from a number of barrels, in good condition, representing at least 5 per cent of the total shipment, each sample to be taken from the middle of the barrel. The individual samples are to be thoroughly mixed and quartered and reduced down to sufficient size, into two equal portions marked A and B. Each portion is to be immediately enclosed in an air-tight bottle and each bottle marked with initial A or B, with date and car number identifying the shipment.

Portion A is to be considered available for test by purchaser and B is to be considered available for test by seller.

Shipper and consumer are each to sample in this manner at shipping and receiving points, respectively.

In case of disagreement on tests between buyer and seller, all portions of all four samples remaining are to be submitted to independent reference laboratory to be agreed upon, and quality, as determined by said reference laboratory is to be final, and the cost of reference work to be paid by the party most in error.

That portion of a shipment of alum which does not fulfill the requirements upon independent test as herein provided for, as proof thereof may be rejected, the shipper paying the freight both ways on the rejected material; or such shipment may, at the option of the consumer, be accepted and claims made commensurate with the degree of shortage or of inferiority as determined by the herein provided independent investigation.

WM. M. BOOTH.

THE AMERICAN ELECTROCHEMICAL SOCIETY TWENTY-FIFTH GENERAL MEETING NEW YORK CITY, APRIL 16-18, 1914

The Twenty-fifth General Meeting of the American Electrochemical Society was held in New York City, April 16-18, 1914, the sessions being in The Chemists' Club and Earl Hall, Columbia University.

Friday, April 17th was given over to an all-day excursion by steamboat around New York Harbor and Staten Island. The plants of The American Smelting and Refining Company, The United Lead Company and The Waelark Wire Company were visited. This excursion and the Smoker at the Chemists' Club on Friday evening were complimentary to the guests, being tendered by the New York Section of the Society. A Subscription Dinner Dance at The Chemists' Club closed the meeting.

PROGRAM OF PAPERS

- Some Economic and Aesthetic Aspects of Electrochemistry.** Presidential Address. (Printed in full below.) E. F. ROEBER.
Characteristics of Electrical Energy as Affecting Chemical Industries. C. P. STEINMETZ.
Efficiency of Power Transmission versus Utilization in Local Electrochemical Industries. P. SOTHMAN.
Some Economies in the Use of Energy in Electric Furnaces. F. A. J. FITZGERALD.
Power for Electric Furnace Work. W. S. HORRY.
Electrolytic Flames. (Illustrated.) WILDER D. BANCROFT.
Electric Steel Castings. C. A. HANSEN.
Electric Furnaces for Steel Making. EUGENE B. CLARK.
Advantage of Southeastern Alaska for Hydroelectrochemical Industries. W. P. LASS.
Progress in Leaching and Electrolytic Treatment of Copper Ores in South America. E. A. SMITH.
Hydro-electrometallurgy of Copper. ROBERT R. GOODRICH.
Leaching of Copper Tailings. RUDOLPH GAHL.
Metal Inventory in an Electrolytic Copper Refinery. RALPH W. DEACON.
Addition Agents in the Deposition of Zinc from a Solution of Zinc Sulfate. O. P. WATTS AND A. C. SHAPE.
The Effect of Addition Substances in Lead Plating Baths. FRANK C. MATHERS AND O. RALPH OVERMAN.
Electrodeposition of Cadmium. FRANK C. MATHERS AND HUGH M. MARBLE.
Electrodeposition of Nickel. C. W. BENNETT, H. C. KENNY AND R. P. DUGLISS.
Electrolytic Deposition of Brass on a Rotating Cathode. C. W. BENNETT AND A. W. DAVISON.

- A New Method for the Determination of Free Cyanide in Electroplating Solutions.** GUSTAVE E. F. LUNDELL.
Electric Conduction at High Temperatures and Methods of Measurement. (Illustrated.) E. F. NORTHRUP.
A New Railway Track Cell. E. L. MARSHALL.
Laboratory Notes on Some Electrical Properties of Silver Sulfide. F. A. J. FITZGERALD.
Polarization Single Potentials. CLAUDE N. HITCHCOCK.
New Cell Arrangements for Direct Determination of the Free Energy. REINHARD BEUTNER.
Experiments on White Lead. R. STUART OWENS.
A Microscopic Study of Electrolytic Iron. OLIVER W. STOREY.
The Effect of Addition Agents in the Electrodeposition of Iron. O. P. WATTS AND M. H. LI.
The Permanency of Base-Metal Thermocouples as Affected by their Microstructure. O. L. KOWALKE.

