BOILER EXPLOSIONS ACTS, 1882 AND 1890.

REPORT OF PRELIMINARY INQUIRY. (No. 2362.)

(Price—TWOPENCE).

Explosion from the Main Boiler of a Steamship.

Date and place of the Explosion.

The explosion occurred on the 17th February last at about 10 p.m., when the vessel was on a voyage from Liverpool to Ulverston, about one mile S.W. of Lightning Knoll Buoy, Morecambe Bay. No one was injured as a result of the explosion.

The boiler, which was of the ordinary marine type, was 9 ft. 3 ins. in external diameter and 9 ft. in length, with cylindrical shell plates $\frac{23}{32}$ inch in thickness connected longitudinally by a quadruple-riveted lap joint. The end plates were $\frac{11}{16}$ inch in thickness, and were stayed in the steam space by ten nutted stays, each 2 inches in diameter. The furnace tubes, two in number, were plain, welded, and were $\frac{9}{16}$ inch in thickness.

The combustion chamber sides and backs were $\frac{1}{2}$ inch in thickness, and were supported by nutted stays, $1\frac{1}{4}$ inches in diameter, spaced $7\frac{3}{4}$ inches by $7\frac{3}{4}$ inches. The tops of the chambers were each fitted with five girders with two supporting stays to each girder. The tube plates were $\frac{5}{8}$ inch in thickness, and the tubes were $3\frac{1}{4}$ inches in external diameter.

The boiler was provided with the usual mountings, including:—

> Two spring safety valves with stop valves on branch connections. Two glass water gauges. Two water test cocks. Scum and blow-down cocks. Donkey steam stop valve chest.

The boiler was made in the year 1900, and it was therefore, fully 14 years old. Two patches were fitted at the bottom of the back end-plate some years ago, and they were repaired, by electric welding, in November, 1913. The boiler was inspected, from time to time, by the owner's superintending engineer.

The back plate of the port combustion chamber was forced over four of the stay ends, which were situated in the second and third rows from the top and the second and third rows from the vertical centre line of the boiler, and steam and water escaped through the open stay holes. The explosion was caused by an accumulation of scale on the back plate of the port combustion chamber, which allowed the plate to be overheated. The consequent expansion of the stay nuts at that part and the weakening of the material by overheating, permitted them to be forced from the stays, as the plate, also reduced in strength by the overheating, was bulged outwards by the ordinary steam pressure until the stay holes were open.

On the 17th February last the vessel left Liverpool, about 1.30 p.m., with a general cargo, for Ulverston, and during the next four hours proceeded at about half speed so as to arrive at Piel at the required state of the tide. Watches were not set in the engine room until 5.30 p.m., when the two men, who attended to the engines and also acted as firemen, took watch alternately. At about 9.30 p.m., the first engine hand relieved the second, and, at 10 p.m., he heard the sound of escaping steam, this being described as similar to the lifting of safety valves. Flames and steam were seen coming from the funnel, and steam and water escaped from the port smoke-box door. The engines were stopped and the fires were drawn, and, on the master learning the nature of the casualty, the vessel was anchored, and later, when the extent of the damage was ascertained, signals for help were made. The vessel was then one mile S.W. of Lightning Knoll Buoy. About midnight, the Barrow tug, *Furness*, arrived with the Piel lifeboat, and the vessel was towed to Barrow.

On inspection, I found that the back plate of the port combustion chamber was forced over the ends of four stays, as already described, and as shown on the plate. The furnace crowns were also badly bulged, and the port combustion chamber top was deflected fully $\frac{3}{4}$ inch as a result of the yielding of the overheated back plate. The only openings, however, through which the steam and water escaped were the four stay holes in the back plate. I also found that the scale on the tops, backs, and sides of the combustion chambers was about $\frac{1}{8}$ inch in thickness; but it had been softened by some means and was readily detached from the plate. Where the plate had been overheated, it was free from scale; but, immediately below that part, the lower half of a blister remained, and had formed a receptacle for scale which had dropped from the parts above. In that way several layers of scale were accumulated over a part of the plate, and it was obvious that a similar accumulation had taken place at the part of the plate which had failed, and where, probably, the flames had impinged.

