

## Part II.

## 16. Industrial Development.

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Engineering establishments in which the design, construction and development of machinery were vigorously carried on came into being in surprising numbers and size very early in the life of the colony. For this there was one major cause—the discovery of gold in 1851, and the necessity for machinery to work the many mines which were sunk in the various auriferous districts of Australia following upon the working out of the richest of the alluvial deposits.

As the colony developed, its public works required machinery and engineering materials. Works to meet such requirements were established by private enterprise, but most of the heavier plant, such as locomotives and heavy pumping and power plant, was manufactured by firms which had been established primarily to supply the demand for mining requirements.

From about the "seventies" may be traced the growth of the agricultural implement industry, which has been one of the largest and most important of Victoria for many years past. In no other industry has more inventive skill and ingenuity been displayed, and many types of new machines have been evolved to meet the requirements of both local and general agriculture.

During the present century, important developments have taken place in such industries as cement, rubber, paper, glass, and porcelain manufacture, and since the War several undertakings for the manufacture of electrical plant have been firmly established with every likelihood of expansion.

The first foundry and engineering works in Melbourne were established in 1842 by two Scotsmen, Robert Langlands and Thomas Fulton, who had formed a partnership before emigrating, and arrived in Melbourne early in that year. They established themselves between Flinders Street and Flinders Lane and King and Spencer Streets, and were known as the Langlands Foundry Co. Their sole machine tool, when they commenced business, was a small slide rest lathe turned by foot, and they had to overcome many initial difficulties. About 1865 they moved across to the southern side of the river, a site now occupied by the Robur Tea building, near the Spencer Street bridge. About 1880 they moved to Grant Street, South Melbourne, a site occupied now by Dorman Long & Co. At this time they commenced the manufacture of cast iron pipes for the Board of Works, doing a big business in this line.

Langlands was the first company in Victoria to take up the manufacture of mining machinery and their products could be found distributed over Australasia from Charters Towers to the Thames goldfields of New Zealand. They turned out the first stamp mills made in Australia, and it is of interest to note that their mills embodied the principle of the stamp and shank being rotated by the lifting cam, thus equalizing the wear on the stamp. Till that time the shanks were square and did not rotate. This was the in-

vention of Fulton, who did not patent the idea, which was quickly copied all over the world.

The firm employed some 350 men for a number of years. As a young man Sir Herbert Austin worked as a fitter in their works. In the early "nineties" the firm declined and was bought up by the Austral Otis Co.—in about 1893. Fulton retired from the firm before this date and practised as a consulting engineer.

Probably the oldest surviving engineering establishment of any size in Victoria is that of Robison Bros. Pty., Ltd., South Melbourne. Established in 1854 (the same year as Morts Dock was established in Sydney) by Jared Robison, with his sons William, Andrew, James and Thomas, the firm was originally known as The Victoria Copper Works. The original site of the works was in Royal Highlander Lane, off Flinders Street, but as the business grew it was transferred to 31 Flinders Street, opposite the Railway Station. Later Henry Dodds, a son-in-law, joined the firm, and the name was changed to Robison Bros. & Co. A further extension of business necessitated new works, which were situated in Moray Street, South Melbourne, near Falls Bridge (now Queens Bridge). It is interesting to note that this property was bought for £8 per foot in 1865, and sold in 1888 for £344 a foot.

The steamer "Florence Maud" of 120 tons, for the Colonial Sugar Refinery Co., was built on the river bank at No. 1 South Wharf near Queens Bridge and launched stern first in 1874. An early achievement of the company was the manufacture of eight tank locomotives for the south suburban railway lines. These were used on the St. Kilda line, the line at this time being at street level, the present embankment having been built later. Twenty-five "R" class locomotives were also built about 1895 for the Victorian Railways. In 1887 the present premises in Lorimer Street were occupied, and here many large ship repairing jobs have been dealt with.

The first commercial cargoes of frozen meat shipped from Victoria to England were carried by the "Protos" in 1880 and by the "Europa" in 1881. The refrigerating machinery of these vessels was of the cold air type, built and installed by Robison Bros., who sent their own engineers to operate it. (T. S. Mort of Sydney was of course the great advocate and pioneer of the frozen meat export business. He chartered a steamer and fitted it with refrigerating machinery in 1875, but owing to a breakdown of this machinery on the voyage the venture failed and involved its promotor in heavy loss).