The following papers had already been presented before the New York Section and were discussed:

- The Power Problem in the Electrolytic Deposition of Metals.** LAWRENCE ADDICKS.
The Power Problem in the Electrolytic Deposition of Metals. H. E. LONGWELL.
Sources of Direct Current for Electrochemical Processes. F. D. NEWBURY.
Improvements in the Metallurgy of Zinc. G. C. STONE.
Electric Zinc Smelting. W. R. INGALLS.
Electrolytic Zinc. JOS. W. RICHARDS

PRESIDENTIAL ADDRESS

SOME ECONOMIC AND AESTHETIC ASPECTS OF ELECTROCHEMISTRY

By E. F. ROEBER

There is beauty in electrochemistry. The late Ludwig Boltzmann once said that of all artists the mathematical physicist is nearest to the World's creator in the simplicity, directness, and economy of his methods; Boltzmann made this remark in appreciation of the work of Kirchhoff and Maxwell. But we can apply it with equal truth to the electronic theory of our own time which in the simplicity of its fundamental conceptions and in the comprehensiveness of its outlook has all the elements of pure beauty. The intellect which builds the structure of the atoms of the different chemical elements out of a positive electric nucleus in association with varying numbers of negative electrons, and makes his atoms produce the desired result, is a true creator and his model has a beauty like that of the visible world around us.

But more beauty is hidden in electrochemistry than the mathematical beauty of electrochemical theory. The research electrochemist who works out a new process, whether it is the production of aluminum from its oxide or the conversion of amorphous carbon into graphite or the production of calcium carbide from lime and coke or whatever else, proceeds exactly along the same methodical lines as the artist, whether he be sculptor or painter or poet. The artist must take nature as it is. But for his work he takes from nature only what his imagination tells him to be essential to the idea he has in mind. It is this selective copying of the essential from nature and this restriction to the essential that makes a work of art beautiful.

The method is exactly the same with the creative electrochemist. He cannot improve on Nature's processes and methods. All he can do is to imitate or copy Nature's processes and combine them to a certain end. But because his goal is a certain product he can select the starting materials which are essential and use nothing else, and he can select those processes of production which are essential and combine them into the most direct way of production and produce only what is wanted. Artificial graphite made in the laboratory is superior to natural graphite, because nature does not set out to make pure graphite and man does. This makes the economic value of artificial graphite, but it also makes the artificial graphite process in the bold directness of its execution a true work of art. Wherever a process is so designed as to reach its object in the most direct

way with greatest economy, it is beautiful in the eyes of those who understand its rationale and this is broadly true and not restricted to electrochemistry. But the trained engineer's or scientist's intellectual eye is needed to see this type of beauty.

The thoughts on some particular aspects of electrochemistry which I want to submit to you for reflection to-night are of a cognate nature. They refer to the part which electrochemistry plays in the change now going on in modern civilization in economic and aesthetic valuations. Our age is called an age of unrest and revolution. Whether we are really so much more restless than our ancestors is open to discussion and hard to decide. But that the scientific and concomitant engineering advances of the last century have brought an entirely new phase (in the phase-rule sense) into the play of human reactions which make up the history of mankind, is not open to question. That the effects of modern science and engineering go far beyond their spheres of immediate interest is undisputed. What then is the effect of electrochemistry on two apparently so remote fields as political economy and aesthetics?

