

“ his speed to about 18 or 20 miles an hour; that the  
 “ up main line signal was at all right when he passed  
 “ it, and as soon as he saw the branch line train go  
 “ past the stop signal, he reversed his engine, the  
 “ fireman applied the tender break, and he gave a  
 “ signal to the guard to apply his break; that he  
 “ saw the signalman run across the line and hold up  
 “ both his hands; that he did not see the up standard  
 “ signal turned on to danger after he had passed  
 “ inside the distant signal with his steam shut off;  
 “ that he kept the whistle open until his engine  
 “ struck the next carriage to the last break-van of  
 “ the empty special train coming off the branch line;  
 “ that he thinks he was about 300 yards back from the  
 “ Junction when he took measures to stop his train,  
 “ it might be a little more, and that they ran about  
 “ 70 yards beyond the spot at which the collision  
 “ occurred.”

The guard of this train states “ that just after  
 “ passing Esher Station he saw the Hampton Court  
 “ Junction up main line distant signal at ‘ danger,’  
 “ and his driver sounded the whistle, and it was  
 “ taken off, as well as the up standard signal; that  
 “ they were about 150 to 200 yards outside the dis-  
 “ tant signal when that was done; that on passing the  
 “ distant signal he discovered an up Hampton Court  
 “ train approaching the junction, and apparently  
 “ travelling about 8 miles an hour, so that they  
 “ could have stopped at the stop signal which was on  
 “ against it; that he is not certain whether the dis-  
 “ tant signals were on also, as he could not see them  
 “ so well; that when the Hampton Court train had  
 “ proceeded a little further, it seemed doubtful whether  
 “ it could stop at the signal, and he then put on his  
 “ break, and his driver shut off the steam, sounded  
 “ the whistle for the breaks, and the fireman applied  
 “ the tender break, and the driver then reversed his  
 “ engine; that he observed that the guard at the  
 “ tail of his own train had also observed the danger  
 “ and had also applied his break, and he thinks they  
 “ were not travelling more than 5 miles an hour  
 “ when the collision occurred.”

The signalman at the junction (Charles Carver)  
 states “ that about 25 minutes past 2 o’clock the up  
 “ signals on the Hampton Court branch line were all  
 “ on at danger, and so also were the up distant and up  
 “ standard signal for the main line; that as soon as he  
 “ saw the 11h. 30m. a.m. up train from Southampton  
 “ coming about a mile distant, he altered the up dis-  
 “ tant and up standard signal from ‘ danger’ to ‘ all  
 “ ‘ right’ for the up main line train to pass, that a  
 “ platelayer, with a flag lower down the main line than  
 “ his distant signal, gave him a signal that an up main  
 “ line train was coming; that he did not alter any of  
 “ the signals on the Hampton Court branch line from  
 “ ‘ danger’ to ‘ all right;’ that he heard a branch  
 “ line train coming before he saw the main line train,  
 “ but the main line train first came in sight, and  
 “ when he saw that the branch line train was coming  
 “ faster than it ought to have done past the repeating  
 “ signal, he shoved the main line up distant signal on  
 “ to ‘ danger,’ and the standard signal as well; but  
 “ he does not know whether the up main line train  
 “ had passed the distant signal when he put it on;  
 “ that the driver of the 11h. 30m. train whistled as  
 “ soon as he had put on the up distant signal and  
 “ shut off his steam and tried to stop; that when he

“ first saw the branch line train coming fast he ran  
 “ back and put some dirt on the rails; that the steam  
 “ was on when he first saw the branch line train;  
 “ that it was a very hot day and it is hard to tell  
 “ whether the steam was on or off, but the special train  
 “ appeared to be coming at a regular pace, and when  
 “ the special train came out on to the junction the  
 “ steam was on, but the train was not travelling very  
 “ fast. He also noticed that the breaks were on the  
 “ wheels of the last van after it was knocked off the  
 “ road, but he could not speak to the breaks on the  
 “ leading break-van.”

The under-guard of the empty special train “ saw  
 “ the outside distant signal at danger before he  
 “ reached it, and when he saw the head guard apply  
 “ his break he did the same; but he could not speak  
 “ to the state of the other signals on this branch  
 “ line.”

