The Presentation of the

EDWARD GOODRICH ACHESON MEDAL

of

The Electrochemical Society, Inc.

to

DR. FRANCIS COWLES FRARY

AT THE SEVENTY-SIXTH CONVENTION OF
THE ELECTROCHEMICAL SOCIETY, INC.
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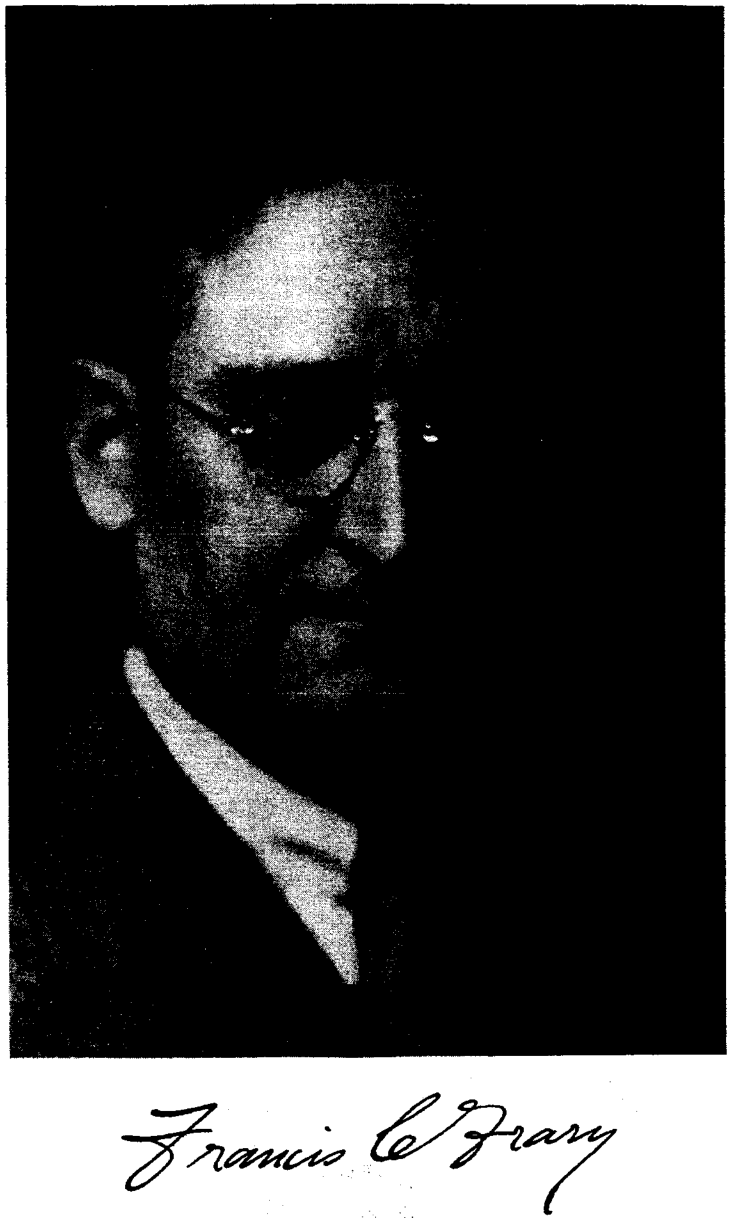

THE AWARD OF THE EDWARD GOODRICH ACHESON MEDAL

H. JERMAIN CREIGHTON.*

It is an agreeable duty to call this distinguished gathering to order and, on behalf of the Society, to extend a warm welcome to our many guests. I need hardly remind you that this is an outstanding occasion, since this evening a presentation is to be made of the Edward Goodrich Acheson Medal and Prize of one thousand dollars, the highest honor the Electrochemical Society can bestow.

In 1928, as many of you know, the late Dr. E. G. Acheson, a pioneer in applied electrochemistry, the noted inventor of carborundum and artificial graphite, and one of our founders and honorary members, presented to our Society a gift of twenty-five thousand dollars, the income therefrom to be used for the award of a gold medal and monetary prize "to any person who has made a distinguished contribution to any of the fields fostered by our Society", without restriction as to sex, nationality or race. Owing to this munificence, it has been possible every other year for the Electrochemical Society to honor a distinguished electrochemist who has "struggled and striven and fought and forced nature to win further favors for man", and thereby to stimulate further inspiration and zest of research.

It is not surprising that the Committee, appointed by the Board of Directors of the Society to recommend to them a candidate for the first Acheson Medal and Prize, concluded that Dr. Acheson's most noteworthy achievements rendered him preeminently fitted to be the recipient of any medal designed to recognize electrochemical superiority. Since the very happy and fitting award of the first medal to Dr. Acheson in 1929, medals and prizes have been meritoriously bestowed by the Society on four other outstanding electrochemists: in 1931 on Dr. Edwin F. Northrup; in 1933 on our honored secretary, Dr. Colin G. Fink; in 1935 on Dr. Frank J. Tone; and in 1937 on Dr. Frederick M. Becket. (The Society is indeed honored in having the last three of these medalists present this evening.) This year the number of recipients of the Acheson award is again to be increased. Acting upon the recommendation of the Acheson Medal Committee, selected as usual for their critical judgment and their wide knowledge and experience in the fields of electrochemistry, the Board of Directors of the Electrochemical Society has awarded the sixth Medal and Prize to Francis C. Frary, one of our fellow members and past-presidents and one who has long been active in the affairs of our Society.

