
DEO FAVENTE
ΕΥΡΗΚΑ

New South Wales Government Railways.

BALDWIN ENGINE ENQUIRY.

Statement by the Chief Commissioner (E. M. G. EDDY),

18th MAY, 1892.

NEW SOUTH WALES GOVERNMENT RAILWAYS.

In connection with certain Charges made by a Member of the Legislative Assembly in regard to alleged defects in some Engines supplied by the Baldwin Engine Works, and their general unsuitability for the railways of the colony, a special inquiry was asked for by the Railway Commissioners. The Government therefore appointed a Royal Commission; and at a Sitting of the Commission held on the 18*th of May*, 1892,

Present—F. E. ROGERS, ESQ., Q.C., PRESIDENT;

PROFESSOR WARREN, M.I.C.E.; ALEXANDER BROWN, ESQ., M.L.C., J.P.,

The following statement was made by the Chief Commissioner on behalf of the Railway Commissioners:—

E. M. G. EDDY, Assoc. Inst. C.E. (Chief Commissioner), stated:

I think I must trespass on the time of the commission somewhat so as to explain the policy which prompted the Railway Commissioners in the new departure they made in obtaining the Baldwin engines, otherwise it will scarcely be intelligible to the commission or to the country. The Railway Commissioners hold that amongst other objects in view by Parliament when the Railway Act was passed, and when they were appointed, was that of working the railways according to the most modern ideas, so that the greatest possible result would be obtained by the country, and it was never expected, they consider, that they should be tied down to working the railways on the principles that were in operation before they took office, as if so, their appointment would be of no effect to the country. The New South Wales railways are most exceptional in their character, having been constructed with an enormous proportion of steep gradients, the worst grades being on the trunk lines, and so situated that the whole volume of traffic has to pass over them. The only way (now that the traffic is increasing so rapidly) to stave off a great amount of duplication work, is to introduce more powerful engines, and so, by taking much longer trains at a better uniform speed, to enable the bulk of the single lines to carry satisfactorily for some time to come the traffic which could not otherwise be carried with the old class of motive power and system of short trains without grave delays and inconveniences.

GRADES, NEW SOUTH WALES LINES.

When the duplication works in hand are completed we shall only have 150 miles of double line in existence ($8\frac{1}{2}$ miles being quadrupled); whereas in the sister colony of Victoria, with its far easier grades, 297 miles of double and quadrupled lines exist. The difficulties surrounding the working of the New South Wales railways, having more than 2,000 miles of single line and exceptionally sharp curves—the steepest grades being also on the main lines within a short distance of Sydney—will be readily understood when I state that there are 629 miles of grades, varying from 1 in 30 to 1 in 75, in the following proportions:—

Gradient.	As Originally Constructed.		Total.		As Improved by Deviations since 1888.		Total.	
	m.	ch.	m.	ch.	m.	ch.	m.	ch.
1 in 30 to 1 in 33	25	20	...		24	54	...	
1 in 34 to 1 in 40	165	25	190	45	165	25	189	79
1 in 41 to 1 in 50	183	60	374	25	183	9	373	8
1 in 51 to 1 in 60	112	12	486	37	109	6	482	14
1 in 61 to 1 in 75	144	59	631	16	146	60	628	74
Totals	631	16			628	74		

The Western line, for instance, is a more difficult line to work than any of the Alpine railways, the ruling grade, radius of curves, and frequent loss of elevation, which has to be regained, being all against the railways of this colony. The table and diagram (Appendix D) which I place before you illustrates clearly the relative positions of the various lines in question.

RAILWAY.	Portion of Line shewn on Diagram.				Portion of Line not shown on Diagram.	
	Length of Incline. (Miles.)	Rise. (Feet).	Maximum Grade Ascending.	Sharpest Curve. (Chains).	Remarks.	Maximum Grade Ascending.
Brenner	22·25	2,586	1—40	14·16	Rises Nil	—
Mont Cenis, North	24·75	2,637	1—33·3	17·0	do. do.	—
Mont Cenis, South	25·25	2,793	1—33·3	24·0	do. 13 feet in 3¼ miles ...	1—1,000
St. Gothard	18·5	2,100	1—38·5	14 to 15	do. 126 feet in 4¼ miles ...	1—172
New South Wales (West) ...	29·5	3,248	1—30	8	do. 323 feet in 22 miles ...	1—33
New South Wales (South) ...	15·5	1,477	1—30	16	do. 322 feet in 23 miles ...	1—30
New South Wales (North) ...	30·0	2,105	1—40	12	do. 890 feet in 71 miles ...	1—44
					Falls to Zero from foot of incline in 17 miles	1—50

Particulars as to Alpine Railways taken from a paper by Mr. L. F. Vernon Harcourt.—Vol. 95, *Minutes of Institution of Civil Engineers.*

I would also like to illustrate the difficulty of our working by a reference to the diagram (Appendix E), which shows clearly our maximum altitude and frequent loss of elevation in reaching the summit. The worst of the Alpine routes has curves of 14 and 15 chains, but on the Western line of New South Wales we are burdened with frequent reverse curves of 8 chains.

Professor Warren—That on the Alpine lines is not a reverse curve?

Mr. Eddy—No. I take it they would have a transition between the two.

Traffic over the Blue Mountains.

The amount of traffic which has to be passed over the Blue Mountains on busy occasions will be seen from the attached diagram (Appendix F) which I have had prepared, showing the trains that passed over the single line with ruling gradients of 1 in 30 and 1 in 33, and frequent 8-chain curves on a recent night which came under my personal notice. Several of these trains were heavy trains drawn by the powerful engines, and had these not been in use additional trains would have been required to have conveyed the traffic. As many as 196 wagons of live stock, in addition to the ordinary goods and passenger traffic, have been moved in one day from the Western line to Sydney (Homebush). This additional traffic has to be worked over a length of nearly 500 miles of single lines, and for nearly 250 miles of the journey with grades ruling the load of 1 in 40, 1 in 30 and 33. Until these Baldwin engines were brought here, over the latter section of the journey short trains of 15 wagons only could be hauled by one engine; it will therefore be seen what a great disturbing and difficult element had to be dealt with, and any improved method for working the traffic in fewer trains was much to be desired. The live stock traffic is also growing very rapidly.

Types of Engines.

As pointed out when the Commissioners took office, there was such an infinite variety of types of locomotives that they decided, in the interest of economy and facility of repair, to adopt as few classes as possible; and, with this in view, determined that the new passenger engines should be sufficiently powerful to work a paying load of live stock or goods, and the engines placed upon the lines (Baldwin and English) effect this object. The failure of the various negotiations for the supply of engines to be built in the colony, and consequent great loss of time, the rapid increase of traffic, the worn-out condition of many of the locomotives, and the prospect of an exceptionally heavy wool season, rendered the immediate addition of new stock absolutely necessary. English locomotive builders being very busily engaged, and consequently unable to supply our wants promptly, the Baldwin works were applied to and offered to deliver a large number of most powerful locomotives within an unprecedentedly short period. While English locomotives are distinguished for the careful design of their details, excellent workmanship and general durability, American engines, while possibly inferior in these respects, undoubtedly possess great hauling power and flexibility, and are consequently adapted for heavy gradients and sharp curves, and for road-beds which are not so well constructed as those found in England. The Baldwin Company is the largest firm of locomotive builders in the world, having built over 12,000 engines, and their output in 1890 was 946 engines—about four times as many as any English maker. Their enormous output is a proof that their work gives satisfaction. In fact, in America the Baldwin works enjoy a special reputation for the improved design of their engines, which are to be found running on nearly all the principal railroads of the United States.

The Baldwin works also export more locomotives than any other locomotive builders in the States, and their engines are to be found in all parts of the world. It may be interesting to state that the number of engines built by the Baldwin Company is equal to three-fourths of the whole of the locomotives running on the railways of Great Britain. The actual performances of the two classes of Baldwin engines have been satisfactory, and the only defects have been in the axles and small details, which have been put right at the cost of the makers. The passenger and good engines have already run over 450,000 miles, and the average failures are less than other engines of somewhat similar type. The returns which have been already supplied to the commission show, I think, that the ordinary running repairs are very moderate when the heavy work the engines are doing is considered. Previously to giving the present order the Government had very satisfactory proof of the class of work turned out by the Baldwin Company, that firm having supplied 33 locomotives for the New South Wales railways and 91 motors for our tramways. It was therefore no new experiment or departure on our part to obtain supplies from that firm; and as one of the leading partners in the firm had some years ago spent a considerable time in the colony, they were in an exceptional position to understand our requirements, which were most urgent. Doubtless, the average amount of fuel burned per train mile is less on English than on American lines, yet if the computation were per ton of train hauled per mile, it would be found that the consumption is less on American than it is on English lines, without taking into consideration the difference in the grades and curves. In my opinion, there are many features in American locomotives which might with advantage be adopted by English engineers. With our heavy grades and curves and growing traffic on single lines, a new departure in locomotive power was absolutely necessary, and the results which are beginning to be accomplished clearly demonstrate the wisdom of the action of the Commissioners, the earnings per train mile for the quarter ending 31st March last showing at the rate of 7s. 5¼d. as against 6s. 6d. for the same quarter of 1890—this is upon a total mileage of over two millions of miles in the quarter. That alone will carry conviction to anyone who thinks of railway management. The amount of assisting-engine miles (*i.e.*, a second engine with trains), is also being largely reduced, in fact I may mention that our engine mileage for last month has shown a reduction at the rate of one million and three-quarter miles per annum, and there will be further reduction when we get the remainder of the more powerful engines now under order.

Weight of Baldwin Engines.

I think it will be desirable for me to distinctly describe the weight, &c., of the Baldwin engine and tender. The total weight of the engine when empty is about 51 tons 5 cwt. 1 qr.; when loaded to its fullest extent with water in the boiler, &c., it weighs about 58 tons 7 cwt. This weight is distributed over 10 wheels, four belonging to the bogie in front of the engine, and the other six are coupled driving-wheels, the middle pair being without flange, so as to reduce the strain on the permanent way in going round curves. The average weight on the three driving axles is 14½ tons, but a weight of about 15 tons 6 cwt. is placed on the middle or flangeless pair of wheels; therefore a weight of about 7 tons 13 cwt. is the greatest weight on any one wheel in the engine when it is fully loaded. The tender, which is mounted on two sets of four-wheeled bogies, weighs when empty 13 tons 12 cwt., and when loaded with its maximum quantity of coal and water about 32 tons. It will therefore be seen that the engine as arranged is exceeding flexible, and far less destructive to the permanent way, with so many curves of 8, 10, and 12 chains radius as we have on our main lines, than engines which have been running here for years past. I now propose to submit to you a set of diagrams of the engines (appendices G and H). (Photographs of English engines were also shown, and the principal differences between the English and American types of locomotives explained.)

These engines (American) are now daily working trains which formerly required two engines to draw them, and are also doing the work in a much more satisfactory manner. Two engines were employed in working the Western mail from Penrith to Wallerawang or Bathurst four out of every six nights in the week, and on the remaining nights as far as Katoomba. An assistant engine had also to be kept in readiness at Bathurst to assist the train if necessary as far as Dubbo, the throughout distance Penrith to Dubbo being 244 miles. The day train, Sydney to Orange, also had to be assisted three days out of four between Penrith and Katoomba. By the introduction of the Baldwin engines one engine (excluding a few very exceptional cases) has a reserve of power for dealing with the ordinary traffic without entailing the necessity for attaching an additional engine. The 5.50 p.m. train, by which regular passengers return from Sydney to the mountains, has been accelerated since the Baldwin engines have been put to work it by 15 minutes between Penrith and Wentworth Falls, and is now running punctually, whereas formerly, even when assisted by a second engine and with 15 minutes additional time, it was almost always late. The Saturday afternoon special train, Sydney to the Mountains, has also been accelerated in a similar manner, and is now worked by one engine with the same result as regards time-keeping and assistance. That might appear a small matter, but we find it is telling upon our traffic in a most effectual way, the superior facilities which these engines enable us to offer to tourists and others leading to good results in the way of increasing our traffic.

One Result of Working.

It should be self-evident that the one engine weighing, with its tender when fully loaded, about 90 tons, will do less harm to the permanent way than two coupled together, weighing in the aggregate 128 tons. There is, however, another and most important point gained, viz., the greater safety secured by having the train controlled by one engine and set of men, instead of two acting independently of each other. The more powerful engine is also able to maintain a better speed up the inclines, so avoiding the excessive speed in going down inclines, which is an element of risk, and is most destructive to the permanent way.

Since I wrote those words we have had a most lamentable illustration of the great advantage gained from this, and I will read to you an extract from the report of a Special Board which was appointed to inquire into the Tarana accident. We brought two gentlemen from outside the railway service to be associated with our Engineer-in-Chief in the inquiry into the Tarana accident. From the report it is quite clear that a very considerable number of lives were saved by the fact of a Baldwin engine, with its powerful brakes on the driving and tender wheels, being on the train on the night of the accident.

The report states:—"From the exceptional amount of brake-power on the train, and especially on the type of engine which was attached when the accident occurred, this power—so promptly applied by the driver—probably saved the train from being totally wrecked, and certainly minimised the loss of life. The weight of this train was such that it would have required two engines of the types previously used for this traffic to do the work, in which case the brake-power would have been materially decreased, while the unbraked weight would have been largely increased; consequently the train would have travelled much further before it could be stopped. We deem it of great importance to point out that the whole of the brake-power and its application was under the control of one man; whereas, in the case of two engines, concerted action in the instantaneous application of the brakes is practically impossible, and the leading engine-driver would, in all probability, be entirely ignorant that anything had happened; consequently, the hauling power of that engine would be working against the brake-power of the train.