This collision was evidently occasioned by gross  
 neglect on the part either of the signalman at the  
 junction in improperly altering the branch line sig-  
 nals, or of the driver of the branch line empty special  
 train in disregarding and running past the three sig-  
 nals exhibited to him by the signalman at the junc-  
 tion.

The preponderance of evidence is altogether in  
 favour of the signalman, although it must be ad-  
 mitted to amount almost to an act of madness on the  
 part of an engine driver to run out of a branch line  
 against the signals in broad day light and in clear  
 weather in front of a main line train appointed to  
 travel fast over that part of the line. Still there are  
 many instances of the kind on record, and this looks  
 very like an additional one.

The 11h. 30m. a.m. up train consisted of engine  
 and tender, 9 first, 5 second, and 1 third-class carriage,  
 3 break vans, 3 horse boxes, 3 carriage trucks, and  
 3 waggons, altogether making up 27 vehicles besides  
 the engine and tender. But only 2 guards working  
 2 breaks were sent with this train, a proportion  
 utterly insufficient for a passenger train.

If a larger amount of break-power had been sent  
 with this train it is almost certain that the collision  
 would not have occurred, and great credit is due to  
 the driver of this train for the manner in which he  
 acted, as he was most undoubtedly justified in running  
 at a higher speed, the signals being all right for him  
 to proceed.

It is right also to mention that unusual care  
 appears to have been taken in one other respect  
 towards providing for the safety of the public past  
 the Hampton Court Junction, in consequence of the  
 extra traffic to the Hampton Court races. In addition  
 to the ordinary signals which should and undoubtedly  
 would be sufficient, if properly exhibited by signal-  
 men and strictly attended to by engine drivers, the  
 railway company had stationed platelayers with flags  
 to caution passing trains.

On the other hand, the Company continually run  
 trains with the tender in front of the engine, and  
 they may do so until some accident results from it.

I have, &c.

*The Secretary,  
 Board of Trade,  
 Whitehall.*

*W. YOLLAND,  
 Col. R.E.*

## LONDON AND NORTH-WESTERN RAILWAY.

*Railway Department, Board of Trade.*

SIR,

*Whitehall, 2nd August 1861.*

I AM directed by the Lords of the Committee  
 of Privy Council for Trade to transmit to you, to  
 be laid before the Directors of the London and  
 North-western Railway Company, the enclosed copy  
 of the report made by Captain Tyler, R.E., of his  
 inquiry into the circumstances which attended the

accident that occurred on the 4th ultimo, near the  
 Rugby Station, from the bursting of the boiler of a  
 locomotive engine.

I have, &c.

*The Secretary of the  
 London and North Western  
 Railway Company.*

*JAMES BOOTH.*

SIR

*Whitehall, 30th July 1861.*

IN compliance with the instructions contained in your minute of the 8th instant, I have the honour to report, for the information of the Lords of the Committee of Privy Council for Trade, the result of my inquiry into the circumstances which attended the accident, that occurred on the 4th instant, near the Rugby station of the London and North-western Railway.

The fast train known as the Irish mail train, leaving London at 8.25, p. m., and Rugby at 10.28, p. m., started from Rugby punctually on that evening, composed of an engine and tender, two post-office vehicles, two composite carriages, two first-class carriages, and two break-vans.

It had proceeded for a little more than four miles, and was approaching a bridge over the railway, called the Easenhall Bridge, when the boiler of the engine suddenly exploded. It had not, at this time, reached its full speed, but is stated to have been running at the rate of thirty-five or thirty-six miles an hour, after travelling over gradients, sometimes rising, sometimes falling, but no where more severe than 1 in 330, between Rugby and the bridge in question.

This bridge is composed of three brick arches, and carries a road over the railway, at a height of thirty-five feet above the level of the rails. The two lines of the railway run through the middle arch, and the other arches afford space for the slopes of the cutting through which this part of the line passes.

The *débris* of the engine were almost untouched, and remained nearly in their original position when I visited the site between 9 and 10 o'clock on the following morning.