We have with us this evening two gentlemen who will tell you about our Medalist and his work upon which the award is based. I now call on Mr. J. D. Edwards to present to you the story of Dr. Frary's technical and scientific accomplishments.

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THE MEDALIST AND HIS WORK

Junius D. Edwards.*

Francis Cowles Frary was born in Minneapolis in the year 1884. After receiving the preliminary education offered by the excellent public school system of Minneapolis, Frary registered at the University of Minnesota in the course in Analytical Chemistry. After four years of study, he received the degree of Analytical Chemist, and an additional year's work brought him the degree of Master of Science. This was followed by a very interesting year of study in Germany and travel in Europe. On his return, he joined the teaching staff of the University of Minnesota, and continued his research work leading to the doctor's degree, which was conferred upon him in 1912.

At this time he also received another degree—but I must first explain. The University of Minnesota, after long years of effort, received from the State money for a new Chemistry building. In the design and construction of this new building Frary was a leading spirit and, after it was finished, only he seemed thoroughly familiar with the intricate piping system, some of which he and his assistant had installed with their own hands. It was quite fitting, therefore, that he should receive the informal degree of "Pipe-Fitting Chemist", a title which he has borne with dignity throughout the rest of his professional career. Of course, he has qualified for other degrees since then, such as Certified Accountant, Patent Counsel, Chemical Engineer, to mention only a few of the fields in which he is an "expert".

It was as a young engineer, struggling with the intricacies of General Chemistry, that I had the good fortune to have Francis Frary as an instructor. The enthusiasm and energy, not to mention thoroughness, with which he taught this subject were good for young engineers. Frary not only taught General Chemistry and Qualitative Analysis, but he also offered a variety of other courses. At one time, out of curiosity, I went through the University Catalogue and counted the number of courses he gave during the University year. The number was, I believe, fifteen, and included General Chemistry, Qualitative Analysis, Electrochemistry, Electro-analysis, Electro-metallurgy, Industrial Chemistry, Photochemistry, and a variety of courses dealing with the practical applications of Photography, such as Photo-engraving.

Frary's interest in chemistry dates back to his school days when he experimented on the family premises, making batteries and carrying out simple experiments in plating. When a sophomore in High School, he became the possessor of a simple camera and proceeded to devour such books on photography as he could obtain from the public library. This led to his experimenting with the making of blueprint paper and other printing papers in his kitchen laboratory. Frary's practical grasp of the subject made his courses in photochemistry very interesting and worthwhile.

Frary's first formal research work was in the field of organic chemistry. It was carried out in collaboration with Dr. George B. Frank-

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forter, then Dean of the School of Chemistry. The principal value of this work was the excellent training he gained in methods of research and the use of chemical literature. It led, moreover, to the publication of his first scientific paper, entitled "The Chlorhydrochlorides of Pinene and Firpene", which he wrote in collaboration with Dr. Frankforter. His second contribution to chemical literature was a paper on "Rapid Analysis by Electrolysis without Rotating Electrodes." This paper presented an ingenious scheme, conceived while studying in Berlin, for stirring the electrolyte during electro-analysis without the use of any mechanical device. The magnetic field produced by a solenoid placed around the beaker containing the electrolyte, acting on the current-carrying electrolyte in the beaker, produced an electro-motor force which resulted in a rapid and efficient stirring of the electrolyte. Frary's scientific contributions during his teaching career at Minnesota led to the publication of a variety of papers, with his students, on electro-analytical methods, the electrolytic production of calcium and magnesium, and various phases of photography and photochemistry. For his doctor's thesis, Frary investigated the equilibria in certain systems containing alcohols, salts and water, and developed a new method of alcohol analysis which depended on the critical solution limits of potassium fluoride and mixtures of alcohol and water.

During this period Frary also made a pioneering contribution to electro-metallurgy in his discovery of the commercially important lead alloys hardened with calcium, barium and strontium—alloys which were later to be known as "Frary Metal" when put on the market by the United Lead Company. In the development of these alloys he was assisted by Sterling Temple. This was in 1915. Frary and Temple found that relatively small percentages of the alkali-earth metals, alloyed with lead, produced hard lead alloys, which not only were suitable for the uses to which antimonial lead had been put, but had other desirable properties which led to new uses. Five patents were granted on these inventions, three of them on applications which Frary personally prepared, filed, and prosecuted through the Patent Office. This early experience of Frary with patents was to prove of value to him later on when he became responsible for obtaining patent protection on the technical developments of a laboratory which eventually employed more than two hundred men.

