PRESIDENTIAL ADDRESS

Delivered by the retiring President,

MR. J. J. C. BRADFIELD, M.E., ASSOC. M. INST., C.E.,

On April 8th, 1903.

AS we have now chosen our President for the ensuing year, I have the honour and privilege of addressing you, before vacating the office to which, some twelve months ago, you elected me.

In October, 1902, we completed the first seven years of our existence, and young though we are as a Society and individually as members, we should aspire to be the premier Engineering Society in New South Wales. We have an advantage which other Societies do not possess, viz., an influx of students year by year to the Engineering School, many of whom become active members of the Society, and though each year graduates leave the School, still the old associations remain, and thus our roll of members should steadily increase.

The object of the Society, as stated in the Constitution, is to promote the welfare of the Department of Engineering in the University of Sydney, and it behoves graduate and undergraduate alike to bear this in mind; for the higher we raise the status of the Society, so much the more will our degree be esteemed by the outside world, and the more we can bring the Engineering School and the Engineering world outside into contact, the better for us. The Society affords this medium, and so deserves the support of every graduate and undergraduate of the Engineering School.

To the Secretaries the success of any Society to a great measure belongs, and it is fitting that I should mention those who have borne the brunt of the work in the past, viz., Messrs. H. J. Deane (1896), R. J. Boyd (1897), W. R. Beaver (1898), R. W. Hawken (1899), J. P. V. Madsen (1900), H. E. Whitfield and A. Boyd (1901), and R. J. Boyd and J. H. F. Hill during the past year. Mr. Boyd accepted the office of Graduate Secretary on the understanding that he would act for several years which will be a distinct benefit to the Society. With Mr. Hill he has initiated a system for the management of our affairs which will simplify matters in the future. To the Secretaries and other members of the Council, I wish to tender my thanks for their hearty co-operation throughout the year.

Professor Gurney, one of our honorary members at the end of last term, resigned the chair of mathematics after a faithful service of some twenty-five years.

Mr. G. H. Knibbs, Lecturer in Surveying and one of our Past Presidents, was appointed last year by the State Government as one of two Commissioners to investigate and report on the various systems of education in Europe and America, and I venture to say there was no gentleman in this State more qualified for such a position. Mr. P. W. Rygate, another Past President, was appointed by the Senate to lecture during the absence of Mr. Knibbs.

At one of our meetings, I had the pleasure of welcoming to the Society, Mr. and Mrs. Jevons. Mr. Jevons had just been appointed Assistant Lecturer in Mineralogy and Petrology, and he has since become a member.

The Jubilee Celebrations of the University were held during the year.

Seven meetings of the Society were held during the past session. At the Annual Meeting, Mr. S. H. Barraclough, M.M.E., Assoc. M. Inst., C.E., the retiring President, gave a short address, and a conversazione was held the same evening, at which a large number of visitors were present. Later in the year in lieu of a Presidential Address, Mr. Barraclough gave a lantern lecture on three typical national industries, viz. :—

1. Krupp's Steel Works at Essen.
2. The Carborundum Works at Niagara.
3. The Parsons Steam Turbine Works at Newcastle.

Interesting papers were read as follows and will be found in the journal for the year :—

(1) Native Mining Tools and Methods in Summatra—
E. W. Nardin, B.E., Assoc. M. Inst., C.E.

(2) Treatment of Drift Sand as applied to the Bondi Sand Dunes—
W. A. Smith, M. Inst., C.E., Metropolitan District Engineer, Sydney.

(3) A Self-Acting Tramway at the Hercules Mine, Tasmania—
B. Sawyer, B.E.

(4) The Catchment Basin, Sydney Water Supply—
J. N. C. McTaggart, B.E., Assoc. M. Inst., C.E.

(5) The Theory of Steel Concrete Bridge Construction—
J. M. Woore, B.E.

(6) The Central Railway Station of Sydney—
H. Deane, M.A., M. Inst., C.E., Engineer-in-Chief for Railway and Tramway Construction, New South Wales.