It was plain from the appearance of both the sides of the cutting, that the explosion had taken place twenty or thirty yards to the south of the bridge referred to, and the area of its action on the grass of the slopes was distinctly traceable.

The barrel of the boiler was blown to pieces, while the fire-box remained almost uninjured. Of the three rings of which the barrel was composed, the middle ring, containing the steam-dome, was thrown off to the right in two pieces, and was separated from the remainder. It struck the south end of the right pier of the bridge with great violence, and knocked away a quantity of the brickwork. The larger portion of it, with the dome attached, after glancing off from the end of the pier, (which was built on the skew), fell on the slope in a crumpled condition, at 24 feet from the pier. The smaller portion, about 4' x 3', lay flattened between the larger portion and the bridge, somewhat lower on the slope, at eight feet from the pier, and almost under the right or east arch.

A large portion, about 8' 6" x 3' 6", was found on the back of the tender after it was brought to a stand. This portion was torn away from the smoke-box, and, in fact, formed the greater part of the foremost ring, of which but little remained attached to the smoke-box. It appeared to have been thrown upwards in the first instance, against the south end of the crown of the middle arch of the bridge, and to have fallen from thence upon the tender. One small piece from the smoke-box end of the barrel was blown away to the left; and a considerable proportion of the fire-box ring, though it was distorted, and forced downwards at its lower part, and though the stays which connected it with the fire-box had given way, was still hanging on to the fire-box. Different sized portions and fragments of tubes, sheeting, lagging, feed-pipes, and hand-rails, &c. were thrown off in different directions. The right, or off driving wheel was blown away, and thrown forward, after striking against the right pier, and knocking some bricks out of it. Not only was the crank-axle fractured, but the framing was also torn away, in front of and behind this wheel; and it lay across the up-line, with a part of the framing and machinery still attached to it.

A ragged elongated hole had been made in the bottom of that part of the barrel of the boiler which remained on the fire-box, in consequence, evidently, of its having been penetrated by the left arm of the right crank, either after the fracture of the crank-axle, or at the time when it gave way; but this hole was an isolated one, and was totally unconnected with any of the numerous lines of fracture into which the boiler had been divided.

Those lines of fracture are clearly shown on the diagrams Nos. 1 and 2 enclosed herewith, the former having reference to the right, or off—the latter to the left, or near side of the engine. The different portions, also, into which the barrel of the boiler was divided, are shown in diagrams 3 to 9 inclusive; and the off driving wheel, with the portions that were blown away with it, in Nos. 10 and 11. These diagrams, which are interesting and important, in demonstrating the cause, and illustrating the effects of the explosion, have been kindly furnished to me by Mr. McConnell, the locomotive superintendent for the Southern division of the London and North-western Railway, and have been prepared by the officers of his department.

The general results of the explosion may be stated to have been,—that the middle ring of the barrel, opening on the left side, was torn away from the other two rings in an irregular manner, thrown off to the right, and broken into two pieces; that the greater part of the foremost or smoke-box ring, torn along the left side through the whole plate, in a line almost continuous from the line of fracture of the middle ring, broken off on the right through the seam of rivets, and carrying away with it part of the angle iron of the smoke-box, was thrown upwards against the arch of the bridge, and fell back on the tender; that the hindmost or fire-box ring was torn open on the right side, had its upper part blown upwards, and its lower part blown downwards, and was penetrated by the broken crank (κ, κ, in diagrams 3 and 4); and that the off driving wheel was blown away to the right, with parts of the framing and machinery; while many of the lighter portions, which covered the boiler, or were connected with it, were thrown off in different directions, and to considerable distances.

The resistance to the explosive force which was offered on the right, by the plates composing the middle ring, and by the driving wheel and framing, caused the engine itself to diverge to the left, and to strike the left pier of the bridge at its south end. Glancing from that pier without doing any material damage to it, it then ran forward on the left of the down line, on which it had been travelling, and finally fell over on that line, an extraordinary wreck, at 72 yards only from the point at which the explosion occurred. It would have been brought to a stand, even in a shorter distance, if it had not thus fortunately struck, and glanced from the brick pier; and the consequences would in that case have been more disastrous. As it happened, the whole of the vehicles composing the train pulled up in their proper order behind the tender, on the left of the down line, leaning more or less against the left slope of the cutting; and the principal damage done to them was from the front end of the leading van coming in contact with the tender.

