4. Railway Development in Victoria.

BY N. C. HARRIS, M.Sc., A.M.I.E.AUST.,
Deputy Chairman of Commissioners, Victorian Railways
J. M. ASHWORTH, M.I.E.AUST.,
Chief Engineer of Way and Work
H. P. COLWELL, M.I.E.AUST.,
Chief Electrical Engineer
AND E. H. BROWNBILL, B.E.E., B.MECH.E.

The Victorian Railways were 80 years old in September, 1934. The first railway in the State, a two mile line from Flinders Street, Melbourne, to Sandridge (now Port Melbourne), was opened for traffic by the Hobson's Bay Company on 13th September, 1854. This was the first line operated in Australia.

A number of other short railways was constructed soon afterwards, but despite substantial assistance from the Government, the private railway companies which owned them were unable to carry on. Legislation passed in 1857 authorizing the Government to undertake the construction and operation of railway lines resulted in the acquisition of the private lines, and by 1st July, 1878, practically all the railways of the State had been merged into a national system.

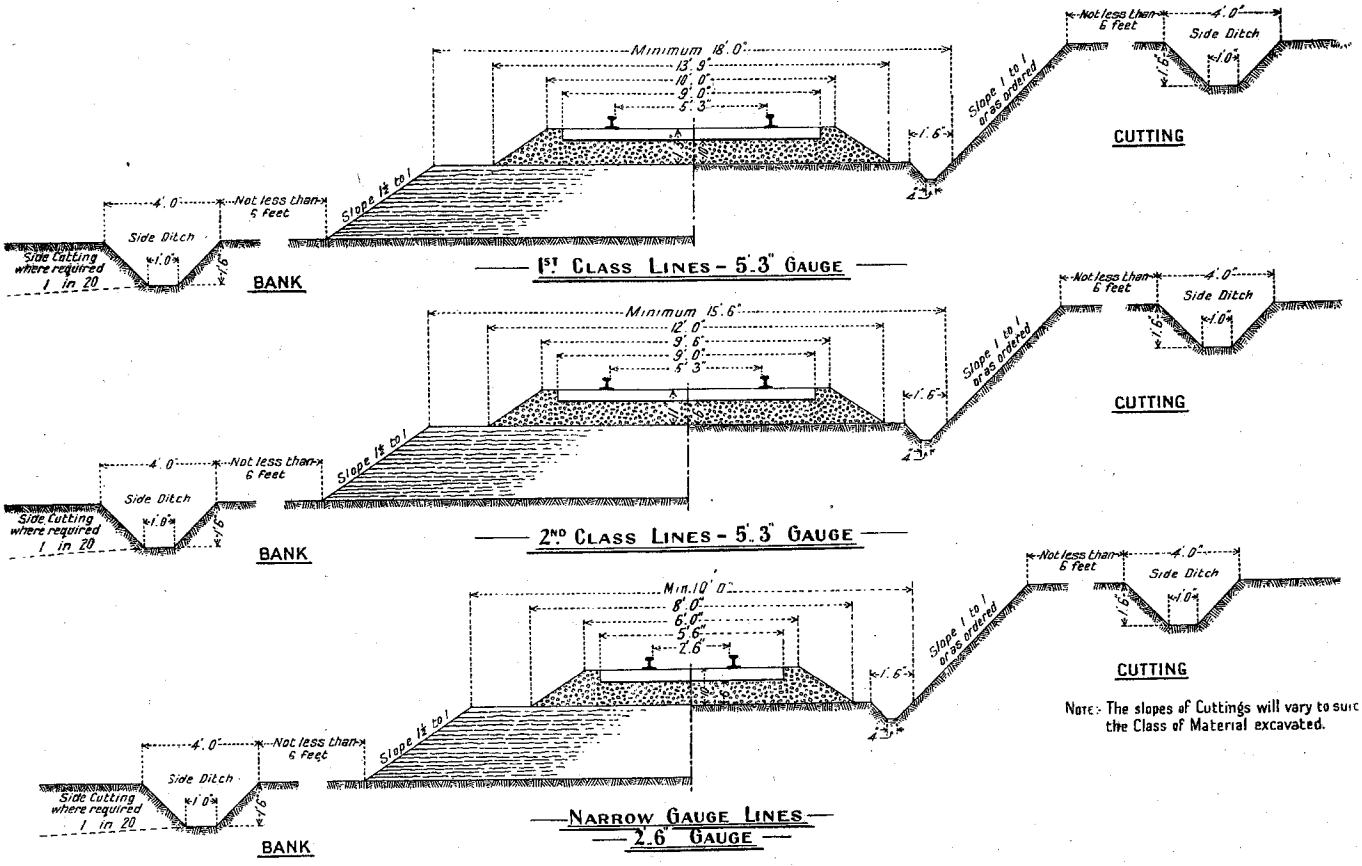
At that time there were 967 miles of railway in operation. To-day there are 4,721 route miles of lines open for traffic.

