Hot and cold running axle boxes

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During the last few months, I have made axleboxes for two locomotives in the workshops and over the years I have developed definite ideas on how I do them, nothing fancy you understand, just copied from others, big and small. Personally, I am always amazed at the sheer amount of hassle the railway companies put up with from axleboxes, almost any account of locomotive works or the experiences of footplatemen and fitters are filled with tales of woe about failures due to hot boxes and even boxes that fell to bits. Given the man-hours put into repairing boxes, not to mention the disruption to the business, it would seem like a good idea to put axlebox design near the top of the "things to do" list and sort it once for all, yet this did not happen. Well not quite, one railway did take the bull by the horns: perhaps you can guess which one!

Full size axleboxes are pretty well like our miniature "split" version: they are split on the journal centreline so that they can be removed from the axles for repair and rebated each side to fit in the horns (guides) which slide up and down to accommodate the sprung movement of the frames. The bearing for the journal is half in the main upper part of the box and half in the removable underkeep, the sprung weight of the engine is taken entirely by the upper surface (about 8 tons for a Class 5). The fore-and-aft driving forces from the connecting and coupling rods are taken by both surfaces, even though this is considerably less than the sprung load, the axleboxes take a beating in practice, particularly on powerful engines and more so those with inside cylinders. The important features are to maintain a close fit to the horns to prevent rough and dangerous riding and to prevent overheating at the journal which leads to seizure. It was this latter that bedevilled the railways. Each axlebox was hand scraped to fit the journal: can you imagine the time spent blueing and scraping? Bearings were usually drip lubricated by a worsted wick from an oil box above: drivers would modify the wick to give them the feed they felt was the best.

Each company had its own design of axlebox in so far as the material it was made from and the method by which the bearing metal was supposed to be retained in position, some were better than others. Looking at the "big three" we find the Midland was any early convert to minimalism when it came to providing bearing surfaces: axleboxes were of manganese-bronze with a hand scraped bearing surface composed of brass strips keyed to the box holding white metal between them. The whole arrangement was dodgy since if (when?) the white metal became warm it tended to squeeze out leading to the loosening of the strips and the total disintegration of the bearing surface. If this was a problem with lightly loaded MR 2P 4-4-0's then handing down the design, even in beefed-up form, to something as powerful as a Royal Scot was to court disaster. North Western boxes were much stronger, as indeed they needed to be to survive their daily punishment, simply being steel with pressed in hand scraped brasses; their frequent failure was due to inadequate lubrication arrangements. On the face of it the GWR used the same sturdy boxes but being the Western they did some homework on lubrication: the boxes were deeper incorporating large underkeeps with very substantial oilboxes fitted with pads of worsted and horsehair kept in contact with the underside of the journal by springs. Oil was delivered on the centreline, the point of minimum pressure, and the pads ensured its distribution over the whole surface. This design was developed further by increasing the diameter of the bearing surface to about 0.02" bigger than the journal so as to create a wedge-shaped space into which the oil was swept, and finally by eliminating the time-honoured practice of hand scraping. On a special test rig a loaded axlebox was run for 10 days non-stop during which time the total consumption of oil was only 150ml. This type of axlebox was found to be very reliable and was adopted by the LMS before being passed on to the BR Standards.

Luckily for us scaling-down works in our favour and although axleboxes were critical in full size they are not usually a source of trouble in 5” gauge: the bearing surface reduces by 12^2 but as the weight goes down more (by 12^3) surface pressure is quite low. Published designs tend to have solid gunmetal boxes for simpler smaller models and split cast iron for the larger engines. In my early models I followed the solid GM design but with “Hunslet” being a hefty NG engine I decided to go for split boxes. The main part is CI with the keep being brass, the bearing hole was bored out on the joint line of the two parts. Just to make sure I milled out cellars at the bottom of the keeps and stuffed them with bits of felt pinched from some toy no longer in favour with my daughter. The axles are drilled 1/16” from the centres to a cross hole leading to the journal and lined up with the cranks so that when the engine is on a vertical centre it communicates with the pad. The felt is kept charged by giving a squirt of oil up the axle hole, the only point to watch is to have a paper towel handy to remove any runs from the wheel back as otherwise oil is sure to get on the tyres. This design has been well tested in passenger hauling service since 1991, furthermore after 8 years use when the wheel sets were out for another reason and I took the opportunity to split the boxes and have a peek at the bearing surfaces and journals.

They looked superb with no sign of wear. I made a slight change with “Lord Rathmore”, as the suspension load is taken through a pin located into the narrow sides by the keep, I was wary of the tension in the cast iron so the box was made of steel with a GM bush silver soldered in as the upper bearing surface (depending on your stock of odds and ends it can work out cheaper).

Now I don’t see any advantage for us in splitting axle boxes (other than to satisfy curiosity about wear) but assembly can be simplified in the case of inside cylinder engines. With the motion between the frames the space between wheel back and either a crank web or eccentric is usually minimal and it is much easier to assemble the driving axle first and fit the boxes later on. The MR Compound is definitely a case in point: the driving axle carries a crank and 3 pairs of eccentrics so it has axle boxes of steel with brass keeps and lubrication pads. The same argument applies to my other locomotive, a LNWR “Jumbo”, but having seen how small the engine and axle boxes were going to be I decided to revert to one-piece construction but still of steel with GM bushes. I did remember to cut a shallow cellar into the bushes before soldering them in and I hope I can persuade a small pad of felt to sit there while I slide the box on to the axle.

Finally, a comment on keeping axles square across the frames. Frames are cut as a pair so however the horn slots are produced (filed or machined) they will be in line; the horns can be machined as a pair, temporarily soldered bottom-to-bottom if not CI, or otherwise machined held in a jig so that the front faces are the same distance from the adjacent locating surface; the axle boxes are made as pairs joined at the top (not forgetting to number stamp everything). So, for each axle the frame slot fronts are dead opposite each other, the horn faces are the same distance away and the bearing holes are the same distance from the guide surfaces, QED: the axles must be parallel. In fact, I assemble my frames without the aid of a square simply by clamping them to the stretchers in a position where the axles rotate freely; that is my definition of “square”. I have just proved that it works even with the three-part frames of the Compound. Phew! What a relief!