent legislation, this to add to experience on the footplate now extending back more than 55 years, plus the premium apprenticeship that was intended to equip me to make contribution to the design of standard gauge steam locomotives.

The loading gauge 'envelope' is fundamental in that no preserved railway today could embark on a programme of station, bridge, tunnel rebuilding, or even track strengthening in order to accommodate bigger and heavier engines beyond the current infrastructure limitations. On the other hand, the proposed locomotive has to be of sufficient power to be able to handle normal traffic loads on all preserved railways to become a univeral 'standard', which is a tall order. In that "Time for a Cuppa" article, I dismissed that most useful BR Standard Class 2 2-6-2T through extravaganze in employing two pony trucks, but further investigation rules it out on other counts. For in 1963 there was a proposal to introduce these engines on the Isle of Wight to replace the ageing 02's, one being brought to Eastleigh for cutting down to suit our loading gauge, an exercise that was suddenly dropped. All that I have seen in print supposes the plan being withdrawn was through cost, and though basically this is true, the reasoning behind it is wrong. For clearance tests were carried out on the Island to assess the feasibility of introducing cut-down Class 2's, to find the alterations required to infrastructure as well as the locomotives were so great as to be impractical, the first major problem I am faced with today. Fortunately for me, within the past year the Isle of Wight Steam Railway have carried out clearance trials with the 'balloon' van which has established a slightly revised loading gauge over the track they now operate, and I have used this information in arriving at **1992**, knowing it will give 100% route availability over the preserved railways operating today.

Turning to Health & Safety requirements, these have a major influence on the design, the first being that the footplate crew be protected as far as possible from risk of injury. As with the BR Standard classes, this means minimum penetration of the boiler within the confines of the cab in the way of fittings, the backhead being restricted to water gauges only. This has been helpful in many respects, for although many cabs look more commodious than that which appears on **1992**, such is a fallacy because of the amount the boiler extends back into such cabs, whereas mine only enters the cab by approximately 4 in. in full size. I can also provide proper and comfortable seating for the crew above the rear wheel splashers, allowing a good look-out in both directions, for which large circular windows are ideal. To aid driving from the seated position, the reverser is of the Gresley vertical type as used on his 'Pacifics', though an ordinary screw reverser could be fitted between the side tank and boiler, where it would not be so accessible! I envisage the regulator extending through the boiler inside a tube and thus therefore not a part of the pressure vessel, to the smokebox where the regulator valves are situated in a header, a part of the superheater if fitted, the alternative being external rodding to same as on the BR Standard classes. The vacuum ejector would also be fitted to the smokebox as for the BR Standards where such fitting is required.

Talking of look-out, or should I say 'all round visibility'?, for a tank engine this must be the same whether running smokebox or bunker first, which brings me to the latter feature. Look at most preserved railways today and it is readily apparent that bunker capacity is far too generous, legacy from the locomotives former use. Many preserved examples are also coaled by hand, thus by lowering the bunker top, not only is visibility improved, but coaling is that much easier. There was the thought of improving bunker capacity as on the BR Standard classes by upward extension clear of the cab windows, but this was ruled out through the requirement to be able to coal the bunker by hand. Looking forward, although there are many examples of snaping the fronts of the tanks to improve forward visibility, nearly all failed as the 'break' occurred much too far forward, thus I have contoured this carefully so that the person coupling the engine to the train can be seen at track level as can be his hand signals. You will also note that the

# Black Five

## The fabulous Stanier Class 5MT 4-6-0 in 5 in. gauge

Part 9 — Tidying up the Chassis

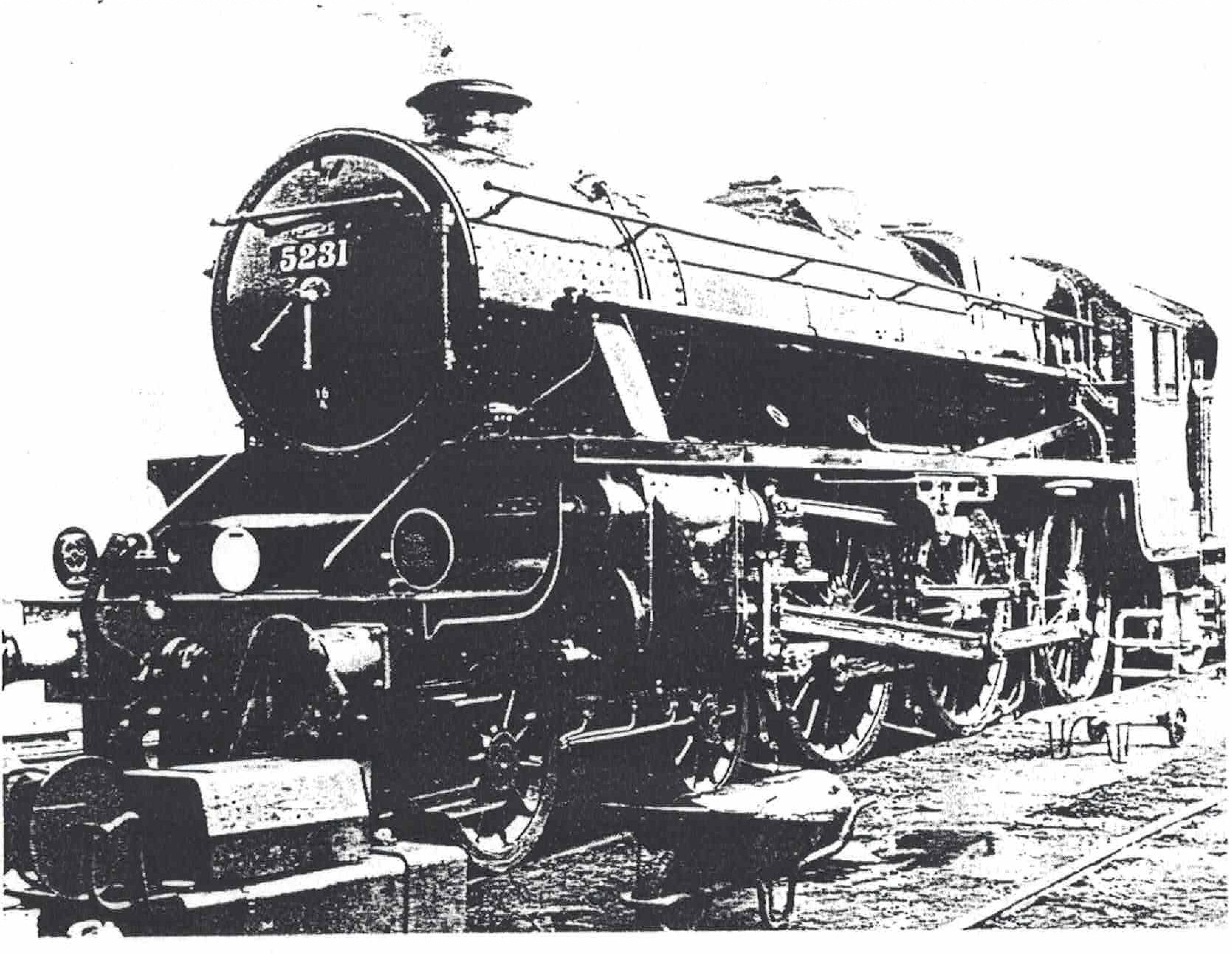
For every tender engine that I have fully detailed this far, there comes a drawing sheet which is very much a tidying up session, and BLACK FIVE is no exception. When I say 'fully detailed', I don't mean every last rivet and bracket; for I am content to leave such extras to master builders such as Fred Kennedy.

