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NICKEL STEEL IN BOILER CONSTRUCTION.

The practical experiments which have been made in the use of nickel steel for boilers have so far given excellent results. Not only is there a lightening of weights due to the superior tensile strength of the alloy, but, what is more important, it has shown both under the test of actual service and in laboratory experiments that it is far more durable than the mild steel ordinarily employed. The saving of weight by the use of the stronger material is not, of course, of so much moment ashore as afloat; but the increased durability which may be given to boilers by using nickel steel for those parts, such as the tubes, which are subject to the most destructive influences, is a question of the very first importance to steam users. Whether the longer life of a boiler built partially or altogether of nickel steel more than offsets its greater first cost may be open to question, but present indications are that it does.

Among the most valuable data on the subject are those afforded by tests which have recently been carried out by Mr. A. F. Yarrow, whose experiments on the question of circulation in water-tube boilers, made a few years ago, attracted much favorable comment and threw upon the subject some greatly needed light. Mr. Yarrow states that the deterioration of boiler tubes is due chiefly to three causes: First, the action of acids in water due to grease; second, the oxidation of the overheated tubes on the outer surface through contact with the hot gases; third, the action of the steam, which if it become superheated decomposes and causes deterioration on the inside of the tubes. Mr. Yarrow made use of lengths of nickel steel and mild steel to ascertain the comparative resisting power of the two materials to the wasting influences above mentioned. This was done in three ways: First, samples were exposed to the action of a dilute solution of hydrochloric acid for certain periods and their weights before and after immersion were compared; then two tubes, one of mild steel and the other of nickel steel, were heated side by side in the same furnace, and the loss due to oxidation through overheating both on the inner and outer surfaces was carefully observed; and lastly, the tubes were heated externally and a jet of highly superheated steam was allowed to act on the inside.

The results in each of the three methods of testing showed the nickel steel to be far superior to the mild steel. In the first test, made on two specimens of the same weight, the loss after 533 hours immersion was in the case of the mild steel 53·19 per cent, while the nickel steel tube had lost only 3·72 per cent.

In the second lot of tests, the amount of oxidation due to the action of fire only was 2·9 times as great in the mild steel as in the nickel steel tubes.

In the third series, with fire outside and superheated steam inside, the nickel steel again demonstrated its wonderful powers of resistance. Each tube weighed originally 612 grammes, and after the test had been running for ten hours, the mild steel tube had burnt entirely through. At this point the nickel steel tube had lost 12·7 grammes as against 85·2 grammes lost by the mild steel. A second mild steel tube was put in, the nickel steel one being retained. After eight hours the second mild steel tube gave out. A third tube was tried and it had been running three hours before the original nickel steel tube gave out, after enduring the test continuously for twenty-one hours. The average life of the first two mild steel tubes was only nine hours. From the last series of tests Mr. Yarrow concludes that deterioration from this cause alone would make it necessary to retube a boiler carrying mild steel tubes 2⅓ times as often as it would one provided with nickel steel tubes.

Another important feature brought out in these investigations related to the permanent increase or decrease in length of boiler plates and tubes due to their heating and cooling. The frequent and sudden variations in temperature due to varying rates of combustion, to opening and closing fire doors, etc., it is well known, produce permanent changes of length in boiler material. In the present tests exact measurements were taken in order to secure accurate data on a question which so materially affects boiler design. It was found that in a mild steel tube 3½ feet in length, which was heated twenty-one times to a dull red for successive periods of two hours length each, superheated steam at a pressure of 60 pounds being passed through the tube, the permanent reduction of length at the close of the tests was seven-eighths of an inch. Now in the case of a nickel-steel tube of similar dimensions exposed to like conditions there was an increase of length of seven thirty-seconds of an inch instead of a contraction. The important bearing of this fact on boiler construction where nickel steel and mild steel are to be placed in juxtaposition is very evident.

Taken altogether, the results of these experiments form a valuable addition to the ascertained data on this subject, and they certainly point to nickel steel as the very material for boiler construction, judged on the score of durability; for Mr. Yarrow estimates that under working conditions boiler tubes containing 20 to 25 per cent of nickel will withstand corrosion for a far longer period than tubes of mild steel, while their resistance to destruction by the action of heated gases or steam is estimated as about twice as great. Of course it must be borne in mind that the greater cost of the alloy more than offsets its longer life, and for this reason mild steel will probably continue to be used for the ordinary stationary boiler; but for special work, where it is desirable to save weight and avoid frequent repairs, it is certainly the ideal material.

TROLLEY CARS ON GRADES.

The trolley car disaster at Stratford, Conn., as we pointed out in our issue of August 19, directs attention not merely to the necessity for providing ample guard-rail protection on bridges but to the perils which arise from careless or ignorant manipulation of the cars on down grades. As a rule, electric cars are provided with unusually powerful hand-brakes and also with means to brake the car by reversing the current. The knowledge that he can stop the car in a very short distance is a temptation to the motorman to run at excessive speed on down grades and to swing around curves at a higher rate of speed than the super-elevation of the outer rail allows. This is a danger to which all trolley roads that combine steep grades and heavy curvature are exposed, and a proper regard for the safety of the public demands that an extra rail should be used on the inside of the inner rail where the degree of curvature exceeds a certain amount. This is particularly important on the long, steep grades which are to be found on many of the existing suburban or interurban trolley roads. A curve which a car will safely negotiate at a speed of fifteen miles an hour would derail a runaway car traveling at thirty or forty miles an hour.

Moreover, on all electric roads that traverse a hilly country the outer rail on curves should be elevated beyond the theoretical amount called for by the normal running speed of the car. This excess of elevation combined with the use of a steel guardrail against the inner rail on the curve would keep a car on the track at a high runaway speed.

