of 21 knots per hour, and a probable coal consumption of 400 tons per day, and there is a proposed new boat 700 feet by 65 feet beam to indicate 45,000 horse power, and maintain an average speed of 22 knots.

The cargo steamers are increasing in the same ratio as regards tonnage. The "Samoa" is 445 feet by 52 feet beam, and is said to carry 9,200 tons on a 25 feet draught.

The twin screw for fast passenger boats has established its supremacy, and the last proposed new steamer for the White Star Line will, it is stated, have three propellers, viz., one in the centre and one under each quarter. No doubt the object of fitting more than one screw is to reduce the possibility of the ship becoming totally disabled by a break down of machinery, more command over her in narrow waters, and last but not least, the utilization of the immense indicated horse power without an extreme draught of water. We are fast approaching the size of the "Great Eastern," designed by Brunel and launched in 1857; she was 680 feet long by 83 feet beam, and 58 feet in depth, and 20,000 tons burden; she was never a commercial success; owing to her heavy draught of water there were very few ports in the world she could enter, and those only at high water.

As regards economy of fuel which is of great moment in maintaining high speed over a long distance it has been reduced from $2\frac{1}{4}$lbs. per I.H.P. in 1872 to $1\frac{1}{2}$lbs. at the present day, and as far as I can judge with our present form of heat engine, we have arrived at or very near the minimum, and we must look to other means of economy if we wish to increase the efficiency, which is the aim of the marine engineer. Reduction of weight will assist us greatly in this direction, forced draught has done good service by increasing the number of pounds of coal burnt on a square foot of grate surface, and thus reducing the size and weight of the boilers, but there is a great deal of prejudice against forced draught, it is condemned for making the boilers leak, our English Navy has especially signalized itself in this way. In my opinion the fault is due to making our boilers too rigid, they are not elastic enough to allow for the expansion and contraction that takes place owing to the unavoidable variations of temperature in opening fire doors, &c., and the sooner we recognise the fact that forced draught has come amongst us to stay, and that we must design suitable boilers, the better. Limiting the air pressure to 1 inch of water is merely begging the question, for in locomotives the air pressure is as high as from 4 to 6 inches of water and they are seldom troubled with leaky tubes, due in a great measure to the elasticity of the boilers and also having clean water as feed.

Too much attention cannot be paid to the purity of the water in the boiler. Just as much care should be taken with the feed as if it was to be served for drinking purposes, and the introduction of filters for the feed water, as lately fitted in some of our Colonial boats, have given good results. They remove all oil and fatty matter, which is a necessity with our present high pressure.

The Serve tube is rapidly gaining favor for locomotive and marine boilers, where forced draught is used.

The factor of safety for boilers demanded by the Board of Trade and Lloyd's is 5, while the British Navy is content with considerably less. Pressure is being brought to bear at Home to persuade the Board of Trade to considerably reduce their factor, and if this can be done with safety, it would greatly reduce the weight of boilers.

Water tube boilers are making headway for marine purposes slowly but surely. The Messageries Maritimes have them fitted to all their boats that trade to this port, and the fact that their last new boat, the "Ville de la Ciotat," is fitted with this type of boiler, after some years experience with them in other vessels, is proof that their introduction has met with considerable success The saving in weight, not only in the boiler, but in the water carried, is enormous, varying from 30 to 50 per cent. Messrs. Thornycroft are also adopting this type of boiler, and in the late scientific journals there is a very interesting description of trials of those that were fitted on board a Danish Gunboat at Copenhagen, indicating about 3000 horse power. By the result of these trials, and what we see daily of the performances of the French mail boats, we are justified in assuming that water tube boilers are suited to marine work, and their general adoption is merely a question of time.

There is a good specimen of the latest type of marine engineering just turned out by one of our Colonial firms. I refer to the new Pilot Steamer "Captain Cook," which the members of this Association had an opportunity of inspecting last session. For design and workmanship, this boat could not be excelled by any of the Clyde Yards, and it is to be hoped that some of our local steam companies may yet find it to their interest to get some of their steamers built here. No doubt we cannot compete with the Home firms as regards price, but then the work can be personally supervised, which is a great advantage for local requirements, and further, a continuation of work of this class would enable it to be performed cheaper.