Now readers will remember Tom Greaves painting specification for a BLACK FIVE that appeared in the opening session, one with which I am in total agreement. It so happens that Fred asked my opinion before painting his 4767 on the question of semi-matt or gloss finish, to which my vehemenent reply was the latter! It came as no real surprise that the judges at the 1992 ME Exhibition commented that Fred's finish was 'too glossy', though it made my blood boil. Many of you will remember, or seen photographs, of the 'Britannia' WILLIAM SHAKESPEARE turned out daily at Stewarts Lane in Dick Hardy's time to run the GOLDEN ARROW; she was immaculate! Now, all of us who worked at The Plant, including Dick, Tom and yours truly, were deeply impressed by engines emerging from the Paint Shop; they really shone. Now Crewe had the same reputation for the way they turned out their engines, right from LNWR days, indeed it was Swindon that was the poor relation on finish as they did not have a Paint Shop. That superb finish was there under the grimiest of BLACK FIVE's, waiting to be exposed when cleaners could be spared, as the photographs of engines under Tom's charge which have illustrated this series bear full witness. Thus I place more credence to Tom's 'magnificent' on sight of Fred Kennedy's 4767 than any judge's criticism, though I am going to reserve final judgement until 4767 is steamed!! We have still to get our BLACK FIVE to that happy state, so let me hurry on without further ado.

### Reverser

Every time I look at this reverser, I shudder at the thought of early running experience with my K1/1 'Mogul', in which I also incorporated a locking feature. Here though the roles were reversed in that the serrated wheel revolved with the reverser screw, the locking lever and pawl being attached to the reverser body. After years of use of pole reversers, with their almost instantaneous action, I found I tried hard to repeat things with the screw reverser, winding furiously. In the middle of this, the pawl would drop and engage in the wheel, bringing things to a rapid standstill, and also putting a very considerable loading on the poor pawl! Fifteen years on, my driving habits have become more sedate, thus today my note concerning the locking feature would be less vehemenent. Let me start description with the stand, though it does bring in other parts as we proceed.

The base is a 2$\frac{1}{16}$ in. squared length from $\frac{5}{8}$ in. x $\frac{1}{8}$ in. BMS flat. Next we require a 2 in. length from $\frac{3}{4}$ in. x $\frac{3}{8}$ in. BMS bar. Face off one end, scribe the vertical centre line on same and scribe a second line across at $\frac{3}{16}$ in. from the top face; set to run true in the 4 jaw then centre, drill and ream either $\frac{5}{32}$ or $\frac{3}{16}$ in. diameter to suit your chosen thread form, this to at least $\frac{3}{8}$ in. depth. Take to the machine vice, on the vertical slide, to mill $\frac{3}{8}$ in. of metal away from the top face to provide the seating for the reverser nut, leaving the reamed lug at the front end. The bottom face is tapered and I have given precise dimensions of $\frac{1}{4}$ in. and $\frac{1}{2}$ in. at the ends of the stand, which are not too critical, only that alignment of the screw be maintained, so deal with this and sit on the base plate. An alignment mandrel is the next requirement, so chuck a length of $\frac{1}{4}$ in. steel rod in the 3 jaw and reduce over a $\frac{3}{8}$ in. length to a tight fit in the reamed hole. Further reduce the outer $\frac{7}{32}$ in. to $\frac{1}{8}$ in.