"The fact that this brake was powerful enough to bring such a heavy train to rest on a falling grade in less than 100 yards we consider a most important advantage, the value of which cannot be over-estimated."

The train was then travelling on a falling grade of 1 in 150.

Working of New English Engine.—Weight of Southern Passenger Trains.

(Diagram of engine class "P" put in. Appendix I.)

On the Southern line, in working the Melbourne express, the same system of working with two engines was in operation as existed on the Western line, the two engines with their tenders weighing 128 tons; whereas a single English 10-wheeled engine weighing about 88 tons works the train with ease.

The weight of the Southern Express and Mail without engine and tender varies from 130 to 192 tons, and may be taken at an average of 156 tons.

The weight to pass over line:—

Train	156 tons	Train	156 tons
2 Engines	128 ,,	10-wheeled Engine	88 ,,
	284 ,,		244 ,,

A saving in weight to be hauled of 40 tons, and also relieving the permanent way of the same amount of wear and tear.

In working the Southern express and mail trains between Sydney and Junee, nine of the new engines will displace 17 of the lighter machines:—

Capital outlay:—

17 Old 4-wheeled Coupled, at	£2,870 =	£48,790
Nine 10-wheeled Engines at	£3,700 =	£33,300
Reduced Capital	...	£15,490

Mileage per annum of the two services, with assisting mileage:—

Under old system	563,760 miles per annum.	
Under new system	345,000	,,
Saving per annum ...	219,000 miles	,,

The average cost of each engine mile for the whole line amounts to 12.35d.; therefore if the saving of running one of the engines is placed at the low estimate of three-fourths of the average cost, viz., a saving of 9d. per mile in connection with the mileage saved, there will be an annual saving of £8,212 per annum, or £912 per annum each engine. The interest on capital outlay for the nine engines at 4 per cent. is £1,332 per annum, or £148 per engine. The investment in each new engine, after paying interest on the same, means a net saving of at least £764 per annum, and all the advantages described are also gained.

Baldwin Consolidation Goods Engine.

With regard to the American goods engines, from very carefully prepared returns made by the Outdoor Superintendent and the Chief Traffic Manager, it would appear that during the months of February and March 15 of these engines on the Western line saved 27,000 train miles, as against working the traffic in absolute full train loads by the most powerful of our ordinary goods engines. These are two light months of the year, and it is estimated that on the whole year's working a saving of about 222,000 miles will be effected. Another great advantage gained is the reduction in risk of accident, by having fewer trains on the lines, and the fewer delays that will be experienced in passing the traffic along the single lines. To illustrate this, it may be mentioned that in February, between Penrith and Dubbo, 15,219 wagons were moved by 551 trains, worked by the American engines, whereas it would have required 796 trains worked by the ordinary engines to have moved this number of wagons. It may also be pointed out that, looking at the great power developed by these engines, the price paid for them is an exceedingly moderate one. Indeed, it has not been suggested in the course of this enquiry that the expenditure incurred in their purchase has been in any way excessive or extravagant.

SPECIFIC CHARGES.

Alteration of Platforms.

I will now deal with the charges seriatim. The first charge is—

"That, in consequence of the extra width of the Baldwin engines, or their great length, the platforms on various parts of our lines have had to be altered."

This is certainly inaccurate. The facts of the case are that either various platforms, &c., had been erected since the lines were opened without proper attention having been paid to building them to the gauge laid down by the late Engineer-in-Chief—Mr. Whitton—or, in maintaining the roads, the rails had been moved towards the structures. The grave inconvenience and danger arising from this state of things was brought forward prominently years before the Commissioners took office, but the subject was not effectually dealt with until the present board took over the control. The question, however, was dealt with and decided upon before the Baldwin engines were ordered. Had the works been kept to the gauge laid down by Mr. Whitton, not one penny would have been required to be spent to admit of the running of the engines. The diagram placed before the Commission of the standard gauge for works and maximum size of rolling-stock in existence before the Baldwin engines were imported shows this clearly. The engines as ordered were within the extreme measurements of engines, &c., already upon the lines, but which had been restricted by the late administration to certain parts of the lines, because of the known defects in gauge. The total cost of making the necessary alterations to admit of the locomotives and rolling-stock of the maximum size passing all over the main lines has only amounted to about £3,200, a very small sum when looking at the great advantages gained by its expenditure, and whether the Baldwin engines were imported or not, the correction of the gauge was a matter of urgent necessity.

Diagram of the profile of the Baldwin engines in connection with the existing structures throughout the whole system, is submitted. Also diagrams of stock provided by the late Administration. (Appendices K. L. M.)

(The witness then described upon a large diagram the relative dimensions of the double tunnel, single tunnel, over-bridge, passenger roofs, goods shed roofs, and goods and passenger platforms with regard to the heighth and width of the Baldwin engines. Appendix K.)

The Baldwin engines were ordered to be 9 feet 3 inches over their cylinders, but as a matter of fact they varied somewhat in width. We had a number of them measured when they were first put together, and they varied from 9 feet $3\frac{1}{2}$ inches to 9 feet $4\frac{5}{8}$ inches, the extreme width of the widest Baldwin engine over its cylinders is shown on the diagram; there is therefore a clearance of $3\frac{5}{8}$ inches if the rails had been kept to the proper distance from the platforms, according to the standard gauge.

(A diagram of class 132 engine was put in (Appendix M). It was mentioned that this engine is equally as wide if not wider than the Baldwin as specified for, being 9 feet $3\frac{1}{2}$ inches over the cylinders, and on account of the known defects in the fixed structures on a portion of the line had been limited in working to certain sections).

Safety of Drawgear.

With regard to the charge :—

"That the safety of the drawgear will be in danger if the Baldwin passenger engines or the Baldwin consolidation goods engines draw the loads that it is stated by the Railway authorities they are intended to draw."

It has already been shown in evidence that the drawgear in the engines was lighter than ordered in consequence of an error in the Baldwin works, and the drawgear was at once changed at the expense of the Baldwin firm. It has also been shown that the drawgear on the rolling-stock is sufficiently strong for all purposes of safety, and that its strength was specially considered prior to the ordering of the engines in question. The recent unfortunate accident at Tarana also established the strength of the drawgear, as it did not break, although subjected to the strain of vehicles being off the line. I may mention also that the actual weight of the train behind the engine has not been increased; previously, two engines coupled were running both on goods and passenger trains, and we have only replaced these two engines by a more powerful locomotive.

Power of new Baldwin Engines and Engines previously in use.

With regard to the charge:—

"That there are engines already in use on our railway system that are as powerful as the Baldwin passenger engines, and, therefore, another type of engine has been added to our stock, thus increasing the already too many types of engines in existence."

There was not in use on our railways a passenger engine as powerful as the Baldwin, and no one in the service could confirm the assertion made. With regard to the types of engines, as the reduction of types was one of the first things the Railway Commissioners on taking office announced their intention of dealing with, they can be safely left to carry out their own intentions. They, however, do not propose to put the locomotive department right by adopting as standard types engines they do not approve of, and so continue the wasteful expenditure caused by having so many types. As a matter of fact, by having sold some of the exceptional types, broken up a few that were completely worn out, and having placed others on the duplicate list to be worn out in performing ballasting and other unimportant work, the 28 recognised types (we often hear talk about 42 types, they are made up of slight differences, there are only 28 actually distinct types of engines) have been already reduced to 18, even if all the new American and English engines are included; and out of the total stock existing at present, of 481 engines standing on the books on capital account, 331 of them belong to four types. I might explain with regard to providing new engines that it is customary with all good undertakings to renew engines, &c., out of the working expenses somewhat in advance of time, because there is a depreciation going on in connection with all rolling stock; unless you pass something in beyond what stands on your books you will afterwards be on the wrong side of the ledger; all good companies therefore renew their engines somewhat in advance of time. The engines so replaced remain as duplicates, and are allowed to work themselves out in performing such work as ballasting and shunting and similar services, and here we are adopting the same principle; we have a number of engines, wagons and carriages now on the books from which the capital account is free altogether.

I think I might at this moment put in the result of some experiments that we had with the engines a few weeks ago to test their hauling power. We had not tested these engines up to what they could do; we had simply put them to work that was necessary for reasonable requirements. With new engines they are never tested to their utmost capacity at first—they are worked gradually up to it. When this inquiry was commenced we thought it desirable to see what the engines could do, and so gave directions for both the passenger and goods engines to be tested, and they were tested on the Western Line. I will read the report submitted.

"Joint Report by Messrs. H. Richardson, C. H. Stanger, and D. H. Neale, relating to tests with the new American Engines.

New South Wales Government Railways.

To the Secretary to the Railway Commissioners,—

We beg to report that, on the 10th instant, we have, as directed, made a series of trials with the American 10-wheeled passenger and Consolidation engines on gradients of 1 in 33, 1 in 40, and 1 in 50, in order to ascertain the loads that can be hauled under ordinary conditions of railway working, and the speeds that can be attained with these loads. To enable us to arrive as near as possible to service conditions no special preparations were made with regard to the engines or vehicles selected. The trials of both passenger and goods engines were made with trains of "D" trucks, loaded with coal, and taken at random from Eskbank Yard, each wagon specially weighed by Mr. Crawford, the Station-master, on the Eskbank weighbridge in order to ensure accuracy. The coal burnt by the engine was also the first that came to hand, and the gradients were those of a sufficient length and those nearest Eskbank, our starting point for the trials.

The gradient of 1 in 33 between Bell and Clarence has few curves, and those of moderate radius. The gradient of 1 in 40 between Wallerawang and Marrangaroo is nearly wholly situated on reverse curves, one known as the 'Horseshoe' being specially long, and of 10-chain radius, and probably this gradient is one of the most unfavourable of the 1 in 40 gradients on the New South Wales Railways. The 1 in 50 gradient between Clarence and Bell is of a fair average character, each gradient being over a mile long; the speed was in each instance taken on the last mile where the engine would lose any impetus it would have gained on approaching the gradients.

There were present in addition to the undersigned,—

Mr. Duff, District Superintendent.
Mr. J. Colley, Assistant to the District Steam Shed Foreman, Bathurst.
Mr. D. Stewart, Locomotive Travelling Inspector.
Mr. R. Crawford, Station-master, Eskbank.

The engines selected were,—

No. 448 10-wheel American passenger, 6 wheels coupled; driver, G. Evans; first fireman, W. W. Green; second fireman, R. Forrest.

No. 487, new American consolidation class, 8 wheels coupled; driver, J. Young; first fireman, C. R. Corbett; second fireman, J. R. Hamilton.

The results obtained are shown in the attached table. We consider that in all cases the loads were hauled without difficulty, except as regards the goods load taken up the 1 in 40 gradient, where the engine commenced to slip on the worst portion of the curve, and nearly came to a stand. By using sand, however, the engine continued to haul the train to the summit; the engine probably could not have started the train from a state of rest. The ordinary goods trains find great difficulty in getting round this particular curve, and travel at this point at a very slow pace. The speed of the goods train on the 1 in 50 gradient more than equalled the traffic requirements, and a slightly higher load could have been hauled.

The speed of the goods train up the 1 in 33 gradient was a fair average, and equals that obtained in regular working, but would have been lower had the gradient contained the numerous and sharp curves contained on many of our gradients of 1 in 33.

The passenger engine would probably have attained higher speed had it been hauling passenger stock instead of goods wagons, which are not so well lubricated, and offer more resistance on curves.

H. Richardson, Outdoor Traffic Superintendent.
11-4-92. C. H. Stanger, Outdoor Locomotive Superintendent.
D. H. Neale, Mechanical Engineer."

New South Wales Government Railways.

Table showing performances of Baldwin Engines during trials made on 10th April, 1892.

Mileage.	No. of test.	No. of Engine.	Grade.	Train. No. of loaded coal wagons.	Train. No. of bogie brake vans.	Weight of train, exclusive of engine and tender.	Length of train, exclusive of engine and tender.	Speed over summit—miles per hour.	Mean boiler pressure.
Passenger—						tons cwt.	ft. in.		lb.
87 to 88	1	448	1 in 33	13	1	168 9	273 8	14·5	162·
102 to 101	2	448	1 in 40	14	1	195 15	291 8	12·5	159·
86 to 85	3	448	1 in 50	18	1	254 2	363 8	14·3	159·
Consolidation—									
87 to 88	4	487	1 in 33	19	2	274 4	421 6	7·5	158·
102 to 101	5	487	1 in 40	25	2	341 16	529 6	4·7	158·
86 to 85	6	487	1 in 50	32	2	433 10	655 6	9·7	158·

H. RICHARDSON.
April 11, 1892. D. H. NEALE.

"Addition to joint Report of trials of new American Engines on 10th April, 1892.

I consider that the performances, especially of the goods engine, have rarely or never been surpassed by Main Line engines in Australia or Europe.

A load of 350 tons, exclusive of engine and tender, is the maximum load hauled up gradients of 1 in 100 in regular service in Great Britain, and on many lines the regular load for this gradient (which on our lines is moderate), is less than the American consolidation engine hauled unassisted up a gradient of 1 in 40, with long ten chain curves.

