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MADRAS RECORD OFFICE.

Government of Madras.

Public works **DEPARTMENT.**

G.O. No. 747 Press ~~Mis.~~

210-11

Dated 9 3 1870.

Not to be folded or roughly handled

No. 210. Read the following Circular from the Deputy-Secretary to the Government of India, Public Works Department, (Railway,) to the Secretaries to the Governments of Madras, Bombay, Bengal, Punjab, and North-Western Provinces; the Chief Commissioner of Oudh; and Resident at Hyderabad, dated Fort William, 17th February 1870, No. 3 :—

WITH reference to the papers received from the Government of Bombay, under cover of No. 286, dated 10th February 1869, which were circulated under docket Nos. 243—7-R., dated 1st March 1869, I am directed to forward the accompanying copy of correspondence on the proper tests to be applied to the boilers of locomotive engines, embodying the views on the subject of the different Local Governments, and those of the Locomotive Superintendents and other officers of the principal Railways in India, together with a report on the matter by Colonel Hyde, R.E., the Master of the Calcutta Mint.

2. The Governor-General in Council does not think it necessary to prescribe any rules on this subject, but is of opinion that such rules should be prepared by the proper authorities for every Railway, and that the Consulting Engineer should see that they are strictly enforced. The Government of India will be glad to receive a copy of the rules as approved by the Local Government.

3. I am further to request that Colonel Hyde's remarks in his letter, No. 801, dated 3rd December 1869, on the construction of boilers, may be commended to the consideration of all Locomotive Superintendents.

No. 211. ORDER THEREON, 9th March 1870, No. 747.

RAILWAY, No. 16.

COMMUNICATED to the Consulting Engineer for Railways, who will, in communication with the Agents of the Madras, Great Southern of India, and Carnatic Railway Companies, prepare and submit a draft of the rules which he would propose for adoption for examining and testing the boilers of locomotive engines.

2. Major Shaw Stewart's attention will be drawn to paragraph 3.

(True Extract.)

Colonel, R.E.,
Secretary to Government.

To the Consulting Engineer for Railways, with copy of Correspondence and Photograph.

Exd. F. R. Bantleman.

Enclosure to Circular No. 3 Railway.

No. 672 G, dated 1st April, 1869.

From—MAJOR J. HOVENDEN, R. E., *Offg. Joint-Secy. to the Govt. of Bengal, in the P. W. Dept., Ry. Branch,*

To—The Secretary to the Government of India, P. W. Dept.

In compliance with the request conveyed in the Public Works Department memorandum No. 244R, dated 1st ultimo, I am directed to forward copies of the documents noted in the margin, relative to the mode of testing locomotive boilers on the East Indian Railway and Eastern Bengal Railway.

Letter from Agent, Eastern Bengal Railway Company, No. 1310, dated 20th March 1869, with enclosure.
Letter from Chairman, Board of Agency, East Indian Railway, No. 178, dated 30th March 1869, with enclosures.

No. 1310, dated 20th March, 1869.

From—F. PRESTAGE, Esq., *Agent, Eastern Bengal Railway,*

To—The Offg. Consg. Engr. to the Govt of Bengal, Railway Dept.

I have the honor to acknowledge receipt of the Officiating Joint-Secretary's No. 475G, with enclosures, and in reply thereto to forward copy of report No. 802 by this Company's Locomotive Superintendent, relative to the examination and test of locomotive engines on this Railway.

No. 802, dated 20th March, 1869.

From—T. HINDMARSH, Esq., *Locomotive Superintendent,*

To—The Agent, Eastern Bengal Railway.

In reply to your No. 1148 of 11th instant, frwarding Officiating Joint-Secretary's letter No. 475G, with enclosures, I beg to inform you that the following rules are observed with reference to the manner in which the boilers of his Company's locomotives are examined and tested :—

1st.—The safety valves are examined, and the spring balances are weighed and adjusted once every month.

2nd.—The fire boxes and tubes of the running engines are examined monthly, and when an engine is stopped for a thorough repair, which occurs every two years or so, the clothing is removed, and the boiler is examined and tested by hydraulic pressure up to 180 lbs per square inch, or 50 per cent. above the ordinary working pressure. The water used for the above test is invariably heated up to 212 degees Fahrenheit before the hydraulic pump is applied, which I consider less liable to strain the plates than by using cold water.

With reference to the Resolution passed by the Government of Bombay, fixing a maximum running distance for locomotive engines to run before the tubes are removed, I am of opinion, it would be impracticable to fix upon any rule which could be applied to all the Railways in this country, as so very much depends upon the water used for locomotive engines. As a proof of this, I have lately tested the boiles of three engines which have run 98,039, 97,355¾, and 86,739 miles respectively, and they are to all appearance as good and strong as they were when the engines were first placed on the line.

This I attribute entirely to the characteristics and nature of the water used on this Railway for feeding the boilers, it being comparatively free from carbonate of lime and magnesia salts.

No. 178G, dated 30th March, 1869.

Memo. by—E. PALMER, Esq., *Chairman, Board of Agency, E. I. Railway.*

Copy of the following, and enclosure, forwarded to Consulting Engineer, Government of Bengal, for information, in reference to his docket No. 474 G of 5th instant.

No. 493, dated 23rd March 1869.

From—G. SIBLEY, Esq., *Chief Engineer,*

To—*The Chairman, Board of Agency, E. I. Railway.*

In reply to the Officiating Joint-Secretary to Government of Bengal's No. 474G* of 5th instant, on the subject of locomotive boiler inspection, I beg to send copy of Officiating Locomotive Superintendent's No. 474 of 18th instant, and to state that, in my opinion, all locomotive boilers should be tested by hydraulic pressure to 50 per cent. above their working pressure, after they have run 50,000 miles, and thereafter on having run a further 25,000 miles.

* Herewith returned.

No. 474, dated 18th March, 1869.

From—H. CARRICK, Esq., *Offg. Supdt., Locomotive Department,*

To—*The Chief Engineer, East Indian Railway.*

I am in receipt of your No. 239 of 11th instant, accompanying letter from Government of Bengal, to Chairman, Board of Agency, East Indian Railway, No. 474 G of 5th March, respecting the testing of locomotive boilers.

The practice on this line is to test all boilers whenever they go into shops, and if at any time there are any doubts of the boiler of a running engine, it is at once tested, and internal inspections are made by removing tubes, if there is the slightest sign of furrowing or undue corrosion.

The test ordinarily applied is cold water pressure, which, if properly carried out, is not, I think, so injurious to boilers as Mr. Charlton, of the Great Indian Peninsula Railway, points out.

I am quite of opinion that, with the water generally obtainable on this Railway, it is not desirable to work any engine at more than 120 lbs. per square inch, which has been carried out since 1st May 1865.

No fixed rule could be laid down for inspecting boilers, as it is found in practice that it could not be carried out. A monthly inspection is made of safety-valves and boiler-fittings, and if there is any doubt about any furrowing taking place in the plates, small holes are drilled to ascertain the thickness.

Our rule for testing is,—engines working at a pressure of 120lbs. are tested up to 200lbs.; 110 lbs. are tested up to 180 lbs; and 90 lbs. to 150 lbs.

One of the greatest difficulties to contend with is, that drivers can so easily tamper with safety-valves, and I fear that this is often done, especially when the train is overloaded, by weighting the safety-valves, and increasing the pressure, so as to enable the driver to get along with his train. Most serious notice is of course taken of any instance of this when it is discovered.

Letter No. 474 G of 5th instant, from Government of Bengal, is returned herewith, with the request that a spare copy may be sent for record in this Office.

No. 411R, dated 20th April, 1869.

From—CAPTAIN F. S. STANTON, R. E., *Offg. Joint-Secy. to the Chief Commr. of Oudh, in the P. W. Dept., Railway Branch,*

To—*The Secretary to the Government of India, P. W. Dept.*

I am directed to acknowledge the receipt of your docket No. 246 R, dated 1st March, with enclosures, on the subject of the examination of locomotive boilers.

The Oudh and Rohilkhund Railway Company possesses only four engines, and these have now been running for two years; they have not been thoroughly examined since they were first erected, but have not run an average of more than 30,000 miles each.

The Locomotive Superintendent is of opinion that new locomotive boilers should be thoroughly examined every two years, and old ones every year, and has promised that as soon as the arrival of the two new engines from England (expected immediately) shall enable him to do so, he will have the present stock thoroughly examined, but until the new engines are running, he does not like to lay up any of the four engines.

The Chief Commissioner considers the subject one of great importance, and has requested that, in future, with each Half-yearly Report, a statement may be submitted showing the number of boilers which have been thoroughly examined and tested during the half-year.

No. 991, dated 1st May, 1869.

Memo. from—MAJOR-GENL. J. P. BEADLE, R. E., *Agent, Oudh and Rohilkhund Railway,*

To—*The Consulting Engineer to the Government, Oudh Commission, Railway Dept.*

TESTING OF LOCOMOTIVE BOILERS.

The undersigned has the honor to forward, with reference to Consulting Engineer's letter No. 412 of 20th ultimo, copy of Locomotive Superintendent's letter No. 591 of 28th April 1869, regarding the above.

It is hoped that, with this explanation, the arrangement made by Mr. Cooke for testing boilers will be considered complete and satisfactory.

Sanction is requested to the accompanying Indent No. 75 for a test-pump complete.

No. 530 R, dated 12th May, 1869.

Endorsed by Offg. Joint-Secy. to Chief Commr. of Oudh, in the P. W. Dept., Railway Branch.

Copy, together with copy of Locomotive Superintendent's letter, forwarded to the Secretary to Government of India, Public Works Department, for information, in continuation of this Office letter No. 411R, dated 20th April 1869.

No. 591, dated 28th April, 1869.

From—J. G. COOKE, Esq., *Locomotive Superintendent,*

To—*The Agent, Oudh and Rohilkhund Railway Company.*

In reply to your No. 946 of the 26th instant, forwarding copy of a letter No. 412 from the Officiating Joint-Secretary to Chief Commissioner, Oudh, with reference to testing boilers, I beg to say that, after new boilers have been running two years, I examine them, and afterwards consider them as old ones, repeating the examination every two months.

I neglected to explain in my letter No. 839 on this subject, that the examination I proposed consists of a thorough cleaning and examination of the external shell of boiler, and testing with steam and water while the clothing is removed, so that all leaks or defects of any kind may be discovered and remedied.

If this proposition should prove satisfactory to the Chief Commissioner, I shall be glad to be informed as early as possible, as two boilers have already undergone this examination, and another will be commenced during the ensuing week.

I herewith send you an indent for a test-pump from England. At present we have only been able to prove the boilers with steam-pressure.

A complete register is kept of the miles run by each engine, and a memorandum of some shall be sent with each Half-yearly Report as requested.

The memorandum of maximum miles run by any one engine shall be forwarded in a day or two.

No. $\frac{224\ P.}{133\ D.}$, dated 28th May, 1869.

From—LIEUT.-COL. H. DRUMMOND, R. E., *Joint-Secy. to the Govt. of the Punjab, in the P. W. Dept., Railway Branch,*

To—*The Secretary to the Government of India, P. W. Dept.*

With reference to Public Works Department No. 245 R, dated 1st March 1869, I am directed to forward, for the information of the Government of India, copies of correspondence as marginally noted, on the subject of testing locomotive boilers by hydraulic pressure, with the remark that the subject will continue to receive attention, and a further report be submitted hereafter.

Letter No. $\frac{234}{182}$, dated 10th March 1869, from Consulting Engineer, Punjab Government, to Agent, Punjab and Delhi Railways.

No. $\frac{1037}{1097}$, dated 22nd May 1869, with two accompaniments from Agent, in reply to above.

No. $\frac{234\ P.}{182\ D.}$, dated 10th March, 1869.

Memo. from—LIEUT.-COL. H. DRUMMOND, R. E., *Consg. Engr. to the Govt. of the Punjab, Railway Dept.,*

To—*The Agent, Punjab and Delhi Railways.*

In continuation of No. $\frac{180\ P.}{149\ D.}$, dated 22nd ultimo, has the honor to forward two copies of Government of India, Public Works Department, No. 245 R, dated 1st instant, and annexures, on the subject of testing of boilers by hydraulic pressure, for information and communication to Locomotive Superintendent and Chief Engineer, and for report of the practice in force on the Punjab Railway. A statement should be prepared by the Locomo-

No. 76, dated 23rd April, 1869.

From—W. J. COLLINSON, Esq., *Acting Locomotive Superintendent,*
To—Agent and Manager of the Madras Railway Company.

With reference to the Consulting Engineer's letter No. 144 of the 10th instant, regarding the practice of testing locomotive boilers on this line, I beg to offer the following observations:—

Para. I.—The practice now in force on this line has been depended, not on a certain number of miles run, but on the work done by each engine, the quality of the water used, and other circumstances connected with the running of our locomotives, which have rendered it necessary for the boilers to be examined.

The first examination of our boilers has been on an average after six years' use, and the second examination on an average of three years, when they have had nearly new boilers and fire-boxes.

For our own satisfaction, we occasionally make a thorough examination of a boiler of each class of our locomotives by taking the tubes out, the roof bars off, and cleaning and examining the inside and outside plates, which we have found has, in a great measure, served as a guide as to the state of the boilers of the other engines working on the same division of the line.

As regards statistics: a record is kept by the Foreman Boiler Smith, and a copy in the office, of the date a boiler is examined, and any special circumstances that he may find necessary to note.

Para. II.—I do not think any more efficient test could be introduced than that now in force. Extra care and precaution have always been taken for the thorough internal and external examinatiom of our boilers.

Para. III.—We make use of hydraulic pressure, but more as an auxiliary; that is, we do not depend upon it for a thorough test of the boiler, but use it more for testing the tubes; and after a boiler has been repaired, for testing the efficiency of the work. The pressure used is from 180 to 210lbs., a little more than pressure and a half.