In an earlier shot of No. 5231 on the Nene Valley Railway, Tom Goulding concentrated on the front end. This view in the course of preparation for a day's work is from a wider angle and provides a host of useful detail.

diameter and screw 5BA; erect to the stand and slide in an odd piece of 1/16 in. packing between mandrel and reverser nut face. Now we can build up the rear end of the stand, starting with the inner piece from 5/8 in. x 3/16 in. BMS flat. Scribe on the vertical centre line after squaring off one end of the bar, then measure down 3/16 in. from this end, to drill and ream at 1/4 in. diameter. Slip the piece over the mandrel and we must now arrive at the 1 11/16 in. dimension, milling the main portion of the stand to achieve this, after which the rear end bearing block has to be snaped as shown to match the base. The next piece is from 3/4 in. x 1/16 in. steel strip, the closing plate for the shield which will be made and fitted later. Mark off and drill the 1/4 in. hole, no need to use a reamer this time, then erect and shape to place, when we come to the end boss.

Chuck a length of 7/8 in. diameter steel bar in the 3 jaw, face, centre, drill and ream 1/4 in. diameter to at least 3/8 in. depth. Follow up with a 13/32 in. drill and 'D' bit to 3/32 in. depth, or you may bore out to size, then use a knife edged tool to scribe on the bolting circle at 23/32 in. diameter. Pull the bar about 1 in. out of the chuck, to start parting off a full 7/32 in. slice, but before parting right off change to a round nose tool to deal with the 15/32 in. diameter spigot. Part off, reverse in the chuck and face to length, then mark off and drill the six No. 51 holes.

Before we braze up the stand, the catch plate must be machined, so chuck the 7/8 in. diameter bar again, face, centre, drill and ream 3/16 in. diameter to about 1/2 in. depth. Bore 13/32 in. diameter to 1/32 in. depth as a positive location, then use a parting off tool, first to reveal the 3/32 in. thick flange and arrive at the 1/2 in. dimension, then the catch plate itself at 5/8 in. diameter, after which you can part right off at a full 1/4 in. length; reverse in the chuck and clean up to length. A rotary table would help enormously in dealing with the 1/8 in. wide slots on the catch plate, but for those of us with the Myford 254V plus, there is a neat alternative. For the vertical slide base is now a rotating one and is accurately marked, thus it is possible to cut the first slot and then rotate 45 deg. each way to deal with the next pair. It is a little hit-and-miss, but quite adequate for our purpose, after which you can rotate by 45 deg. in the machine vice and go on to deal with the rest of the slots in turn. To align the two pieces, chuck a length of 7/16 in. steel rod in the 3 jaw, face and turn down to 13/32 diameter over a 1/4 in. length, parting off an 1/8 in. slice, using this to align the spigots so that you can spot through, drill and tap the 10BA holes. Assemble the reverser body to drawing, braze up, clean and thoroughly oil to prevent rusting.

**Reverser Screw and Nut**

For the screw, chuck a length of 7/16 in. steel rod in the 3 jaw, face, centre, then bring the tailstock into play with about 2 1/2 in. of rod protruding from the chuck. Turn to drawing, right back and including the 13/32 in. diameter thrust bearing, the actual thread form making no difference to the dimensions other than the length of undercut at the runout of the thread. I am not going to tell builders how to cut a square thread and make the mating tap from 1/4 in. silver steel rod, never having had a great deal of success with same in miniature, and though my K1/1 has such refinement it is courtesy of Gordon Chiverton, replacing the 1/4 in. Whitworth thread as originally produced. Part off at 2 13/16 in. overall, reverse in the chuck and complete turning to drawing, filing on the 9/64 in. square, then assemble to the stand to check that the screw turns sweetly.

The nut is from 5/8 in. square bronze bar; face off and mark on the centre for the screw, chucking this truly in the 4 jaw; centre and drill to suit the thread form to 3/4 in. depth, then tap out. Part the bar off at 1/2 in. overall, then mark off for the first reach rod spigot, again chucking truly in the 4 jaw. Turn down to 11/64 in. diameter over an 1/8 in. length, then reverse and chuck in the 3 jaw to repeat. Back to the 4 jaw to deal with the last spigot for the indicator plate, tapping this 8BA to 3/32 in. depth. Assemble to the reverser screw in the body and file or mill the bottom face to suit said body, when we can make and add all the embellishments.

The indicator plate is a diamond from 1.2mm brass, perfectly straightforward, which brings me to the shield which is a mite more complicated, though as usual we shall win! A forming block from 1 in. x 5/8 in. BMS bar will come in extremely useful; radius two edges of the bar to properly form the shield. The latter can best start as a 2 1/2 in. square from 1.2mm steel sheet; scribe on the centre line, clamp to the flanging block and hammer over the two sides. Now it is a case of trimming the ends and bottom edges to suit the stand, very much to place, after which you can mark off and drill the specified holes. The insert is a 1 11/16 in. length of 7/16 in. x 3mm section brass. Drill a row of No. 15 holes to start forming the centre slot, opening out with an end mill and filing the corners square. Sit on the shield, scribe around, then cut out so that the insert is a tight fit for silver soldering into place. Offer up, spot through and tap the 10BA holes for round head screws.

Although it is tempting to fabricate the handle, it is so flimsy that it is best made from 3/8 in. x 1/4 in. steel bar. Square off one end, then drill and 'D' bit 3/32 in. diameter to 7/16 in. depth, this being the starting point from which to mark out the rest of the handle. Mill across the front face to establish a proper datum, then cross drill No. 53 for the pin to secure the locking handle. Turn the bar over again to mill the back face, then deal with the 1/8 in. wide slot to accept the catch, using the material as your gauge. Centre and use a No. 43 drill to start forming the 11/64 in. x 3/32 in. slot, changing to an end mill and completing with files, then mark off and drill the remaining specified holes, tapping the 10BA and either broaching or filing the 9/64 in. square one. The profile will have to be dealt with by filing, though it is just possible to bolt through the No. 34 and 9/64 in. square holes onto a, say, 1/2 in. square block of steel and grip the latter in the machine vice to at least mill some of the profile.

