

1886-5-11, Boiler Explosions Act, 1882; Report 178: Explosion on board the canal boat *Ida*. Consultative Branch, Marine Department, Board of Trade, Bedford Street. Covent Garden, London, W.C., 11th May 1886.

I have the honour to inform you that I proceeded to Liverpool on Monday, the 3rd instant, and there made preliminary inquiry respecting the explosion of steam boiler that occurred on board the canal boat *Ida* while making a passage from Leeds to Liverpool.

Date and Place of Explosion.

The explosion occurred at 3.50 p.m. on Friday, 9th April last, while the boat was stopped outside Foulridge Tunnel, which is 46 miles from Leeds.

Name and Address of Owners.

The boat belongs to the Leeds and Liverpool Canal Company, whose head office is in Old Hall Street, Liverpool

Persons Killed.

One of the crew, named James Gore, was severely scalded, and died in Blackburn Infirmary on Tuesday, 19th April, having been admitted to that institution on the day of the explosion.

Description and Principal Dimensions of the Boiler, &c.

The boiler in question supplies steam to a pair of non-condensing screw engines by which the boat is propelled, and is of the cylindrical vertical type with Field tubes hanging from the crown of the fire-box, as shown on the sketches herewith, Plate IL The usual working pressure is about 100 lbs.

The shell is 5 ft. 6 ins, high by 3 ft. 6 ins, in diameter, and was originally made of two plates $\frac{1}{2}$ in. thick, arranged vertically with the longitudinal seams at the sides, but the front is now in two parts, the bottom half having been renewed and secured to the top half by single riveting. The vertical seams are lap and double riveted with $\frac{3}{4}$ -in. rivets, pitched $2\frac{3}{4}$ ins. apart. The crown is flat and made of one plate $\frac{5}{8}$ in. thick, flanged downwards at the periphery and joined to the cylindrical portion by single riveting.

The fire-box is about 3 ft. in height and 3 ft. in diameter, and is made of two plates $\frac{7}{16}$ in. thick, arranged vertically with the longitudinal seams at the sides. It is worked out in the usual way at the bottom end, and at the firing hole, but not to the full extent at the latter, there being a solid distance ring $\frac{1}{2}$ in. thick intervening there. The crown, like that of the shell, is flat and made of one plate $\frac{5}{8}$ in. thick. It is flanged upwards at the centre, and downwards at the periphery for connexion with the uptake and sides respectively. All the seams, including those of the crown, are lap and single riveted.

The uptake is placed centrally with respect to the shell, and is made of one plate $\frac{1}{2}$ in. thick, welded longitudinally, the diameter being 10 ins. The top end passes through a flanged collar secured to the crown of the shell by single riveting, and inside it there is a fire-clay lining protected by a wrought-iron sleeve for the purpose of preventing the portion that passes through the steam space from becoming unduly heated.

The Field tubes (iron) are $\frac{1}{10}$ inch in thickness, $2\frac{1}{4}$ inches in diameter outside, and 18 inches in length over all, except those immediately in the wake of the fire-hole, which are somewhat shorter, in order to leave sufficient room for firing. The open ends of these are expanded into the holes, slightly conical, provided for them in the fire-box crown, and the bottom ends are worked into a hemispherical form and welded. There is a wrought-iron pipe inside each tube for the purpose of assisting the circulation of the water in the latter. These pipes, which are $\frac{15}{16}$ inch and $1\frac{3}{16}$ inch diameter inside and outside respectively, are a few inches shorter than the tubes, and the top end of each is fitted with a cast-iron conical cup with four ribs, which

rest on the top of and partly enter the tube, thus leaving an opening between the cup and tube for the passage of the ascending current of mingled steam and water.

Above the crown of the fire-box, and encircling the uptake, there is a circular cast-iron basin which forms a quiescent part in which earthy matter collects.

Beneath the uptake, at a few inches below the level of the fire-box crown, there is suspended by a long bolt from the top of the sleeve, referred to above, a cast-iron circular plate, the object of which is to cause the flame and hot gases rising from the fuel to pass between and in contact with the tubes while on their way to the chimney, instead of taking the shortest route to the uptake, as they otherwise would. There are four mud-holes, one of which will be referred to further on. The boiler is fed with canal water, which contains a large quantity of lime in solution.

Boiler Mountings.

The mountings consist of—

One steam-pressure gauge (Bourdon's principle) graduated to 120 lbs. by 10 lb. increments.

One safety-valve, 2½ inches diameter, loaded direct by a spiral spring in compression.

One glass water-gauge.

One blow-off cock.

One steam stop-cock to main engines.

One pipe to donkey engine.

One feed check-valve with cock between it and boiler.

One steam whistle.

One blast pipe.

One feed-heater, consisting of a coil of piping inside a cast-iron box. The exhaust steam enters the box and heats the feed water while passing through the coil on its way to the boiler. There is also a by-pass through which the boiler can be fed direct in the event of the heater becoming disabled.

Name of Maker and Age of Boiler.

The boiler was made by Messrs. William Wilkinson and Co. (Limited), Engineers and Ironfounders, Holme House Foundry, Wigan, in September 1879, and was put on board the *Alert*, belonging to the Leeds and Liverpool Canal Company, who, between November 1881 and February 1882, transferred it to the *Ida*.

Particulars and Dates of Repairs.

The front plate of the shell was cropped and the bottom half renewed in March 1883.

The fire-box appears to have been almost renewed on two occasions, viz., at the time the front plate was cropped, and again in September 1884. The boiler was also re-tubed at the latter date. About four months ago a rivet in one of the vertical seams of the fire-box leaked, and a hole was cut in the shell to get a new one in, the hole being afterwards fitted with a portable door, and utilised as a mud-hole.

In September 1885 the boiler was re-tubed, in accordance with the Company's practice of re-tubing each boiler once a year. From that date until the middle of November none of these tubes were renewed, but since then six tubes were supplied to the boat on each of the following dates: 21st November, 11th December, 18th January, 8th February, 22nd March.

Twelve additional tubes were supplied on 12th April, that is, three days after the explosion occurred, and ten others on Saturday last, 1st May, four of which are still on board unused.

Persons, Societies, &c. who have inspected the Boiler.

The boiler has been frequently inspected by William Mather, an engine-fitter who has been in the service of the Company since March 1882. Mather stated that he last examined it on

Sunday the 28th March last, after it was cleaned, and thought a good job had been made of it, but he did not examine the tubes internally. It has also been inspected by John Gibson, who has been engine superintendent to the Company since June 1884. Gibson stated that he made a thorough inspection of the boiler in September 1885; and that between that date and 11th April last he had examined it internally about half a dozen times, the last occasion being on or about the 14th March, and that it was then in fair condition as regards scale.

It has not been examined by any of the inspecting companies, nor is it insured, except in so far as the owners have a fund set apart for that purpose.

As regards cleaning, it was the practice of the boatmen to open the boiler once a fortnight and clean it internally, a tool like a long-handled spoon being used to lift the soft deposit out of the tubes.

Nature of Explosion, and Part of Boiler that gave way.

The bottom of one of the Field tubes at the back part of the boiler was blown out, leaving an orifice, the area of which I estimate at about two square inches, through which the water and steam rushed down on the burning fuel.

Cause of the Explosion.

The bottom of the tube that burst was worn out, being no thicker than an old sixpence, and, judging

from the condition of some of the other tubes, it was in all probability overheated, owing to the presence of lime scale on its inner surface. It was also subjected to a much higher pressure when the explosion occurred than it was intended to bear, as the safety-valve was screwed down almost solid, and there was no outlet for the steam generated except the safety-valve, which, owing to its having been tampered with as described, would be more appropriately called a plug than a safety-valve.

General Remarks.

The Canal Company have 10 other steamers almost similar to the *Ida*. They make the trip from Liverpool to Leeds and back in the course of a week, and are kept going night and day, except when loading and discharging. It is the rule, however, to lay up each boat one day a week to give the crew a rest and an opportunity of examining the boat. The crew consists of a captain and three mates, who work in couples, one steering and the other attending to the boiler and machinery, which they take in turns.

The *Ida* left Leeds at about 6 p.m. on the day prior to the explosion, with the boiler apparently in good condition. As she approached Foulridge tunnel the first mate was steering, James Gore was in charge of the boiler and machinery, and the other two men were asleep in the cabin. At about 3.45 p.m. a stop was made at the entrance to the tunnel to allow a boat to pass in the opposite direction, and ere five or six minutes had elapsed the explosion occurred, with the results already stated.