The practice of testing boilers by hydraulic pressure is one which has always been a vexed "question," and on this point several discussions and disputes have arisen both as to the necessity or otherwise for this test, and the amount of pressure which ought to be used. In 1864 and 1866, this subject seems to have created considerable discussion in England, and in a leading article in the *Engineer*, of the former year, the writer says—"Within the last year a considerable number of locomotive boiler explosions have taken place, and in every case upon one or other of the great lines upon which locomotives are never tested by the force-pump; on the other hand, we believe that there is no account of the explosion of any boiler regularly tested by the pump upon either of the lines where that test is adopted." And in *Engineer* of May 11th of the latter year, there is a report of a paper read at the Meeting of the Mechanical Engineers held at Birmingham on the 3rd of the same month, by Mr. William Kirtly, of Derby, "on the corrosion of locomotive boilers and the means of prevention," in which he gives his opinion as follows regarding the use of the test pump:—

"In the course of our own experience, we have known several instances in which the application of the hydraulic test has revealed desects, which, if not thus discovered and remedied, would, in all probability, have led to the most serious results. We do not consider that the hydraulic test is any substitute for a thorough external and internal examination of the boiler, but it is a most useful auxiliary, and it is a test which can be applied at times when an internal examination of the boiler is impossible."

I quite concur in these opinions; in fact, the same system has all along been adopted on this line as that advocated by them, and although an internal examination of a locomotive boiler is a very costly affair, there can be no doubt it is not only the greatest safeguard, but the surest mode of preventing accidents.

Para. IV.—The maximum distance an engine may safely run without undergoing thorough examination and repairs, varies on this line from 100,000 to 134,000 miles.

On examining many of our boilers after running these distances, we found the centre bottom-plates furrowed inside near the lap-joint, caused no doubt by the sediment and the expansion and contraction of the boiler.

The twenty new locomotives now under construction in England for this Railway are, I believe, to have the boilers made with "butt joints and bands double rivetted seams," so that the place will be quite even along the inside of the boiler. This improvement will greatly remedy the evil experienced with boilers with lap-joints, and no doubt considerably increase the mileage these engines will be able to run safely without undergoing thorough examination and repairs.

The working pressure of our locomotive boilers is 120lbs. per square inch, but although, on examining our old boilers, we discovered in some of them no signs of wanting repairs, yet, for greater safety, we reduced the pressure to 100lbs.

No. 2988, dated 23rd April, 1869.

From—The Acting Agent of the Great Southern of India Railway,
To—The Consulting Engineer of Railways, Madras.

I have read over the correspondence embodied in the Government Order No. 1098, on the subject of testing locomotive boilers, and herewith send you copy of a letter from the Locomotive Superintendent of this Company, affording information on all the points in question.

No. 193, dated 21st April, 1869.

From—The Acting Locomotive and Carriage Superintendent,
To—The Acting Agent of the Great Southern of India Railway.

Your No. 4385—2048 and enclosure.

When I arrived in India in 1867, I found there was no means of testing boiler joints or tubes in the Company's works. I indented for a hydraulic press, which arrived here in July 1868. Since then each engine, as she has come in for repair, has been tested and examined. I purpose testing and overhauling all the engines as they come in. I attach a statement showing the original working pressure of our engines and that at which they are now working:—

Nos. of Engines.	Time they have been working.	Original Working Pressure.	Present Working Pressure.	Hydraulic test pressure.	
1 to 9	8 Years.	120 lbs.	100 lbs.	200 lbs.	Passenger engines.
10 & 11	3 „	100 „	100 „	150 „	Ballast „
12 to 15	2 „	120 „	120 „	200 „	Goods „
16 & 17	6 Months.	120 „	120 „	200 „	Ditto „

There has been but one instance of corroded plate (Ballast Engine No 11), and this was detected and repaired. The boiler-shell was eaten away at the angle-iron of the smoke-box, the plate being reduced from $\frac{3}{8}$ths of an inch to bear $\frac{1}{8}$th of an inch; this was discovered by a hammer-tapping test. I do not consider hydraulic pressure a test for corrosion; it is more useful as a test for joints or new tubes, and a check upon spring balance safety-valves. The only means of detecting corrosion is by tapping the boiler carefully along the joints. There is, however, no certainty of detection, a bad place may escape through being encrusted, and have no appreciable difference in ring from a sound plate. Boilers always get thin at the joints, whether butt or lap-joints, in course of time, due to the spring upon the plates by constant vibration, causing friction between the angle-iron and the plate, and also through the obstruction of the collar for the angle-iron or plate, forming a lodgment for deposit. The most effective and safest kind of boiler-plate, in my opinion, is that known as "thick-edged plate," made at the Lowmoor Iron-works. This gives an extra thickness of metal at the place where plates always weaken. Our water on the west of Trichinopoly is very bad. I should be glad to adopt any means of preventing incrustation which takes place to a great extent. The Bombay Consulting Engineer (in his letter No. 2211) is evidently not aware of the enormous expense which would be entailed if his suggestions were adopted. Engines run say 180 miles a day every 18 months, therefore each engine would have to be dismantled. He cannot know the expense of so doing. Removing tubes is a thing to be avoided as much as possible, unless imperative. Each removal of tubes enlarges the holes in the copper tube-plate, and in many cases needs new tubes. Tubes removed eight or nine times in this way would need a new tube-plate, or at least removal to bore out. The expense of this would be enormous, and, with the indifferent means at our disposal in this country, a work of great time. Railway Companies would need their engine stock doubled to do it. I have known engines run for five and six years without a tube being touched greatly to the engine's advantage.

No. 3015, dated 12th May, 1869.

From—The Acting Agent of the Great Southern of India Railway,
To—The Consulting Engineer for Railways, Madras.

I have the honor to attach copy for the Locomotive Superintendent's remarks in answer to your call (letter No. 147, dated 28th April 1869) for further information, with regard to the manner of examining and testing boilers of engines on this line.

No. 219, dated 6th May, 1869.

From—The Locomotive and Carriage Superintendent,

To—The Acting Agent of the Great Southern of India Railway.

Consulting Engineer's letter No. 147 (returned).

I did not reply directly to the para. 4 referred to, as I do not agree with the views expressed by the Superintendents of the Bombay lines regarding the examination needed or demanded by the fact of the engines having run the number of miles mentioned. The expression "thorough examination" is qualified in the Consulting Engineer's No. 147 as meaning the removal of tubes. I am quite alive to the necessity of constant precaution and careful examination with boilers to ensure immunity from explosion, if possible. I quite think that when an engine has run 150,000 miles, she should be examined, but, as I said in my former letter, I disagree entirely as to what constitutes needful examination. I think that, unless some cause be given, such as suspicion of the engine's state, it is not expedient to dismantle an engine every two years or so. Our engines Nos. 1 to 9 could not be examined, as the Consulting Engineer proposes, without entirely pulling them to pieces. The steam-douse is over the fire-box, and no one, not a boy, can get inside the boiler without removing longitudinal boiler stays and fire-box roof stays; unless this be done, the taking out of the tubes is useless, as nothing at all approaching an examination of the joints can be made from looking through the tube-plates at either end. As I explained in my former letter, I have only had the test-pump nine months. The system in force here is such as is usually adopted on all English lines. Entries are made by the drivers in the shed-books of the general condition of their engines, and if any remarks are made, calculated to make the state of the engines suspicious, she is overhauled at once. When tubes leak on the three bottom rows, the whole rows are taken out and the boiler cleaned, and the engine's lagging removed, and the boiler examined. When an engine has been running two years, she is stripped and examined, if she requires repair; but if she be otherwise in good condition, she runs until she comes in for repair. All our engines but three have been examined and overhauled since I have been here just two years. These three engines I shall endeavour to get in to the shops when they require such a repair as will bring them down to Negapatam. These three engines may have run about 100,000 miles. I keep a record of the conditions of our engines and the nature of examination they undergo, so that no care is wanting to ensure their being in good order.

No. 2113, dated 9th June 1869.

Endorsed by the Govt. of Madras, in the P. W. Dept., Railway Branch.

Copy of the above forwarded to the Government of India, with reference to their Proceedings, dated 1st March 1869, No. 243R.

Extract from Inspection Report by LIEUTENANT L. CONWAY-GORDON, R. E., *Assistant Consulting Engineer to the Government of the Punjab, Railway Department, on the Punjab Railway, and of the Beas Section of the Delhi Railway, for the fourth quarter of* 1868-69.

PARA.—23. There can be no doubt that the working expenses of these lines are considerably enhanced by the bad quality of the water supplied to the engines, and consequently by the loss of fuel and increased wear and tear of the machinery, though the fact may not be sufficiently realized till the locomotive stock has to be renewed from Revenue.

24. For it should be remembered that of the 40 engines supplied to the line only six years ago, some are in want already of thorough repair, and that with a net revenue of only Rs. 1,50,000, how large a proportion of the profits will have to be diverted for the renewal even of one engine annually, the average cost of the engines being about Rs. 35,000.

25. From some rough analyses of the water from the wells along the line made by Dr. Henderson, and kindly placed at my disposal, it appears that the total solids amount to from 100 to 280 grains per gallon, which is very large compared with the canal water, which contains only about 7 grains of solid matter per gallon.

26. Below are the constituents of the solids contained in the water taken from the tank at the Lahore Railway Station, which may be taken as a fair sample of the whole :—

	Grains.	
Insoluble matter.		
Carbonate of Magnesia	13·6	
,, of Lime	19·3	
Silica	a trace.	
	——	32·9
Soluble matter.		
Alkaline Carbonate	5·9	
Sulphate of Soda	51·3	
Chloride of Sodium	38·0	
	——	95·2
TOTAL SOLID GRAINS PER GALLON. ...		128·1

27. Besides the above, the water contains a very large quantity of free carbonic acid gas.

28. On the water being heated, the carbonates of lime and magnesia are deposited, and form a scale more or less non-conducting on the tubes and bottom of the boiler; the water then gradually turns into brine, sustaining the soluble salts to the limit of maximum saturation, at which point the salts of soda are deposited also. On the admission of fresh water to this heated brine, the immediate effect is to set free the carbonic acid gas existing in the freshly admitted water, thus causing a violent effervescence.

29. The ill-effect may therefore be considered as three-fold, *viz.*, *first*, waste of fuel and burning of the tubes and boiler owing to scale; *secondly*, loss of heat in making steam from brine instead of water; and *third*, the priming caused by the foul water and the violent ebullition consequent on the escape of the free carbonic acid gas.

30. The carbonates might be got rid of in the tank by the addition of a small quantity of lime water, or freshly slacked lime. This converts the soluble bicarbonate into the insoluble carbonate, which precipitates and is thus got rid of.

31. The free carbonic acid gas could be removed by taking care that the water remained some time in the tank previous to being used. This, with some simple mechanical apparatus, for slightly agitating the water in the tank, to be worked by the lifting machinery, would practically remove the evil.

32. For the soluble salts I can suggest no practical remedy beyond blowing off, which might be carried out in connection with the spray alluded to in para. 18 above. In Lancashire, potato-pulp or some other vegetable matter is used to prevent the formation of scale from sulphates, which seems to act mechanically in preventing the adhesion of the crystals as they form.

33. Another remedy would be to supply canal water at Lahore, and every other possible place, as well as at Raewind and Chunga Munga, and to use no other water, enlarging the tender tanks sufficiently for this purpose.

34. Perhaps the simplest expedient of all would be to provide the engines with Wagner's apparatus for purifying the feed water from the injectors. This apparatus appears by all accounts to be simple and efficient, and would, I believe, soon repay its cost.

35. My object, however, in writing these remarks, is not so much to suggest remedies myself as to invite the attention to the subject of those who have larger experience in the matter.

No. 984R, dated 24th July, 1869.

From—MAJOR E. C. S. WILLIAMS, R. E., *Under Secy. to the Govt. of India, P. W. Dept.,*

To—The Mint Master, Calcutta.

In continuation of Public Works Department No. 247R of the 1st March 1869, I am directed to forward copy of further papers* relative to the subject of testing locomotive boilers, and to request you will favor the Government of India with any remarks you may desire to offer at an early date. An extract, paras. 23 to 35 inclusive, of the Inspection Report of the Punjab Railway for the fourth-quarter of 1868-69, is also enclosed as bearing on the subject.

* From Government of Bengal, No. 672G, dated 1st April 1869, and enclosures.
From Oudh Administration, No. 411R, dated 20th April 1869.
From Oudh Administration, No. 530R, dated 12th May 1869, and enclosures.
From Government of the Punjab, No. $\frac{224P}{133D}$, dated 28th May 1869, and enclosures.
From Government of Madras, No. 2113, dated 29th June 1869, and enclosures.

Office Supdt. Govt. Printing.—No. 8436 P. W. D.—2-3-70.—46.

No. 1036, dated 27th May, 1869.

From Colonel M. K. KENNEDY, R.E., *Secretary to the Government of Bombay, P. W. Department, Railway, to the Mint Master, Calcutta.*

Referring to your letter No. 762, of 5th March, 1869, to the address of the Secretary to Government of India in the Public Works Department, I am directed to forward to you—

1*st.*—A photograph of the engine after explosion.
2*nd.*—The Locomotive Superintendent's report on the accident.
3*rd.*—A sketch showing the grooving of the boiler.
4*th.*—A report on the accident at the time it occurred.
5*th.*—Details of life of the exploded engine.
6*th.*—Extracts from monthly examination of boilers and fire-boxes.
7*th.*—A piece of the exploded boiler.

2. The engine did not leave the rails on the explosion. The photograph has only lately been taken, but nothing has been done to the engine since the accident.

No. 361, dated 6th May, 1869.

