8th May, 1890.

VAN RYSSELBERGHE'S HYDRO-DYNAMO SYSTEM OF ELECTRIC LIGHTING.

In the address which our worthy President delivered at the past March meeting of our Association, he drew attention to one of the principal questions of the day, viz., the substitution of electricity for gas for the lighting of cities. He showed us the great extent to which electric lighting is already applied, and the still greater extent to which it will be applied in the near future.

It is well known that some firms can hardly keep up with the demand for electric plant; one thing is certain, and that is, that those firms constructing electric machinery are making larger profits than the shareholders who have had the misfortune to invest in electric lighting companies.

Are there any of you gentlemen who could name a company that sells the electric light at the same price as gas, the said company being in a prosperous condition, and paying a reasonable dividend? This proves at once that there is something wrong in the present method of electric lighting.

Our President has, however, expressed the opinion that, notwithstanding the panic that took place in New York and elsewhere, there is no reason to apprehend any danger under the existing systems, and that there is nothing to prevent capitalists from investing in electric light companies. You will see from the substance of the paper to which the author now asks your attention, that if our President had gone a little deeper into the matter, he would probably have arrived at a slightly different conclusion.

Mons. F. Van Rysselberghe, the Belgian electrician, inventor of the system of simultaneous telegraphing and telephoning at long distances on the same wires, the system which connects Paris and Brussels, and many of the principal cities in Europe and America, but not yet adopted in this country of progress, has submitted to the Brussels Council, a system of his own, which the author will now endeavour to describe.

We all know that the gas companies could, if they chose, considerably reduce the price of gas to the consumer without in the least compromising their own interests. They might still pay very handsome dividends, while charging a much lower rate.

Supposing the gas companies reduced the price of gas to the extreme limit, what would then become of all the present electric companies? But the gas companies do not reduce the price of gas, simply because they see no such necessity yet; they are not yet afraid of the competition of the electric light, for the reason that existing electric light companies make little or no profit, while the greater number have already been forced to wind up their businesses.

If electric light has to be made a complete success, it must not only be sold at the same price as gas, but it must be produced at the same, or, better still, at a smaller cost, and the day that that is accomplished gas will have finished its career.

In the present paper the author proposes not only to show you that such a result can now be obtained, but also to prove to you the absurdity of the principles on which, at the present time, electric lighting is conducted.

On the 25th of March, of last year, the Municipal Council of Brussels called for tenders for "the establishment and working of an underground system of distribution of electricity for lighting the city, to supply motive power, and, if required, currents to be made use of for other purposes."

Electricity is only one particular form of energy. Heat, wind, running water, are so many forms of energy, susceptible of being transformed one into the other.

A distribution of electricity in a city, for the purpose of lighting, is at the same time a distribution of motive power. But, *vice versa,* a distribution of energy in the form of water under pressure or compressed air is also a distribution of electricity. Considering that they may be utilized for driving a dynamo, and by the aid of a suitable motor, the energy which has been mechanically distributed can be converted into electricity.

Which is now the mode of energy best adapted to be distributed on a large scale? That is the question.

M. Van Rysselberghe has treated it in a work called "*Théorie Elémentaire de l'Electricité et du Magnetisme,*" published some time ago. The conclusion of this book is given in the following words:—"Certainly, all economical considerations being put aside, there is not a mode of energy more suitable to the requirements of a large distribution, than electricity. Nothing is easier than the erection of a copper wire, which, though of a comparatively small diameter, is able to convey to any place the electric current, and this through motors which are as simple as they are compact, can be transformed at will into heat, light, mechanical work, &c.

"It is not surprising that, at the time of the International Exhibition of Electricity in Paris, in 1881, when the practicability of the production and industrial utilization of electricity was demonstrated on such a large scale, that vast projects were formed and a total revolution was predicted in the art of lighting, heating, and power.

"The enthusiasm of the first hour even made some see the possibility of the utilization of the natural energies, such as wind, the tides, the rivers and waterfalls, of supplying the many requirements that progress and civilization have created in the large centres of population.

"I should be very pleased if I could encourage those hopes. But the scientific man, like the historian, owes himself to truth, or to what he believes to be the truth, above all else.