The train the passenger engine hauled up the 1 in 33 gradient is equal to 7 lavatory carriages in weight. The power of the engine needs no further demonstration, as such a train exceeds the carrying capacity of the majority of the fast express trains both in England and America, where such trains are, moreover, generally assisted over gradients steeper than 1 in 70.

D. H. Neale, 11-4-92."

Secretary.

"The Secretary to the Railway Commissioners.

Addendum to Report on Trials of American Engines on the 10th April, 1892, between Wallerawang and Mount Victoria.

23rd April, 1892.

Having suspected from the behaviour of the engines on the 1-40 grade at Marangaroo that it was somewhat steeper than 1-40, I find now, from a special survey just made under the direction of the Engineer-in-Chief for Existing Lines, that after passing over 50 chains of 10-chain reversed curves without any intermediate straight, the engine came to a piece of 1-37·5 five chains in length, and that this doubtless checked the engine and was the cause of the slow average speed up the bank, as the check caused by the extra grade was coincident with the effect of the curvature and the engine slipping. The fact that the engine was able to pull the train up the bank, despite this combination of grade and curvature, speaks volumes for the power of the engines. I annex tracing of grade.

D. H. NEALE."

PROF. WARREN: We had better results on Sunday.

MR. EDDY: You had passenger stock then; this was with goods wagons. As I was entering the room I had the results of the tests made on May 15 put into my hand. I will read the interim report of the engineers:—

"TO THE COMMISSIONERS OF RAILWAYS, NEW SOUTH WALES.

Gentlemen,—In compliance with your request we have made a careful series of experiments with a 10-wheeled American engine, No. 447, in order to ascertain accurately the performance of the engine when hauling passenger vehicles up grades of 1-30 and 1-40. In your letter to the Baldwin Works, 22nd September, 1890, you stated that you wished the engines to haul regularly a load of 120 tons, exclusive of engine and tender, up a gradient of 1-30, without sharp curvature, and that occasionally you expected that a load of 144 tons should be taken up. On a gradient of 1-40 you stated that the regular load of 152 tons should be taken at about 22 miles per hour, and that the engines should be capable of occasionally taking a load of 176 tons. Our tests were especially directed to ascertain if the engines were capable of performing the above work. The trains were made up of Pullman sleeping-cars and first-class lavatory carriages, and in all cases weighed somewhat more than the stipulated loads. We succeeded in taking no less than 44 indicator diagrams, which will enable us in a few days to present you with a complete report as to the indicated horse power of the engine, with the tractive power and the resistance of the train. Meanwhile the data so far obtained enable us to say that the load hauled and speeds obtained were as follows.—

No. of Trip.	Gradient.	Mean Speed on the Whole Length of Gradient (Miles per Hour.)	Weight of Train exclusive of Engine and Tender. Tons	cwt.	Remarks.
1	1-40	18·50	179	5	Length of Gradient, 2½ miles. Several curves of 16 chains radius on first mile.
2	1-40	20·15	157	12	
5	1-40	21·09	157	12	
3	1-30	18·87	121	14	About 2 miles of 1-30, and ¾ mile of 1-33. Curvature moderate.
4	1-30	16·71	144	2	

We regard the results as extremely satisfactory, and have little doubt that had the driver run such a train regularly he would have been able to obtain even better results from the engine on the 1-40 gradients, which occurring immediately after he left Picton with a somewhat dead fire prevented the engine steaming as freely as she did on the 1-30 grades. The latter, however, were approached by several miles of easy rising gradients, in running over which the action of the blast thoroughly ignited the fire, and consequently enabled the engine to steam freely and maintain its speed on the grade.

We have the honor to be, yours faithfully,

(Signed) HECTOR KIDD.

ROB. POLLOCK."

(*Subsequent complete report given in Appendix B.*)

DESIGN OF BALDWIN ENGINES.

With regard to the charge—

"That the Baldwin passenger engines and the Baldwin consolidation engines are faulty in design, and that certain parts—the axles of the bogies and tenders—were dangerous, and grave neglect was shown by allowing the engines to run before the parts in question were removed."

I submit that not one iota of evidence of any weight has been produced to prove that the engines are faulty in design; on the contrary, the witnesses called to testify against the engines have nearly all admitted that they are well designed, and are performing the work expected of them. When the charges were promulgated in Parliament, not a defect had shown itself in any of the engines; in fact, only a portion of the passenger engines were in steam, and not one of the goods engines had arrived in the colony, the first one being put in steam on the 30th September, whereas the charges were made on the 20th of August. Although the attack was made in Parliament on the 20th of August, the first failure that occurred was on 27th October—more than two months afterwards. With new engines, small matters like axle boxes running hot and points of that kind cannot be looked upon as failures, as all new machinery, whether in steamships, workshops, or locomotive engines, requires careful attention for a time. With regard to the failure of bogie axles, &c., the Commission have had placed before it a letter from the Baldwin firm, which reads as follows :—

"BALDWIN LOCOMOTIVE WORKS,
BURNHAM, WILLIAMS & CO., PHILADELPHIA,
February 15, 1892.

Mr. H. M'LACHLAN,
Secretary Government Railways of New South Wales, Sydney, New South Wales.

Dear Sir,

Your two favors of the 27th November and the 7th December were duly received, but our reply has been unavoidably delayed. It is with the utmost regret that we have learned of the breakages of the engine and tender axles of the 12 10-wheel passenger locomotives which were received last year per 'Henley.' The several reports sent us have received careful consideration. In contracting for these locomotives the Commissioners desired to obtain engines adapted to unusually heavy service. In order to secure the utmost efficiency, and to obtain the best results of American experience, they left many of the details of the specification to our judgment. The material for the driving, truck, and tender axles was left optional, and as, in our opinion, the most satisfactory results are usually obtained from axles carefully forged from selected scrap iron, we ordered such axles from the manufacturer whose product we had been largely using with good results, and whose reputation for excellent work is generally recognised. No test was prescribed by us, as it is well known that no test of scrap axles is conclusive. We relied upon their showing clean, uniform, well-worked material when turned up in the lathe. Steel axles, or axles forged from muck-bars, can be tested under a drop with reasonable probability of the uniformity of the axles not tested; but the fact that a hammered scrap axle withstands such test is no guarantee that others of similar manufacture and appearance will stand. Not only have we been buying axles in this way for many years, but, so far as we know, it is the general practice in buying hammered scrap axles, both by railroads and manufacturers. These axle forgings did turn up clean, smooth, and free from flaws, and we supposed to be as good as the many hundreds which we have received from the same maker without one instance of failure coming to our knowledge. We go into the matter at this length to assure you that there was no conscious lack of diligence exercised by us to supply materials of the best quality, which your government was entitled to receive from us. We have already replaced the 24 engine-truck axles with others of steel. We offer to reimburse the Government the cost of replacing the 48 tender axles. We also offer to pay the reasonable cost of the labour involved in effecting the replacement. We are of the opinion that the original dimensions of the truck and tender axles and journal bearings are ample for the fast speed for which the locomotives are suitable, provided the quality of the material is good; and the bearings for such engines have been widely adopted for similar service with good results. We should have much hesitation in increasing the diameter of the bearings with such small wheels, owing to the higher rotative friction. It should be borne in mind that the smaller truck wheels necessary in engines of this type require closer attention to the lubrication than the larger wheels used in English locomotives. If, however, large bearings are adopted, we urge the desirability of making them 5½in. rather than 6in. diameter. In view of the above we think the cost of new boxes, whether of iron or solid gunmetal, should not be charged to us, as we are certain that the replacing of the axles will prove a sufficient remedy. We remark that the driving axles were not made by the same party as the truck and tender axles. We therefore trust they will upon investigation prove satisfactory. There appears to have been a clerical error in transmitting to our shopmen the dimensions of draw-hooks shown by your drawings. We authorise you to debit our account the cost of replacing them with stronger hooks. With these modifications we trust the engines will speedily show the special adaptation, which we believe they possess, to the difficult service for which they were ordered. That similar engines are doing such work on our American railways is shown by the recent test of our 10-wheel locomotives on the Baltimore and Ohio railroad. Under separate cover we mail you three copies of the report of these tests. We trust these tests will in a measure justify the wisdom of the Commissioners in the purchase of these locomotives, and that after the defective axles are replaced the performance of the locomotives will be such as to merit their entire approval.

Very truly yours,

(Signed) BURNHAM, WILLIAMS & CO."

All the cost of failures due to faulty workmanship has already, and without demur, been paid by the Baldwin Company, and we still hold a considerable sum of money belonging to the company in case ony other weakness should develop. We deem it only right to say that we feel sure the Baldwin Company did not knowingly allow any defective material to be placed in the engines, and also to acknowledge the readiness with which they and their representatives in Sydney did all in their power to rectify defects.

With regard to the latter part of the charge, it has been shown in evidence, even by witnesses called in support of the charges, that the usual precautions were taken in regard to inspection before the engines were put into work, and that no ordinary and usual mode of inspection could have detected the weaknesses which later on developed themselves.

SAFETY OF PERMANENT WAY.

With regard to the charge—

"That in consequence of the great weight of these engines (the Baldwin passenger and consolidation) the safety of the permanent way is likely to become endangered, our standard rail being 71lb. per yard, whereas the above-mentioned engines were designed for an 80lb. rail".

I beg to state that the whole charge is erroneous. The standard rail for the New South Wales railways is 80lb. to the yard steel rail, and at the present time no less than 200 miles exist, and the sleepers are laid 2ft. 7in. centre to centre, each sleeper averaging in weight over 2 cwt. 1 qr. The lightest rails these engines work over are 71lb. steel rails, but much of the road is 75lb. iron and steel and 80lb. steel.

The question of the weight of the rail, however, is rather one of economy than of security, as the 71lb. steel rail is sufficiently strong to carry an engine with a greater weight upon an axle than is the case with the engines under review. So far as the ordinary permanent way is concerned the actual weight of the engine is of far less importance than that of the distribution of weight upon the wheels. In the case of the engines under consideration the 58 tons which the engine weighs when fully loaded is distributed over five pairs of wheels and axles, and the weight upon any one axle and pair of wheels is less by 1 ton 2 cwt. than engines which have been running upon our lines for years past, and at a time when the roads were not in so satisfactory a condition as they are to-day.

I have had prepared with a great amount of care a statement shewing the weight of rail in use in other parts of the world, and the weight of engines run upon those rails, together with particulars of the weights borne by some of the driving wheels; and this table will give a large amount of valuable and reliable evidence on the subject:—(Appendix A.)

WEIGHT OF RAILS.

It is, of course, difficult to produce facts at this distance from England and America to disprove statements made without justification; but fortunately I am in possession of some valuable information on this particular subject. It was stated at the opening of this enquiry, in support of this charge, that the rail in use on the Baltimore and Ohio line was a steel one weighing 80lb. to the yard. This was stated to be on the authority of *Poor's Manual* and the *Railway Gazette*. *Poor's Manual* states that the rails in use are iron, 60lb. to 80lb. per yard, and steel 67lb. per yard. I submit to the judgment of the Commissioners the fairness of such a distortion of what is given in *Poor's Manual*. In addition to this I append copies of cables that were sent in August last to and from America when the statement was first made in Parliament (as it was so contrary to what was understood by the Railway Commissioners), from which it will be seen that 67lb. steel is the new standard rail. Our steel rails are 71lb., 75lb. and 80lb. to the yard.

Copy of cable from R. TOWNS AND CO. to Messrs. R. W. CAMERON AND CO.:—

"New York, 24th August, 1891. Telegraph immediately for Government how many six-wheel couple passenger and eight-wheel consolidation goods, the same as 'Henley,' 'Strathdon,' are running America; is result satisfactory generally? Consult Forney; advise weight rail, Baltimore."

Copy of Reply :—

"Eight-wheel goods in general use with favourable results; weight better distributed and less destructive to rails. Coupled six-wheel passenger same result as to rails over four-wheels, with increasing demand for heavy trains, especially on western roads, but not used on Pennsylvania or New York Central; they prefer dividing trains. Baltimore steel rails, 67 lb. per yard."

The Commission has had evidence placed before it in support of the charge as to the importance of the society in America styled the Master Mechanics' (Locomotive Superintendents') Association. The body is undoubtedly a most important one, and much good has come out of its deliberations. It is well, therefore, to know what that body has decided upon this important question. At the annual convention of the association in June, 1891, a committee of the society reported that the limit of weight per driving axle should be 32,000lb. (14½ English tons) for rails under 60lb., and 36,000lb. (16 tons 1 cwt.) for rails above that weight. Authority, "Official report of proceedings at annual convention," 1891.

Wellington's work, "Railway Location" (Ed. 1887), is one of the standard works on railways, and from the extracts which I will read it will be seen that in America 70lb. per yard for steel rails was evidently the highest general standard in 1887, but that for reasons of economy an 80lb. rail was urged, and it was thought would doubtless be adopted ultimately. He states (p. 740) : "Light rails are sooner or later avoided as the plague by all railways." Tables 195, 196, and 197 shew that by substituting an 80lb. rail for a rail of similar form, but 70lb. weight, the gain in the three essential qualities of a rail is as follows:—Percentage increases in stiffness, 30 per cent.; strength, 22 per cent.; durability, 43 per cent. As the increase in first cost is barely 14 per cent. the advantage is obvious.

He states (p. 747 and table 198) "That even supposing a 70lb. rail has a life of 60 years, it is more economical to buy 75lb. rails reckoning compound interest at 5 per cent."