From T. S. SPECK, Esq., *Locomotive Supdt., to the Agent, Scinde Railway, Kurrachee.*

In reply to your endorsement No. 327 of 1869, I have the honor to forward the information desired by the Master of the Mint, Calcutta, and asked for by the Deputy Consulting Engineer for Railways in Scinde.

1*st.*—A full report of the state of the boiler after the explosion.

1*st.*—On examining the boiler after the explosion, its state was found to be as follows:—

The middle plate of barrel was entirely blown out, as was also the lower part of front plate of barrel. The plates were rent in some places through the line of the rivet holes, as also through the fair plate in the front part of barrel.

The fractures showed a certain amount of crystallization, and the nature of the iron had apparently changed The middle plate of barrel, at a point just above the longitudinal joint and at the point of fracture, was found to be only $\frac{3}{16}$th of an inch in thickness, or less than one-half of what it was originally: a piece of plate cut from this portion of the barrel is forwarded.

The dome was torn almost entirely from the middle plate, only a small part of it being found attached; the parting or fracture was chiefly in the line of the angle iron rivets.

The tubes were found to be bent outwards from the centre at the middle of their length, but retained their position at each end. They were clean in appearance, as were the other parts of the boiler.

The barrel of the boiler may be said to have been thoroughly destroyed, while the remaining portion (of boiler) had not sustained material damage.

2*nd.*—Any photographs, if taken.

2*nd.*—Photograph is forwarded.

3*rd.*—A rough drawing of the fractures, grooving of the plate, &c.

3*rd.*—Sketch is forwarded.

A

4th.—A sketch of the position after the explosion.

I should also like a copy of the boiler-maker's report referred to, as well as copies of all other reports of the state of the boiler when examined, and of all repairs executed during its life.

5th.—I should like to know the miles run, with such other information as the Locomotive Superintendent will well know how to give.

I am not aware of there being any other information I can give, but I shall be most willing at all times to furnish any information specifically asked for.

4th.—As the engine remained on the rails, this will not, I think, be necessary.

Copies of all boiler-maker's reports, together with account of all repairs executed, are forwarded attached.

5th.—My report to the Agent, No. 676, (copy attached) gives this and other information relating to this accident.

No. 646, dated 7th May, 1869.

Endorsed by the Acting Agent, Scinde Railway.

True copy forwarded, to the Deputy Consulting Engineer, in reference to his endorsement No. 406 of 23rd March last, together with—

1st.—Two copies of photograph of the boiler after explosion, [Fig. I.]

2nd.—Locomotive Superintendent's report, No. $\frac{A}{676}$ of 30th June last.

3rd.—Sketch showing grooving of the plate, [Fig. II.]

4th.—Driver W. Powdrill's report, dated 29th June last.

5th.—Memorandum showing life of the engine.

6th.—Statement showing monthly examination of the boiler and the fire-box.

7th.—A piece of the boiler.

(Signed) John Wood,
Acting Agent.

No. $\frac{A}{676}$, dated 30th June, 1868.

From T. S. Speck, Esq., *Locomotive Supdt., to the Agent, Scinde Railway, Kurrachee.*

I regret to have to report that Engine No. 17, Driver Powdrill, while taking the 5-50 P.M. up goods train of the 26th instant, exploded at Bolari station. The circumstances, so far as they have come to my knowledge, are the following:—

The engine left Kurrachee with the train in good working condition, and the train arrived at Bolari at right time. The driver was, at the time of the mishap, sitting on the engine with his back turned to the boiler, looking out for the signal to start, when he was suddenly thrown off the engine and stunned, I presume from concussion. He, however, soon recovered. His head fireman was sitting on the fore-buffer, and the second man was on one side and slightly off the line when the explosion of the boiler took place; and it is a matter for congratulation that it has not resulted in serious injury to either the driver or his firemen.

The boiler, barrel and tubes are entirely destroyed, leading axle bent, and motion damaged. The fire and smoke-boxes, however, were not injured.

I have no hesitation in saying that the explosion was due to the middle plate of the barrel of the boiler having been eaten away to the extent of nearly one-half its original thickness, just above the longitudinal joint.

From the records of this office I find that the boiler was proved (by hydraulic pressure) to 200lbs. to the square inch, in February 1866.

From foreman boiler-makers' reports I see that in the months of March, April and May last, the boiler of this engine has been reported as middling, as also has the fire-box.

The engine was built in 1860, and commenced running in June of that year. The number of miles run from that time to end of last month is 117,980.

In conclusion I must, in justice to the driver, state that I acquit him of all blame; and I am happy to say that he has been at his own request put on the list of efficients this day.

The driver's statement is enclosed. The working pressure was 107lbs. per square inch, and the driver informed me, when I arrived at Bolari on Saturday last, that the engine had just begun to blow off when the explosion took place.

Dated Kurrachee, 29th June, 1868.

From Driver W. Powdrill *to the Locomotive Supdt., Scinde Railway, Kurrachee.*

On the 26th instant, I left McLeod station with No. 17 Engine. Before starting I examined the engine, and found everything all right. I left at my usual time, and arrived at Bolari station punctual to the time. I was on the engine waiting for the signal to proceed, when the explosion took place, from what cause I cannot tell, as I had only the usual quantity of steam, and up to that time everything seemed all right.

Life of No. 17 Engine.

Construction of, and repairs to, the Engine.	1860.		
	January	7	Erecting.
	Ditto	14	Ditto.
	Ditto	21	Ditto.
	Ditto	28	Completed.
	June	9	Repairing and examining clock-boxes completed.
	Ditto	16	Ditto and fitting in one of Kitson's duplicate brass plugs to boiler end.
	Ditto	23	Ditto damper handle, and grinding in gauge cocks.
	Ditto	,,	Ditto fire-box plugs.
	Ditto	30	Ditto covering plate.
	July	14	Ditto connecting rod brasses.
	Ditto	21	Ditto blow off cock, and examining safety valves.
	Ditto	,,	Ditto connecting rod brasses.
	Ditto	28	Ditto feed cocks and covering plate.
	Ditto	,,	Ditto clock valves.
	August	4	Ditto connecting rod brasses.
	Ditto	11	Ditto eccentric rod brasses.
	Ditto	18	Erecting.
	Ditto	25	Repairing and examining eccentric straps and feed pipes.
	Ditto	,,	Erecting.
	September	8	Repairing and examining safety valves.
	Ditto	15	Ditto and connecting rod brasses and gauge cocks; examining donkey engine.
	Ditto	29	Examining pistons and slide valves.
	October	27	Ditto safety valves, and repairing ball and socket pipes.
	November	10	Repairing clock-boxes.
	Ditto	17	Examining safety valves, and repairing motion bar blocks.
	Ditto	24	Repairing connecting-rod brasses.
	December	1	Ditto clock valves, feed pumps, and lifting links.
	Ditto	8	Ditto feed pumps, examining safety valves, and fitting on two lamps, iron,—one on engine and the other on tender.
	Ditto	15	Ditto pump rod and brass ram, and fitting on one left hand cast-iron duplicate pump, donkey engine and sand boxes, pistons and slide three duplicate packing-rings.
	Ditto	22	Ditto pump rod and brass ram; fitting in one left hand cast-iron duplicate pump, donkey engine examined, fitting in one new valve spindle, repairing sand boxes, examining pistons and slides, fitting in three duplicate piston packing-rings, repairing connecting rod brasses.
	Ditto	,,	Ditto feed pipes.
	Ditto	29	Ditto donkey pet cocks.
	Ditto	,,	Ditto connecting rod brasses, examining safety valves and sand box gearing, repairing donkey slide valve.
	1861.		
	January	12	Repairing feed pump-rod and donkey valve.
	Ditto	19	Fitting on screw staples on to awning pillars, and repairing ball and socket pipes.
		,,	Repairing connecting-rod brasses.
		26	Ditto outside rod brasses and warming pipe.
	February	2	Ditto and examining safety valves, clock-boxes and gauge cocks.
	Ditto	16	Ditto clock-boxes and blow-off cocks.

Construction of, and repairs to, the Engine.	1861.		
	February	23	Repairing and lining up motion-bar blocks; repairing warming pipe and tender feed pipes.
	Ditto	„	Ditto and examining pistons, fitting in three duplicate piston packing-rings, and lining up motion-bar blocks.
	March	2	Grinding in gauge cocks, and repairing clock-box joint.
	Ditto	9	Ditto in gauge cocks.
	Ditto	16	Repairing and examining safety valves and grinding in gauge cocks.
	Ditto	„	Grinding in small whistle.
	Ditto	23	Repairing connecting-rod brasses, warming pipe and ash-pan door.
	April	6	Ditto connecting-rod brasses, and examining safety valves.
	Ditto	13	Fitting on one telescopic pipe with nut belonging to No. 16 engine, which was stolen from No. 17 engine.
	Ditto	„	Repairing connecting-rod brasses, and examining safety valves.
	Ditto	20	Fitting in one duplicate motion-bar block, examining safety valves, and repairing motion-bars.
	Ditto	„	Repairing left hand bottom clock, and examining safety valves.
	Ditto	27	Ditto and fitting on one new wood buffer.
	Ditto	„	Ditto outside rod brasses.
	Ditto	„	Ditto steel link blocks.
	May	4	Ditto donkey valve spindle.
	Ditto	„	Examining clock-boxes and donkey valve spindle.
	Ditto	11	Repairing eccentric straps and right hand quadrant block.
	Ditto	18	Ditto eccentric straps and left hand pump-rod, and caulking up tubes.
	Ditto	25	Ditto connecting-rod brasses and gauge cocks, and fitting in one new slide spindle gland stud.
	June	1	Lifting and examining leading axle-boxes, fitting in new sponges into axle-box keeps, and repairing connecting-rod brasses.
	Ditto	„	Repairing connecting-rod brass, grinding in gauge cocks, and examining safety valves.
	Ditto	8	Grinding in gauge cocks, repairing feed pipes, and fitting on one ball and socket.
	Ditto	15	Examining safety valves and donkey valve, chipping out slot in motion plate for clearance for connecting-rod, and repairing feed pipes.
	Ditto	22	Repairing outside rod brasses, and caulking tubes in fire-box.
	Ditto	29	Ditto connecting-rod brasses and feed pipes, and fitting a new awning to engine.
	Ditto	„	Ditto connecting-rod brasses and right hand feed pipe.
	Ditto	„	Caulking tubes in fire-box, and repairing tender feed pipes.
	July	6	Ditto tubes in fire-box, and examining outside of fire-box.
	Ditto	„	Examining large whistle joint.
	Ditto	13	Repairing right hand feed pipe, grinding in large and small whistles, and repairing brass plugs in smoke-box.
	Ditto	„	Ditto outside rod brass, and caulking bottom of fire-box.
	Ditto	02	Caulking bottom of fire-box, and repairing pet cocks.
	September	2	Repairing cast iron buffers and donkey engine, and examining pistons.
	Ditto	9	Ditto donkey engine and tenders, cast-iron buffers, and fitting on one tail lamp iron, to replace one which was broken.
	Ditto	„	Examining pistons, and fitting in six duplicate piston packing-rings.
	November	2	Caulking tubes in fire-box, and examining safety valves.
	Ditto	9	Examining lead plug, washing out plug in smoke-box, and repairing warming cock.
	Ditto	„	Ditto pet cocks.
	Ditto	16	Ditto safety valves.
	Ditto	„	Ditto donkey valves and pistons.
	Ditto	23	Caulking tubes in fire-box.
	Ditto	„	Repairing connecting-rod brasses and feed pumps.
	November	30	Repairing outside rod brasses, and examining safety valves.
	Ditto	„	Fitting in a new piston gland stud.
	December	7	Examining outside rods, donkey steam pipe, and safety valves.
	Ditto	21	Repairing connecting-rod brass.
	Ditto	28	Stripping and caulking bottom of fire-box.

Construction of, and repairs to, the Engine.	1862.		
	January	5	Caulking tubes in fire-box, and examining outside rod brasses.
	Ditto	„	Repairing connecting-rod brasses and feed pipes.
	Ditto	12	Caulking bottom of fire-box, and repairing feed pipes.
	Ditto	19	Ditto bottom of fire-box and tubes, and fitting on one duplicate tender buffer.
	Ditto	25	Fitting on a duplicate leading spring, and repairing damper handle.
	February	1	Caulking tubes in fire-box, fitting in duplicate ferrule, and repairing and fitting in two new studs into bottom of ash-pan.
	Ditto	22	Lifting and turning up wheels, and going through general repairs.
	May	17	Turning up wheels, fitting in two new piston packing-rings, and going through general repairs.
	Ditto	24	Repairing connecting-rod brasses.
	1863.		
	January	4	Caulking bottom of fire-box, and examining lead plug.
	Ditto	„	Repairing whistle joint, and fitting in a new warming cock.
	Ditto	10	Examining steam pipe, and fitting in four new piston packing rings.
	Ditto	„	Caulking bottom of fire-box, and grinding in gauge cocks.
	Ditto	17	Ditto bottom of fire-box, and repairing eccentric strap brasses.
	Ditto	24	Removing two boiler tubes, and fitting in four brass plugs.
	Ditto	31	Repairing steam pipe and safety plugs.
	February	7	Ditto whistles.
	Ditto	14	Ditto ash-pan, and caulking bottom of fire-box.
	Ditto	28	Ditto pet and small whistle cocks.
	March	7	Caulking tubes in fire-box.
	Ditto	14	Repairing connecting-rod brasses.
	Ditto	21	Ditto gauge cocks, and caulking tubes.
	Ditto	28	Fitting in two new washing out plugs into back end of fire-box.
	Ditto	„	Ditto in two new piston packing-rings.
	April	10	Examining steam chest cover.
	Ditto	20	Lifting and re-laying on both leading wheel tyres, fitting in one new set of axle boxes and brasses, one pair of connecting-rod big end brasses, lining up trailing spring pin, new outside rod back trailing brass, and fitting two new studs for ash-pan.
	May	2	Lifting and re-laying on both leading wheel tyres, turning up wheels, fitting up one set of new axle-box brasses, one outside rod back trailing brass, and repairing trailing spring pin and motion bars.
	Ditto	10	Repairing both pet cocks, and gauge cocks ground in.
	Ditto	17	Ditto donkey engine throttle valve.
	Ditto	„	Re-tapped wash-out hole, bottom of tube plate, smoke-box, and one new brass plug for valve.
	Ditto	24	Caulked front left hand corner of fire-box, and repaired plugs in tube holes.
	Ditto	31	Repairing both big end connecting-rod brasses, and caulked tubes.
	Ditto	„	Examined pistons, and fitted in two new piston packing-rings.
	Ditto	„	Examining lead plug.
	June	14	Caulked tubes.
	Ditto	„	Ditto corners of fire-box and stays.
	Ditto	20	Repairing stays in fire-box and caulked tubes.
	Ditto	„	Small whistle ground in.
	Ditto	28	Took down fire-box, leading new stay in fire-box, ground in donkey engine valve, caulked tubes, and 60 new ferrules put in, repaired stays in fire-box.
	July	5	Caulked tubes, new lead plug.
	Ditto	12	Repairing both little end connecting-rod brasses, replaced 125 ferrules, and caulked tubes.
	Ditto	25	Right feed cock examined.
	Ditto	„	Left driving spring taken off and new one put on, all outside rod brasses set together, donkey engine taken down, fire-box repaired, and stays outside of fire-box repaired.
	August	2	Repaired both big end connecting-rod brasses.
	Ditto	„	Both pump-rods repaired.
	Ditto	8	Examined right, bottom and middle clock.

