BOILER EXPLOSIONS ACTS, 1882 AND 1890.

REPORT No. 2323.

(Price—TWOPENCE).

(Printed by MESSRS. BARCLAY & FRY, The Grove, Southwark Street, S.E.)

Explosion from a Cast Iron Evaporator.

Date and place of the Explosion.

The explosion occurred when the vessel was about 10 miles from Monte Video, on a voyage from Rotterdam to Coronel, Chile.

The third engineer was scalded about the face, arms, and upper part of the body, by the escaping steam and hot water. The fourth engineer, was similarly scalded, though somewhat more severely, and his eyesight was affected. The injured men have now fully recovered, with the exception of the fourth engineer whose eyesight is still affected.

The shell of the evaporator was made of cast iron, $\frac{5}{8}$in. in thickness, in the form shown on the attached plate; the particulars given being copied from a print supplied by the makers. The upper portion was cylindrical in form, being about 2ft. 7ins. in height and 2ft. 6ins. in internal diameter. The lower portion was of "U" form, and was about 3ft. 8ins. in height; the radius of the cylindrical part being 1ft. 5ins. The thickness of the top and bottom was $\frac{7}{8}$in. Attached to a flange cast on the body of the lower portion was a flat cast iron inspection door, 3ft. $10\frac{3}{8}$ins. in length by 3ft. 4ins. in breadth. The heat of evaporation was supplied by steam from the main boilers, which worked at a pressure of 180 lbs. per square inch. A copper coil, $1\frac{1}{2}$ins. in bore, 106ft. 10ins. in length, and $\frac{1}{8}$in. in thickness was fitted, and the steam supply was controlled by a stop valve, $1\frac{1}{4}$ins. in diameter. A vapour valve, 3ins. in diameter, spring-loaded, to lift at a pressure of 10 lbs. per square

inch, a relief valve, 1½ins. in diameter, spring-loaded, to lift at a pressure of 15 lbs. per square inch, and the other usual mountings were fitted. It was about three years old.

The makers state that it is their practice to test all evaporators both by steam and water before they leave their works, but they cannot state definitely whether or not this evaporator was so tested. The mountings of the evaporator have been overhauled from time to time. About one month prior to the explosion, the relief valve was overhauled and adjusted by the second engineer, who also fitted a new compression screw. Other than the above no repairs have been made. The evaporator and its mountings have been inspected periodically by the engineers of the vessel, the last inspection being made by the second engineer about one month prior to the explosion. The evaporator, together with the rest of the machinery and the hull of the vessel, was insured with various companies and with Lloyd's Underwriters.

The explosion was of a violent nature; the lower portion of the shell being broken into a number of pieces, one of which struck the donkey pump and disabled it. The access door was also broken. The upper portion of the shell fell over on to the auxiliary condenser, and cracked it. The copper heating-coil and the pipe connections were fractured and otherwise damaged. The explosion was due to excessive pressure of steam in the evaporator. This excessive pressure was caused by the steam generated not having a means of escape; the vapour or outlet valve being closed and the relief valve partially, if not totally, inoperative.

The evaporator, an explosion from which forms the subject of this Inquiry, was fitted on board when the vessel was built, to supplement the feed water for the boilers. The vessel left Monte Video about 11.0 a.m. in continuation of a voyage from Rotterdam to Coronel, Chile. The first, second, and fourth engineers were in the engine room carrying out the usual duties involved in the vessel leaving port. When the vessel was clear of the harbour about 11.30 a.m., the first and second engineers left the engine room and the fourth engineer was then left in charge. Before leaving, the first engineer gave the fourth engineer instructions to start the evaporator, and the fourth engineer carried out this instruction and opened the vapour

valve when the pressure register on the gauge reached 7 lbs. The fourth engineer was relieved by the third engineer at noon or shortly afterwards. The third engineer states that, when he went on watch the pressure registered on the steam gauge of the evaporator was about 9 lbs., but he did not try the vapour valve to see if it was open or not; he again saw the evaporator, about 12.20 p.m., when it was, apparently, working satisfactorily. The fourth engineer returned to the engine room, about 1 p.m., to relieve the third engineer for dinner, and while they were talking together on the bottom platform near the H.P. engine they heard a hissing noise like that made by the escape of steam, coming from the direction of the evaporator. They proceeded towards the evaporator, but had only gone a few paces when they were knocked over by the force of a violent explosion; both, however, escaped, by way of the stokehold to the deck. They were both scalded, and the fourth engineer lost his eyesight. They were treated on board by the master, and, on the arrival of the vessel at Monte Video, were removed to a hospital, where they stayed for about five weeks. They returned home convalescent, and have now recovered, except that the fourth engineer's eyesight is still somewhat defective.