Then again he says:—"Of all directions for economy, cutting down the rail section is the most costly in the end." (p. 748).

Then again he says:—"It is in every way probable that within a few years 80lb. or 90lb. rails will be the rule and lighter rails the exception. The inertia from past precedents which have come down to us from the days when rails were several times more costly than now, will, in time, be overcome." (p. 761).

And again:—"We have reasons enough and to spare why all roads should tend as they do tend to use a heavy rail." (p. 747).

The ordering of the engines in question and the weight to be borne by each axle received the most anxious consideration at the hands of the Commissioners and their officers before the order was given; but as a further increase in weight might become advisable in future years, I took the opportunity when I was recently in the old country of discussing the whole question with Sir Benjamin Baker and Sir John Fowler, two of the most eminent engineers in England. Sir Benjamin Baker unhesitatingly agreed that we could, with safety, carry 16 tons on one axle on a 70lb. rail with ironbark sleepers 9ft. x 10in. x 5in. placed 3ft. centre to centre. As Sir John Fowler, Bart., is our consulting engineer, I asked him to place his views in writing, which he did in the following terms :—

"2 QUEEN SQUARE PLACE, QUEEN ANNE'S MANSIONS, WESTMINSTER, S.W.,

22nd October, 1891.

NEW SOUTH WALES WEIGHT OF RAILS.

Dear MR. EDDY,

The question you put to me yesterday with reference to the safety or otherwise of allowing locomotive engines with driving wheels having a weight of 16 tons on a pair to work on your 70 lb. rails was an important one, but I have no hesitation in answering it. Provided that the sleepers are of ironbark, 9 ft. long by 10 in. wide and 5 in. thick, placed at a maximum distance of 3 ft. centre to centre, and the line level, drainage and ballast well maintained, there is no objection or danger in the use of such engines for either passenger or goods traffic. Of course I assume that the rails are renewed before they are worn and weakened according to usual good practice, which may be said to be applicable to rails of all weights. But, at the same time, I should like you to understand quite distinctly, as my opinion, that with your present and certain increase of traffic, and the power and weight of engines you are practically compelled to use, a rail of 80 lb. per yard is more economical than one of less weight, from its higher percentage of wearing weight and its greater length of life before renewal.

Believe me, yours very truly,

(Signed) JOHN FOWLER."

The Lancashire and Yorkshire Company have running upon their lines no less than 366 engines, with a weight upon a pair of driving wheels of from 15 tons 10 cwt. 1 qr. to 17 tons 10 cwt.

The Great Western of England have engines carrying 15 tons 10 cwt, 15 tons 16 cwt., and 16 tons 10 cwt. on a pair of wheels. As I am on the Great Western line, and you have had so-called expert evidence to speak of the weight of the rails on the Great Western line of seven years ago, which I know to my knowledge to be absolutely wrong, I will give an extract from a work by Mr. Wolfe Barry, entitled "Text Book of Science, Railway Appliances" (1890). The expert who came before the Commission said nothing about the bearings; he gave absolute facts about the weight of the rails. Mr. Wolfe Barry, after referring to the longitudinal sleepers, says:—

> "Thus, on the Great Western railway, a rail weighing 62 lb. per lineal yard has carried for many years, and is now carrying, the heaviest traffic, while other companies and the Great Western itself is using cross sleepers for a rail weighing 75 lb. to 80 lb. per yard."

I do think it wrong when witnesses come as experts who say they have been studying the question for the purpose of giving evidence, and make statements of the sort that were made before you. I will not be content with that. I will give you information up to two days ago, from Sir John Fowler, who is consulting engineer of the Great Western railway, because I think it is most wrong that the reputation and credit of the country in connection with the Commissioners should be attempted to be broken down by witnesses who speak without absolute knowledge of facts. I may add that the section of line enquired about is that between Didcot and Bristol, which carries the heaviest section of traffic; and as the broad gauge was to have been altered to the narrow gauge about last Sunday, there was an opportunity of altering the rail if it had been thought desirable. Sir John Fowler says in reply to our cable:—

> "The quantity of 86 lb. rails is very small, very nearly the whole length is 68 lb. flat bottom bridge rails."

That was on the 12th of this month. It is simply a repetition of the Baltimore and Ohio statement.

The Midland Railway Company carry 17 tons 10 cwt. on the driving axle of an express engine.

The London and North-Western carry 15 tons 10 cwt. on each of the two pairs of driving wheels of Mr. Webb's new description of engine, "Greater Britain."

The Eastern of France, for the purpose of avoiding running two engines with their passenger trains, has just put to work an engine carrying 32 tons on the two driving axles—*i.e.*, 16 tons on each axle—their general rail being 69 lb. in weight. The chief permanent way engineer has also reported that the rail is capable of carrying 10 per cent. more weight with safety. This engine is to run at very high speeds.

I will not detain the Commission longer on this subject, as one of our officers will give evidence regarding the practice in America in running engines with as great a weight as 17 tons to 19 tons on one axle, at exceedingly high speeds, upon rails varying in weight from 56 lb. to 70 lb. Some stress has been laid upon the spacing of the sleepers upon the N.S.W. railways as compared with those upon English and American lines, and the question has been put in such a way as to lead the Commisson to believe that it is the prevailing practice in England to place the sleepers close together, and in New South Wales, 3 ft. to 3 ft. 1 in. apart, whereas the reverse is really the case.

In dealing with the sleeper question, however, it must be borne in mind that this is not determined solely by questions of strength, but by the fact that a sufficient bearing area must be obtained for the rail on the sleeper and the sleeper on the ballast, and the class of wood used. With the soft woods in use in Europe and America, it is absolutely necessary that the bearing-surface of the rail and the sleeper should be large enough to prevent the rail cutting into the sleepers. In England this is guarded against by using cast-iron chairs, and in America by placing the sleepers close together. Even then continual trouble is experienced in consequence of the rails and chairs cutting into the soft woods, which involves constant attention to prevent the road from becoming loose. The very exceptional ironbark sleepers we possess in this country are so hard and durable that the fastenings retain their hold exceedingly well for years, and the rail cuts but slightly into the timber.

The question of durability is also very important. The uncertain quality of the timber used for sleepers in America renders it necessary for a larger number to be used as a matter of precaution. A most important point to be considered in connection with permanent way is the weight of the road, as compared with that of the rolling stock passing over it, as the weight of the road as a whole measures its resistance to the blows of the traffic. The following statement shows the weight of a mile of permanent way of our three types of road, as compared with the standard main line of a leading railway company in England :—

WEIGHT OF ONE MILE OF PERMANENT WAY.

		t.	c.	q.	lb.
New South Wales	75lb. D.H. iron and steel rails laid in 27lb. C.I. chairs upon ironbark sleepers 9ft. long x 10in. x 5in., 3ft. apart centre	384	7	3	11
	71½lb. T steel rails laid upon ironbark sleepers, 8ft. long, 9in. x 4½in., 2ft. 7½in. and 2ft. 8in. centres	282	2	2	15
	71½lb. T steel rails laid upon ironbark sleepers, 9ft. long, 10in. x 5in., 2ft. 7½in. and 2ft. 8in. centres	346	8	1	11
	80lb. T steel rails laid upon ironbark sleepers, 9ft. long, 10in. x 5in., 2ft. 7in. centres (Standard road)	371	1	3	1
English	84lb. bull-headed steel rails laid in 45lb. cast-iron chairs upon creosoted Baltic sleepers, 9ft. long, 10in. x 5in., 3ft. apart centres	344	1	1	4

The weight of the standard Baltic timber sleeper in general use on the best lines in England, 9 ft. long by 10 in. by 5 in., creosoted, is 160 lb., and that of our ironbark sleepers of similar dimensions is 252 lb. As regards durability, the life of the ironbark sleeper may be taken at fully double that of the former; I fancy a great deal more, but I want to be within the mark. (Prof. WARREN—Yes, it is more than double.)

In the evidence brought in support of the charges, the rails on the New South Wales railways have been spoken of generally as being laid on sleepers 3 ft. to 3 ft. 1 in. centre to centre; whereas out of our total mileage of 2,180 miles on no less than 1,650 miles of the road the sleepers are placed 2 ft. 7 in. to 2 ft. 8 in centre to centre on the straight.

On the old road, where the sleepers were placed 3 ft. centre to centre in the straight, the road on curves was strengthened by additional sleepers, the rule having been to place the sleepers as close as 2 ft. 4 in. centre to centre in sharp curves of less than 15 chains radius, and 2 ft. 9 in. in curves of from 15 to 30 chains radius.

It has also been represented that only a few miles of steel rails heavier than 71½ lb. to the yard exist on our lines, whereas since the Commissioners have been in office no less than 215 miles of line have been laid with 75 lb. and 80 lb. steel rails, and an additional 55 miles with 71½ lb. steel rails.

In regard to improving the ballasting of the lines, no less than 700,000 tons of ballast have been used; out of that quantity 600,000 tons have been blue metal, hard quartz, or slag. 430,000 ironbark sleepers have also been used. In connection with the ordinary repairs to the permanent way, it may be mentioned that for relaying alone there has been paid out of working expenses during the three and a half years the Commissioners have been in office, £230,000. During the 15 years preceding the Commissioners taking office a sum of £195,000 was paid for the same purpose. This and other important work has been done, and the working expenses reduced by over 5 per cent. per annum.

As practically the whole of the Baldwin engines are working on the Western line, it will be well to detail the improvements made on the oldest section (Granville to Bathurst), a distance of 132 miles, of which 25 miles are double line. During the past three and a half years no less than 45 miles have been relaid, and more than 60 miles completely reballasted and lifted, while on the remaining portion a very large amount of lifting and slight re-ballasting has also been done. Before the close of the year we expect that the whole of the rails on the Western line, Sydney to Bourke, 503 miles, will be of steel, varying in weight to the yard 71½ lb., 75 lb., and 80 lb.

I propose, with your concurrence, Mr. President, to call witnesses to prove the reverse of what the charges indicate, and then I shall ask you to be good enough to allow the Commissioners to make a few general remarks on the evidence placed before you.

THE PRESIDENT—As regards the witnesses, yes, certainly; but as to the remarks, I do not think it will be necessary to have anything in the shape of advocacy. If that statement is not even amply borne out it will need no advocacy. That is really part of your evidence.

MR. EDDY—That is my evidence.

APPENDICES TO CHIEF COMMISSIONER'S EVIDENCE

AT

BALDWIN ENGINE ENQUIRY.

A.

WEIGHTS OF RAILS AND EXPRESS PASSENGER ENGINES.

WEIGHTS OF RAILS, AMERICAN ROADS, TAKEN FROM POOR'S MANUAL, 1891.

Railway.	Total Weight in working order. Engine.		Engine and Tender.		Maximum weight on one axle.		Weights of Rails per yard. Iron.	Steel.	Weight of Steel Rail per yard, per ton on each wheel. Lightest Rail.	Heaviest Rail.	Remarks.	Authority for Weights of Engines.
	tons.	cwt.	tons.	cwt.	tons.	cwt.	lb.	lb.	lb.	lb.		
Central of New Jersey	55	6	......		19	14†	56 and 65	62, 62½, and 70	6·3	7·1	Runs regularly 70 to 90 miles per hour ...	*R. R. Gazette*, Feb. 12, 1892.
Baltimore and Ohio	59	8	93	6	15	14	60–80	67	8·5			„ „ Nov. 27, 1891.
New York Central	57	1	89	6	17	16†	none	65 and 80	7·4	9·0	Runs regularly Empire State Express, fastest train in the world.	„ „ Sept. 18 „
Philadelphia and Reading ...	50	0	......		17	0†	none	56, 58, 60, 64, 68, 70, 88, and 90.	6·6	10·6	Has run 91·7 miles per hour	„ „ Nov. 13 & 27, 1891
C.C.C. and St. Louis	58	13	92	19	15	6†	mostly steel	67	8·8			„ „ Jan. 1, 1892.
Erie	58	0	92	0	15	0† abt.	......	56–65	7·4	8·7		„ „ June 13, 1890.
Atchison, Topeka, and St. Fé ...	58	0	......		15	9†	(3095 miles)	56–65 (4015 miles)	7·2	8·4		„ „ Aug. 15 „
Chesapeake and Ohio	59	5	......		15	6	......	56, 62, and 75	7·3	9·8		*R. R. Journal*, July „
Master Mechanics	59	8	......		14	18†	......	......	......	......		*R. R. Gazette*, Jan. 8, 1892.
L. & N. W. R.	52	0	77	2	15	10	......	84–90	10·8*	11·6*		*Engineering*, Nov. 13, 1891.
North Eastern	46	13	86	13	17	15	......	? 90	......	10·1*	Has attained highest speed (86 miles per hour) ever attained in England.	*R. R. Journal*, May, 1890.
Great Northern	45	3	78	11	17	0	......	? 82	......	9·6*	Runs fastest trains in England last 20 years	*Engineering*, May 20 „
N.S.W. (10-wheeled Baldwin)...	58	7	90	6	15	5½	70 and 75	71, 75, and 80	9·2	10·4		
Eastern of France	54	18	97	1	16	2	......	69–89¼§	8·5	11·0	Running fast expresses	*Engineer*, March 4, 1892.