To express the question concisely I borrow Friedrich Nietzsche's phrase of the revaluation of values. My subject is: How does electrochemistry bring about a revaluation of economics and aesthetic values? I have brought Nietzsche's name into this discussion for still another reason. Nietzsche's brilliant and at first sight extraordinarily daring attempt of a revaluation of ethical values for the sake of creating the "Uebermensch" is perhaps in the final analysis of its positive aspects nothing more than a robust reassertion of what was strong and healthy in the viewpoints and valuations of classic Greece and Rome, but has been lost in the last nineteen centuries to an exaggerated weak sentimentality. Nietzsche wanted to make restitution of this lost strength and health from classic Greece to modern civilization and then create a new ethics. Now, it would seem that the effect of science and engineering on aesthetics is acting at present in the same direction in emphasizing the necessity of a return to the aesthetic viewpoint of classic Greece, as embodied in Socrates' view of the kinship of beauty and utility. It is for this reason that before speaking of aesthetic aspects of electrochemistry it is necessary to take up its economic aspects.

How are economic values being created by industrial electrochemistry? For this discussion Prof. Karl Knies' old and well-known conception is very useful that economic value is of three kinds—*place* value, *time* value, and *form* value. If I may use the text book illustration, ice in winter in the Maine woods has no economic value because there is no market for it there. Brought to New York, it gets place value, because there is a demand for it in New York. Stored and sold in summer time, it gets an additional economic value—time value. Nothing has been done to the ice itself by man. The place value has been created by transportation, the time value by storing, and as we shall see later these two points are of importance for the production of economic values by electrochemistry.

But for the present let us consider the third kind of economic value—*form* value, *i. e.*, the value created by the work done by man on the materials of nature, comprising mechanical work as well as chemical changes. Any chemical reaction produces or annihilates form values economically speaking. But what is the distinguishing characteristic feature of the form values produced by the electrochemical industries? Let us take a few typical examples.

By the electrolysis of a solution of common salt we get caustic soda and chlorine and we work up the latter perhaps into bleaching powder. The excess of the value of the caustic soda and bleaching powder over that of common salt is the form value produced by this process. So it is in the production of calcium carbide from lime and coke, of nitric acid and nitrates from atmospheric nitrogen and so on.

The fixation of atmospheric nitrogen representing an extreme case is most instructive. The raw material is atmospheric air which as such has no economic value at all, so that we might say that in the production of nitrate from air the economic efficiency becomes infinitely high. It sounds very well to speak of a process with an infinitely high economic efficiency, but if we take the time to remember that exactly this process which is now worked with fair financial results in Norway turned out a commercial failure some ten years ago in Niagara Falls, it is evident that our consideration must have been in some way so one-sided as to be misleading.

Why was fixation of atmospheric nitrogen a failure at Niagara Falls and why is it a success in Norway? Not primarily on account of the process because the Bradley-Lovejoy process worked with about the same technical efficiency as the Birke-land-Eyde process, though the apparatus was considerably more complicated. No, the decisive element which caused failure at Niagara Falls and success in Norway, is the cost of electric power which is three to five times lower in Norway than at Niagara Falls. And this brings us right to the root of the whole matter.

In discussing the economic value of some electrochemical products we have so far in a one-sided way compared only the value of the starting materials and of the end products, but we have entirely neglected the fact that in these cases we have not only to do with materials as such, but rather with the storage of energy in materials. The form value of many products of electrochemical industries is essentially due to their high energy content. A large amount of chemical energy is stored in electrochemical products; it is latent under ordinary condition, but it may be gotten out wherever and whenever necessity arises and this fact makes them useful and economically valuable.

Let us carry this consideration a little further by making use of the conception that the energy of a given system may be considered as the product of two factors—the capacity factor and the intensity factor, to use the terms of Ostwald. The total amount of energy remains the same. But for the engineering applications it makes an enormous difference whether we make the capacity factor small and the intensity factor large or the former large and the latter small.

In case of a waterfall the amount of water passing over the fall in a certain time is the capacity factor, the height of the fall is the intensity factor. The engineering requirements of the development of a waterfall with little water and a high fall are very different from the case of a lot of water with a small fall, though the energy may be exactly the same in both cases.

In the case of electrical energy the current passing in a certain time, measured in coulombs, is the capacity factor, the pressure in volts is the intensity factor. For electric power transmission we make the intensity factor the voltage, as large as possible, in order to decrease the transmission loss.