The first and second engineers shut off steam and had the fires drawn, and the former made an examination and found that the evaporator had exploded, that the vapour valve was closed, but that the relief valve was free to lift. He further states that the second engineer informed him that he had slackened back the compression screw on the relief valve after the explosion had occurred. The second engineer stated in his evidence that, when he examined the evaporator, after the explosion, he found the vapour valve closed, and he also noticed that the compression screw on the relief valve had been screwed down further than when he adjusted it about a month prior to the explosion. The third engineer states that he had never seen the relief valve lift properly although the pressure registered by the gauge had been about 20 lbs. per square inch, and, further, that he is certain that the relief valve was not blowing off steam immediately before the explosion. He also states that he has known the screw, by which the vapour valve was closed, to work down by the vibration of the machinery and partially close the valve. But this would not account for the position the screw was found in after the explosion, namely, hard down, and the valve closed.

The usual method of working the evaporator was to use it for two hours during each watch; then to blow it down and allow it to remain idle for another two hours. In blowing down, the vapour valve was closed and the pressure allowed to rise to 12 or 14 lbs.; then the heating system was shut off and the blow down cock opened, the pressure forcing the brine overboard. Thus, there would appear to be no necessity for the vapour valve to be closed at the time the explosion occurred. The broken parts of the evaporator were thrown overboard whilst the vessel was at sea; and I have, therefore, been unable to ascertain the condition of the shell or the mountings at the time of the explosion.

The relief valve fitted was of the dome type, with a screw working through the dome for regulating the compression on the spring. This type of valve is unreliable owing to the fact that it can be easily tampered with, and the load on the valve can be increased without the knowledge of the first engineer. This, apparently, is what happened in the present case, as the second engineer overhauled the relief valve, fitted a new compression screw, and adjusted the valve to lift at 14 lbs. per square inch. The first engineer states that he had no knowledge of this having been done; he received the first intimation regarding it after the explosion had occurred, when he noticed that a new compression screw had been fitted. The heating coil was $1\frac{1}{2}$ inches in bore, and 106ft. 10ins. in length, and steam was supplied from the main boilers, which worked at a pressure of 180 lbs. per square inch; the steam-inlet valve being $1\frac{1}{4}$ inches in diameter. In the event of the vapour valve being shut when the evaporator was under steam, the size of the relief valve fitted was totally inadequate to prevent steam from accumulating to a dangerous pressure.

Observations of the Engineer Surveyor-in-Chief.

The pieces of the broken castings were unfortunately thrown overboard, and therefore the Surveyor has had no opportunity of examining them, but by the evidence obtained from the engineers of the vessel the explosion would appear to have been due to over-pressure of steam.

The outlet for steam is stated to have been closed, and the area of the relief valve provided, even if the valve was properly loaded, was inadequate to relieve the apparatus of undue pressure. The valve could only be considered as a "sentinel" valve to warn the engineer in charge that the inlet steam should be shut off. Moreover, it was of such a type that it could be

readily overloaded without the knowledge of the first engineer, and it would appear that this did happen at some time prior to the explosion.

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BOILER EXPLOSIONS ACTS, 1882 AND 1890.

REPORT No. 2328.

(Price—TWOPENCE).

(Printed by MESSRS. BARCLAY & FRY, The Grove, Southwark Street, S.E.)

Explosion from Main Boiler.

The explosion occurred on the 9th July, at about 11.10 a.m., when the vessel was on a voyage from the Hook of Holland to Harwich. Two firemen were scalded on the arms, body and face. Both men have now recovered from their injuries.

The boiler is of the ordinary cylindrical marine type, 13ft. 3ins. internal diameter and 11ft. 6ins. long, with three furnaces of the Fox corrugated type 3ft. internal diameter and constructed for a working pressure of 180 lbs. per square inch. The boiler is fitted with the usual mountings and is worked under the closed stokehold system of forced draught.

On the trial trip of the vessel, in 1904, this boiler was allowed to become short of water, resulting in the buckling of the crown and wrapper plates of the port combustion chamber. The defective portion of the crown plate was cut out and renewed, but nothing was done to the wrapper plate. In December, 1912, a patch was fitted on a stay hole and the stay renewed, in the back plate of the starboard chamber. Six stays fitted in the back plate and four stay nuts renewed in the port chamber. In August, 1913, a patch was fitted to the port wrapper plate, the rivets renewed in the bottom seam and tee bars and four stay nuts renewed in the back plate of the centre chamber. One stay renewed in the back plate of the port chamber.

