BOILER EXPLOSIONS ACTS, 1882 AND 1890.

REPORT No. 2384.

Explosion of a Donkey Boiler.

THE explosion occurred on the 7th day of June, 1915, at about 2.30 p.m., the vessel then being in Algiers and cargo being worked. James Gordon, fireman, was badly injured and he died about ten minutes after the explosion, from the effects of his injuries. Robert Bateman, Matthew Taylor, Thomas Proctor and Peter Erskine, firemen, also William Dixon, donkeyman, were injured and received attention in hospital, but they were able to join the ship before leaving Algiers, and have now recovered from their injuries.

The boiler, which was made in 1899, is of the ordinary cylindrical, multitubular, marine type, 8 feet 6 inches mean diameter and 8 feet 6 inches mean length, with two plain furnaces 30 inches external diameter. The shell is made up of two belts of shell plating, original thickness $\frac{15}{32}$ inch, each belt being made up of two plates; the circumferential seams are single riveted lap joints, rivets $\frac{13}{16}$ inch diameter and $2\frac{1}{8}$ inches pitch; the longitudinal seams are treble riveted lap joints, there being five rivets, $\frac{13}{16}$ inch diameter, per pitch of $4\frac{1}{4}$ inches. All the customary mountings are provided, including one single-spring-loaded safety valve $3\frac{3}{4}$ inches diameter, which had been adjusted for a working pressure of 80 lb. per square inch, this being the working pressure the boiler had been constructed for. In 1912 all plain tubes were cut out and removed, six screwed stays in combustion chamber were removed, and a new safety valve fitted, besides a general overhaul, grinding in, and re-packing of the mountings. The after belt of the shell plating immediately above the starboard longitudinal seam fractured in a longitudinal direction for about 3 feet 6 inches and then in a circumferential direction from both ends of the fracture for a little over half the circumference. The re-action of the explosion caused the two boiler stools to buckle and pierce the shell of the boiler on the bottom port side, also bulging inwards and fracturing the port furnace. Two wing combustion chamber riveted stays were drawn through the shell on the port side and several other stays started. The shell had a small hole immediately below the starboard longitudinal seam, and also a fracture in the middle of the top of the after belt of shell plating, caused by striking a beam above the donkey boiler recess. The auxiliary stop valve, donkey stop valve, safety valve chest, water gauge cocks and pressure gauge were broken off the boiler; and the donkey boiler was forced from the stools over against the port side of the donkey boiler recess. Considerable damage was done in the stokehold to pipe connections, main boiler smoke boxes, ventilators, etc. The cause of the explosion was a weak plate, so corroded as to have been unable to withstand the pressure of steam to which it was subjected.

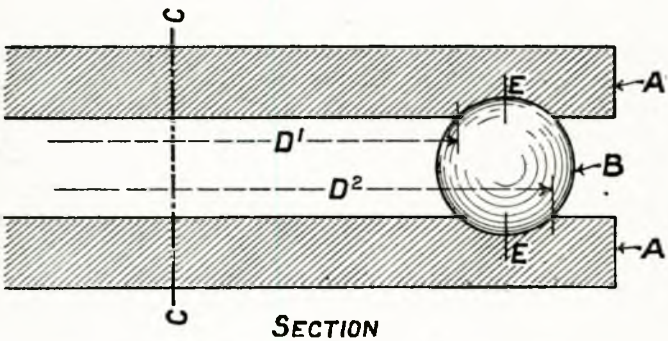
This is a formal investigation into the causes and circumstances attending the explosion of a boiler which occurred at Algiers last June. The boiler which exploded was a donkey boiler, used for supplying steam to auxiliary machinery in this ship, and was placed in a recess in the forward part of the stokehold. The facts are simple, and not really in dispute. The vessel and machinery were classed at Lloyds 100 A.1. This classification depends upon periodical surveys by the surveyors to Lloyds' Register of Shipping. The survey of the boiler in question was made on the 8th April, 1915, by an Engineer Surveyor to Lloyds. Previous annual surveys had been made, but nothing arises out of them. A survey was also made on the 8th April by the engineer assistant to the consulting engineer to the owners, and had charge on their behalf of all engineering matters, including the inspection of the boilers and their repair. The survey having been made, and the boiler passed as safe, the vessel started on a voyage to Genoa on the 5th May. The chief engineer of the ship held an extra first-class certificate. On the voyage, the heating surfaces of the boiler were scaled, and he examined the boiler generally. On arriving at Genoa the winches were used for the working of the cargo, and during this work a small crack was discovered in the shell plate of the boiler, on the starboard side. The lagging was partly removed, the boiler emptied, and both the exterior and the interior of the shell in that part were examined by the chief engineer, who then discovered corrosion round about the crack over an area of about 4 inches by 1½ inches on the inside. The crack ran longitudinally in the direction of the seam. The exact position of this crack was immediately under a patch. The chief engineer had a hole bored at each end of the crack to prevent its extension, and a plate put over the outside, and this plate was jointed and bolted to the shell. The inside over the area of corrosion was covered with Portland cement. The chief engineer having satisfied himself that the boiler was safe for a pressure of 80 lb. per square inch (the pressure at which the safety valve was set to blow off), steam was got up, and the boiler again used. On the 1st June the vessel left Genoa for Algiers, and during this voyage the boiler was washed out and the loose scale removed. The chief engineer again examined the boiler, and the cement on the inside was taken off for that purpose and the place from which the cement had been removed was re-cemented. On arrival at Algiers on the 4th of June the boiler was again used to supply steam for the purpose of working of the cargo, and it continued to be so used until it exploded on the 7th June, at about 2.30 p.m. The explosion ruptured the outer shell longitudinally on the line of the crack.