Frary was an Assistant Professor at Minnesota from 1911 to 1915. In the year 1915, he was offered a position as Research Chemist by Mr. Lidbury of the Oldbury Electro-Chemical Company, Niagara Falls. The salary offered was probably attractive in comparison with that paid an assistant professor, but what really attracted Frary was the opportunity to spend all of his time on chemical research work. There was little of electrochemical interest in his work with the Oldbury Electro-Chemical Company, but Frary became an authority on the production and handling of phosgene. It was his experience along these lines that led to his selection by the Government, along with Prof. D. J. Demorest, to design and operate a phosgene plant at Edgewood Arsenal. Here again, Frary's ability as a chemical engineer and pipe-fitting chemist was invaluable in the functioning of this plant. At the close of the war, Dr. Frary left the Army as Major in the Chemical Warfare Service.

Prior to entering Government service, Dr. Frary had accepted a position as Director of Research with Aluminum Company of America, but he did not assume these duties until December, 1918. His first task was to assemble a competent group of men for his research staff. Apparently he did not think too badly of your speaker for he soon asked me to come to New Kensington and, as a result of this conference, I became a member of his staff. An acquaintanceship extending over thirty years, and active association with him for the past twenty years, give me some basis for appraising the medalist's scientific achievements. In doing so, however, I feel somewhat in the position of Clarence whom—you will remember—Mark Twain wrote about in his fantastic story, "A Connecticut Yankee in King Arthur's Court". Frary's forebears were from Massachusetts and not Connecticut, but there are other analogies between Mark Twain's famous character and the man we are honoring tonight. Clarence, you will remember, was assistant to the Yankee inventor of the story and in public, at least, you will remember that he addressed him as "Sir Boss", and it is of the achievements of "Sir Boss" during the last twenty years that I now speak.

Only a few of his contributions to the aluminum industry can be mentioned, and perhaps the first of these should be the electrolytic refining of aluminum. In the Hall process for the electrolytic reduction of aluminum it is necessary, as you know, to start with pure materials—pure alumina, pure carbon, and a cryolite electrolyte substantially free from iron and silicon, since the metals more electropositive than aluminum are reduced at the cathode and contaminate the aluminum. Aluminum with a purity of about 99.7 per cent was the limit reached in the year 1920.

Years before, William Hoopes, the Chief Electrical Engineer of Aluminum Company of America, had conceived the idea of producing pure aluminum by electrolytic refining of an aluminum alloy. There was no opportunity of developing the process at the time but, with the establishment of the new research laboratories under Frary, such an opportunity was presented. Hoopes had the idea that if you could float a suitable molten fluoride electrolyte upon a heavier molten aluminum alloy, such as an aluminum-copper alloy, then pure aluminum could be electrolytically dissolved from the heavy anode alloy and deposited in a cathode layer of pure molten aluminum floating on the electrolyte. The success of such a process depended on an exact knowledge of such physico-chemical properties of the electrolyte and alloy as density, melting points, etc., so as to permit an exact control of the process. These data were determined by physical chemists in the laboratory, and Hoopes and Frary, working in Badin, North Carolina, undertook the building of an electrolytic refining pot and its operation.

This was an exciting and somewhat hazardous investigation, but they carried it through to a successful conclusion. One day a telegram was received stating, "Purissimum has arrived". A subsequent analysis showed that the refined aluminum was not quite "purissimum", but it was much purer than any aluminum that had ever been prepared before. The process was soon developed to the point of commercial operation, and thousands of pounds of aluminum with a purity of better than 99.95 per cent were produced. At times, substantial quantities of metal having a purity of 99.99 per cent were made.

The benefits which flowed to the aluminum industry from this achievement were many and not always foreseen. In a scientific way, possession of metal of this high purity permitted the physical chemists and metallurgists of Aluminum Research Laboratories to determine a variety of physical properties of pure aluminum and various alloys and to work out new equilibrium diagrams for the alloy systems. In a practical way, the possession of metal of this purity enabled us to determine the properties of aluminum alloys without the presence of contaminating iron and silicon. Some of the newer and more important aluminum alloys now available were made possible by this work. We were also able to share this aluminum of high purity with research workers in other laboratories and other countries.

In all good research work, one thing leads to another. Years before, Charles M. Hall had attempted to make pure alumina by treating bauxite in the electric furnace with a reducing agent such as carbon, so as to reduce and separate the contaminating metals, iron, silicon and titanium. Hall's fused alumina was crushed to a coarse powder before being added to the molten cryolite electrolyte in the Hall reduction pots. This form of alumina did not work satisfactorily and the process was abandoned for the time being.

Our experiments on the direct electrothermal reduction of the aluminum alloy for the electrolytic refining process showed that iron and titanium must be reduced to a very low value. It was found possible, moreover, with the electric furnace technique then developed, to produce fused alumina of sufficient purity to permit its direct conversion to commercial aluminum in the Hall reduction pots. After analyzing the situation, Frary came to the conclusion that the Hall dry process alumina had not worked well in the previous tests because the particles were not fine enough to dissolve quickly in the electrolyte. Because of the coarseness and high density of this alumina, it sank through the electrolyte and the cathode metal and formed a gummy, pasty mass which interfered seriously with the operation of the process. It occurred to Frary that if fused alumina of this character could be made fine enough so that it would dissolve quickly and completely when stirred into the molten electrolyte, it could be satisfactorily employed and this fact was soon demonstrated.