* As this Engine has the wheels and springs without equalizers, it is liable to have a considerably greater weight on the wheels.
† Average weight on each pair of coupled wheels.
§ The heavier rail has only been used of late years on parts of the line. The Engineer-in-Chief of the Permanent Way reports that 10% additional weight could be carried on the 69-lb. rail.

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B.

Report by Messrs. KIDD and POLLOCK on Trials with Baldwin Passenger Engine.

Sydney, May 21st, 1892.

To the Commissioners of Railways,

Gentlemen,

In compliance with your request we made a series of careful trials on May 15th with the ten-wheeled Baldwin engine, No. 447, to ascertain accurately the performance of the engine when hauling passenger vehicles up grades of 1-30 and 1-40, and have the honor to submit the following report.

The trials were made on a part of the line between Picton and Hill Top. The train was made up of Pullman sleeping cars and first-class lavatory carriages, and in every case weighed somewhat more than the stipulated loads. The Pullman sleeping cars were carried on six-wheeled trucks or bogies, and all the remaining passenger vehicles on four-wheeled bogies. All these wheels were 3 ft. diameter.

The general dimensions of the engine are as follows :—

Diameter of cylinder	21 in.
Stroke "	24 "
Diameter of drivers	61 "
Area of firegrate	27.7
" H. S. in firebox (copper)	105.6
" " tubes (brass)	1,822.5
Total Heating Surface	1,928.1

Tractive force per lb. of Mean Effective Pressure per □″ =	171.0 lb.*
Maximum boiler pressure	160 lb. □″
Total weight of engine in running order with $\frac{2}{3}$ glass of cold water and sand boxes full :—	

	T.	C.	T.	C.
Weight on driving wheels			43	11
" bogie "			14	16
Total weight of engine			58	7
Weight of tender empty	13	12		
" 3,000 gallons water ...	13	8		
" 5 tons coal	5	0		
Maximum weight of tender			32	0
Maximum weight in running order, engine and tender			90	7

The weight of the train was ascertained by weighing each vehicle on the previous day on an accurate weighbridge at Eveleigh. An addition varying from 2 tons to 1 ton 15 cwt. was made for the weight of the passengers carried.

The incline of 1-40, on which the trials No. 1, 2 and 5 were made, was $2\frac{1}{2}$ miles long, and there were four curves of 16 chains (1056 feet) radius on the first mile.

The incline of 1-30, on which the trials 3 and 4 were made, was about 2 miles along, having at the foot an incline of 1-33. The trials were made on the combined length $2\frac{3}{4}$ miles of these gradients. (See Appendix C.)

The position of these inclines is shown on the accompanying section. The train approached the foot of these gradients at about the speed usual in ordinary running.

The weather was fine, with a dry rail, and no slipping was observed throughout the trials.

The full train (179 tons 5 cwt.) was run from Sydney to Campbelltown by one engine, but two engines of the English express type (four wheels coupled with inside cylinders) were required to haul the train from Campbelltown to Picton over the 1-70 gradients between these points. It is noteworthy that the ten-wheeled Baldwin engine then took the same train unassisted over the 1-40 gradients between Picton and Picton Lakes, thus very clearly demonstrating its superior power.

The first trial was made with a load of 179 tons 5cwt. up a grade of 1-40. The indicated horse power developed and tractive force exerted during the trial being as follows :—

* Allowing a deduction for the area of the piston rod. Without this deduction the tractive co-efficient is 173·5 lb.

TABLE I.

FIRST TEST UP 1-40. MAY 15TH, 1892.

	Tons.	cwt.	qrs
Actual load, exclusive of engine and tender	179	5	2
Stipulated load, as per letter to Baldwin Works, September 22, 1890	176	0	0
Excess of actual over stipulated load	3	5	2

No. Indicator Card.	Mile post, where taken.	Speed in miles, per hour.	Boiler Pressure. lb.	Initial Pressure.	M.E.P. lb.	I.H.P.	Tractive Power. lb.	Frictional Resistance in pounds per ton of whole train.
1	$54\frac{1}{8}$	31·0	155	139·5	63·4	996	10,841	-16·1
2	$54\frac{5}{8}$	22	155	139·5	95·6	959	16,347	-4·62
3	$54\frac{7}{8}$	19·56	155	144·0	103·4	922	17,681	9·51
4	$55\frac{1}{8}$	17·47	150	140·0	105	838	17,955	10·59
5	$55\frac{5}{8}$	17·64	150	138	102·8	826	17,578	9·18
6	$55\frac{7}{8}$	17·00	147	137 0	105·5	817	18,040	10·9
7	$56\frac{1}{8}$	15·93	140	134	102·0	740·9	17,442	8·78
8	$56\frac{3}{8}$	15·79	135	127·5	101·0	728·0	17,271	8·05

The accompanying tables give an analysis of the performance of the engine during the trials. It will be seen that the boiler pressure was better maintained on the 1-30 than on the 1-40 gradient. This is probably attributable wholly to the difference in the condition of the fire; the engine commenced the ascent of the 1-40 gradient after running down hill slowly tender first and standing for some time at Picton. The fire thus became partially dead, and was not thoroughly ignited in the short distance run before reaching the gradient. In ordinary working this would not occur, as the firemen usually take the opportunity of building up the fire and getting it in good condition for rapid steaming when approaching a heavy gradient.

The engine approached the 1-30 gradient after having run for some miles on slightly rising gradients, the blast had consequently thoroughly ignited the fire and the engine maintained steam, and in some cases showed an increase of speed and tractive power towards the summit. Had the engine been running the regular mail or express trains she would have approached the 1-40 gradient under the same condition, and would doubtless have carried a higher pressure and obtained a higher speed, especially on the trial with a load of 157 tons up 1-40.

The distance run on the trials was 21 miles 10 chains.

The coal used was (Metropolitan) of fair quality, and the total amount burned 91 cwt. 2 qrs. 21 lb.=82·38 lb. per mile.

TABLE II.

SECOND TEST UP 1-40.

	Tons.	cwt.	qrs.
Actual load, exclusive of engine and tender	157	12	2
Stipulated load, as per letter to Baldwin Works, September 22, 1890	152	0	0
Excess of actual over stipulated load	5	12	2

No. Indicator Card.	Mile post, where taken.	Speed in miles, per hour.	Boiler Pressure. lb.	Initial Pressure. lb.	M.E.P. lb.	I.H.P.	Tractive Power. lb.	Frictional Resistance in lb. per Ton of Whole Train.
9	54¼	29·8	155	141·5	56·8	772	9,712	–16·8
10	54⅝	21·43	150	139	79·4	776	13,577	–1·09
11	54⅞	19·147	145	134	91·7	801	15,680	+ 7·22
12	55	18·75	145	136	94·7	808	16,193	9·3
13	55⅜	18·55	150	138·5	101·12	855	17,291	13·7
14	55⅝	18·75	150	139·0	95·4	815	16,313	9·77
15	56⅛	19·35	150	138·5	98·43	872	16,829	11·859

TABLE III.

THIRD TEST UP 1–33 and 1–30.

	Tons.	cwt.	qrs.
Actual load, exclusive of engine and tender	121	19	2
Stipulated load, as per letter to Baldwin Works, September 22, 1890	120	0	0
Excess of actual over stipulated load	1	19	2

No. of Indicator Card.	Mile post, where taken.	Speed in miles, per hour.	Boiler Pressure lb.	Initial Pressure. lb.	M. E. P. lb.	I. H. P.	Tractive Power. lb.	Frictional Resistance in lb. per ton of whole train.
			Grade 1–33.					
16	65⅞	30·5	160	143	58·4	812	9,986	–20·85
17	66⅛	26·08	160	147	85·55	1017·3	14,629	+ 1·01
18	66⅜	21·95	150	140	92·5	925·6	15,817	6·6
			Grade 1–30.					
19	66⅝	20·45	155	142	97·85	912·0	16,732	4·12
20	67	17·64	155	144	107·5	864·7	18,382	11·8
21	67⅜	17·45	160	144	106·6	849·8	18,228	11·17
22	67⅞	16·82	155	145	109·7	841·8	18,758	13·6
23	68⅛	17·47	155	142	108·4	863·5	18,536	12·6
24	68⅜	18·18	150	136	103·8	860·	17,749	8·9

TABLE IV.

FOURTH TEST UP 1-33 AND 1-30.

	Tons	cwt.	qrs.
Actual load, exclusive of engine and tender	144	2	2
Stipulated load, as per letter to Baldwin Works, September 22, 1890	144	0	0
Excess of actual over stipulated load	0	2	2

No. of Indicator Card.	Mile post, where taken.	Speed in miles, per hour.	Boiler Pressure. lb.	Initial Pressure. lb.	M. E. P. lb.	I. H. P.	Tractive Power. lb.	Frictional Resistance in lb. per ton of whole train.
				Grade 1-33.				
25	$65\frac{7}{8}$	31·57	160	138·5	61	878	10,431	– 23·1
26	$66\frac{1}{8}$	25·35	155	141·5	89·1	1029	15,236	– 2·12
27	$66\frac{1}{2}$	19·56	155	141·0	95·35	850	16,304	+ 1·9
28	$66\frac{5}{8}$	18·75	155	143·5	104·8	896	17,920	8·8
				Grade 1-30.				
29	$66\frac{7}{8}$	16·82	155	144	112	860	19,152	7·4
30	$67\frac{1}{8}$	15·38	155	145	116	815	19,836	10·3
31	$67\frac{5}{8}$	15·65	...	145	113	807	19,323	8·73
32	$67\frac{7}{8}$	14·87	155	145·5	114·3	774·5	19,545	8·22
33	$68\frac{1}{8}$	14·81	160	140	112·5	750	19,237	7·7
34	$68\frac{1}{4}$	14·062	150	145·5	113·9	730·3	19,476	8·7
35	$68\frac{3}{8}$	14 4	155	146	114·9	754·5	19,647	9·32
36	$68\frac{1}{2}$	14·7	145	137·5	112·85	756·4	19,297	8·00

TABLE V.

FIFTH TEST UP 1–40.

	Tons.	cwt.	qrs.
Actual load, exclusive of engine and tender	157	12	2
Stipulated load, as per letter to Baldwin Works, September 22, 1890	152	0	0
Excess of actual over stipulated load	5	12	2

No. Indicator Card.	Mile post, where taken.	Speed in miles, per hour.	Boiler Pressure. lb.	Initial Pressure. lb.	M.E.P. lb.	I.H.P.	Tractive Power. lb.	Frictional Resistance in lb. per ton of whole train.
37	$54\frac{1}{4}$	31	155	141·5	54·9	776	9,387	–18·15
38	$54\frac{3}{8}$	26·86	150	140	77·9	954	13,320	–2·29
39	$54\frac{3}{4}$	20·93	150	136	93·2	889	15,937	8·26
40	$54\frac{7}{8}$	21·17	150	136·5	91·8	866	15,697	7·29
41	$55\frac{3}{8}$	19·56	155	139	96·7	862	16,535	10·67
42	$55\frac{5}{8}$	20·22	155	139·5	99·8	920	17,065	12·81
43	$55\frac{7}{8}$	19·78	150	135	97·15	870	16,612	10·98
44	$56\frac{3}{16}$	20·0	145	130	97·0	884·6	16,587	10·88
45	$56\frac{3}{8}$	20·93	140	118·5	88·46	844	15,126	4·99

The indicator diagrams were taken by means of a "Crosby" indicator. The L. H. diagrams are from the front end of the cylinder and the R. H. diagrams from the back. The pipes connecting the cylinder ends and the indicator were of copper, 1in. diameter, reduced to ½-inch where they joined the breeches piece. They were carefully lagged with asbestos and spun yarn. We regret that the position and design of the cylinder necessitated these pipes being so long, viz., about 4ft. 11in. at the front end and 5ft. 6in. at the back, and we are of opinion that an allowance of 5 per cent. should be added to the mean pressure indicated on the cards to allow for friction and condensation. In support of our opinion we would refer to some trials reported in the Proceedings of the Institute Mechanical Engineers, England, January, 1890, in which 10 per cent. was considered a fair allowance, and in this case the pipes were only 3ft. long, as against pipes 5ft. long.

On the evening previous to the trials we rode on the engine from Picton to Campbelltown, attaining a speed of about 45 miles per hour. The engine ran very steadily and took the curves very smoothly, there being a noticeable absence of shock on entering the curves.

In conclusion, we would observe that we consider the engines to be very satisfactory in design and workmanship, while the haulage power and steadiness in running leave nothing to be desired.

We would further observe that the maximum tractive power obtained on the trial of 1-30, viz., 19,836lb., exceeded the maximum recorded in the trial of the Baltimore and Ohio engine (viz., 19,064lb.), which is nearly four tons heavier and has larger heating surface and cylinder capacity.

We beg to enclose four packages, containing in all 45 indicator cards, being the originals taken during each test.

We have the honor to remain,

Gentlemen,

Yours obediently,

HECTOR KIDD, A.M.I.C.E., M.I.Mch.E.

ROBT. POLLOCK, President Engineering Association.