"*Electricity cannot be transported economically.* Facts have demonstrated the veracity of this conclusion.

"Up to the present gas has remained cheaper than electricity, except where the latter can be produced and consumed on the same spot.

"It is quite possible to create in the heart of a large city, where one can depend upon a large consumption within a small radius, a central station for the production of electricity, and so compete advantageously with gas from a purely economical point of view.

"But the future will not belong to central stations, the consumer having too great an interest in producing himself the electric energy that he may require.

"With our present knowledge, we have to give up the idea of a large central station, distributing the current direct, over a whole city at a reasonable rate: carrying to each house and to the most distant spots of a thickly populated city, the charm and the hygienic advantages of the electric light. We must also give up the expectation that every workshop and each small manufacturer will get his motive power from such central station.

"Referring to natural forces, if one could, for instance, utilise the work of a waterfall and distribute it over the whole of a city, I do not believe that the most economical way would be to transform on the spot this force into electric energy, and to distribute it in this form. It would be better to utilise the work of the waterfall in forcing water into accumulators, which would deliver it into pipes all over the city. Then for electric lighting one could erect a great number of small stations, where the dynamos would be worked by small water motors, each of which would supply the requirements within a small radius.

"The economical law for the transport of water under pressure, compressed air, or gases, is quite different from that of electricity.

"Water under pressure and compressed air can, like gas, be distributed economically over the whole surface of a large city. They are sources of motive power, and can as such produce electricity at the small consumer's home. It is in that direction that the innovators have to work. Let them simplify the gas engines, let them produce perfect hydraulic or air motors of high efficiency; above all, let these motors require but little attention when working, and the problem of the economical distribution of energy will be solved, and at the same time the cheap production of electric light.

"In the United States, lighting by electricity is carried out to a much larger extent than in Europe. The cause is, that there they do not trouble themselves much about the cost of a thing so long as it is convenient and good. All progressive steps are always well received there. The cost being a secondary consideration.

"Electricity at high tension is transported comparatively cheaply, but it becomes dangerous for those manipulating the machines and the wires. In more than one American city, the tension of the current used is 4,000 volts, but it would be difficult to number the victims it has made.

"At 100 volts electricity is harmless; but its transmission becomes costly.

"Finally, as soon as the question arises of lighting not a single house or a single establishment, but part of a city by a central installation, the difficulty of maintaining a uniform electric pressure at every point, becomes extreme.

"In conclusion, the electric current, which in the genera opinion is so easily transported, is not transportable at all."

This is the conclusion arrived at by one of the ablest electricians of the day, and yet in face of it, our President in his last address gives the example of an American Company which intends to carry the electric current to a distance of no less than twelve miles before distributing it.

There are other sources of energy, which for purposes of transmission are far superior to electricity. Let us consider, for instance, water under pressure. Supposing the initial pressure to be fifty atmospheres, a tube of ten square centimetres section and in which the water would have a speed of one meter, represents in reality an energy of 500 kilogrammetres per second, which is equal to six-horse power.

The pipe necessary for this pressure costs, say a shilling a meter, the loss by friction is only four meters per kilometre or 1,000 meters, which is equal to the $\frac{8}{1000}$ of the 500 meters.

To transmit an electric current at 100 volts tension, the same quantity of energy, it would be necessary, in order to avoid heating, to use a copper conductor of 44$^{\square mm}$ section. Such conductor, without counting the insulating material, would cost only ninepence or the $\frac{7}{10}$ of the price of the hydraulic pipe. But the loss by resistance would be 17 volts per 1,000 meters, that is to say 17 per cent. in a system at a hundred volts, while with water the loss is only 8 per cent., a marked difference In other words, the efficiency of water under pressure is twenty times greater than electricity.

For the loss by resistance of the copper conductor to only equal $\frac{8}{1000}$ of the original current, as is the case with the water, it ought not to offer more than 0.02 ohm. resistance per 1,000 metres, which would necessitate a section of 800 square milimetres. But then the conductor would cost twelve shillings per meter, that is to say *twelve* times more than the hydraulic pipe.

