THE JULIEN SYSTEM OF ELECTRICAL TRANSMISSION.

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JOS. M. WILSON, President, in the Chair.

MR. SALOM.—I take great pleasure in bringing to your attention this evening, what Dr. Wahl has been pleased so happily to term “The Julien System of Electrical Transmission.” I feel somewhat diffident in presenting this subject as I am not an electrician. But electricity is approaching so close to the domain of chemistry, that the border line is becoming more and more indistinct, and it is a question now, whether electricity will absorb chemistry or chemistry devour electricity. This, then, must be taken as my excuse. But I am here to-night not so much to expatiate on the electric qualities and attributes of storage batteries, as to inform you that a new field of industrial development in the mechanic arts has been opened. A field that will give employment to thousands of men and women and, therefore, it has a high industrial as well as scientific value. In taking up the theoretical aspect of the case, I would state that I believe a conscientious study of the galvanic battery, and more particularly the storage battery, will help us materially in forming a correct scientific conception of the nature of electricity. We are in the same relative position to-night in regard to electricity that our forefathers were 100 years ago in regard to heat. Not quite so bad, perhaps, for while we are willing to admit that we know nothing about electricity, they thought they knew a good deal about heat.

It was not until Lavoisier's time that a true conception (on a chemical basis) of the phenomena of heat was found, and it is to chemistry again that we must look for a true explanation of the phenomena of electricity.

As it is a fundamental maxim that we can create neither matter nor force, and as heat is the sensible result of chemical union or combination, where does this energy come from? manifestly from the atoms taking part in the reaction.

May not electricity, under certain conditions, be the result of chemical disunion, decomposition or molecular transposition. Of course, we understand that an amount of energy must be absorbed by chemical decomposition equivalent to that developed by chemical combination. But in the galvanic battery, there is a double action of combination and decomposition, in which the energy does not appear and disappear as heat, but under such conditions manifests itself as an electrical current. In other words, *electricity is the mechanical expression of chemical affinity, or the force of chemical attraction*. I mean by that, that the mysterious force that holds an atom of H to an atom of O will, when those two atoms are separated under certain conditions, manifest itself in the form of an electric current, and that the amount of current developed will be directly proportional to the number of atoms involved in the reaction and the intensity of the current, or E. M. F., to the chemical affinity they may have for each other. If such an explanation is correct, it accounts for the lack of progress Mr. Edison has made in the great problem of converting the latent energy in coal into electricity directly without the intermediate stage of steam. Such an explanation might account for the dual nature of electricity, since two different elements must always be concerned in its production. And electricity, derived from the dynamo, might be compared to heat developed by friction.

That this idea of the chemical basis of electricity, if I may be permitted to so term it, is becoming more and more general, is evidenced by the works of Favre and Silbermann, Andrews, Thomson, Bertholet and others, and Mr. John T. Sprague, in his great work on *Electricity*, has done for it what Joule did for heat. The mechanical equivalent of electricity is now as well-known as that of heat, and the day is not far distant when we will have with the table of atomic weights a table of atomic energies, and we can then deal with the mechanical equivalent of energy of a chemical reaction, as we now do with the masses of matter taking part in it.

But to return to our subject.

The Julien Electric Company has been organized for the introduction and sale of storage batteries and systems of electric traction of E. Julien, who, in these departments of electricity, has attained a high degree of perfection. Their successful use at Antwerp, Brussels, Hamburg, and Paris, have warranted their introduction

here. Electricity, like water and gas, ought to be stored, the better to admit of its use at all times and as it may be required. Indeed, it is owing to the want of a proper method of storage that it is not in more general use.

The importance of having a practically, indestructible, secondary battery cannot be overestimated. The flexibility of electricity, so to speak, the infinite variety of purposes for which it can be employed, render a safe, cheap, and simple mode of application—a desideratum of the highest importance. These three elements are united in a storage battery.

History.—The reverse current arising from plates of the same metal, which had been used in a voltameter, was first observed by a French chemist, named Gautherot, in 1801. It was at first thought that the plates received a charge of electricity, and that the secondary pile was, in fact, analogous to a condenser. But the chemists soon demolished this idea, and showed that the return current and counter E. M. F. were not due to a storage of electricity, but to the chemical affinities of substances produced by the previous decomposition. In 1859, Gaston Planté, who made the most exhaustive researches in secondary batteries, constructed a secondary pile, which is really the parent of all modern accumulators. A number of attempts have been made since that time to store the electric energy of a dynamo, the most notable of which are those of Messrs. Houston & Thomson, in 1879, who proposed to use a gravity form of the Daniell cell. Mr. Brush, of electric light fame, and M. Faure.

Under the action of a primary current, the storage battery becomes a reservoir of dynamic energy, which it returns at will, in the form of heat, light, power, etc.