Construction of, and repairs to, the Engine.	1863.		
	August	15	Left pump pet cock examined, a new cock fitted in, and warming pipe repaired.
	Ditto	22	Both pistons examined, and new piston packing-rings fitted in; warming cock joint repaired, and safety valves ground in.
	Ditto	„	Repaired safety plug.
	Ditto	29	Repairing right feed cock.
	September	5	Both big end connecting-rod brasses repaired, right big end brasses examined, and journal repaired.
	Ditto	15	Right feed pipe repaired, tender brake stays straightened, and blocks repaired.
	Ditto	„	Both pet cocks examined, drag-bar shortened, steam chest cocks repaired, and weigh-bar brackets set together.
	Ditto	26	Coupling rod brasses reduced and lined up, wheel tyres examined, and caulked stays in fire-box.
	October	3	Repaired lead plug.
	Ditto	17	Pistons examined and six new packing rings fitted in; repaired fire-hole and fire-box stays.
	Ditto	„	Donkey engine regulator valve ground in.
	November	7	Right big end connecting-rod brasses reduced and repaired stays in fire-box caulked.
	Ditto	„	Right big end brasses reduced and repaired.
	Ditto	14	New cotter fitted in right top gland stud, and caulked stays in fire-box.
	Ditto	21	Both right and left connecting-rod little end brasses reduced.
	Ditto	„	Brake block examined and repaired; caulked stays in corner of fire-box.
	Ditto	29	Coupling rod double and single eyes contracted and pins repaired; new tapered pins fitted in, stays in corner of fire-box caulked.
	Ditto	„	One pair of new big end brasses fitted on left connecting-rod.
	Ditto	„	Warming cock ground in, and right small end connecting-rod; brasses repaired.
	December	12	Caulked stays in corner of fire-box.
	Ditto	„	Right big end brasses set together.
	Ditto	„	Left big end brasses set together.
	Ditto	27	Put in new rivets round bottom of fire-hole, and caulked tubes and stays.
	Ditto	„	Caulked tubes and stays.
	Ditto	„	Repaired lead plug, and caulked stays.
	1864.		Lead plug repaired, and caulked stays.
	January	2	Left pet cock rod examined.
	Ditto	„	Right suction pipe repaired, warming pipe union examined,
	Ditto	9	and caulked tubes.
			Donkey engine regulator valve ground in, both pistons ex-
	Ditto	16	amined, and two new rings fitted in.
			Caulked tubes, and donkey engine regulator valve ground in.
	Ditto	„	Brought into shop to have fire-box top cleaned and tubes
	Ditto	23	caulked.
			Fire-box top cleaned.
	Ditto	30	Fire-box top cleaned, safety valves ground in, stays in fire-box
	February	13	caulked, and two repaired tubes put in.
			One new cylinder gland stud fitted in left cylinder, gauge
	Ditto	20	column cocks ground in.
			Donkey engine valve spindle and eccentric rod repaired.
	Ditto	27	Eight new iron rivets and two iron studs renewed.
	March	5	Right top cluck examined, and left reduced $\frac{1}{8}$th, break block
	Ditto	12	repaired, and right pump suction pipe repaired.
			Right big and little connecting-rod brasses reduced and
	Ditto	19	fitted to journals; one stay re-placed on right side of fire-box.
			Left big and little end connecting-rod brasses set together and
	Ditto	„	fitted to journal; right pet cock repaired.
			One new copper stay put in left hand front corner of fire-box.
	Ditto	26	New stay put in front of fire-box, right side, and two copper
	April	2	stays renewed.
			Safety valves ground in.
	Ditto	„	Stays in fire-box caulked.
	Ditto	9	Repairing small end connecting-rod, brasses set together, new
	Ditto	„	regulator valve spindle fitted on donkey engine, tubes in fire-box caulked, and brake blocks lined up.

Construction of, and repairs to, the Engine.	1864.		
	April	16	Two new copper stays put in front of fire-box.
	Ditto	„	Two new copper stays put in back of fire-box, and others caulked.
	Ditto	23	New lead plug fitted in; stays and tubes in fire-box caulked.
	Ditto	„	Tubes in fire-box caulked.
	May	7	Safety valves ground in.
	Ditto	„	Brought into erecting shop to undergo general repairs.
	Ditto	21	All axle-box guides faced up; axle-boxes lined up; all bearing brasses lined on ends, and fitted to journals; all wheel tyres relaid on, fixed with new bolts and turned up; piston rods and slide spindles turned up; piston and slide spindle glands bushed, and new packing-rings fitted into stuffing boxes; slide valves and cylinder faces faced up; cylinder ends repaired; fire-box top cleaned.
	Ditto	29	Both connecting-rod big and little end brasses, straps and cotters repaired; all outside end brasses lined up and set together; cotters and set screws repaired.
	June	4	Coupling rods and cotters repaired; all brasses lined up and set together.
	Ditto	11	Cleating taken off boiler, shell of boiler examined, and seams caulked; outer shell of boiler painted, and cleating re-placed; copper shell of fire-box straightened, and all old copper stays rivetted and caulked.
	July	2	134 old tubes taken out.
	Ditto	23	86 repaired tubes and 50 duplicate tubes put in boiler, and 272 new ferrules; copper box straightened, and all stays re-rivetted and caulked; 46 new copper stays put in fire-box.
	August	6	Finished on the 6th August.
	Ditto	13	Ash-pan damper repaired, and ash-pan put up.
	Ditto	20	Lead plug renewed.
	Ditto	27	Both big end and right little end connecting-rod brasses set together; right pump cover joint re-made.
	September	3	Right little end brasses set together, and lead plug repaired.
	Ditto	10	Ditto connecting-rod big end brasses set together and repaired; blow off cock repaired.
	Ditto	17	Fire-box bottom caulked.
	October	1	Right suction pipe repaired, and left pump bottom clock joint re-made; 6 rivets put in bottom of fire-box, and ash-pan repaired.
	Ditto	15	Warming cock ground in, tubes in fire-box caulked, and 12 rivets put in bottom of fire-box.
	Ditto	18	Right outside motion block lined up with patent metal.
	Ditto	„	Ditto top clock, examined front of fire-box, and stays caulked in fire-box.
	Ditto	„	12 new rivets put in bottom of fire-box and caulked.
	Ditto	22	New front buffer plank supplied, and fixed wash-out plug; hole on left of fire-door re-tapped.
	Ditto	29	Corners of fire-box caulked, and lead plug renewed.
	Ditto	„	New wash-out plug fitted in top end back of fire-box.
	November	5	Left connecting-rod big end brasses set together and repaired; fire-box top examined, and safety valves ground in; 12 roof stay bolts and nuts replaced, and top straightened.
	Ditto	12	Left pump pet cock examined and repaired; lead plug renewed.
	Ditto	19	Both whistles ground in.
	1865.		
	January	8	Donkey engine regulator valve repaired.
	Ditto	„	Two copper stays put in fire-box, stays caulked, lead plug renewed, and corner of fire-box caulked.
	Ditto	15	Bottom cock of gauge column examined, and steam chest tallow cock ground in; tubes caulked in fire-box.
	Ditto	15	Both connecting-rod big end brasses set together, and spark arrester thoroughly repaired.
	Ditto	21	Steam chest grease cock ground in.
	Ditto	„	Four copper stays put in fire-box.
	Ditto	28	Four copper studs put in fire-box, and bottom of fire-box caulked.
	Ditto	„	One copper stud fitted in tube plate, and stays caulked in fire-box.

Construction of, and repairs to, the Engine.	1865.		
	February	4	Top of tube plate and stays rivetted in fire-box.
	Ditto	„	Top of tube plate caulked, and one copper stud put in fire-box.
	Ditto	11	Tube plate and stays rivetted; two copper stays put in fire-box.
	Ditto	18	Tube plate in fire-box caulked; stays and tubes caulked.
	Ditto	25	Top of tube plate caulked, and copper stays rivetted in fire-box.
	March	4	8 copper studs put in crown seam, and tubes caulked in fire-box.
	Ditto	„	Two new copper stays put in belly bracket, and tubes caulked.
	Ditto	11	Tube plate caulked at top, and one new belly bracket stay put in.
	Ditto	18	Tubes and top of tube plate caulked.
	Ditto	25	Top of tube plate caulked, and two new copper stays put in belly bracket.
	April	1	Top of tube plate caulked; one wash-out plug re-placed with new one.
	Ditto	8	Right spindle gland repaired with new stud; top of tube plate and stays caulked.
	Ditto	15	Ash-pan damper handle repaired.
	Ditto	22	Brought into erecting shop for general repairs.
	May	13	Boiler lifted out of frame.
	September	9	Undergoing repairs to fire-box.
	1866.		
	October	14	One new piston gland; supplied four new bolts in right hand pump; coupling-rod brasses set together and lined up.
	Ditto	28	Pistons examined and supplied with new rings; brick arch repaired.
	November	7	Both big and little end brasses set together; fire-box caulked.
	Ditto	22	Right top clock examined.
	Ditto	30	The hand delivery pipe repaired.
	December	5	Tubes caulked.
	Ditto	11	Fire-box stays and tubes caulked; right hand feed pipe repaired.
	Ditto	19	Fire-box stays and tubes caulked; new pin supplied to right hand pump-ram, top clock ground in, side-rod brasses set together, and brake blocks repaired.
	Ditto	22	Gauge column plug, warming cock plug, and donkey steam cock plug ground in; one new small cotter supplied to right hand driving side rod stays, caulked bottom of fire-box stays, and blow-off cock plug ground in.
	December	25	Warming pipe joints re-made.
	Ditto	26	Pistons examined.
	Ditto	28	Tubes and stays in fire-box caulked, and bottom corners of fire-box caulked.
	1867.		
	January	1	Tubes in fire-box caulked, and left hand middle tender axle-box examined.
	Ditto	3	New spring supplied to reversing lever, and stays at bottom of fire-box caulked.
	Ditto	5	Bottom of fire-box caulked, donkey steam cock plug ground in, and new spring supplied to reversing lever.
	Ditto	10	Right hand piston examined; left hand motion blocks lined up.
	Ditto	13	Right hand piston examined; tender feed pipe examined; small whistle plug ground in; tubes caulked.
	Ditto	17	Right hand tender feed pipe repaired, left hand big end set together; donkey steam cock ground in, and tubes caulked in fire-box.
	Ditto	19	Both coupling-rod brasses set together and lined up, tubes and stays in fire-box caulked, motion bars set together, and new tallow coupling supplied to valve cover.
	Ditto	21	Left hand piston examined, right hand big end brasses set together, stays in fire-box caulked, donkey steam cock plug gound in, and motion bars set together.
	Ditto	24	Left hand feed pipe repaired, stays in fire-box caulked, and donkey steam cock repaired.
	Ditto	26	Fire-box caulked.
	Ditto	28	Stays in fire-box caulked, and blow-off cock ground in.
	Ditto	29	Right hand motion block lined up, and left hand feed pipe joint re-made.
	February	1	All eccentric straps set together, and corner of fire-box caulked.

