HAULAGE POWER (exclusive of engine and tender).

Grade.	Tons.	Speed per hour.
1 in 30	220	8 miles
1 in 40	350	10 ,,
1 in 60	525	10 ,,
1 in 70	600	10 ,,
1 in 75	615	12 ,,
1 in 100	700	15 ,,
1 in 150	750	18 ,,

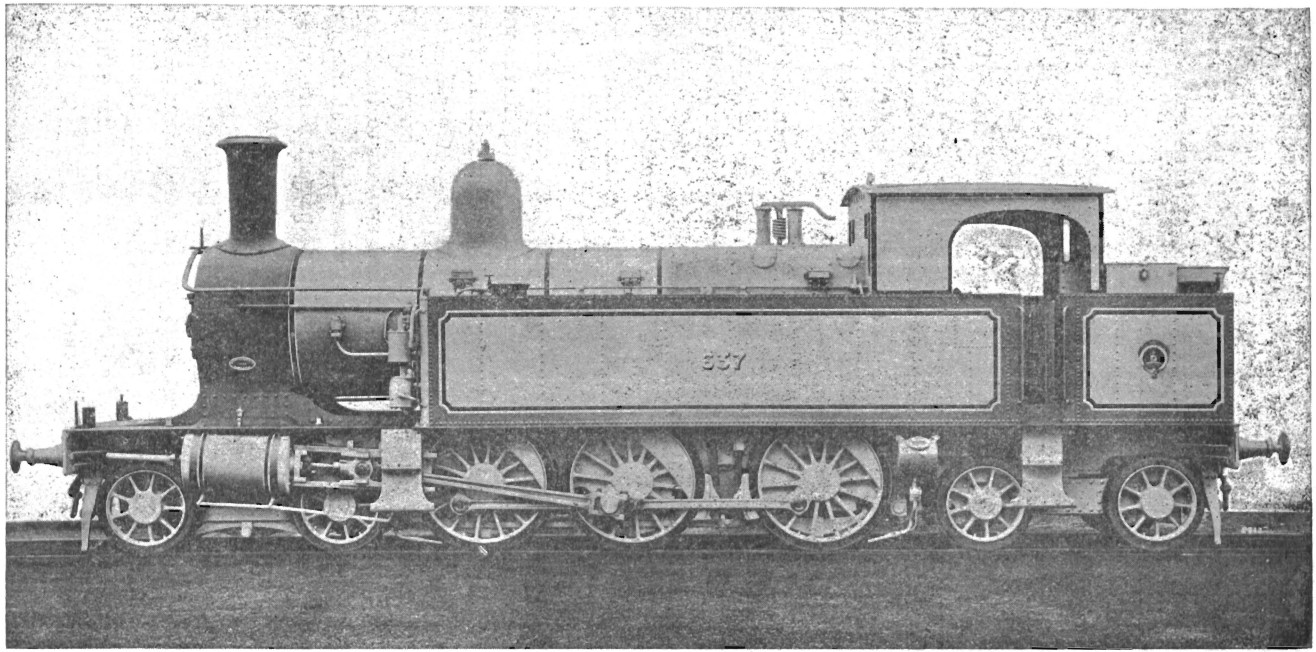
When it is remembered that the elevations attained on the Main lines of these Railways, are, on the North 4,470 feet; South, 2,360 feet; and West, 3,660 feet above the sea level, and between Sydney and each terminus, the loads have to be lifted through accumulated vertical heights of 12,666 feet, 9,470 feet, and 9,627 feet respectively, and in addition to this frequent reverse curves of 8 and 12 chains radius are met with, it will be readily understood that engines of great power are required to be capable of performing this class of work in a satisfactory manner.

"S" CLASS HEAVY SUBURBAN PASSENGER ENGINES.

Owing to the heavy passenger traffic that had to be carried over the suburban lines, during the busy hours of the morning and evening, having increased in 1900 to such an extent, and it not being possible to run more trains, or increase the length of those hauled, to overcome the difficulty, and deal with the vast number of passengers required to be transported at certain hours of the day, the Railway Commissioners decided to introduce a new type of engine capable of hauling at least 25 per cent. more load than that taken by the heaviest suburban engine then in use.

These engines possess the features of both power and speed at starting, so that a more expeditious system of working, and heavier loads may be hauled than previously.