In the case of electrochemical products, the weight of the materials is the capacity factor, the specific energy stored in them per unit of weight is the intensity factor. If we make the latter high, if we store a lot of energy in a little matter, it will again be favorable as reducing the cost of transportation.

Now the element of transportation brings us to the conception of the place value of electrochemical products. If their form value is due to their high energy content, their place value is due to the possibility of chemical power transmission by material transportation of electrochemical products. These products of the electrochemical industries which are characterized by a high specific energy content are the principal medium of chemical power transmission.

There are two points of chemical power transmission to be specially emphasized. One is that it is not bound to a fixed route. It requires no line wires. It makes use of the ordinary transportation facilities for materials—railways, ships, etc.

This is important as it opens fields for chemical power transmission where electrical power transmission fails. For instance, there are still very large areas in this country, Canada and elsewhere which are so little populated that it would not pay to erect an electric transmission system to provide electric lighting. Here acetylene lighting is of supreme importance. Acetylene lighting is a case of chemical power transmission. At Niagara Falls the electric furnace produces calcium carbide from lime and carbon and chemical energy is thus stored in the carbide which is transported with its energy to any place where acetylene is required for lighting.

If transportation creates place value, storage creates time value. The use of chemical energy after it has been transmitted is not limited to a certain time and that is the second important feature of chemical power transmission. With electrical energy which cannot be stored as such, it is necessary to use the transmitted energy at once or to provide special means for storing it. In this respect chemical power transmission differs essentially from electric power transmission and is superior to it. Chemical energy is in itself essentially stored latent energy and is used, therefore, in connection with other systems of power transmission for storage purposes, as in the case of storage batteries for electric power systems. The time value of calcium carbide is due to the fact that we can store it and can produce the acetylene just at the moment when it is needed for lighting.

There is a long list of electrochemical products which may be considered from the viewpoint of chemical power transmission. In bleaching powder we transmit the possibility of producing a bleaching or a disinfecting liquid whenever and wherever it is needed. In the series of peroxides we transmit their avidity to give off an atom of oxygen when and where we want it, or the reaction caused by it.

As pretty and concrete an illustration of chemical power transmission as we may wish we have in Hans Goldschmidt's ingenious aluminothermic reaction. The heat of reaction of aluminum and oxygen in forming alumina is relatively very high per unit of weight of aluminum. This is just the reason why the economical production of aluminum from alumina did not succeed until electrolysis was resorted to. Now the fundamental idea of the aluminothermic method is that we have in metallic aluminum a medium which gives us by combination with oxygen a large amount of energy wherever or whenever needed. In thermit, the mixture of aluminum and iron oxide, we transport essentially the capability of producing at any place and at any time, highly superheated molten steel for welding rails, for making repairs, and so on.

Again in the new and important Norwegian nitrate industry we have an example of what we may call international chemical power transmission, as the economical value of Norsk saltpeter depends on its easy transportation by ship to other countries. Thus we have at the same time creation of economic values in Norway by building up a new and important industry and creation of economic values in other countries by using Norsk saltpeter to further agriculture.

I have dwelt on the relation of electrochemistry to chemical power transmission at such length because so many electrochemical products can be considered from this viewpoint. But it would be wrong to think that the whole of electrochemistry can thus be viewed. There are quite a number of very important electrochemical products in which with no stretch of imagination I am able to detect time value. But in all cases the form value is high.

In the case of aluminum we have the aspect of chemical power transmission only in the aluminothermic reaction, which though big in itself uses only a small amount of the total output of aluminum. In cooking utensils, in line-wire construction and other applications it is simply the mechanical and electrical

properties of aluminum which count and which give it a high form value.

In electrolytic copper refining, the oldest and certainly one of the biggest electrochemical industries, the increase of form value is remarkable. It is a double one: (1) The gold and silver are recovered; (2) the copper itself is considerably increased in form value, due to its greater purity and resulting higher electric conductivity.

All those products of electrochemical industries which have nothing to do with chemical power transmission have a high form value and must have it because otherwise it would not pay to use an electrochemical process in view of the high cost of electrical power. Hence, the well-known axiom that in all such applications the use of electrochemical processes should be restricted as much as possible to the finishing touches, that is, to the refining of a comparatively advanced product.