Robison Bros. were the pioneers of the centrifugal pump in Australia, building their first pump in 1874. Mr. Thomas Robison designed and patented a diffuser type swivelling casing pump which proved highly efficient and convenient for irrigation work, for which purpose it has been

widely used all over Australia. To-day Australia builds practically all the centrifugal pumps she requires, the industry centreing chiefly in Victoria.

So far as is known the first dock for ship repairs in Melbourne was owned and operated by a Mr. Sennitt and was known as Sennitt's Slip. This slip could accommodate only small vessels of less than 100 tons displacement, and was located on the south side of the river near the present Spencer Street bridge. Later a dry dock, 330 feet long by 46 feet wide by 16 feet deep, was erected by a Mr. Wright, who was subsequently joined by Mr. Orr. The dock was enlarged to 430 feet by 64 feet by 23 feet 6 inches, and is at the present time the smaller of the two existing dry docks. A larger dock, now 550 feet by 70 feet by 23 feet 6 inches, was erected by a Mr. Duke, and for some years keen competition existed between the two docking firms until finally amalgamation was effected and the present company, Duke's and Orr's Amalgamated Dry Docks, Ltd., was formed.

The firm of Anderson, Campbell and Sloss grew from small beginnings in the early "fifties" and identified itself with the maritime work of the port. Its record includes cutting and lengthening the s.s. "Julia Percy" and supplying her with a new boiler of 42 tons weight, and in about 1887 it built the s.s. "Lady Loch." The firm no longer exists.

Another old firm still in business is the Tyne Foundry of Johnson & Sons, which was founded in 1869 by J. C. Johnson, who had formerly been with Langlands Foundry. Besides building 13 gold dredges for New Zealand, they built a number of small steam craft and hopper barges. In 1880 they carried out extensive repairs to the Orient Company's s.s. "Sorata," whose bottom plates had been so badly damaged as to need replacement. Work on this job was carried on by continuous shifts for seven months.

Wright and Edwards established an engineering works in Little Bourke Street between King and William Streets about 1860. They built engines, wool washing, pressing and dumping plant, and later railway trucks and mining plant, and employed from 100 to 200 men. The business was later known as the Atlas Iron Works, but declined and was absorbed by Geo. W. Kelly and Lewis in 1899.

In 1880 Hughes, Pye and Rigby started in business in City Road, moving to Moray Street in 1885. Hughes had been foreman with Wright and Edwards, with whom Rigby had served his time. They had only £600 capital between them, but their business grew so that it was purchased at the end of six years for £33,000. They built mining machinery, engines, and boilers, and undertook ships repairs; they also began building hydraulic lifts for the tall buildings, which were then being erected during the building boom.

The Otis Elevator Co. of the United States of America, at this time, sent their Vice-President to investigate the possibility of business in lifts in Australia, and as a result of his visit a new company was formed, with the help of B. J. Fink, to acquire the business of Hughes, Pye and Rigby and to manufacture hydraulic lifts under license to the Otis Elevator Co. The company was styled the Austral Otis Engineering Co., Rigby and Hughes remaining as Managing Directors. The company employed some 400 men and carried out many large and creditable contracts. They were very active in mining work and supplied boilers, winders, smelters, batteries and treatment plants to many of the largest mines all over Australia, and powerful pumping plants for the Charlotte Plains Consolidated Co., the Victorian Deep Leads, the Loddon Valley and the Berry United Mining Companies, all deep lead propositions. They made much of the original plant for the Melbourne cable tramway system;

the boilers and engines for the City of Melbourne electric light station at Spencer Street and for the Electric Light and Traction Co's works at Richmond; and sewage pumping engines for the Melbourne and Metropolitan Board of Works. Many suction and bucket dredges were built for mining purposes, including 13 for New Zealand.

During the golden days of Ballarat, Bendigo and Castlemaine, a number of engineering works flourished in these centres. In Ballarat the largest and best known firm was the Phoenix Foundry, founded in 1856 by Carter, Bodycomb and Shaw, the last named being manager. They manufactured mining plant for years and in 1870 added locomotives for the Victorian Railways to their products. By 1886 they had built 203 complete engines and tenders, but they went out of business about 1909, no doubt largely as the result of the decision of the Railway Department to build its own locomotives. The Phoenix Co. employed normally some 250 hands.