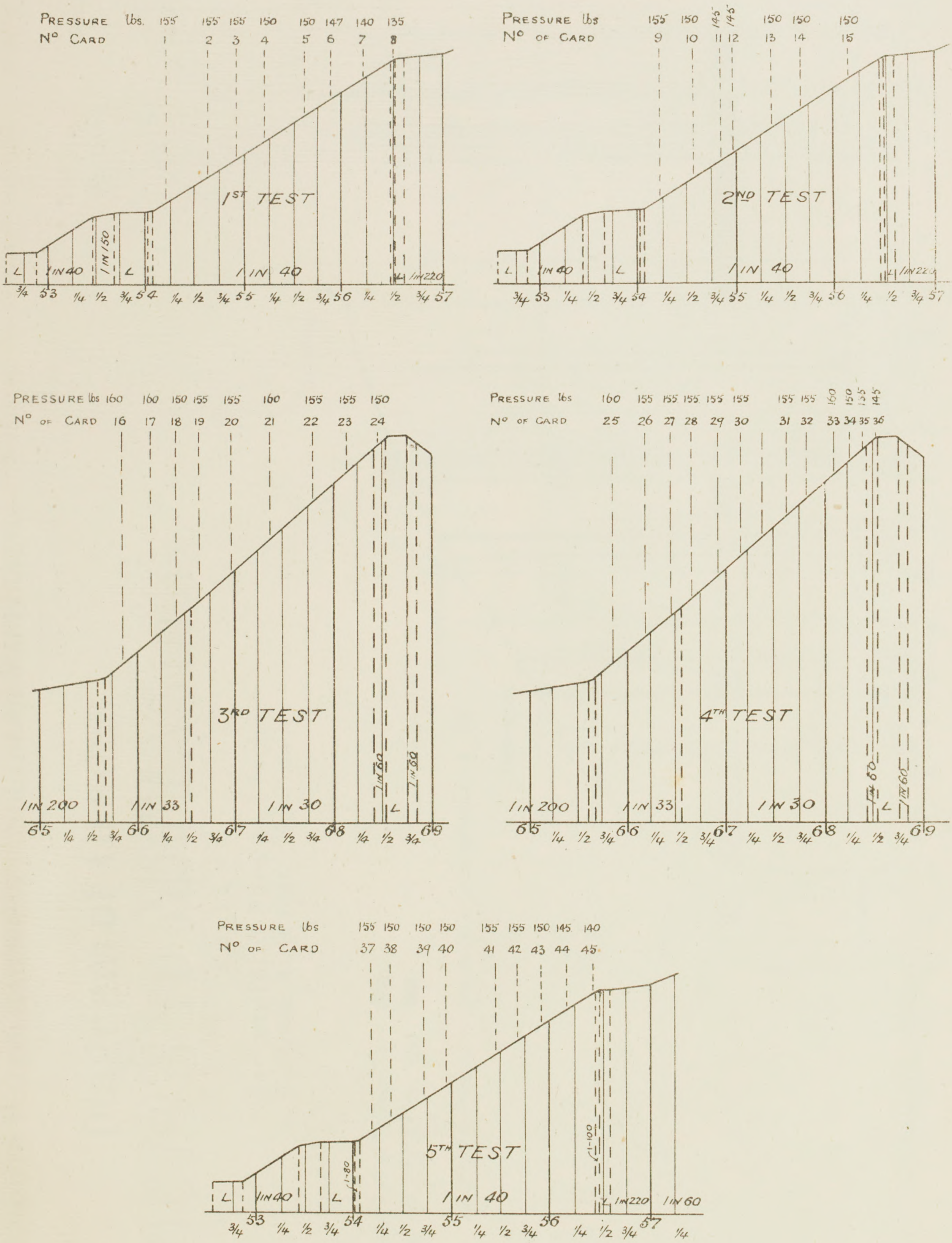
C

— Appendix to report by Messrs Kidd & Pollock —

— DIAGRAM OF GRADE —

SHOWING WHERE INDICATOR CARDS WERE TAKEN

AND CORRESPONDING BOILER PRESSURE



4u1217-92(h) (Sig. 6)

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SYDNEY, NEW SOUTH WALES.

(CC)

New South Wales Railways (Southern Main Line)

Diagram of Grades

PICTON TO MITTAGONG

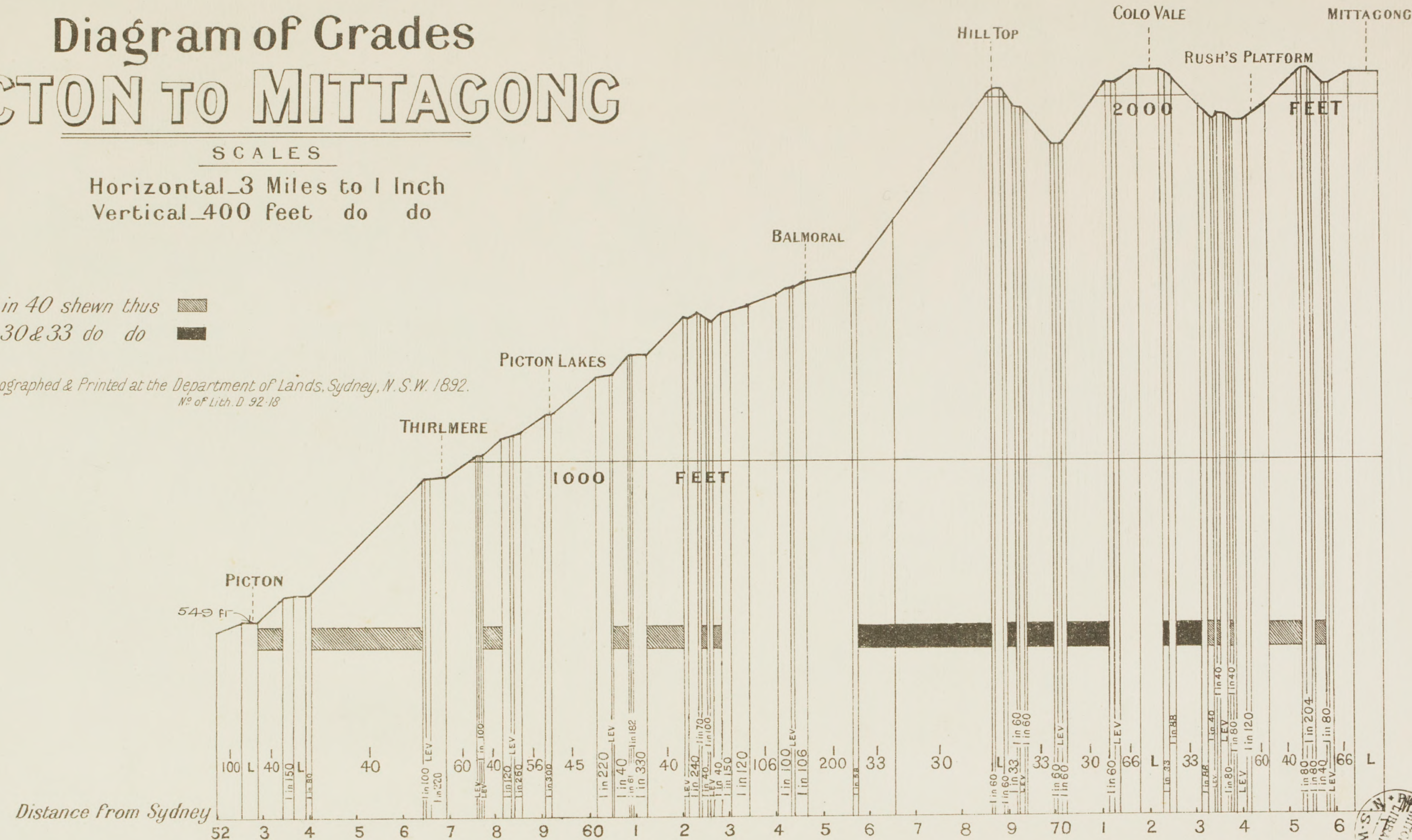
SCALES

Horizontal_3 Miles to 1 Inch
Vertical_400 feet do do

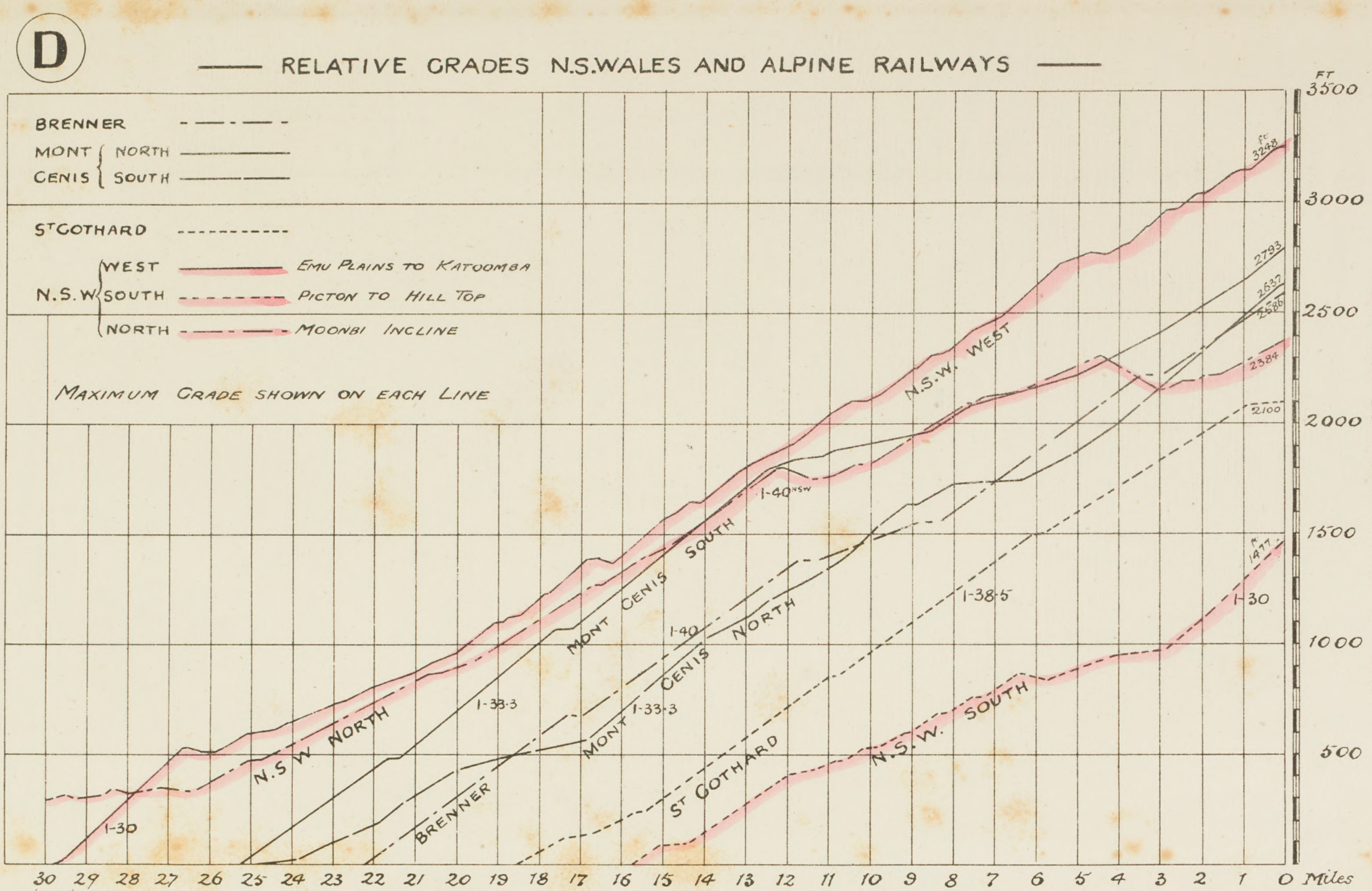
NOTE

Grades 1 in 40 shewn thus [hatched bar]
do 1 in 30 & 33 do do [solid black bar]

Lithographed & Printed at the Department of Lands, Sydney, N.S.W. 1892.
No. of Lith. D 92-18



RELATIVE GRADES N.S.WALES AND ALPINE RAILWAYS



Information re Alpine Railways taken from Paper by J. L. Vernon Harcourt, Proceedings Institute Civil Eng^rs Vol. XCV.

401217-92(a)

PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE,
SYDNEY, NEW SOUTH WALES.

D

(E)

N. S. W. R.

WESTERN LINE

DIAGRAM OF GRADES

PENRITH TO BATHURST

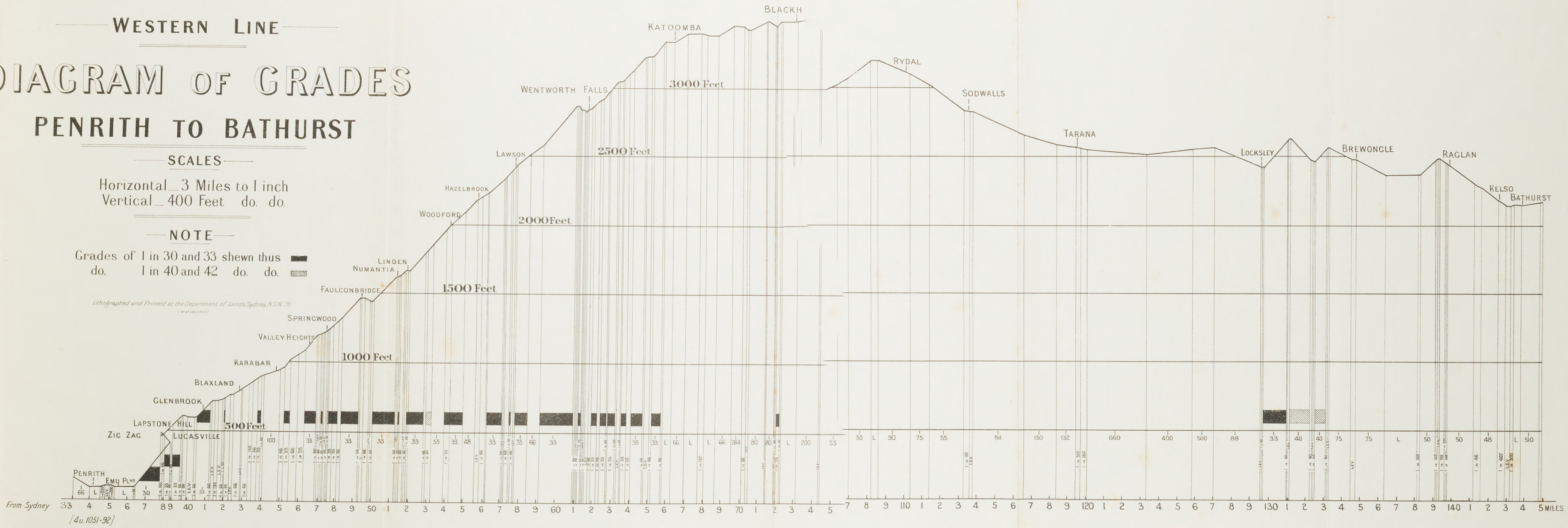
SCALES

Horizontal _ 3 Miles to 1 inch
Vertical _ 400 Feet do. do.