The catch starts as an 11/16 in. finished length from 1/8 in. square steel bar; first grip in the machine vice and reduce to 1/8 in. x 3/32 in. section, then mark off for the slots. Drill No. 53 holes to start forming same, completing with end mill and swiss files. On to the locking handle, first turning the tapered length on the end of a length of 3/16 in. steel rod. Grip in the bench vice and file on the two flats to the 3/32 in. dimension, then centre pop and cross drill No. 52, before completing with files and a heavy pop mark for plunger engagement; assemble the pieces made so far and check operation before case hardening the locking handle.

The plunger is from 3/32 in. silver steel rod, so turn on the point, part off and harden to a dark straw colour, then assemble with a wee spring behind the plunger and press in a pin to secure the locking handle; check operation again. That leaves the fixed handle which is plain turning from 5/32 in. stainless steel rod, being riveted to the main handle to complete the reverser.

**Reach Rod and Support**

After all the involved fabrications that have gone before, those for the reverser stand and stool are barely worth a mention. Lightly skim the top and frame fixing faces of the stand, then offer up to the frames to drill through as specified, and of course the RH splasher box can be of identical construction to the stand. Mill top and bottom faces of the stool, sit on the stand, spot through, drill and tap the latter 8BA, then bring up the reverser to its stool and bolt this on in turn to provide a rigid structure. Set the reverser nut in its mid position, the engine in mid gear, then measure the length of the reach rod.

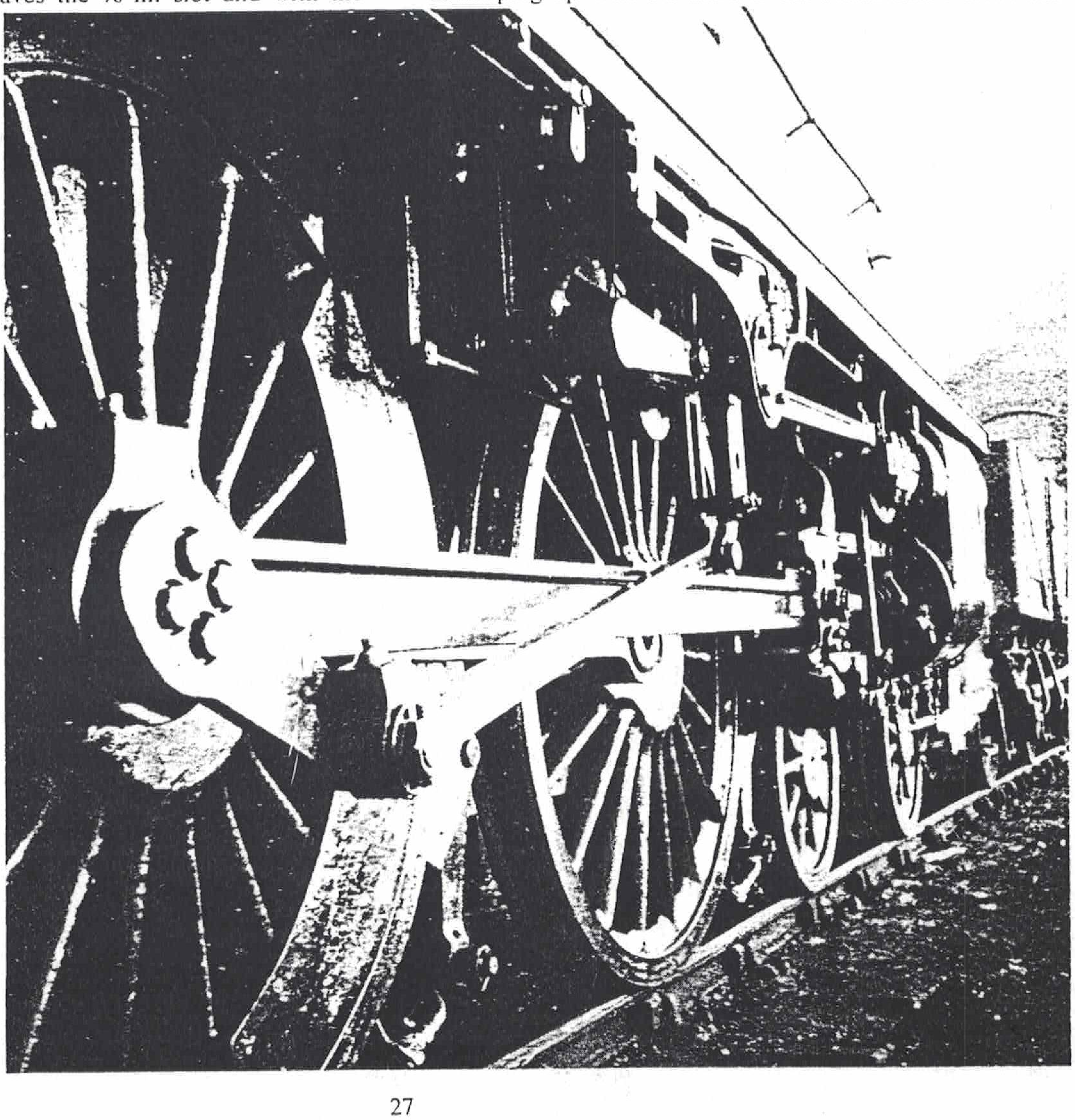
Whilst I still get Out & About quite frequently as reports in LLAS bear witness, the early 1970's for me was the period of maximum travel, gaining experience of miniature steam locomotives at work, and one of the things I noticed were many instances of reach rod 'whip'. I resolved to do something about it as far as DYD's were concerned, thus for BLACK FIVE my specification was to stiffen up the reach rod by thickening it from a scale ⅛ in. to what I thought then was a more realistic 3/16 in. Looking at the problem again today, provided the support is accurately positioned and without clearance to allow side play, then I see no reason why the reach rod section cannot be 5/16 in. x ⅛ in. to be that bit much more authentic, though ultimately it is for you the builder to decide. For those who agree with my revision, material requirement is a 15 in. length of ⅜ in. x ⅛ in. BMS flat for the main member, brazing a lump of ⅜ in. square steel bar on at the front end. Grip in the bench vice to produce the required set, then mark off and cross drill No. 23 for the pin. Radius around a mandrel with an end mill, then reduce the width to 5/16 in. working from the front end. We really require the side running boards to locate the reach rod support, but reference back to the G.A. shows that it is over the centre line of the rear sand box, which is already marked on the frames, thus we can position the chock from same and braze it in place. Moving back again, we come to the stirrup to fit over the reverser nut, for which we require a 3⅛ in. length of ½ in. square steel bar. Mark on the centre for the No. 17 hole on the reach rod, then mark forward from this for the pair of No. 41 holes. Reduce the stirrup to ⅛ in. thickness in this area, spot and drill through at No. 41 and bolt together. Drill the No. 17 hole right through, radius this end over a mandrel with an end mill, then complete reducing the width of reach rod and stirrup to 5/16 in. That leaves the ⅜ in. slot and with the reduced thickness of reach rod, all of it is in the stirrup, so mark off and drill a ⅜ in. hole with both parts firmly bolted together, then saw down and file or mill to complete; erect. This is the proper time to carry out the valve setting, and when you have established the mid gear position on the reverser, mark the shield to coincide with the indicator plate with a three cornered file.