According to the evidence, the boiler was opened out and cleaned at intervals of about three months, and it was stated that this rule was adhered to as nearly as possible. The dates on which it was cleaned during the previous eighteen months were as follows:—9th September, 1913; 13th November, 1913; 19th February, 1914; 3rd June, 1914; 8th September, 1914, and 9th December, 1914. On these occasions the boiler was inspected by the Company's superintending engineer, but he stated that, on the last occasion, he was away elsewhere on business, and depended upon the report of a boiler scaling company's manager, who holds a first-class engineer's certificate of competency, stated that he examined the boiler when the work of cleaning was almost completed, and that he could tell, from his private notes, that he was satisfied with the work done, which included the scaling of the furnace crowns, combustion chamber tops and the tube plates; but the tubes were not cleaned externally at that time.

The thickness of the plate which failed was about $\frac{7}{16}$ inch, as measured at that part, the original thickness being given as $\frac{1}{2}$ inch; the stays were in good condition, the nuts being 1 inch in depth. The boiler was fed, when the vessel was under way, by a feed pump, which was worked by the main engines, and any extra feed required was made up from the sea. In harbour, it was fed from the dock or river by an injector. Also in port the loss of water caused by the working of a winch required to be made up.

From the evidence, it appeared that the engine man in charge, who did not possess any certificate of competency and had been promoted from second engine man or fireman, joined the vessel on the 20th January last. He had previously acted as first engine man for short periods. He was then informed that the boiler was last cleaned on the 11th December, and he states that he had not received any special instructions as to the density at which the boiler water should be kept, but that he knew it was the general practice to keep it about $\frac{1}{32}$ or as near thereto as possible. Shortly after he joined, he tested the density by means of a salinometer and found it to indicate about $\frac{4}{32}$. The vessel was then in dock at Preston, and he took steps to scum, blow-down, and pump up within the range of the glass water gauge until he performed the operation six times, and the density was then stated to be $\frac{1}{32}$. On other occasions the work of scumming and blowing-down was resorted to with the intention of keeping the density as low as possible, and on the 17th February, before leaving Liverpool, the density was found to be $\frac{2}{32}$. Further there was no evidence, of any damage to the boiler on that date before proceeding to sea.

It appears to have been the practice to test the feed-water during every trip, and there was no evidence of any leakage from the condenser or extra feed cock. Also, it was the practice to keep the scum and blow-down cocks on the boiler shut when not in use, and the sea cock, which I found to be perfectly tight, was also shut after being used, and, therefore, there did not appear to be any loss of water from the boiler on that account.

When leaving Liverpool, on the day the explosion occurred, the water in the boiler was noted to be about 1 inch from the top of the glass gauge; and when the ship was rolling during the passage, up to the time of the explosion, it was observed that the water moved up and down throughout the length of the glass. The steam pressure was well maintained during the passage, the safety valves lifting on two occasions, and steam was showing from the valves nearly all the time; the pressure at the time of the explosion being 120 lbs. per square inch. The superintending engineer, further stated that he instructed the engine men in the Company's vessels not to allow the density to get higher than $\frac{2}{32}$, and that he meant by that instruction that they should not commence to blow-down for the purpose of reducing the density until it rose above that amount, but he did not appear to have had an opportunity of ascertaining the practice in this particular case.

It was evident that, although the engine man in charge showed discretion in the selection of some of the places where he more or less changed the water in the boiler, his practice resulted in an increase of scale in the boiler, although it kept the density low. Loose scale to the depth of three inches was found on the bottom of the boiler. Further, the treatment had softened the scale, which had become more or less detached from the surfaces, and this condition was the apparent cause of the accumulation of the scale in places. The scale on the tubes, which was from $\frac{3}{16}$ to $\frac{1}{4}$ inch in thickness and was readily removable, had dropped upon the furnace crowns, causing them to be so severely pocketed as seriously to threaten rupture of the plate.

Observations of the Engineer Surveyor-in-Chief.

This explosion was clearly the result of the over-heating of the plates, in consequence of which the vessel was disabled and had to be towed into port. Fortunately, no injury was sustained by those engaged in the engine room.

A. BOYLE.