The driver was thrown off to the left at the moment of explosion, and against a telegraph post; but he appears to be in a fair way of recovery from the injuries that he sustained. The fireman was carried forward with the engine, and was so dreadfully crushed about the lower extremities, that his case was hopeless from the first, and he did not long survive. A post-office clerk was injured on the head, as well as the guard in the leading van; but the passengers appear to have escaped without further ill effects than resulted from the alarm and the severe shocks that they received.

The engine was one of a class known as the "Bloomer" class, and was rather less than ten years old. It was delivered to the Company by Messrs.

To accompany Captain TYLER'S Report, dated 30th July 1861, on the bursting of the Boiler of No. 249 Engine, attached to the Irish Mail Train, near Rugby, on the LONDON AND NORTH WESTERN RAILWAY, on the 4th July 1861.

FIG. 1.

Longitudinal Section showing lines of fracture on right side.

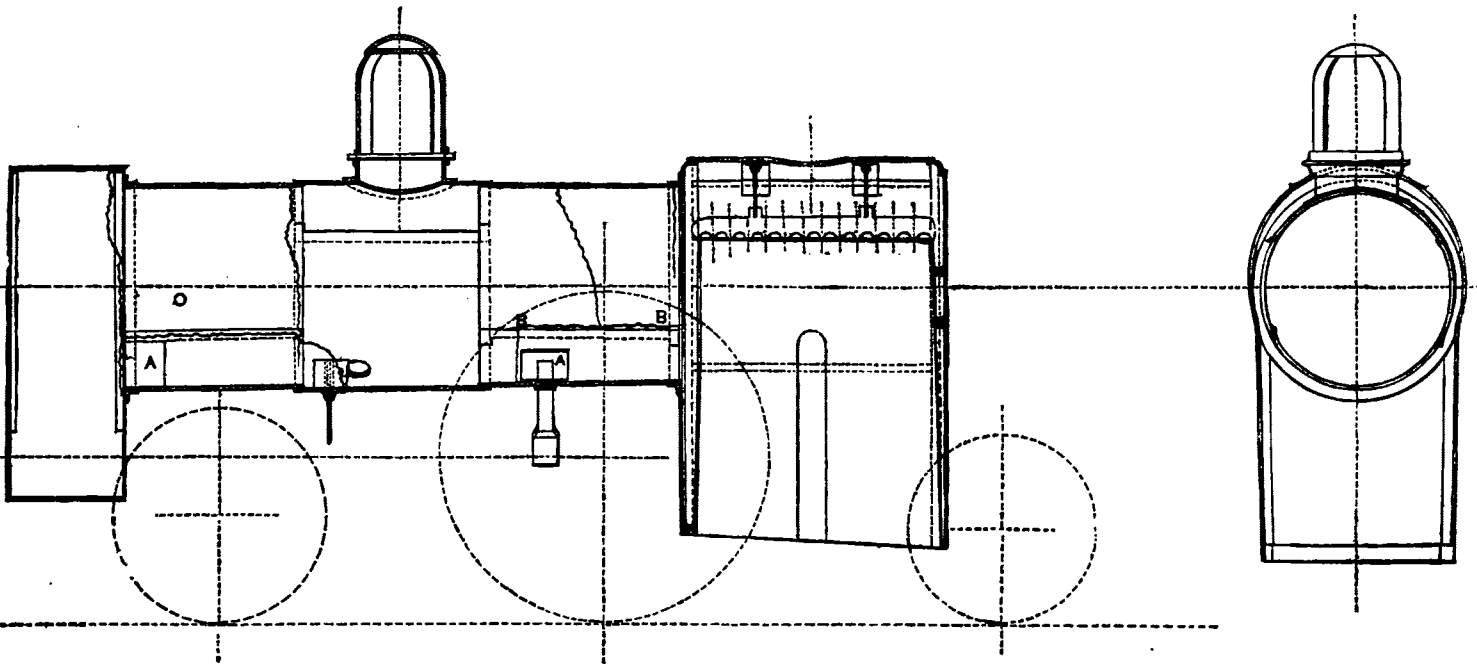


FIG. 2

Longitudinal Section showing lines of fracture on left side.