**Reach Rod Shield**

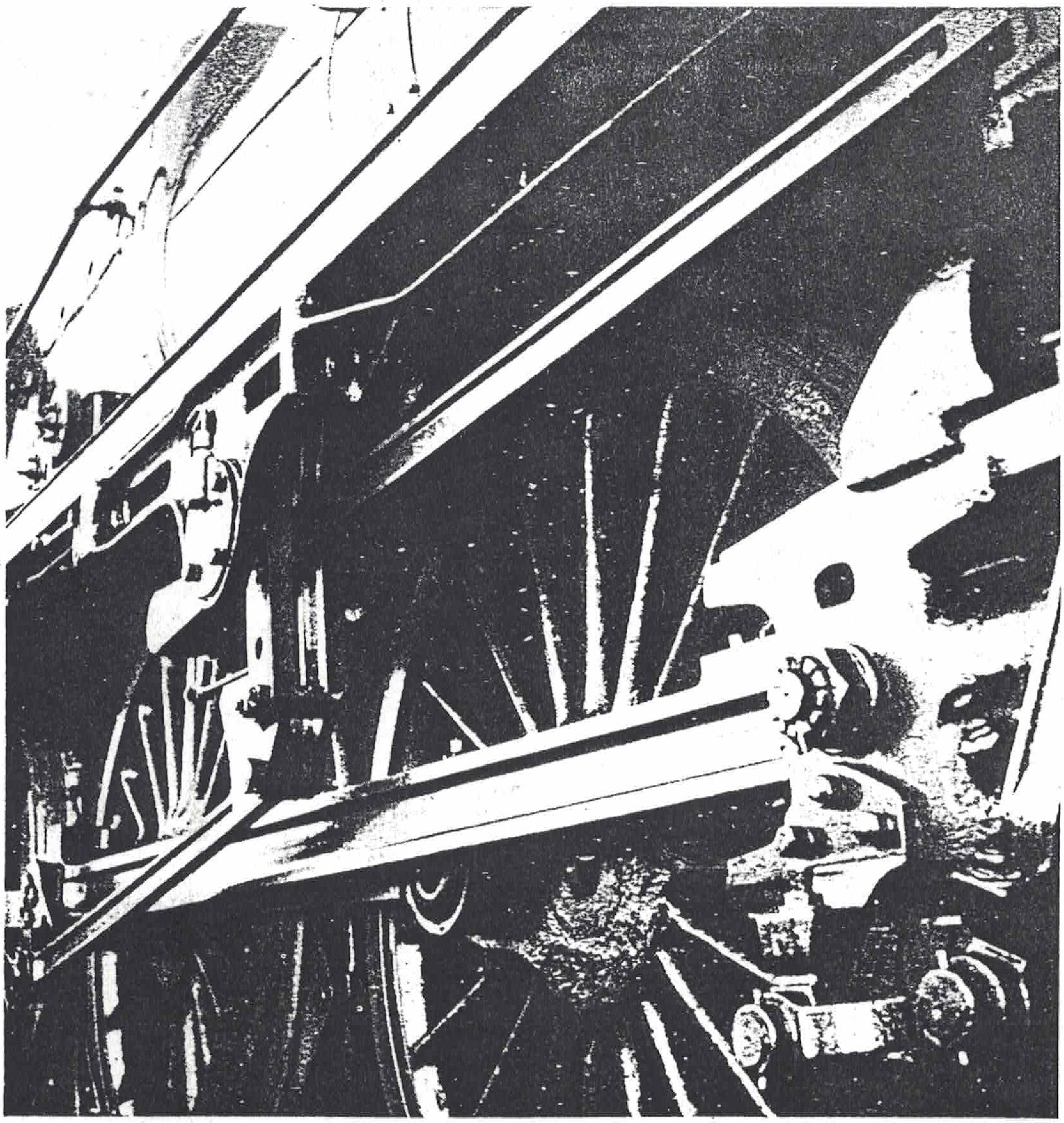
It is interesting coming back to a job that was detailed all of 15 years ago and finding how experience in the interim has tempered one's thoughts and judgement, like on the reach rod as instance. The shield has also set me thinking and today I am going to specify a mixture of steel, copper and brass to ring the changes yet again. For the base, cut a piece 4 1/16 in. x 25/32 in. from 1.2mm steel sheet. For the cover, we first need a flanging block from ¾ in. x 5/16 in. BMS bar with two of the corners rounded. The cover itself is 4 in. x 1⅝ in. from 1.2mm copper sheet, hammered over the flanging block and then trimmed to suit the base. That leaves the beading, 1/16 in. half round brass, when the whole is silver soldered together. Mark off and drill the 12 1/16 in. holes, when you can either cut the base away to the full 5/16 in. as per drawing, or simply cut a slot about 5/32 in. wide to clear the reach rod, which will leave the base slightly stiffer.

