PART II.

PAPERS.

14TH MARCH, 1901.

PRESIDENTIAL ADDRESS.

BY HECTOR KIDD.

In opening our meeting to-night, my first duty is to thank you for the mark of confidence you have shown towards me by electing me as your President. I should, however, say that I accept the position with hesitation, as I think there are other members better qualified, and with more leisure, to attend to the responsible duties which devolve on your President. However, having accepted office, it is my duty, in accordance with past custom, to deliver a few remarks on subjects that are likely to prove of interest to members.

We meet this evening under peculiar circumstances, for more than ordinary interest should be attached to the opening of the thirty-first session of our Association, as it is our first meeting after the inauguration of the Commonwealth of Australia, and also the first meeting in the new century. These two circumstances suggested to my mind, when casting about for a subject on which to address you for a short time, that it would be a fitting opportunity to briefly review the progress of the colony generally, but more particularly from an engineering point of view, and to refer briefly to some matters, past, present, and future, which affect the welfare of all members of the engineering profession.

The progress of our Association during the past year may be considered satisfactory. The papers read and discussed were of much interest, and the members had the opportunity afforded them of visiting the works of some of the leading manufacturing industries in the colony.

We have to regret the loss, by death, of our late honorary member, the Hon. A. H. Jacobs, M.L.C., and also Mr. P. B. Walker, late Engineer-in-Chief of the Electrical Department, General Post Office.

As the making of roads and the building of bridges were among the first engineering works carried out in the colony, our review should commence with an account of these.

The first successful attempt to cross the mountain range was made in 1813, and the road was completed, as far as Bathurst, by the 21st of January, 1815. After this date the records are not very clear as to the progress of road construction until 1857, when the Department of Roads and Bridges was formed. It was not, however, until seven years later that the whole of the roads and bridges received the attention of the State. The length of roads completed on the 31st June, 1899, was 43,693 miles, divided into various classes of construction. The total expenditure on all classes of roads and bridges from 1857 to 1880 was £6,213,830, and from the latter date to the 30th June, 1899, the expenditure has been £13,055,569, or an average of £687,000 per annum since the year 1881.

On the 30th June, 1899, there were 1540 miles of road bridges and culverts completed. In addition to the bridges there are about one hundred ferry-punts for crossing rivers, where the construction of bridges is unsuitable. The expenditure on the roads and bridges of the colony for 1899 contains an item of £38,702 for salaries, which shows that there are a considerable number of engineering officers engaged in the construction department; and as the roads and bridges in the various States of the Commonwealth should, in the near future, be rapidly extended, there should be considerable scope and employment for a large number of engineers.

The next, and most important, work in the development of the colony was the construction of railways. The first section of railway (from Sydney to Parramatta) was opened in 1855. The subsequent progress in railway construction in the colony is given in the following table taken from the report of the Railway Commissioners for 1900, which shows that there were 2881½ miles in operation on the 30th June, 1900.

The railway systems of the colony are divided into three branches—the Southern, Western, and Northern. There is also the Illawarra line, which forms part of the Southern system, and connects Sydney with a district in which there are extensive coal deposits and a large area of rich agricultural land. A portion of the North Coast system, extending from Murwillumbah, on the Tweed River, to Lismore, on the Richmond River, was opened for traffic in 1894. This line passes through some of the richest agricultural land in the colony, and has had the effect of opening up and developing the dairying and sugar industry in that district.

Included in the 2881½ miles of lines referred to, there are 71¼ miles of tramways. The total capital expended to the 30th June, 1900, is given in the Railway Commissioners' report as £40,401,989, divided as follows:—Railways, £38,477,269; tramways, £1,924,720.

The average cost of construction of the whole of the lines is estimated to be about £12,000 per mile, including all charges except those for rolling stock, machinery, and workshops; and, considering the character of some parts of the country through which the lines have been taken, the cost may be considered moderate. The progress of railway construction in the colony may, therefore, be considered satisfactory, more especially when the mileage of paying lines is compared with the mileage of non-paying lines.

In the Commissioners' report for 1900, the various non-paying lines are enumerated, and they total up to 1286.85 miles, the annual loss on which, after paying working expenses, was £318,040. It will be seen from these figures that the non-paying lines are about 40 per cent. of the total mileage.