In addressing the American Electrochemical Society I need hardly show at length how this creation of economic values by the electrochemical industries has affected and is affecting modern civilization in its various phases. What was waste before, and what was considered a nuisance, becomes valuable. When the early Colorado gold seekers discovered the tungsten ores in Boulder Canyon, they cursed them as they were not what they wanted. But "heavy black sand" electrochemistry has given to civilization ferro-tungsten and the tungsten lamp. From culm, the waste material of the anthracite coal mines, Acheson has given to the world artificial graphite with its numerous applications. Then there are the enormous electric-furnace industries of artificial abrasives in use in so many walks of life. And so I could go on through the list of electrochemical products down to Cottrell's electrostatic process of recovering values from obnoxious smelter fumes. I should add, however, that electrolytic copper refining, itself made possible by the dynamo, has paid its debt to electrical engineering and by furnishing firm high-conductivity copper has made modern electric power transmission possible. And as we have seen, in chemical power transmission electrochemistry has brought into modern civilization an absolutely new element by which what is now waste power is being scattered all over the world to build up industries, to further agriculture with fertilizers, to light cities with acetylene, to aid public health with bleaching powder and to affect civilization in general in its most heterogeneous aspects. That electrochemists as true creators are bringing about a revaluation of economic values there can be no doubt. But what has electrochemistry to do with aesthetics?

If beauty is perceived through our senses, the first question is: How has modern engineering affected our senses? The answer is simply that modern engineering has given us artificial senses in addition to our natural senses. In the old days when the apparatus in physical and chemical laboratories were home-made affairs, it was said that experimental physicists and chemists should be able to see with their ears and hear by touch, smell with their tongues and measure temperatures with their eyes. Now modern engineering has given us instruments and apparatus which really represent new senses and which are available to a much more general public. And what is more, our artificial senses can be repaired or replaced by new and better ones and they give us permanent records.

I am not stretching the meaning of the term senses in speaking of instruments as artificial senses. To the electrical engineer the readings of the voltameter and wattmeter are as real and as true indications of the outside world as though he put his head out the window to feel whence the wind blows. Pyrometers give as real, though much more exact indications of temperature, as the touch of a hot body by hand or the trained eye of the furnace man. The photographic camera is a new artificial eye that preserves the record of what it sees. Successive photographs put together in a moving picture show enable us to

crowd into a period of five minutes what may have happened in a year. We can see crystals and plants grow. The electric oscillograph gives us a record that permits us to see in leisure transient phenomena that happen in portions of a second, and study over them for hours. The telephone stretches the ability of the human ear so that it can hear in Denver what is said in New York. And if we hear our children of three or four years talk to us over the long-distance telephone in such a self-evident matter-of-fact way as though they were sitting on our knees, we cannot escape the conclusion that a new generation is rising to which the perception of the outside world comes through new senses and which consequently looks at the world with new eyes. What has electrochemistry to offer to this new generation in aesthetic ideals?

It seems to me that the fundamental contribution which electrochemistry has to make to aesthetics is to carry to its last consequence the principle that waste can never be beautiful. Of course this principle is as old as art. Waste of words in a work of literature, waste of lines or colors in pictures, waste of space in architecture have always been considered the opposite of beautiful. But the growing multiplicity of our sensual knowledge due to the magnified and projected extension of our senses forces us to see waste where our ancestors saw beauty and had a right to see beauty.

Permit me to concentrate my remarks on the one subject that is uppermost in this connection in the minds of American electrochemists—the question of the power development of Niagara Falls. I use it as a clear cut example of what revaluation of aesthetic values by electrochemistry means. The magnificent group of electrochemical industries of Niagara Falls which are the pride of every American electrochemist and should be the pride of the whole American nation suffers seriously from the power famine due to the cessation of power development by international agreement between the United States and Canada. This agreement is based on the alleged will of the people of both countries to have the falls preserved as a scenic spectacle on the principle of conservation of natural beauty. The battle cry is conservation of natural beauty for the people.