NOTE

Grades of 1 in 30 and 33 shewn thus ▬
do. 1 in 40 and 42 do. do. ▨

Lithographed and Printed at the Department of Lands, Sydney, N.S.W. '92



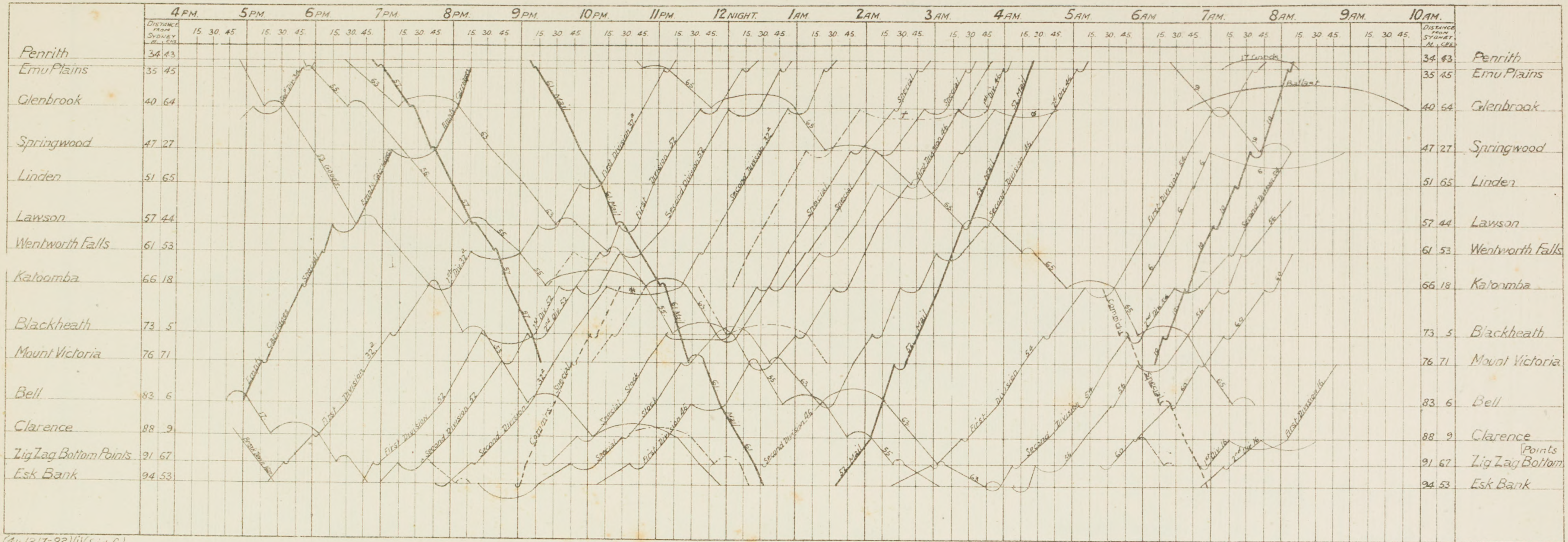
Passenger Trains thus	———
Goods Trains and Stock Trains thus	———
Light Engines thus	—·—·—
Commrs Specials thus	- - - - -

F

N.S.W.C.R^ys

Diagram shewing Running of Trains between Penrith and Eskbank and vice versa

Between 5 pm. on 27th and 8 am. on 28th April 1892.



(4u 12(7-92)(i)(Sig 6)

‡ Crossing Nos 55, 63 & 61 Down Trains.

†. Waiting to take forward Live Stock put off by Trains reducing their load at Glenbrook

Ø. Shunting off Coal and picking up Live Stock

PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE,
SYDNEY, NEW SOUTH WALES.

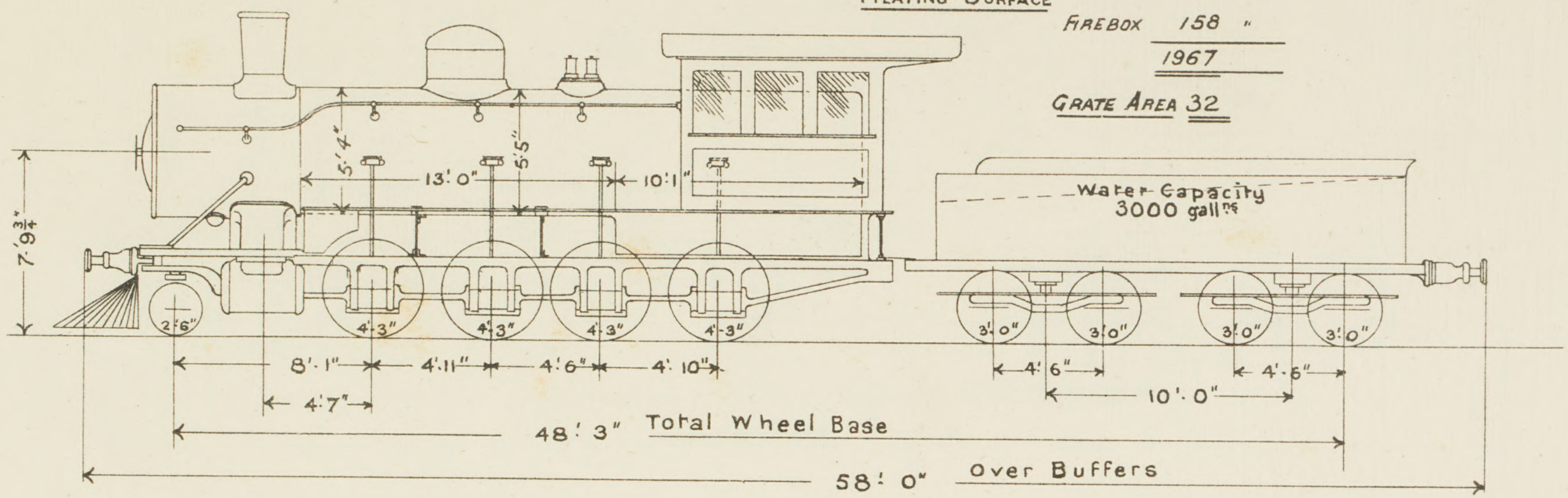
G

CONSOLIDATION GOODS. — BUILT BY THE BALDWIN COY.

Engines Class J. (483)

HEATING SURFACE: TUBES 1809 □Feet; FIREBOX 158 "; 1967

GRATE AREA 32



NOTE:- THE TWO MIDDLE PAIRS OF COUPLED WHEELS ARE FLANGELESS

Cylinders 21" × 26" Stroke

	EMPTY (T · C · Q)	RUNNING ORDER (T · C · Q)
Weight Engine	55 · 15 · 3	62 · 12 · 2
" Tender	13 · 12 · 0	32 · 0 · 0
" Total	69 · 7 · 3	94 · 12 · 2

Total weight on 4 sets of driving wheels when loaded. T C Q lb 56.15.3.0

(Sig. 6) ×

4u/217–92(b).

PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE, SYDNEY NEW SOUTH WALES.

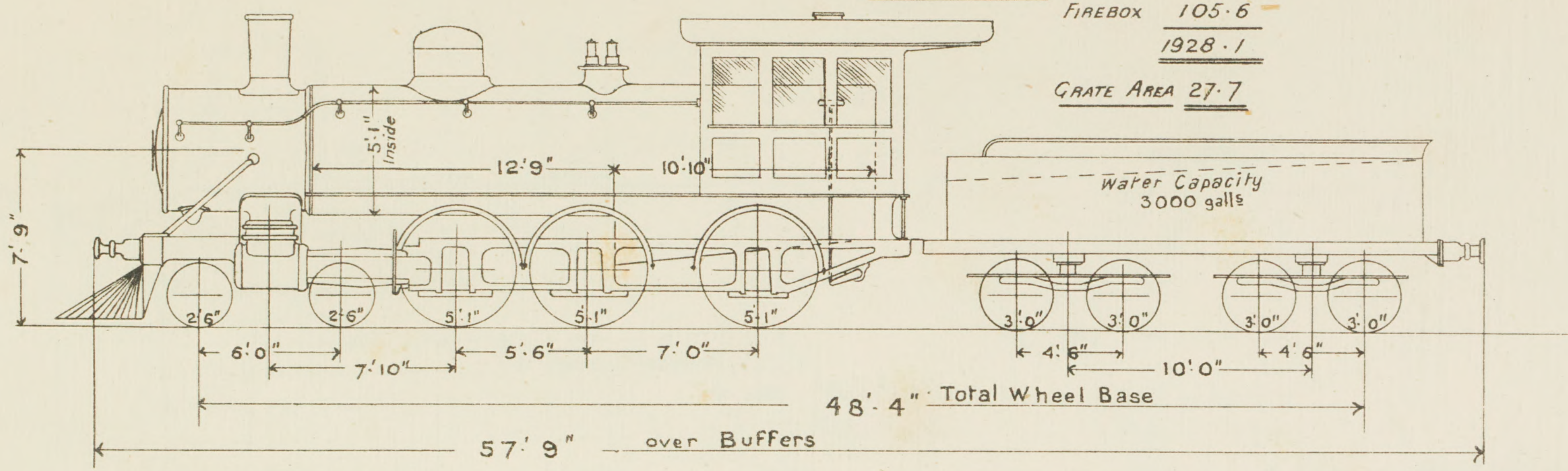
H

10 WHEELED EXPRESS.— BUILT BY THE BALDWIN COY.

Engines Class O

HEATING SURFACE
TUBES 1822·5 □ Feet
FIREBOX 105·6
1928·1

GRATE AREA 27·7



NOTE: THE CENTRE PAIR OF COUPLED WHEELS ARE FLANGELESS

Cylinders 21" × 24" Stroke

	EMPTY T C Q	RUNNING ORDER T C Q
Weight Engine	51 · 5 · 0	58 · 7 · 2
" Tender	13 · 12 · 0	32 · 0 · 0
" Total	64 · 17 · 0	90 · 7 · 2

Total weight on 3 sets of driving wheels when loaded 43 T . 11 C . 0 Q . 0 lb

H. S. Yogan.

Sig 6. ×

4u1217-92(c)

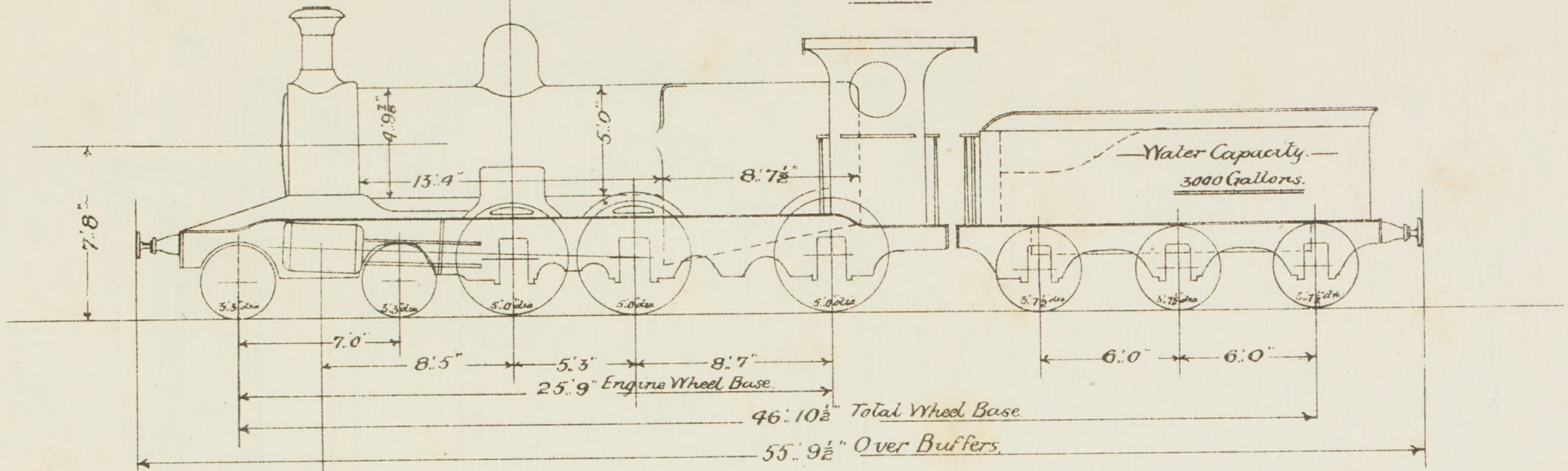
PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE,
SYDNEY, NEW SOUTH WALES.