Construction of, and repairs to, the Engine.	1867.		
	February	4	Buffer spring repaired, bottom of fire box caulked, and weigh shaft brackets set together.
	Ditto	„	Spl pins supplied to all eccentric straps, and gauge cock gound in.
	Ditto	6	New spring supplied to reversing lever; new tender buffer spring supplied; gauge cocks ground in, and blow-off cock ground in.
	Ditto	8	Bottom of fire-box caulked, valves examined, and warming pipe repaired.
	Ditto	10	Left hand piston examined, waste water cocks ground in, and left hand pump examined.
	Ditto	15	Washer supplied to right pump-rod, and left hand piston rod studs supplied.
	Ditto	17	Two new sand pipes supplied, two new wash-out plugs supplied in fire-box, and new blinds supplied to awning.
	Ditto	20	Two steel pins supplied to pump-rams, two new wash-out plugs to front of fire-box, and draw-bar shortened.
	March	3	Stays in fire-box caulked, and pressure gauge examined.
	Ditto	6	Tubes caulked, bottom corner of fire-box caulked, both tender feed plugs ground in, and warning cock plug ground in.
	Ditto	13	The left tender tyre loose, new rivets supplied, and left hand corner of fire-box caulked.
	Ditto	17	New motion blocks supplied, right hand side.
	Ditto	21	Tubes caulked.
	Ditto	24	Tubes caulked, valves examined, and big end brasses let together.
	Ditto	28	Side-rod brasses set together, and fire-box stays caulked.
	April	1	New steam pipe supplied in boiler, all the feed pipe joints re-made, and left end tender feed pipe rod repaired.
	Ditto	6	Tubes and fire-box caulked, left hand piston-rod and cotter repaired, and smoke-box door repaired.
	Ditto	9	Blow-off cock ground in, waste water cock rod repaired, new set screws supplied, and right hand coupling rod.
	Ditto	12	Tubes and fire-box caulked; new stud for gauge column supplied.
	Ditto	15	Tubes and fire-box caulked, lead plugs examined, and cylinder cocks repaired.
	Ditto	21	Side-rod brasses reduced.
	Ditto	26	Went into the shop for repair.
	Ditto	„	Right hand bottom cock and pet cock examined; left hand big end brasses set together, and pressure gauge repaired; new tyres on all the wheels turned up; six new axle-boxes supplied; six new outside rod brasses supplied; six axle-box brasses supplied; four new motion blocks supplied; all the horn cheeks filed up; valves and facings faced up; regulator faced up; feed pipes repaired; new pistons and piston rings supplied; piston gland re-bushed; one piston gland bush supplied; valve supplied; gland re-bushed, and two new glands supplied with bushes; piston rods turned up; valve spindles turned up; motion bars re-set; pump-rams turned up; glands re-bushed and bushes supplied; pumps repaired; blast pipe repaired; feed pipes repaired; left hand end straps reduced; eccentric strap closing, and one new bracket for the reversing shaft supplied; all clocks examined; clocks repaired; new springs on the reversing lever supplied; trailing spring examined; motion repaired; four new pins supplied; horn cheeks rivetted on.
	July	30	Both pistons examined, and both leading axles of engine examined; right hand pet cock and warming pipe cock repaired; a nut supplied.
	Ditto	„	Damper rod repaired, and blow-off cock ground in.
	August	9	Both valves and both pistons examined; right hand pet cock repaired.
	Ditto	13	Tubes caulked.
	Ditto	22	Bottom nut of warming pipe repaired, tubes caulked in fire-box end, and two new tubes supplied.
	September	1	Both valves and right hand pistons examined, back end brasses reduced, left pet cock ground in, tender brake repaired, and bottom of fire-box caulked.
	Ditto	17	Both safety valves examined and spring balance tightened.
	Ditto	20	Both forward gear eccentric straps reduced; left hand pet cock repaired; right hand leading and middle tender spring repaired, and right hand pet cock ground in.

Construction of, and repairs to, the Engine.	1867.		
	September	28	Right hand cylinder cover joint re-made; right hand middle clock stud repaired; both spring balances examined; plug supplied; bottom of smoke-box and right hand pet cock repaired; tubes caulked.
	October	10	Two new sand pipes supplied, and a washer supplied on top both of left hand lifting link hanger, and both whistles ground in; left hand leading tender axle examined; tubes caulked, and valves and valve facings faced up.
	Ditto	15	Left hand feed pipe repaired near the bottom clock; reversing lever spring repaired; pressure-gauge steam pipe examined, and bottom of fire-box caulked.
	Ditto	18	Both valves and valve facings faced up; left hand piston examined; left hand feed pipe repaired near the bottom clock; both bottom feed pipe joints re-made; left hand small end brasses reduced, and left hand pet cock ground in.
	November	1	Left back gear eccentric sheaves fastened.
	Ditto	3	Valve cover joint re-made, and a brick arch supplied.
	Ditto	6	The left back gear eccentric fastened, and left cylinder cover joint re-made.
	Ditto	12	Lead plug examined, and new brick arch supplied.
	Ditto	16	Both coupling-rod brasses reduced, and both pet cocks examined.
	Ditto	20	Regulator examined; both corners of fire-box caulked; and a small set screw supplied in bottom gauge column.
	Ditto	25	Steam pipe and steam pipe joints examined; both pistons examined, and right top wash-out plug hole re-tapped.
	December	11	Plug in top gauge column examined.
	Ditto	18	Left small end brasses reduced, and fire-box caulked at the bottom.
	Ditto	26	Both valves examined; both whistle plugs ground in, and lead plug examined.
	1868.		
	February	2	Blow-off cock ground in, and a washer put on; also a washer on top; glands packed and tubes cleaned.
	Ditto	5	Tubes cleaned.
	Ditto	7	Brick arch supplied to the fire-box.
	Ditto	11	Right hand top clock, top feed pipe and bottom joints examined; tubes caulked in fire-box, and brick arch made.
	Ditto	15	Both pistons examined, and small whistle supplied.
	Ditto	20	Pistons and spindles packed, and tubes cleaned.
	Ditto	21	Both little end brasses reduced; both back corners of the fire-box caulked at the bottom; tubes cleaned, and glands packed.
	Ditto	23	Both pistons, spindles, right hand pump packed; tubes cleaned.
	Ditto	24	Left hand pistons examined, and tubes cleaned.
	Ditto	25	Left hand bottom short feed pipe renewed; pistons and spindles packed, and tubes cleaned.
	Ditto	26	Right hand piston packed, and left hand piston and spindle screwed up; tubes cleaned
	March	27	Glands screwed up; tubes cleaned.
	Ditto	28	All slide blocks examined; tubes in the middle in the fire-box caulked; tubes cleaned, and both pistons and spindles packed.
	Ditto	30	Drag spring and exhaust top rod repaired; right hand top cluck examined; glands packed; regulator gland packed; tubes cleaned, and both back corners of the fire-box caulked.
	April	1	Both pistons and spindles packed, and tubes and smoke-box cleaned.
	Ditto	2	Reversing lever spring supplied; regulator gland packed, and tubes cleaned.
	Ditto	3	All side-rod brasses reduced; both back corners of the fire-box caulked.
	Ditto	7	Right hand piston examined, and donkey pump steam plug ground in.
	Ditto	13	Donkey pump steam plug examined.
	Ditto	18	Both big end brasses reduced; boiler end, smoke-box side and awnings repaired.
	Ditto	26	Valve spindle caps in the steam chest cover examined.
	May	7	Left hand piston examined; all side rod brasses reduced; back corners of the fire-box caulked at the bottom, and the fire hole door; inside steam jet examined; smoke-box end and new lead plug supplied.

Construction of, and repairs to, the Engine.	1868.		
	May	11	Both back gear eccentric straps reduced.
	Ditto	14	Fore gear eccentric strap reduced, and engine awning repaired and fastened down.
	Ditto	19	Both pistons and right hand top cluck examined.
	Ditto	23	Steam chest cover examined; right hand front corners of the fire-box caulked, and both front mud plugs made new; right hand trailing axle of tender lifted, and right hand top clock examined.
	Ditto	27	All axle-boxes examined and repaired.
	Ditto	31	Donkey pump steam cock examined.
	June	5	Right hand bottom short feed pipe repaired; right top clock examined, and both back corners of the fire-box patched at the bottom.
	Ditto	10	Right hand bottom clocks examined.
	Ditto	14	Right hand top and middle clocks examined.
	Ditto	23	Right hand top clock examined, and right hand bottom clock joint made; spark arrester in the smoke-box examined.

Boiler-maker's Account of Repairs to No. 17 *Engine.*

Date.		Particulars.
10th June, 1865	...	New ash-pan perforated, with damper complete.
20th January, 1866	...	New fire-box, new corner-piece put on, and general repairs.
29th July, 1867	...	6 new copper stays connecting fire-box with barrel stays; 8 new rivets in solid ring round bottom of fire-box; all tubes and stays caulked, also bottom of fire-box casing caulked, &c.; balance weight rivetted; smoke-box door set, and flap on tender set; new lead plug.
26th August, 1867	...	40 pieced-tubes put in.
3rd January, 1868	...	4 pieced-tubes put in.

KURRACHEE; *3rd May*, 1869.

(Signed) T. S. SPECK,
Locomotive Superintendent.

SCINDE RAILWAY.

Monthly Examination of Boilers and Fire-Boxes.

Date when examined.	Number of Engine.	Working pressure.	State of Boiler.	State of Fire-Box.	Date when proved.	Proving pressure.	Remarks.
1866.							
31st May ...	17	100	Honey-combed	Good (new box) ...	25th Feb., 1866	200	
1st July ...	17	100	Good, honey-combed a little	Good (new) ...	" "	200	
3rd August ...	17	100	Ditto ditto	Good ...	" "	200	
4th October ...	17	100	Good, but honey-combed.	Ditto ...	" "	200	
1867.							
18th June ...	17	110	Under general repairs	Middling ...	25th Feb., 1866	200	
17th August ...	17	110	Pretty fair	Ditto ...	" "	200	
30th September ...	17	110	Boiler middling	Ditto ...	" "	200	
31st October ...	17	110	Ditto	Ditto ...	" "	200	
31st December ...	17	110	Ditto	Ditto ...	" "	200	
1868.							
30th January ...	17	110	Middling	Middling ...	25th Feb., 1866	200	
29th February ...	17	110	Ditto	Ditto ...	" "	200	
31st March ...	17	110	Ditto	Ditto ...	" "	200	
30th April ...	17	110	Ditto	Ditto ...	" "	200	
30th May ...	17	110	Ditto	Ditto ...	" "	200	

(Signed) T. S. Speck,
Locomotive Superintendent.

Abstract of Opinions of Chief Engineers and Locomotive Superintendents of Railways in India, on the examination and testing of Locomotive Boilers.

W. Charlton, Esq., *Locomotive Superintendent, G. I. P. Railway Company.*

"I do not agree with testing boilers by hydraulic pressure. Testing an old boiler is no use without an examination. A boiler (to use the words of the Consulting Engineer) in a 'middling' condition may be tested by hydraulic pressure, say 40lbs. per square inch over what it is intended to work by steam, no external defect may be visible, but it is quite possible the fracture (if any existed) would be increased by that pressure, and when steam is got up, the boiler would explode.

"Our practice is to make a thorough internal examination after the engine has run 150,000 miles or upwards, according to the class of boiler; defective plates are removed, &c., and all repairs or alterations carefully noted in the boiler-book as a guide for future examination."

E. B. Carroll, Esq., *Locomotive Superintendent, B., B., and C. I. Railway Company.*

"For this railway, I consider that testing every 18 months or two years will be about an average; more frequent testing will be necessary on the Northern Division than the Southern from the inferior water.

"I think that 50lbs. more than the ordinary working pressure is sufficiently high to test to, higher than this may injure a boiler by straining. The practice of Engineers differs much in this particular, and some object entirely to testing by hydraulic pressure on account of its giving strains of a different character from steam, the boiler being cool in one case and hot in another.

"The precautions I use against possible explosion of boilers are a monthly test of the safety valves, and internal examination of the boiler when it comes in for repair, which is about once in 18 months or two years. No hydraulic test has hitherto been used, but I indented on England for test pumps, which have just now arrived. I hoped to have a trial of them before writing this letter, but they are not ready.

"Locomotive Foremen have orders to use their discretion in reducing pressure of boilers which appear in a doubtful state, and then reporting to the Locomotive Superintendent.

"I think periodic test by hydraulic pressure, in addition to internal examination when opportunity offers, is the best practice, and I intend to pursue it with one alteration, that I will warm the water to assimilate the condition of the boiler as much as possible to what it is under steam."

G. Berkley, Esq., *of B., B., and C. I. Railway Company.*

"The practice of examining locomotive boilers, without at the same time testing them by hydraulic pressure, is not, in my judgment, satisfactory, on account of the difficulty of making a thorough examination.

"An engine that will not bear a test of at least 25 per cent. more than the working pressure, is not safe.

"Plates of boilers have been recorded as removed on account of grooving, or becoming thin after having run as short a distance as 67,000 miles, with an evaporation of 2,354,227 gallons of water, and of 83,500 miles, with an evaporation of 1,462,774 gallons of water.

"I am of opinion that all boilers should be as thoroughly examined as possible, and tested with hydraulic pressure to 25 per cent. over the working pressure after running 50,000 miles on the Great Indian Peninsula Railway, and also that the working pressure should not exceed 120lbs. per square inch.

"The question of the best construction of boilers received much attention from me about three or four years ago. The boilers of the 20 passenger and 20 goods engines ordered in 1865, and 40 passenger and 100 goods engines ordered in 1866, have been made with butt, instead of lap-joints, and are thereby made much stronger and less liable to deterioration; but, nevertheless, I consider the examination and testing hereinbefore described desirable even with them."

T. Hindmarsh, Esq., *Locomotive Superintendent, E. B. Railway Company.*

"1*st*.—The safety valves are examined, and the spring balances are weighed and adjusted once every month.

"*2nd.*—The fire-boxes and tubes of the running engines are examined monthly, and when an engine is stopped for a thorough repair, which occurs every two years or so, the clothing is removed, and the boiler is examined and tested by hydraulic pressure up to 180lbs. per square inch, or 50 per cent. above the ordinary working pressure. The water used for the above test is invariably heated up to 212 degrees Fahrenheit before the hydraulic pump is applied, which I consider less liable to strain the plates than by using cold water.

"I am of opinion it would be impracticable to fix upon any rule which could be applied to all the railways in this country, as so very much depends upon the water used for locomotive engines. As a proof of this, I have lately tested the boilers of three engines which have run 9,803,997,355¾ and 86,739 miles, respectively, and they are to all appearance as good and strong as they were when the engines were first placed on the line.

"This I attribute entirely to the characteristics and nature of the water used on this railway for feeding the boilers, it being comparatively free from carbonate of lime and magnesia salts."

G. Sibley, Esq., *Chief Engineer, E. I. Railway Company.*

"In my opinion, all locomotive boilers should be tested by hydraulic pressure to 50 per cent. above their working pressure after they have run 50,000 miles, and thereafter on having run a further 25,000 miles."