Without being invidious I wish to draw attention to the papers of Messrs. Deane and Smith. Mr. Deane, an honorary member of the Society contributed the above paper, embodying the early history of the Central Station, obtained at great trouble from the Departmental records, for which the Society is much indebted to him, and no less so to Mr. Smith who is not a member. Both papers were illustrated by lantern slides.

The Hon. E. W. O'Sullivan, Minister for Public Works, was invited to be present on the occasion of Mr. Smith's paper, but as he was unable to attend he deputed W. J. Hanna, Esq., the Acting Under Secretary to represent him. Mr. O'Sullivan undertook to have the map and several of the photographs lithographed, and has kindly supplied the Society with copies, which will be found in the journal.

At present our roll of members stands at ten honorary and 179 ordinary members. The total revenue received during the year was £101 17s. 6d., and the total, but not the true, expenditure, (as last year's painting bill was paid this session), was £75 10s. 8d.* leaving a balance of £26 6s. 10d. cash in hand. But setting aside £17 17s. 0d. of this balance for the Life Membership and Prize Trust Funds, and an amount of £3 3s. 0d. for subscriptions belonging to the coming year, the remainder is the true cash balance on the last three year's operations and amounts to £5 6s. 10d. As we started the session with a actual deficit of 2s. 11d. on the 1901-02 session, this speaks favourably for the exertions of the Council and especially our graduate Secretary, Mr. R. J. Boyd. Now you have approved of our report, the incoming Council have to their credit Trust Funds amounting to £17 17s. 0d. and in current account a credit balance of £8 9s. 10d.

Irrigation.

On one occasion President Roosevelt remarked that the forest and water problems were the most vital internal questions of the United States, and this is equally true of New South Wales, and indeed the whole of Australia, and to these questions I purpose almost entirely to confine my address.

On land and ocean, engineers have in some degree made their skill apparent, but the realm of the cloud king is yet a realm unknown, the knowledge requisite to control the formation and distribution of the clouds or precipitate the rain from them when and where we mortals wish, is far beyond our ken. Still we can conserve the water when it has fallen and lead it whither we will, or bring it up from the depths of the earth by artesian bores and wells.

We have neglected our opportunities in this State in the past as the recent disastrous drought only too clearly brought home to us, and in the western districts where the average annual rainfall is only eleven or twelve inches, and where periods of drought occur with unfailing regularity, the only solution of the drought problem is to conserve the water during rainy seasons, and also tap the subterranean reservoirs below, and so mitigate its baneful effects.

Arid lands are rich lands, and when irrigated produce bountifully. In our own State the dry western districts produce a wool unsurpassed in the markets of the world.

In the dawn of civilization the most advanced countries were agricultural countries, and the advantages of artificial irrigation were well known. Osiris taught the people of ancient Egypt, the arts of agriculture and irrigation, and after his death he was worshipped as a god. Irrigation was without doubt a pressing necessity, as Herodotus relates that the inhabitants of ancient Thebes were once greatly terrified by a shower of rain, which they took for an omen of fearful import. Be that as it may, many marvellous works were constructed in ancient Egypt for that purpose, for instance Lakes Moeris and Mareotis; indeed the Nile itself was diverted so as to flow through the middle of Egypt in the reign of Menes the first or one of the first Egyptian Kings.

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* This includes 2s. 11d. the deficit for the year 1901-02.

Shinnung, the divine husbandman of China, began to reign 2832 B.C., and instructed the people in agriculture and irrigation. Yu was raised to the throne of that country B.C. 2205 for his skill in draining and irrigating. In those days at any rate engineers received the reward they merited.

The sacred writings of most of the ancient nations placed irrigation and the digging of tanks and wells as some of the acts most acceptable to the gods.

In the New World the Spaniards found aqueducts of surprising magnitude in Chili, Mexico and Peru, which must have been built long before the year 1500 A.D. The important towns of Mexico had water brought from the mountains in pipes and it was laid on to every house which generally contained a bath, whilst fountains were plentiful in the streets.