**Drain Cocks**

Ball type drain cocks have become a firm favourite since I first arrived at them back in 1969 to fit to Gordon Chiverton's MAID OF KENT, they being described in 'Model Engineer' a year or so later; now we have difficulty in keeping up with the demand for same. Screw them into



I have a feeling from the square negatives, and the background which says 'Horwich' to me, that the next two photographs are from Norman Lowe's collection, though I stand to be corrected. This is the way I viewed engines on a daily basis when at Doncaster and Eastleigh, which I feel is much more impressive than from platform level.



Although 'square-on' views are much better for checking building dimensions, this sort of shot comes into its own in showing the offset of the drop link and assembly of a pair of expansion links. Also note the valve gear pins with their plain collars secured with taper pins, a feature perpetuated on the BR Standard classes, as against the castle nuts and split pins on the LNER.

the cylinder blocks, using thin copper washers that are now widely availble to correctly orientate them, then cut the pull levers to fit the slots in the drain cocks. Bend the front of the levers over to engage the push pins on the front drain cocks, and for the remaining ones, you can either cut short lengths from 1/4 in. x 1/4 in. x 1/16 in. brass angle and rivet in place, or use short pieces of the pull lever material and silver solder them to drawing. If the latter is your preference, do make sure to remove the guide plates from the drain cocks and slide them on the lever ahead of silver soldering, otherwise you will have to modify those plates so the pull levers are no longer captive, a retrograde step.

Neither cross shaft or trunnions require description, which brings me to the three levers. As there is only a single long one and its length is uncritical, go ahead and make it up, but the short ones do want to be a matched pair, for which we require a simple building jig. This is a 1 1/4 in. length from 1/2 in. x 1/4 in. BMS bar, with No. 13 and No. 30 holes drilled through at 3/8 in. centres; press a 1/2 in. length of 3/16 in. steel rod into the No. 13 hole then coat the jig with marking off fluid to prevent the spelter adhering. Chuck a length of 5/16 in. steel rod in the 3 jaw, face, centre and drill No. 12 to 3/4 in. depth, parting off two 3/16 in. slices. The arms are from 5/16 in. x 3/32 in. steel strip; drill No. 31 for the pin, radius the end, press the pin home and then complete the profile, including a scallop to suit the boss when assembled over the jig. Cross drill for both spring dowel and split pins to drawing, then assemble to the drain cock shaft. Bend up the levers, drill the No. 30 holes and radius the ends, then assemble when you can assess the need for collars on the drain cock shaft to control any side movement; they are by no means essential.

For the adjuster, chuck a length of 1/4 in. steel rod in the 3 jaw, face and turn down to 7/32 in. diameter over a 5/8 in. length, then mark off and cross drill No. 41 at 5/32 in. from the outer end. Rechuck in the 3 jaw, centre, drill and tap 8BA into the cross drilled hole, then part off at 15/32 in. overall. Reverse in the chuck and turn down to .110 in. diameter over a 7/32 in. length, screwing the outer 1/8 in. at 6BA.

I very much doubt if the BLACK FIVE's had Bowden cable operation of their drain cocks, Norman Lowe has all the Works drawings I used then and I certainly cannot remember such detail, but it is so superior that I cannot imagine why the feature was not more widely used in full size. Just look back at all the levers and pull rods employed on E. S. COX and compare with what you see hereabouts, and I think you will agree. For running the Bowden tube is simply a matter of finding the easiest route, thus the later this is left the better, even though it has the disadvantage that you then have to strip the engine down to be able to drill to fit the vital 'P' clips to hold the tubing firmly in place. You can use either piano or multi-strand wire as the Bowden cable, crimping an electrical terminal on at the rear end to fit to the operating lever, this latter being just a longer edition of the levers we have just made and fitted to the drain cock shaft. The operating lever will attach to the RH cab side, using an 1/8 in. rivet as fulcrum pin, to be completed with a restraining bracket, just to limit movement of the lever.

## BRAKE GEAR

The rest of the session will be spent on brake gear, my Achilles heel!, though not all the details for same appear on Sheet No. 8.