Although forced draught, water tube boilers, and the introduction of cast steel in our machinery instead of cast and wrought iron has greatly reduced the weight and so enabled us to obtain increased speed, yet I look forward to the introduction of aluminum as the means by which marine engineering will take its next great stride. This metal is of a white lustrous appearance, with a bluish tinge. It is found combined with silicon in clays and slate, and is the most widely distributed of all our metals, being far more common than iron. Its specific gravity is 2.68, being one third the weight of copper and steel. Its tensile strength is 12 tons per square inch. Air, water, sulphuric acid, nitric acid, or sulphuretted hydrogen have no effect on aluminum.

The idea of aluminium, pure and simple, superseding steel for constructive purposes is a mistake, as although it is only one third the weight, it is only about one third of the tensile strength, but it readily combines, and it is generally thought chemically, with most other metals excepting lead, antimony, and mercury. it has also the peculiar property of absorbing a large percentage of certain metals without increasing in volume, in fact in some cases its volume decreases, so that when we speak generally of articles made of aluminium it means in combination with some other metal.

A steam launch has been built of aluminum, and the saving of weight over steel is given as 35 per cent. Bicycles are now being constructed of it at a saving of weight of 40 per cent., in fact we only want to be able to produce it cheaply for it to revolutionise all mechanical industries; it is at present in much the same stage that steel was before Bessemer made his great discoveries in 1856, and if anyone had then prophesied that before 20 years had passed steel rails would be sold at £4 per ton how he would have been laughed at; so it is with aluminium. Three years ago the price was 20s. per lb., to-day it is about 3s. 6d. per lb., and some of our ablest chemists are continuously working at the problem of how to produce the metal cheaply. It is largely due to the application of electricity to its manufacture that its cost has been so greatly reduced, and so far as we can see at present to produce aluminium cheap we must have cheap electricity, and at risk of being tedious you must allow me to say a few words on this wonderful science.

Electrical science is as yet in its infancy and it promises enormous developments in the near future. As a means of illumination, whether for small or large areas, whether displayed in the lighthouse to warn the mariner from some danger and enable him to establish his position at night, or on board the ship itself, the electric light for purity, brilliance, and absence of heat, stands unsurpassed. In 1879 the first Clyde vessel was fitted with electric light, and now there is hardly a steamer of any note without it. It is also being rapidly adopted for street lighting, and, in the course of time, when it becomes cheaper it will in all probability supercede gas in the middle class houses. There are some 60,000 incandescent lamps manufactured daily and sold at a price of about 5s. each. When the royalty for the patent expires, which is some time in the current year, the price is expected to fall to 2s. per lamp, and as in street lighting you expect to renew your lamps three times in the course of the year, that will mean a saving of say 10s. per lamp per annum. It will in the near future entirely supercede gas or oil for lighting railway carriages, as it will entirely obviate the danger of carriages taking fire in the event of a collision, which often occurs where gas is the illuminating agent. But electric lighting, although perhaps the most known, is the smallest offspring of this giant science, the great future of electricity is as a means of transmitting energy.

In our ship-building yards, and in erecting bridges in place, the electric riveter is rapidly superceding the hydraulic, the wires being found much easier to manipulate than the pipes in conjunction with the hydraulic, and the inventor looks forward to putting the rivet in cold and heaidng the point with the current. If this can be done it will improve our boiler and bridge work as the rivet will then fill the hole which, theoretically, under our present system it can never do.

The electric driller now used in ship yards for drilling holes in the plating in place, attaches itself to the plate by merely switching on the current.

Electric launches are now being made by the score and in large factories it is found economical and advantageous instead of distributing the power either by numerous steam engines, scattered over the works by long lengths of shafting, to have one central power station in the works, and electric motors wherever required to drive machines, &c.

Distributed over the earth are vast forces stored up by nature in what may be termed energy of position, or potential energy, bodies of water at high elevations, waterfalls, swift running streams, and the rise and fall of the tide, which in some parts amount to as much as 70 feet, &c. These vast reservoirs of power have not been utilised except in a very small way, owing to the difficulty in transmitting the power to where it would be advantageously used, the usual means of shafting, ropes, air or water under pressure were found unsuitable, it is here where electricity steps in as it can transmit the energy almost any distance with comparative economy, and this economy will always be in an increasing ratio as insulation, &c., is improved.

In the Falls of Niagara we have one of the greatest instances of energy of position, where it is estimated that 275,000 cubic feet of water passes over every second, the depth at the crest is about 6 feet, and fall 164 feet, approximately there is about 8,000,000 horse power running to waste, or more than the whole of the steam and water power used in all the manufactories of the United States.