The first mate's evidence as to what transpired at that time is as follows: *The steam was blowing off from the safety-valve, but not strong. It only started blowing when we stopped. Gore had been in the stokehole about half a second, when the explosion occurred. Before going below the last time, he asked me if he should put the donkey on, and on my answering yes, he went down. Before we stopped, I asked him how much water there was in the boiler, and he answered nearly full glass, to which I rejoined that he had better get plenty in, so that we might be able to get through the tunnel without requiring to put on the donkey (pump).* It appears that the funnel had to be lowered while passing through Foulridge tunnel, and that the draught in the boiler was so injuriously affected in consequence as to render desirable, if not necessary, such precautions as getting up a good head of water and steam to start with. It was stated that Gore came on deck without help, although suffering great pain, and that he was

taken to the cabin, where his clothes were cut off, and such remedies applied as were available; a doctor was also sent for. The captain then put a new tube in the boiler in lieu of the one that burst, and on steam being again raised, the boat proceeded with the injured man to Blackburn, where he was removed to the infirmary.

On the 11th April, that is two (lays after the explosion, the boiler was inspected by the engine superintendent, who stated that he saw no signs of overheating except that the bottom ends of four tubes had a red appearance. These tubes were consequently removed, because the bottoms were red, and new ones substituted; and on 1st May, ten other tubes were removed because the bottoms were red, and new ones substituted. It seems from the statements of several of the witnesses that many of the tubes have failed by the bottom ends cracking, and sometimes by a small hole forming, and that prior to failure occurring the ends of the tubes acquired the red appearance referred to above, which is similar to that frequently observed on pieces of iron that have been made red hot in an open fire and allowed to cool in the atmosphere. It seems, too, that some tubes have been found as thin as the one that burst, and that occasionally the lower ends of circulating pipes have been found stuck fast in deposit at the bottom of the tubes, the deposit in cases being 3 inches deep.

The circulating pipes had been withdrawn and the boiler cleaned before my inspection took place, so I am unable to say positively what its condition would be as regards scale at the end of a fortnight's work. I had, however, one tube taken out and sawn open, and found it lined with lime scale the thickness of which on the sides was about $\frac{1}{8}$ in. and $\frac{1}{16}$ in. at the bottom. The bottom of that tube was black, and the scale upon it bore marks of a scaling tool. A red tube, supplied at my request, was also sawn open and found lined with lime scale about $\frac{1}{8}$ in. thick on the sides, and about $\frac{1}{4}$ in. on the bottom, but the scale on the bottom, like that on the black tube, bore marks of a scaling tool and was probably considerably thicker when the tube changed colour. The thickness of both tubes was practically the same as that of a new tube which I had sawn open for comparison.

I found one of the circulating pipes completely choked with scale, while in six others it was about a $\frac{1}{4}$ in. thick, and in the remainder it varied in thickness from a mere wash to $\frac{3}{16}$ in. The maximum and minimum internal diameter of the pipes measured inside the scale was, therefore, about $\frac{13}{16}$ in. and $\frac{7}{16}$ in. respectively while the mean was about $\frac{5}{8}$ in. or a little over.

The circulation of water in Field tubes cannot, under the most favourable conditions, be perfect, owing to the downward and upward currents being so closely associated above the crown of the fire-box, and when the circulating pipes become lined with scale it must be more or less defective, according to the quantities present, and cease altogether when they become completely choked. Looking to the state of the circulating pipes as regards scale when seen by me, as well as in the conditions under which the boiler was fed and worked, it is not surprising that the ends of the tubes acquired a red appearance from overheating, and that they frequently frequently cracked.

It should be remarked here that the boat was supplied with spare tubes and suitable tools for fixing them, and that when a tube cracked or otherwise failed, the crew stopped the boat, drew the defective tube, and put a new one in.

The safety-valve design is fairly good, but would be improved if gear were provided with which to lift the valve from its seat by hand when such might be deemed desirable or necessary. Mr. Wilkinson, of the firm who made the boiler, stated that the safety-valve was originally loaded to 90 lbs. per square inch, and that 90 lbs. was a suitable pressure for the boiler. He also said that the cotters marked A A on the sketch, Plate 1., for limiting the maximum pressure, were fitted with padlocks to prevent their withdrawal by unauthorised persons. The spring was originally exposed, but about three years ago the Canal Company

had it enclosed within a sheet-iron hood so fixed to the valve-chest that it could not be removed while steam was up, and, to prevent its removal when steam was down, the bolts for securing it were padlocked. I found the hood in position, but the padlocks were missing, and when the hood was removed it was observed that the cotters A A were also missing, also that the compressing cap B almost covered the cotter holes, and that the spring was screwed down until the coils were touching each other, although not absolutely closed throughout their circumference.

I have some doubts as to who committed this reprehensible act, but whoever it was, evidently intended to completely jam the valve on its seat, for the spring compressing bolt marked C is twisted at the cotter hole apparently from a turning force applied to the nut when it reached the end of the thread, which is the position in which it was found. I had the spring loaded by dead weights, and found it closed with a weight of 619 lbs., which gives a load on the safety-valve of about 126 lbs. per square inch. This pressure is very much higher than the makers intended, and is greater than I consider prudent. Moreover as the safety-valve was prevented from lifting more than about $\frac{1}{64}$ inch, the pressure due to the accumulation of steam when the boat was suddenly stopped must at times have been considerably more.

I am, &c., PETER SAMSON. The Engineer Surveyor-in-Chief, Board of Trade.

Observations of the Engineer Surveyor-in-Chief.

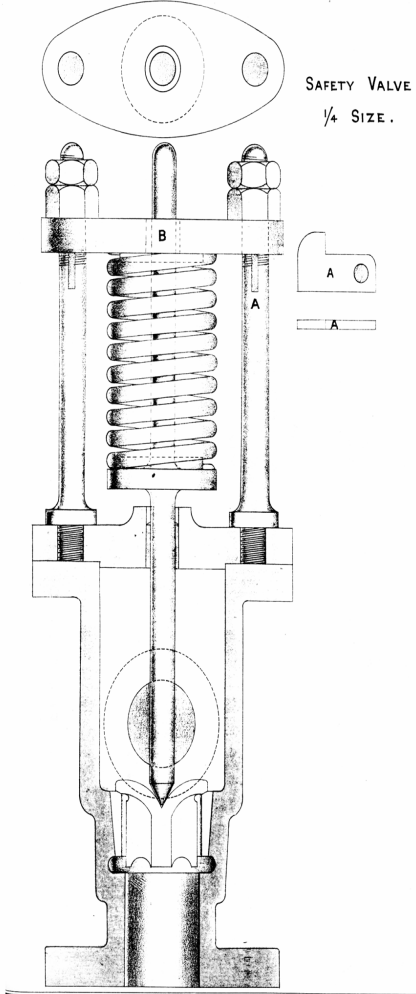
It would appear from the character of the repairs that the parts of the boiler exposed to heat had been frequently subjected to abnormal conditions, and it would seem from the ends of the tubes becoming red and cracking, that those conditions arose from overheating, due to the presence of scale, either hard or soft. Boilers with Field tubes should be fed with clean water. The one in question was fed with canal water, and most canal waters are not by any means clean.

The condition of the safety-valve shows that there has been a good deal of recklessness on the part of some one, and a similar amount of carelessness on the part of those who were responsible for the safety of the boiler.

Unfortunately this explosion has resulted in the death of one man, and ought to be a warning to owners and others to look after their boilers and fittings, and see that suitable water is used with such tubes. In this case they had repeated warnings, as the tubes were frequently giving out.