Before leaving the question of lines already built, I would like to draw your attention to a class of light or pioneer lines, designed by Mr. H. Deane, M.A. (Engineer-in-Chief for Railway Construction), the cost of which averages about £2300 per mile. The length of lines of this class built and in progress is about 254 miles. Mr. Deane, in a paper on economical railway construction, read before the Institution of Civil Engineers, gives a clear description of the design and construction of these lines, and there can be little doubt that the system of pioneer construction proposed by him will enable the railway systems of the colonies to be rapidly extended, at moderate cost, to parts of the country much in need of railway communication. The working rolling stock of the railways on the 30th June, 1900, is given as follows:—Engines, 489; tenders, 402; coaching vehicles, 1025; and goods waggons, 10,928. In addition to the rolling stock there are extensive workshops at Eveleigh, fitted with the most modern tools for carrying on the work of building and repairing all classes of rolling stock. The equipment includes four electric cranes, with a lifting capacity of 35 tons each, electric motors for driving the machine tools, hydraulic cranes for handling the heavy forgings, and an air compressor installation with pneumatic tools for chipping, caulking, drilling, tapping, and riveting. There is also a large installaton of hydraulic cranes in Newcastle for facilitating the rapid shipping of coal.

Before concluding this brief reference to the railway progress, I would like to draw attention to what will no doubt be one of the important railway engineering questions which must receive consideration in the near future, i.e., the gauge to be adopted for the main trunk lines of the Australian Continent. At the present time there are three different gauges in use, viz.:—New South Wales, 4ft. 8½in.; Victoria, 5ft. 3in.; South Australia, 5ft. 3in. and 3ft. 6in.; and Queensland, 3ft. 6in. And as railway engineers in all parts of the world are giving their attention to the design and construction of locomotives of the greatest possible traction power, it may be found advisable to adopt the 5ft. 3in. gauge, to enable engines of maximum power to be constructed. Mr. S. W. Johnson, M.I.Mech.E., in his presidential address to the Institution of Mechanical Engineers, used the following words when referring to railway gauges:—

"My ideal gauge for a railway is 5ft. 3in. How many of the difficulties experienced by locomotive superintendents and mechanical engineers would have been avoided had the 4ft. 8½in. gauge been superseded years ago by the 5ft. 3in. gauges."

The opinion herein expressed by such an experienced railway engineer should carry considerable weight from a constructional point of view, and it is equally important from the standpoint of economical railway working, as the wider gauge would admit of locomotives of greater tractive power being constructed, and thereby reduce the cost of transportation of the agricultural and pastoral products of the soil, and enable us to compete with the power of production of other countries with lower wages, and often with subsidised undertakings.

I will now briefly refer to the agricultural progress and development of the State. The records relating to the agriculture of the early days of the State are very few. In 180 the total quantity of land under cultivation was 7677 acres; in twenty years this increased to 32,000 acres. The estimated area of the State under cultivation in 1900 was 2,990,000 acres. The total area of the State, excluding the surface covered by lakes, streams, and rivers, is estimated to be 195,882,150 acres, and Mr. Coghlan (the Government Statistician) estimates the area absolutely unfit for cultivation at 5,000,000 acres. The actual area available for cultivation has not been determined, but there can be little doubt that the greater portion of the available area may be brought under profitable cultivation, provided proper attention be given to water conservation and irrigation.

As bearing on the connection between engineering and farming, the following figures are interesting:—

The estimated value of implements used in connection with farming is £1,754,000, and the value of plant of all kinds used on farms is estimated at £2,650,000, and as the machinery used comprises engines, boilers, steam pumps, and other classes of machinery, the development of agriculture means a considerable demand for machinery. The total value of agricultural products for the year 1899 was £4,827,700.