In Peru, an almost rainless country, the first Inca, Manco Capac, who flourished some 400 years before the arrival of the Spaniards, taught the people agriculture and irrigation. He also taught the people to overcome their enemies by the force of benefits, and to use their superior knowledge to ameliorate the condition of a conquered foe, and thus his power extended over a large portion of South America. Succeeding Incas constructed magnificent aqueducts and reservoirs. The seventh Inca, Viracocha, constructed water works which in their beneficial effects equalled any similar undertakings in the world. He constructed an aqueduct twelve feet deep and 120 leagues in length, the sources of which were mountain springs, and it watered almost the whole country of Peru. Another aqueduct was 150 leagues long running north and south, and there were many others, and these watered the whole Inca Empire, but during the Spanish conquest they were destroyed by the inhabitants and the Spaniards.

The works of the ancient Egyptians were stupendous, and this we may truly say of the dam just constructed across the Nile at Assoun, near the ruins of the Temple of Philae, since the British occupation of Egypt. It is the largest and most important project of its kind yet devised, regulating as it does the flow of the Nile and in conjunction with a barrage 330 miles lower down the river, near Assiout—for diverting the waters into the Ibrahimia irrigation canal with an increased head—provides an adequate system of artificial irrigation.

The dam, built of masonry, is one-and-a-quarter miles long, extending across the Rapids of the Nile at the first cataract. The water level is raised forty-six feet at the dam, and the river is backed up for 150 miles impounding some 257,000 million gallons. The conception of the scheme belongs to Mr. W. Willcocks, C.M.G.; Sir Benjamin Baker was Consulting Engineer, and the work was carried out by Messrs. J. Aird & Co.

The Nile is methodical in its flow. About the middle of July at Assoun, the flood waters steadily rise and attain their maximum height in September, remaining at a constant height about twelve days, and then subsiding rapidly till January. No floods then occur, and the volume of water steadily diminishes right up to the middle of the year, the last months being termed "Low Nile." The flood waters are extremely muddy and this mineral and organic matter, when deposited, is a remarkable fertilizer. It is necessary for this mud to be deposited on the agricultural lands below the dam, and to permit this, there are 180 regulating sluices in it. In July when the Nile is rising, the sluices are raised to allow the total flow of muddy water to pass freely down the river. In December when the water becomes clear, but before the floods abate, the sluices are closed and impound the surplus water, the dam is filled, but the flow of the river is never stopped. When the period of Low Nile arrives, the natural flow is insufficient to provide for irrigation and the other needs of the country; the flow is then augmented with the water impounded by the dam and regulated to suit requirements. This was the reason for constructing the dam.

In Australia, it is only of late years that the people have awakened to the necessity of works for the purposes of irrigation, indeed our settlers generally are almost ignorant of the advantages to be derived from systematic irrigation. Notwithstanding our civilization, our people generally lack the knowledge of the ancient Egyptians and Peruvians in the art of irrigation. We need an Osiris to arise in the State. From this branch of Engineering many our graduates will in the future derive their livelihood.

Water Supply.

To us, in Sydney, the discomfort of a lack of water was first brought prominently forward when, in December, 1901, the North Sydney water supply failed. In May, 1902, owing to the continued absence of rain, restrictions were placed on the use of the water, and later in the year the supply at Prospect fell below gravitation limit and pumping had to be resorted to, but at the close of the year a welcome fall of rain brought the water level well above gravitation limit and the restrictions were removed.

On March 12th, 1902, when a shortage was evident, a Royal Commission was appointed of which J. Davis, Esq., M. Inst. C.E., Under Secretary for Public Works, was Chairman, to make a full and diligent inquiry into the Sydney Water Supply. In their report they recommended sundry improvements to the weirs, tunnels and canals leading into the Prospect reservoir, also a subsidiary reservoir on the Cataract river to impound 7,000 million gallons at a cost of £126,000. Messrs. Hughes, Keele and Wade, three members of the Commission thought that the dam to impound 7,000 million gallons should be constructed of the necessary section at a cost of £186,000 as would admit of its being raised at some future time to impound 18,200 million gallons. The Parliamentary Standing Committee on Public Works however, recommended that the Cataract Dam should be built so as to impound 18,200 million gallons at a cost of £217,500, and this dam is now in course of construction by day labour. The dam will be constructed of random rubble, faced with concrete blocks five feet by three feet by two feet laid header and stretcher alternately, and the water led into Prospect reservoir and distributed therefrom as at present.