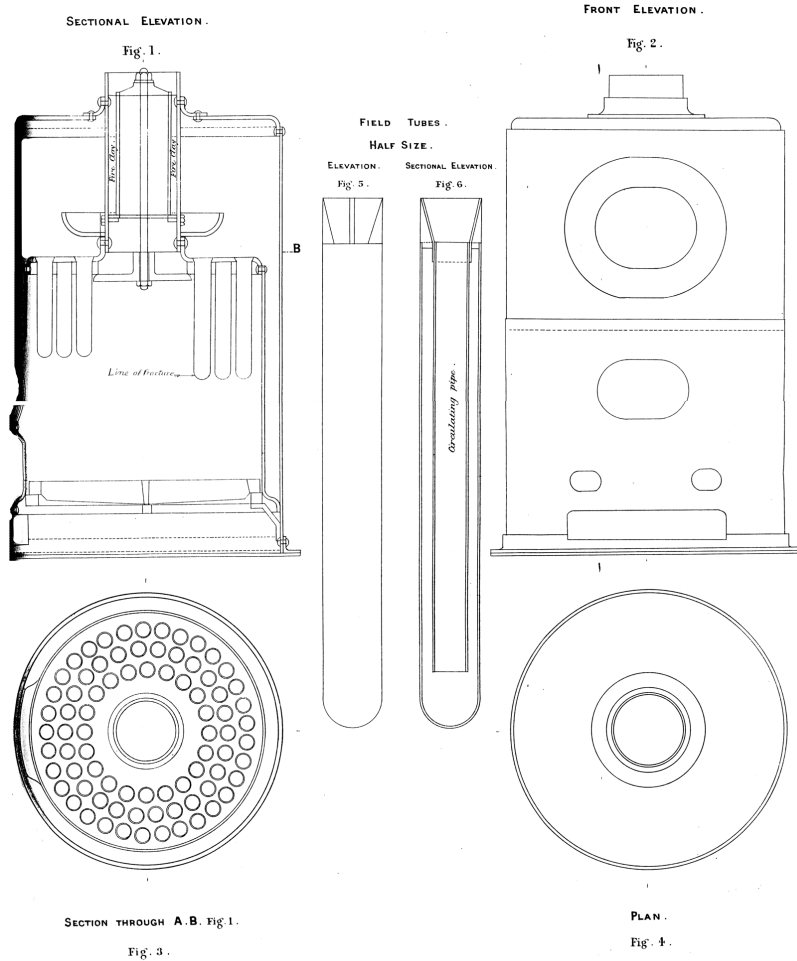
THOMAS W. TRAILL. The Assistant Secretary, Marine Department, Board of Trade.

EXPLOSION ON BOARD THE CANAL BOAT "IDA".



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EXPLOSION ON BOARD THE CANAL BOAT "IDA".



1889-1-22, Boiler Explosions Act, 1882; Report 311: Explosion on board the canal boat *Comet*.

Consultative Branch, Marine Department, Board of Trade, Bedford Street. Covent Garden, London, W.C. 22nd January 1889.

I have the honour to submit the following report of a preliminary inquiry held by me with respect to the afore-mentioned explosion :—

Date and Place of the Explosion.

The explosion occurred at about 7 a.m. on the 10th instant, at which time the vessel was in the "top lock" at Newlay, near Leeds.

Name and Address of the Owners.

The boat belongs to the Leeds and Liverpool Canal Company, whose head offices are known as Canal Offices, Pall Mall, Liverpool.

Persons Killed.

John MacHale, one of the crew, was severely scalded, and died in Leeds Infirmary on the same day.

Description and principal Dimensions of the Boiler.

The boiler is of the cylindrical vertical type, made of iron, and having Field tubes hanging from the top of the fire-box, as shown by the sketches, Plate I. herewith. It supplies steam to a pair of diagonal direct-acting screw engines by which the boat is propelled.

The shell is about 5 ft. 2 ins. in height by 3 ft. 6 ins. in diameter, and $\frac{7}{16}$ in. in thickness. The cylindrical part is made of three plates. The back portion consists of one plate, which extends from the top to the bottom of the boiler, but the front portion is made of two plates joined to each other at about the middle of the height of the boiler. The front plates are joined to the back plate by two vertical seams which extend the whole height of the boiler. The crown plate is flat, and is flanged at its outer edge for attachment to the cylindrical part in the usual manner.

The fire-box is about 3 ft. in height and also in diameter. The cylindrical part is made of two plates about $\frac{7}{16}$ in. in thickness joined to each other by two vertical seams. The plate is worked out in the usual way at the bottom and at the firing hole for attachment to the shell. The crown plate is about $\frac{5}{8}$ in. in thickness, and, like the crown of the shell, it appears to have been flat when the boiler was constructed. but at the time of my inspection it was depressed into the shape shown by the dotted lines. Plate I.; it is flanged downwards at its outer edge for attachment to the cylindrical part of the fire-box, and upwards at its centre for attachment to the uptake. It also forms the tube plate into which the upper end of the Field tubes are fitted.

The uptake is about 11 ins, in diameter, externally, and is made of one plate. Its lower end is fitted into the flanged portion of the fire-box crown plate, to which it is secured by means of a single row of rivets. Its upper end passes through, and is secured to, a flanged plate fitted to the centre of the crown of the boiler.

The vertical seams of the shell are of the lap and double riveted description, the uptake seam is welded, and all the other seams are of the lap and single riveted description.

There are 76 Field tubes, arranged in three circular rows, as shown by the sketch, Plate I. The outer row contains 32 tubes, the middle one 25, and the inner one 19. Those in the inner row, at the time of my inspection, were about 15 ins, in length and $2\frac{1}{4}$ ins, in diameter, externally: nearly all those in the middle and outer rows were about 18 ins, in length, but there were some exceptions, one or two short tubes having been inserted in consequence of the original ones having failed when the stock of spare tubes on board consisted of short ones only. Five of the tubes in each of the outer rows immediately opposite to the firing-hole were also of the short description in order to clear the top of the firing-hole. All the tubes were about $\frac{1}{10}$ in. in thickness.

The mountings consist of—

One safety-valve, $2\frac{1}{2}$ ins, in diameter, loaded direct by a spiral spring in compression, said to have been adjusted to blow when 100 lb.. was registered by the steam-gauge.

One glass water-gauge.

One 4-inch dial steam-gauge graduated in one pound increments to 150 lbs., and marked with figures at every 10 lbs.

One blow-off cock.

One steam stop-valve.

One steam connexion to the donkey.

One steam connexion to the bilge ejector.

One steam whistle.

One blast, pipe.

One feed-water heater.

There are five mud-holes in the lower part of the shell and one man-hole, measuring 12 ins, vertically by 15 ins. horizontally, in the front of the upper front part of the boiler, as shown by the sketch, Plate I.

Name of Maker and Age of the Boiler.

The boiler was made by Messrs. Hough and Sons, Boilermakers, &c., Wigan, and was supplied new by Messrs. William Wilkinson, and Co., Engineers, &c., Wigan, about the year 1882. Mr. John Ross, the engine superintendent for the Leeds and Liverpool Canal Company, said that this boiler was one of a number of the same description which were supplied by the same firm at about the same time, but he had been unable to find any records which would have enabled him to state the date upon which this particular boiler was placed on board the *Comet*.

Particulars and Dates of Repairs.

Mr. Ross said that the vertical seams in the fire-box had been caulked, and defective Field tubes had been removed and replaced by new ones at various times when found to be necessary, but no records were kept as to the dates on, which these repairs were executed. Two defective Field tubes were removed, and new ones fitted, by George Aspinall, the first mate of the vessel, on the night of the 8th instant, and as these two tubes were also found to be defective, on the 9th instant they were removed and two others inserted on the same evening by the same man. Aspinall was acting as captain of the boat on the particular voyage on which the explosion occurred, the captain having left her at Blackburn in consequence of illness.

Persons or Societies who Inspected the Boiler.

The boiler was insured by the Engine, Boiler, and Employers' Liability Company, Limited, whose head offices are at 12, King Street, Manchester. Mr. Michael Longridge, the insurance company's chief engineer, attended the inquiry and stated that the boiler had been insured by the company he represented since the 17th of November 1886. According to a statement handed in by Mr. Longridge, the boiler had been examined by one of their inspectors on six occasions whilst working, and once when not working, although full of water. The last examination whilst working was made on the 16th of October 1888. It is remarked on the statement with reference to a working examination made on the 4th of February 1887, that 13 tubes had been replaced since the previous inspection, owing to leakage at the bottom. In the remarks referring to another working examination made on the 13th of July 1887, it is also stated that 41 new tubes had been put in six weeks prior to that date, and with reference to a working examination made on the 5th of May 1888, it is recorded that 40 new tubes had been put in during the two months preceding that date.

According to the statement handed in, it seems that the boiler has not been *internally* examined on the insurance company's behalf during the period for which it has been insured. Mr. Longridge stated, however, that opportunities for making thorough examinations had been "asked for" on three occasions, viz., in February 1887, in November 1887, and in October 1888.

Mr. John Ross said that he had held the position of engine superintendent for the canal company for about one year and nine months, and during that period he had examined the boiler at every opportunity that he could get. He last examined it about a month before the explosion took place; he then found a slight leakage from one of the vertical seams in the fire-box, but no other defects.

Nature of the Explosion and Part that gave way.

