

INSPECTION OF BOILERS AND MACHINERY.

Boilers and Pressure Vessels.

The following is a statement of the number of inspections made during the year, the corresponding figures for the previous year being shown in parentheses :—

Boiler and pressure vessels inspected for the first time	..	..	339	(293)
Air-receivers inspected for the first time	..	..	36	(75)
Total inspections of all boilers, pressure vessels, and receivers	..	..	8,000	(7,922)

The number of inspections is a slight increase on that of last year, but is still 144 below the peak year of 1931. The inspections include eighty-one new power boilers, of which fifty-seven, with a total of 1,197 horse-power, were manufactured within the Dominion, and twenty-four, with a total of 761 horse-power, were imported from abroad.

The outstanding boiler defect of the year was found in July last during the ordinary annual inspection of a battery of eight water-tube boilers used in a large factory. Hydraulic tests applied in course of the inspection revealed a number of leaks at the longitudinal lap seams of six out of the eight steam and water-drums of the boilers. Further investigations showed that the leakages were due to a large number of fractured rivets. The majority of the defective rivets were fractured immediately beneath the heads within the boiler, but some were broken clean across the shank about $\frac{5}{16}$ in. from the internal head. The drums were made in three courses of plates, and the defective rivets in every case were in the front and rear courses.

The defective rivets were renewed in five boilers, and the remaining boiler was laid aside for some months while the cause of the defects was being fully investigated. The possibility of the existence of cracks in the plates was considered, and, to eliminate any doubt on the matter, the whole of the rivets in the longitudinal seams of the front and rear courses of the idle boiler were removed and the plates carefully sprung apart to reveal the hidden surfaces. Careful examination by magnifying glasses and a rivet-hole microscope failed to reveal any cracks on the surfaces of the plates or at the rivet-holes.

In the meantime samples of the defective rivets were forwarded to the School of Engineering, Canterbury College, for tests, photo-micrographs and sulphur prints, and to the Dominion Analyst for analysis of the material. The result of tests, Brinell and scleroscope, and photo-micrographs showed the steel to be of average quality in the unannealed state, but rather soft when annealed. No sign of corrosion cracks was observed. Sulphur prints did not reveal any marked segregation of sulphur. The results of analysis showed that the material of the rivets as regards chemical composition was satisfactory in every respect. The sulphur and phosphorus contents were low, and manganese and carbon conformed with the requirements of standard specifications of boiler-rivet steel.

The possibility of the defects being due to chemical embrittlement was not lost sight of during the investigations. Chemical embrittlement is caused by the combined effect of high stress and an intergranular chemical attack on the crystals of the material. Abnormal stresses exist in the neighbourhood of rivet-holes and at the edges of lap-jointed longitudinal seams. Imperfections in workmanship, such as were noted in the seams, accentuate these stresses. Intergranular chemical attack causing loss of adhesion in the crystals of steel has been noted in cases where the ratio of the soda carbonate alkalinity of the boiler water to sodium sulphate has been low. The nature of the rivet-fractures pointed to the desirability of investigating the composition of the boiler water. By arrangement with the manufacturers of the boilers, a very comprehensive report on the water was submitted by a qualified boiler-water analyst. As a result of the analysis the boiler water is regarded with suspicion. The water was found to have a ratio of soda carbonate alkalinity to sodium sulphate of 0.09, but, on the other hand, it contained a certain amount of phosphate, which in the opinion of some authorities inhibits embrittlement. Sufficient evidence is not yet available to definitely establish this opinion, and the owners have therefore been recommended to treat the boiler water with anhydrous soda sulphate, which is a proved inhibitor of embrittlement. Competent authorities have prescribed for the pressure at which these boilers are working a ratio of soda carbonate alkalinity to sodium sulphate of one to one. Routine tests will be made by the owners' chemist to see that this ratio is maintained.

As a further precaution, detection slots $\frac{1}{4}$ in. wide by $\frac{7}{32}$ in. deep will be cut across the outer landings of the longitudinal seams. Should cracking occur its presence should be indicated by slight leakage at the slots before it becomes dangerous.

MACHINERY.

Owing to a change having been made during the second half of the year in the system of reporting machinery inspections it is not possible to say exactly what number of machinery inspections, calculated on the basis of the old system, has been made. From a careful estimate, however, the number would be not less than 27,686, an increase of 1,661 over the previous year's number.

There were five fatal and sixty non-fatal accidents reported during the year, as against seven fatal and thirty-three non-fatal reported during the previous year. As the total number of machines inspected of all classes is about 65,000, the ratio of number of accidents to numbers of machines inspected is 1 in 1,000. In every case the circumstances of the accident were fully investigated by an Inspector of Machinery and the whole of the relevant facts were obtained, including a description of the machine at which the accident occurred, period the machine has been in use, history of previous accidents with the machine, period injured person had been engaged at the machine, complete description how accident occurred, and an opinion as to what was considered to be the cause of the accident, date, and particulars of last inspection of the machine, condition of the machine, description of guarding and fencing, particulars of the danger and warning notices exhibited in the factory, statement of the injured person,