The construction of railways since 1892 has been carried out by the Railways Construction Branch, under the control of the Board of Land and Works. After construction, the lines are transferred to the Victorian Railways Commissioners, who are then responsible for their operation and maintenance.

TRACKS.

In the construction of the early lines the tracks were laid with iron rails in lengths of 23 feet, the weight varying from 50 to 80 pounds per yard.

When, in 1881, heavy renewals commenced, 75 lb. rail in lengths of 23 ft. was adopted for relaying important lines. The standard has been progressively raised, and at the present time for important country and suburban lines 90 lb. and 110 lb. rail, respectively, are generally used, having the present maximum length of 45 feet.



Standard Drawing—Earthwork, Ballast and Track.

A recent development is the welded rail joint. This affords more comfortable travelling, and 40 miles of welded track now exists in lengths up to 225 feet. The welding is done in situ where the interval between the passage of trains permits.

The standard spacing of the sleepers, originally 3 ft. (except at rail joints) has similarly undergone progressive reductions, and a considerable mileage of track now has sleepers spaced 2ft 2in.

Grades and Curves.

The nature of the country traversed by most of the important lines in Victoria has necessitated the adoption of ruling grades of 1 in 50. With this grade very flat curves of 40, 60 and 80 chains radius were adopted for the earliest lines, but since 1873 curves of 15, 20 and 30 chains radius have been freely used.

Branch lines in mountainous country have been constructed in a few cases with grades of 1 in 30 and curves of 8 to 10 chains radius, but normally this class of line has a ruling grade of 1 in 40 and minimum curves of 15 chains radius.

As traffic has grown, important economies in train operation have been secured from time to time by easing the limiting grades on important lines. For example, the ruling grade from Dimboola to Ararat has been reduced from 1 in 50 to 1 in 100.

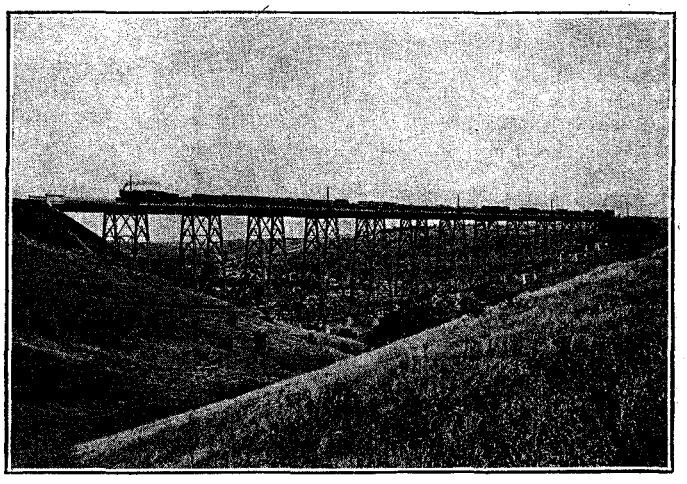
Bridges.

The majority of the bridges are of simple design, the chief exception being several of the continuous girder type, built in early days. The longest span (dating from 1857) is of 210 feet over the Maribyrnong River at South Kensington.