H. Carrick, Esq., *Offg. Locomotive Superintendent, E. I. Railway Company.*

"The practice on this line is to test all boilers whenever they go into shops, and if at any time there are any doubts of the boiler of a running engine, it is at once tested, and internal inspections are made by removing tubes if there is the slightest sign of furrowing or undue corrosion.

"The test ordinarily applied is cold water pressure, which, if properly carried out, is not, I think, so injurious to boilers as Mr. Charlton, of the Great Indian Peninsula Railway, points out.

"I am quite of opinion that, with the water generally obtainable on this railway, it is not desirable to work any engine at more than 120lbs. per square inch, which has been carried out since 1st May, 1865.

"No fixed rule could be laid down for inspecting boilers, as it is found in practice that it could not be carried out. A monthly inspection is made of safety valves and boiler-fittings, and if there is any doubt about any furrowing taking place in the plates, small holes are drilled to ascertain the thickness.

"Our rule for testing is—engines working at a pressure of 120lbs. are tested up to 200lbs.; 110lbs. are tested up to 180lbs.; and 90lbs. to 150lbs.

"One of the greatest difficulties to contend with is—that drivers can so easily tamper with safety valves, and I fear that this is often done, especially when the train is over-loaded, by weighting the safety valves and increasing the pressure, so as to enable the driver to get along with his train. Most serious notice is of course taken of any instance of this when it is discovered."

J. G. Cooke, Esq., *Locomotive Superintendent, Oudh and Rohilkund Railway Company.*

"After new boilers have been running two years, I examine them, and afterwards consider them as old ones; repeating the examination every two months.

"I neglected to explain in my letter No. 839 on this subject, that the examination I proposed consists of a thorough cleaning and examination of the external shell of boiler, and testing with steam and water while the clothing is removed, so that all leaks or defects of any kind may be discovered and remedied.

"I herewith send you an indent for a test-pump from England. At present we have only been able to prove the boilers with steam pressure.

"A complete register is kept of the miles run by each engine, and a memorandum of some shall be sent with each half-yearly report, as requested.

The memorandum of maximum miles run by any one engine shall be forwarded in a day or two.

J. Harrison, Esq., *Chief Engineer, Punjab and Delhi Railway.*

"Mr. Bocquet has tested some of the boilers by hydraulic pressure, and invariably test tubes has taken out for repairs previous to putting them in again.

"I have, with Mr. Bocquet, examined some of the boilers and found the plates a little pitted and eaten away near the joints, but not to anything like the extent of some of the Scinde engine boilers which I saw when at Kurrachee three years ago.

"I am of opinion the boilers should be thoroughly examined internally after running about 80,000 miles on the Punjab Railway (which is about the mileage at which the tubes begin to go), they should also, before going out of the shops, be tested with water up to 200lbs. per square inch, the temperature of the water being nearly at boiling point. I would further test them with steam 30lbs. the square inch above the intended working load."

Officiating Locomotive Superintendent, Punjab Railway.

"I have examined No. 7 boiler, and find that three plates are eaten through along the seam to barely $\frac{1}{16}$th of an inch in thickness, the original calibre being $\frac{3}{8}$th. The reason of this is apparent, the joints or seams of the boiler form in certain positions a ridge which allows the salts and other foreign matter to accumulate (this is only the case with boilers of Messrs. Sharpe and Stewart's manufacture on this line, those of Messrs. Neilson and Co. do not suffer from the defect); and I believe that even Baker's patent anti-incrustator would not have the effect of dislodging it. I cannot help thinking that the cause of the rapid decay of the plate along the seam must be due to some electric influence, which I am not prepared to explain, for the bottom-plates of the boiler, where the conglomeration of sediment was greatest, are all sound. With regard to the method of testing, we use hydraulic pressure and work from 165lbs. upon the square inch of surface. We invariably use cold water, we prefer it because it shows more quickly where joints and packings are defective, while hot water or steam causes many slight imperfections to pass unnoticed on account of the expansion of the parts; though many Engineers aver, and with some show of reason, that steam boilers can resist a greater pressure when cold than while hot, on account of the greater cohesion of the particles at a low temperature. If my opinion may be allowed to pass, with the many diversified theories of men of the present day, I unhesitatingly affirm that I do not approve of pressing boilers at all, as it strains them unnecessarily. I have times out of number observed that after testing a boiler with a view to ascertain to state of the tubes, the gauge has indicated a pressure of 185lbs. without a single tube giving way, and the very next trip, three or four would burst at 120lbs. steam-pressure.

"*Engine No. 7.*—This engine began to run March 26th, 1863, ran 52,701 miles, had two new tubes put in during March 1867; ran 7,503 miles; two new tubes put in during July 1867, ran 9,214 miles, had two more put in; November 1867, ran 4,069 miles; two more December 1867, ran 1,237 miles; January 1868, two new tubes put in, ran 3,350 miles; March 1868, two new tubes put in; ran 3,060 miles.

"April 16th, 1868, engine boiler tested per hydraulic pressure to 165lbs. per square inch; five tubes burst; June 6th, 1868, engine boiler tested to 186lbs.; one tube burst, ran 11,862 miles; October 1868, seven new tubes put in, ran 8,019 miles; January 1869, nineteen second-hand tubes put in; on the 27th of same month, ten second-hand tubes put in ran 2,957 miles; March 1869, one second-hand tube put in, ran 2,185 miles.

"The total of miles this engine has run is 106,257."

W. J. Collinson, Esq., *Acting Locomotive Superintendent, Madras Railway Company.*

"*Para. I.*—The practice now in force on this line has been dependent, not on a certain number of miles run, but on the work done by each engine, the quality of a water used, and other circumstances connected with the running of our locomotives which have rendered it necessary for the boilers to be examined.

"The first examination of our boilers has been on an average after six years' use, and the second examination on an average of three years, when they have had nearly new boilers and fire-boxes.

"For our own satisfaction, we occasionally make a thorough examination of a boiler of each class of our locomotives by taking the tubes out, the roof bars off, and cleaning and examining the inside and outside plates, which we have found has in a great measure served as a guide as to the state of the boilers of the other engines working on the same division of the line.

"As regards statistics,—a record is kept by the Foremen Boiler-smith, and a copy in this office, of the date a boiler is examined, and any special circumstances that he may find necessary to note.

"*Para. II.*—I do not think any more efficient test could be introduced than that now in force. Extra care and precaution have always been taken for the thorough internal and external examinations of our boilers.

"*Para. III.*—We make use of hydraulic pressure, but more as an auxiliary; that is, we do not depend upon it for a thorough test of the boiler, but use it more for testing the tubes; and after a boiler has been repaired, for testing the efficiency of the work. The pressure used is from 180 to 210lbs., a little more than pressure and a half.

"The practice of testing boilers by hydraulic pressure is one in which has always been a vexed 'question,' and on this point several discussions and disputes have arisen both as to the necessity or otherwise for this test, and the amount of pressure which ought to be used. In 1864 and 1866 this subject seems to have created considerable discussion in England, and in a leading article in the *Engineer* of the former year, the writer says:—'Within the last year a considerable number of locomotive boiler explosions have taken place, and in every case upon one or other of the great lines upon which locomotives are never tested by the force-pump; on the other hand, we believe that there is no account of the explosion of any boiler regularly tested by the pump upon either of the lines where that test is adopted.' And in *Engineer* of May 11th of the latter year, there is a report of a paper read at the meeting of the Mechanical Engineers held at Birmingham on the 3rd of the same monthly by Mr. William Kirtly of Derby 'on the corrosion of locomotive boilers and the means of prevention,' in which he gives his opinion as follows regarding the use of the test-pump:—

"In the course of our own experience, we have known several instances in which the application of the hydaulic test has revealed defects, which, if not thus discovered and remedied, would, in all probability, have led to the most serious results. We do not consider that the hydraulic test is any substitute for a thorough external and internal examination of the boiler, but it is a most useful auxiliary, and it is a test which can be applied at times when an internal examination of the boiler is impossible.

"I quite concur in these opinions; in fact, the system has all along been adopted on this line as that advocated by them, and although an internal examination of a locomotive boiler is a very costly affair, there can be no doubt it is not only the greatest safeguard, but the surest mode of preventing accidents.

"*Para. IV.*—The maximum distance an engine may safely run without undergoing thorough examination and repairs, varies on this line from 100,000 to 134,000 miles.

"On examining many of our boilers after running these distances, we found the centre bottom-plates furrowed inside near the lap-joint, caused, no doubt, by the sediment and the expansion and contraction of the boiler.

"The twenty new locomotives now under construction in England for this railway are, I believe, to have the boilers made with 'butt-joints and bands double rivetted seams,' so that the plates will be quite even along the inside of the boiler. This improvement will greatly remedy the evil experienced with boilers with lap-joints, and no doubt considerably increase the mileage these engines will be able to run safely without undergoing thorough examination and repairs.

"The working pressure of our locomotive boilers is 120lbs. per square inch, but although on examining our old boilers we discovered in some of them no signs of wanting repairs, yet for greater safety we reduced the pressure to 100lbs."

Locomotive Superintendent, Great Southern of India Railway.

"I purpose testing and over-hauling all the engines as they come in. I attach a statement showing the original working pressure of our engines, and that at which they are now working—

Nos. of Engines.	Time they have been working.	Original working pressure.	Present working pressure.	Hydraulic test pressure.	
1 to 9	8 years.	120 lbs.	100 lbs.	200 lbs.	Passenger engines.
10 to 11	3 „	100 „	100 „	150 „	Ballast „
12 to 15	2 „	120 „	120 „	200 „	Goods „
16 and 17	6 months.	120 „	120 „	200 „	„ „

There has been but one instance of corroded plate (ballast engine No. 11), and this was detected and repaired. The boiler shell was eaten away at the angle-iron of the smoke-box,

the plate being reduced from $\frac{3}{8}$th of an inch to bare $\frac{1}{8}$th of an inch; this was discovered by a hammer-tapping test. I do not consider hydraulic pressure a test for corrosion; it is more useful as a test for joints or new tubes, and a check upon spring balance safety-valves. The only means of detecting corrosion is by tapping the boiler carefully along the joints. There is, however, no certainty of detection, a bad place may escape through being encrusted, and have no appreciable difference in ring from a sound plate. Boilers always get thin at the joints, whether butt or lap-joints, in course of time, due to the spring upon the plates by constant vibration, causing friction between the angle-iron and the plate, and also through the obstruction of the collar of the angle-iron or plate forming a lodgment for deposit. The most effective and safest kind of boiler-plate, in my opinion, is that known as 'thick-edged plate' made at the Lowmoor iron-works. This gives an extra thickness of metal at the place where plates always weaken. Our water on the west of Trichinopoly is very bad. I should be glad to adopt any means of preventing incrustation, which takes place to a great extent. The Bombay Consulting Engineer (in his letter No. 2212) is evidently not aware of the enormous expense which would be entailed if his suggestions were adopted. Engines run, say 180 miles a day every 18 months, therefore each engine would have to be dismantled. He cannot know the expense of so doing. Removing tubes is a thing to be avoided as much as possible, unless imperative. Each removal of tubes enlarges the holes in the copper tube-plates, and in many cases needs new tubes. Tubes removed eight or nine times in this way would need a new tube-plate, or at least removal to bore out. The expense of this would be enormous, and, with the indifferent means at our disposal in this country, a work of great time. Railway Companies would need their engine stock doubled to do it. I have known engines run for five and six years without a tube being touched, greatly to the engine's advantage."

Locomotive and Carriage Superintendent, Great Southern of India Railway.

"I do not agree with the views expressed by the Superintendents of the Bombay lines regarding the examination needed or demanded by the fact of the engines having run the number of miles mentioned. The expression 'thorough examination' is qualified in the Consulting Engineer's No. 147 as meaning the removal of tubes. I am quite alive to the necessity of constant precaution and careful examination with boilers to ensure immunity from explosion, if possible. I quite think that, when an engine has run 150,000 miles, she should be examined, but, as I said in my former letter, I disagree entirely as to what constitutes needful examination. I think that unless some cause be given, such as suspicion of the engine's state, it is not expedient to dismantle an engine every two years or so. Our engines Nos. 1 to 9 could not be examined as the Consulting Engineer proposes without entirely pulling them to pieces. The steam-house is over the fire-box, and no one, not a boy, can get inside the boiler without removing longitudinal boiler stays and fire-box roof stays; unless this be done, the taking out of the tubes is useless, as nothing at all approaching an examination of the joints can be made from looking through the tube-plates at either end. As I explained in my former letter, I have only had the test-pump nine months. The system in force here is such as is usually adopted on all English lines. Entries are made by the drivers in the shed-books of the general condition of their engines, and if any remarks are made calculated to make the state of the engine suspicious, she is over-hauled at once. When tubes leak on the three bottom rows, the whole rows are taken out and the boiler cleaned, and the engine's lagging removed, and the boiler examined. When an engine has been running two years, she is stripped and examined if she requires repair; but if she be otherwise in good condition, she runs until she comes in for repair. All our engines but three have been examined and over-hauled since I have been here, just two years. These three engines I shall endeavour to get into the shops when they require such a repair as will bring them down to Negapatam. These three engines may have run about 100,000 miles. I keep a record of the condition of our engines and the nature of examination they undergo, so that no care is wanting to ensure their being in good order."

Extract from the Chief Engineer's Reports Nos. 85 and 86, of the Association for the prevention of Steam Boiler Explosion, Manchester.

"No. 25 explosion, 1868, by which three persons were injured, but fortunately no one killed, occurred at about twenty minutes before seven o'clock on the morning of Tuesday, July 14th, 1868, to the boiler of a locomotive engine employed in the goods traffic of one of our leading lines of railway.

