PART II.

PAPERS.

9TH MARCH, 1899.

ADDRESS BY THE PRESIDENT.

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More often than not the Presidential Address delivered before scientific societies is a resume of the advance made in engineering and science during the previous twelve months, although it very often represents a vast amount of labor in obtaining the necessary data and information and ability in its compilation, the result, though interesting, is generally not original, as the subjects dealt with are more or less known to the members.

I may say that I gave considerable thought to the question of what subject I should deal with in my address to you to-night, and ultimately came to the conclusion that I could not do better than take as my theme the one I am most conversant with, viz., Railway engineering in New South Wales, a subject that has never yet been brought before this Association, and which I trust, will prove of interest to you.

In opening the subject I feel some diffidence, as my time has been devoted to hard practical working, and scientific deductions which will probably be expected in

an address to this Association, have not come within my experience; I hope, therefore, you will allow me to devote myself rather to plain facts, and to speak from an experience in mechanical engineering, spread over a period of 46 years, nearly 35 of which have been spent on the N.S.W. Government Railways.

We practical men, I am afraid, get somewhat discounted in these day of—well, I might almost say "Rougemont" scientists—but at the same time I claim we have "kept our end up," and followed along where sensible improvements were being made in mechanical appliances.

The first combined movement on the subject of introducing railways into N.S.W., took place in January, 1846. On the 29th of that month a public meeting was held in Sydney for the purpose of considering the expediency and practicability of establishing railways in the colony. A provisional committee was appointed to collect information on the subject, and in August of the same year a report was made that from the best ascertainable data as to products, population, and the traffic between Sydney and Goulburn, and the existence of no insurmountable engineering difficulties, the cost of construction would not exceed £6,000 per mile, and that a return of 8 per cent. on the required capital could be anticipated. A petition was presented to the Legislative Council on April 4th, 1848, a select committee being appointed, and after consideration they recommended that as the time had arrived for the formation of railways in the Colony, some inducement be offered to encourage private enterprise, such as grants of land along the lines, a guarantee of 6 per cent. per annum on the first £100,000 of the capital subscribed, and the investment of £30,000 from the Savings Bank in any company that might be formed. These proposals were laid before the Secretary of State by the Governor,

and in November, 1848, the Sydney Tram Road and Railway Company was formed, with a capital of £100,000 in £5 shares. The expressed intention of the promoters was that the first line should be laid in the County of Cumberland, commencing from the City of Sydney, or its immediate vicinity, and that the main trunk lines should be carried to a point from which it might afterwards be determined that the Southern, Western, and North-Western Branches should diverge, and that those branches be extended as far as the funds of the Company would permit.

I had the opportunity, nearly forty-nine years ago, of seeing the first sod turned of the N.S.W. Railways. This event took place on the 3rd of July, 1850, and the ceremony was performed by the Hon. Mrs. Keith Stewart, in the presence of her father, the Governor, Sir Charles Augustus Fitzroy, and a large concourse, consisting of the civil, military, and naval officers, and other inhabitants of the Colony I was a lad then, and did not speculate as to the ultimate result of the ceremony I had that day witnessed, or of the immense advantages that would accrue to the Colony from the system of railways then inaugurated. Fourteen years after (1864) I joined the N.S.W. Railways, and I can with profit refer to the advancement that has taken place in mechanical appliances since that time.

Although the first sod was turned at what is now Redfern Station, the first contract was for 4½ miles from Haslam's Creek (now Rookwood) towards Sydney. A tender was accepted for the construction of that part of the line at the rate of £10,000 per mile, but soon after gold was discovered, and the revolution in the prices of labor and material compelled the contractor to give up his contract, and caused the company considerable trouble.

Tenders were called for the other portions of the line, but no offers were received, and it was considered advisable to commence near Sydney, an offer being accepted to perform certain works between Cleveland Paddocks (now Prince Alfred Park) and the village of Ashfield at schedule prices. The contractor commenced his operations on August 9th, 1852, and on October 14th, 1852, the company applied to the Government for assistance, which was given; and three Government directors were appointed.

On April 20th, 1853, a meeting was held in Newcastle for the purpose of forming a railway company, and the Hunter River Railway Company was formed, with a capital of £100,000. This company was granted thirty acres of land at Bullock Island for a terminal station A tender was accepted for the construction of the line from Honeysuckle Point to Hexham, at schedule prices.

After an existence of little more than a year, this company, like the Sydney one, had to yield to the pressure of the times, and the whole was taken over by the Government.

On August 14th, 1855, the Government Directors or Commissioners accepted a tender for the construction of the line from Hexham to East Maitland, at £10,000 per mile.

The line from Sydney to Parramatta was opened for traffic on September 26th, 1855, just twenty-five years after the opening of the first railway in England; the line from Liverpool to Manchester being opened for traffic on the 16th September, 1830.