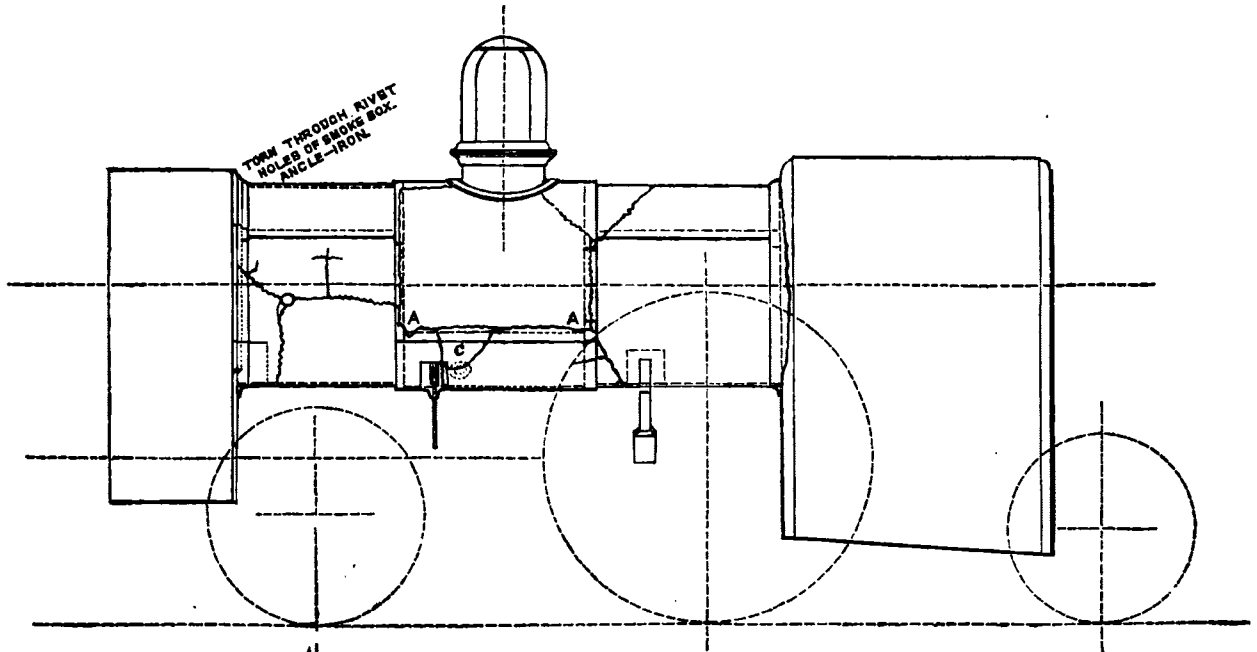


FIG. 3.

End elevation of fire-box, as seen from the front, with remains of fire-box ring attached.

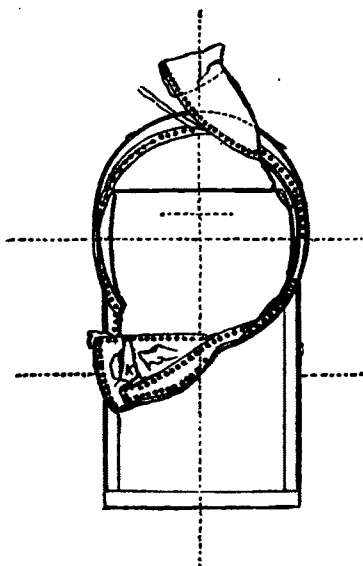


FIG. 4.

Side view of fire-box, and remains of fire-box ring of barrel.