Before closing this brief reference to the agricultural progress of the colony, I would like to draw attention to the question of irrigation, with a view to pointing out the great scope and employment in store for engineers in laying out such works, and in designing and constructing the machinery required to carry them out successfully. A very considerable amount of work has already been done in the direction of water conservation and irrigation by the State Department controlling this part of the public works, and there are a number of schemes now receiving attention which will tend to the more equitable distribution of the available water supply in our rivers in times of drought. The extent to which irrigation is in use in the State is not recorded, so far as I have been able to find out, but there can be little doubt that there is a large area of rich agricultural land which may be made very valuable under an efficient and economical system of irrigation. I do not intend here to refer to methods of irrigation in detail, nor of irrigation applied to arid or semi-arid regions, because under these circumstances its value is readily admitted; but as I am fully persuaded that the productive capacity of the lands of the Australian Commonwealth can be greatly increased by irrigation, and as much of the water used for that purpose will have to be raised from the rivers and sub-artesian wells by some system of pumping, I should like to be allowed to refer to some irrigation water pumping plants which I had the privilege of seeing at work during a recent visit to the Hawaiian Islands and in Queensland. On the island of Oahu, one of the Hawaiian Group, the quantity of water being pumped for irrigation purposes in the early part of last year was estimated to be about 200,000,000 gallons in 24 hours, and when the plantattions, which are now extending their area of cultivation, have finished their planting, the quantity of water to be pumped is estimated to be about 300,000,000 gallons in 24 hours. The height to which this large quantity of water has to be raised varies from 40 to 550 feet, and when it is considered that this volume of water is about 15 times the daily consumption in Sydney and suburbs, an idea may be formed of the magnitude of the undertaking. There are several types of pumping engines in use in Hawaii for raising irrigation water, and as the cost of coal varies from 35s. to 40s. per ton landed at the pumping stations, special attention has been given to installing the most economical type of engine; they are all, therefore, without exception, constructed on the triple expansion principle. Some of these engines (in which the pump valves, both suction and discharge, were actuated mechanically) were working at a piston speed of from 450 to 540 feet per minute, and at the latter speed the pumps were running without the slightest knocking in the pump chamber, when working against a pressure head of from 350 to 550 feet of water. The pumps for raising irrigation water—used in Hawaii—are generally built in units, having a capacity of from 8 to 10 million gallons in 24 hours. The economy attained by these pumps may be gathered from the results of a duty test made with a triple expansion pumping engine when working under ordinary every-day conditions. This pump is fitted with ordinary suction and discharge valves; the engine is fitted with Corliss valve gear. The test was conducted by special experts, and the satisfactory figure of 130,000,000 foot lbs. per 1000 lbs. of feed water was obtained, which figure corresponds with about 125,000,000 foot lbs. per cwt. of coal. I was informed that some of the pumping stations obtained as high a figure as 135,000,000 foot lbs. per 1000 lbs. of feed water.

On the Burdekin River, in North Queensland, I visited a plantation on which they were pumping irrigation water at the rate of 20,000,000 gallons in 12 hours by means of centrifugal pumps, nearly all of which were of Australian manufacture. The pumps were belt-driven from portable engines, the object being to facilitate their removal from place to place as required. I should like to draw attention to a feature in connection with the working of these pumps which seems to me worthy of notice, and that is the facility with which they were drawing the water, on the suction side, to a height of about 28ft. 6in., which corresponds to a vacuum of about 25in. The efficient working of these pumps, under such conditions, was somewhat of a surprise to me. I had, therefore, careful measurement taken, so that there should be no mistake about the accuracy of the figures. In one case I found the pump drawing the water to a height of 28ft. 9in., measured from the surface of the water to the centre of the pump disc; in another instance, where the pump was drawing the water from 40 small tube wells sunk about 35 feet into the ground and connected together into a main suction pipe 12in. diameter, the vacuum recorded by a tested gauge, fitted on the suction pipe close up to the pump disc, was 25½in. I have mentioned these details at some length so that they may be put on record, as some of our members may be interested in the construction of an irrigation plant, where exceptional conditions may occur similar to those above stated.

As to the commercial success of irrigation, when carried out with a due regard to the suitability of the soil, and the cost of supplying water, there is abundant evidence in nearly all parts of the world.

The extent to which irrigation is practised in other parts of the world may be gathered from the figures quoted by Mr. H. M. Wilson, who, when speaking on this question, placed the averages in various countries as follows:—

Total area irrigated in—

India	25,000,000	acres.
Egypt	6,000,000	acres.
Italy.	3,700,000	acres.
Spain	500,000	acres.
France	400,000	acres.
United States..	4,000,000	acres.