A company has started and, in fact, have nearly completed their works to utilise 120,000 horse power, which it is estimated will take 10,200 cubic feet per second, an amount which will not be perceptible, the effective fall being about 140 feet. Shafts 160 feet deep are sunk communicating with a tunnel 21 feet by 19 feet, which forms the tail-race and whose outlet is at the bottom of the Falls. A turbine of 5000 horse power nett is placed at the bottom of each shaft, the efficiency of the turbine is expected to be between 80 and 85 per cent. Generators will be driven direct from the turbine shafts and they are expected to have a 90 per cent. efficiency. The power will be electrically transmitted to Buffalo, a city about 18 miles from the Falls, with 275,000 inhabitants. To generate this power in the ordinary way with our most improved machinery would necessitate a consumption of 80 tons of coal per hour, and the water that this is using is under 4 per cent. of the total flow, so you can see what vast possibilities are opened up. It is expected that the company will be ready to transmit power to

Chicago, over 500 miles distant, in time for the great Exhibition, and they anticipate delivering 600 horse power for every 1000 furnished at the Falls, and they look forward to ultimately running the printing presses of New York by power generated at Niagara Falls.

The Canadians have also started a scheme for utilizing the water power on their side of the Falls, and these schemes are merely the forerunners of many others, which will spring up for utilizing the vast sources of power stored up for the use of man.

Let us reflect on what this will lead to. One of the principal items in building up successful manufactories is cheap power, which, until now, meant cheap coal; in fact many authorities say that Great Britain owes her commercial supremacy to the abundant store of coal, and manufacturing industries tend to congregate in the vicinity of coal fields. The iron ship building industry sprang into prominence on the banks of the Thames, but it gradually but surely was transferred to the northern rivers, the Tyne, Wear, Clyde, &c., owing to the cheapness of coal; but now we may expect countries that possess stores of natural power to enter into competition with those that have cheap and plentiful coal.

Rome is lit by electricity generated by a waterfall at Tivoli, some 17 miles distant.

The great improvement made in electric locomotives by winding the armature direct on the axle, thus abolishing all gearing, makes it certain that in a very short time the electric tram motor will supersede all other types, except, perhaps, where the inclines are very steep, and, in consequence it will be a necessity to still employ the cable system.

The City and South London Railway is an underground line, carried in two tunnels, each about 10. ft 6 in. diameter, driven at a depth of from 50 to 70 feet below the road way. They go under all gas, water, and sewer services, and do not interfere with any building, and there is only a small way leave to pay to the owners of property. The advantage of having two tunnels, one for the up line and one for the down, is that the tram acts as a piston, driving the air before it, which makes it self-ventilating. Each electric locomotive is capable of developing 100 horse power, weighs 10 tons, and runs at a maximum speed of 25 miles per hour, the mean speed including stoppages being 13 miles per hour; the armature is wound direct on the axle and at a speed of 20 miles per hour makes about 250 revolutions per minute; they are fitted with Westinghouse air brakes, the rail gauge is 4ft. 8½in., and the rails weigh 60lbs. per yard. This line has fourteen electric locomotives and twenty-five cars, and carried three million passengers in six months on a line only 3¼ miles in length, and by their third half-yearly report the total working cost is 16 per cent. less than for ordinary steam traction. The success of this line has been so great that numerous projects of the same kind are only waiting the sanction of the House of Commons, and before long London will have a network of these electric roads running in every direction. In the United States there is upwards of 3,600 miles of electric roads, using 5,800 motor cars constructed at an estimated cost of 31 millions sterling.

Welding pipes, &c., by the electric arc is now employed by the best makers, and I look forward with confidence that the time is near when plates for boilers, ships, &c., will be welded in place by electricity, and we shall look back with amazement at our present barbarous method of uniting iron and steel together by cutting away a large per centage of their strength in making holes to insert rivets in.

In these remarks it is to be borne in mind that situated as we are thousands of miles from the great centres of Engineering our information comes to us through the scientific papers, so that I am well aware there may be nothing new to you in this address, but if I have only aroused an interest in the progressive nature of our profession in the minds of the younger members of our Association, so as to encourage them to come forward and throw themselves heart and soul into one of its branches, I am satisfied.

This our adopted or native country, as the case may be, is rich in coal, gold, silver, lead, iron, and nearly every mineral, its soil is prolific and only requires the conservation and distribution of the water that falls on it to yield bountiful crops; the work of its development, as I have endeavoured to show will in a great degree devolve upon the members of our profession; let us try, therefore, if this Association cannot in some small way help on this great woak. By so doing you not only benefit yourselves, the country and its inhabitants, but confer happiness on thousands of families that will flock from the overcrowded countries of the old world.