One of the Field tubes—the position of which is shown on the sketch, Plate 1.—was blown bodily out, leaving an aperture in the tube-plate about 4 sq. ins. in area, through which the

steam and heated water rushed. From the evidence given, it seems probable that MacHale was throwing coals on the boiler fire at the moment of the explosion, and so received the full force of the issuing contents of the boiler and the burning fuel, with the result previously stated.

Cause of the Explosion.

The tube was blown out in consequence of its not having been properly secured in the tube-plate. The tube was said to be one of those inserted by Aspinall on the evening of the 9th instant, and when examined after the explosion, it was found to be cracked, as shown on the sketch, Plate II. The crack appears to have been produced when the tube was being expanded, and as its effect would be to partially destroy the holding power of the tube in the tube-plate, it may be regarded as the primary cause of the explosion.

Mr. Ross said the *Comet* was employed carrying cargo, and towing barges, on the canal between Leeds, and Liverpool, and that the company also owned 14 other steam barges, which were similarly employed.

Aspinall said that the vessel left Liverpool between 10 and 11 o'clock on Sunday morning, the 6th instant, and that the boiler was then tight. On the Tuesday and Wednesday following, however, he found it necessary to insert the tubes previously mentioned.

The tube which was blown out differed somewhat from those said to have been originally fitted to the boiler. The original tubes were said to have been $2\frac{1}{4}$ ins, in diameter externally, in the body, and to have been swollen at their upper ends sufficiently to fill the holes in the tube-plate. Latterly, however, the original ones have been gradually displaced by tubes of $2\frac{1}{2}$ ins, in external diameter for about $\frac{2}{3}$ rds of their length, measured from their bottom ends, tapering to about $2\frac{1}{4}$ ins, where intended to be fitted into the tube-plate. These tubes were adopted in consequence of the increased heating surface they presented, and the defective tube was one of this description.

The operation of fixing the original tubes was said to have differed from that used in fixing those of the new type. In the former case the tube was usually lowered from the inside of the boiler into the tube-hole it was intended to occupy as far as the swollen part, a few blows with a hammer being then applied to drive it into its proper position, the process was easily completed with the expander. The lower parts of the tubes of the new type, however, were too large to pass through the holes the tube-plate, and this necessitated their being inserted from the lower, or fire-box, side. Aspinall said the particular tube which forms the subject of this report, was very slack in the hole of the tube-plate before being expanded, and he found it necessary to have it held in its proper position while being expanded. The application of the expander to a very slack-fitting tube would, unless very great care was used, be very liable to split it, and the crack which was, as previously stated, afterwards found in the tube end, appears to have originated from this cause.

It is to be regretted that the insertion of tubes of this description should not be entrusted to men having more practical experience of boilers, and the use of tools used in their repair, than the man who put in this tube could be expected to have. Aspinall said he had had about three years and ten months' experience with boilers, that is, that he had been one of the crew of a steam barge during that period. The crew of the *Comet* consisted of four persons who were known as the "Captain," "Mate," "Second Mate," and "Last Mate." When the boat was steaming, the "Captain" and the "Last Mate" kept one watch and the "First" and "Second Mates" the other. The watches were regulated according to the distance travelled by boat, regardless of the time occupied, the time occupied by the boat in travelling 12 miles being regarded as the duration of a watch. Each of the two persons on watch steered the vessel whilst traveling six miles, and attended to the requirements of the boiler during the time

occupied by the vessel in going the remaining six miles. The levers for starting, reversing, or stopping the engines are placed within the reach of the steersman and are manipulated by him. Every member of the crew therefore acts steersman and engineman for part of his watch and as stoker during the remaining part. Experience of this nature is scarcely such as is likely to qualify a man to perform such an important duty as putting in of the Field tubes, having regard to the fact that if the work is imperfectly performed it may, and in this case did result in fatal consequences.

It appears that at about 25 minutes prior to the explosion, a man named John Rockliffe completed his turn at stoking, and then went to the sleeping cabin in the fore part of, the boat to rouse Aspinall, it being his duty to take the next turn at stoking. Rockliffe was not one of the regular crew of the steamer, he belonged to the "Bradford fly-boat, *Ralph*" a boat which the *Comet* had towed from Liverpool to Stockbridge. He joined the *Comet* at Stockbridge in consequence of her being short-handed, owing to the captain's illness. Rockliffe did not return to the engine-room after calling Aspinall, prior to the explosion taking place and Aspinall had not finished dressing himself when the casualty occurred. Rockliffe said that, when he left the engine-room, the steam-gauge registered 70 lbs., and the water was visible between four and five inches in the glass of the water-gauge. He also said that MacHale was then steering, and that the vessel had stopped at Newlay lock about five minutes before the explosion took place. When the vessel was stopped MacHale was relieved from the steering wheel, and it seems that he went into the stoke-hole and threw coals on the fire at the moment of the explosion, and Mr. Ross thought that in doing so he probably struck the lower part of the defective tube a blow with the shovel. This, though quite possible, is purely conjectural.

This the second explosion reported upon under the provisions of the Boiler-Explosions Act, 1882, which has taken place on board the steam barges belonging to the Leeds and Liverpool Canal Company. The previous case occurred on board the *Ida*, and was investigated by Mr. Samson, whose report (No. 178) contains full particulars. In that instance, as in the one now reported upon, a defective Field tube was the cause of the casualty. In that case the bottom end of the tube was burned off, while in this one the tube was blown out bodily; but the consequences were very similar, and they show clearly that, however trifling a matter a defect in tubes of this description may be regarded, their failure is liable to be attended with fatal results.

The representatives of the owners appear not to have fully realised the importance of Mr. Samson's remarks with reference to the safety-valve of the *Ida*. Mr. Samson commented upon the small amount of lift of the safety-valve fitted to the boiler of that vessel, and he alluded to the fact that although provision was made by which a lock could be applied to prevent the valve being tampered with, yet the lock was missing.

I found the safety-valve on the boiler of the *Comet* practically similar to that described by Mr. Samson in his report, and, although provision for a lock was likewise made, the lock was missing. There was, similarly, no provision to prevent the spring being compressed until the coils touched each other, and it was found after the removal of the hood that the coils touched each other when the valve was lifted $\frac{5}{64}$ inch by means of a lever. The spring consisted of nine coils, and the space between each coil was therefore less than the $\frac{1}{100}$ th part of an inch. Thus if a coating of rust formed on the spring the spaces between the coils would be reduced, and the valve liable to be rendered wholly inoperative.

There seems, however, no reason to believe that the explosion was due to the boiler having been subjected to a pressure in excess of that at which the safety-valve was said to be loaded, but attention is drawn to the importance of the above points with the view of averting, if possible, what might be a far more disastrous explosion than that which forms the subject of this report.

As the name of the insurance company has been given, it is thought desirable to explain what appears to be the views of their chief engineer as to their position with regard to a boiler which they have not had an opportunity to thoroughly examine. Those views are somewhat forcibly expressed in Mr. Longridge's printed report to the directors of his company in 1883, to which my attention has been drawn in the course of this inquiry. In that report he says :--
To state that the company holds itself morally responsible for the condition of boilers its officers are not permitted to examine, would be in itself an absurdity of which one would have thought no reasonable man could possibly be guilty. Again, in his report of 1885, in commenting on cases where owners had disregarded their requests to afford facilities for making proper inspections, he says :—*If the refusal arises from any idea that insurance companies accept more than mere pecuniary responsibility in such circumstances, it cannot be stated too clearly that such an idea is entirely erroneous.*

As, therefore, according to the statement handed in by Mr. Longridge, the requests of the insurance company for facilities to enable them to make a thorough examination of this boiler had not been granted, their responsibility with regard to it was of a pecuniary nature only.

I am, &c.,

GEO. E. BROWN. The Engineer Surveyor-in-Chief, Board of Trade.

Observations of the Engineer Surveyor-in-Chief.

This explosion appears to have been due to a Field tube having been blown out; the tube had been put into the boiler only a few hours previously by the "Chief Mate" or acting "Captain." Although the man may have been fully competent to perform the general duties of the position he held, such work as putting in of Field tubes can scarcely be included in that which such mates or masters should be expected to be able to perform. If the failure of one of these tubes could not, under any circumstances, be attended with serious results, it might be a matter of no great consequence whether they were properly or improperly put in; but, unfortunately, experience teaches us that their failure is sometimes attended with fatal results. It is therefore incumbent on those responsible for the safety of boilers, fitted with tubes of this type, to make such arrangements as will ensure this description of work being performed by men who have the necessary practical knowledge and experience in the use of tools used in repairing boilers.

