engine. This plant is a complete success, and economical in working. This method of transmitting energy in a coal-mine does away with any exhaust steam in the return airways, which is always more or less of a nuisance, and is unavoidable if the work is done by a steam-engine below ; it is also much easier to lead a cable down the shaft than a steam-pipe.

The scheme for lighting our city by electricity—the power to be generated at the Colo and Grose Rivers, and then electrically transmitted to one or more stations in Sydney—is also suggestive of electrical advancement.

Electricity is now used for producing cheap disinfectants by electrolysing sea water, which is then passed directly into into the sewers; and its effect is so marked that the effluents are found free from offensive odour, and quite robbed of their dangerous properties. It is expected that this plan of deodorising sewerage matter will be adopted in the city of New York.

Electric traction has not made the progress anticipated in the United Kingdom, the reason being the strong opposition shown to the overhead wire system in the towns. There are only about 50 miles of electric tramways in the United Kingdom, while the United States have over 5,000 miles running ; but there are a large number of electric traction schemes waiting the approval of the English Parliament, so that it may be presumed that a satisfactory method of conveying the current has been found.

The Paris Engineers are at work on a proposed system of underground electric railways similar to the City and South London, based on the Greathead system of tunnels 50 feet below the surface. Brussels has a proposed electric railway on the same principle, consisting of a complete circle of double track 4 miles in length, with eleven stations.

In the neighbouring Colony of Tasmania the city of Hobart has a complete system of electric trams on the overhead wire system, which are said to run very economically, and give great satisfaction.

The electric tram on the overhead wire system that was running between Waverley and Randwick has been moved to North Sydney, where it runs with considerable success between Ridge Street and the Spit Road; and it is proposed to extend the line to the Spit.

There is probably no system of tramways that has so much undeserved opprobrium heaped upon it as our steam trams in Sydney. For some time the papers were full of arguments in favour of supplanting them by horse trams, and then popular opinion favoured the cable tram system adopted in Melbourne, the financial success of the latter being especially dwelt upon; but since the collapse of tram shares in that city we have not heard so much about them.

In our own city there has been an extension of the North Shore Cable tram of about three-quarters of a mile of double-track, necessitating a complete new plant for working the cable; consisting of compound high pressure Corliss type engines of 280 indicated horse-power, working at a pressure of 120 lbs. The machinery is of local construction, and works well.

There is a cable tram two and a-half miles long now in course of construction, and will be opened shortly, from King Street to Ocean Street. It embraces all the latest improvements in cable traction; the driving machinery is in duplicate, with easy means of connecting and disconnecting, so as to minimise the risk of detention, and consists of compound surface condensing engines, cylinders 24in. and 45in. diameter, with a stroke of 66in., to indicate 1,000 horse-power. Steam at a pressure of 120lbs. is supplied from three multitubular boilers, each 7ft. diameter and 17ft. long. The whole plant is located at Rushcutter's Bay, in a handsome power-house, 190ft. x 94ft., in the Romanesque style of architecture. The base course is of Pyrmont sandstone, wall of double-pressed facing bricks, relieved with terra-cotta; the chimney is 180ft. high. The whole plant is of local manufacture, and is designed with

the view of further extension. A feature in the engine-house is a dado of white enamelled bricks 6ft. high.

The road has been specially designed and constructed to withstand heavy vehicular traffic, and the great strain thrown upon the slot bearers by the expansion and contraction of the wooden blocks forming the roadway. The neglect of this precaution has caused considerable expense in the Melbourne trams. Though not myself an advocate of cable trams, except in cases where the grade renders them unavoidable, I must testify to the completeness of the design, and the efficient manner in which it has been worked out. We are promised a paper descriptive of this work, and I am sure it will be of great interest to the members.

In Marine Engineering the tendency is still for increased speed, and every record broken is hailed with triumph. The Cunard Company's steamer "Campania" holds the sea-going record, having maintained an average speed of 21·28 knots (equal to 24½ statute miles) per hour on a voyage from New York to Queenstown. The torpedo boat "Ariete" made on trial a speed of 30·16 miles per hour; and, for the sake of comparison, I may here mention that the bicycle record for an hour stands at 26 miles 107 yards. It is stated that the "Columbia," a man-of-war lately completed in the United States, maintained on her trial a speed of 22·81 knots per hour for two hours. This vessel is a triple-screw, and there is no doubt that the demand for higher speeds will lead to the adoption of the triple screw. The length and beam of a vessel can be increased at the will of the designer; the only difficulty being to get dry docks large enough to take the vessels in for the purposes of repair; and up to the present the increase in the size of the graving docks has kept pace with the increased tonnage of the ships; but the draught of the ship cannot be increased with impunity, or the number of ports available for her entrance will be much reduced. Thus, 30ft. is the maximum draught of a vessel that could come into Sydney