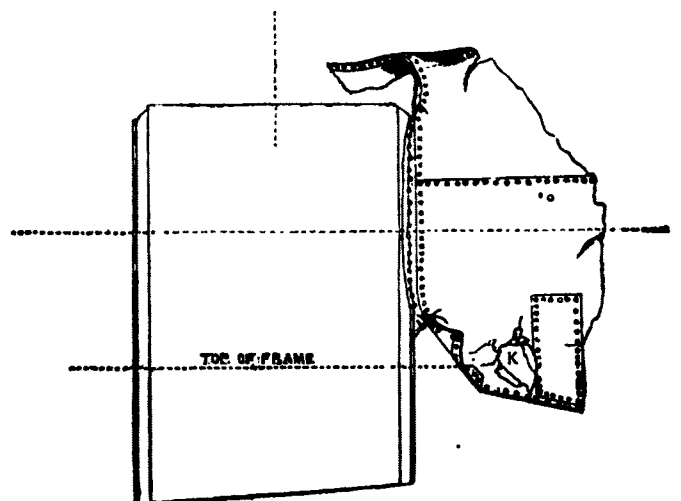


FIG. 5.

End view of smoke-box, as seen from behind, with remains of tube-plate, and small portions of smoke-box ring of barrel.

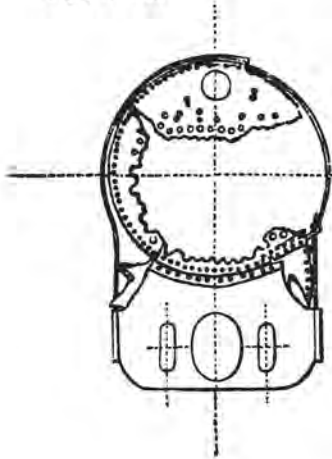


FIG. 6.

Side view of smoke-box, with portion of barrel attached.

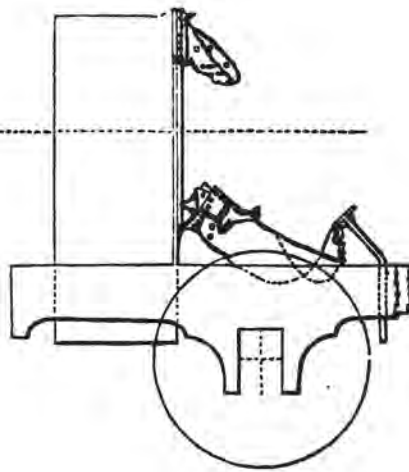


FIG. 7.

Larger detached portion of middle ring of barrel, with steam dome attached.

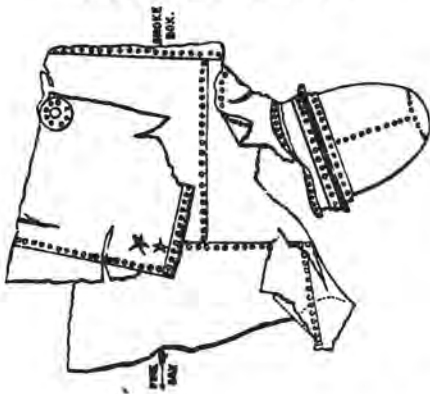


FIG. 8.

Small portion of middle ring, fitting in between the steam dome and the line of explosion on the left of the barrel.

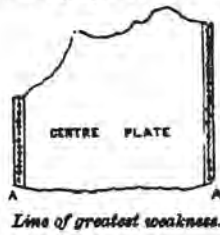
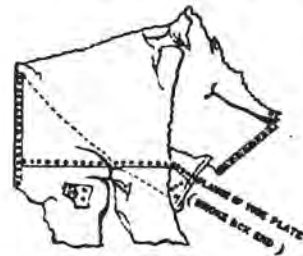


FIG. 9.

Portion of smoke-box ring found on back of tender after explosion.



Part of middle ring marked C in Diagram No.2.



FIG. 10.