The counter-argument has been made that the natural beauty conservationists want to conserve something that no longer exists. With this I agree, but I cannot agree with the expression usually given to this argument, that, if Niagara Falls could be preserved in its original magnificence, it would be worth while but that Niagara as a majestic spectacle has never belonged to the present generation and that its beauty has been given up to noisy and offensive exploitation long before the first power station was created.

This may be true, but it seems to me that this argument does not reach the root of the matter. The beauty of Niagara Falls, like all beauty, is subjective in the onlooker. The question is simply: What do we see when we stand at the brink of Niagara Falls?

Our ancestors who knew nothing of the principle of conservation of energy, of transformation of different forms of energy into each other looked simply at the material side of the Falls and saw beauty and had a right to see beauty. And if we force ourselves into such a one-sided attitude of mind, we can still see beauty.

But if we stand as modern men at the Falls with a free attitude of mind, we don't see simply water, we see power. We see the possibilities of using this power for electric power transmission for lighting, traction, and industrial purposes on a wider area. We see the even greater possibility of storing this power in electrochemical products and utilizing them all over the land in all walks of life. If we look at the Falls with this attitude of mind which is the natural one for us, every cubic foot of water that goes thundering over the falls unutilized appeals to us as waste and nothing but waste.

Now waste can never be beautiful. If the artist's selection of the essential and nothing but the essential makes a work of art beautiful, anything that strikes our imagination as waste must prevent aesthetic enjoyment. If we could look at Niagara Falls with the eyes of our ancestors it would be different, but in full possession of our extended senses which an engineering age has given us, the Falls of Niagara—as much of them as is not utilized—must simply impress us as a waste of immense proportions.

And just the element of bigness which was an element of beauty to our ancestors, has necessarily become to us the reverse, emphasizing only more emphatically the criminal negligence of letting waste on such a tremendous scale go on. Undeveloped, Niagara Falls remains spectacular even to the modern man, but it is no longer beautiful.

The perverse mind of Nero could enjoy the spectacle of Rome burning. A savage tribe could naively enjoy a conflagration that would consume for spectacular purposes a million tons of coal a week. We let the equivalent waste go on in water-power and hear it called saving beauty for the people.

But there is little use in arguing in aesthetic matters. All we can really do is to make people see for themselves, use their own senses, all of them, their natural ones and their artificial ones. This is what the engineering developments tend to do every day and we can depend upon it that as surely as day follows night, a new generation is rising that will use its senses, all of them, and make its own aesthetics.

When that time has come, the Falls of Niagara running dry will reveal to the world immense beauty, health and wealth scattered by electrical and chemical means all over the country, while the grandeur of the whirlpool rapids, unchanged and undiminished, will have a higher aesthetic value, a deeper meaning of beauty than they can possibly have for us. The world will then smile at the aesthetic scruples of so many well-meaning people of our own time and will wonder what all that talk of saving Nature's beauty was about.

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—293rd MEETING

The 293rd meeting of the American Institute of Electrical Engineers was held in Pittsburgh, April 9–11, 1914. About 200 members attended.

Wilfred Sykes presided at the first day's session, which was largely devoted to a discussion of the use of electricity in mines. H. O. Swoboda presented a paper on "Self-Contained Portable Electric Lamps," in the course of which he demonstrated an incandescent lamp which may be used in any position and so protected as to resist damage and to prevent the emission of sparks on rough handling.

H. H. Clark discussed "The Regulation of Electrical Installations in Mines." Among other matters dealt with were the rules proposed by the Bureau of Standards, American Mining Congress, and the English and German laws for electrical installations in mines.

The banquet was held on Thursday evening, April 9th. A. M. Dudley, chairman of the Pittsburgh Section of the Institute, delivered the address of welcome.

On April 10th, safe mine operating and the installation of electric signal and telephonic systems were taken up and discussed; and G. M. Eaton read a paper on "The Development of the Electric Mine Locomotive."

On April 11th, the convention closed after trips of inspection to the Westinghouse plants and to the station of the Bureau of Mines.

W. A. HAMOR.