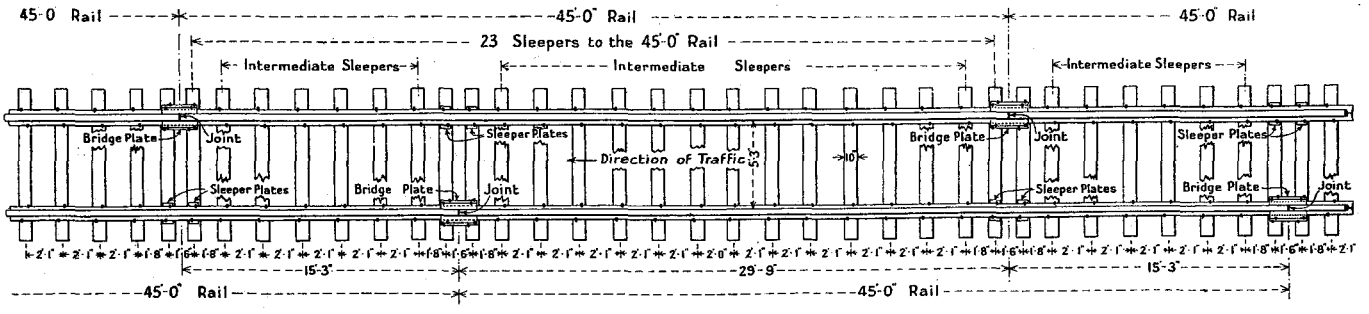
The highest bridge is the Maribyrnong River viaduct near Albion, built in 1929. This consists of 13 spans of 61 feet and 12 spans of 39 feet and carries double tracks at a height of 180 feet above the bottom of the valley.

The longest viaduct on the system is of timber, with 501 openings of 15 feet and 1 opening of 20 feet (nearly 1½ miles), and crosses the River Yarra flats at Yarra Glen.

The rapid increase in the weight of locomotives in the past thirty years has necessitated the strengthening and reconstruction of bridges on many of the lines. In some cases advantage has been taken of electric arc welding as a means of increasing the carrying capacity of the structures. The first instances in which this was used in Victoria and perhaps the first job of its kind of comparable magnitude in the world, was at the Murray River Bridge at Echuca, a notable pioneering work.



Maribyrnong River Viaduct at Albion.



Standard Drawing—90 and 110 lb. Track.

SCHEDULE OF QUANTITIES

ITEM	Size	Weight Each	Per 45-0" of Single Track		Per Mile of Single Track	
		lb.	Number	Cwts.	Number	Tons.
Rails, 90 lb. "A.S." Class	45-0"	1366·830	2	24·408	235	143·395
,, 110 lb. "A.S." Class	45-0"	1653·080	2	29·520	235	173·425
Fishplates, 90 lb. ,, ,,	25"	32·621	4	1·165	470	6·845
,, 110 lb. ,, ,,	25"	38·730	4	1·383	470	8·126
Fishbolts	1" x 5⅛"	2·035	8	·145	940	·854
Spring Washers	1" x ⅜" x ⅜"	·177	8	·013	940	·074
Bridge Plates, 90 lb.	25" x 9"	31·200	2	·557	235	3·273
,, 110 lb.	25" x 9¾"	38·100	2	·680	235	4·000
Sleeper Plates, 90 lb.	8" x 9"	9·800	4	·350	470	2·056
,, ,, 110 lb.	8" x 9¾"	12·100	4	·432	470	2·539
Dogspikes, (Round)	¾" x 6"	·900	16	·129	1880	·755
,, (Round)	¾" x 5"	·775	84	·581	9870	3·415
Sleepers	9' x 10" x 5"	224·000	23	46·000	2699	269·900

In 1902 Cooper's E 40 loading was adopted as standard for bridge design, but since 1907 the designs have been based on E 50.