After the explosion it appeared, from an examination of the boiler, that the outer shell had been corroded over a much larger area than the part covered by the patch, this corrosion being about 1 foot wide, tapering towards the seam where the crack had been found, and extending for some distance nearly parallel therewith. There was also corrosion on the inside of the outer shell over the stools supporting the boiler. The smallest thickness to the metal was found to be $\frac{1}{16}$ inch in places at the edge of the rupture but this may have been due, to some extent, to the tearing of the metal by the explosion. It is quite clear that if the thin part of the plate (caused by corrosion) found after the explosion, had been discovered at the survey in April, the boiler would never have been passed for any useful pressure of steam. The engineer surveyor to the Board of Trade stated that "there must have been sufficient corrosion to render the boiler unsafe for any reasonable working pressure." The question arises how this deterioration of the plate, caused by corrosion, escaped observation. The deterioration of the plate appears to have been of long standing, the corrosion having been arrested by the scale, which formed a natural preservation to the metal. We were told that the scale on the inside of the outer shell was not discoloured, and that there were no indications of corrosion at the time of the examination in April, either to the eye or as revealed by the hammer test. The Engineer Surveyor to the Board of Trade stated that he could not say that "if competent surveyors inspected the boiler in April previous to the explosion the corrosion (viz., the corrosion which was found to exist after the explosion) could have been detected."

The state of mind of an examiner of a boiler should be one of suspicion of every part of the boiler, a defect in which might affect its safe working, and he should not be satisfied until he has ascertained, by one method or another, that his suspicions are unfounded. With regard to the chief engineer of the ship, he relied, no doubt, to some extent, upon the fact that the boiler had been recently inspected and passed by the Surveyor to Lloyds' Register. He tells us that the corrosion he discovered was confined to a space of 4 inches by $1\frac{1}{2}$ inches. There was no evidence before us to show that this corrosion should have put him on inquiry as to the other parts of the boiler, and the Engineer Surveyor to the Board of Trade said that he could not say from his examination of the boiler after the explosion that the engineer was wrong in the evidence which he gave as to the thickness of the plate round about this corrosion where the patch was put on.

Correspondence.

The August Transactions contains the paper read by Mr. J. Veitch Wilson on "Comparative Efficiency of Lubricants," and in the discussion which followed the question of lubricating ball-bearings was raised. Writing as a Graduate to Graduates, it may be interesting to note that in theory, ball-bearings should not require much lubricant, *if any*.



Ball-bearing *re* Mr. Veitch Wilson's Paper on Lubrication.

In sketch, let A.A. be two plates slightly grooved as shown to accommodate race of balls B, which whole rotate about axis C.C. (in plane of paper). Now, in rotating, the periphery of ball touching D_1 will not traverse so far as that touching diameter D_2; from these conditions the ball must perform a cyclical rotation with an axis parallel to C.C., *i.e.*, through the plane of paper. The result of this secondary motion is a "scouring" of the ball surfaces in contact with A.A., this causing the usual "scaling" of balls' outer skins. Should this scouring take place more on one ball than the rest, its diameter will be effectively reduced, thus causing a greater intensity of stress on the other balls. The amount of the increasing intensity of stress will cause rupture to the bearing as a whole, if not checked in time. In order to reduce this inevitable "scouring" we use a lubricant to minimise the whole trouble. But, should we use flat races (A.A.) ungroved, the ball evidently has one pure revolving motion unattended by this above-mentioned "scour" or scaling of the balls. Further, as the friction between our flat surfaces and balls is now one of rest and not motion, as the ball surface and flat plates or races A.A. are momentarily at rest touching at one point only E.E., the use of a lubricant is unneccessary for good running. A disadvantage for flat ball races would be the consequent lowering of the safe load, compared with the grooved race. It is for engineers to determine as to how far we shall form a compromise of these two types of ball-race.

My only excuse in troubling you with a note so much "out-of-date" is that my time of late has been occupied to the full.

D. Laugharne-Thornton,
Graduate.

ELECTION OF MEMBERS.

Members elected at Council Meeting in January, 1916:—

As Members.

Grenville Crosby Austin, West End House, Little Shelford, Cambridgeshire.

John Thorburn, 135, Boundary Road, East Ham.

Joseph Matthews Bowman, The Laurels, Trelaw, Rhondda, Glam.

John Chalmers McLean, 22, Dempster Street, Greenock.

Norman Macgregor Yorke, 9, Berthwyn Street, Cardiff.

Donald MacNicoll, 7, Kingsland Drive, Cardonald, Glasgow.

Wm. Caldwell Houston, 31, Clarendon Gardens, Ilford, E.

John Smart Smith, 47, Parliament Street, London, S.W.

As Associate Member.

Sibbald Pollock, Fire Station, Aberdeen.

As Associates.

Francis Donald Anderson, 8, Yorke Avenue, Jordan Hill, Glasgow.

Thomas Wm. Chick, Barrodene Cottage, Grosvenor Road, Weymouth.