The Union Foundry was started in 1865 by John Walker, Wood, Braddock and Sandry, and was purchased in 1879 by John Hickman. Two seventy-two inch diameter beam engines built here were claimed to be the largest made in Australia at the time. Heavy mining machinery was supplied for use throughout Australia. About 100 men were employed. The works were finally closed about 1912. An offshoot, established about 1868 at Maryborough survives to-day as Walkers, Ltd., the largest private engineering works in Queensland. Other engineering firms established in the early mining days were the Victoria Foundry and Engineering Works of Hunt and Opies, McIvers, Trahar Bros., Lonie and Dingle, Brown's Albert Foundry and Cowley's Eureka Ironworks.

In Bendigo the largest engineering works were those of Roberts & Son who lived almost exclusively on mining work for about 50 years. They employed about 250 men and went out of existence about 1917.

Harkness and Sons was another firm engaged for many years on mining plant and employing about 150 men. Smaller firms were Taylor Horsefield and the Central Foundry.

In Castlemaine also there were several engineering works including Vivian and Co., The Albion Foundry, afterwards Horwoods Foundry, and Thompson and Co.

Of all these works established in the goldfields in the latter half of the last century only those of Thompsons Engineering & Pipe Co., Ltd. of Castlemaine have survived and expanded. David Thompson, trained under his father as an engineer and ironfounder in the north of Ireland, reached Melbourne in 1852, engaged for some years in mining, and in 1875, with his brother James, established the present engineering business, which for some years was carried on as an adjunct to their flour mill. The engineering side developed rapidly, however, and the flour milling was discontinued a little later. The brick walls of the present offices are in part those of the original flour mill. Fifty years ago a contract for points and crossings was obtained from the Victorian Railways and the contracts for these have been held continuously ever since. Mining machinery of all kinds for many years comprised a very large portion of their work. Situated in the centre of an alluvial field, the firm became acknowledged leaders in the practice of hydraulic sluicing and dredging with the aid of gravel pumps.

David Thompson, a son of the founder, later directed the firm and with him was associated W. V. Dam, who will be remembered by the fine steam winding engines for which he was responsible, such as that for the Great Boulder, Western Australia. From 1904 to 1919, sixty "DD"

locomotives were built for the Victorian Railways Department, and subsequently 22 for the Commonwealth Railways, while in 1918-1921 six sets of marine engines and propelling gear were made for the 5,000 ton Commonwealth steamers. In 1925 a steam driven reciprocating blowing engine was built to the order of Hoskins Iron and Steel Co., Lithgow, to discharge 50,000 c. ft. per minute against a pressure of 30 lb. per sq. in., the weight of this engine complete being 350 tons. To-day the principal products are centrifugal pumps, air compressors, electric winders, steam turbines, condensing, evaporating and de-aerating plant, railway tyres and crossings. In 1920 the works of Gray Bros. at Williamstown were acquired. Large steel pipes, barges, tanks and structural steel work are made there, and there too, is the steel foundry. Some 600 men are normally employed at the two works.

The firm of Geo. W. Kelly and Lewis Pty. Ltd. commenced business in Little Bourke Street, Melbourne, in 1899. The business was previously carried on by G. W. Kelly who admitted as a partner E. P. Lewis, who had for several years previous been Works Manager of Thompson and Co., Castlemaine. Both men possessed outstanding mechanical ability. The works were extended first in Melbourne, and in 1927 the transfer of the whole works to Springvale was completed. The firm is particularly known for its pumps, condensing plant, compressors, and petrol engines and has a large structural steel shop, which recently supplied the whole of the structural steel work for the extensions to the Yallourn power house. Geo. W. Kelly died in 1909 and E. P. Lewis in 1930, and the business is now carried on by his sons, E. L. Lewis and K. P. Lewis.

Chas. Ruwolt Pty. Ltd., was founded by Chas. Ruwolt, the son of a South Australian farmer, who served his time with Martin & Co. of Gawler, worked 3 or 4 years with Thompson and Co., Castlemaine, and left to start a small general engineering business in Wangaratta in 1901. Within three or four years bucket dredging developed very rapidly on the Ovens River. By this time he had twenty to thirty employees and was called upon to do a good deal of repair work to the dredges. Shortly he began to build complete dredges. By 1911 local requirements were satisfied, and in this year he transferred his works to Richmond.