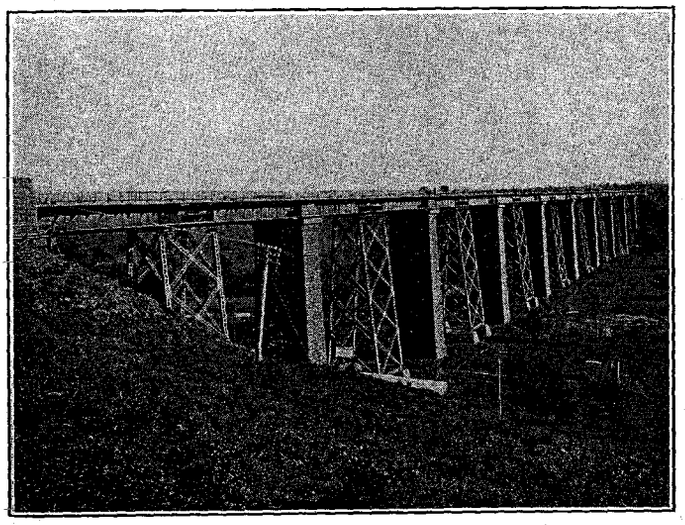
A variety of notable works has been carried out at various times, of which the duplication of Flinders Street Viaduct, the Ararat locomotive depot, the suburban platforms at Spencer Street and the newer workshop buildings at Newport and Spotswood are good examples.

Signalling and Interlocking.

The manually-operated signals are two-position, lower quadrant semaphore signals. Three-position speed signalling was adopted when power-operated signals were introduced about 20 years ago, upper quadrant sema-

phores and, latterly, color light signals being used. Automatic signals are spaced according to the headway required on the various sections, one and a half minutes' headway being the minimum. Automatic train stops are installed at all power operated signals in the electrified area.

The points and signals at most of the stations and junctions on busy lines are usually manually operated by interlocking mechanisms. In several recent installations the operation is by remote-controlled electric motor. Under both systems the area controlled is track circuited and an illuminated diagram showing the occupied sections is provided.



Moorabool River Viaduct—Geelong to Ballarat Line.

Rolling Stock.

The locomotive which hauled Victoria's first train from Melbourne to Sandridge in 1854 was an improvised tractor consisting of a stationary engine mounted on a railway truck, with belt drive to an axle. This was a temporary expedient necessitated by the late arrival of two engines ordered from England. No reliable records of the design of this engine are in existence. It has been stated, however, that it was of 30 horse-power and capable of drawing a load of 130 tons at a speed of 25 miles an hour.

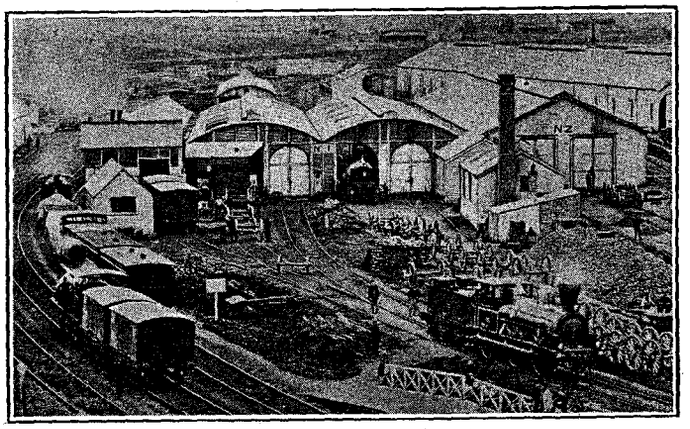
The early rapid development of the Victorian Railways of the State is evidenced by the fact that, in the year 1862, there were on the register 44 locomotives with a total tractive effort of 396,000 lb., 140 carriages, and 737 trucks having a total tonnage capacity of about 5,000 tons. It is on record that the stock included one prison van and one bullion van.

To-day the rolling stock of the department comprises 622 locomotives, including 12 electric units, the total tractive effort being 14,538,665 lb., 17 steam cranes, 1,845 carriages (including 390 suburban electric motor coaches and 466 trailer cars), 1,002 vans and 20,702 trucks with a total capacity of 310,394 tons.

Workshops.

A small workshop at Williamstown was the forerunner of the big Newport workshops which, established in 1888, are the centre of the constructional and repair work of the system, and which with their yards cover an area of 130 acres and in normal times provide employment for a staff of more than 3,000 men.

All rolling stock, including locomotives, is now designed by the Railways Department's engineers, and constructed at the Newport workshops.



Williamstown Workshops in 1865.

Until a few years ago, these important workshops were of obsolete lay-out, and generally antiquated. Much of the work was of necessity performed in the open at the expense of efficiency as well as the comfort of the employees, and it was impossible in many cases to concentrate allied operations.