Harbour at high water; and as the efficiency of a screw propeller is greatest when it is completely immersed, triple screws will be a necessity to utilise effectively the enormous indicated horse-power necessary for high speeds. Furthermore, the three screws and three sets of machinery give a further guarantee against accident. Our mail steamers entirely depend on their machinery; their masts are practically merely for signalling purposes; and I am of opinion that in a few years the demand for higher speeds and increased safety will render it desirable and necessary that our first-class steamers will be fitted with triple screws and a distinct set of engines for each screw.

Professor Elgar lately read a paper on fast ocean steamships, in which he points out that steamers are increasing in length and breadth, but the draught of water has to be kept the same; and consequently we shall soon get to the limit of speed imposed by the restriction of water. On the other hand, Mr. Biles, the designer of the "Paris" and "New York," states his belief that within ten years there will be steamers running between the United States and Great Britain averaging a speed of thirty knots per hour, the increase in speed being gained by increasing the size of the vessel, lightening the weight of machinery by using lighter metal—probably alloys of steel and aluminium—using oil as a fuel instead of coal, and water-tube boilers.

Although the draught of our vessels has about reached its limit, I am of opinion that the evolution of speed will still go on; and now the United States are the possessors of an ocean line across the Atlantic, the experience and skill of the American engineer will be enlisted to shorten the passage between the States and Great Britain.

The water tube boiler is making steady progress in Marine work, and there is no doubt it is the boiler of the future. We are in a great degree indebted to the French engineers for experience gained with it, and I would direct the attention of those interested in this branch of engineering to a paper read

on water-tube boilers by Mr. Milton, Chief Engineer Surveyor to Lloyds', before the Institution of Naval Architects, where, amongst other valuable information, I note that in working the Belleville boiler—that is, the type of boiler adopted by the "Messageries Maritimes," and which we are familiar with in the "Australien," "Ville de la Ciotat," and other boats trading to this port—the feed water is treated with a small quantity of lime, in a very dilute solution, in order to purify it before entering the parts of the boiler comprising the heating surfaces, which therefore do not become encrusted. Experience shows that this actually takes place to a considerable extent, there being practically no deposit on the heating surface, even when sea-water is used as a make-up, while a white muddy deposit is found in the separating chamber. In working the Lagrepel D'Allert boiler, the feed-water is similarly treated with lime, about 4lb. per 24 hours per 1,000 indicated horse-power being used; an arrangement being adopted whereby this small quantity is continually added to the feed. I am sorry the paper did not give any particulars as to the saving of weight over the ordinary return tubular boiler, because that is the great benefit of the water-tube boiler to the marine engineer, whose aim is to develop the greatest indicated horse-power from the least weight of boilers and machinery.

It was reported that the two new battle-ships, "Magnificent" and "Majestic," are to be fitted with water-tube boilers, but this at present lacks confirmation.

The use of petroleum and other oils for fuel instead of coal is gradually coming into practice. The carrying of oil in bulk as cargo has given much valuable information as to the best means to adopt for safety, while the practice obtained by its use in steamers running on the Caspian Sea, and the locomotives in Baku and its vicinity, has demonstrated its utility and economy. The steam used in driving the machinery at the Chicago Exhibition was raised by petroleum oil, pumped from Ohio, distant about 150 miles, through a line of 6in. pipes. In

England, the Great Eastern Railway have twelve oil-burning locomotives running on their line, the cost being slightly less than coal. As to whether oil fuel is cheaper or dearer than coal depends on a great many local circumstances; but as regards the attainment of speed in steam vessels it is not so much a question of cost as a question of weight. Can we produce more steam by burning a ton of petroleum oil than by burning a ton of coal? And the result of a number of experiments show that, weight for weight, oil has about double the efficiency of good average coal; that is, half a ton of oil will generate as much steam as one ton of ordinary coal; so that there will be an immense saving of weight in the adoption of oil as fuel, also great saving in labour; the fires are easily lit, and as easily extinguished; there are no ashes to throw overboard, and the ease and facility with which oil can be put on board compared with coal are obvious. One great reason against its more general adoption as fuel for marine work is the fear of the shipowner that an increased demand would raise the price, as the sources of supply are in comparatively few hands; but I have no doubt that we shall shortly see great developments in the use of refuse oil as fuel for ocean steamers.