Frary's interests have been broad and he has a good grasp of every subject in which he has interested himself. Just to mention the subjects of some of the thirty patents issued to him will give an idea of this breadth of interest. These include, in addition to the patents having to do with the electrolytic refining of aluminum and the electrothermal reduction of alumina, patents on the manufacture of aluminum chloride, electric annealing of aluminum sheet, calcination of coke for electrodes, calcination of bauxite, molding sand for casting magnesium, insulation of refrigerators, removal of dross from aluminum, refractory lining for crucibles, and a number of aluminum alloys.

Frary's keen analysis and discussion of the problems of the aluminum industry have always been very stimulating and have led directly and indirectly to many discoveries by members of his staff. His thirst for knowledge has led him to acquire the ability to speak German, Norwegian and French and, in addition, to read Italian, Swedish, and perhaps some other languages I haven't heard about. Frary has actively participated in the technical discussions at the many meetings of The Electrochemical Society which he has attended, and in that way made the meetings more interesting for others. He has also been generous in speaking before technical groups and has made some forty such addresses in the last twenty years.

The achievement of which Frary would be most proud is, of course, Aluminum Research Laboratories, and its record of things done. This research group of two hundred, captained by "Sir Boss", has helped keep the aluminum industry of America at the head of the procession for twenty years. In doing this, Frary has displayed at all times not only a keen sense of the Company's rights and responsibilities, but also a sense of public service in making aluminum more useful to everyone and in building a firm scientific basis for the technologic progress of tomorrow.

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Dr. Creighton then called upon Mr. Kirkpatrick to tell something of Dr. Frary's life outside of the laboratory.

FRANCIS C. FRARY AS FRIEND AND ASSOCIATE

SIDNEY D. KIRKPATRICK.*

I deem it a high personal privilege to participate this evening in the award of the Acheson Medal to Dr. Francis C. Frary. As I contemplate the title that was assigned for my brief remarks and as I look out over this fine audience of Dr. Frary's friends and associates, I realize only too well that there are many here who can speak of longer friendship and from much more intimate association. Yet I yield to none of you in my respect and admiration for the great electrochemist we are to honor tonight.

My official acquaintance with our expectant medalist began back in the days of the first World War when I was a lowly lieutenant and he was a mighty major of Chemical Warfare. After the Armistice, he went to a big job with the Aluminum Company while I became a G-man —that is, I worked for the Government in the United States Tariff Commission. Dr. Grinnell Jones of Harvard was my boss and one of my first assignments was to write a report on the Serpek process of nitrogen fixation. When it was completed, I sent it, with some hesitancy, to the Aluminum Company of America for review and imagine my surprise when it was returned to me in person by none other than that corporation's distinguished president, Mr. Davis, who was accompanied by his new director of research. The latter carefully read and meticulously corrected my amateurish document and helped me tremendously in putting it into form for publication. I shall never forget his sympathetic interest and cooperation on that occasion which impressed me with a fundamental characteristic of our friend that I have marvelled at many times since, namely, his conscientious, patient attention to detail without for one moment losing sight of the main purpose and objective. But I shall speak more of such things later.

Our early acquaintance developed into warm friendship as we were thrown together in the work of this Society and other scientific and technical organizations. Later our wives and daughters got to know each other quite well and as good Middle-Westerners soon found many interests in common—in fact, so many that Francis and I as mere husbands became quite unimportant in the scheme of things.

I am pleased that Dr. Lillian Cohen is here tonight for she is a sort of mother confessor and patron saint of every Minnesota chemist I have ever met. She is a very kindly person and, because she knows everything about everybody that ever went to Minnesota, I naturally

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turned to her for some reminiscences of Frary's years at Minneapolis. No. 1 on her list is this:

"I remember that Frank became engaged at the comparatively early age of 19. At the time I thought I would kid him a little by telling him that I'd heard some rumors about him and a certain young lady. He turned to me with some indignation and said, 'Miss Cohen, if you wish to know about such things, please don't listen to rumors. If there's any truth in the matter, I'm the one who should know about it.' All of which certainly put me in my place, but about two weeks later he bounded into my laboratory beaming from ear to ear and said, 'Well, what you heard is so! I can confirm the rumor. Alice and I are going to be married.' "

To this Miss Cohen adds,

"Mrs. Frary was an unusually gracious and lovely girl and is today an unusually lovely and gracious lady"—a statement with which I am sure we all agree.