"The engine had but just left a station at which it had stopped in the course of its journey, and entered an adjoining tunnel, with a train attached to it, consisting of a van and some 57 waggons, when the explosion occurred, reducing the boiler to a wreck, severely

scalding the engine-driver, fireman, and leading guard, blowing down some plate-layers at the other end of the tunnel, and skaking down some rockwork in a cemetery under which the tunnel passed.

"The engine was of the six-wheeled coupled class commonly employed for goods traffic, while the boiler was of the ordinary multitubular type, the barrel—which is the only part to which allusion need now be made—measuring 10 feet 9 inches in length, 4 feet in diameter, and half an inch in thickness. There were three belts in the length of the barrel, each consisting of two plates, and so arranged that the longitudinal seams of rivets broke joint. The boiler was furnished with two open lever safety-valves, loaded to a pressure of 130lbs. on the square inch, by means of spring balances, fitted with suitable stop ferrules to prevent excessive pressure through the thumb screw being turned too far. It appears that the engine had been built in the year 1854 or 1855, while the tubes were taken out and the boiler thoroughly over-hauled but three years before the explosion; in addition to which, slight repairs had been effected, and the engine turned out of the shop on the 30th of June 1868, after having been tested by hydraulic pressure up to 180lbs. on the square inch, so that the boiler only ran about a fortnight after the last repairs before its explosion. When new, it had been worked for some years with steam at a pressure of 140lbs. per square inch, but latterly this has been reduced to 130lbs.

"The boiler rent in the barrel, nearly the whole of which was torn away from the fire-box as well as the smoke-box, and divided into three pieces, while the tubes were bulged out in a lateral direction both to the right and left, and the front tube plate torn away from the inner casing of the fire-box.

"The position and course of the rents, as well as the lay of the plates in the barrel of the boiler, will be better explained by the accompanying sketch fig. V than by any description.

"On an examination being made of the fragments, it was found that the boiler had been attacked internally by corrosion, the bottom of the barrel being pitted from one end to the other, and for a width of about 4 feet, to a depth of one-sixteenth of an inch generally, and one-eighth of an inch in some cases. Added to this, the plates were grooved at the bottom of the barrel at the edge of the overlap of the ring seams of rivets,—in one case to a depth of nearly a quarter of an inch. Besides this, and which is of far more importance, there was a longitudinal furrow, measuring 18 to 20 inches in length, and from three-sixteenths of an inch to a quarter of an inch in depth, at the edge of the overlap, at a seam of rivets situated on the right hand side of the boiler, and in the belt of plates nearest the smoke-box end. Where this furrow occurred, the plating was so arranged that the edge of the inner plate looked upwards, and formed what is termed a shelf, which is generally thought objectionable on account of the facility it affords for the lodgment of corrosive impurities in the water. Through this longitudinal furrow the boiler rent; and there is little doubt that this rupture was the primary one from which the other sprung, and thus that the cause of the explosion was internal grooving or furrowing to which locomotive boilers are especially liable.

"The subject of grooving or furrowing is a very important one with regard to locomotive boilers. It is, however, very simple, and too much mystery has been attached to it. This action takes place in stationary boilers as well as in locomotives, especially in those of the 'Lancashire' type. The Association's inspectors are perfectly familiar with it; they know at which part of the boilers to expect its effects, and regularly report upon them. It always takes place, to a greater or less extent, when an alternate hinging or buckling action occurs, combined with the use of a corrosive feed water. The parts of all boilers are in movement, more or less, from the local action of the fire and the internal pressure of the steam.

"In locomotive boilers the longitudinal grooves are caused by the constant changes of form which take place on the alternations of pressure, and thus induce the hinging or buckling action at the longitudinal seams of rivets already referred to, while it is possible in some cases that this may be promoted by the working of the engine. This distortion from internal pressure would not arise in the barrels of locomotive boilers if they were truly cylindrical; but the high pressure to which they are now worked has led to the adoption of thick plates; and it must be clear that the thicker the plate the greater the departure—with the ordinary overlap joint—from the true circle.

"When making reference, in the Association's printed monthly report for November 1862, to an explosion of a locomotive boiler which occurred on the 8th of that month, and resulted, like the present one, from a longitudinal furrow at the edge of an overlap, I ventured to suggest the propriety of making the longitudinal joints with double butt strips, one being placed inside, and the other out, so that the true form of the circle might be maintained, the rivets placed in double shear, the line of strain always confined within the limits of the plates, and thus the parts maintained in equilibrio. Since then I have been informed by the locomotive superintendent of one of the main trunk lines of railway, that he has adopted this plan, while he employs but one length of plate in the barrel of the boiler circumferentially; so that there is only one longitudinal joint in each belt which he places above the tubes, so that it may

not only be out of the water, and thus free from its corrosive action, but also in a part of the boiler more accessible to examination than when at the side or bottom of the barrel as heretofore. This plan appears to be extremely simple, and all that is needed to prevent the occurrence of these longitudinal furrows, from which so many locomotive boiler explosions arise; and, therefore, it was thought well to call attention to it on the present occasion, while it is trusted it will receive that general consideration which it appears to deserve."

"No. 2 explosion was briefly referred to in the last report, but complete details had not then been received. Since then, however, through the courtesy of the locomotive superintendent of the line on which the explosion occurred, I have had the opportunity of making a personal examination of the boiler, so that the particulars can now be given.

"This explosion, which occurred at about two o'clock on the morning of Friday, January 22nd, 1869, to the boiler of a locomotive engine, is very similar in its character to No. 25 explosion, 1868, particulars of which were given in last month's report. It appears that the engine had been detained for some time at a station, owing to the shunting of other trains, the steam meanwhile blowing off freely at a pressure of 130lbs. The engine and its attendant train had but just got under weigh again, and proceeded about a mile from the station at which it had been standing, when the explosion occurred, throwing the engine off the line and on to its left side, whereby the driver and fireman were severely shaken, but fortunately no one else injured.

"The engine was of the heavy goods class, having six wheels coupled. It was built in the year 1855, and had undergone a general overhaul in March last, when it was tested by hydraulic pressure up to 180lbs. per square inch. The boiler measured about 18 feet 6 inches in length over all, while the barrel was 10 feet 6 inches long by 4 feet in diameter, and made of plates seven-sixteenths of an inch thick, which were lap-joined and single-rivetted. There were three plates in the length of the barrel, and two in each belt, circumferentially. The boiler was fitted with two safety valves, loaded to a pressure of about 130lbs. by means of spring balances, which were fitted with stop ferrules, to prevent the thumb screw being overrun, and thus the load on the valve increased.

"The boiler gave way at the bottom of the barrel or cylindrical portion of the shell, the rent taking place at the edge of the over-lap of a longitudinal seam of rivets close to the fire-box. On the occurrence of this longitudinal rent the barrel opened, tearing at the ring seams of rivets for a length of about 3 feet, when, in consequence of the unbalanced pressure arising from this large opening, the engine was thrown off the line, as already stated.

"The cause of this explosion is very clear. The plates at the bottom of the boiler were pitted by corrosion, and there was a deep furrow running along at the edge of the overlap at the longitudinal seam of rivets where the rent occurred. This furrow was five-sixteenths of an inch deep, and had thus eaten away the strength of the plates, so that rupture took place from simple weakness.

"The position of the primary rent and the lay of plates, as well as the shape of the furrow, will be more clearly understood on reference to the accompanying cuts, one (fig. III) of which gives a bird's-eye view of the boiler, with the plates laid out flat, showing the position of the primary rent; while the other (fig. IV) view gives a transverse section through the furrow in question, and the adjoining longitudinal seam of rivets, the parts being shown full size.

"The subject of grooving or furrowing was gone into so fully in last month's report in treating on another locomotive boiler explosion, that it need now only briefly be stated that this furrowing is due to a corrosive action in the water, combined with a constant buckling movement in the plates, caused by the varying pressures of steam. This movement would not take place if the barrels were truly cylindrical, and constructed so that the line of strain ran through the centre of the plates, when changes of form would not take place with changes of pressure.

"It is most important that these locomotive boiler explosions should be put a stop to, or some day in a crowded railway station the results may be most tragical. The remedy for these explosions in boilers constructed with lap-rivetted seams, is simply more frequent internal examination. On account, however, of the number of small tubes crowded into locomotive boilers, internal examinations cannot be made of them as of ordinary boilers, so that locomotives work on without internal examinations, or at all events without complete ones, until the tubes are worn out and removed in order to be replaced by new ones. On making inquiries of several engineers experienced in the manufacture and working of locomotives, I have been informed that the expense would not be so very serious of removing the tubes before they are worn out, and repairing the ends so as to replace them; and that in this way an internal examination of a locomotive boiler once in three years would be quite practicable. This would certainly prove a great safeguard, and the subject is commended to the serious attention of locomotive superintendents."

No. 801, dated 3rd December, 1869.

From—Lieut.-Colonel H. Hyde, R. E., *Mint Master*,

To—*The Secy. to the Govt. of India, Public Works Dept.*

Referring to your letter No. 247 of the 13th March last, and to the previous correspondence on the same subject.

2. Having received full particulars as to the state of the boiler that exploded, and a portion of the corroded plate, I have the honor to forward the following observations :—

1.—On the explosion, and

2.—On the question of locomotive boilers in India generally.

3. The explosion of boiler No. 17 engine, Sindh Railway, appears to have been consequent on the reduction in thickness of, and injury caused to, the plates of the boiler by corrosion.

4. The corroding of boiler plates is a well-known action, and the greater number of explosions that occur in locomotive boilers are from its effects. In inspections this injurious action is always looked for, and the exact positions in which it occurs are well known. It occurs in long irregular courses (hence the action often termed, grooving) on the top of the horizontal seams of the barrel below the water-line, and in the plates adjoining the end angle-irons.

5. Whenever, therefore, a boiler is ascertained to be grooving, ordinary prudence suggests that it is positively necessary to ascertain the extent to which the action has reduced the plates in thickness, and thereby impaired the strength of the boiler. It is impossible to ascertain this by mere surface inspection; the only way of ascertaining the thickness of the iron remaining in the plates is by a thorough inspection, by stripping the boiler, boring small holes in the grooved places, and actually measuring the thickness of plates remaining.

6. By this means all doubt is removed and a certain knowledge of the state and strength of a boiler is obtained; and it was obviously the duty of the locomotive superintendent under whose charge No. 17 engine was, to have made such an inspection as soon as the boiler was reported "honey-combed, middling." If he had made such an inspection, and if the progress of the action known to be going on had been carefully watched, it is evident, from the state of the bit of the plate sent to me, that the corrosion of the boiler would have been detected, and the engine would not have been sent out to work in the line.

*7. No such inspection appears to have been made. The engine appears to have been sent out to work in May 1868, with the character "middling"— more than doubtful character; for in May, 1866, the boiler was reported "good, but honey-combed," and it was therefore known that this corrosive action had been in operation for two years.

8. I cannot but think therefore that the explosion would not have occurred if the Locomotive Department, Sindh Railway, had carefully inspected the boiler; and that the Locomotive Department are responsible for the accident.

9. Having received the opinions of all the locomotive superintendents in India on the subject of inspection of boilers, I have extracted the opinions, and annex them.

10. In some of these opinions there is considerable diversity, others only differ in degree, especially on the question of testing by hydraulic pressure.

11. There are very adverse opinions on the method of testing held by the best engineers, but all, I think, agree that it is a useful test, if properly and judiciously applied, but a very injurious test, if unnecessarily, ignorantly, or carelessly applied.

12. Most locomotive superintendents are, and all should be, quite competent to arrange an efficient examination of their own stock; indeed, this is the most important part of their duty.

13. The character of the engines, the work they perform, the water they use, and the line of railway they run over, must have so much to do with the rules under which locomotives must be inspected, that rules for inspection must vary almost for each line; and it would not only be difficult, but it would, I think, be injurious to the working of lines, and would take away from locomotive superintendents the responsibility, which is the main part of their duty, if any regulations were issued on the subject.

14. No locomotive superintendent ought to be appointed to an Indian Railway, who is not thoroughly competent to be responsible for and superintend his locomotive stock. I think the entire management of the stock should be left to the locomotive superintendent, and that if he was found incompetent in any way whatever, he should immediately be removed.

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* If hydraulic test is of any use, it would appear to have been desirable after the repairs of July 1867, yet the last test was made in February 1866.

15. I think the rules in the several lines, with full reasons for the practice, might well be furnished to Government for submission to competent opinion when any error ascertained might be communicated to the railways concerned, with intimation of the responsibility incurred, and orders for immediate remedy of the errors.

16. I think, however, that though Government should leave the responsibility of locomotive superintendents intact, it is most advisable that certain conditions should be required in the construction of all locomotives sent to India, such conditions being those that are admitted by the best engineers to be conducive to safe construction.

17. I have adverted to the process of grooving. This action and the screwing down of safety valves by drivers are the main dangers to which boilers are subject.

18. It is now ascertained that grooving occurs only in certain forms of construction, and that it is due to the unequal motion of the several parts of the boiler.

19. All this is so thoroughly explained in two reports from the Manchester Association for the prevention of Steam Boiler Explosions, that I have extracted them in full; and I would specially draw attention to the two cases, *viz.*, Nos. 25 and 2, because the two boilers exploded under conditions identical with that of the Sindh Railway boiler of No. 17 engine.

20. Mr. Fletcher so thoroughly explains the causes of explosion, and the remedy for the same, that I need only to point out the construction which I think Government might insist on in all locomotive engines running on Indian lines as affecting public safety.

21. All locomotive boilers should be made with barrel plates, either in one ring welded, or in one length circumferentially. All joints to be butt joints, with covering rings, strips inside and outside, double rivetted, the longitudinal joints to be placed above water-line. No angle-irons, but end plates to be flanged; boilers to be quite free to move longitudinally with no interfering rigid attachments. One of the safety valves to be adjusted (beyond the power of the driver to alter) to blow off at the maximum admitted pressure.