Aerial Navigation has lately received considerable attention, and is divided into two branches, aviation and ballooning, of which aviation, or the act of navigation through the air with a machine heavier than the air it displaces, has amongst its exponents Mr. H. Maxim, the inventor of the well-known Maxim guns, and Mr. Phillip, of Harrow. Mr. Maxim is a believer in the æroplane system, and is carrying out experiments with a machine weighing 7,000lbs., and maintains that, so far as propulsion and raising power are concerned, flying is perfectly feasible. Although the art of flying by mechanical means is still very much in the experimental stage, there is little doubt of its ultimate accomplishment. What we must strive for is to reduce the weight necessary to produce a horse-power. The

greater the reduction, the greater speed in our steamboats, and the nearer we shall be to a practical flying machine.

It is a matter of congratulation that even in these depressed times the steady improvement of our railways is still going on. The quadruplication of our suburban lines between Redfern and Homebush marked an era in the history of our railways. effect is seen in the increased speed and marvellous punctuality of our trains. All the new permanent way is laid with 80lb. rails, and generally speaking our roads are now second to none in the world. The station accommodation is greatly increased and brought up to modern requirements; the level crossing at Burwood Station is dispensed with, a great boon to the inhabitants of that suburb. The economy and efficacy of a railway is measured in a great degree by the number of tons that can be hauled by an engine. This depends, of course, on the grade of the line, the steepest grade on the line governing the weight of the train; and the New South Wales railways have been specially handicapped in this manner, owing to the routes chosen by the original designers of our lines, and the contour of the country, we have quite a notoriety for heavy grades. These are being gradually but steadily cut down. Between Singleton and Murrurundi there were grades of 1 in 33 and 1 in 44; they have now been reduced to 1 in 70. On the Southern line, between Granville and Picton, the grade has been reduced from 1 in 66 to 1 in 100; between Dubbo and Minore, on the Western line, the grade has been reduced from 1 in 55 to 1 in 70; and between Lawson and Wentworth Falls a grade of 1 in 33 has been cut out, and one of 1 in 73 substituted. The Lapstone Hill Zig-zag has been cut out by a deviation, saving time and admitting heavier trains.

The great saving in haulage and economy of working by these alterations can only be appreciated by those versed in the working of railways. The improvements in the road have been supplemented by a heavier type of locomotive, so that the trains that in former days required two engines are now drawn

by one. Automatic brakes are being fitted to the goods traffic. The interlocking of points and signals, which provides for the economical and safe working of junctions and sidings, is being largely extended. The old staff and ticket system of working the trains is being superseded by the absolute block system for double line, and the electric staff and tablet for the single lines. These systems are of such a nature that accidents by collision are practically impossible; and travelling by rail in New South Wales is rendered as safe as human knowledge or wisdom gained by repeated trial and practice can render it.

Looking at the Australian railway system as a whole, the great defect is the difference of gauge. Queensland and South Australia have a narrow gauge, Victoria a broad gauge, and New South Wales the standard gauge. This is already the cause of detention, inconvenience, and expense, which will increase as the traffic between the Colonies increases; and a little reflection will show that it is merely a question of time when the gauges must be equalised, and the greater the delay in doing so the greater the expense will be. As the Commissioners for our Railways are fully seized with the importance of this matter, we can rest assured that any delay will not be the fault of New South Wales.

The financial depression has greatly affected all local engineering works; in fact, the Government very wisely reduced them to a minimum; but in the case of some works, notably those under the supervision of the Water and Sewerage Board, it was necessary to complete them before any benefit could be had from the work done. This was especially the case in the Western suburbs outfall sewer, where an expenditure in works of about £185,000 had been incurred, and it will take about £90,000 more to complete the sewer and the farm, without the branches. The sewerage farm consists of about 600 acres of land between Botany and Arncliffe, 34 acres of which are at present under cultivation. The daily supply of sewerage is 1,800,000 gallons, all of which is utilised in connection with

the working of the farm, without in any way affecting the health of the inhabitants.

