

PART II.
PAPERS.

12TH MARCH, 1908.

ADDRESS BY THE PRESIDENT

MR. JAMES SHIRRA.

In opening our 38th session, I desire, in the first place, to express to you my sense of the high honour you and your Council have done me in appointing me to this chair, which has been so worthily filled in past years by many distinguished engineers in various branches of our profession. I can only say I will try to emulate them, and to maintain the traditions of the Association. I trust you are all of like mind, that the end of the session will find the Engineering Association still endowed with the virility and industry of former years; that we shall find it a pleasure and profit to attend the meetings, and count it an honour to work for the good and progress of our Society.

That progress in the past year has been well maintained. At the close of last session we had 178 members of the various grades, as compared with 149 at the end of the previous one (Plate I.), half the new members being students who have organised a scheme for mutual help and instruction, which, I hope, will further the general interests of the Association. Thirty-eight new members were admitted last session, nineteen being full members; five gentlemen have retired through resignation or otherwise, and we have lost four members by death. My predecessor in this chair, when opening last session, referred to the loss we had sustained by the deaths of three of these gentlemen. I have now to express my regret at the loss of the fourth, Mr. Duncan Salmond, who had been a member since 1890, and took much

interest in our meetings and outings, at which his genial presence will be much missed in future. I have also to record the death, since the close of last session, of another member, Mr. W. H. Nisbet, a distinguished railway and locomotive engineer.

The general meetings held last session dealt with highly interesting subjects, the discussion on Re-inforced Concrete Construction, which was attended and taken part in by members of our allied societies, the Engineering Branch of the Royal Society and the New South Wales Institute of Architects, alone makes the annual volume a valuable one—but besides we had noteworthy papers on our Ferry Steamers, and on Steam Turbines. The scheme of giving prizes for the best Student's paper brought out some commendable work, and three of the papers were read at a general meeting by their authors. The annual dinner winding up the session was held as usual, and was a successful and enjoyable function. Visits were made during the session to the Sydney Municipal Power Station, and to Lithgow Ironworks, which were well attended by members.

The funds are in a satisfactory condition, although the balance in hand is but small, the only arrears are on the credit side, being subscriptions due from members, and those are of less amount than of late years. The arrears of publishing the annual volumes have been wiped out, and the series is now complete from Volume I, 1885-6, forming a very interesting engineering library in itself, which every member should possess, there being a number of the back volumes still on hand. This issue has not been made without much labour on the part of our Honorary Secretary and Editor; we endeavoured to recognise his services at our annual dinner by presenting him with a small memento, and admitting him a life member of the Association, which was the very least we could do to thank him for his assiduous services.

We have a valuable library which is more accessible in our new rooms than in our former meeting-place; the most valuable part of it being the exchanges, copies of the proceedings of the technical societies all over the world, with whom we are in correspondence, and whose number is always increasing. Meeting as we do in the home of the most dignified scientific association in Australia, under whose roof are various kindred societies to ourselves, we are brought to some extent in contact with these; and really thus form part of a great University, whose parts preserve their full freedom of action, but yet have common interests, and can act in unison should occasion arise. The visits to the Cataract Dam in 1906, and to Lithgow Ironworks last year, could scarcely have been brought about but by this co-operation, and these outings form red-letter days in the Association's history.

The prospects for the next session are hopeful, although somewhat vague; we confidently expect to get some interesting addresses; and as we have never been sent empty away from our meetings in the past, some pabulum will assuredly be forthcoming at them this session also.

The prospects of Engineering in our State, in which we are all interested, and which are reflected in the life of our Association, are good, though, as usual, beset with uncertainty; even the new tariff on engines and machinery may prove a doubtful blessing, and commercially our manufacturers may have cause to repeat "timeo Danaos dona terentes," and to fear the gift-bearing Greeks. But the natural conditions of the country are on the whole promising—people are more than ever alive to the need of machinery for developing its resources—money never seemed to be more plentiful than now among the primary industrials of the States,—and they are gradually learning to invest it against—not a rainy day, but its converse—a dry season. The drought experienced lately in what are usually well-watered

districts, as the South Coast, has been a sharp object lesson. Even our rural communities are awakening to the fact that the amenities of civilization consist of more than a racecourse and a town hall, and all this brings grist to the mill of the engineer.