From 1908 to 1922 some thirty bucket dredges were built which, with their machinery, were worth about £1,500,000. A number of these dredges was sent to the Philippines and Siam. After 1922 conditions for building further dredges in Australia became very difficult and the firm turned to industrial work, occupying itself with road making machinery and plant for rubber and cement works, etc., and general mining machinery. With the revival of mining in 1930 the activity of the firm increased greatly. Ball mills and Wilfley pumps are included in the specialities made by the firm, which has a large steel foundry and a number of modern heavy machine tools.

The largest establishment to-day specializing in structural steel work are Dorman Long & Co., Ltd. and Johns and Waygood Ltd. The former established their works in South Melbourne in 1899 while Johns and Waygood derive from Johns Hydraulic and General Engineering Co. which was founded in 1856, and developed a large business in hydraulic machinery including lifts and wool presses.

Amongst old established iron foundries still vigorous may be mentioned Payne & Sons (1894), Main & Sons (1855), J. Nixon & Sons (1883), Monteath & Sons (1882) and John Danks and Sons Pty. Ltd. (1852).

#### INTERNAL COMBUSTION ENGINES.

The internal combustion engine—apart from the motor car—has found its principal application in Victoria in small sizes for farm use. The two largest firms specializing in these engines are A. H. McDonald & Co. Pty. Ltd. of Hawthorn, and Ronaldson Bros. & Tippett Pty. Ltd. of Ballarat. From the nature of their business it has resulted that both of these firms have a sales organization more highly organized than most other engineering works of their size in Victoria. A. H. McDonald started in a small way in 1900 and now employs about 200 men. Oil engines, crude oil engines, tractors, road rollers and milking machines are the principal products.

Ronaldson Bros. & Tippett Pty. Ltd., commenced operations in 1903, and in their early days particularly identified themselves with the Wimmera district. They build petrol, kerosene, and crude oil engines and manufacture electric lighting plants, tractors, shearing plants, sprayers, milking machines, sawbenches, etc. Their sales of engines now exceed £1,000,000.

Among firms who specialize in certain lines may be mentioned The Richardson Gears Pty. Ltd., D. Richardson & Sons Pty. Ltd., who specialize in fans, McPhersons Pty. Ltd., nut and bolt factory and also their machine tool works; The Ford Motor Co., motor works at Geelong, and Jacques Bros. Pty. Ltd., who specialize in rock breakers and road making machinery.

#### PIPES.

Great enterprise and inventive skill has been shown in connection with the manufacture of steel and concrete pipes in Victoria. Mephan Ferguson founded his firm in 1875 as general engineers and for many years produced straight riveted and spiral riveted pipes. He gave much thought to improved methods of pipe manufacture and one day, in 1896, on opening a drawer, he noticed its dovetailed joints and conceived the idea of applying the principle to steel pipe construction. After some experimenting he produced the first locking bar pipe. In the year mentioned large contracts were offering in South Australia for 26 in. and 28 in. diameter pipes so a model of the new pipe was submitted for test. The locking bar joint proved to be 100% efficient. These contracts were secured and completed in the specified time and the method was adopted in other parts of the world with complete success. Famous among the contracts taken up by Mephan Ferguson Pty. Ltd., was the Perth to Coolgardie pipe line, consisting of 350 miles of locking bar pipes, 30 inches diameter of  $\frac{1}{4}$  in. plate. This whole contract was completed within two years and the output of pipes often exceeded one mile per day. Any one who has seen this pipe being manufactured cannot but be impressed by the ingenious and powerful machinery designed and built by the inventor for its rapid manufacture.

About 1910 W.R. and E. J. Hume, who were carrying on a successful steel business in Adelaide, began experimenting on the possibilities of making pipes for water supply purposes from reinforced concrete. They succeeded in developing a practical and economical method of forming pipes, without using cores, by introducing the concrete mixture at the ends of a cylindrical mould, which is revolved at a considerable speed by friction drive. The mixture distributes itself evenly along the length of the pipe and the superfluous water flows away from the inside, leaving a hard compact and watertight wall. Internal diameters of almost any size—say, 2 inches to 8 feet—may be dealt with in this manner.

The Hume Pipe Co. (Australia) Ltd., formed in 1920, now has its headquarters in Melbourne, with works at Maribyrnong and branches in all the other capital cities, carrying on the manufacture of concrete pipes in a very extensive way. Concrete pipes are also made under the Hume patents in various other parts, notably South Africa, New Zealand, India, United States of America, and Great Britain. A subsidiary company in Victoria also manufactures welded steel pipes and lines them with cement when so required.