Prospect reservoir has a storage capacity of 11,392 million gallons of which 6,000 million gallons only are available by gravitation, the average daily consumption at present is forty-four gallons per head. With Prospect and Cataract reservoirs full, the quantity stored will be 29,592 million gallons. Allowing a daily consumption of seventy gallons per head which is not extravagant, and a population of 700,000, which should obtain about the year 1925, plus an allowance of seven million gallons per day for evaporation from the two reservoirs, the quantity stored represents 528 days supply, during which period the requirements of the City of Sydney and Suburbs would be amply met without a single shower of rain falling on the catchment areas.

To provide against the contingency of a water famine till the new reservoir is available, an electric pumping plant has been installed on the Nepean River at Menangle, capable of pumping four million gallons per day to Prospect reservoir; this will little more than counter-balance the daily evaporation.

So much for the Metropolis where the water supply was restricted and that for a short period only. At Mosgiel, White Cliffs and Cobar, the supply was exhausted, and but for government aid these places would have been deserted. At Mosgiel after the first cart load of water had been brought an opportune thunderstorm filled the tanks. At White Cliffs the supply gave out in May last and water was carted from privately owned tanks at Kerrara at a cost of £200 per week for some seventeen weeks. Water was taken from Warren to Cobar, a distance of 130 miles by special water trains for domestic use and for the mine, some 50,000 gallons being supplied daily, the total cost being £5,244. At Tamworth, Scone, Armidale, and many other places the supply all but gave out, whilst in the western districts most of the watercourses, tanks and dams were dry.

Turning from the scarcity in our own State it is pleasing to call to mind the bold scheme for the supply of the goldfield towns in Western Australia, which was brought to a successful issue in January last. A dam has been constructed across the Helena River at Mundaring, near Perth, to impound 4,600 million gallons. From here it is pumped to Coolgardie some 328 miles distant at the rate of five million gallons per day and supplies the towns of Southern Cross, Boulder, Kalgoorlie and Coolgardie, and there are eight pumping stations en route. The pipes, of the locking bar type, consist of quarter-inch steel plates and are twenty-eight feet long, thirty inches inside diameter, tested by hydraulic pressure to 400 lbs. per square inch. The velocity of the water through the pipes is 2,124 feet per minute. The contract for the supply of the papers was let to Messrs. G. C. Hoskins and Mr. Mephan Ferguson on October 18th, 1898, at a cost of £1,025,124 for the 328 miles of pipes. They are laid partly above and partly below the surface of the ground, and were at first caulked by hand, till a specially designed machine did the work more effectively. When above the surface they are laid on timber trestles, and covered with galvanized iron on wood frames, the space between the corrugated iron and pipe being filled with sawdust.

It is the largest scheme of its kind in the world and was inaugurated by the late C. Y. O'Connor, M. Inst. C.E., Engineer in

Chief to the Western Australian Government. The cost of the scheme including the reticulation of Coolgardie, Boulder and Kalgoorlie is £2,850,000.

So much for the enterprise of our sister State, but the most important and complex question, which can arise in Australia is the Conservation and Distribution of the Water of the Murray River Basin. The Navigation of the river and the ultilisation of the water for Irrigation purposes diversely affect the interests of the States of New South Wales, Victoria and South Australia, and as the inauguration of the Commonwealth brought into existence a new interest, an Inter-state Royal Commission was appointed to investigate and report on the matter, of which J. Davis, Esq., Under-Secretary for Public Works, New South Wales, was President, the other members being Stuart Murray (Victoria) and F. N. Burchell (South Australia).