The provisions of three new sections—a foundry, a boiler shop and an erecting shop—on modern lines, has removed many of these serious disabilities. The old erecting shop had rope-driven 35-ton capacity overhead cranes 24 feet above floor level. The new shop has four 75-ton electric cranes, 38 feet above floor level, and a lower 10-ton runway, 24 feet above floor level.

Rationalization of workshop operations in recent years includes the introduction of the "spot" system, which is being largely applied to engine repairs, truck and tender tank construction and repairs, and to the conversion of rolling stock to automatic couplers. Under this system, the principle of sectionalized mass production is applied as far as practicable, each group of operations being carried out in the one place or "spot." The staff and equipment necessary for the performance of the operations to a prearranged programme are assigned to each spot. Benefits of specialization are thus obtained, and the handling and control of materials is greatly simplified.

Although hampered in many respects by obsolete lay-out and buildings, modern practices are extensively applied. For example, electric welding is now being freely used in both constructional and repair work. Numbers of the standard "IZ" goods trucks—a 27-ton capacity vehicle—are now of all-welded construction. In addition to construction work, the electric arc is being utilized economically to fabricate numerous component parts of vehicles which on most railway systems would be purchased as steel castings.

Machinery for repetition work is generally of the most efficient types obtainable, and includes some excellent drop forging equipment. All important furnaces are now oil-fired, including those in a modern heat treatment shop.

These developments, allied with the advantages obtained from an efficient testing and research laboratory, have been responsible for many economies in the purchase and utilization of materials as well as in production costs generally. Efficiency of unskilled labour has been increased by the use of industrial tractors, which have supplanted hand truck methods for the transport of material between the various sections of the shops.

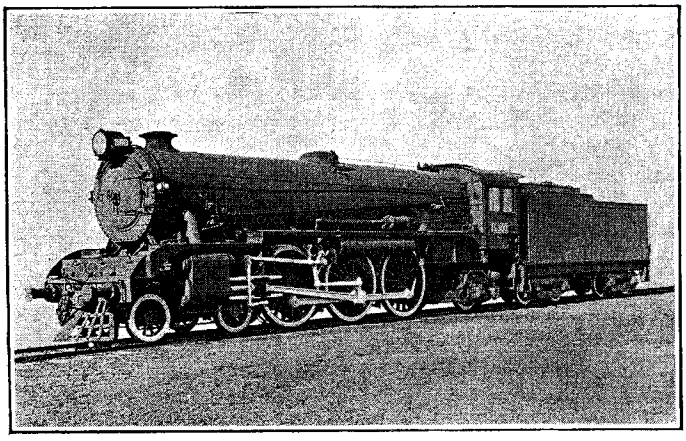
Locomotive Development.

The first locomotive (No. 100) constructed in railway workshops (then located at Williamstown) was built in 1872.

An interesting contrast is provided by the latest locomotives constructed at the Newport workshops—the "X" ("Mikado") class, for goods work, and the "S" ("Pacific") class for passenger work, described in Table I.

TABLE I.

	No. 100.	"X" Class	"S" Class
Type	2-4-0	2-8-2	4-6-2
Cylinders	16in. × 22in.	22in. × 28in.	20½in. × 28in.
Cylinders, number	2	2	3
Grate Area	14 sq. ft.	42 sq. ft.	50 sq. ft.
Working Pressure	140 lb. per sq. in.	205 lb. per sq. in.	200 lb. per sq. in.
Weight (total)	58 tons	183 tons	194 tons
Tractive Power	9,386 lb.	37,040 lb.	41,000 lb.
Tractive Power (with booster)		46,000 lb.	



"S" Class, 3-Cylinder Pacific Type Locomotive.

Prior to 1880, the boilers were supplied with feed water by pump operated from the crosshead, so that if water became low in the boiler it was necessary to run the engine for some distance, usually backwards and forwards. The provision of injectors has since eliminated this difficulty.

Until 1900, all engines were equipped with "D" slide valves. Locomotives built since that date have had piston valves.