Miss Cohen's stories are all so intensely human and interesting, at least to me, that I'm tempted to give you more of them rather than bore you with the elaborate biographical data I have carefully extracted from Chem. & Met.'s morgue and half a dozen different "Who's Who's." Miss Cohen writes further:

"Frank Frary was always noted for climbing up and running down stairs in the Chemistry Building at least three steps at a time—with knees bent up to his chin and his head way out in front of his feet. His mother told him he ought to spruce up and get his pants pressed (of course, that was before he got engaged!) but Frank said, 'Oh, what's the use, they'd be out of press in no time, for I've simply got to keep on the run hurrying from one job to another in the Chemistry Building.' "

That boundless physical energy appealed to lots of his early friends and associates. One writes me as follows:

"Enthusiastic, earnest and energetic, we students all marvelled at his great strength. He had long legs and he used to race up and down the stairs of the old Chemistry Lab. three or four steps at a time. On Saturday afternoons he went on hikes with some of his students. George Morey, Walter Badger and I used to accompany him, but Frary was such a fast walker and kept at it so long that I soon became discouraged from going on any of his longer hikes."

Strength and good health are, after all, extremely important factors in the success of any man and this is particularly true of a man who works as hard as Francis Frary. Here's the way another of his anonymous associates of the Minnesota days puts it:

"Frank Frary has always been a strong man physically as well as mentally. In fact, there is documentary evidence to prove this statement. Somewhere in the Frary family archives is a photograph of the University of Minnesota's 'Strong Men's Squad' of 1903. This photograph, slightly scandalous in those days, showed the bare and manly chests of the 50 strongest men in the university. Frary is in the center of that picture for he was a member of the squad that won the National Intercollegiate Championship of 1903, defeating both Harvard and Columbia. Frary kept in good condition while teaching by shuttling back and forth between his classroom in the basement and his research laboratory on the third floor. It is a tradition at Minneapolis that he got his electrochemical education three steps at a time."

And as some of us can testify, Frary still loves outdoor exercise. When he's home, almost any Saturday afternoon will find him out at the Oakmont Country Club studying the effect of elastic impact skillfully applied to about 47.8 elusive grams of gutta percha!

To get back again to Miss Cohen's "Frary-Tales", here is another!

"Frank worked about 36 hours in every 24. He'd be doing chemical research in his laboratory while his senior students were solving their examination problems and at the same time he was developing a new course in photography, photochemistry or photo-engraving. In fact his photographs were so lovely that I once remarked to him, 'You know, Frank, you could do very well and make a fine living as a professional photographer.' He turned to me a bit upset and with a quizzical look in his eyes, said, 'Don't you think I'm going to do pretty well as a chemist?'"

Some of his other friends in those days were equally sure that he should be a professional glass-blower. This was a hobby which, as Mr. Edwards pointed out, grew out of his boyhood adventures when he had to make all of his own laboratory apparatus. One of his early associates writes me that he can still picture Dr. Frary "racing down the stairs with a long gangling lope from the attic storeroom, his arms full of dusty, broken condensers, distilling flasks and what-nots—all of which he would carefully repair for further use because he was as frugal as he was industrious in those days."

The worst part of all this—at least as far as the laboratory glassware industry is concerned—is that Frary actually taught other people to be frugal and to repair their broken apparatus instead of spending their money to buy new glassware. In 1914 he conspired with a certain corporation in New York to publish a book entitled "Laboratory Manual of Glass-Blowing." That little book of Frary's had to go through two reprintings in its first edition and was completely revised with the help of Edwards and Taylor in 1928. The total sales to date are close to 7,000 copies. Just think how much that has cost the laboratory glassware industry during these past 25 years!

A final story from Miss Cohen:

"When Frank first joined the Aluminum Company of America, he was making his customary visit to Minneapolis. A lady remarked to him, 'You know, Dr. Frary, aluminum isn't good for applesauce.' 'Pardon me, Madam,' said he, 'but what you mean is that applesauce isn't good for aluminum.'"

The highly exemplary personal habits of our medalist are almost too well known to be worthy of comment here. As far as my researches have revealed to date, he came by his dislike of alcohol quite early in life. Dean Edward E. Nicholson, whose job it is at present to look after the student morals and their other affairs on the campus at Minnesota, writes me this:

"Francis C. Frary came back to Minneapolis from his graduate studies in Germany very disgusted with the wild ways the German students spent their time drinking beer and living with their sweethearts. Nevertheless one of Frary's very first researches had to do with making alcohol from cactus juice (I think they call it Tequila in Mexico) and then when Dean George Frankforter gave him the research for his Ph.D. it had to do with the production of anhydrous alcohol with potassium fluoride. Thus, believe it or not, in those days, Minnesota's leading authority on alcohol was the most abstemious man on the campus.

"Again, although Frary was always strongly opposed to smoking, his aluminum research laboratory is said to have carried out one of the most elaborate researches ever made on cigarette smoking which led to the development of the now famous Zeus cigarette filter. Only recently I have heard from his associate, Mr. Junius Edwards, that there is plenty of smoking being done in New Kensington. Doubtless the head of the laboratory is mellowing as he grows older in the ways of the world."