In 1924 Thompsons Engineering & Pipe Co. Ltd. (Castlemaine) erected a modern plant at their Williamstown works for the manufacture of large welded mild steel pipes. This plant was designed to make pipes up to 6 feet diameter and 30 feet long, and includes heavy tools for planing, pressing and testing pipes of this size, as well as a dipping and coating plant of the same capacity.

The welding of the plates is effected by Cutler-Marsden automatic electric welding machines, the patent rights of which were secured by the firm. For the longitudinal seams a wholly automatic machine is used: this traverses, feeds and maintains a constant length of arc quite automatically, and the arc itself is controlled by a magnetic field. For the circumferential and other welding a semi-automatic machine is used which automatically maintains a correct length of arc but is traversed by hand. These machines were all built by Thompsons, and are wholly an Australian invention.

#### IRON AND STEEL WORKS.

While there is a known deposit of about 750,000 tons of good iron ore located at Lal Lal (near Ballarat), and another deposit at Nowa Nowa, the lack of accessible coal has rendered it impossible to smelt ore cheaply in Victoria. A very small and crude blast furnace was operated for a brief period at Lal Lal producing about 5 tons per day of hard pig. In 1860 William Edgerton erected a rolling mill in Dudley Street, Melbourne, and rolled the first piece of bar iron in Australia. This historic plant with numerous extensions and improvements was operated by the Victoria Iron Rolling Co. Pty., up till 1923 when it was transferred to Brooklyn. In 1929 it amalgamated with the Lion Rolling Mills, a plant established at South Melbourne in the early "nineties" and the firm is now in active operation producing all classes of carbon and engineering alloy steels, rail components and re-rolled iron. The firm possesses a 7-ton Heroult electric furnace with a capacity of 150 tons of steel weekly. The plant includes a 500 ton Davy hydraulic forging press, one 18 inch and two 10 inch mills.

The first firm in Australia to produce mild steel castings was the Steel Co. of Australia Pty. Ltd. of Brunswick. This firm operates a large steel and iron foundry and produces various types of steel casting including heat treated chrome manganese and alloy steels in its side blown converter.

Charles Ruwolt Pty. Ltd. at Richmond operates a large well equipped steel foundry and has specialized for many years in mining and railway work. Installed in the foundry are converters, cupolas and an electric furnace. A considerable quantity of manganese steel is made for mining and road making machinery.

Steel converters are also operated by Thompsons Engineering & Pipe Co. Ltd., at Williamstown, who make railway and general castings, and by Davies and Baird Pty. Ltd., who cater for light and medium weight castings. The combined capacity of these steel foundries is more than sufficient to meet all the requirements of the State.

During the Great War the Railway and Tramway authorities of the various states were faced with a serious shortage of rolled steel tyres. Thompson & Coy. of Castlemaine decided to undertake this work. At first the tyres were produced by flattening, piercing, and becking roughly to shape under a 500 ton Davey hydraulic press. Subsequently a tyre rolling plant was designed and built and a 1,000 ton Davey press added to the forge equipment, and a special tyre boring and turning plant installed. This plant now turns out most of the railway and tramway tyres for Victoria, in addition to considerable orders for other states.

#### THE AGRICULTURAL IMPLEMENT INDUSTRY.

The father of the agricultural implement industry in Australia is undoubtedly John Ridley, a flour miller and farmer of Adelaide. The extreme difficulty of securing labour to harvest a fine crop of 15 acres of wheat led him to design and manufacture a horse power machine which he had ready for the next season of 1843. It did its work at the first time of asking. Ridley's machine was the first to take off the heads of ripe standing grain as it moved through the crop and to thrash them—all in one operation. It had a horizontal comb in advance, and behind this was a revolving beater which knocked off the heads of grain as they came into the comb. The heads then passed between the revolving beater and a concave plate, and in so doing, they were thrashed and the mass of grain and chaff then passed in to a receptacle at the rear. This was periodically emptied onto a canvas sheet spread on the ground and the grain was winnowed later. Ridley's machine treated a strip 3 feet wide at each passage through the crop and was pushed by two horses walking behind it. This machine was the prototype of the Australian strippers which were made in large numbers until the end of the nineteenth century and are still manufactured to a small extent. Ridley did not take out letters patent for his invention. Practically he made a present of it to his fellow colonists. It encouraged the culture of wheat, first in South Australia and later in the other colonies, and it was the foundation on which the manufacture of farm implements in Australia was first based. From 1843 to 1880 thousands of strippers were built in Australia in greatly varying patterns, but none of them went one step further towards finishing the work than Ridley's original machine had done. Winnowing was back breaking labour and had to be done during the hot summer months. In the "eighties" inventors began to bestir themselves on account of the constant complaint of the farmers, and many turned their thoughts towards the possibility of mounting a winnower behind the stripper, so that the horses might be made to do the whole work of stripping and winnowing in one continuous operation. Names that were prominent in connection with experiments of this sort were George Marshall of Alma, South Australia; J. E. Adamson of Auburn, South Australia; G. Phillipson of Wangaratta; James Martin of Gawler, South Australia; James Morrow of North Melbourne and Hugh Victor McKay of Drummartin, Victoria.