The extension to Liverpool was opened on September 26th, 1856, just twelve months after the opening of the first line. This line differed from the Sydney line, it being laid with double-headed rails.

LOCOMOTIVES.

The first four locomotives were built by R. Stephenson & Co., and for the conveyance of passengers and goods, these engines were considered larger than necessary, their great weight rendered them most objectionable for the passenger traffic, for which they were chiefly used, and engines of one-half their weight would have been quite sufficient to run ordinary passenger trains, which consisted of six carriages and a luggage van.

At the time I entered the Railway Service, in 1864, the N.S.W. railway system was a small concern, the number of engines had increased from four at the opening to twenty-five engines—13 at Sydney and 12 at Newcastle—but these engines were of a smaller type than those first imported. I may briefly say that at that time the mileage in operation totalled 143 miles, 19 miles having been opened in that year; to-day, we have the not inconsiderable length of 2,705 miles. The gross earnings in 1864 were £147,654; the last financial year showed a result of £3,026,748, and from the last half-yearly report furnished recently, it would appear that an increase of at least £100,000 on those figures may be expected for the present financial year.

The table on page 6 shows the number of passengers, tonnage of goods, earnings and working expenses on the N.S.W. Railways during the years 1855 and 1858 inclusive, and for each of the succeeding ten years, viz., 1868-78-88-98

The first locomotive which at present occupies a place at the Technological Museum, Sydney (Plate I.) differed little from the machine that first attracted my attention and care when I entered the Railway Service a few years after the opening of the lines.

The standard if we could be considered to have standards in those days, was a four wheel coupled ten-

Year.	Length of Line, 31st December.	Number of Passengers.	Tonnage of Goods.	Train Mileage.	Earnings from Coaching Traffic.	Earnings from Goods Traffic.	Total Earnings.	Working Expenses.	Earnings per Train mile.	Working Expenses per Train mile.	Percentage of working expenses to gross earnings.	Net earnings.	Capital Invested on Lines open.	Interest on Capital.
	Miles.				£	£	£	£	Pence.	Pence.	Per cent.	£	£	p. cent
1855	14	98,846	140	14,107	9,093	156	9,249	5,959	167·34	101·37	64·43	3,290	515.347	·638
1856	23	350,724	2,469	68,371	29,526	2,757	32,283	21,788	113·32	76·48	67·49	10,495	683,217	1·536
1857	40	329,019	20,847	107,822	34.470	8,417	43,387	31,338	96·58	69·75	72·23	12,050	1,023,838	1·176
1858	55	376,492	33,385	141,495	45,858	16,451	62,309	43,928	105·69	74·51	70·50	18,381	1,231.867	1·493
1868	247	714,563	596,514	768,529	99,408	12,495	224,359	144,201	70·06	45·03	64·29	80,158	4,060,950	19·72
1878	688½	3,705,733	1,625,886	2,655,176	306,308	596,681	902,989	536,988	81·62	48·54	59·47	366,001	9,784,645	3·741
1888	2,171	16,086,223	3,485,839	7, 41,769	1,025,601	1,512,876	2,538,477	1,634,602	79·72	51·34	64·39	903,874	29,839,167	3·14
1898	2,691¼	23,233,206	4,630,564	8,340,338	1,126,257	1,900,491	3,026,748	1,614,605	87·10	46 46	53·34	1,412,143	37,719,402	3.75

der locomotive, wheels 5ft 6in. in diameter, and the cylinders 16in, x 24in. The engine and tender in working order weighed 104,076 lbs. or 46 tons 9 cwt., the tractive power being 8,937 lbs, particulars of which are as follows:—

No. 1 Engine, built by Stephenson & Sons. Makers' number, 958.
Commenced to run on New South Wales Railways, May, 1855.
Worn out and removed from service, 1877.
4 wheels coupled—diameter of wheels, 5ft. 6in.
Cylinders, 16in. x 24in.
Working boiler pressure, 120lbs. per square inch.
Wheel base of engine, 14ft. 6in.

	T.	cwt.	qrs.
Weight of engine in steam	26	1	1
Weight of tender in steam	20	8	0
Total weight	46	9	1

Total mileage run by engine from May, 1855, to May, 1877, when the engine was removed from service .. .. 383,636 miles.
First driver, W. Sixsmith.
First fireman, W. Webster.
Cost of engine .. .. £3,083 17s.
(One of four engines.)
Tractive power of engine, 8,937lbs.

The first of these engines, old No. 1, commenced to run on these lines in May 1855 being used by the Contractor for ballasting before the lines were opened for traffic, and worked continuously until May 1877 when it was withdrawn from service, after having run 383,636 miles.

