CORRESPONDENCE.

STAYBOLTS.

Editor American Engineer and Railroad Journal:

The whole secret, I believe, of the staybolt question is the larger water space. We have proved beyond any doubt that, by increasing the width of the water space, and consequently the length of staybolts, we have increased their period of usefulness about thirteen times without the slightest change in the material.

We are still drilling tell-tale holes in the ends of staybolts, and even on old boilers we drill them and afterward test them. In this way a great many partially broken staybolts are discovered.

We are not now putting in corrugated or cupped side sheets in our fireboxes, because we found that the cupped sheets had a life of but 18 to 20 months' service, and, while these sheets have lasted fully as long as straight sheets, we met with difficulty in patching them and found that this could not be done successfully, while with a straight sheet a portion may be cut out and replaced with a patch which is, of course, greatly in favor of the straight sheet.

In riveting up our mud rings we used to put the head of the rivet on the inside of the firebox. We now put the head on the outside of fireboxes, countersinking the sheet inside and driving the rivets up flush. There are several points in favor of this. The first is, that by getting rid of the head there is no obstruction whatever to putting up side grates. We used to have to chop out the side grates for the head. Another advantage is that the corrosive matter does not now stick on top of the heads and cause the sheets to rust out; also, by this method we have quicker work, as the rivet is hammered down flush. The riveting is done on the most important sheet in the firebox inside, where it is likely to give us less trouble from corrosion than if it were on the outside.

Chicago, Ill.,
Nov. 27, 1899.

ROBERT QUAYLE,
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STAYBOLT PROGRESS.

Editor American Engineer and Railroad Journal:

The article in the American Engineer and Railroad Journal of December, under the above caption, was peculiarly interesting to the writer on account of some tolerably thorough investigations concerning staybolt practice made in the winter of 1892-93, the results of which were published in the proceedings of the Southern and Southwestern Railway Club for April, 1893. At that time these results, judging from subsequent correspondence and references, attracted considerable attention, but in seven years' time the report referred to has become ancient history and forgotten, the subject matter investigated all over again by others produces the same results and recommendations to be again forgotten. That the same thing has been going on for generations is plain from the fact that staybolts of the form recommended in the article referred to last month, and in the report of April, 1893, have been found in ancient locomotive boilers that were being cut up years ago. Some thoughtful men had investigated and reached the same results years before, the results to be lost and buried. Our text-books and treatises, our technical teachers, etc., are largely responsible for this.

The writer, being familiar with the rules and formulae, tests, government and Lloyd's rules, etc., was rather taken aback at one time when some staybolts were found broken in three pieces. The boilers in which these were observed were fitted with circulation sheets, and the stays referred to were found broken off at the outside sheet and again at the circulating sheet, through which they had been tapped. Here was an object lesson—the steam pressure and its strains had had nothing to do with the second fracture, as all strain on the stay was relieved when the first fracture occurred.

The next thing that came to the writer's attention in following up staybolt breakages was that bolts broken at the same places in boilers of the same classes and designs, when examined in place, or by marking their position before removal, showed that they had been broken off in the same way. For instance, the staybolts at the reverse bends in the sides of radial stay fireboxes near the middle always showed that vertical bending had broken them, because the line of final fracture, or "let go," was always horizontal. Similarly, in certain long fireboxes the end stays showed a vertical line of fracture, proving that horizontal bending had been their ruin. Different writers, who have touched on the subject of expansion of locomotive fireboxes, have considered the vertical movement of the box or lifting of the crown sheet, but I have yet to see the first mention of the longitudinal expansion as a factor in the staybolt breakages. In a deep, short firebox of the old style, between frames, the differences of longitudinal and lateral expansion are so small that no trouble to speak of comes from them, while the differences in vertical expansion are considerable. With modern shallow fireboxes, ten and eleven feet long, the opposite is the case, and it is the longitudinal expansion which does the most damage in many designs of boilers.

The writer well remembers the pride with which a prominent master mechanic some years ago pointed to a large boiler in the shop wherein all the portions of the firebox where broken stays were troublesome were strengthened by doubling the number of stays—placing them 2¼ inches centers—with the firm conviction that "now, by joining, we won't be worried any more with broken staybolts." The boilermaker and designer places stays, bolts, braces, etc., to make the boiler as rigid as possible, and ignores the destructive effect of the expansion and contraction; or, if he does anything to meet it, it is as above illustrated, to try and master it instead of providing for it intelligently. To attempt to overcome or master the expansion of a boiler due to heating is absurd, and, when indulged in, is really due to lack of appreciation of the irresistible power to be contended with.

Experiments made in England with cylindrical, corrugated fireboxes, showed that, to shorten a "Fox" corrugated firebox 30 inches diameter, one thirty-second of an inch required a pressure of over 300 tons. What would be the power exerted by a flat firebox sheet 10 feet long, well held to its place, and prevented from buckling by numerous staybolts, when due to, say, 1/16 inch of scale, it must expand, say, 1/32 inch in length more than the outer shell? The power is there and is inevitably absorbed by crushing the sheet or breaking the stays; then, when the cooling off process comes, the sheet having been previously shortened, is stretched again. Leaky seams and cracked and pocketed side sheets are the inevitable result.

Inquiry made in 1892 from 22 prominent and progressive railroads brought out the fact that on some roads staybolts had to be tested every week, the renewals being a heavy source of expense and delay to the engines; while on other roads broken staybolts were rare, it being found sufficient to test them once a year. Why the difference? The trouble from broken stays was found to be directly proportionate to the amount of scale forming matter in the water. Where the firebox sheets became rapidly incrusted, so that the inner sheet would be many degrees hotter than the outer shell, there the broken stay and cracked sheet and leaky flue were household words. Where the water was soft and good, so that little or no deposit ever formed on the sheets, both sheets could heat up and cool down together, broken stays and cracked sheets were rarities, and staybolts only had to be tested once a year. It is the repeated bending that breaks the staybolts, assisted of course, by the strain.

A wire rope, if the ends could be secured steam -tight in the sheets, would make an ideal staybolt.

But flexibility in the staybolts is only half the battle. The firebox sheets must expand and contract in all directions more rapidly than the shell sheets; this expansion and contraction should be considered in the design of the boiler at every brace and stay rod, at every seam and corner of the firebox, giving easy curves and bends at all the corners with room for the boiler to breathe vertically, horizontally and laterally. The recently illustrated boiler with a single large corrugated, cylindrical firebox, seems to offer a remedy for all these ills, if it does not introduce other evils of perhaps a worse nature. A few years' hard service for such boilers in districts where the water bears scale and boilers have to be worked to their utmost will bring the answer.

Roanoke, Va.,
December 16, 1899.

R. P. C. SANDERSON,
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