The possible risks of a car "getting away" on a down grade received a curious illustration on August 21 upon the steep trestle which leads from the Jersey City Heights to the Hoboken ferry. It seems that the trolley pole had left the wire and that the motorman, in leaning out and looking back, lost his balance and fell from the car, leaving it free to descend by its own gravity. The track is thoroughly well guardrailed throughout, and no disaster followed. Fortunately among the frightened passengers was one having presence of mind enough to spring to the platform and apply the brake, thereby bringing the car to a standstill.

In view of the enormous growth of electric roads and the haste with which they are frequently constructed, it would certainly be advisable for the Legislatures to call in expert advice and pass some laws regulating the question of trolley car control and safety appliances, not merely on bridges, but on grades and heavy curvature.

THE STATISTICS OF OUR VAST RAILROAD SYSTEM.

The latest report of the Interstate Commerce Commission shows that the vast railroad system of the United States has settled down to a steady rate of growth which is in marked contrast to the enormous and, as later developments proved, disastrous additions to its mileage which were made in the last decade. That a boom in construction which resulted in the addition during a single year of 12,000 miles of new road was altogether disproportionate to the demands of the situation was proved by the large number of roads which went into the hands of receivers during and after the panic of 1893. Of late years there has been a decided improvement in the railroad situation, for not only have many roads been removed from the control of receivers, but a certain amount of new construction has been undertaken. The report for the year ending June 30, 1898, shows at that date 94 roads operating 12,744 miles of track were in the hands of receivers, a decrease of 6,116 miles. During the year 45 roads were removed from the receivers' hands as against 11 roads for which receivers were appointed. The total number of railways in the United States was 2,047, and the total number of miles of track in operation, including side tracks and sidings, was 247,523.

To operate this system required 36,234 locomotives and 1,326,174 cars, an increase of 248 locomotives and 28,694 cars as compared with the previous year. The total number of passengers carried was 501,066,681, which is 11,621,483 more than in the previous year, while the number of tons of freight carried showed an increase of 137,300,361 tons, the total for the year being 879,006,307 tons. The gross earnings reached a total of $1,247,305,621, an increase during the year of $125,235,848, while the net earnings for the year were $429,352,345, an increase of $ 59,787,336. The amount available for dividends or surplus was $140,319,421, and the total amount of dividends declared was $96,240,864. The total amount of railway capital outstanding was $10,818,554,031, and of this only thirty-four per cent paid any dividend.

We learn that out of a total of 47,741 casualties there were 6,859 persons killed during the year and 40,882 injured. Two hundred and twenty-one passengers were killed, or one for every 2,267,270 carried, while the number of injured was 2,945, or one for every 170,141 carried. The perils of "railroading," however, are painfully manifest in the facts that one out of every 447 employés is killed and one out of every 28 is injured, the total number of killed during the year being 1,958, and of injured 31,761. We feel constrained again to point out that these statistics of injuries and fatalities indicate that much remains to be done in introducing safety appliances for the protection of employés. The Interstate Commerce Commission has done good work in enforcing the equipment of cars with automatic couplers: and it is to be hoped that in its leniency toward roads which are financially embarrassed it will not lose sight of the fact that the life and limb of the vast army of employés that work our railroads are of paramount importance.

WEIGHT OF MAIL MATTER IN THE UNITED STATES.

Strange as it seems, the United States government has not taken a complete accounting of the actual total weights of the mail matter carried by it for over twenty years. During the time since the last general weighing of mails handled by the railroads and other common carriers the volume of our postal business has increased enormously, and in recent years the transportation weights charged for by these carriers have been largely taken on faith, as the Post Office Department could only estimate, but not accurately know, whether it was being overcharged in the enormous sums that it annually pays for mail transportation.

Some idea of the wonderful increase of this branch of governmental business is had from the fact that an expenditure of $30,393,209.53 for carrying the mails in 1888 had swelled to $52,294,382.23 in 1898, an increase to nearly double in ten years. In 1879 the total length of our postal routes was 79,991 miles; the last report shows it to be now 174,777. The annual transportation over these routes in 1879 was 96,497,463 miles, the last report showing a mileage of 281,595,612. In other words, less than twenty years has seen an increase of 116 per cent in the total miles of route, and of 191 per cent in the gross of annual mileage.

A partial idea of what this whole system of the transportation in bulk of our mail matter has grown to under enlightened management, and owing to the great increase in general literacy, is derived from the following statements taken from figures in the last annual report of the Postmaster-General: Of traveling post offices, on railway, steamboat, electric and cable tramways, we have 1,268 lines, covering 167,755 miles, with a grand total mileage of 285,565,343. Over these and throughout the service were handled 6,349,662,320 pieces of first-class matter, 5,876,043,900 pieces of inferior classification, and 591,492,490 pieces of purely city handling, a grand total of 12,817,198,710 pieces. These, if only averaging the length of a medium-sized envelope, would stretch 1,213,750 miles, or a little over forty-eight and one-half times around the earth.

It is scarcely to be wondered at, when we consider that an accurate weight tally of this enormous bulk of mail has not been taken within a time during which it has more than doubled in size, that there has been considerable Congressional and newspaper criticism of former Postmaster-Generals for paying the immense and rapidly growing bills for this transportation without question; nor is it to be wondered at that almost every session of Congress for the past decade has seen the introduction of some bill looking to the curtailment of these expenses.

The country is now to be congratulated on the fact that Postmaster-General Smith has set in motion an inquiry into this whole matter, from which will grow a clearer and more comprehensive report to Congress on this subject than has been possible since the days of the Grant administration. Three experts from New York city, aided by others already in Washington, have been for some days perfecting plans and preparing circulars, blanks, tables, etc., whereby on October 3 next every post office in the country will begin