### Brake Hanger and Bracket

It is good to see the growing number of specialised parts that Doug Hewson is producing for DYD's, and I am hoping he will consider brake hanger brackets for the BLACK FIVE in due course, for they would save a lot of time and effort. For the moment we must fabricate them, so first square off six 7/8 in. lengths from 1/2 in. x 3/16 in. BMS flat and reduce the width to 7/16 in. Mark out the centre for the No. 22 hole and get this running truly in the 4 jaw, then centre and drill through before turning on the raised face. For the outer portion, start with 7/8 in. lengths from 1/2 in. x 1/8 in. BMS flat, mark the centre of the No. 22 hole at 3/16 in. from one end, again turning on the raised boss and reducing the rest of the material to 3/32 in. thickness. Grip in the bench vice and hammer over, trim off the excess length to arrive at the 7/16 in. wide throat, then complete the profile. Chuck a length of 1/4 in. steel rod in the 3 jaw, face, centre and drill No. 22 to 5/8 in. depth before parting off a 7/16 in. slice. Assemble the pieces with this sleeve using a length of 5/32 in. rod, screwing each end for suitable nuts to hold firmly together for brazing, then clean up and paint black undercoat to prevent rusting. This is the only part of the actual brake gear that will be painted gloss later on, all the rest being plain steel finish, which I represent by painting black undercoat.

For the brake hangers, we need a simple building jig, for which the base is a 3 in. length of 3/4 in. x 1/4 in. BMS bar. For 5/32 in. diameter brake beam ends, drill two No. 23 holes at 2 9/16 in. centres and press in 3/4 in. lengths of 5/32 in. steel rod, the third hole for the brake shoe pin being drilled No. 31 with a length of 1/8 in. rod pressed in. Turn up spacers for the two lower pins, so that the hanger and bottom boss will be aligned to drawing, then coat the whole jig with marking off fluid. Now it is a question of chucking the 5/16 in. steel rod and churning out the 12 end bosses. The hanger will have to come out of 1/2 in. x 3/16 in. BMS flat, so start with 3 in. lengths and clamp to the angle we used last time to machine the coupling and connecting rods. Use the side teeth of an end mill, first to reduce to 5/32 in. thickness over 2 1/2 in. of bar, then further reduce the 9/64 in. thickness to leave the raised portion at the brake shoe; reverse and repeat. Drill the No. 30 hole and use this as reference to saw off and scallop the ends to fit the jig, then profile before brazing up. Fabricate both brake hanger and brake shoe pins as I have described many times, erect hangers and brackets to the frames, to drill the No. 51 holes, then rivet the brackets in place.

### Brake Beam and Shoe

Brake beams next, the central section being 5 1/8 in. squared lengths from 3/4 in. x 1/8 in. steel flat. Mark off and drill the No. 22 hole, then the profile, gripping in the machine vice to mill the latter to line. For the ends, chuck a length of 5/32 or 3/16 in. steel rod in the 3 jaw, face and turn down to .11 in. diameter over a 7/64 in. length. Reduce the next 5/32 in. to .142 in. diameter and screw 4BA, then start parting off at 37/64 in. overall, but only reduce to about 1/16 in. diameter before moving on another 1/16 in. and parting right off. Mike the spigot and drill the beam to accept same, a press fit, which will hold things firmly together for brazing up, building up a good fillet for the strength this provides; erect to the hangers.

The shoe is a mite complex for something that could last less than a week in service!, in fact some of the later BLACK FIVE's were fitted with double shoes for that reason. Sadly, I do not have a suitable brake shoe ring, but for many years I have been using a cast ring supplied me by Reeves from their HERCULES which is eminently suitable for BLACK FIVE and should save me a lot of queries. Either bolt to the faceplate or chuck in the 4 jaw, to bore out to suit the coupled wheels, with a good radius to avoid biting into the vital root radius on the wheels. Mark off and drill the No. 30 holes, then saw into individual shoes, gripping each in turn in the machine vice to mill the 5/32 in. slot to accept the brake hanger. I am afraid the rest of the profiling is reliant on files, as I know of no way to machine to arrive at the tapered outline; I certainly would not like to fabricate these shoes!

### Pull Rods and Connectors

Pull rod connectors next, the intermediate ones being from 5/16 in. square steel bar. Start by drilling the No. 22 hole for pinning to the brake beam, then turn the bar over and drill No. 30 and 22 holes to suit the pull rods. Mark out for the 1/8 in. slot to suit the brake beam, drilling a row of holes, keeping clear of the No. 22 one, then mill to the 3/4 in. dimension. Change to a 5/32 in. or 3/16 in. end mill and carefully enlarge the slot at its centre to pass over the brake beam end, then mill the flanks of the connector, leaving the centre boss which with the greatest care can be milled over a mandrel, though I would resort to a filing button here. The rear connector follows roughly the same process, the difference being that it starts from 3/8 in. square bar, plus the pull rod pin holes vary; assemble to the beams and clamp the brake shoes hard onto the wheels. From this you will obtain accurate lengths of the front and intermediate pull rods, there being no adjustment or compensation for same on a BLACK FIVE.

All pull rod ends are fashioned from 5/16 in. square steel bar and I suggest each be fashioned on the parent bar before parting off and completing the inner end profile. So drill the hole for the brake pin, radius the end over a mandrel with an end mill, turn the bar over to drill the hole to start forming the slot, sawing and filing to suit the connector end,

I have no idea of the source of this photograph, only that it serves as reminder to builders to make provision to clear the boiler, which latter will be dealt with in the next session.

then complete the profile before sawing off. The central section is plain steel rod and if you turn a wee spigot on each end of same, this will give a register to locate into the fork ends for brazing.
The rear pull rod fork end is produced in identical fashion, but this time the plain portion is turned from ¼ in. steel rod; first the outer ⅞ in. down to 7/32 in. diameter and screwed 1BA, the remaining length to 3/16 in. diameter, again with a wee spigot as you part off to length; braze up. The brake rod follows the latter process, but is attached to a plain boss; the adjuster plain turning. Ideally the adjuster and its mating parts should have a combination of right and left hand threads, but in miniature it is just as easy to drop the brake rod and give it a couple of turns as the shoes wear; a very rare event anyhow.