Since then the evolution of the Locomotive has been comparatively small, in regard to main parts, the tendency has been to enlarge on main principles, and to build machines more powerful year by year. Of course as engineers we must be guided by commercial considerations and it has always seemed to me that more advancement might have been made in mechanical appliances if we had not to study so closely the economi-

cal effects of improvements, and the necessity to design our machines solely with a view to meeting the demand of purely commercial requirements.

We practically have made little change in our locomotives since I took a personal interest in them, except to give more power to enable them to haul greater loads. The latest type of engine (particulars and illustrations of which are as follows) was designed by the Chief

AUSTRALIAN CONSOLIDATION ENGINE (DESIGNED, 1894).

PRINCIPAL DETAILS.

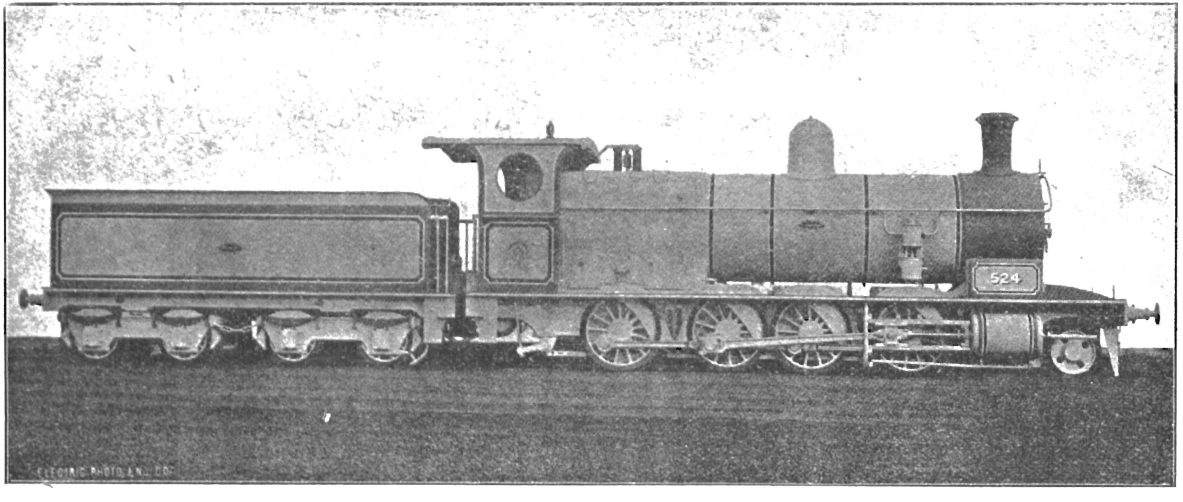
	ft.	in.
Diameter of bogie-wheels...	2	9½
Diameter of coupled wheels	4	3
Cylinders, 21 in. diameter by 26 in. stroke.		
Heating surface: Tubes, 2032 sq. ft.		
Firebox, 166 sq. ft.		
Total, ...	2198 sq. ft.	
Total grate area ...	29¾	,,
Boiler pressure, 160 lb. per sq. in.		

Weight in working order—

	t.	c.	q
Bogie (two wheels) ...	6	6	0
Leading do. (coupled)	14	2	0
Intermediate wheels (coupled)	15	10	0
Driving	15	9	0
Trailing	14	8	0
Total	65	15	0
Tender	41	10	0
Total engine and tender	107	5	0

Water capacity, 3650 gallons.
Coal ,, 6 tons.

	ft.	in.
Wheel base of coupled wheels	15	0
Total ,, engine	23	2
,, ,, tender	16	0
,, ,, engine and tender	51	10
Total length over buffers	60	3½
Centres of cylinders transversely	7	0
Width over cylinders	9	2¾
Height of centre of boiler above rails	7	8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ELECTRIC PHOTO. & N. CO.

HAULAGE POWER (EXCLUSIVE OF ENGINE AND TENDER.

Grade.	Tons.	Speed per hour.
1 in 43	354	13¾ miles.
1 in 70	697	7½ miles.
1 in 100	697	15 miles.

Tractive power of Engine, 28,777 lbs.

Mechanical Engineer Mr. W. Thow, and is a heavy consolidated engine, class "T" of which there are 20 now at work and 25 others under construction in England. The total weight of the engine and tender in working order is 240,240lbs. or 107 tons 5 cwt., of which 133,168lbs. rest on the coupled wheels, and 14,112lbs. on the bogie wheels.

The engine loaded weighs 92,960lbs, the tractive power of the engine being 28,777lbs. as compared with that of the first engine of 8,937 lbs., and it is capable of hauling behind the tender a load of 700 tons on a grade of 1 in 70, or in other words the engine we had in 1864 and which on the same grade modestly pulled its 215 tons has grown to a huge fellow that runs up with 700 tons, and from this it will be seen that one of these locomotives will take a load equal to what would have been taken by 3¼ of the old type of locomotives.