In January, 1914, one stay was renewed in the back plate of the starboard chamber. In May, 1914, the ends of three stays in the port chamber, owing to defective screw threads, were reduced by means of a die nut from $1\frac{1}{2}$ins. to $1\frac{3}{8}$ins. diameter and new nuts were fitted. These nuts and an adjoining one

were those which failed and caused the explosion. There have also been a number of stay nuts renewed and seams caulked of which no record was kept. The combustion chamber screw stays have 12 threads per inch.

The boiler was constructed under Board of Trade survey. It has since been under the supervision of the owner's Superintending Engineer and his assistants.

The nuts were forced off the ends of four stays in the starboard wrapper plate of the port combustion chamber, the plate was forced along the stays until the holes in the plate were over the reduced stay ends referred to above.

The explosion was caused by the screw threads in the stay holes of the wrapper plate being destroyed, owing to buckling of the plate when the boiler was new and to subsequent repeated caulking in order to prevent leakage. The stay nuts also were not a good fit on the stay ends.

The nuts when heated under working conditions expanded and had insufficient hold on the stays to support the plate at the ordinary working pressure of the boiler.

General Remarks.

The steamer is a twin screw vessel, fitted with two sets of triple expansion engines, and steam is supplied to the main engines and auxiliary machinery by two single-ended boilers working under the closed stokehold system of forced draught. The safety valves are adjusted to lift at a pressure of 180 lbs. per square inch.

On the 9th July, at 9.50 a.m. the vessel left for Harwich, and at 11.10 a.m. the Chief Engineer, who was on watch in the engine room, heard the fireman, A. Keeble, shouting on the deck, and upon inquiring what was wrong was informed that the starboard boiler had given out and that his mate, R. Cheek, was still in the stokehold.

The Engineer then went to the air hatch, through which access is obtained to the stokehold, but just as he got there the man came out. The forced draught fans were stopped and the main and auxiliary steam valves on the starboard boiler were shut and the safety valves eased.

The water gauge glass which was $\frac{3}{4}$ full just previous to the boiler giving out, was found to be empty and the steam pres-

sure had fallen from 175 lbs. to 100 lbs. per square inch. All the feed water was discharged into the starboard boiler, but failed to bring the water into the gauge glass.

About 20 minutes afterwards the relief firemen were able to enter the stokehold and draw the fires from the furnaces of the damaged boiler. Water was running out of the port furnace and in the combustion chamber it was found that the plate had moved along the four stays, forcing the nuts off them, and as three of these stays had the ends reduced from $1\frac{1}{2}$in. to $1\frac{3}{8}$in. diameter there was considerable leakage. The vessel proceeded on her voyage to Harwich, steam being supplied by the port boiler, and she reached her destination without further trouble. The injured men received medical attention on the vessel's arrival.

Observations of the Engineer Surveyor-in-Chief.

The defective condition of these stays does not appear to have escaped notice, as the plates had been caulked from time to time on account of leakage. The continued caulking of the plate, and also the reduction of the stay ends by means of a die nut is at all times a very questionable method of repair, and it would have been much better had new stays and nuts of a larger size been fitted in the first instance. The pitch of the threads on the stays also is finer than is desirable.

Fortunately the personal injury was not serious.

BOILER EXPLOSIONS ACTS, 1882 AND 1890.

(Price—Twopence-Half-penny).

(Printed by MESSRS. HARRISON & SON, St. Martin's Lane, W.C.)

Report to the Secretary of the Board of Trade upon the Working of the Acts during the Year ending 30th June, 1914.

Under the provisions of the Boiler Explosions Acts, 64 preliminary inquiries and four formal investigations have been held respecting boiler explosions which occurred during the year ending 30th June, 1914.

Of these 68 explosions, 40 resulted in loss of life or personal injury—22 persons being killed and 74 injured. The 22 deaths were caused by 11 explosions, of which eight occurred on land and three on ships.

The number of persons killed is below the average (26·3) for the 32 years since the Act came into force, but the number of injured is above the average. It is satisfactory to be able to record a drop in the number of explosions which occurred during the year, which is below the average (72·8).

Reference may be made here to the important recommendations made by the Commissioners in Report No. 2,299. The Commissioners recommend that every boiler should be thoroughly examined periodically and tested by water pressure by a competent person, and they also suggest that makers of ploughing engines should put a plate or mark on each engine showing the date of construction and the working pressure for which the boiler was constructed.

A summary of the reports of inquiries is given in Appendix A, and the causes of the explosions and the types of boilers which exploded are classified in Appendix B, which also shows the cases in which the boilers were under the inspection of