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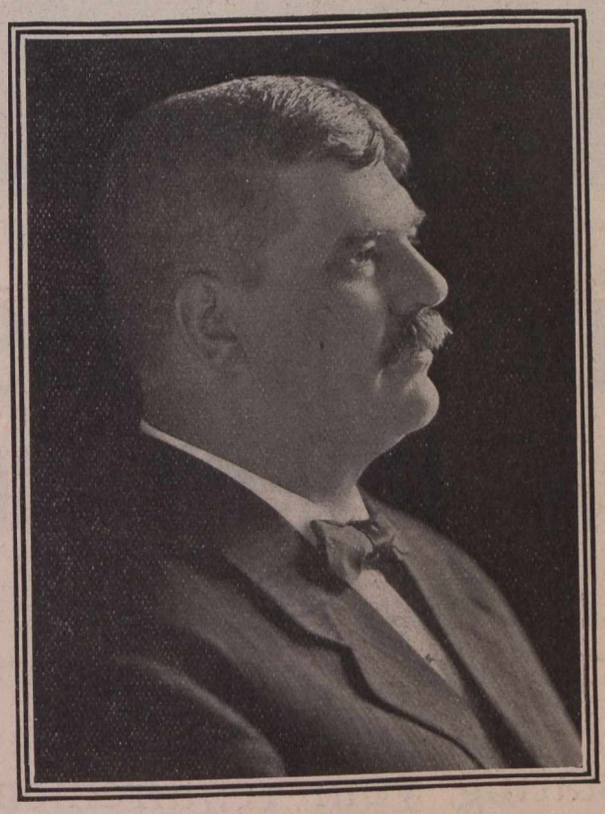
A Review of the Past and Present Locomotive Boiler, with Suggestions.

By T. W. Lowe, General Boiler Inspector C. P. R. Western Lines.

It is not my intention in this paper to attempt to give a complete description of the design, construction and maintenance of locomotive boilers between 1874 and 1910, but rather to refer to them in a general way, and explain the necessity for the many changes in design during the past 36 years. Further on in the paper I will refer to the "Maintenance and care of the modern locomotive boiler," make some remarks on round house practice, and conclude with special reference to feeding the boiler with water, and carrying a sufficient quantity to avoid damage to the crown sheet of the inside firebox, due to the absence of water. When I refer to the boiler, I am speaking about plates under tensile stress, and when speaking about the inside firebox, I refer to plates under compression.

The types of locomotive boilers which have been, and still are, in general use on locomotives on the North American Continent are commonly titled under the following names: Straight, figure 1; wagon top, figure 2; extended wagon top with Belpaire firebox, figure 3, and extended wagon top round top firebox, figure 4, together with many other designs under experiment in the U.S., and which derive their names from the patentee. The only material difference in their construction compared to any I have already quoted is to be found in the design of the inside and outside firebox. The straight boiler, figure 1, derives its name because the barrel plates and outside firebox are parallel on the top, and steam dome being usually located ahead of the firebox. The wagon top boiler, figure 2, consists of a firebox elevated above the barrel courses, with a tapered section joining them, having its dome located over the firebox or taper course, dependent entirely upon the style of staying adopted to support the crown sheet of the inside firebox. The extended wagon top with Belpaire firebox, figure 3, carries the designer's name, the most noticeable difference in construction is at the firebox, here the top is flat and tapered, otherwise the general shape ahead of it conforms to that of the extended wagon top design. The extended wagon top round top firebox, figure 4, has one or more courses ahead of the firebox corresponding in diameter to that of the firebox, with the dome usually located on the course next the firebox and a taper course further forward.

Locomotive boilers consist of the following main parts: smoke box, front tube sheet, tubes, barrel, steam dome, outside firebox, and inside firebox, the latter two being separated at the bottom legs by a foundation ring secured in place by suitable rivetting, all of the inside firebox being supported by threaded stay bolts, excepting a portion of the crown on some designs, which have crown bars and sling stays. Other staying in general use are face plate staying, barrel stays to back tube sheet, front tube sheet staying, dome stays, lateral stays, and flexible stay bolt, all of which when properly designed, marked off, assembled, rivetted, caulked and tubed, entitle the boiler to receive a proof water and steam test, when, if satisfactory, it is ready to be applied to the engine.



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Let us now look into the construction of the straight boiler, figure 1, which in the early days were built with the longitudinal barrel seams lap-jointed, and double rivetted, with very little consideration given to whether the rivet and plate section were proportionately strong, and when of the best construction and workmanship did not figure to have more than 56% of the strength of the original plate, with the factor of safety frequently as low as three, yet we find from our experience that not one of the many of this old construction could ever have failed in service had the practical man and supervisor used common sense, and taken reasonable precaution to repair defects brought to their notice because of leakage. This longitudinal seam construction has been abandoned in the modern boiler and we can now have seams designed which all afford the same strength or more than the original plate, with that much more security. Several of the straight boilers which I met with in my early practice had the longitudinal seams welded throughout and at the time of scrapping they were probably 25 years or more old, and had not caused any inconvenience working under the customary 140 lbs.. pressure per square inch. The Countess of Dufferin, now in the Wm. Whyte park at Winnipeg, is a relic of this design. The steam domes on the Dubb boilers all came to the C.P.R. with welded vertical seams, and although some of these boilers are still in existence working under 150 lbs. pressure, not one of these welded seams were ever known to fail or leak. If asked why the practice of welding seams has been abandoned, I will have to take refuge under the plea that it is expected to be restored again, probably with more success than before because of the thicker material now in general use. The flanging of the old straight boilers had a very sharp radius in contrast to the present designs, and this resulted in frequent cracking in their root, as well as serious leakage at the bottom corners of the firebox.

Although the design of the straight boiler has not been abandoned altogether, the wagon top boiler, fig. 2, was introduced because of the necessity for more steam room. A much improved longitudinal and circumferential seam joint for the boiler came into practice with this design, yet the application of the steam dome on top of the firebox, and the necessity of partly supporting the inside firebox crown sheet with sling stays attached to the dome and crown bars, together with sling stays from the crown bars secured to the wagon top, set up breathing stresses throughout the wagon top, which were constantly being recorded by defects developing with the dome stays, sling stays, dome and wagon top itself, which necessitates frequent inspection and expense to maintain, and because of this it was not long before the extended wagon top with Belpaire firebox, fig. 3, came into favor, and although straight boilers are being built and operated, principally in good water, I would never expect the wagon top boiler to regain its popularity. The extended wagon top boiler with Belpaire firebox, fig. 3, was a radical departure from any previous design in construction, because the top of the firebox is