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FRIDAY EVENING, SEPT. 9, 1881.

Practical Electricity.

Dr. Siemens's Report of New and Marvelous Experiments in Electro-Horticulture.

London Cable Letter to the World.

I send you to-day, as of the greatest scientific importance, Dr. C. W. Siemens's paper on some applications of electric energy to horticultural and agricultural purposes. Dr. Siemens, as you know, is a fellow of the Royal Institute and a leading member of the institute of civil engineers. "On March 1, 1881," says Dr. Siemens, "I communicated to the Royal society a paper on the influence of electric light upon vegetation, in which I arrived at the conclusion that the electric light was capable of producing upon plants effects really comparable to those of solar radiation, that chlorophylle was produced by it, and that bloom and fruit rich in color and aroma could be developed by its aid. My experiments also went to prove that plants do not, as a rule, require a period of rest during the twenty-four hours of the day, but make increased and vigorous progress if subjected in winter time to solar light during the day and to electric light during the night. During the whole of last winter I continued my experiments on an enlarged scale, and it is my present purpose to give a short account of these experiments, and of some further applications of electric energy to farming operations, including the pumping of water, the sawing of timber, and chaff and root cutting, at various distances, not exceeding half a mile from the source of power, giving useful employment during the daytime to the power-producing machinery, and thus reducing indirectly the cost of the light during night-time. The arrangement consists of a high pressure steam engine of six-horse power nominal, supplied by Messrs. Tangye Brothers, which gives motion to two dynamo machines, Siemens D., connected separately to two electric lamps, each capable of emitting a light of about 4,000 candle power. One of these lamps was placed inside a glass house of 2,318 cubic feet capacity, and the other was suspended at a height of 12 to 14 feet over some sunk green houses. The waste steam of the engine was condensed in a heater whence the green houses take their circulation supply of hot water—thus saving the fuel that would otherwise be required to heat the stoves. The experiments were commenced on October 23, 1880, and were continued till May 7, 1881.

"The general plan of operation consists in lighting the electric lights at first at 6 o'clock, and during the short days at 5 o'clock, every evening except Sunday, and continuing their action until dawn. The outside light was protected by a clear glass lantern, while the light inside the house was left naked. In the earlier experiments, one of my objects being to ascertain the relative effect of the light under those two conditions, the inside light was placed at one side over the entrance into the house, in front of a metallic reflecter, to save the rays that would otherwise be lost to the plants within the house. The house was planted in the first place with peas, French beans, wheat, barley, oats, as well as with cauliflowers, strawberries, raspberries, peaches tomatoes, vines and a variety of flowering plants, including roses rhododendrons and azaleas—all these plants being of a comparatively hardy character. The temperature at this house was maintained as nearly as possible at 60 Fahrenheit. The early effects observed were anything but satisfactory; while under the influence of the light suspended in the open air over the sunk houses the beneficial effects due to the electric light observed during the previous winter repeated themselves. The plants in the house with the naked electric light soon manifested a withered appearance. Was this result the effect of the naked light, or was it the effect of the chemical products, nitrogenous compounds and carbolic acid which are produced in the electric air? Proceeding on the first named assumption, and with a view of softening the ray of the electric arc, small jets of steam were introduced into the house through tubes drawing atmospheric air with the steam and producing the effect of clouds interposing themselves in an irregular fashion between the lights and the plants. This treatment was decidedly beneficial to the plants, although care had to be taken not to increase the amount of moisture thus introduced beyond certain limits.

"As regards the chemical products, carbonic acid and nitrogenous compounds it was thought that these would prove rather beneficial than otherwise in furnishing the very ingredients upon which plant life depends; and, further, that the constant supply of pure carbonic acid resulting from the gradual combustion of the carbon electrodes might render a diminution in the supply of fresh air possible, and thus lead to the economy of fuel. The plants did not, however, take kindly to these innovations in their mode of life, and it was found necessary to put a lantern of clear glass round the light for the double purpose of discharging the chemical products of the arc and of interposing an effectual screen between the arc and the plants under its influence. The effects of interposing a mere thin sheet of clear glass between the plants and the source of the electric light was most striking. On placing such a sheet of clear glass so as to intercept the rays of the electric light from a portion only of a plant, for instance a tomato plant, it was observed that in the course of a single night the line of demarcation was most distinctly shown upon the leaves. The portion of the plant under the direct influence of the naked electric light, though at a distance from it of nine to ten feet, was distinctly shriveled, whereas that portion under cover of the clear glass continued to show a healthy appearance; and this line of demarcation was distinctly visible in individual leaves. Not only the leaves but the young stems of the plants soon showed signs of destruction when exposed to the naked electric light, and these destructive influences were perceptible, though in a less marked degree, at a distance of twenty feet from the source of light. A question here presents itself that can hardly fail to excite the interest of the physiological botanist. The clear glass does not apparently intercept any of the luminous rays, which cannot therefore be the cause of the destructive action. Professor Stokes has shown, however, in 1853 that the electric arc is particularly rich in highly refrangible invisible rays, and that these are largely absorbed in their passage through clear glass. It therefore appears reasonable to suppose that it is those highly refrangible rays beyond the visible spectrum that work destruction on vegetable cells, thus contrasting with the luminous rays of less refrangibility, which, on the contrary, stimulate their organic action.