The Belpaire firebox, another innovation about 1900, improved boiler performance and altered the appearance of the engines considerably. Brick arches, introduced in the firebox about the same time, have secured a useful economy in fuel.

Originally all the locomotives were of the saturated steam type. The principle of superheating was adopted in 1914, and more than half the existing engines embody this feature, which has led to substantial savings. Shortly afterwards, the Walschaert valve gear superseded the Stephenson link motion, which had been standard for many years.

In recent years, a "booster" (or auxiliary engine) has been fitted to a number of the locomotives. This is a horizontal two-cylinder steam engine mounted on the trailing truck and connected directly to the trailing truck axle through suitable gearing, by which it may be engaged or disengaged at will.

From the efficiency standpoint, engines have been equipped in recent years, with more liberally designed boilers, having larger grate areas, self-cleaning smoke boxes and increased pressure, while the engine itself has been more liberally proportioned in its steam passages, resulting in reduced back pressure and consequent increase in power.

Extensive use is now made of a dynamometer car to obtain accurate data of locomotive performance and tractive resistance of various classes of rolling stock.

Following upon the conversion of the Melbourne suburban system from steam to electric traction, electric locomotives were introduced in 1923, for shunting and suburban goods work. The tractive effort of these is 14,160 lb. at 16 miles per hour on an hourly rating, and the starting tractive effort is 26,000 lb. Multiple unit operation is provided for when two or more units are coupled together.

Truck Stock.

The development which has taken place in truck stock is illustrated by the examples in Table II.

TABLE II.

Standard Open Type Trucks.

	Built Williamstown Shops 1873	Built at Newport Shops. 1901	Built at Newport Shops. 1933
Material	Wood	All Steel	All Steel
Dimensions	14 ft. 5 in. × 7 ft. 5 in.	18 ft. 0 in. × 8 ft. 6 in.	22 ft. 0 in. × 9 ft. 0 in.
Carrying capacity	6 tons	15 tons	27 tons
Tare	4 tons 15 cwt.	6 tons 3 cwt.	9 tons 13 cwt.
% tare to carrying capacity	79%	41%	35·7%*

*This figure will be reduced to 33.6% when conversion to automatic couplers is completed, as buffers and chain couplings will then be dispensed with.

Carriage Stock.

In 1857, a standard carriage, accommodating about 50 passengers, was 24 ft. long and had a tare weight of 8 tons 8 cwt. Judged by present day standards, it was a comfortless vehicle, devoid of any conveniences save the seats.

The modern carriages, weighing approximately 40 tons, are up to 71 ft. long, and have 4 or 6 wheel bogies, with corridor throughout, and a vestibule and lavatory at each end. The first class carriages provide accommodation for 48 persons and the second class for 72.

All-steel construction was adopted for the latest sleeping cars and dining cars placed in commission.

In 1922 petrol-driven rail motors were introduced. In the earlier types road motor lorry chasses were utilized, the road wheels being replaced by steel flanged wheels and a light timber super-structure added. This car, which accommodated about 37 persons, had a long wheelbase (18 ft 2 in.) and weighed 6¼ tons, and was operated by one man from one end only. It was superseded by a larger and more powerful unit, weighing about 14 tons, designed for operation from either end and having seating capacity for 56 passengers.

This type, in turn, has now been supplanted by the petrol-electric car, the power equipment of which consists of a 220 horse-power six cylinder petrol engine, directly coupled to a generator supplying power to two traction motors of 110 horse-power each. Designed for a speed of 60 miles per hour on level track with a trailer attached, this car has accommodation for 54 persons. In addition, the trailer will accommodate up to 77 passengers.

Lighting of Rolling Stock.

The lighting of carriages with kerosene was superseded on the main lines by Pintsch gas in 1884. Later, electric lighting became the standard method of illumination, both for suburban and country stock, although gas is still used on vehicles running on some of the country lines.

A number of the more powerful locomotives has been equipped with electric head and cab lights in place of kerosene lamps.

Brakes.

The original rolling stock was fitted with hand brakes only, the brake blocks being of wood. Later, experiments were carried out with the Woods hydraulic brake, the Westinghouse automatic air brake and the Vacuum brake. Both the Woods and the Westinghouse brakes were in use for a time, but eventually the latter was adopted as the standard, and is now applied to all rolling stock.