**Brake Shaft Trunnion**

I detect a lot of Crewe ingenuity in the brake gear design, the return spring arrangement as depicted being a classic example. Unfortunately we can only deal with the brake shaft trunnion to complete this session, though it is clear that the rest of the brake gear holds no terrors.
As you are unlikely to have 2¼ in. x ⅛ in. flanging quality steel flat by you, the recommendation is that the trunnion be made in three parts, when it will be that much easier to match the sides. Mark one side off, clamp to its partner and first drill the 13/32 in. hole. Saw and file to profile, milling the radius around the hole over a mandrel; the tapped holes will have to await the bearings. The base is a 27/32 in. length which is 1⅛ in. wide from the same material, which leaves the plate for the return spring, a ⅞ in. length from ¾ in. x ⅛ in. BMS flat. You can use a spacer and pin as we did earlier for the brake hanger brackets to hold to two side plates in proper alignment, then sit on the base and adjust the length of the return spring plate to be a tight fit; silver solder together. Clean up and paint, which is as far as we can go in this session; next time we take a break from the chassis to tackle the boiler.

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# Book Reviews

BRANCH LINES TO EXMOUTH by Vic Mitchell and Keith Smith, published by Middleton Press at £8.95.
This is the 100th book to be published by M.P., and as they have been running for around the same time as LLAS, this means a publishing interval of the order of six weeks, which is quite remarkable, thus congratulations are well in order. It would have been nice if I could have added that Vic and Keith have celebrated their centenary in style, but BRANCH LINES TO EXMOUTH for me is one of their less exciting offerings, at least as far as their selection of motive power is concerned. Actually, this is not their fault, for these lines were graced by 02 and M7 class 0-4-4T's and then Ivatt Class 2 and BR Class 3 2-6-2T's in their turn, thus predominate the pages. There is of course personal interest in making comparison between the 'mainland' 02's and those that were so familiar on the Isle of Wight, including a fascinating glimpse of one running bunker first in which a stovepipe chimney is clearly visible. Anyhow, to put BRANCH LINES TO EXMOUTH in proper perspective, I can do no better than quote from the authors footnote:—
"The Exeter-Exmouth branch was the first in south-east Devon and is the only one now to survive. The scenic Tipton St. John-Exmouth route was relatively short lived but both had a fascinating variety of stations and rolling stock, all of which are fully illustrated and described. Many unusual events, such as troop trains and bridge rebuildings, are also included, as are maps and tickets from every station."

WELSH HIGHLAND STOCK LIST, Photo Fact File No. 1.
To complete the introductions, the Welsh Highland Railway advise that this 12 page booklet is available at the Shop for £1.99, or for £2.25 including postage from Mr. Les Blackwell, 29 Cefn-y-Gadir, Morfa Bychan, Porthmadog, Gwynedd LL49 9YH.
In some ways, the WHR can be compared to Sleeping Beauty being awakened by a kiss from Prince Charming in the shape of Gwynedd County Council and beginning to flex its newly found muscles. History means the WHR has a lot of sympathy and support, both locally and much further afield, your reviewer wishing to stand up and be counted in this respect, and it is for this reason that I must be critical of the WELSH HIGHLAND STOCK LIST.
To condense the publicity issued with my review copy, this is purported to be a stock list with a difference, enlivened with 36 photographs and divided into five sections which cover locomotives and rolling stock, designed to appeal to enthusiasts and modellers as well as the casual visitor seeking a souvenir. My considered opinion is that the booklet falls between these three stools, not catering adequately for either interest, so what is the alternative? Most who visit the WHR will make their own record in colour, either with still photography or on video, thus the need for so many black and white photographs in the booklet is very doubtful.
What I think the WHR needs to portray is a vision of the future, to inspire all who visit them, in which words are probably more important than pictures. The jewel in the WHR crown though is the Aberglaslyn Pass, thus there should be priority to get trains running again on this section of track bed, and it matters not if such be isolated from present HQ in Porthmadog. Visit the Pass on almost any day and watch members of the public taking risks to obtain a view from the opposite bank of the River Glaslyn, when they could be conveyed there in comfort on a WHR train; currently this must be the largest untapped asset in North Wales?
Thus, though I wish the WHR every success in this the first of an intended series of booklets, I can foresee greater rewards in other directions, agreeing wholeheartedly with their promotional caption "The little railway with the big future!"

MITCHAM JUNCTION LINES from the London Suburban Railways series, by Vic Mitchell and Keith Smith, published by Middleton Press at £8.95.
This of course is 'electric territory', a part of the South London sprawl, though still with a surprising amount of rural scenery. Having resigned myself that MITCHAM JUNCTION LINES would be distinguished by its architectural features, of which many notable examples appear, nevertheless our intrepid authors have still managed to find at least 57 varieties of steam, all the way from a humble Kerr Stuart 0-4-0ST to the mighty Bulleid 'Pacific' — incredible!
Perhaps a majority of M.P. books are pure nostalgia, reliving a past that can be no more, the routes having been swallowed up by 20th Century 'progress'. MITCHAM JUNCTION LINES though is different, for starting from an 1803 tramway, it traces events to the present time and then goes on to predict a bright future under the Croydon Tramlink scheme; for that alone this book is recommended viewing. On another tack, my NEWPORT series has drawn readers attention to William Stroudley, there being a fine selection of his designs in MITCHAM JUNCTION LINES, all of them supremely elegant!