The following information gleaned from the evidence may be of interest. The area of the Australian continent is 2,950,000 square miles of which the Murray River Basin comprises about 414,253 square miles or about one-seventh of the whole. This area includes 104,525 square miles of Queensland, 234,362 square miles of New South Wales, 50,979 square miles of Victoria, and 24,387 square miles of South Australia; but of the total area of the basin, only 158,499 square miles make any effective contribution to the volume of the river, the scanty rain which falls on the rest of the area is quickly absorbed; indeed the average rainfall over the whole area is only thirteen inches per annum.

The Commission made the following recommendations:—

(1) From July to January 440,000 cubic feet of water per minute might be diverted by New South Wales and Victoria for irrigation purposes from the Murray and its tributaries, and 170,000 cubic feet per minute allowed to pass down the channel into South Australia; from February to June 370,000 cubic feet to be diverted and 70,000 cubic feet allowed to pass down the channel, a proportionate increase or reduction to be made in the above quantities according to the volume of the river.

(2) A weir to be constructed on the upper Murray at Cumberoona having a storage capacity of 25,367 million cubic feet, the cost being equally divided between the States of New South Wales, Victoria, and South Australia.

The decisions arrived at were not unanimous, the South Australian representative being of the opinion that a larger quantity of water should be allowed for navigation purposes, and it now remains to be seen what action the Commonwealth and State Governments will take in the matter.

Reverting to our own State, where population demands, and also along the stock routes, tanks are excavated in flat country and small water-courses, dams and weirs constructed in favourable places, and wells sunk to collect the soakage water or tap the water-bearing drift. From these the water is pumped by hand, steam, horse or wind power, and distributed as required. Artesian bores are sunk where water-bearing strata are known or supposed to exist. The artesian country extends from the Gulf of Carpentaria to the Great Australian Bight, and consists of a porous layer enclosed between strata impermeable to water, forming a vast geological basin. Rain falling on the outcrop of the permeable layer gradually fills the basin below, where the water is confined and cannot escape, unless it flows underground into the ocean, as in Australia it is supposed to do. When the water-bearing strata is tapped by a bore, the water rises to the surface if the level of the outcrop is relatively higher than the surface level at which the bore is sunk. In most cases the water rises to the surface, but sometimes it has to be pumped. The water contains mineral matter, consisting chiefly of carbonates, chlorides, or sulphates of sodium, potassium, calcium and magnesium, also traces of iron and alumina. It is, of course, brackish, and is sometimes though seldom, unfit for human consumption, watering stock or irrigation. The deepest bore sunk in this State is the Dolgelly bore, 4,086 feet deep.

The construction of these small water schemes is to be vigorously prosecuted in this State, a bill to enable the Government to spend £200,000 a year for the next five years having been passed by Parliament last session. At present, some 259 tanks, 51 dams, 97 bores and 84 wells have been completed by the State; these do not include those constructed by private persons. The bores completed last year (1st July, 1901, to 20th June, 1902) yielded 17,000,000 gallons daily, the water from seven of the bores (12,180,000 gallons daily) was directed into ninety-six miles of channels, and benefitted an area of 466,000 acres. The daily flow of the Government bores in this State is 51,000,000 gallons.

In Queensland, most of the artesian bores have been put down by private enterprise, but a record is kept by the Hydraulic Engineers' Department. At present, 934 bores are completed, representing about 215 miles of boring, and the daily flow from all the bores is 382,000,000 gallons. The deepest bore, *viz.* 5,045 feet, is on the Bimerah Run; daily flow, 70,000 gallons. The shallowest bore is on Manfred Downs, ten feet, daily flow 2,000 gallons, whilst the hottest water is at Dagworth, No. 5 bore, *viz.* 196 F. For these particulars I am indebted to the Hon. T. B. Cribb, State Treasurer of Queensland.

A digest of the various Acts of Parliament passed in this State dealing with the water question is appended, and I wish to thank Mr. G. W. J. Downey, of the Public Works Department, for his courtesy in preparing it. This digest will, I hope, be of interest to all and useful to some, at any rate, of our members.