In India and other countries efforts were made, in very early times, to preserve and utilise the rain and rivers for irrigation purposes. In Egypt irrigation works can be traced back to a very remote period, dating from about 1388-22 B.C.; and at the present time some engineering works of very great magnitude are being carried out, which will increase the area of land under cultivation in Egypt by several hundred thousand acres.

Australasia, with its uncertain and irregular rainfall, is a country which should benefit immensely by well-devised system of irrigation, and I need only point out the great scope there is in the future for the energy and ability of the civil and mechanical engineer in carrying out works of this class to a succssful issue, and as the success of any scheme greatly depends on the cost of putting the water on the land, it mainly rests with the engineers to study the various problems involved and find an economical solution of them in order that the great Continent of Australia may be able to support a large population, and export largely to other countries the products of the soil.

The next industry to which I will refer is that of mining, mainly with a view to directing attention to its importance as a factor in the expansion of our engineering industries. The value of the machinery employed in the various mining industries is estimated as follows:—

Coal and shale	£1,030,000
Gold	800,000
Silver	557,000
Copper	123,000
Other mining industries	23,000
	£2,533,000

and there is about 28,000 indicated horse-power employed in the working of the mines.

The value of the output of the mines for 1899 was about £5,000,000.

In addition to the machinery mentioned above, there are many other works in connection with mining which call for the services of the engineer, such as branch and local railway lines, rolling stock, etc.

The manufacturing industries of the State will now be briefly referred to, with a view to drawing attention to their bearing on the development of mechanical engineering industries. The manufacturing industries in the State are represented by a fixed capital of from £17,000,000 to £20,000,000, and the value of production turned out by them is given by Coghlan for the year 1898 as £8,079,700, and there is about 33,000 horse-power used for operating the machinery employed in the factories. The total horse-power used in the State is estimated at 221,300, or 166 horse-power for every 1000 persons. This figure compares favourably with other countries, as will be seen from the following figures:—

Country.	Horse Power Employed.	Per 1000 Population.
United Kingdom... ...	9,200,000	250
France	4,520,000	110
Germany	6,200,000	130
Russia	2,150,000	30
Austria	2,150,000	50
Italy	830,000	30
Spain	740,000	40
Belgium	810,000	140
Holland	340,000	80
United States	14 440,000	240
N. S. Wales	221,000	166

These figures show that the State of New South Wales uses more horse-power per 1000 of the population than the other countries mentioned, excepting the United Kingdom and the United States. The services for which the power is used in the State are shown in the following table:—

Transport, land.	66,000 H.P.
Transport, water	41,200
Manufacturing	33,000
Agricultural, Pastoral, and Dairying.	36,100
Mining	27,200
Miscellaneous.	15,300
	221,000 H.P.

These figures show that, from an industrial point of view, the State has made considerable progress. The quantity of coal consumed to produce the power may be put at 600,000 tons per annum; this, in turn, gives employment to a large number of engineers, both ashore and afloat.

Sanitary Engineering.—The century just closed has witnessed a great change in the sanitary engineering of large cities, towns, and villages. It is about half a century since the first efforts were made to improve the health of the great masses of the people by the introduction of sanitary measures. The first system of sewerage laid out for Sydney was designed on the principle of what is known as the "combined system." It was, however, found so defective, and a menace to public health, that the present system was adopted, which intercepts all sewerage above the 40ft. level, and it is carried out to the northern outfall at Ben Buckler. There is, however, a large area, estimated at about 2900 acres, below the 40ft. level, which will have to be handled by some system of pumping.

In the excellent and exhaustive paper read by Mr. A. E. Cutler, M.I.Mech.E., Ass. M.I.C.E., on the Sydney and suburban low-level sewerage, during our last session, the various systems were explained and discussed, and the conclusion arrived at that a system of pumps driven by electric motors would give the highest efficiency and be the most economical. The engineering work sketched out in Mr. Cutler's paper consists of 20 pumping stations, which, when finished. will make the sewerage system of Sydney—as far as the engineering features are concerned—one of the most complete in existence, and if the Health authorities be empowered to enforce a house-to-house inspection, and to make it compulsory that all buildings and houses be connected to the sewers by proper and approved sanitary appliances, the city should be a very healthy one and almost immune from a serious attack of plague. It should, however, be pointed out that until some efficient system of garbage destruction be brought into use, we are still, to some extent, liable to the spread of plague, so long as we have the obnoxious rubbish tip system in use. It is not the intention in these remarks to go into the merits of the metropolitan area, suburbs, and inland towns. are about 30 different designs, all working more or less successfully, in various parts of the world, and surely it is not expecting too much of the new City Council to come to a decision to instal a system suitable for the city at an early date. The capital cost of the metropolitan sewerage works, up to 1899, is £2,699,426.