In October last the members of this Association had, by the courtesy of the contractor, Mr. J. F. Carson, an opportunity of visiting Contract No. 64, consisting of the construction of the aqueducts between Cook's River and Rocky Point Road, Arncliffe. There are three valleys to cross, the first having twenty-six arches, each of 24ft. span in the clear. Owing to the nature of the soil, the piers were each built on a foundation of thirty piles, driven to a depth varying from 30ft. to 60ft. On the top of the arches are built the sewers, which are of bluestone concrete and brickwork, in three sections, each 6ft. inside diameter. Over the second valley the sewer is carried on twenty-six brick arches each of 6ft. span, and seventeen each of 27ft. 6in. span; and it then crosses Wolli Creek on an iron bridge with two spans of 80ft. each. The aqueduct is constructed to carry three lines of iron sewer, each 6ft. diameter. After crossing another valley it is carried over Cook's River on an iron bridge, with two spans of 80ft. each. The construction of aqueduct is similar to Wolli Creek. All the wrought-iron pipes are 6ft. in diameter; are machine riveted on the works by a special hydraulic riveter, made to Mr. Carson's order by Tweddell and Co., which has an 8ft. gap, and is said to close on an average 2,000 rivets per day; 22,000 casks of Portland cement have been used, and the price for this contract is about £98,000. Contract No. 69 is now let, and is a continuation of the present line. The cast-iron syphon pipes are to be supplied by Mort's Dock and Engineering Company.

The Eskbank Iron Works in January last inaugurated a plate iron and steel rolling mill, with galvanising and corrugating plant, a valuable addition to their works. The iron plates will be rolled out of scrap, and the steel from imported blooms. The iron works are very happily situated; good coal is at the door, and iron ores are said to be in abundance, exceedingly rich, easily accessible, and readily worked; so that

there is little doubt that, looking ahead, we shall see steel and iron plates rolled at Eskbank from the native ores before long.

The year 1894 will be remembered as witnessing the completion of the Manchester Ship Canal, which was opened on New Year's Day, and has transformed Manchester into a seaport town. The canal is 35½ miles long, 172ft. wide at the water level, and 120ft. wide at the bottom, with a minimum depth of water of 26ft. The work was actually commenced in November, 1887, so that the time occupied in this stupendous work is only six years and one month; and this includes excavating about 137 acres of dock—a standing evidence of the mechanical efficiency of the age. The total cost is about 15 millions sterling, and the average number of men and boys employed about 10,000.

This canal enables the continuation of ocean voyages to Manchester; and instead of the goods for Manchester being landed at Liverpool and then conveyed by rail, they are now discharged from the ship at the docks in Manchester. It is premature to quote the saving that will be effected in freight, but the lowest estimate places it at 5s. per ton, and this after the railways have considerably reduced their charges in anticipation of the opening of the canal.

Time will be required to appreciate the full benefit of this canal to the surrounding population, but it is generally thought that it will induce such an increase in the traffic as ultimately to benefit the competing railways connecting Liverpool and Manchester.

In Bridge Engineering, the latest novelty is the Tower Bridge over the Thames, now nearly completed. It is on the bascule principle, with two Gothic towers, each 200ft. in height from the piers. The centre span of 200ft. is cut in halves, and raised and lowered by hydraulic machinery in the towers to allow the passage of vessels. A footpath at the top of the towers is used by passengers when the lower roadway is open.

There are two hydraulic lifts in each tower for conveying the passengers to the footpath. The length of the bridge and approaches is about half a mile, and the cost about one million sterling. One great advantage in this style of bridge is that it is never closed to passengers. We have all experienced the annoyance of waiting on Pyrmont Bridge until the swing was closed. The Tower Bridge design avoids this, and at the same time a roadway is kept at a level to suit the contour of the surrounding country, and it appears to me worthy of consideration whether such a design would not be most suitable to connect Sydney with North Shore. I commend this to the notice of those of our members who are connected with this branch of engineering.

Having now very briefly reviewed some of the most prominent advances made in our profession as Engineers, we can with fair justification congratulate ourselves on the exceptional ability, energy, and enterprise displayed; and one of the most suggestive features claiming special notice and reflection is the sure and steady increase of distinct branches in engineering, a large percentage of them requiring a training and proficiency which takes years to attain, and which in a financial sense can only be successful by (in almost every case) making them specialities. Such a system, however, is by no means an unmixed blessing, as our productive power has been so enormously increased beyond our requirements that it almost appears as if the skill of the engineer and the progress of civilisation were slowly, but surely, increasing the struggle for existence. The problem of the age, and one exercising the greatest minds in all civilised countries, is to find work for the masses and keep the people employed. Legislators and labour leaders have, so far, signally failed to find anything approaching its solution, and while freely admitting the great difficulties surrounding the problem, we in this country might help to simplify it by recognising the supreme necessity for cultivating habits of thrift and economy,

and also by taking a logical common sense view of our position, realising that things are not, and probably never will be, as they have been in bygone days; that we must all work and get a fair return for our labour if we can, but if not to make a virtue of necessity and accommodate ourselves to circumstances.