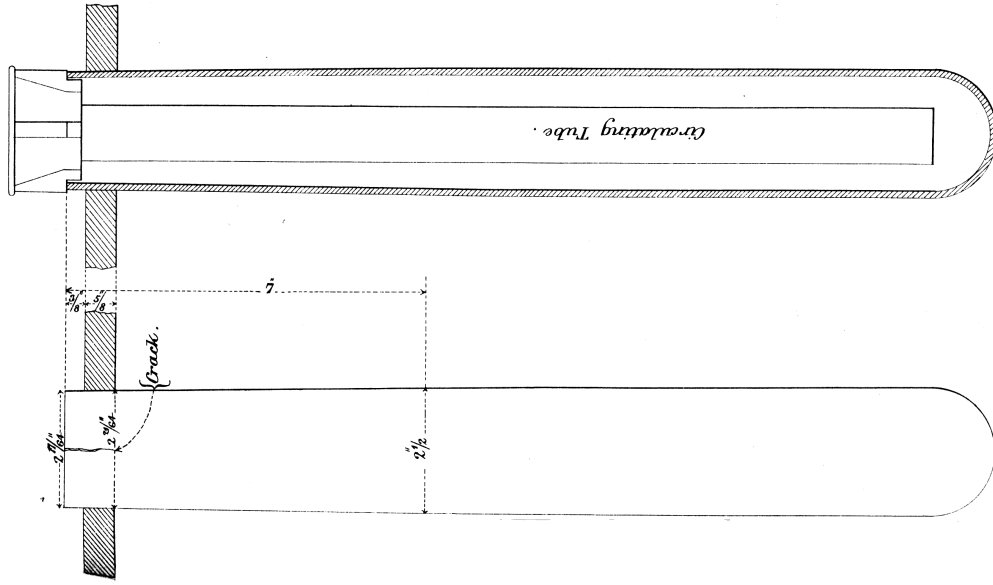
The quotations given in the report from the Insurance company's chief engineer's report, fairly describe the position of insurance companies with regard to boilers for whose safety they take a monetary risk, but which they are unable to obtain opportunities to examine. In such cases the transaction is merely a commercial risk undertaken by the insurance company for an annual premium paid to them by the owners. If the boiler explodes the insurance company is held liable for the amount mutually agreed upon, and the owner no doubt considers himself fortunate in having secured himself to that amount against pecuniary loss. As a purely commercial transaction there may be little said against it, but such transactions may tend to remove one of the incentives which ought to influence owners to have their boilers kept in a safe condition, as, if it explodes, his pecuniary loss is to some extent covered.

THOMAS W. TRAILL. The Assistant Secretary, Marine Department, Board of Trade.

(Report No. 311.)

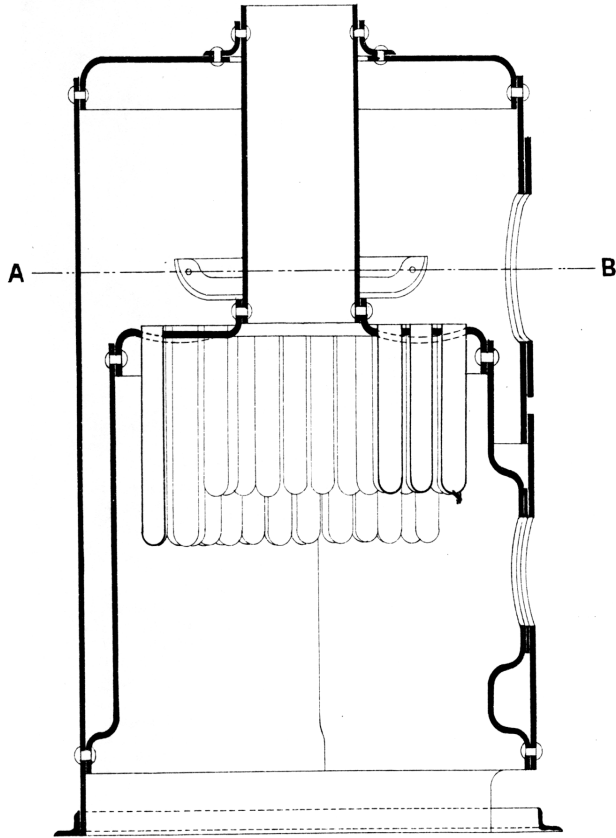
EXPLOSION ON BOARD THE CANAL BOAT "COMET".

VIEWS OF THE TUBE WHICH WAS BLOWN OUT.

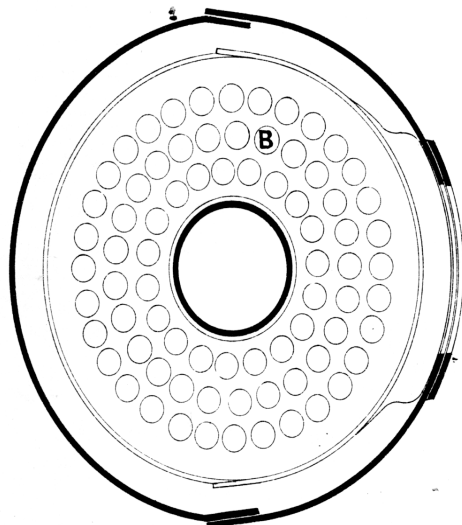


(Report N^o 311.)

EXPLOSION ON BOARD THE CANAL BOAT "COMET."



SECTIONAL ELEVATION.



*NOTE. The position
of the tube
which was
blown out
is denoted
by the letter
B.*

SECTIONAL PLAN THROUGH A.B.

1892-7-27, Boiler Explosions Act, 1882 & 1890; Report 582: Explosion on board the steam barge *Sun*.

In pursuance of our appointments dated 11th July 1892, we held a formal investigation in the above matter at the County Sessions House, Liverpool, on 27th July 1892. Mr. Gough appeared for the Board of Trade and Mr. Maskell Peace for Mr. William Wilkinson, mechanical engineer and iron founder of Wigan.

Having heard and carefully considered the evidence, we beg to report as follows :—

Date and Place of Explosion.

The explosion occurred on the 4th July 1892 on board the steam barge *Sun*, at Bankhall, near Liverpool.

Name and Address of Owners.

The Leeds and Liverpool Canal Company Limited, Liverpool.

Persons Killed.

Richard Youds, mate of the vessel, died from injuries received.

Description and Principal Dimensions of Boiler.

The boiler was of the cylindrical and vertical type 5 ft. 9 ins, in height, and 3 ft. in diameter, and was made throughout of steel with the exception of the tubes, which were of copper. The shell-plates were $\frac{7}{16}$ in. thick and were made with a double riveted lap joint with rivets $\frac{3}{4}$ in. in diameter pitched $2\frac{3}{4}$ ins. apart. The end of the shell was dished and flanged to receive the shell-plates and was connected to them by a single row of rivets pitched 2 ins. apart.

The fire-box was vertical and was welded longitudinally and connected with the tube-plate and shell-plates by a single row of rivets $2\frac{3}{4}$ ins, in diameter spaced 2 ins. apart. The tube-plate was the crown of the fire-box, and from it there were placed vertically into the fire-box 78 Field's patent hanging-tubes. These tubes were all 2 ins. in diameter and $\frac{1}{8}$ in. thick. The majority of them were 2 ft., but some few by the fire-door were only 1 ft. 6 ins, in length. They were made of drawn copper. The top end of each tube was contracted to $1\frac{3}{4}$ ins, for a distance of 2 ins, and the lower end was formed by means of a brass cup brazed into the end of the tube. In each tube there was a small iron tube $\frac{7}{8}$ in. in diameter, fitted loose and used as a circulator. The uptake was in the centre of the tube-plate and passed vertically to the crown of the shell. A baffle-plate was fitted to the centre of the fire-box near to the tube-plate.

The mountings consisted of—

- One feed check-valve.
- One steam-pressure gauge.
- One set of water-gauge cocks.
- One main steam stop-valve.
- One spring loaded safety-valve $2\frac{1}{2}$ ins, in diameter.
- One steam whistle and cock.
- One blast-cock.
- One ejector-cock.

Name of Maker and Age of Boiler.

The boiler was made in the month of May 1892 by Mr. William Wilkinson, trading under the name of Messrs. Hough Brothers, New Town, Wigan. It was two months old.

Particulars and Dates of Repairs.

Shortly after the boiler had been built, several copper tubes were rebrazed by Messrs. Roger Bolton and Sons, who made them.