All lead-plate batteries are founded on the principle of Planté's invention, an electrode, consisting of a conducting support with active material. But on account of this very principle, based as it is upon the oxidation of the support plates (which oxidation cannot be arrested), the plates rapidly deteriorate, and are therefore of very little industrial value. Notwithstanding the improvements made upon Planté's secondary pile during the last five or six years, by a large number of electricians, Faure, Brush, etc., the storage battery (which made no little noise at the time the electric light-

ing began to take on the development it has since acquired), did not respond to the public expectation then created, and soon fell into what may very appropriately be called a state of "innocuous desuetude." This condition of things was brought about by the well recognized defects of those batteries—low efficiency—irregular discharge—rapid deterioration—exorbitant cost of maintenance, etc. These are all defects resulting from the application of a principle which has for its basis, as well as consequence, the peroxidation of the positive support plates, whether the active matter on the plates be obtained by disintegration or addition. It remained for Edmund Julien, a Belgian engineer, who first introduced the Faure battery into notice, and who better than any other person became acquainted with its defects, to solve this important difficulty by adopting a principle diametrically opposite to the one employed by his predecessor. His batteries are made according to a new process, that of an *inoxidizable* support plate. They are absolutely exempt from the defects inherent in all other secondary batteries, and so have the industrial advantages which are wanting in all others. It is largely owing to the wide-spread attention which Mr. Julien's invention has attracted, that storage batteries have re-entered the domain of electrical industry, and a new industry of gigantic magnitude will undoubtedly be added to our other resources. In support of this statement, we cite the following facts:

(I.) It is by subjecting his invention to public tests and inspection that Mr. Julien has re-conquered the ground that had been lost. In 1885, on the occasion of the general Exposition at Antwerp, the Belgian government invited the various nations to a trial of the different systems of street-car traction. The contest was begun on the first of May, and lasted until October 31st. "L'Electrique," a Brussels company, organized for the purpose of exploiting Mr. Julien's system abroad, took part in that exhibition, with an electric street car, whose motor was driven by storage batteries. This car, which was operated side by side with cars propelled by steam and compressed air, took first prize and the DIPLOMA OF HONOR, at the same time the jury awarded Mr. Julien a second diploma of honor for his batteries. These were the highest distinctions awarded at the exhibition. The jury which awarded these diplomas consisted of ten members, appointed by the governments

of France, England, Germany and Belgium. In reporting on Mr. Julien's car, they speak as follows :

"The electric street car very regularly performed the ordinary service with one or two cars, and the extra service, also with one or two cars, which was imposed on it.

"The two batteries of accumulators, which were employed, and which seemed to have been *in use previous to the opening of the exhibition, showed no change* when they were withdrawn from service. The metal of the support plates was found to be *absolutely sound*, and the active matter adherent throughout ; no plate showed any tendency to buckling or deterioration ; this result is to be attributed to the *special composition* of the support plates made by 'L'Electrique.' There was an entire absence of polarization. The treatment of the batteries was confined to the replacing of acidulated water lost by evaporation, and during the charging. The battery weighed less than a ton, including boxes and liquid."

Those acquainted with the work required of a battery employed for traction, and which is peculiarly trying by reason of the heavy currents exacted from plates of the lightest admissible weight, and of the constant shaking of the car, will comprehend the importance of a report like the one above given. An account of the daily work done by the car may be found in the table annexed to the report of the jury. This table shows that the batteries furnished the necessary current during fifteen hours to propel the electric car, drawing another ordinary street car, both heavily laden with passengers, over a course of fifty-nine miles a day.

(II.) In his work on *Electro-Technology*, Prof. Eric Gerard, of the University of Liège, says : "In all storage batteries it has been found necessary to replace the positive electrodes after a certain duration of service, for the reason that the lead becomes transformed into peroxide, and the plates fall to pieces. Mr. Julien, of Brussels, has succeeded in prolonging the life of these electrodes by employing for their support a metallic compound, which prevents their oxidation and buckling."

The author then gives the result of trials made at the University of Liège, in 1885, with a battery of twenty-four elements of the Julien system. This trial was made under the supervision of the International Commission, charged with testing the products exhibited at the Antwerp Exhibition.

The following are the results, already published in the *Electrical World*, of New York, of November 20, 1886.

Duration of charge,	7 hours, 33 minutes.
E. M. F. per cell,	2'35 volts.
Average strength of current per kilogramme, . .	1'86 ampères.
Energy absorbed per kilogramme,	10,700 kilogrammetres.
Ampère hours per kilogramme,	14.
Duration of discharge,	6'48 minutes.
Final E. M. F. per cell,	1'89 volts.
Average strength of discharge per kilogramme, .	1'74 ampères.
Energy given out per kilogramme,	8,600 kilogrammetres.
Ampère hours per kilogramme,	11'83.
Commercial efficiency,	80 per cent.