They were supplied by Messrs. Beyer, Peacock & Co., Manchester, from designs and specifications prepared at the



"S" CLASS HEAVY SUBURBAN TANK ENGINE.

Locomotive Offices in Sydney, and are of the six-wheel coupled type, with a four-wheel bogie at each end, of the arrangement known as the side tank engine.

The boilers, though smaller, are of the same type, constructed in a similar manner, and of the same class of materials as those for the P class passenger, and the "T" class heavy goods' engines. The tanks are arranged at the sides of the engine with a gangway at each side for access to the enginemen's platform, and a coal bunker at the hind end.

These engines are thoroughly equipped with the Westinghouse Automatic brake and hand-brake gear, and there are 35 now in service, the first of which was introduced in 1902. (See Photo Print.)

The P, T, and S classes are arranged with outside cylinders with the steam chests and ports placed between the frames. Thirty-five of the T class only were equipped with cylindrical piston valves, the others being fitted with balanced slide valves, all of which are operated by Allen's straight link motion, and controlled by screw reversing gear.

Continuing the rebuilds, 6 Goods' tender engines of A class have also been dealt with, re-designed, converted into side tank engines, and fitted with Belpaire boilers, for the purpose of hauling mineral trains, and were placed in traffic during 1902 and 1903.

During 1904 six passenger tender engines, known as the old 23 Class, were remodelled, and had applied to them four wheel bogies in place of a single axle Bissel truck at the leading end. They are also fitted with Belpaire boilers, and it is anticipated that seven more of these engines will be placed in service by July this year.

A number of other types of engines have also been reconstructed on more modern lines, by the application of larger and heavier boilers of the Belpaire type, raising the centre of boiler, and several other changes in details of construction to meet the necessary requirements.

As these arrangements provide for more heating surface, give greater adhesive weight, and permit in most cases of higher boiler pressures being carried, it will be seen that heavier loads can be hauled, and they have now been rendered more useful and serviceable engines.

Some classes have been relegated to country districts for the purposes of operating pioneer lines, and at the present time work is in hand for the construction of Belpaire boilers to be fitted in the near future to some of the engines that were imported in 1891.

From this it will be seen that while the most modern engines take the first place, a certain amount of attention has been devoted to others by having them brought up to date as far as it has been possible to do so.

From the 1st January, 1880, to the end of December, 1904, 574 new engines were introduced, and 172 altered or reconstructed, and all new engines put in service since 1890 have been designed under the supervision of the Chief Mechanical Engineer to the Railway Commissioners.

At the end of 1904 there were in Service the following:—

	Regular.	Duplicate.	Total.
Goods tender engines	275	32	307
Passenger tender engines	220	7	227
Passenger and goods tank engines	132	15	147
	627	54	681

as shown on Table II. appended, which practically represents the different types available, and indicates to some extent the general advancement that has been made. These engines are now used in operating 3,280¾ miles of railway, and the lines now open for traffic are:—

920 miles on the Northern Section.
1190 miles on the Southern Section.
1074¾ miles on the Western Section.

As comparison of the advancement made during the twenty-five years' progress making allowance for the engines that would be out of service undergoing repairs during 1879 and 1904 is shown as follows:—

	1879.	1904.
Number of engines in stock ...	177	681
,, ,, available for traffic	164	560
Tractive power aggregate, in lbs...	2,442,062	12,101,791
Miles in operation	734½	3280¾
Variations of grades on lines opened		1 in 33 to 1 in 150
Ruling gradient		1 in 33
Radius of reverse curves		8 to 12 chains
Goods, mineral and livestock tonnage	1,720,815	6,605,005
Train mileage	2,932,463	10,569,053
Engine mileage	3,710,395	14,364,796
Number of passengers carried ...	4,317,864	34,485,478

Owing to the growth of the Locomotive in power and numbers, it has been found necessary to go in for extensions of the Workshops, also, and put down additional machinery at various periods. The main shops for executing repairs and renewals were situated at Redfern, and fitted with machinery which answered very well in its time, still, the want of space for extensions, and the available appliances, had become so inadequate, that in 1886 new Shops, covering an area of about 6 acres, were erected at Eveleigh, for the purpose of dealing more expeditiously with all classes of work.

Though these shops were not fully occupied at first, the time presented itself for further extensions, and it will be seen from Plate II. that the present buildings now cover an area of nine acres, and represents the changes that have been made at different periods.