Persons or Societies who have Inspected the Boiler.

The boiler was approved on its delivery by Mr. John Ross, superintendent engineer to the Leeds and Liverpool Canal Company.

Nature of the Explosion.

One of the copper hanging tubes which had been previously leaking at its lower end was plugged up from the tube-plate end by means of a plug made of hard wood. This plug was forced down the tube by the steam pressure through its lower end into the fire-box, and the steam and water escaped from the tube through the furnace door into the engine room.

Cause of the Explosion.

The explosion was caused by the wooden plug having become saturated and weakened and ultimately being forced into the empty tube by the pressure of steam. The bottom of the tube had either been burnt out or had become so reduced by the action of the fire that the plug burst through it.

Remarks.

At the conclusion of the evidence we were asked by Mr. Gough to state whether blame attached to the Leeds and Liverpool Canal Company, Mr. Ross their superintending engineer, and to Mr. Wilkinson, all or either of them. Having heard the respective parties and Mr. Gough in reply, we stated as follows "The explosion which forms the subject of the present investigation occurred on board the steam barge **Sun**, the property of the Leeds and Liverpool Canal Company, who own a fleet of vessels trading between Liverpool and Wigan. Of this company Mr. White was engineer, Mr. Robert Henry White assistant engineer, and Mr. John Ross engineer superintendent. At the close of 1891 Mr. William Wilkinson, manufacturing engineer and iron founder, carrying on his business at Wigan, was instructed to construct engines and boilers for two new vessels that were being built for the company, and which were to be called the **Sun** and the **Moon**. A consultation took place between Mr. Wilkinson and the engineers of the Company, when it was determined to fit the boilers for these vessels with copper tubes instead of iron tubes, with which the boilers of the other vessels composing the fleet were fitted, as it was thought that thereby the heating surface would be increased, which no doubt would be the case, as copper conducts heat better than iron.

The boiler for the **Sun** was delivered and fitted to the vessel in June of this year, being constructed to resist a pressure of 150 lbs. per square inch., and from the specification dated 28th November 1891, we find that it was of the cylindrical and vertical type 5 ft. 9 ins, in height and 3 ft. in diameter, and was made throughout of steel, with the exception of the tubes, which were of copper. The shell-plates were $\frac{7}{16}$ ins, thick stud were made with a double riveted lap joint, with rivets $\frac{3}{4}$ in. in diameter pitched $2\frac{3}{4}$ ins. apart. The end of the shell was dished and flanged to receive the shell-plates, and was connected to them by a single row of rivets pitched 2 ins. apart.

The fire-box was vertical and was welded longitudinally and connected with the tube-plate and shell-plates by a single row of rivets $2\frac{3}{4}$ ins, in diameter spaced 2 ins. apart. The tube-plate was the crown of the fire-box, and from it there were placed vertically into the fire-box 78 Field's patent hanging-tubes. These tubes were all 2 ins, in diameter and $\frac{1}{8}$ in. thick. The majority of them were 2 ft., but some few by the fire-door were only 1 ft. 6 ins, in length. They were made of drawn copper. The top end of each tube was contracted to $1\frac{3}{4}$ in. for a distance of two inches, and the lower end was formed by means of a brass cup brazed into the end of the tube (vide Plate II.). In each tube there was a small iron tube in. in diameter, fitted loose, and used as a circulator.

The uptake was in the centre of the tube-plate and passed vertically to the crown of the shell. A baffle-plate was fitted to the centre of the fire-box near to the tube-plate. The fittings were a feed-check valve, a steam-pressure gauge, a set of water-gauge cocks, a main steam-stop

valve, a spring-loaded safety-valve 2½ ins, in diameter, a steam whistle and cock, a blast cock, and an ejector cock.

The hanging tubes were obtained from Messrs. Roger Bolton, of Wigan, and were composed of the best copper. Their lower ends were formed by means of a brass cup brazed into the ends of the tube. These tubes were bored out $\frac{1}{32}$ in. and $\frac{3}{8}$ in. deep to receive the cup, and afterwards the ends were drawn over the brass cup and brazed (vide Plate II.). The tubes were tested by steam to 50 lbs. or 60 lbs. and by hydraulic pressure to 450 lbs. per square inch, and we have been told by the person who applied these tests that every tube in each boiler was subjected to them. Before the boiler was delivered to the *Sun* several of the tubes were sent back to Messrs. Bolton and Son, on account of defective brazing, and were by them rebrazed and afterwards tested as before.

Two trial trips were made of the *Sun*, one a short one, and the other from Liverpool to Wigan, when the vessel was fully laden. On both these occasions Mr. Wilkinson was on board, no leak was detected, and the boiler appeared to work very well.

On the 4th July 1892, when the *Sun* was at Burscough, near Liverpool, Mr. Ross received information at Wigan that one of the tubes was leaking. He thereupon instructed George Denning, a fitter, to construct an iron stopper, to proceed to the vessel, take the tube out, and plug up the aperture with the stopper. Denning accordingly proceeded to Burscough and did what was required. In the meantime, Mr. Wilkinson having heard of the defective tube proceeded to the *Sun*, and found that the iron plug had been put in the aperture marked B on the plan which has been put in (vide Plate I.) and was satisfied that the work had been properly done. When the water was admitted into the boiler, he looked into the furnace, and by means of a lamp, examined the bottom of nearly all the tubes, especially those in the inner or smaller circle, and found that one tube marked A on the plan (vide Plate I.) was leaking. There being no iron stopper available, he recommended Denning, the fitter, to procure a piece of hard wood about 7 ins, long and to shape it so as to form its diameter of 1½ ins, at the point and $1\frac{7}{8}$ in at the head and with it to stop the hole in the tube-plate, so as to prevent the water from going into the tube. This operation having been, performed by Denning to the satisfaction of Mr. Wilkinson, the latter sent a telegram to Mr. Ross, requesting an interview on his arrival at Wigan, whence he proceeded by train.

The *Sun* started towards Wigan about 7 p.m., and when about 200 yards below Bankhall Bridge John Alty, the skipper who was steering, heard a noise like the report of a gun, and saw steam arising from the stokehold which was filled with steam and hot water which had escaped from the tube through the furnace. He pulled out of the stokehold Richard Youds, the mate, who was very severely scalded and who died next morning from the effects of the injuries he had received. On his body an inquest was held and the jury found that the cause of death was extensive scalds on the face, neck, hands and body, and that they were caused by the bursting of a copper tube belonging to a boiler and which was situated in the fire grate of the steam flat *Sun*, belonging to the Leeds and Liverpool Canal Company, in the canal near to Bankhall, owing to the smelting which secured the hemispheric cup at the end of the tube nearest the pipe melting through excessive heat.

The explosion was caused by the wooden plug having become saturated and weakened and being eventually forced into the empty tube by the pressure of steam. The bottom of the tube had either been burnt out or had become so reduced by the action of the fire that the plug burst through it.

We have now to consider the following points, first, whether copper is a suitable material for hanging tubes in vertical boilers of this description, and, secondly, whether blame attaches to any person for the explosion.

In our opinion copper is not so suitable for tubes of this description as iron, the former being fused or burnt at a lower temperature than the latter. At the bottom of tubes of this description there is almost sure to be a small amount of incrustation or deposit whatever water may be used, and besides, the water is liable to be driven off the bottom by excessive heat from the furnace, in either of which cases the copper would be exposed to the heat without any protection and would deteriorate very rapidly.

We are of opinion moreover that the tubes of this boiler were faulty in construction, for the brass cups being brazed in the lower end the tubes would probably give way at the brazing (vide Plate II.) and the tubes being closed at one end, the water circulation was most likely imperfect.

We understand that the opinion we have formed as to these tubes is now shared by Mr. Wilkinson, Mr. Robert Henry White, and by Mr. Ross.

No blame can attach to the Leeds and Liverpool Canal Company except there has been default by some of their servants. It has been suggested that when Mr. Ross heard that one of the tubes was leaking, he should have himself gone to the vessel to ascertain what should be done. He was not told nor had he any reason to believe that any other tube was leaking, in sending Denning the fitter with proper directions and with proper appliances to perform the necessary work, we are of opinion that he fully discharged his duty, and therefore is not to blame for the explosion. We further desire to state that Mr. Ross and the other engineers in the employ of the company have showed that they desired to take every care with regard to the safety of their boats, for after having met Mr. Wilkinson at Wigan, and having ascertained from him the condition of the tubes, they immediately countermanded the copper tubes which were being made for the *Moon*, and they have stated that they had determined not to use the *Sun* any longer after her arrival at Wigan until the existing tubes had been taken out.

