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Locomotive slide bars and problems

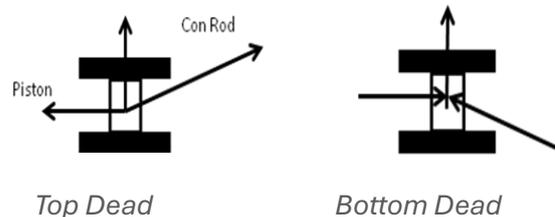
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Keep Things Tight

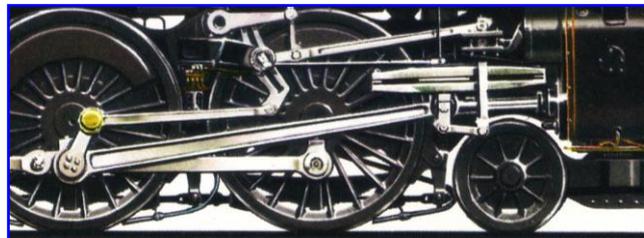
One of the routine tasks in preparing a locomotive for a run is to examine the engine to make sure that fixings of suspension and motion parts are all tight; for bits that come adrift on the run can wreak much havoc. On large locomotives every part that can fall off is pinned or chained on: just have a look at castellated nuts, cotters and bits of brake gear. After I expressed doubt about the use of Britannias on the ex-Midland main line a club member almost instantly presented me with the accident report involving "Firth of Tay" at Settle in January 1960. I found it both a fascinating and salutary read, so much that I think a summary of what occurred might interest others.

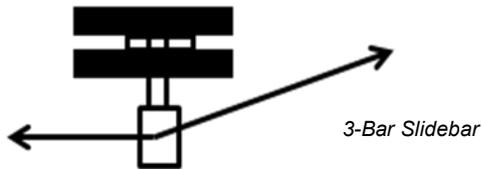
Before relating events, it will be useful to think a little about slidebars. On all conventional locomotives since Rocket the outer end of the piston rod is fitted into a block (cross head) sliding between parallel bars (slidebars) so as to keep it in line with the centre of the cylinder, this is necessary as the connecting rod takes up angular positions as the crankpin rotates.

Consider an engine moving forwards: when the crankpin is on TDC the connecting rod is in tension and it pulls the crosshead up against the top slidebar, then at BDC the connecting rod is in compression and again it pushes the crosshead up against the top slidebar. It looks like only a top slidebar is required for a locomotive that never reverses.



I have taken advantage of this situation on models by using mild steel for the lower slidebar and reserving gauge plate for the upper one that takes the force pulling a train (sounds like LNWR penny pinching!) Most designers used two identical slidebars with symmetrical crossheads on outside cylinder engines but a frequently used alternative was the Laird 3-bar arrangement in which the top bar is conventional but the bottom bar is replaced by two narrow bars bolted to, and separated by spacers from, the underside of the upper bar. This is arranged above the piston rod so that an asymmetrical crosshead with a "T" shape passing through the slot between the lower bars carries the slipper running between upper and lower bars. As usual in engineering there are trade-offs, the Laird design uses a smaller crosshead thereby reducing reciprocating mass but has forces unequally distributed about the centreline.





The GNR adopted the Laird layout with Gresley's first 3-cylinder engine and it was used thereafter to the end of the LNER. Bullied took it with him to the SR but instead of supporting the assembly between the rear cylinder cover and a motion bracket he used a substantial overhanging casting to hold it at the centre where the maximum load is applied; he also differed in employing two bolts at each end of the lower bars to hold the assembly together. Although

the LMS used only the symmetrical 2-bar arrangement, surprisingly the centre supported Laird style was adopted on BR Standard 4-6-0s and larger engines, but Riddles had previously used the LNER layout on his Austerity designs.

In the history of railway accidents, the 1960 scenario was not new: a snowy winter's night in the bleak country traversed by the Settle & Carlisle line. After slogging against 15 miles of 1-in-100 the Holbeck men on the footplate of 70052 "Firth of Tay" pulling the Glasgow St Enoch to St Pancras sleeper probably considered themselves as good as home as they ran on to the slight down gradient at Ais Gill. The driver notched up a few turns and eased the regulator when he noticed a severe knocking which seemed to come from the RH big-end but on opening up a little on the slight rise before Garsdale the knock reduced considerably and he decided to stop there within the protection of the box and examine the engine. Trying to keep the snow out of his eyes the driver concentrated on the motion in the darkness but both big ends were cool and seemed satisfactory, although he failed to notice something that was not there to be seen. Hellifield was 25 miles away on a mainly falling road and the best plan seemed to carry on carefully and call out the shed fitters there.

The knocking started again on the 1-in-100 down from Blea Moor Tunnel but the driver managed to reduce it by working the engine against the brakes, signal box records showed speed to be about 45 mph. There was a loud bang $\frac{3}{4}$ mile before Settle box and the engine shuddered, the driver made a full brake application. Just then Horwich "Crab" 42881 working hard on a down freight passed alongside the stationary express and derailed into the side of the carriages causing death and injury to passengers. 70052 was not damaged in the collision but was found to be without either of its RH lower slidebars and with the piston rod fractured: the part rod, crosshead and connecting rod were bent outwards and lying in a trailing position on the sleeper ends. The Crab lost its truck and suffered considerable damage around one cylinder: a photo is to be found in Locomotives Large & Small No. 15 where Don Young used it to reveal construction details usually hidden from view.

The slidebars, bolts and nuts of 70052 were found distributed along the line from 34 miles back: first a nut & bolt, then another nut, then the inner slidebar, etc, finally the other slidebar just at Ais Gill summit, 70052 had worked 9 miles with only one lower slidebar and 22 miles without either. The 9 miles were run with the engine working hard, all the force was upwards and the only function of the remaining bar was to provide some lateral constraint. Once coasting the engine was driving the pistons so the crosshead force was down (calculated as 0.6 tons at 45 mph) causing the other slidebar to come off. I would imagine the knock was decidedly pronounced. By working the engine against the brake force was again transferred to the upper slidebar, the driver thought he was running at about 20mph but holding the train against the gradient with the regulator open over miles must have been almost impossible.

Eventually the piston rod fractured and the motion fell on to the track, what followed seems impossible. The broken piston rod caught in the track and the engine "pole vaulted" over the connecting rod but it did not derail! The broken motion was over 10' long and it was bent outwards, but about 6' of it was forced into the ground and drawn out again to drag behind. Of course. the broken motion displaced the adjacent track causing 42881 to derail.

Lower slidebars were attached to the upper bar at each end with one $1\frac{1}{8}$ " BSW bolt passing through spacers, heads were down with feathers to prevent rotation and the nuts were on top with $\frac{1}{4}$ " split pins above. The front nuts lay under the valve casing and could only be tightened using a thin spanner, although bruise marks indicated that a chisel like tool had been used. This design had already been recognised as unsatisfactory and a revised one with heads on top had been developed. Each Region was carrying out the modification at its own pace, the LMR decided to wait for routine visits to works. On 70052 the RH front bolt had been reported loose 9 times in the previous 5 months. The need to tighten the RH inside nut had been reported 4 times in three weeks, the last time on the previous day when the fitter took up $\frac{1}{64}$ " without refitting the split pin. The

bars had worked against the loose bolts so that holes were elongated by up to 98 thou and one bolt was wasted by 17 thou.

I am pretty sure that things falling off our engines can cause severe derailment, and while it is unlikely that a DYD "E S Cox" will plough into us, damage to engine is certain and possibly also to passengers. Do check regularly to keep things tight.