Our Government has done much for the city, our water supply, for instance, would be a source of anxiety but for the store accumulated behind the Cataract Dam. May we not hope to see many of our upland swamps yet converted into permanent lakes, to form compensating reservoirs for our uncertain rivers in dry seasons, so that even if no new land is brought into cultivation our present settlers may be assured of permanent water, and our mines and country factories not be hung up for want of the indispensable fluid?

But the most immediate necessity of the country is the provision of facilities for transport; a Roads and Bridges policy is sometimes sneered at, but carried out intelligently and impartially, it is what every young country needs; thus the new North Coast Railway, whatever the immediate profit it may bring to the Railway Commissioners, will be a great stimulus to industrial progress in many directions. Our Ways and Means of transport in New South Wales, our railways, roads, and coastal steamers, are such as we may very well be proud of; but great as the achievements of the engineer in this direction may have been in the past, the necessity for further progress is ever with us. We wonder how, a few years ago, we existed without electric tramways in Sydney--now we wonder how we are going to supplement them and overcome the difficulties of our congested main avenues of traffic. The lands to be opened to settlement by our irrigation projects will be incapable of full utilisation without more railways, the great Northern Territory must be connected to the East and South by railway and regular teamship services, as the West is being connected, before it

can much attract a population or develop its latent wealth; and the rivers and ports of the Commonwealth call for constant attention and improvement of access both from sea and land. Our electric tramways are in constant expansion; the electrification of our railways is a present problem, and much may be done to solve it in the near future. We have not the great water powers of America or Scandinavia, so much of which now runs to waste, to utilise for this purpose amongst others; in Sweden and Norway the Governments are alive to their opportunities, and are securing and improving the water rights for railway purposes, while water power is largely used in metallurgy. There are great schemes, some of which are approaching practical completion, in the West Highlands of Scotland, for thus utilising the "white coal" of the mountain lochs, and reviving metallurgical industries forgotten since the oak woods of the glens were all converted into charcoal for fuel; so re-peopling the wastes of Lorn and Lochaber with sturdy Highlandmen, who will produce from the mountain and the flood and the peat-moss, aluminium, ferro-silicon, and hard cash, at Bonawe and Kinloch-leven. Our local schemes for conserving and utilising the water power of such rivers as the Grose and the Colo, seem to have fallen into abeyance, but dams on the George's River and its tributaries are suggested, which would be available both for supplying water and power. The Cataract Dam, if once filled, could supply 1000 horse-power day and night for five years, although not a drop of rain fell in the meantime, if we might neglect evaporation and seepage, owing to its available head of 500 feet above the Nepean River. And we have cheap coal at places along our inland lines; power stations for railway and industrial purposes could be erected at these, where the fuel could be burned economically and smokelessly, the nitrogenous elements being recovered from the flues to fertilise our somewhat deficient soils. This might be so worked

as to be a great economic gain; and the substitution of the electric locomotive for the steam one would save the constant expense and anxiety of grass and bush fires, which seem inevitably attendant on our steam railways.

And here I would like to quote from a eulogy of the late Lord Kelvin, whose loss to the world of theoretical and applied science last year we all deplore, by Professor Gray in the "Glasgow Herald" of the 18th December last. After referring to the scandalous waste of fuel our ordinary methods of burning it involve, he says: "It is not apart from our present theme to urge that it is high time the question of the national economy of fuel, and the desirability of utilising by afforestation the solar energy continually going to waste on the surface of the earth, were dealt with by statesmen. If statesmen would but make themselves acquainted with the results of physical science in this magnificent region of cosmic economics, there would be some hope; but alas, as a rule, their education is one which inevitably leads to neglect, if not to ignorant disdain, or physical teaching."