In our judgment the explosion was caused by the action of Mr. Wilkinson in recommending that a wooden plug should be inserted in the tube marked A on the plan (vide Plate I.). Mr. Wilkinson has admitted that this proceeding was wrong, but has said that at the time it did not occur to him to be so, for he had then in his mind the fact that he had used two or three wooden plugs to stop up tubes of a boiler used in a steam launch of his own, and that with the tubing in that condition he had worked the launch from Beaumaris to Liverpool and onto Wigan in safety. It must, however, be remembered that Mr. Wilkinson is a manufacturing engineer, and, in our opinion, it ought to have occurred to him that he was recommending a proceeding that at all events was a very risky one. It has been said that he was only acting as a volunteer, but even if this were so we should hold him to blame for having voluntarily given wrong advice. In fact, however, as he had constructed the boiler, he was interested in its working, and the master of the vessel and Denning, the fitter, would naturally act under his directions and follow his advice. Besides, it is clear to us that Mr. Wilkinson considered the tubes to be unsafe, for he telegraphed to the company at Wigan, asking their representative to meet him, and there informed Mr. Ross that he considered the tubes a failure, or, in other words, that they were unsafe. As we consider the conduct of Mr. Wilkinson reckless, and as the explosion was caused by it, we find him to blame for it. We desire, however, to say that Mr. Wilkinson has given his evidence very fairly, and certainly with no desire to shirk responsibility, and we are convinced that he now feels that his conduct was not that of a careful engineer.

We directed that Mr. William Wilkinson should pay to the solicitor to the Board of Trade the sum of £20. towards the costs and expenses of this investigation.

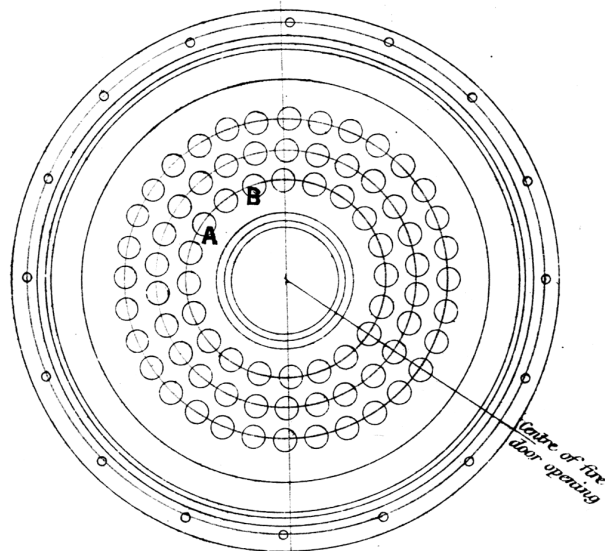
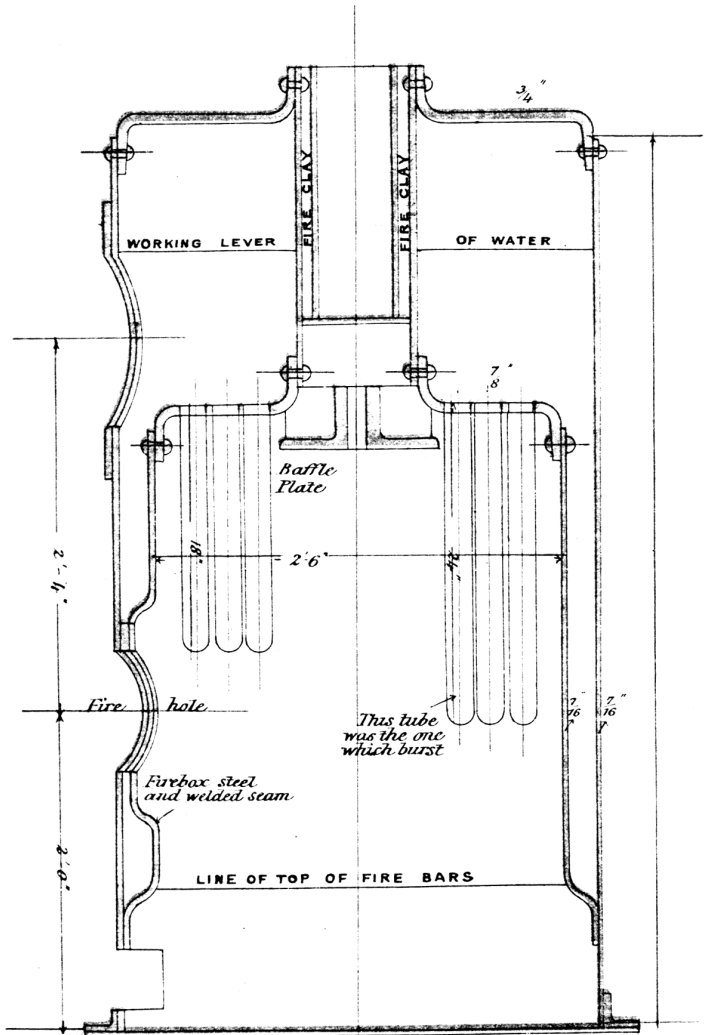
Dated the 4th day of August 1852.

HOWARD SMITH, Commissioner.

G. FULLERTON BELL, Commissioner.
To the Assistant Secretary, Board of Trade.

(Report N^o 582.)

EXPLOSION OF A STEEL BOILER ON BOARD THE STEAM BARGE "SUN."



Scale 1ⁱⁿ = 1 Foot

1894-10-5, Boiler Explosions Act, 1882 & 1890; Report 777: Explosion on board the steam barge *Nell*. Board of Trade, Surveyor's Office, Custom House Arcade, Liverpool
5th October 1894

In accordance with instructions, I have held a preliminary inquiry respecting the above-named explosion, and now respectfully submit the following remarks:--

Date and Place of the Explosion.

The explosion occurred on the 8th September last, at 11 p.m. when the vessel was at New Lane, near Burscough, on the Leeds and Liverpool Canal.

Name and Address of the Owners, &c.

The owners are the Leeds and Liverpool Canal company Limited, of which Company Mr. Alfred

Williams, Pall Mall, Liverpool, is Manager and Secretary, and Mr. John Ross, Wigan, Engine Superintendent.

Persons Killed or Injured.

James Lamb, first mate, was burnt on the face, hands, and legs, by the flame blown out of the fire-door by the force of the explosion; he is now almost recovered from his injuries.

Description and Principal Dimensions of the Boiler.

The boiler is made of steel, with the exception of the tubes which are of iron. It is of the vertical cylindrical type, with Field tubes fitted in the crown of the fire-box.

The shell is about 3 ft. 6 ins, diameter by 6 ft. high, formed of two steel plates $\frac{3}{8}$ in. thick, lap-jointed and double-riveted with $\frac{3}{4}$ in. rivets spaced about $2\frac{3}{4}$ ins. apart; the crown of the shell is flat, and made of one steel plate $\frac{3}{4}$ in. thick, which is flanged for attachment to the shell and uptake.

The cylindrical part of the firebox is made of one steel plate $\frac{7}{16}$ in. thick, welded longitudinally, and attached to the shell and firebox crown by a single row of rivets $\frac{3}{4}$ in. diameter spaced about 2 ins. apart; it is also stayed to the shell by two rows of screwed stays about $\frac{7}{8}$ in. diameter, spaced circumferentially about 10 ins. apart and riveted at the ends.

The firebox crown is made of one steel plate $\frac{7}{8}$ in. thick, flanged for connection to the firebox and uptake, and secured thereto by a single row of rivets $\frac{3}{4}$ in. diameter and about 2 ins. pitch; it also acts as a tube plate, 79 Field tubes are inserted in it. 64 of which are about 2 ft. 2 ins. long, and 15 about 1 ft. 7 in. long, the short ones being placed opposite the fire-door; the tubes are all $2\frac{1}{2}$ ins, diameter outside and about $\frac{1}{8}$ in. thick, contracted at the open ends where fastened in the tube plate to $2\frac{1}{4}$ ins. diameter. The closed ends of the tubes are hemispherical in form; in the course of manufacture they are worked or gathered nearly to that shape, then welded, and afterwards finished on a mandril with a snap tool. Each tube is tested to 1000 lbs. per square inch by water pressure before leaving the maker's works.

The mountings consist of:—

One spring safety-valve $2\frac{1}{2}$ ins, diameter loaded direct to 120 lbs. per square inch.

One set of water gauge-cocks and glass.