The consumption of coal averages 80¼lbs., per engine mile, which must be regarded as satisfactory, considering the heavy loads hauled and the steep grades met with on the N.S.W. Railways.

While on the subject of heavy locomotives, I would like to make passing reference to the largest locomotive yet built and which was described recently in the American and English Engineering papers. This Locomotive was built by the Pittsburg Locomotive Works for the Union Railroad, which is a part of the Carnegie System connecting the Homestead Steel Works and

the Edgar Thompson Steel Works, and extends nominally from Munhall to North Bessemer, Pa, a distance of about 12 miles. Four miles of the line has a grade of 1 in 75 while for about 2,000 feet there is a grade of 1 in 42.

The engine is of the consolidated type—8 wheels coupled and the principal dimensions taken from the November 1898 number of the "Locomotive Engineering" are as follows:—

Gauge	4ft. 8½in.
Cylinders	23in. dia. x 32in. stroke
Heating Surface:	
Tubes	3,116.5 square feet
Firebox	205.5 .. ..
Total	3,322
Total grate area	33.5 square feet
Working pressure of boiler	200lbs per sq. inch
Number of Boiler tubes	355
Diameter of Boiler tubes	2¼in. x 15ft. long
Diameter of coupled wheels	4ft. 6in.
Tank capacity water	5,000 gallons
„ „ coal	10 tons

The total weight of this engine is 230,000lbs., 208,000lbs. of which rests on the coupled wheels, and 22,000lbs. on the bogie wheels. The tender, loaded weighs 104,000lbs. the total weight of the engine and tender is 334,000lbs. or 148 English tons. The tractive power of the engine is 53,293lbs. The centre of the boiler is 9ft. 3⅜in. above the rails. The coupled wheels have cast steel centres, the centres of the other wheels being of cast iron. The journals of the coupled wheels are 9in. x 12in., and of the truck 6in. x 10in.. The wheel base of the engine is 24 feet, that of the coupled wheels be-

ing 15 feet, 7 inches. The total length of engine and tender is 65 feet 3½ inches.

The great feature which has rendered it possible to construct locomotives of the great power we now have in use is due to the raising of the centre of gravity.

One of the principal conditions laid down by designers in the early days was to endeavour to keep the centre of gravity of the engine as low as possible with a view to minimising the oscillation and thereby the risk of derailment more especially when rounding curves.

The adoption of this practice has had a very decided influence in retarding the development of the locomotive as the maximum diameter of the boiler was determined by the distance between the driving wheels, thus limiting its size and power, further if it was desired to extend the firebox backwards, it had to be carried over one of the axles, this making it very shallow, which resulted in the following disadvantages viz: very imperfect combustion, and thereby excessive heating of the tube plates and consequent leaking of the tubes.

The Continental Engineers were the first to depart from the ordinary practice, which was necessitated by the calls for greater power, and English and American builders soon followed in adopting it.

In the older types of locomotives the distance from the top of the rails to the axis of the boiler was on the average 5.25 feet, but in England during the last 12 years, the practice in constructing express engines has been to increase this distance to between 7.21 and 7.47 feet, and in America to 8.95 feet, and it will be noticed that in the engine built by the Pittsburg Locomotive Works, it has been raised to 9ft. 3in.

The departure in this direction from the old practice which on looking back, might be termed a

prejudice has proved most conclusively that it has everything in its favor, and the leading advantages may be summed up as follows:—That within certain limits that have not yet been reached, the raising of the centre of gravity results in decreasing the strains on the axles, cranks and other parts of the engine and also on the permanent way, thus reducing the cost of maintenance, and at the same time the running is much smoother, owing to the springs coming more into play under the action of lateral motion. The tendency to derailment is also decreased owing to the increase of the load on the outer rail, when rounding curves at high speeds. The raising of the centre of the boiler above the tires of the driving wheels, was the cheapest and the simplest method of allowing of an increased diameter of boiler, and consequent increase in the power of the engine at the same time as the weight of the boiler is only about 25 per cent of the weight of the whole engine for whatever height it is raised the centre of gravity is only raised a quarter of that amount.

In connection with this matter I would further like to point out that the centre of gravity of the highest locomotives of the present day is much lower than that of passenger carriages and loaded wagons, and therefore could be considerably raised if found necessary or desirable without endangering safety. The advantages of this departure have been amply proved in a number of engines that have been rebuilt in our own workshops for since the alteration decidedly improved results have been obtained.

Reference has been made in the description of some of our recent locomotives to the weight shown on the coupled wheels and to that on the bogies, and the advantage of the bogie can be readily understood, for by increasing the size and weight of the engines it