All of these inventors took out patent rights on various features of their machines, but none secured a master patent.

The name that emerges, both as one of the earliest inventors and the most successful manufacturer is H. V. McKay. The first public demonstration of his machine was given at Kamarooka in 1885, so that the Centenary of Melbourne corresponds with the Jubilee of the Australian harvester. It was not until 1895 that McKay was able to start a tiny factory of his own at Ballarat. This grew to employ 400 men.

The great drought, culminating in 1902, caused most Australian implement factories to close down, but McKay, more enterprising, sent a shipment of his machines to the Argentine Republic with his brother Samuel McKay. The result was a surprising success, as the combine harvesters were welcomed by the wheat growers of the River Plate, and some 10,000 of them were shipped to Buenos Aires from 1902 till 1914, when the war stopped the business. In 1906 the works were removed to Sunshine, the works of the Braybrook Implement Company having been acquired at that site. The buildings now cover more than 35 acres and contain a most efficient plant for the fast and economical mass production of agricultural machinery. Two thousand operatives are employed at busy times. Some of the earliest and most prominent of the agricultural implement manufacturers date back to the "seventies." Among these were Hugh Lennon who was the most prominent manufacturer of ploughs in Victoria, with his factory at North Melbourne; George Gibbons who had a large business in multi-furrow ploughs; John Buncle & Son Pty. Ltd., of North Melbourne, who lead in the chaffcutter business, and did much to develop the large travelling chaff cutters, taking up baling presses at a later date; T. Robinson & Co. Pty. Ltd., originally of Melbourne but now of Spotswood, who were amongst the early manufacturers of strippers and winnowers, also wool presses, and are now prominent in stripper harvesters, header harvesters, etc. Established later in, the "nineties" were Nicholson and Morrow, also prominent in strippers and then in stripper harvesters but now out of business; and Mitchell & Co. Pty. Ltd. well known for their ploughs and drills.

#### THE ELECTRICAL INDUSTRY.

In 1898 Mr. George Weymouth laid the foundations of what was to be known later as G. Weymouth Pty. Ltd., a company devoted to the manufacturing of electrical machinery. A report of April, 1906, shows that at that date these works had manufactured 334 electric motors with an aggregate horse power of 2,434. Amongst these machines were included one 200 h.p. and two 50 h.p. 3 phase motors; and two 50 h.p. direct current motors.

Generators totalling 1,000 kW. had also been manufactured including polyphase units of 330 kW. and 120 kW. each. Winding engines, electric elevators, electric pumps and even mining electric locomotives were amongst their products. The resources of these works afforded a much needed means for the repair of the electric generating units which were being used in ever increasing size and number. The energy, vision and technical knowledge displayed by Mr. George Weymouth entitles him to be regarded as the first big figure in the electrical manufacturing industry in Australia. The works have now been absorbed by an amalgamation and specialize in transformer and switchgear construction, retaining as Works Manager, Mr. H. Weymouth, who was associated with his brother in the early development of the company.

In 1908 Messrs. Staerker and Fischer, later absorbed by the Australian Metal Co., agents for the A.E.G., established a workshop off Little Latrobe Street in Melbourne West, and by 1912, this company employed about 100 men in the workshop, chiefly devoted to electrical repairs and the construction of electric switch and control gear from parts imported from Germany.

About that time the Australian Porcelain Insulator Co. Pty. Ltd. initiated the manufacture of insulators, but it was not until after the outbreak of the War in 1914 that the

manufacture of electric machinery and apparatus was seriously regarded as an industry suitable for development.