There will always be a field for the use of the steam locomotive, however; and the Iron Horse, the most popularly impressive, the most picturesque, and I would say the most perfect, production of the mechanical engineer, is in no more danger of extinction than its animal prototype. Some may think the steamship merits this eulogy rather than the locomotive; it equally deserves it, and it has often the attribute of magnificent size; there is no loading or other gauge, but the depth of our harbours and width of our dock entrances for steamers, and they keep on increasing in dimensions; but locomotives have to keep to the same roadway as in George Stephenson's day, and thus a modern express engine is as concentrated and intense a prime mover as one can imagine.

Considering the restricted conditions, the increase in the power and weight of locomotives in the last fifteen years or

so is as remarkable as the increase in size of steamships. America, always addicted to admiration of the big, has engines which weigh 140 tons, or fully 200 including their tenders, which is a fair train load by itself, but they will handle trains of ten times this weight. Here and in Great Britain there is no such occasion for heavy trains, and comparatively few engines exceed 60 tons weight, but that is double the weight of a heavy engine of 30 years ago; the North British "Atlantic" type of 75 tons, or 120 with tender, being about the heaviest one in Britain. Ten-wheeled engines, four being on a bogie in front, and either four, or all the other six, being driving wheels, seem to be preferred for heavy passenger and fast goods trains in Britain; for heavy slow goods, an eight-wheeled engine seems to be favoured, all the wheels being drivers; and so the whole weight of engine is available for adhesion without any complication. In New South Wales we have long used heavy engines for our steep grades, but have been handicapped by the frequent sharp curves on the lines, so that a more elastic engine than that with four coupled axles is needed, yet such engines are running on our private colliery lines, taking heavy loads over steep grades. Our T class, "Consolidation" engines have the four coupled axles, but in addition a pony truck in front, which deprives the drivers of some adhesion weight; this pilot does not seem to be thought necessary for slow, heavy traffic in the United Kingdom, but then they have few curves of 10 chains or less radius there. The weight on the drivers and the co-efficient of friction between tyre and rail are what limit the tractive power of a locomotive, so no matter what kind of engine is used, it cannot haul more, on the straight, than a simple engine of equal weight and steaming power with all its wheels directly driven. But on sharp curves it is necessary for the rigid wheel base to be short, and hence Fairlie introduced forty years ago his double bogie engine,

where the boiler is supported on two swivelling trucks, each with its own pair of cylinders. Meyer followed up the idea, and Mallet compounded the engines; the heavy American engine above mentioned is a Mallet articulated compound. The Shay engine, which is being used on the Commonwealth Oil Company's line in this State, one of which we had the pleasure of seeing at Pymont last January, carries the subdivision still further, there being three four-wheel trucks under the engine and tender, all the wheels being driven; a three-cylinder vertical engine driving a fore-and-aft shaft with universal joints and telescopic couplings, and pinions gearing into bevel wheels on each axle. On a railway made with curves so sharp as to need such articulation, it would, I think, if the line was to permanently serve an important district, pay better to avoid the use of a special locomotive altogether, and to drive each axle of the train by an electric motor, thereby securing very short individual wheel bases and perfect flexibility, as well as power to surmount much steeper grades than any train drawn by a locomotive on smooth rails could tackle.

The idea of an articulated driving shaft has been amplified by the Renard Road-train Syndicate in France and England, which proposes to run trains of wagons on ordinary roads, coupled by long revolving shafts with universal joints, driving each wagon by gearing on the axles, and elaborate coupled-up steering gears on the front axle of each. The Heilman electric locomotive tried in France in 1893, was a much neater arrangement of the sort for driving railway trains, but was given up after a short experience. A dynamo on the locomotive supplied current to a motor on each axle of the locomotive, and possibly of the train behind it, so that each wheel of the train could be driven, and the whole weight thereof available for adhesion. Although an economic failure originally, where high speed was what was aimed at, on our