Forest Conservation.

In this State we are just awakening to the fact that we must conserve our forests. Cedar has almost gone and the ironbarks are fast following suit. There are about 6,000,000 acres of timber producing country still held by the Crown, whilst some 1,500,000 acres are let on grazing leases, or are in private hands.

The eucalypts are scattered over large areas, different varieties growing together, no one variety forming a forest like the pines and firs of Europe and America. If raised as seedlings and transplanted in groves they do not appear to succeed; if the soil is trenched, the growth is too quick and the timber inferior in quality. Cedar, for instance, as a cultivated tree seldom grows straight or to any height; to succeed it requires to grow in a thick forest similar to its natural habitat.

Neither do our indigenous trees stand a change in climate, they may grow well, but the timber is inferior. Near Auckland, in New Zealand, is a plantation about fifteen years old, comprising the best varieties of the eucalypts, but it does not promise to be a success. Blue gum has been tried in South Africa, it grows quickly, but the quality is inferior to the Australian grown timber. Indeed, in this State, comparing one district with another, there is a marked difference in the quality of the same variety of timber; *e.g.*, spotted gum to the South of Sydney is generally superior in quality to that North, whilst blackbutt of the lower North is superior to that in the Clarence River district.

The only way to conserve the forests, and, at the same time, preserve the high quality of our timber, is to reserve certain areas, enclose them from stock, and allow nature to do its own work and re-afforest the area; the growth will be slower, but the quality will be good.

We have scarcely enough ironbark, grey gum and tallow wood for our own use, but there are large quantities of blackbutt, spotted gum, blue gum (*E. saligna*), and turpentine which can be exported. During the last five years Germany has been steadily taking red mahogany and blackbutt for wood-paving. Last year some 2,700,000 super. feet of sawn ironbark and tallow wood, 53,000 lineal feet of piles, and 21,500 railway sleepers were exported to New Zealand for railways and other public works; whilst recently an order has been received from South Africa for 540,000 railway sleepers ten inches by five inches by seven feet long, the timber to be blackbutt, grey box, brush box and red mahogany. These few figures show that other countries are recognising the excellence of our hardwoods, and it is the duty of this State to adopt a system of forest conservation.

I propose to touch on two other subjects only, *viz.*, the growth of our Railway System and the Sydney Harbour Bridge.

Railways.

The greatest created asset of Australia is its Railway System, and to such magnitude has this grown that up to June 30th, 1902, some 12,681 miles were opened for traffic in the Commonwealth at a cost of over £125,000,000 as follows:—

	Miles.	Cost.
New South Wales ...	3,025¾ ...	£40,565,073
Victoria	3,302½ ...	40,613,784
Queensland	2,801 ...	20,119,143
South Australia ...	1,736¼ ...	13,275,037
Western Australia ...	1,356 ...	7,410,426
Tasmania	459½ ...	3,799,098
Total	12,681 ...	£125,782,561

After paying working expenses, the net profit for 1902 was £3,779,349, or 3·0047 per cent. on the capital, and the average cost per mile, £9,919.

In our own State, the first sod of our railway system was turned by the Hon. Mrs. Keith Stewart, on July 3rd, 1850, but it was not until September 26th, 1855, that the line, Sydney to Parramatta (a length of some fourteen miles), was declared open for traffic. The scarcity of labour caused by the discovery of gold and the financial difficulties of the Railway Company caused the delay; the Government eventually took over and completed the work.

About this time it was proposed to construct 4,000 miles of tramway, to cost about £4,000 per mile, along the existing highways, the system to be worked by horses. The newly appointed Engineer-in-Chief (Mr. John Whitton) strenuously opposed the proposal, and, though supported by the Governor, Sir William Denison, it was abandoned.

On September 26th, 1856, the Granville to Liverpool line was opened, whilst the first length of the Northern System from near Newcastle to East Maitland (a length of seventeen miles eight chains) was opened on April 5th, 1857. Next year the Northern line was carried into Newcastle and extended to West Maitland, and the Liverpool to Campbelltown section completed; and up to 1860 the total length completed was only seventy miles.