The physical law is as follows :—

The transmitting capacity of hydraulic pipes increases according to the *fifth* power of the radius; while the conductability of electric cables increases only according to the *square*.

Further, we need not fear, that water, at a pressure of 50 atmospheres, presents any danger. With compressed air or steam it would be dangerous, owing to the expansion of air and steam. But water is almost incompressible; it never causes explosions because there is no expansion. When we submit a tube filled with water to increasing pressure, in order to burst it, everything goes as quietly as possible: the tube bursts and the water escapes, but no damage is done. A jet of water has very little projective power, owing mainly to the great pressure the water is shattered, and after leaving the tube at a yard's distance is reduced to spray.

The tubes to which reference is made as costing a shilling a meter have a bursting strength of over 300 atmospheres; they are tested to 180, and, considering they are worked only at 50 atmospheres, the security is perfect.

Hydraulic power of this kind has been in existence for a long time in all the large seaports, especially in Antwerp, and every detail of the system has received the sanction of every day practice.

To produce electric light by water power, a dynamo coupled with a hydraulic motor is required. Hydraulic motors are simple, do not require any looking after, and can be left to themselves. Although of small size, they possess considerable power; and to set them in motion or stop them, only a cock has to be opened or closed, which can be done by the most ignorant or unskilled person.

In a word, the hydraulic motor can be made simpler than the simplest gas meter, and M. Van Rysselberghe lays great stress on the point that it requires no care nor looking after. Up to the present, however, there are no hydraulic motors of high efficiency working at high pressures. M. Van Rysselberghe has made a special study of this question, and has designed a motor which meets all requirements. With this new machine, electricity can be produced under such advantageous conditions that the electric light has the advantage over gas, not only for elegance, hygiene, and comfort, but also from an economical point of view.

The scheme which M. Van Rysselberghe has formed for the electric lighting of the city of Brussels, and which would apply equally well to Sydney or any city, can be described in a few lines. He proposes to erect as near the city as possible, on a spot where land is cheap, near the River Seine, hydraulic pumps, similar to those used in Antwerp for the services of the wharves and docks; and pump the water out of the river, and force it into accumulators. Cast iron pipes would be laid from the accumulators all over the city, and the water would be available as motive power for small industries.

For the interior lighting of buildings and private houses, a hydro-electric apparatus would be erected. When light is required, it will only be necessary to open the cocks just as at present one opens the cock of the gas meter, and thus the electric light will be produced at once.

For the lighting of the streets at a certain number of points, these same hydro-electric machines, relatively powerful, but always of small dimensions, and each supplying a zone of restricted size will be erected. These would be small stations producing electricity, but unembarrassed by all the cumbersome steam boilers, engines, and numerous staff which renders so difficult and costly the establishment of ordinary electric stations. The author thinks it will interest you to know that a hydro-electric machine of 500 horse-power, of the model adopted by his countrymen can be erected on an area of 6 ft. 8 in. square. The water after having been used would run into the gutters or sewers, which would thus be constantly cleansed, which is an important item from a hygienic point of view, especially in a hot and sometimes very dry climate like that of Australia.

Another consideration is that in our democratic Australian cities we must avoid a public service or benefit being of advantage in only some privileged quarters. Should the city of Sydney establish a service of electric lighting on the scheme he proposes, the taxpayer of a remote street would have the same advantage as any inhabitant of a principal thoroughfare. Though this desideratum can be obtained with M. Van Rysselberghe's scheme, it is very doubtful if it could be attained by a direct distribution of electricity.

M. Van Rysselberghe stated before the Municipal Council of Brussels :—" The working of the Central Electric Station, by the present methods returns to the shareholders of the best organised and most flourishing companies only a dividend of five per cent.

" Those central stations, as at Berlin, sell the electric light at 5 centimes per lamp per hour, and give 5 per cent. dividend.

" I am convinced, and I am ready to prove it at my own risk, that I can supply the same light for $3\frac{1}{2}$ centimes, and make a profit of 100 per cent.

" Do you believe me? If so, undertake the thing on your own account, and keep all the profit for the municipality. Are you not sufficiently convinced? Are you afraid of embarking in