Dr. Victor Roehrich goes back to his student days when Dr. Frary was his instructor to tell me this story:

"The last experience that the writer had with Dr. Frary while at Minnesota was in trying to build a dynamo that was to generate an electric current in a coil of glass tubes filled with electrolyte in place of metal conductors—of which there were none. At about that time Hering had published some work on currents set up in an electrolyte without the use of electrodes. We worked for weeks on the glass-blowing of all of the coils of tubing, and the winding of the electromagnet. The latter had a rotating pole intended to produce a rotating field cutting the electrolytic conductors. At last it was completed and one Saturday afternoon in the spring of 1910 we were ready and not a little excited and expectant. We started the motor that turned the dynamo that was to generate the electrodeless current. But, sad to relate, all we got was a lot of vibration and absolutely not a bit of current in the tubing. On that day it would have been hard to convince either of us—Dr. Frary especially—that nearly thirty years later he was to receive the highest award in the electrochemical field."

I haven't run out of "Frary-Tales" by any means but here are two comments in a little more serious vein:

Walter Badger of Dow and Michigan says:

"Frary's outstanding characteristic is his infinite capacity for work. While at Minnesota he worked harder, at longer hours, took more abuse and unfair treatment, accomplished more with less support in the way of money and materials than any two other men on the campus."

R. S. McBride, another old-time associate from Minnesota, writes:

"It is not surprising that Francis Frary has made good. So much hard work could hardly have failed even if he had not been—as he was—one of the most brilliant and clear thinkers in his class."

These are some of the things which friends and associates of Francis Frary who could not be present tonight have permitted me to tell you about him here in his very presence. In closing now I want to add, by way of summary, just a thought or two of my own. Francis Frary may not be quite the paragon of all the virtues that these friends have so willingly attributed to him. But you and I know that he combines in a single, dynamic personality a great many of the fine qualities we like to see in the leaders of our chemical profession. Absolute intellectual honesty, tremendous energy and enthusiasm, a brilliant, active, researching mind and, last but not least, a genuine interest in people. That is why each of us is proud to be numbered among his friends and associates. That is why I am so pleased, Mr. President, to have had this privilege of publicly proclaiming my friendship for the man who is to receive and well deserves the highest honor that it is in the power of the Electrochemical Society to bestow—the Edward Goodrich Acheson Medal and Award.

President Creighton then presented Dr. Frary with the Edward Goodrich Acheson Gold Medal and the $1,000 Prize, which Dr. Frary graciously accepted and then delivered the following address:

ELECTROCHEMICAL RECOLLECTIONS.

FRANCIS C. FRARY.

In looking back over the forty years in which I have been interested in chemistry, ever since as a boy I played with electroplating and batteries, I was surprised to see at how many points and in what important ways the work of Edward G. Acheson had influenced and helped me. Unfortunately, I never had the pleasure of making his personal acquaintance, but his inventions, and particularly Acheson graphite, have been connected with much of my electrochemical work.

Aside from the schoolboy experiments, my first contact with electrochemistry was in the summer of 1904, when I spent a day at Niagara Falls. Walking the length of Buffalo Avenue from the Falls to the Carbide plant, I was assured that none of the electrochemical industries would let me in, unless possibly it was the Acheson Graphite Company. I finally knocked on their door; and, being a chemistry student, was referred to their chemist—a young man by the name of E. C. Sprague, who had been only recently graduated from Worcester Polytechnic Institute, and had a little laboratory just inside the front door. Explaining that he could not take me into the plant, he showed me his laboratory and the work he was doing on graphitic oxide, and gave me pieces of graphite, siloxicon, etc., which served as treasured souvenirs of my first visit to the electrochemical center of the world. The Shredded Wheat plant and the Cave of the Winds were, I believe, the only other establishments I was able to get into that day.

The possibilities of chemically inert massive graphite, which could be easily worked with tools and had high electrical conductivity, naturally intrigued me. When in the fall of 1906 I found myself in the electrochemical laboratories of the Technische Hochschule, in Berlin, and had to choose a subject for a small piece of research work, I decided to investigate the possibility of using an Acheson graphite anode instead of the platinum anode which, according to the literature, was customarily employed in the electrolytic manufacture of chlorates. My first inquiry brought me up against a stone wall; the storeroom man had never heard of Acheson graphite, and the assistant in charge of the laboratory was sure that no such artificial graphite was manufactured or available in Europe. However, an appeal to Professor von Knorre developed the fact that he had a consulting connection with the electrolytic chlorine plant at Aussig, in Austria, and they had given him an Acheson graphite anode, which he had carefully treasured as a museum piece. Out of the goodness of his heart, he permitted me to cut off a little slice of this anode and use it for my experiments. Needless to say, that one piece covered all my needs for that year.

When I returned to the University of Minnesota to teach (among other things) electrochemistry, including electric furnace work, I found that I had to start from the beginning, so far as equipment was concerned. In order to get material for electric terminals and other parts of electric furnaces, I sent to Acheson Graphite Company for a price list, and was overjoyed to learn that they made a special discount—I think it was about 80 per cent off list—to educational institutions. Since in those days we had to count every dollar several times before we even thought of spending it, this courtesy on their part very much facilitated the equipment of the laboratory. A couple of heavy blocks for furnace terminals, and smaller pieces out of which crucibles could be carved, were the basis of all the electric furnace work I could do. As a matter of fact, the first research which Mr. Badger and I did in that laboratory*, on the production of electrolytic calcium, was made possible only by the use of home-made Acheson graphite crucibles. With such pieces of graphite, a little crushed foundry coke and a few firebrick, the students carried out a variety of electric furnace experiments ranging from the production of calcium to the laboratory-scale production of silicon carbide. None of them ever finished their course without a deep respect for the versatility of Acheson graphite.