mountain and pioneer lines some arrangement like this might yet prove useful, now that electric traction is much better understood than it was fifteen years ago; or there are plenty of high waterfalls on the coastal escarpment of the New England plateau, for instance, which, with a little water storage, would provide power to thus drive electric trains from the coast to the Dorrigo or the Great Northern Line. The Brennan mono-rail, which has been a source of much interest during last year, promises to be more than a scientific toy, and may yet practically facilitate access to mountain districts. The vehicles are kept erect by the gyroscopic action of a rapidly revolving fly-wheel inside each, which resists any displacement of the plane of its rotation.

The same principle is being applied to maintain the stability of floating vessels, and successful experiments have been made in Germany and England with a small steamer, which is steadied in a sea-way by a horizontal fly-wheel revolving inside it, so that some of the cross-channel steamship companies are investigating the device with a view to make sea passages more comfortable.

The idea is not novel, but is an extension of Mr. Beauchamp Tower's device for securing a steady gun platform in a sea-way, described to the Naval Architects' Institute in 1889. Heavy swinging pendulums for this purpose have been more than once suggested, and chambers containing free water; but the failure of the swinging saloon on the cross-channel steamship "Bessemer," in 1875, has rather discouraged shipowners from trying expensive experiments of this sort.

Notwithstanding the uneasy motion, steamships on our coast will always command a large share of the passenger and goods traffic, and when not prevented by our uncertain bar harbours, run with great regularity, although more allowance might be made for contingencies in arranging their time-

tables. Our great mail lines start with commendable punctuality, and arrive with the same, although we have to put up with the arrival of the English mail, that great link of the scattered Empire, being regularly three days ahead of time every alternate week

To attain this regularity, a reserve of power is obviously needed, so that time may be made up if circumstances require; but if engines, boilers, and coal stores, are supplied much in excess of what is needed for normal power and speed, the interest on first cost and power lost in driving the larger and heavier ship necessitated by the extra weight, mount largely on the debit side of the profit and loss account. The cost of the last knot of a steamer's speed is well known to be immense, and the progressive trials we have seen made of some of our harbour steamers well show this. The statistics of the struggle for the championship of the Atlantic also show it emphatically; the coal consumption of the "Mauretania," which is understood to be about 1000 tons daily, being ten times that, per voyage, of the first Cunarders of 60 years ago. To be sure, she is about fifteen times the size of, and goes nearly three times as fast as, the old "Brittania" did, so that the high consumption is really small, considering: the consumption per ton-mile, notwithstanding the much higher speed, being only about half that of the earlier boat.

The great fall in the consumption per ton-mile in these Atlantic boats of the first class, occurred 40 years ago on the introduction of the compound engine, about 1868, and up to about 1880 this comparative fall was a positive one also, so that the "Gallia," of 1879, used no more coal on the voyage than the "Russia" of 1867, though she was half as big again and went nearly three knots faster. After 1880, however, although the triple expansion engine much reduced the coal used per indicated horse-power, the coal used in these fast

steamers per ton-mile showed a slight increase, as the vogue of Ocean Greyhounds began, speed becoming the first consideration; so that although any of the fast Atlantic steamers of the last thirty years have expended only something under two ounces coal for every ton displacement carried one mile, and the consumption per indicated horse-power per hour has fallen from $2\frac{1}{4}$ to about $1\frac{1}{4}$ lbs., the total coal needed to cross the Atlantic has gone up, in the largest and fastest steamers, from 700 to about 5000 tons.

The introduction of the compound engine thus marks a great era in history, for it made long steam voyages as from England to Australia profitable. Just as the fore-and-aft sails of the Norsemen made sailors almost independent of a fair wind, and led to the Viking's "long serpents" appearing in medieval times on every shore of the Northern Hemisphere, from the Bosphorus to the Hudson—so the compound and triple expansion engines enable tramp and other steamers to penetrate every sea, from China to Peru; and even the lumber trade, that last resource of the old sailing craft, is now being taken up by steam.