Early in 1915 the Australian Metal Co. was declared an enemy subject and some of the engineers associated with that company grouped themselves together to found Electric Equipment Manufacturers Pty. Ltd., specializing in switch and control gear, becoming subsequently Metropolitan Vickers, Australia, Pty. Ltd., which in 1930 was absorbed by the amalgamation of the works owned by the Associated Electrical Industries Ltd. of England, the General Electric Co. of America and Weymouths Ltd.; the Victorian works now occupying the premises of Weymouths Ltd.

Another firm specializing in electrical control and switch gear is Williams and Benwell Pty. Ltd. In 1911 the two principals, soon after the completion of their apprenticeship with Messrs. J. A. Newton & Co., joined forces and commenced on their own account with little or no capital, and having only a single foot-operated lathe, doing at first jobbing and repair work. After two or three years the manufacture of industrial switch gear was begun in a very humble way, commencing with a circuit breaker. Later oil switches, compensating starters, star deltas and no-volt switches were developed, and then the application of the press button was exploited. Equipment for automatic remote control of pumps with float or pressure switches has been supplied very largely, and complete automatic and manually-operated industrial equipment is now being made for all parts of Australasia. Modern works were erected in South Melbourne in 1923 and some 40 hands are now employed.

The McColl Electric Works Pty. Ltd. manufacture motors of small and fractional horse power and have made steady progress and growth of recent years.

Hecla Electrics Pty. Ltd. established in South Yarra only a few years ago specialize in radiators, toasters, etc., and have a good modern works employing some 100 hands.

Following the Great War the demand for electrical power increased very rapidly and many large generating units were required in the capital cities. Thompsons Engineering & Pipe Co. Ltd. of Castlemaine became licensees from Metropolitan-Vickers Electrical Coy. in 1922 and under this arrangement steam turbines and condensing plant to the extent of 265,000 kilowatt capacity have been manufactured at Castlemaine, including 7/25,000 kW. tandem sets for Bunnerong and 2/25,000 kW. 3,000 r.p.m. tandem sets for Yallourn.

#### ELECTRIC WELDING.

Victorian engineers have without doubt been well to the fore in their appreciation of the great advantage offered by electric welding. Serious developments in structural welding resulted from the extensive programme of the Metropolitan Gas Co., undertaken by Mr. J. N. Reeson following considerable experimental work. The three million cubic feet capacity gasholder for South Melbourne, with which the Company commenced was a most extensive undertaking in 1922, and the various novel methods employed evoked the greatest interest. It was followed by further gasholders and their framing, retort houses and other structures. The reconstruction by the Railway Construction Branch of the combined highway and railway bridge over the Murray River at Echuca in March, 1925, a considerable work involving over 10 miles of welding, is claimed to be the first extensive application of the process in bridge work anywhere in the world. This work was followed by the application of the process to the partial or completed fabrication of some 60 highway and railway bridges in the State.

The year 1928 marks the beginning of extensive development in welded building construction, and in 1929 the first all welded steel frame was erected for the Australian Oxygen and Industrial Gases Pty. Ltd., by Messrs. Gardner Constructions Pty., Ltd., who were responsible for most of these earlier welded buildings. Welding is now the standard method of construction of railway wagon stock.

#### THE CEMENT INDUSTRY.

The pioneer in the cement industry was David Mitchell, who in the early "nineties" commenced manufacture at Burnley, the works being run in conjunction with his lime quarries at Lilydale. After his death both operations were continued by the David Mitchell Estate, until a few years ago when cement manufacture was discontinued and the business confined to the manufacture and distribution of lime from the works at Lilydale.

The Fyansford Cement Works owe their creation to Mr. Peter McCann (father of the present General Manager), who first made cement at Geelong in the "eighties." He was aided by Mr. Richard Taylor, who had previously been a cement manufacturer in New Zealand. Limestone deposits had been secured by Mr. Peter McCann and in 1890 a syndicate, comprised mostly of Geelong and Melbourne contractors, was formed to take over the business. On 16th October, 1895, the Australian Portland Cement Co. Pty. Ltd., was registered in Victoria with works at Fyansford.

As with many pioneering concerns, the company had a hard struggle for existence in its initial stages, and in 1910 it was sold to Mr. T. J. Noske and re-registered under the same name. The old works were scrapped and a modern plant installed, capital being expanded for the purpose. With a capacity of 400 tons a week the new plant commenced manufacturing with what is known as the "dry" process. In 1914, however, acting on expert advice from Europe the works were converted to the "wet" process, which ensured more perfect mixing of the ingredients and guaranteed uniformity in the quality of the cement. The new system also eliminated dust emission from the kiln stacks.