On the subject of the capacity of the accumulators and their efficiency, Mr. Gerard states that to store one electrical horse-power hour (270,000 kilogrammetres), it requires 180 kilogrammes of Planté's accumulators; sixty kilogrammes of Faure accumulators, with an efficiency of only fifty per cent., according to experiments made at the "Conservatoire des Arts et Metiers," in Paris.

According to the above results, $\frac{270,000}{10,700}$, or twenty-five kilogrammes of Mr. Julien's accumulators, will give one electric horse-power hour with an efficiency of eighty per cent.

(III.) The diagram (exhibited) of discharge of a Julien battery, composed of twenty-nine elements of forty kilogrammes each, used by the Edison Company, in Paris, shows the efficiency and the regularity of action of the same, charged at a rate of fifteen ampère hours per kilogramme and discharged at a rate of thirteen and one-half ampères with an efficiency in ampères of ninety per cent. It will be perceived that the electro-motive force of the battery was two volts, after twenty-two hours of continual discharge.

(IV.) As an additional proof, we would state that Mr. Huber, engineer, who exploits the Julien system (accumulators and electric traction), in Hamburg, has run electric cars in regular daily service of sixty-nine kilometres in the streets of that city, since May, 1886, with a success that all scientific papers abroad are pleased to acknowledge. The same set of batteries has been employed from the beginning without any change or deterioration whatsoever.

(V.) And finally, Mr. Julien has lately been the recipient of new

distinctions in addition to those already obtained by him for his batteries.

On the occasion of the International Exhibition of Arts and Sciences in Paris, which began on June 21, 1886, Mr. Julien decided to renew, on the large thoroughfares of that capital, the official demonstrations made by him at Antwerp. Two of his cars conveyed passengers from the Place de la Concorde to the Palais de l'Industrie during the exhibition.

The jury, presided over by M. Fontaine, President of the International Society of Electricians of France, and composed of ten eminent members of that society, awarded Mr. Julien the FIRST PRIZE and DIPLOMA OF HONOR, for his accumulators and with an equal distinction for his system of electric traction.

His competitors, who exhibited the Planté and Faure types of accumulators, only obtained third-class prizes.

The confirmation of the decision of the Antwerp jury by the Paris jury is of manifest importance.

(VI.) I purposely abstain from citing other than those which, like the preceding, are publicly known and supported by official proof. These facts are sufficient to establish, beyond question, the superiority of the accumulators of this company.

By way of comparison between the Julien and other well recognized secondary batteries—those of Faure, for example—let us turn to a pamphlet, recently issued by the Electrical Accumulator Company (by some called the Vail Company), in which we find the following data in relation to their accumulators:

For a cell weighing 125 pounds, E. M. F., 2 volts.
Intensity of current, 35 ampères.
Capacity, 350 ampère-hours.

or, a current of $\frac{2.8}{100}$ ampère and a capacity of $2\frac{8}{10}$ ampère-hours per pound.

It is fair to assume that this is the very best that that battery will do. We have no proof, other than the company's own statement, that it will even do that.

Now, putting these figures side by side with those of the Julien accumulator, given above, and as the result of public and official tests, we find :

	INTENSITY OF CURRENT PER POUND—	
	<i>Faure.</i>	<i>Julien.</i>
Ampères per pound,	0.28	0.86
Capacity per pound in ampère-hours,	2.8	5.38

Thus, the capacity per pound of the Julien accumulator is about *twice as great* as that of the Electrical Accumulator Company's, while the current is *three times more intense*, and with a *greater E. M. F.*

The Brush Company claim only an E. M. F. of 1.82 volts.

These comparisons must not be regarded in the light of criticism. They are introduced solely to show the superiority of the principle of construction of the accumulators of this company, viz : an inoxidizable support plate.

The accumulators of this company may be employed for the following purposes :

The electric traction of all vehicles, more especially street cars.

The utilization of natural forces, such as water-falls and streams.

Domestic lighting.

Running motors of every kind.

Lighting of railroad cars and of street cars.

Aërial navigation.

Medical uses, etc.

I would call attention to the fact that the batteries in use here this evening have been made in this country by men who, six months ago, had never seen or heard of a secondary battery.

They have been brought from our factory in Camden already charged, in trays similar to those used in our system of lighting railway cars. The four trays, containing twelve cells each, will run twenty sixteen-candle-power lamps for eight hours, and you will observe that the lecture-room has been brilliantly illuminated during the evening (three hours) by eighteen sixteen-candle-power lamps and two 150-candle-power lamps, without the slightest diminution in quality or steadiness of the light. The latent energy these forty-eight batteries possess is equal to about 50,000,000 foot-pounds.