"Being desirous of following up this inquiry a little further, I sowed a portion of ground in the experimental conservatory with mustard and other quick-growing seeds, and divided the field into equal radial portions by means of a framework xcluding diffused light, but admitting light at equal distances from the electric arc. The first section was under the action of the naked light, the second was covered with a pane of clear glass, the third with yellow glass, the fourth with red and the fifth with blue glass. The relative progress of the plants was noted from day to day, and the differences of effect upon the development of the plants was sufficiently striking to justify the following conclusions, viz.: Under the clear glass the largest amount of and most vigorous growth was induced; the yellow glass came next in order, but the plants though nearly equal in size were greatly inferior in color and thickness of stem to those under the clear glass. The red glass gives rise to lanky growth and yellowish leaf, while the blue glass produces still more lanky growth and sickly leaf. The uncovered compartment showed stunted growth with a very dark and partly shriveled leaf. It should be observed that the electric light was kept on from 5 p. m. till 6 a. m. every night except Sunday during the experiment, which took place in January, 1881, but that diffused daylight was not excluded. At intervals also the circulation of air through the dividing framework was provided for. The results are confirmatory of those obtained by Dr. J. W. Draper in his valuable researches on plant life in the solar spectrum in 1843, which led him to the conclusion, in opposition to the then prevailing opinion, that the yellow ray—and not the violet ray—was most efficacious in promoting the decomposition of carbonic acid in the vegetable cell. Having in consequence of these preliminary inquiries determined to surround the electric arc with a clear glass lantern, more satisfactory results were soon observable. Thus peas which had been sown at the end of October produced a harvest of ripe fruit on February 16, under the influence, with the exception of Sunday nights, of continuous light. Raspberry stalks put into the house on December 16 produced ripe fruit on March 1, and strawberries put in about the same time produced ripe fruit of excellent flavor and color on February 14. Vines which broke on December 26 produced ripe grapes of stronger flavor than usual on March 10. Wheat, barley and oats shot up with extraordinary rapidity under the influence of continuous light, but did not arrive at maturity. Their growth having been too rapid for their strength caused them to fall to the ground after having attained the height of about twelve inches. Seed of wheat barley and oats planted in the open air and grown under the influence of the external electric light produced, however, more satisfactory results. Having been sown in rows on January 6 they germinated with difficulty on account of frost and snow on the ground, but developed rapidly when milder weather set in and showed ripe grain by the end of June, having been aided in their growth by the electric light until the beginning of May.

"Doubts have been expressed by some botanists whether plants grown and brought to maturity under the influence of continuous light would produce fruit capable of reproduction. In order to test this question the peas gathered on February 10 from the plants which had been grown under almost continuous light action were replanted on February 18. They vegetated in a few days, showing every appearance of healthy growth. Further evidence on the same question will be obtained by Dr. Gilbert, F. R. S., who has undertaken to experiment upon the wheat, barley and oats grown as above stated, but still more evidence will probably be required before all doubt on the subject can be allayed.

"I am aware that the great weight of the opinion of Mr. Darwin goes in favor of the views that many plants, if not all of them, require diurnal rest for their norman development, and it is with great diffidence and without wishing to generalize that I feel bound to state as the result of all my experiments, extending now over two winters, that although periodic darkness evidently favors growth in the sense of elongating the stalks of plants, the continuous stimulus of light appears favorable for healthy development at a greatly accelerated pace through all the stages of the life of the plant, from the early leaf to the ripened fruit. The latter is superior in size, in aroma and in color to that produced by alternating light, and the resulting seeds are not at any rate devoid of regerminating power. Further experiments are necessary, I am aware, before it would be safe to generalize. Nor does this question of diurnal rest in any way bear upon that of actual or winter rest, which probably most plants that are not called 'annuals' require. The beneficial influence of the electric light has been very manifest upon a banana palm, which at two periods of its existence—viz., during its early growth and at the time of the fruit developments—was placed in February and March of 1880 and 1881 under the night action of one of the electric lights, set behind glass at a distance not exceeding two yards from the plant. The result was a bunch of fruit weighing seventy five pounds, the banana being of unusual size and pronounced by competent judges unsurpassed in flavor. Melons also remarkable for size and aromatic flavor have been produced under the influence of continuous light in the early spring of 1880 and 1881, and I am confident that still better results may be realized when the best condition of temperature and of proximity to the electric light have been thoroughly investigated.