DESCRIPTION OF THE WORKSHOPS—EVELEIGH AT THE PRESENT TIME.

The Main building now consists of sixteen bays, with a large Erecting Shop and Foundry at one end, and a heavy Forge and Spring-smith shop at the other, the Coppersmiths, Tinsmiths, Wheel-tyring, and Hydraulic Wheel Press Shop, &c., being arranged on one side.

Bays Nos. 1 and 2 of the Main Shope are devoted entirely to Forge and Smiths work, and contain 50 smiths' Forges, 2 roots blowers, 2 heavy steam hammers (15 and 40cwt.) with furnaces, boilers, and cranes, and other steam hammers of smaller sizes ranging from 5 to 8½cwt., in addition to which there are 4 mechanical strikers operated by compressed air, power driven punching and shearing, slotting and drilling machines, hot and cold iron saws, hydraulic presses, and a Bulldozer for bending heavy bars, plates, &c., served by a pneumatic crane. At one end of the Shops a special heavy punching and shearing machine is used for cutting up old boilers, and general heavy work, and a special case-hardening furnace, by Messrs. Brown & Sharpe has recently been put in operation.

Nos. 3 and 4 are used exclusively for Boiler Work, many of the machines being operated by Hydraulic power, consisting of two heavy stationary gap rivetters, with overhead traversing cranes and lifting gear; portable rivetters with all requisite lifting and regulating appliances, punching and shearing machine; and large flanging press.

There are also plate rolls capable of bending plates up to 12 feet; rolls for bending heavy angle bars; plate edge planing machine; tube-plate boring; ordinary drilling, tapping, countersinking; copper stay straightening and screwing machines, which are all operated by a pair of wall engines. In addition to the above, a heavy milling, and a large multiple drilling machine are in use, driven by separate electric motors, and the shops are equipped with ordinary smiths' fires, and

special forges for flanging plates and all angle bar work.

Overhead cranes are provided of 10 and 16 ton capacity, both being electrically driven. Compressed air is used for working portable tools, such as drills and pneumatic hammers.

No. 4a forms an addition to the Boiler Shop to be brought into operation this year, and will contain an overhead crane of 25 tons, electrically driven, and a medium-sized hydraulic flanging press for plate work with a suitable furnace for the present equipment.

Nos. 5, 6, 7, and 8 are used as erecting shops, containing pit and bench accommodation for dismantling, repairing and erecting 28 engines and tenders, and are provided with a ground traverser for the purpose of taking the engines and tenders in and out of the Shops. 25 tons electrically-driven overhead cranes are erected over three bays, and suitable machines are provided for Cylinder re-boring, and facing steam ports in the frames, and drills operated by compressed air ae extensively used.

Nos. 9, 10, 11 are set aside for machine work and are equipped with heavy wheel, duplex and axle lathes, tyre boring, cylinder boring, drilling, and spindle boring machines, modern capstan lathes, lapping machines, heavy and light milling tools, both vertical and horinzontal, slide bar, piston-rod, tool grinding machines, and numerous large and small gap, lathes varying from 16in. to 6in. centres for general work, brass finishing and ferule lathes, and the usual heavy planing, shaping, slotting, radial drilling, nut tapping, and special screwing machines are provided as used in first-class locomotive workshops.

There are also two hydraulic presses used for taking wheels off and putting them on axles ranging from 200 to 750 tons pressure; these will be shifted to an adjoining building at an early date.

Five ton overhead cranes, rope driven, are erected over

these three bays, and air hoists and suitable cranes are used in connection with many of the heavy machines for the purpose of handling detail parts expeditiously.

The whole of the machinery in these shops is driven by two pairs of 50 horse-power wall engines.

A large tool store containing small lathes, and milling machines, used for making and repairing special tools and cutters is situated inside this building at one end.

No. 12 is used for repair work to Westinghouse brake, fitting-up cylinders, axle boxes, connecting and coupling rods, brass finishing, and all water supply requirements.

No. 13 is at present a spare bay available for future use.

No. 14 is occupied by the patternmakers and the carpenters, and fitted with wood-turning lathes, saw benches, planing machines, and all necessary appliances for the speedy construction of patterns. All patterns are stored in one end of this building.

No. 15 is used as a branch store under the Compt. of Stores, and contains a supply of material such as may be required for daily use in the workshops or country depots.

