now for some time been successfully carried on, the cost of the aluminum in the alloy having been reduced to a small fraction of the price for which the metal is sold as made by the older methods. The Messrs. Cowles and Professor Mabery have opened a new and broad field of experiment, and no one can surmise, even, what may come of the infinite range of possibilities so presented.

THE COMPOSITION OF CERTAIN PRODUCTS FROM THE COWLES ELECTRICAL FURNACE.

BY PROF. C. F. MABERY.

[*Read at the Buffalo Meeting of the American Association for the Advancement of Science, August, 1886, and revised for publication in the* JOURNAL, *by the Author.*]

At the meeting of this association last year at Ann Arbor, a paper was presented by the Messrs. Cowles and myself, which gave a description of the electrical furnace and of the products which had then been obtained from it. During the past year, several improvements have been introduced into the construction of the furnace which have increased its efficiency very considerably; and, although, as compared with results that will probably be reached in the application of electricity to smelting purposes, the present development of the process may in the future seem very crude, it has already reached the stage when by actual trials, extending over considerable periods of time, its commercial success can be satisfactorily demonstrated. Those who listened to that paper, or who read it subsequently, will remember that the principle of the furnace is based upon the intense heat that may be produced by the resistance which is encountered when a powerful electric current is passed between electrodes through coarsely pulverized charcoal. In late experiments, it was found by A. H. Cowles that the efficiency of the charcoal could be largely increased, and the rather rapid formation of graphite prevented, to a certain extent, if the charcoal were coated with lime previous to using it. It was also found that the quantity of product formed was increased when the electrodes were allowed to enter the mixture of ore and carbon in an inclined position, at an angle of about 30° from the horizontal plane. A continuous reduction is more

easily effected when the electrodes are capable of being drawn apart so as to gradually expose fresh portions of ore to the action of the current. But perhaps the most important modification for the economy of the process is the adaptation of the furnace by the Messrs. Cowles for the reception of very powerful currents. It consists of a general enlargement of the furnace and the accessory apparatus, including electrodes, conductors and resistance-boxes with certain variations in the detail of its construction. Now the energy from 300 horse-power may be utilized instead of that from thirty horse-power, which was formerly employed. Inasmuch as the resources of the company have been fully occupied during the past year in the development of the commercial features of the process, it may seem that the scientific possibilities have not received due attention. While this criticism may be true in part, I think I shall be able to show that incidentally considerable material of some interest from a scientific standpoint has been collected. I have recently noticed certain statements of opinion concerning the furnace and the process that are not strictly accurate.

In the discussion that followed a paper read by Dr. Mehner, of Berlin, Dr. Martius was inclined to the belief that the metal aluminum was of no greater value for ornamental purposes than zinc, and that its alloys possessed no properties relating to corrosion, strength, etc., that were worthy of mention. These assertions can best be answered by referring to the actual properties of these metals which are established beyond doubt. But the opinion expressed by Dr. Werner Siemens, that so far as practical results are concerned, this electrical furnace is identical with that constructed by his brother, Sir William Siemens, is of more importance. The continuous working of an electrical furnace requires as nearly as possible a constant resistance between the electrodes. Assuming that a dynamo machine was carrying the energy from 300 horse-power and distributing it in an arc a few inches in length, and that suddenly the arc was broken by the introduction of fresh material, the effect upon the dynamo can be imagined. Dr. Siemens thought that the reduction of aluminum depended upon the presence of copper, and he expressed doubts as to whether reduction would result in its absence. Reference was made to the statement that aluminum bronze had been made in a crucible furnace by fusing together copper carbon and corundum. We have tried the

latter experiment at the highest temperature we could produce in a crucible furnace without the slightest reduction of aluminum. Nevertheless, it may be true that traces of aluminum can be introduced into copper by this method. The assertion of Dr Siemens that aluminum could not be reduced without copper is erroneous. We have repeatedly taken mixtures of metallic aluminum and carbon from the furnace in large quantities. The question by another chemist as to whether any analysis of the products had been made followed a remark by Dr. Martius that they did not need to be informed by Americans concerning aluminum or its alloys.

A product which has attracted considerable attention during the past year is obtained by reducing aluminum in presence of iron. A cast iron is formed containing sometimes as much as ten per cent. of aluminum, and this product is used to facilitate the working of crude iron and to introduce into the various grades a small percentage of aluminum. The slags resulting from this reduction are composed chiefly of calcic aluminate and cast iron. In the reduction of aluminum in the presence of copper, a yellow product is frequently taken from the furnace, which is composed of metallic aluminum to the extent of one-half or three-fourths, the balance being silicon and copper. With a small percentage of calcium it is also formed in the absence of copper and then contains a higher percentage of aluminum and often contains nitrogen. It has a resinous lustre and decomposes water at 100° C. The aluminum slags are composed of reduced metal, calcic aluminate and fused oxide, and since they have always proved to contain about one per cent. of carbon, which is liberated in the gaseous form by hydrochloric acid even in the absence of iron, a carbide of aluminum may also be present. A remarkable effect was observed in a bar of ten per cent. bronze which had been heated for the purpose of forging. It was allowed to become too hot and when struck the entire bar assumed a crystalline condition. Some of the individual crystals were nearly perfect in form, resembling certain forms of the isometric system. A striking analogy between them and certain forms of meteorites, has recently been observed by Mr. O.W. Huntington, of Howard College. In the reduction of silicon, the formation of a greenish-yellow substance is frequently observed, and it has proved by analysis to be a new oxide of silicon—Si O. By fusion with

fluxes it is converted into the dioxide, and hydrofluoric acid acts upon it the same as upon the dioxide.

The ingot of metallic aluminum here shown contains less silicon and iron than the average commercial metal, although no special care was taken to obtain a pure product. It was made by methods which are controlled by patents held by the company, and experiments are in progress which it is expected will lead to results that will cheapen very materially the cost of its production.

CARBOHYDRATE AND FATTY FOODS.

BY N. A. RANDOLPH, M. D., PHILADELPHIA.

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Under the general heading of Fats is recognized a certain group of bodies composed of carbon, hydrogen and oxygen, which are capable of saponification and of emulsification, and which are insoluble in water. The true or neutral fats belong to one of three groups; stearine, palmitine and oleine; margarine being usually accounted a combination of the first and third. Chemically, each of these bodies is analogous in composition to any of the neutral salts. In the fats, however, the acid radical is represented by a fatty acid, and the base by glycerin. Thus, stearine may be regarded as the union of stearic acid with glycerin, and palmitine and oleine as respectively a palmitate and an oleate of glycerin. The fatty acid is, however, by far the preponderant portion of the molecule, the glycerin never exceeding from eight to ten per cent. of the substance. The fats named have been mentioned in the order of their solidity at ordinary temperatures, stearine being hard and oleine entirely fluid under usual conditions, while palmitine occupies an intermediate position in regard to density. As foods, these bodies are of extreme importance, though their full value has not been appreciated until a comparatively recent period, because, when taken to the exclusion of other foods, continued nutrition becomes impossible.

We eat fat in a nearly pure state in lard, in oils and in butter. It exists in varying amount in every organic food. Thus we find in