"My object hitherto has rather been to ascertain the general conditions of this growth, from which I am led to think that the time is not far distant when the electric light will be found a valuable adjunct to the means at the disposal of the horticulturist, making him independent of climate and season and furnishing him a power of producing new varieties. Before electro-horticulture can be entertained as a practical process it would be necessary, however, to prove its cost, and my experiments of last winter have in part been directed towards that object. Where water-power is available the electric light can be produced at an extremely moderate cost, comprising carbon electrodes, wear and tear and interest upon apparatus and machinery employed, which experience elsewhere has already shown to amount to 6d. per hour for a light of 5,000 candles. The personal current attention requisite consists simply in replacing the carbon electrodes every six or eight hours, which can be done without appreciable expense by the under-gardener in charge of the fires in the greenhouse. In my case no natural source of power was availabe and a steam engine had to be resorted to. The engine of six nominal horse power which I employ to work the two electric lights of 5,000 candle-power each, consumes fifty-six pounds of coal per hour (the engine being of the ordinary high pressure type), which taken at 20s. a ton would amount to 6d. per hour, or to 3d. per light of 5,000 candles. But against this expenditure has to be placed the saving of the fuel effected in suppressing the stoves for heating the greenhouses, the amount of which I have not been able to ascertain accurately, but it may safely be taken at two-thirds of the cost of the coal for the engine, thus reducing the cost of fuel per light to 1d per hour. This calculation would hold good if the electric light and engine power were required during say twelve hours per diem, but inasmuch as the light is not required during the daytime and the firing of the boiler has nevertheless to be kept up in order to supply heat to the greenhouses, it appears that during the daytime an amount of motive power is lost equal to that employed during the night.

"In order to utilize this power I have devised means of working the dynamo machine also during the daytime, and of transmitting the electric energy thus produced by means of wires to different points of the farm where such operations as chaff-cutting, timber-sawing and water-pumping have to be performed. These objects are accomplished by means of small dynamo machines placed at the points where power is required for these various purposes, and which are in metallic connection with the current-generating dynamo machines near the engine. The connecting wires employed consist each of a naked strand of copper wire supported on wooden poles or on trees without the use of insulators, while the return circuit is effected through the park railing or wire fencing of the place, which is connected with both the transmitting and working machines by means of short pieces of connecting wires. In order to ensure the metallic continuity of the wire fencing, care has to be taken wherever there are gates to solder a piece of wire buried below the gates to the wire fencing on either side. As regards pumping the water, a three horse power steam engine was originally used, working two force pumps of $3\frac{1}{2}$ inches diameter, making thirty-six double strokes per minute. The same pumps are still employed, being now worked by a dynamo machine weighing four hundred-weight. When the cisterns at the house, the garden and the farm require filling, the pumps are started by simply turning the commutator at the engine station, and in like manner the mechanical operations of the farm, already referred to, are accomplished by one and the same prime mover. It would be difficult in this instance to state accurately the percentage of the power actually received at the distant station, but in trying the same machines under similar circumstances of resistance, with the aid of dynamometers, as much as 60 per cent. has been realized.

"In conclusion, I have pleasure to state that the working of the electric light and the transmission of power for the various operations just named are entirely under the charge of my head gardener, Mr. Buchanan, assisted by the ordinary staff of under gardeners and field laborers who probably never before heard of the power of electricity. Electric transmission of power may eventually be applied to threshing, reaping and plowing. These objects are at the present time accomplished to a large extent by means of portable steam engines—a class of engine which has attained a high degree of perfection. But the electric motor presents the great advantage of lightness, its weight per horse-power being only two hundred-weight, while the weight of a portable engine with its boiler filled with water may be taken at fifteen hundred-weight per horse-power. Moreover, the portable steam engine requires a continuous supply of water and fuel and involves skilled labor in the field, while the electric engine receives its food through the wire (or the light rail upon which it may be made to move about) from the central station, where power can be produced at a cheaper rate of expenditure for fuel and labor than in the field. The use of secondary batteries may be resorted to with advantage to store electrical energy where it cannot be utilized. In thus accomplishing the work of a farm from a central power station considerable saving of plant and labor may be effected. The engine power will be chiefly required for day work, and its night work for the purposes of electro-horticulture will be a secondary utilization of the establishment involving little extra expense. At the same time the means are provided of lighting the hall and shrubberies in the most perfect manner and of producing effects in landscape gardening that are strikingly beautiful."

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