A large foundry is erected at this end of the main building, fitted with all modern appliances for iron and brass moulding, including 3 cupolas for melting iron, and 12 furnaces for melting brass.

An overhead rope driven crane of 16 tons capacity, traverses the whole length of the building, in addition to which there are two hydraulic jib cranes of 2 and 5 tons capacity, one steam moulding machine, two core ovens, sand mixing machine, chilian mill, special rumblers, emery wheels for cleaning, castings, pneumatic sand sifters, and a special machine for extracting brass fragments from the refuse.

On the outside of the foundry, hydraulic lifts are provided for raising all scrap to the feeding platforms.

A large erecting shop adjoins the foundry, and has recently been increased from 400 to 600 feet in length, it con-

sists of two bays, each 55 feet 6 inches wide, and is fitted with all modern appliances required in the repairs of locomotives, consisting of six thirty-five-ton overhead electric cranes, two of which have been erected for the requirements of the extension to be brought into use at an early date. Small lathes, shaping, drilling, milling machines, and grinding tools are provided and driven by electricity from a line of shafting in the centre of the building, worked by an electric motor.

The cylinder re-boring steam port facing machine and portable drills are all operated by compressed air. Each bay contains three lines of road, the centre one being clear, and those on each side used for placing engines under going repairs, on which pits are provided, running the whole length of the building for the convenience of working beneath the engine. Bench accommodation is provided for dismantling, repairing, and erecting 48 engines, and arrangements are provided for the heaviest engines to be lifted by the cranes and passed from one road to the other over any of the engines that may be undergoing repairs.

A steam laundry adjoins this erecting shop, for the purpose of dealing with all sponge cloths and waste used for cleaning purposes all over the railways, and is fully equipped with engines, boilers, revolving washing machines, hydro-extractor, boiling tanks, etc., and special drying ovens.

At the opposite end of the main building, near the smiths' shops, stands the heavy forge, in which is erected a 4-ton steam hammer with the necessary furnaces, boilers, two hydraulic jib cranes, capable of lifting $3\frac{1}{2}$ tons each; a small rolling mill, and a heavy cold iron saw are also erected, driven by separate eletric motors.

The springmakers occupy one end of the building, and are provided with the necessary appliances for repairing and renewing all the locomotive, carriage and waggon springs on the Railways, consisting of a large hydraulic machine

for removing buckles, served by two pneumatic jib cranes, large testing machine operated by compressed air, slotting and nibbing appliances, plate furnaces, setting tables, and tempering baths.

The coppersmiths are situated at one side of the main building and are provided with gas furnaces of special design for brazing and piecing tubes, small furnaces for flange work, and the necessary appliances for bending and setting steam pipes and tubes of various sizes.

The tinsmiths, plumbers, and gasfitters' shop is situated near this building, and contains several small gas furnaces, two pipe screwing machines, and a number of specially arranged tools and dies for flanging, pressing and punching tin plates, appliances for testing pressure gauges, and pipes under hydraulic pressure, and other necessary gear for dealing with Westinghouse Air Brake pipes, water tanks, lamps, etc. Adjoining this shop, stands the building in which a gas tyre heating plant is being installed at one end, with the large hydraulic wheel presses (previously mentioned) at the other; also a large chain testing machine, running down one side, capable of testing chains up to 100 feet in length is now being erected.

Two hydraulic jib cranes, each of 5 ton capacity will be used for handling the wheels on their axles, during the pressing and re-tyring process.

Two large potash tanks with a jib crane and suitable boiler are erected near this building, for the purpose of cleaning grease, etc., from the detail parts of all engines as they come in for repairs, and a spring store stands near the end of the smiths' shop.

All the compressed air is supplied by an Ingersoll-Sargent Air Compressor situated in an annex to the boiler shop, and capable of compressing 950 cubic feet of free air per minute, up to 100lb. per square inch, and from which air mains are

carried to the various shops for operating all hoists, pneumatic tools, etc.

All the hydraulic power is supplied from a hydraulic engine plant with an accumulator weighted up to give a pressure of 1400 lb per square inch, and piping is arranged for the transmission of power to the various machines throughout the workshops.

All electric power used in operating the overhead cranes, and special machinery, is generated at the Ultimo Power House.

In conclusion, I have to thank the officers of the Railway Department for the assistance they have given me in compiling the detailed information for this subject, which I trust will prove of some interest to the members of this Association