Water Supply.—I will now refer briefly to the engineering progress made in connection with the water supply of the various destructors. Suffice it to say that there The extensive scheme of water supply for the metropolitan area and suburbs is one of great magnitude. The supply is drawn from the watersheds of the Nepean, Cordeau, and Cataract Rivers, a distance from Sydney of over 60 miles, the total watershed areas being about 354 square miles. The water is conveyed from the watersheds through 11¾in. miles of tunnel and of 33¼in. miles of canal into Prospect Reservoir, which has a storage capacity of 7,325,000,000 gallons, which at the present average rate of consumption is equal to 385 days' supply., The capacity of the works above Prospect is estimated at 150,000,000 gallons daily, or equal to eight times the average daily consumption. There is a reservoir of 108,000,000 gallons capacity at Potts Hill, about half-way between Prospect and Sydney. There are also 15 service reservoirs situated within the metropolitan area and suburbs, the largest and most recently constructed one being on the Centennial Park site, having a capacity of 18,500,000 gallons. The total capacity of all the service reservoirs is about 24½ million gallons. In the report of the Water and Sewerage Board for 1899, the quantity of water pumped per annum into the various service reservoirs is given at 3,782,368,609 gallons, which is 55 per cent. of the total discharge from Prospect. The consumption of coal for the same year is given at 6442 tons. There is, therefore, employed about 700 I.H.P. every hour during the 24 to pump water into the service reservoirs in the metropolitan area and suburbs

The capital expenditure on the metropolitan and suburban water supply up to 1899 is £4,398,945.

The next important water supply is that of the Hunter River district. The water is pumped from the Hunter River, about a mile and a half up stream from the Belmore Bridge, West Maitland. The scheme comprises a number of storage reservoirs and about 180 miles of water mains. The capital expended up to 1899 is £477,890.

In addition to the metropolitan and Hunter water supply schemes, there are 41 inland towns which have had water supply schemes carried out suitable for their requirements. The total cost of these works is £224,000

The total cost of the water supply schemes in the State up to date is £5,200,000.

Telegraphy.—This brief review would be wanting in interest if some reference be not made to the development of the telegraph service of the State. The electric telegraph was first used in January, 1858, when the line (22 miles long) from Sydney to Liverpool was brought into operation. In 1899 there were 13,416 miles of line, carrying 35,800 miles of wire, in use. The total cost of construction, including telephone installation, up to 1898 is £989,423.

No trials have been made in the State—so far as I have been able to learn—to introduce the system of wireless telegraphy for signalling or other purposes; the delay in doing so may be due to the fact that there is no service to which it can be put that cannot be equally well done by the ordinary systems. Attention may, however, be drawn to a successful trial, made in England, of the wireless system of telegraphy for warning vessels of their approach to points of danger; if such a system were in use at some of our lighthouses, and on dangerous headlands, it would doubtless be the means of preventing many shipwrecks.

The "Marconi" system of wireless telegraphy has been definitely adopted for the British Navy, and there seems to be no question among British naval men that this is the best wireless system. It would, therefore, seem that it has passed beyond the experimental stage, and our Navigation authorities should take steps to introduce it in connection with the lighthouse service on the coast, so that we may acquire experience in the working of the system.

Steam Ferry Service.—Considerable improvements have been made during the last few years in the class and speed of vessels employed in the steam ferry passenger service to the various marine suburbs situated on the shores of the harbour and rivers. The latest addition to the already numerous fleet is the new vessel recently launched, and nearing completion, at the Balmain works of Mort's Dock and Engineering Co. The vessel was designed by Mr. Walter Reeks, N.A., one of our members. The vessel is 175ft. in length, 31ft. beam,