Increased business arising from the better quality of the company's products necessitated the duplication of the plant in 1915 and six years later further extensions were made, bringing the total capacity of the works to 2,500 tons a week.

By the end of 1924 it was decided that the business had grown too large to be successfully exploited by a private company, and in January, 1925, a public company, Australian Cement, Limited, was registered in Victoria with a nominal capital of £1,500,000 in £1 shares. This company took over, as a going concern the Australian Portland Cement Co. Pty. Ltd. The purchase consideration was £750,000. The new company commenced operations with a paid-up capital of £750,005 in £1 shares.

The existing plant was expanded and its capacity increased to 4,000 tons a week. This was more than the total consumption of Victoria but was in accordance with the company's policy of keeping production well ahead of the demand.

To that end provision was made for additional units capable of producing a further 75,000 tons per annum. Extensive areas of land were purchased in the adjoining district of Batesford to provide for a new quarry, and two steam shovels able to handle 1,500 tons of earth a day were installed to remove the overburden from the face of the limestone deposits. The new units were brought into operation in August, 1926.

In order to stimulate sales, a rapid-hardening cement, which in three days reached a tensile and compression strength equal to that attained by ordinary Portland cement in 28 days, was placed on the market by the company. Good progress was made at the new quarry at Batesford and the overburden was stripped from 5 acres of land to the face of the limestone deposits.

The new quarry was sufficiently developed to enable limestone to be delivered to the works direct by railway, and to reduce production costs, a tunnel 4,376 feet long was excavated from the quarry to the works, thus permitting train haulage to the crushers. With a height of 15 ft and a width of 14 ft. this concrete-lined tunnel was the longest in Victoria. The contract price was £60,000.

In August, 1929, negotiations with the Kandos Cement Co., Ltd. of New South Wales, which had been in progress for some time, were finalised. It was agreed that the two companies should pool their interests in an operating company and so eliminate wasteful competition and over production. To give effect to the decision a new company, Australian Portland Cement Co. Pty. Ltd., in which each of the above companies had equal share interests, was registered in Victoria on 16th October, 1929, with an authorized capital of £5,000,000 in £1 shares. Paid-up capital is £2,000,000.

Australian Cement Ltd. was appointed to act as managing agent in Victoria and Tasmania for the proprietary and the Kandos Cement Company became the agent in New South Wales. In this way both companies were able to preserve their trade connections.

The main operating units at the Geelong works are.—	
4 raw mills capable of production of	... 220,000 tons p.a.
4 Coal mills, capacity	... 126,000 tons coal p.a.
4 Kilns capable of production of	... 211,000 tons p.a.
6 Cement mills capacity	... 220,000 tons p.a.
Power plant capable of generating	... 5,150 kilowatts

The silos provide a total bulk storage for cement of 28,000 tons, in addition to which a clinker storage with capacity 15,000 tons is in use.

Mr. D. H. Dureau is Chairman of Directors; Mr. W. B. McCann is General Manager.

We may well conclude this review by briefly recalling the names and achievements of a few citizens of Victoria who made important contributions to engineering—Brennan, who invented a new form of torpedo, sold it to the Imperial Government and was engaged by them to superintend its manufacture. Later he invented a mono-rail system of traffic and a helicopter which performed well. A. G. M. Michell invented his improved thrust bearing in 1905. Engineers were at first slow to appreciate its principles and advantages, but during the war its tremendous value in the construction of ships was recognized. It enabled powers to be employed in ships that had hitherto been impracticable and made possible the employment of turbines of higher power and speed than had been installed in any ship before.

Applying the principle to a rotary engine he produced the Michell crankless engine. He also originated a very ingenious and efficient centrifugal pump which contained in itself a turbine for the efficient conversion of the kinetic energy of the water leaving the main rotor. Another patent relates to a novel type of impulse water wheel.

Australians have reason to be proud of the lead given by their mining engineers and chemists in the development of the flotation principle for the separation of minerals. C. V. Potter of Melbourne took out the first patent in 1901, and C. D. Delprat followed in 1902. Since that time over 7,000,000 tons of zinc concentrate have been produced at Broken Hill by flotation processes.