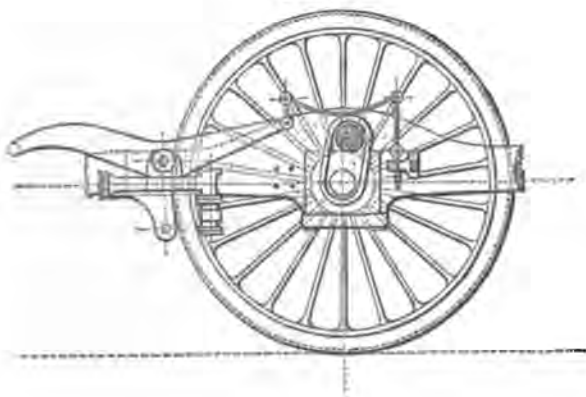
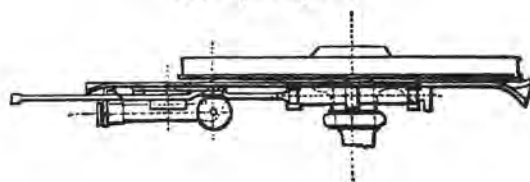


FIG. 11.

Plan and elevation of wheel and part of framing of No. 249 engine after explosion.



Sharp, Brothers, and Co., of Manchester, in October, 1851. It had 142 square feet of heating surface in the firebox, and 1152 square feet in the tubes, of which there were 195. It was a six-wheeled single engine, with 16-inch cylinders, a 22-inch stroke, and driving wheels 7 feet in diameter. It was provided with two safety valves, 3½" in diameter, set to a pressure of 120 lbs. on the square inch, and a Bourdon's pressure gauge. It weighed 9 tons 18 cwt. on the leading, 12 tons 7 cwt. on the driving, and 6 tons 15 cwt. on the trailing wheels. It ran 196,885 miles between October 1851 and October 1857, when it was supplied with a new set of tubes, and 139,483 miles between that date and the period of its explosion. It was the same engine that came into collision with a cattle train at Atherston, when attached to the limited mail, on the 16th of November last, with such serious consequences.

The barrel of the boiler was 11 feet 9 inches long by 4 feet 1 inch in diameter in the two outer rings, and 4 feet 1½ inches in diameter in the middle ring, measured in both cases in the interior. The barrel was composed of ¾" plate, and the outer shell of the firebox of ⅞" plate. Assuming the ultimate strength of the plates at 51,000lbs. to the square inch, and of the rivetted joints at 34,000lbs. to the square inch, and taking the diameter at 49 inches, the bursting pressure of the barrel would have been, when it was new, 520lbs. per square inch at the longitudinal joints, and 778lbs. to the square inch through other parts of the plates. On the same calculations the bursting pressure through the plates would become 129lbs. to the square inch, if their thickness were reduced to ⅙th of an inch.

In examining the fractured portions of this boiler, I observed that corrosion had been actively going on in several parts of it, and particularly above two seams of rivets, the one situated on the left side of the middle ring, and marked A A in the diagrams Nos. 2 and 8; and the other on the right side of the firebox ring, marked B B in diagram No. 1. The former was the worse of the two lines, and was the weakest part of the boiler. The metal had been eaten away along this line in an irregular manner, and had been reduced in places, to little, if any, more than ⅙th of an inch, which, as I have before shown, would approach closely to the thickness at which rupture might be expected at the ordinary working pressure of the engine.

The engine appears to have been in good order in every other respect; the safety valves to have been working properly; the supply of water to have been attended to; the pressure of steam to have been rather under than over the prescribed 120lbs. Looking to the way in which this line of greatest weakness is connected with all the other lines of fracture; to the general effects of the explosion, and the subsequent position of the fragments; to the way in which the engine and train were diverted from their course; and to all the circumstances of the case; I have no doubt that the line referred to, marked A A in the diagrams, was that on which the boiler first opened; and that it gave way along this line under ordinary pressure, solely in consequence of the thin condition to which the plate was reduced.

The interior of the barrel had been last examined in October 1857, at which time, as I have already stated, a new set of tubes was inserted. It is said to have been in good order, and was expected to outlast another set of tubes.

It is impossible to believe that the corrosive action which has at length led to its explosion had not commenced at that time, though it had not apparently arrived at a stage to excite apprehension in the mind of the foreman who superintended the renewal of the tubes. It is more probable, if, indeed, it may not be considered as certain, that the reduction to about one sixth of its original thickness which is apparent in the plate that failed, had been spread over nine years and eight months that the engine has been at work, and that this plate must have been in a condition to re-

quire renewal when the boiler was re-tubed three years and eight months ago.