10 WHEELED (ENGLISH) EXPRESS, BUILT BY MESSRS BEYER, PEACOCK & Co

1

—— *Engines Class "P"* ——

Heating Surface { *Tubes* 1786 ft² / *Fire-box* 130 " }
Total 1916 "
Grate Area 27 "



Weight Empty — 13-14-2 — 12-5-3 — 12-5-1 — 12-1-2 — 5-2-3 — 5-3-0 — 5-1-0 — *Total Weight Empty* — 65-13-3.

in Steam — 7-4-0 — 7-9-2 — 14-10-3 — 14-13-0 — 12-13-2 — 10-13-0 — 10-13-0 — 10-10-1 — *do. — in Steam* — 88-7-0

—— *Cylinders* — 20" dia x 26" stroke ——

—— *Coal Capacity* — 4½ Tons ——

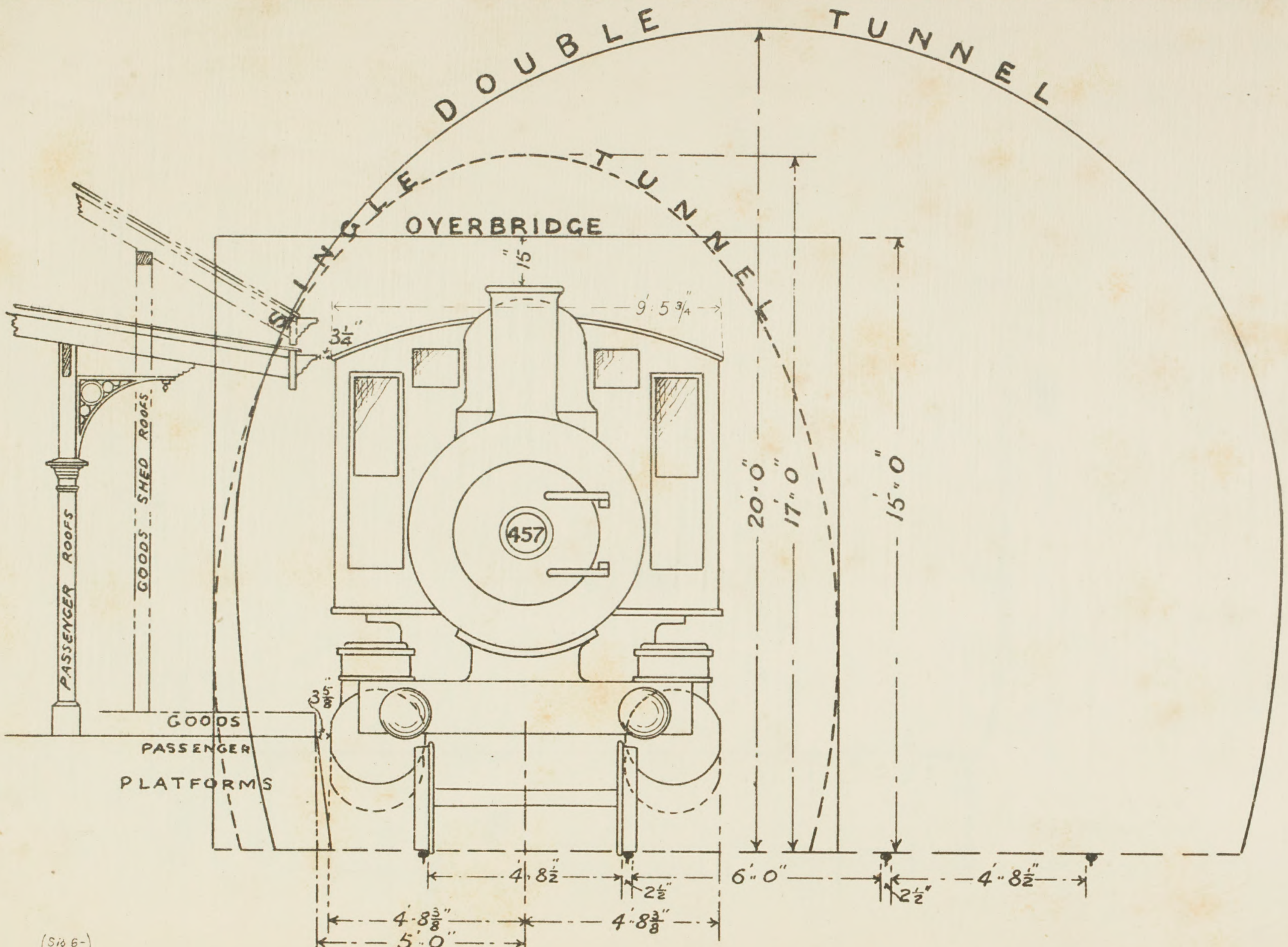
(Sig 6) -

4u1217-92(F)

PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE,
SYDNEY, NEW SOUTH WALES.

W. Thow

(K) Diagram, shewing Profile of Baldwin Engines, in Connection with the existing Structures throughout the Railway System.



4u 1217-92 (g)

(Sig 6-)

Sydney
N.S.W.
11-5-92

DIAGRAM

SHOWING "MANN CAR"

Ordered prior to the Commissioners taking Office

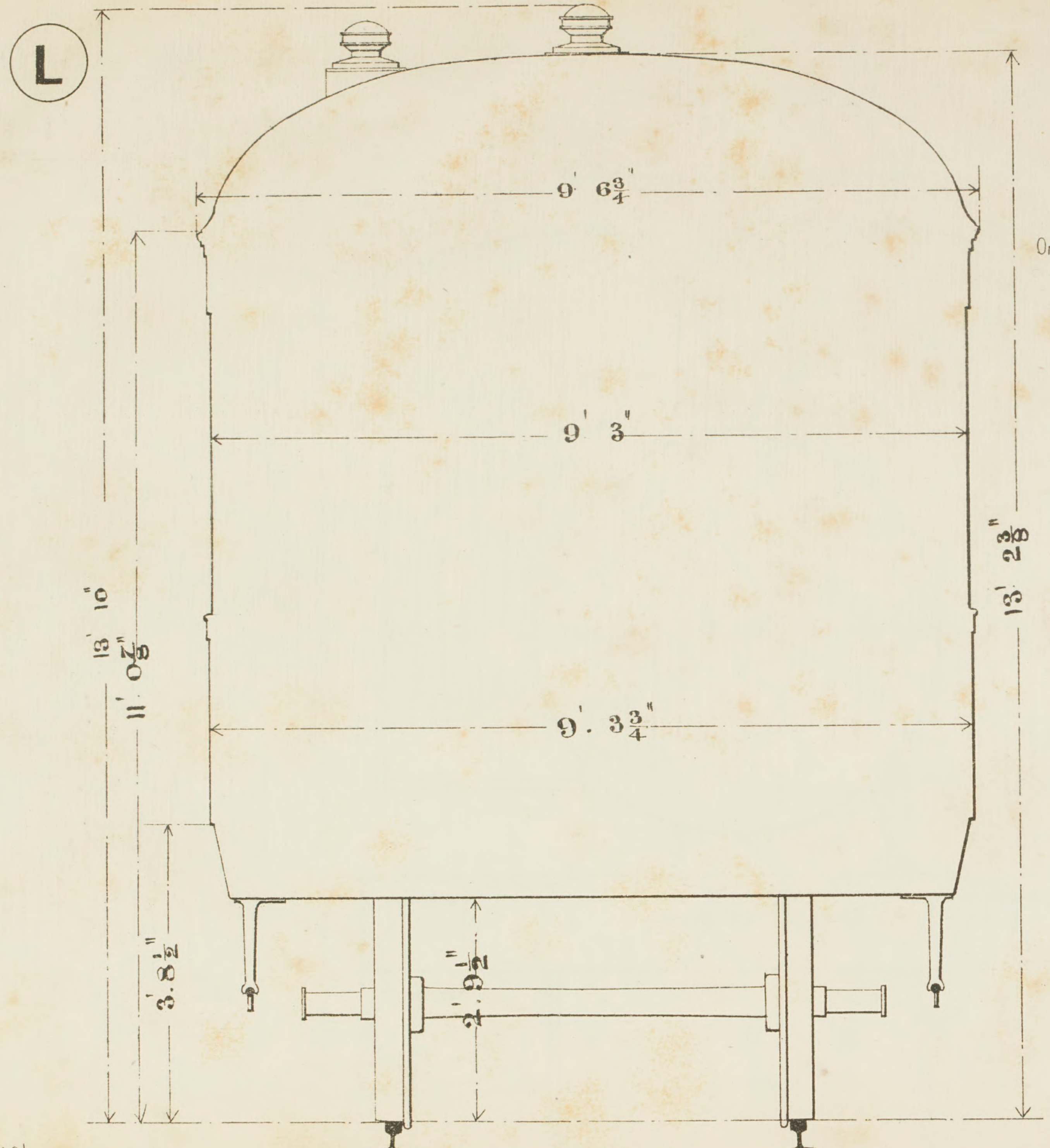
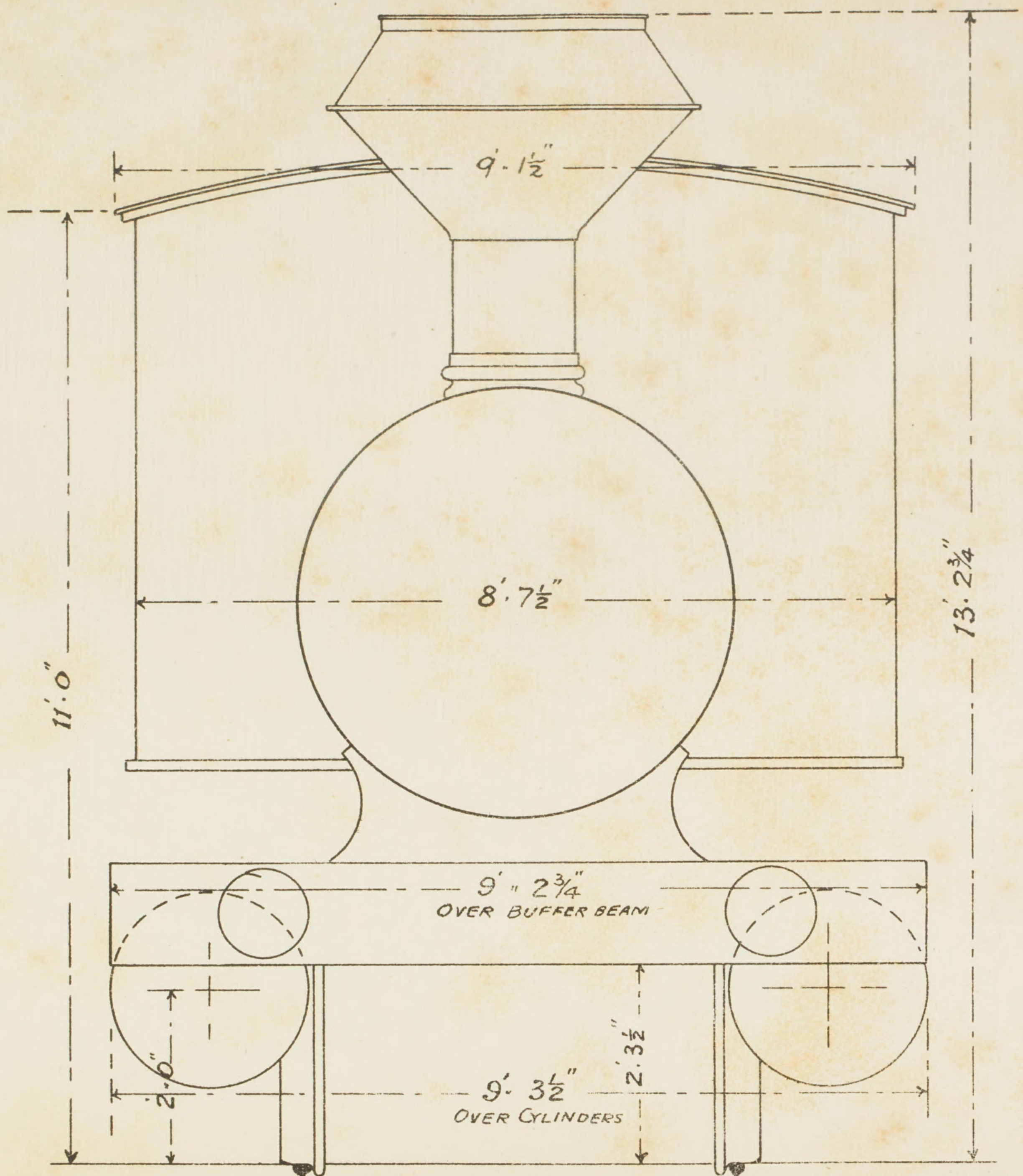


Diagram of Engine No. 132 Class J.

(Running upon some portions of the lines since 1879.)

M



4u1217-92(d) (Sig 6.)