Automatic Couplers.

The increasing power of locomotives, with consequent longer and heavier trains, has necessitated a strengthening of the drawgear on vehicles, and the system is now in the transition stage from the drawhook and coupling type to automatic couplers.

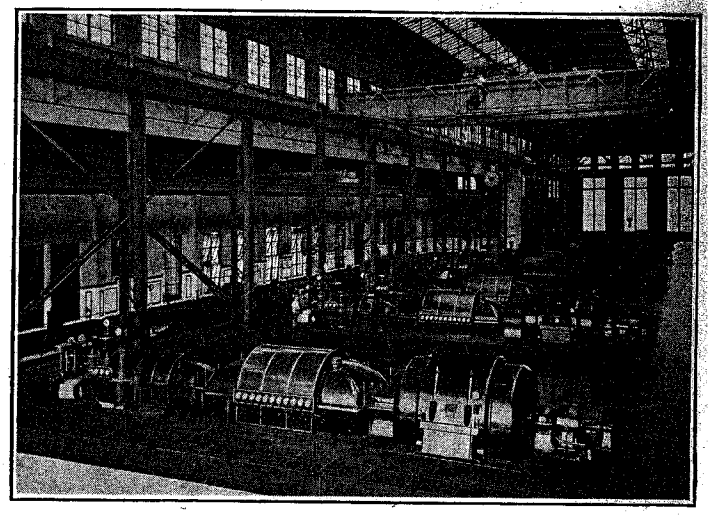
To date 219 engines, 12,943 trucks, 47 carriages and 52 vans have been equipped with automatic couplers, including a simple transition feature to facilitate connection to vehicles fitted only with drawhooks.

Already substantial economies in train handling have been derived from the new drawgear, but the full effects will not be realized until all vehicles have been so equipped.

Melbourne Suburban Electrified Railway System.

In 1908, Mr. C. H. Merz first reported upon the conversion of the Melbourne Suburban steam railway system to electric traction, and four years later Parliament decided to proceed with the conversion. The system adopted was a 1,500 volt direct current one with overhead contact wires, this being the first occasion on which such high voltage was so used on a large scale. The power generating plant was designed to provide three phase alternating current, 25 cycles, with a continuous pressure between terminals of 3,300 volts, the voltage being stepped-up to 20,000 for transmission to the substations.

The power house, which is located at Newport, was originally provided with six generating units, four of 12,500 and two of 14,000 kW. continuous capacity, respectively. The turbo-generators are of the Parsons type, running at 1,500 revolutions per minute. Each turbine exhausts to a twin contra-flow type condenser and has its own step-up transformer, auxiliary air filter and ventilating fan.



Engine Room, Newport Power Station.

There are two boiler houses each equipped with 12 boilers, and each boiler includes a superheater, mechanical stoker and economiser. The normal working pressure of the boilers is 210 pounds per square inch and the normal evaporative capacity 30,000 pounds per hour when burning Victorian black coal. One boiler has been successfully converted to burn pulverised fuel, increasing the boiler rating to 52,000 pounds per hour. The coal used is principally from the State mine at Wonthaggi.

Energy is transmitted to the traction substations by 20,000 volt feeder cables of the split conductor type, placed for the most part underground. The substations, the majority of which operate automatically, are equipped with step-down transformers and rotary converters or mercury arc rectifiers.

Direct current at 1,500 volts is transmitted to the overhead contact wires whence it is conveyed to the train equipments through the pantographs, finally returning to the substations through the return circuit provided by the rails.

Since the completion of the suburban electrification, two additional turbo-generators of 16,000 kW. capacity each, and an additional boiler house complete with the necessary auxiliaries, have been erected in an annexe to the Newport power station by the State Electricity Commission. The plant is operated and maintained by the Railways Department for and at the expense of the Commission.

The official opening of the electrified service took place on 28th May, 1919, when the first line to be converted, viz., Essendon to Sandringham, was put into operation. The whole of the conversion was effected without any interruption to the operation of the traffic or to the supply of energy to any departmental or "outside" activity, and the subsequent results have been entirely satisfactory.