When I joined the staff of the Oldbury Electro-Chemical Company at Niagara Falls, in 1915, I was not surprised to find them using Acheson graphite electrodes for various purposes. Naturally, when in the manufacture of phosgene we later found it necessary to line the steel boxes containing our catalyst with something which would be completely inert to this extremely active chemical, we turned again to Acheson graphite. Even after I went with Aluminum Company of America, which naturally manufactures its own electrodes on a tremendous scale, I still found some occasions to use Acheson graphite. As a matter of fact, its exceptional properties solved the important problem of properly leading the current into the molten aluminum cathode, in our work on the electrolytic refining of aluminum in a fused salt bath.

The importance to me of the life and work of the founder of this Medal, as interpreted to me through the courtesy and kindness of members of his organization, has turned my thoughts to the influence which other men have had upon my work during these forty years.

It seems to me that much of what I have been able to accomplish has been brought about by the combination of favorable circumstances with the advice, inspiration and assistance received from various friends. Mr. Sprague's courtesy and its influence upon my career have been mentioned. My schoolboy interest in chemistry and desire to experiment in it were nurtured and encouraged by Prof. George B. Frankforter, then Dean of the School of Chemistry of the University of Minnesota, to whose inspiring teaching and leadership in research I owe much of

* Trans. Electrochem. Soc., **16**, 185 (1909).

my early training. It was his recommendation which led me to take a year's graduate work in Berlin, where the opportunity to hear lectures by van't Hoff, Nernst, Theo. W. Richards (it was his year of exchange professorship there) and others, and observe German methods of teaching and research, opened a new world to me. I shall always be glad that I took advantage of the opportunity, in the spring of 1907, to attend the Hamburg meeting of the Deutsche Bunsen Gesellschaft, where I was fortunate enough to hear the historic controversy between Nernst and Haber, on the ammonia equilibrium, as well as papers by such masters as Fritz Foerster, who did so much work on the electrochemistry of aqueous solutions.

As a result of the publication of several small papers on electroanalysis, I received upon my return a personal letter from Prof. Joseph W. Richards, inviting me to join this Society. Thus began an acquaintance and friendship with a remarkable personality, which eventually resulted in his suggesting my name to Aluminum Company of America, when they decided to establish a central research laboratory. Of the few meetings of this Society which the limited financial resources of a young instructor permitted me to attend, I recall especially at the moment the Denver meeting in the fall of 1913. There I first met my good friends, Messrs. H. C. Parmelee and J. V. N. Dorr, who were then living in Denver, and in the early stages of their respective careers. Also I remember meeting Mr. F. Austin Lidbury, under whose direction I was later to work at Niagara Falls, Mr. A. T. Hinckley, Dr. Colin G. Fink, and others of the older members of the Society, whose friendship and influence have meant so much to me.

It was at the Atlantic City meeting of the Society, in the spring of 1915, that I met Mr. H. B. Coho, then Secretary-Treasurer of the New York Section, who suggested to me the desirability of finding a new hardening agent for lead, because of the acute scarcity of antimony. Remembering a calcium-bearing lead alloy which Badger and I had made, I started to study the effect of small amounts of alkaline earth metals in hardening lead. As we had no facilities for measuring hardness, I had Mr. Coho send me a small specimen of antimonial lead for a standard. Dr. Temple and I electrolyzed fused calcium chloride, barium chloride and strontium chloride with molten lead cathodes in an Acheson graphite crucible, to make the rich alloys. By diluting these with lead, casting small discs, and striking the edges together, we could compare hardness by the sizes of the nicks produced.

Thus we worked out the hardening effect of calcium, barium, strontium, and magnesium, alone and in combinations, as compared with the hardening effect of 13 per cent antimony. We discovered that the hardness of the new alloys increased spontaneously on natural aging, and that we must wait a few days after casting before drawing conclusions. When the antimonial lead disc got so badly nicked that we had to remelt it, we were surprised to find that it also showed the same age-hardening effect after casting. Age-hardening was quite a new

phenomenon in those days. We managed to hire an attorney to draw up two of the patent applications, and then drew the other three ourselves. Strange to say, they were all granted in a few weeks, and that fall we sold them to the United Lead Company, through their President, Mr. J. R. Wettstein, for whose kindness and fair dealing I shall always be very grateful.

Earlier that same spring, I had my first and only experience as a consulting chemist. A small match factory in Duluth had some trouble with their product and asked Dr. Frankforter's help. He kindly turned the job over to me. The cause of their difficulty was a complete mystery to me, but fortunately an independent consulting match chemist turned up in the nick of time and solved it with a slight change in one of the formulas used. Incidently, he told me tall stories of the troubles of inexperienced workers who tried to experiment with match-head compositions, and expatiated at length on the difficulty of manufacturing the active ingredient, phosphorus sesquisulfide, because of the explosive violence with which phosphorus reacted with sulfur.