In Australian waters, although there were many notable steamers in the sixties and seventies—here we still hear of the fast passages of the "Telegraph," and the old "City of Melbourne" successfully crossed the Pacific in the Panama mail service—our modern coastal fleet may be said to date from about 1882-83, when such boats as the "Cintra," the "Gabo," and the "Maranoa," still doing good work on the coast, and the "Adelaide," which left us lately for the North Pacific, started the run of fairly large and fast coastal steamers; and since then the rate of progress has been notable, and increasing. Our interstate fleet can now boast of several steamships of a size and speed equal to those of the early Atlantic Greyhounds that were thought perfection not so long ago; and some of the steamers in the State coastal trade, which,

25 years ago were all small and slow, now equal in size and surpass in speed and accommodation, the crack intercolonial steamers of that time.

I would call your attention to this diagram (Plate II.), of the mid-ship sections of a few representative steamships here. The vast size of new Cunarders, the "Mauretania" and "Lusitania," is apparent, exceeding in every way the dimensions of the "Great Eastern," which marked for so long the absolute maximum in naval architecture. The "Adriatic" is a good second to these, but has less beam than the prematurely born monster of Brunel and Scott Russell. The "Kaiser Wilhelm II.," which, with the "Deutschland," maintained the championship for Germany, is not much less. The "Oceanic," the biggest ship at the beginning of this young century, is considerably so, though her displacement equalled that of the "Great Eastern." The "Mooltan," one of the largest P. and O. steamers, is small compared with these Atlantic magnates. The "Kanowna" and "Kyarra," two Australian coasters, make a good show, and are large enough to envelop the "Gallia," the crack Cunarder that was built in 1879, to beat the "Arizona." The "Wodonga," that is now considered quite a small boat, is not much less than her in midship section; and the "Electra," one of our smaller boats in the State trade, is given for comparison. It is evident that our modern steamship development gives a great field for engineers, and that the best talents and skill are needed for its construction and maintenance. Our floating hotels, as they have been called, would be in a great part useless without electric lighting, which is an ideal illuminant for steamships, passenger, cattle or cargo. Gas, made from coal was tried in one of the early White Star Atlantic boats, but soon given up; even if the gaswork had worked well, the heat and vitiation of the air in state-rooms would have been intolerable. Acetylene is used in some small vessels,

and is a great improvement on oil lamps, but is far less convenient than the dynamo and glow lamp. The sanitary arrangements, ventilating and heating, cargo hoists, steering gear, the various auxiliaries needed as feed heaters, filters, evaporators, and so on, the forced draft apparatus for the furnaces, as well as the main engines themselves, all represent an immense amount of mechanical and scientific ingenuity and skill.

But the work of the engineer is not only on board the steamship. The provision of deep water harbours and channels for modern steamers means a great increase of harbour works, and the building and working of enormous dredges. At the entrance to the port of Liverpool, sand-pumps, which can fill their hoppers of 3000 tons capacity from a depth of 27 feet in 45 minutes, have been at work for some years, and one of 10,000 tons capacity is being built, while a 5000-ton one has been delivered for dredging the approach channels to the Thames, and one of the same size is doing good work in the Hooghly. The Clyde has been further deepened lately so that the "Lusitania," drawing 29½ feet, was able to negotiate it from Clydebank to the sea, and New York is spending vast sums in deepening and improving the channels in her bay. Ports which have been favoured by Nature with deep-water approaches, although less favourably so with proximity to manufacturing districts, are laying themselves out for attracting the immense steamships that get the cream of the trade. Southampton, whose death-knell was supposed to have been sounded when it ceased to be the home port of the P. and O., has gone in for accommodating the large Atlantic steamers, and Liverpool is apprehensive of her rival.

The provision of dry-docks for the repair and cleaning of the Mercantile fleet is ever growing; and it is of interest to note how popular the iron or steel pontoon or floating-dock is