During the period, 1860-1865, the Western line was extended from Parramatta to Penrith, and the branch line constructed from Blacktown to Richmond; the Southern line extended from Campbelltown to Picton, and the Northern line to Singleton; the mileage constructed during the five years was seventy-four miles twenty-three chains.

From 1865-1870, the Western line reached Bowenfels; the Southern, Goulburn, and the Northern, Muswellbrook. From 1870-1875, the Western line reached Kelso, the Blue Mountains being negotiated by the Zig-Zag; the Southern line reached Gunning, and the Northern line Murrurundi; the total length constructed during the past twenty-five years being 435 miles. As the main trunk lines neared Goulburn, Bathurst and Murrurundi, the question of extending by a narrower gauge arose, but the Engineer-in-Chief successfully opposed it.

When opening the extension to Bathurst on April 4th, 1876, his Excellency, Sir Hercules Robinson made pointed reference to the necessity of developing the interior by affording railway communication with the coast. His advice was taken, and construction was vigorously pushed on; during the year 1880, 115 miles was opened, the total mileage then constructed being 848.

From 1884-1885, the length had grown to 1,745 miles, 282 miles being opened in 1882, and 301 miles in 1884; these are the two greatest lengths constructed in a single year in this State. On February 3rd, 1881, the Great Southern line had reached Albury, and on 14th June, 1883, Sydney and Melbourne were connected. Branch lines from Junee to Hay, and from Narrandera to Jerilderie tapped the Riverina, and Mudgee was reached by a branch line from Wallerawang.

When the Railway Act of 1858 was repealed, and the new Act, placing our railways under three Commissioners, came into force on 22nd October, 1888, the main trunk line had reached Byrock, and the Northern line to Glen Innes. The North-western extension from Werris Creek had reached Narrabri, the Southern line Goulburn to to Cooma had been started, and the South Coast line had reached Hurstville.

The extension to the Queensland border was opened for traffic on 16th January, 1888; the final link in the chain between Adelaide and Brisbane, *viz.*, the Hawkesbury Bridge, was completed on 1st May, 1889.

Since that date the Railway System has steadily grown, the total mileage up to 30th June last being 3,025¾ miles. During the last decade pioneer or light lines of standard gauge have been constructed, generally without ballast.

Sydney Harbour Bridge.

Tenders were received in 1900 for this proposed bridge from competitors all over the world. Certain live loads were specified, but the type of bridge, floor system, materials, working stresses, etc., were left to the choice of the tenderers, and two prizes of £1,000 and £500 were to be awarded. The first prize fell to Sir Wm. Arrol & Co., and the second to the Maschinenbaugesallschaft, of Nürnberg, Germany, with whom Mr. Norman Selfe, one of our honorary members, is associated; a design much admired was submitted by the Union Bridge Company, of New York. Owing, however, to the high working stresses adopted, unsuitable type of decks, etc., the Board—which consisted of the Public Works Tender Board—could not recommend the acceptance of any of the designs, so in March, 1901, an Advisory Board was appointed to deal with the matter anew, two of the members being Professor Warren and Mr. Deane; Mr. Dare was appointed Secretary to this Board.

The Advisory Board issued a complete specification and called for fresh tenders. In a joint paper by Professor Warren and Mr. Dare on the Determination of Working Stresses for Bridges, read before this Society on October 18th, 1901, will be found many of the considerations which led up to the Specification issued by the Board.

On June 30th, 1902, the tenders were received, and, on investigation, the three designs which found favour in the first competition were selected, and, with a view of reducing the tendered prices, the Board made certain modifications in the manner of loading and the three firms were asked to amend their tenders.

These tenders came to hand on March 16th last, and are now being considered by the Advisory Board.

Before vacating the chair, I wish again to thank you for the honour you did me when electing me President last year, and I have great pleasure in welcoming Mr. J. N. C. MacTaggart, B.E., Assoc. M. Inst. C.E., our new President.