This intrigued me, and I decided that the violence of the reaction could be controlled by carrying it out in the presence of a relatively large amount of an inert solvent. Monochlornaphthaline ("Halowax Oil") was then just coming on the market, and had suitable boiling point, dissolving power and incombustibility for this purpose. Experiment proved that the reaction went smoothly and the product was a mass of fine crystals.

This yielded me my very first patent, and was the occasion of my contacting Lidbury again, as he was the only manufacturer of "sesqui" in the country. After examining my patent and samples, he asked me to come to the Falls, and it took us only about an hour to come to an agreement for the sale of the patent. I was charmed with his personality and the fairness with which he treated me, and when he asked me to come and take charge of the Research Laboratory he had just built, I promptly agreed to do so. Much as I had enjoyed teaching, the opportunity to give all my attention to research, with adequate facilities, was too good to pass by. Six patents worked out, granted and sold, new friends and a new job made 1915 a memorable year for me!

My two years at Niagara Falls, my year in the army, and twenty years with Aluminum Company of America have been so crowded with new contacts that time would fail me if I attempted to catalogue even the more important of them. The army experience in particular brought contacts of a variety of entirely new types, and I learned a good deal about how an organization should *not* be managed. However, the experience there in connection with the design, construction and operation of toxic gas plants was very valuable, and the cooperative spirit and zeal of the officers of the chemical plant of Edgewood Arsenal left nothing to be desired.

Naturally, these twenty years of association with the management, the operating and technical personnel of Aluminum Company of

America, and my associates in the Aluminum Research Laboratories, have been most fruitful in personal contacts and inspiration. Fortunately, most of these friends are still with us, and it would be an embarrassment both to me and to them to attempt to name them or mention even a few of the many instances of their advice and assistance. There is one among them, however, who is no longer with us, and whose influence was fundamental; so I may perhaps mention him as an example. He was Mr. William Hoopes, chief electrical engineer of Aluminum Company of America from some time in the early nineties, and head of its Technical Department from 1919 until his death in 1924. His best claim to the regard of posterity is perhaps his invention and development of Aluminum Cable Steel Reinforced, including the tremendous amount of engineering and development work required to put this on a satisfactory commercial basis. The many hundreds of thousands of miles of this cable now in use all over the world, and the efficient and intricately designed power plants of our company, are perhaps his best monument.

When I entered the Company twenty years ago, he was deeply engaged in the semi-commercial development of the Serpek process for the manufacture of aluminum nitride, from which it was expected we could obtain by-product ammonia and cheap alumina. The boundless enthusiasm and ingenuity with which he tackled the extremely difficult problems of construction and accurate temperature control of electric furnaces with circulating nitrogen, operating around 2,000° C., and the persistent optimism with which he met each difficulty as it appeared, were an inspiration to all of us. When the technical difficulties involved and the development of cheap ammonia by direct synthesis sealed the doom of Serpek's process, he was ready with a new and fundamental problem for us to tackle. This was the electrothermal reduction of alumina to metal, in the presence of heavy metals which would prevent its evaporation at the electric furnace temperatures, to be followed by the electrolytic refining of the base metal alloys thus produced.

Many years before, he had proposed to Mr. Charles M. Hall the electrolytic refining of aluminum in a molten bath, in a three-layer system, but this seemed impractical to Mr. Hall. They therefore carried out the refining operation experimentally in another type of apparatus, which was later the basis of a patent of Mr. Hoopes', but Mr. Hoopes had always felt that the three-layer method (later patented by Anson G. Betts) was fundamentally the correct one. After we had done enough work in the laboratory to determine the composition of a suitable bath, in the midst of a sharp financial depression he schemed out a simple and inexpensive way in which we could try out the principle of the process in one of our plants. The result was that we got a few buttons of electrolytically refined aluminum of good purity, and were assured that the principle of the process was sound, so that we

Dr. Frary

were justified in spending money on its development, even in those difficult times.

During the years of work on the electrothermal reduction and electrolytic refining processes, and the electrothermal purification of alumina directly from bauxite, which followed these early experiments, his persistent enthusiasm and ingenuity were an inspiration to all of us. His death, in the midst of these experiments, was a great personal loss to us all, as well as a loss to the profession.

In closing these rather fragmentary recollections, I want to leave with you one remark which Mr. Hoopes made to me many years ago. He said that some of the younger men wondered how he earned his salary, and he told them that he did it by keeping them from making mistakes. I have often thought of that, not only as epitomizing an important function of any man who is responsible for the direction of the work of others, but also as indicating the importance and scope of the personal contacts which a man makes. They orient him, giving him a point of view from which he may intelligently decide on the right course, choosing the things which are wiser to do, and avoiding as many as possible of the pitfalls in his path. This is perhaps the way in which our friends and associates in our own circles and in the technical society groups are most helpful to us, and also the way in which we, each of us, can be most helpful and most valuable to them.

Dr. Frary receiving the Acheson Medal from President Creighton.