If it is not so,—if the plate in question has been reduced in three years and eight months from its original thickness, or from nearly its original thickness, to the condition in which it is now found to be, then it is the more clear that inspection is necessary at shorter intervals to ascertain the condition of the plates.

When no symptoms of leakage or other indications of defect are observed, it is not at present the practice in the locomotive works of railway companies, to examine the interior surfaces of the barrels of engine boilers, except when the tubes are taken out for renewal. The first set of tubes in the engine now referred to lasted for six years, though its mileage was a heavy one, and it may be said that this practice provides that they shall be inspected once only in every five or six years. Partial inspections, it is true, occasionally take place when some of the tubes are removed, but in order that a thoroughly efficient examination may be made, it is necessary that they should all be taken out, and that a man or a boy should be sent into the interior, to knock away the deposit (when there is any) which has formed from the impurities of the water.

It must be admitted, that the taking out and replacing of 195 tubes, as in the case of this engine, or of a greater number, as with some other engines, is a serious operation, and that it is not desirable to take a high-pressure boiler to pieces more frequently than is absolutely necessary; but it is clear, that if it be safe to trust the barrel of such a boiler to wear out one set of tubes without an intermediate examination, it cannot at all events be safe to allow it to wear out a second set in the same manner. The present instance is only a forcible illustration of the experience which has been obtained in sufficient abundance in other cases, in which boiler plates have been eaten away in a greater or less time according to circumstances.

The peroxide of iron appears to have a peculiar property of propagating itself, as it were, and of eating its way into the metal in particular places, when it is formed in combination with it on its surface, in a manner that is not observable in the case of the oxides of any other metal. This action goes on in the interior of boilers as well as in iron employed for other purposes, and it is so treacherous in its character, and so uncertain in its choice of time and place, as well as in the rapidity with which it is carried on, that no reliance ought to be placed, for a series of years, upon the strength of iron which is exposed to it, in any position where it cannot be examined at proper intervals.

The plates of locomotive boilers, besides being pock-marked, as it is termed, or eaten in holes, are constantly found to be extensively corroded near the seams of the rivets. This is caused, no doubt, by the expansion and contraction of the metals consequent upon the variation of temperature and pressure which promotes mechanical movement, and favours this corrosive action more particularly along the portions, where, next to a joint, the metal is most subject to distortion. In order to remedy this tendency to corrosion along the seams of rivets, it has latterly become the practice to place the upper plates inside of the lower ones, instead of outside of them, at the joints, a mode of construction which had not been adopted when this boiler was made. It is generally believed that by thus avoiding the ledge which is formed by the edge of the lower plate, when that plate is placed inside the upper one, the deposit caught by such a ledge, which promotes corrosion, is deprived of its resting place. This improved method is no doubt one which it is desirable to adopt, but it is only found, apparently, to be a partial remedy, and the plates continue to be eaten away below the seam in somewhat the same manner as they are gradually rendered unsafe above it.

The only method by which accidents of this description can be properly provided against, is by more frequent examination, coupled with an ample margin of strength in original construction, and with ample strength in proportion to the pressure employed as the boiler deteriorates, as it must always do, more or less, in after years.

The factor of safety originally allowed in this boiler, was only  $4\frac{1}{2}$ , instead of 6, which it ought, in my opinion, to be; inasmuch as the working pressure was 120 lbs. and the bursting pressure 520 lbs. per square inch, as I have already stated; and the full working pressure was maintained whilst the plates were getting thinner and thinner, until at length the boiler exploded in the performance of its ordinary duty.

This is an important instance of the danger of trusting for too long a period to iron plates, and of the necessity of more frequent inspection; and it is worthy of serious attention on the part of the locomotive superintendents of the different railway companies. The hydraulic test which some of them are in the habit of applying, and which is, when properly used, a good auxiliary means of security, cannot be considered in any way to supersede this necessity, which undoubtedly exists, for careful examination at stated periods.

I have, &c.

*The Secretary,  
Railway Department,  
Board of Trade.*

H. W. TYLER,  
Capt. R.E.