One steam stop-valve.

One blow-off cock.

One feed check-valve.

One steam-pressure gauge.

One donkey steam-pipe.

One injector steam-pipe.

One test-cock (for standard steam-gauge).

One steam-whistle.

Name of Maker and Age of Boiler.

The boiler was made by Messrs. Hough and Sons, Newtown Boiler Works, Wigan, in May 1890, and the tubes by Messrs. A. and J. Stewart and Clydesdale. Limited, Coatbridge.

Particulars and Date of Repairs.

The boiler was retubed by the owners in September 1892. and several leaky tubes have been renewed by them at various times since then.

Persons or Societies who have Inspected, the Boiler.

The boiler is insured with the Engine Boiler and Employers' Liability Insurance Company, Limited. 12, King Street. Manchester, one of whose inspectors examined it as far as practicable on the 30th July last. and found it in order. It is also inspected from time to time by Mr. Ross, the Canal Company's Engine Superintendent, besides being thoroughly overhauled when the boat is laid up for the usual annual repairs.

Nature of the Explosion.

One of the Field tubes gave way at the bottom. The fracture extended about 1¼ ins. round the tube. and was about ¾ in. wide; through this aperture the steam and water in the boiler escaped, blowing flame, &c.. through the firedoor and bars, and extinguishing the fire.

Cause of the Explosion.

The explosion was due to the overheating and consequent weakening of the lower end of the tube, owing to the presence there of an excessive amount of solid matter (scale), which had been conveyed into the boiler by the feed-water.

General Remarks.

From the statement given by Mr. Ross, Engine Superintendent, the boiler in which the tube exploded and the barge in which it was fitted was about due for an annual overhaul, but owing to the graving dock being occupied she was sent on another trip. The practice of the Company is to clean the boilers every fortnight; this is done by the men who work the boat when the time is due, at whatever place the boat may be, it is, however, only the softer material that can be taken out, the hard scale being difficult of removal, hence the necessity for the annual or periodical cleaning and overhaul above-mentioned; at these times the tubes are thoroughly cleaned and any other repairs done that may be required. The thickness of the scale in the exploded tube was about ¾ in. on the side and about 7/8 in. on the bottom, and was greater than in any of the others. This may probably be accounted for by this tube being omitted at a previous cleaning. The pressure in the boiler at the time the explosion occurred was said to be about 118 lbs. I had the exploded tube sawn up the middle through the fracture, but I found no appreciable diminution from the thickness of a new tube. It was also stated by Mr. Ross that the life of the tubes in the canal boat-boilers under his care is about from two to two-and-a-half years; after working for that period he generally takes them out and fits new ones, principally on account of the loss to the Canal Company which the use of tubes thickly lined with scale would involve, and to avoid the risk of explosion that must always accompany the working of boilers having tubes in that condition. The small open-ended tubes that are inserted inside the other tubes, with the view of promoting the circulation of the water. also become covered with scale, thereby reducing their internal capacity and increasing their size outside, the result being a decrease in whatever circulation there may have been, when the tubes were clear and clean, and likewise a tendency to a greater accumulation of deposit and consequent overheating of the tube.

The scaling of the tubes will continue so long as the feed-water is obtained from the canal, without means of preventing the impurities in the water from being conveyed into the boiler.

I was informed, however, that it is proposed to construct at the Canal Company's works a filter, which is intended to prevent as much possible foreign matter getting into the boiler. This filter when completed will be tried on one of the boats, and, if successful, similar filters will be fitted to all the other boats belonging to the Company.

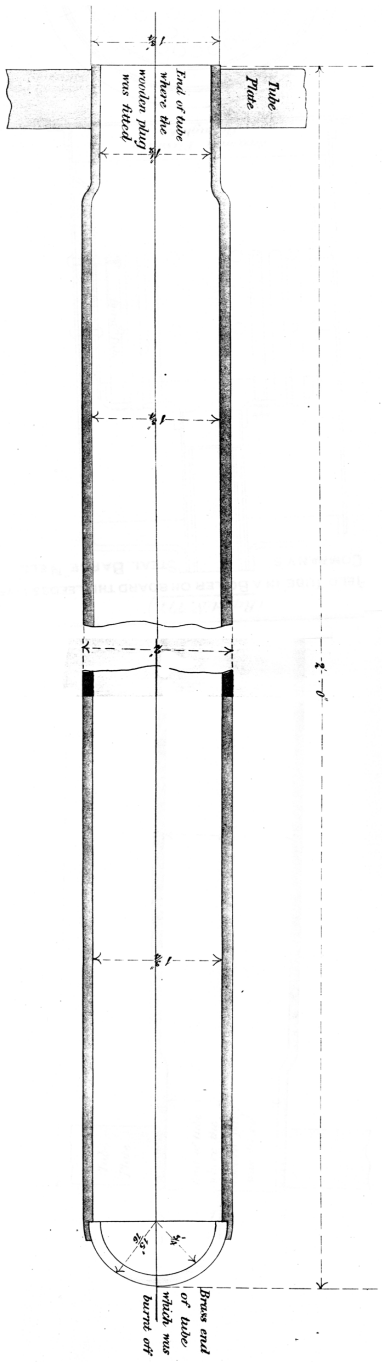
I am, &c., JAMES WISHART.

Observations of the Engineer Surveyor-in-Chief.

In this case the explosion was caused by the bursting of the lower end of a "Field" tube, which, together with a large number of similar tubes, depended from the crown of the firebox. The boiler was fed with water (canal water) holding a large amount of earthy matter in suspension, and a portion thereof had collected in the bottom of the tube in the form of scale, and thereby led to the overheating and subsequent rupture of the tube. Boilers having "Field" tubes are not sufficiently safe when fed with such water, and that now appears to be the opinion of the owners of the boiler, as it is said they intend constructing a filter for the purpose of removing, as far as possible, the earthy matter from the canal water used by them as feed, and if it succeeds, it is their intention to carry a similar filter in each of their boats. The steps which the owners now intend taking with a view of purifying the feed-water are doubtless praiseworthy; but they should, I think, have been taken long ago, as several explosions similar to the one in question have occurred in their boats, some of which unfortunately proved fatal.

THOMAS W. TRAILL.

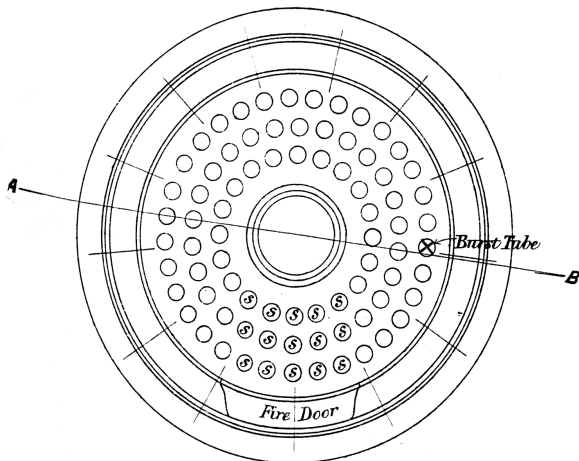
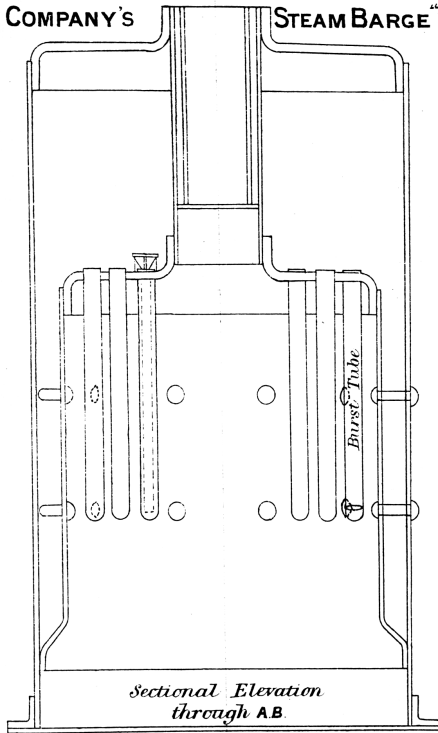
The Assistant Secretary, Marine Department, Board of Trade.



COPPER TUBE WHICH BURST.

(Report N° 777.)

EXPLOSION OF A "FIELD TUBE" IN A BOILER ON BOARD THE LEEDS & LIVERPOOL
CANAL COMPANY'S STEAM BARGE "NELL"



Cross Section

Short Tubes in front next fire door marked, s.