22. I would advise a maximum recording arrangement at the back of all gauges sealed, so that the maximum pressure attained during every journey can be ascertained and recorded on the return of the engine to the running shed.

23. I annex—

1.—Report on locomotive No. 17 engine, Sindh Railway.

2.—Abstract of opinion of locomotive superintendents on the subject of inspection of engines.

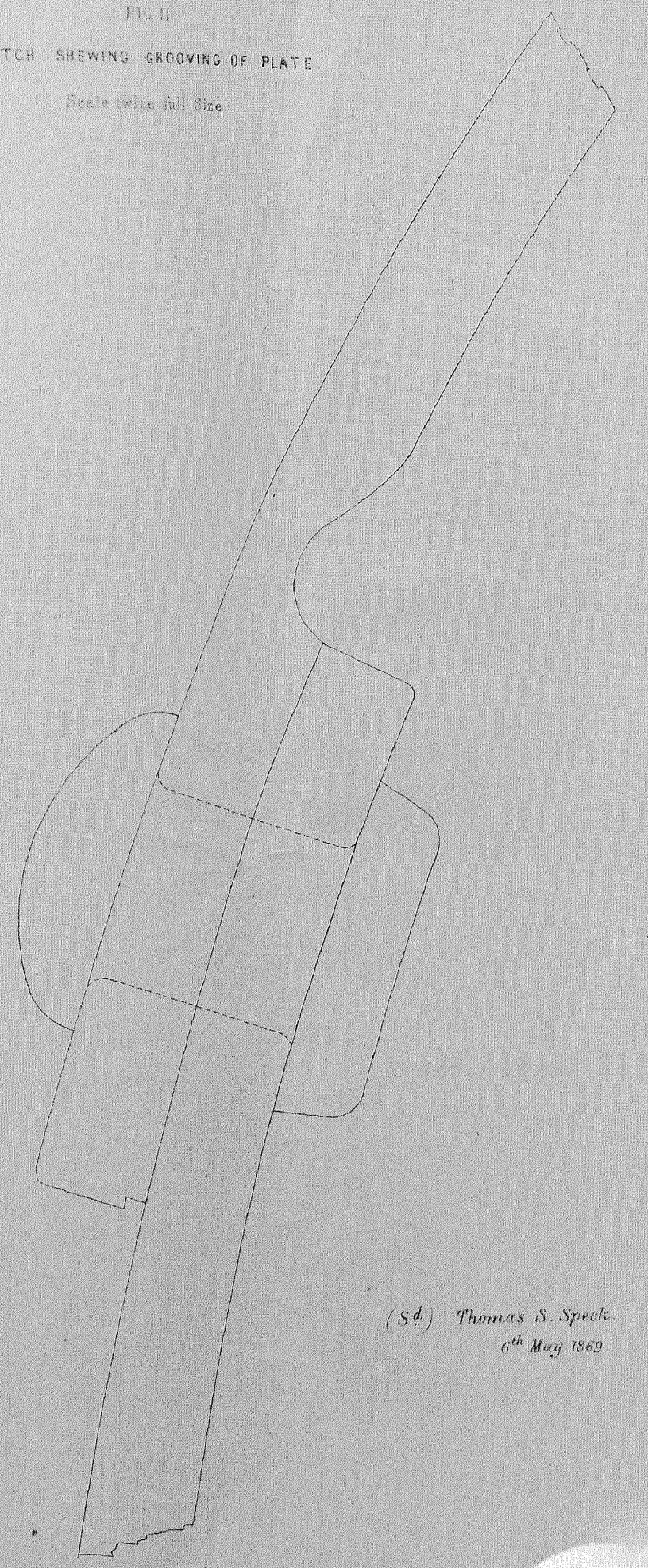
3.—Report of Chief Engineer, Manchester Association, of explosions Nos. 25 and 2.

4.—A portion of the corroded plate of exploded boiler, No. 17 engine.

FIG II

SKETCH SHEWING GROOVING OF PLATE.

Scale twice full Size.



(Sd) Thomas S. Speck.
6th May 1869.

FIG: III

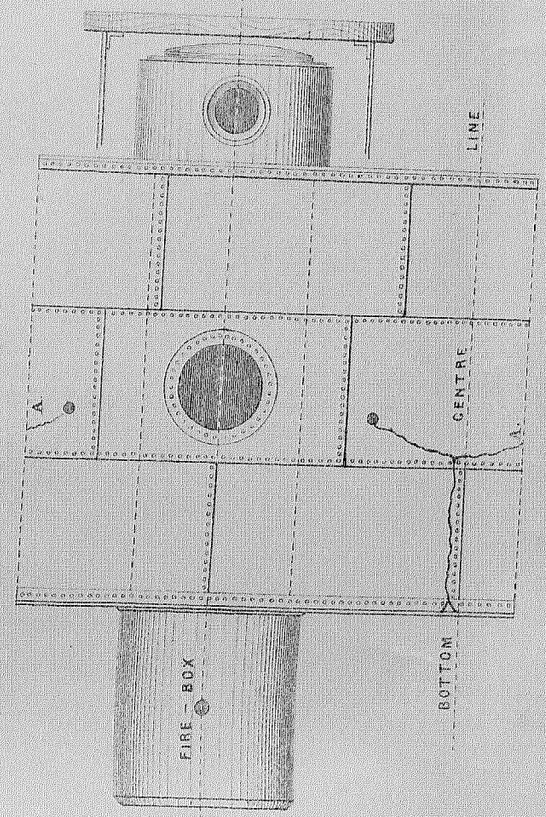


FIG: IV.

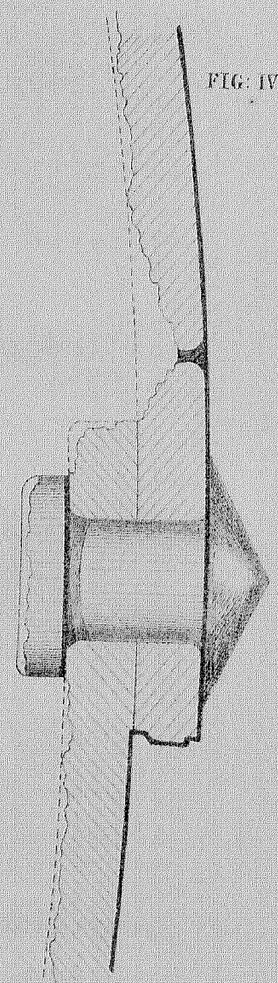
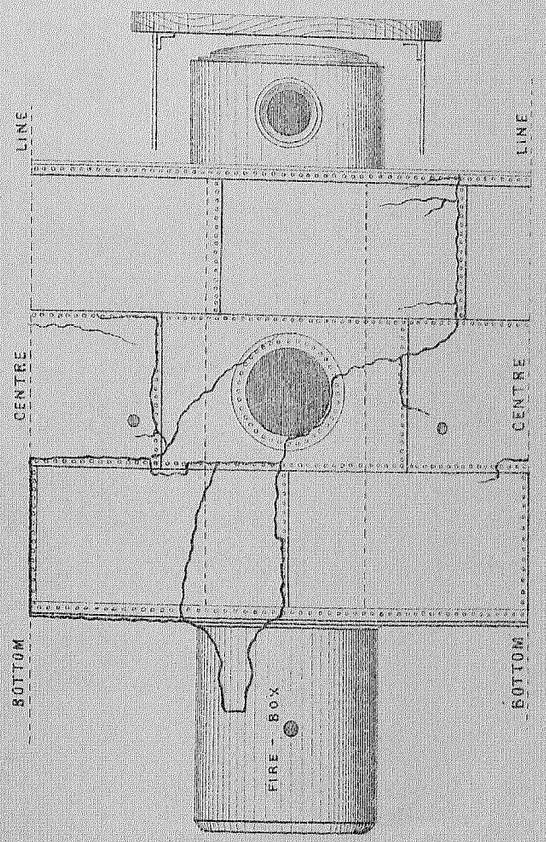


FIG: V.



No. 1, dated 4th January, 1870.

From—MAJOR J. H. M. SHAW-STEWART, R. E., *Consg. Engr. for Railways, Madras.,*
To—*Secretary to the Government of Madras, in the P. W. Dept.*

In continuation of my letter dated the 3rd June 1869,* No. 179, I have the honour to submit a letter† from the Agent of the Great Southern of India Railway, giving cover to a copy of a communication from Mr. Bruce, the Company's Consulting Engineer, upon the subject of testing engine boilers.

* *Vide* G. O., 29th June 1869, No. 2,112.
† No. 3,248, 15th December 1869.

No. 3248, dated 15th December 1869.

From—*Agent of the Great Southern of India Railway,*
To—*Consulting Engineer for Railways, Madras.*

With reference to your docket No. 333, dated the 16th October last, I forward herewith copy of a letter from Mr. Bruce, conveying his remarks upon the subject of "boiler incrustation."

Dated 18th October, 1869.

From—G. B. BRUCE, Esq., *Consulting Engineer,*
To—*Secretary to the Great Southern of India Railway.*

BOILER TESTS.

I duly received the paper forwarded with yours of 15th June last, having reference to the explosion of a locomotive in Bombay, and the reports of various Locomotive Superintendents in India upon the question of regular testing of locomotive boilers; and also the Order of Government based upon the Report of their Consulting Engineer, which Order is dated April 1869, No. 1098.

2. I have carefully examined the whole of these as well as the letters of Mr. Sheward upon the same subject. I think that Mr. Sheward, in his letter of 6th May 1869, has correctly described the mode generally in use in England as to the watching and examination of the state of the boilers. The Engine Drivers have books into which at the end of each day they make entries regarding the condition of their engine. These are examined by the Shed Foreman, and, if necessary, the engine is kept in the shed for further examination, and not sent out again to work until any complaints have been thoroughly sifted and repairs made accordingly. The first link on the chain of examination is the day-to-day experience of the Driver and his record accordingly in his book. On some lines of Railway the boilers are tested once a year by hydraulic pressure without any reference to the reports made by the Driver, but on other lines no such test is applied unless the Locomotive Foreman has reason to suspect from the complaints of the Drivers that there is something wrong. On no Railway that I am aware of are the tubes ever taken out and the engine thoroughly dismantled for the simple purpose of examining the boiler. As a rule, boilers do not require repairs until the tubes are burnt through, when, of course, a careful examination of every part internally is made before renewing the tubes; and, as the duration of a set of tubes may be (in round numbers) said to be 100,000 miles, run, the object aimed at by the Consulting Engineer to the Bombay Government is necessarily gained, inasmuch as, at or about the time when the engine has run that distance, new tubes being required, there is the opportunity for thorough internal examination. There is no such rule in force by the Government in England as the dismantling of an engine at certain fixed times, and I should deprecate the introduction of such a rule into India. With the thousands of locomotives that work in England, it is the rarest thing possible to hear of the explosion of one, and you cannot lay down rigid rules of the kind adverted to without relieving both the Drivers and the Locomotive Superintendents of the responsibility which fairly rests upon them to exercise care and judgment in the discharge of this part of their duty. However, such an order may be accompanied by a reservation that the Company is not relieved of its responsibility, it is contrary to human nature to feel responsibility of acting according to iron rule apart from the exercise of judgment. Drivers and Foremen, from constant hourly experience, can ascertain with wonderful accuracy the condition of their engines, and the fact already adverted to, of the extreme rarity of accidents, shows that it is as unnecessary as undesirable to lay down any fixed rules upon the subject. In testing boilers with hydraulic pressure, the usual practice is to test them to double the working pressure, and I think that at all events such tests should not be less than 50 per cent. in excess of the working pressure. I observe that the Bombay Superintendent proposes to use hot water in testing his boilers by hydraulic pressure. The same effect is gained,

probably more thoroughly, by filling the boilers quite full of water, and then heating the water up to the required pressure at which it is to be tested without the use of the hydraulic press at all. The strains thus produced are considered to be more thoroughly like the ordinary working strain upon the engine, and on that account, this mode of testing is preferred in some quarters.

3. As to the use of Baker's Anti-incrustators, I have no faith in the application of any of these things, and the probability is that they will do more harm than good where used. This at all events has been the experience up to the present time in the country. I certainly would not recommend its adoption on the Great Southern of India. I know of no means of keeping the boilers clean where the water is inferior, except more frequent washings out where the water is bad. It would be worth while to see whether, by a careful examination of the country, good water could not be got, because a little expense to secure this would very soon re-pay itself in the greater efficiency and the smaller repairs required in the Locomotive Department.

4. I return the papers herewith.

No. 321, datad 26th January, 1870.

Endorsed by the Govt. of Madras, in the P. W. Dept.

Copy of the above forwarded to the Government of India, in continuation of the docket from this Office, No. 2113, dated 29th June 1869.



attentions will be drawn

P. W. Department.

No 747

Proceedings of the Madras Government.

Under date the 9th March 1870

Read the following

From the Deputy Secretary of Govt. of India — M. E. No 3 of 17th February 1870

Communicated to the Consulting Engineer for Railways who will in communication with the Agents of the Madras, Southern of India, and Carnatic Railway Companies, prepare and submit a Draft of the rules which he would propose for adoption for examining and testing the boilers of Locomotive Engines.

Major Shaw's Memo attention will be drawn to

Klara 5.

Fortsättning 1988/29-7-7

To Langley for
Railways site
Copy of correspondence
Photographs

Circ 863

Govt. of India. Works.

PUBLIC WORKS.

To the Consulting Engr.
for Railways

Dated

Read

Ans

G. G. G. Simla 1870. No. 747

Nos. 210-211

Boilers of Locomotive Engines (Rly)

The Cons Engr requested to prepare and submit a draft of the rules which he would propose for adoption for examining and testing the boilers of locomotive Engines -