

An expression of this kind, far from being an "eccentricity," is a triumph of nomenclature. It is possible to mould language by logic; it is the only way to mould language that shall be truly scientific. It is this method which has given such power of expression to the French language, not only in its magnificent modern prose, but more especially in its incomparable clearness when used for the exposition of science. Though our own language is somewhat less pliant, we cannot do better than imitate our more logical and enterprising neighbours in replacing confusing or ambiguous language by clear and rational terminology.

ALBERT CAMPBELL.

Teddington, June 19.

Training for Scientific Research.

I SHOULD like to say in regard to my letter on the above subject in NATURE of June 17, that, owing to exceptional circumstances, I had not read Prof. W. H. Perkin's presidential address to the Chemical Society which appeared in the Journal of the Society for April, in which he makes precisely similar suggestions. This was unknown to me at the time of writing, and naturally I am very glad to find myself in agreement with so influential an authority. I can only add my hope that he, furnished with all the qualifications for the task, will succeed in persuading the universities to a reform upon which so much depends, and for which the time is favourable.

T. S. PATTERSON.

Organic Chemistry Department, University of Glasgow, June 20.

Extinguishing Fires.

IN reference to Sir W. A. Tilden's article in NATURE of June 10, may I direct attention to the fact that an ordinary syphon of "soda-water" is a very effective fire-extinguisher if used in the early stages of an outbreak due to bombs, etc., and it is a wise precaution to keep a supply, of the larger size, in readiness.

A small piece of rubber tubing may be slipped over the nozzle in order to direct the discharge, or the syphon may be inverted whilst held in the hands.

C. CARUS-WILSON.

June 14.

THE SYNTHETIC PRODUCTION OF NITRIC ACID.

THE recent pronouncement of the German Chancellor, and the statements which have appeared from time to time in the daily Press and in technical journals, respecting the enormous extension in the methods of transforming atmospheric nitrogen into ammonia and nitric acid, which are claimed to have been developed by German chemical engineers, have attracted such widespread attention at the present time on account of the necessary employment of this acid in the manufacture of explosives, that it may not be uninteresting to explain shortly, and in general terms, the main principles of the methods by which such transformation is effected. The actual details of the manufacturing processes now employed in Germany have not been published, and are not likely to be made known for some time to come. But there is little doubt that these processes are, in the main, merely extensions or refinements of methods already established, and in more or less successful operation, at Odda,

Notodden, and Christiansand in Norway, at Legnano, near Milan, at La Roche-de-Dame, in the south of France, and at Niagara Falls. Even before the outbreak of the war, factories for the utilisation of atmospheric nitrogen in the manufacture of synthetic ammonia and nitric acid were at work in Westphalia, at Knapsack, near Cologne, at Spandau, and in one or two places in Austria-Hungary. Similar works have been erected, or are in course of erection, in the United States, Switzerland, and Japan.

Although a considerable amount of British capital has been invested in Norwegian enterprises, no attempts have hitherto been made in Great Britain to utilise the vast stores of potentially combined nitrogen which exist in the air. It has been calculated that the air over a dozen acres contains as much potential nitric acid as is annually exported in the form of Chile saltpetre. The apparent apathy of the British manufacturer is probably due to the circumstance that hitherto we have not suffered to any appreciable extent from any shortage of nitrates or nitric acid, and that, so long as we have command of the sea, we are not likely to suffer for some time to come. But it must not be forgotten that the supply of Chile saltpetre is not inexhaustible. The rich deposits of Tarapaca are already worked out, and what is now obtained from the more inaccessible districts of Antofagasta, Toco, and Taltal is of much lower quality. On the other hand, we gather from the Chancellor's statement in the Reichstag that the new industry in Germany is to be protected for at least a number of years, which would seem to imply that the manufacture cannot be worked on ordinary commercial lines. The probable effect of protection would be to limit, if not altogether to destroy, the importation of Chile saltpetre into Germany, and thereby to diminish its price to us unless German syndicates manage to obtain control of the workings.

Another reason for the apparent lack of enterprise on the part of the British chemical manufacturer is the assumption that hitherto the commercially successful working of all such synthetic processes would seem to depend upon cheap water-power, of which this country has no very ample store. But it may be doubted whether this disadvantage is altogether insuperable, at least under certain conditions. At all events, it is certain that the German engineers have to look to other sources of energy. What will be the ultimate effect on the price of nitric acid remains to be seen. In the meantime, it is probable that its present cost to Germany is far higher than to us.

The new methods of making nitric acid from atmospheric nitrogen are twofold in character; either direct, that is, by the direct combination of nitrogen and oxygen, or indirectly through the intermediate production and subsequent combustion of ammonia. The direct formation of ammonia by the union of its elements, nitrogen and hydrogen, has frequently been attempted, but hitherto with very limited success. It has long

been known that small quantities of ammonia may be formed by the action of high temperatures, say by the passage of electric sparks, on a mixture of hydrogen and nitrogen. But the reaction is necessarily incomplete, since it belongs to the class known as reversible, and in ordinary circumstances the yield of ammonia is wholly incommensurate with its cost. But it was found by Haber that when a mixture of 1 part of nitrogen and 3 parts of hydrogen, under a pressure of 175 atmospheres, is heated to about 550° in presence of a catalyst, about 8 per cent. by volume of ammonia is formed, which may be isolated by passing the products through a refrigerating apparatus, the uncombined gases being returned to the compression chamber.

The catalyst first used by Haber was osmium, a comparatively rare metal belonging to the platinum group. Later, finely powdered uranium was employed. Much experimental work has been spent in the effort to find other and cheaper catalysts, in studying the influence of temperature and pressure upon the yields, and in overcoming the technical difficulties inseparable from the construction of apparatus of large size capable of withstanding such high pressures as, say, a couple of hundred atmospheres.

The nitrogen is obtained from the air by the use of a Hampson or Linde liquefying apparatus, and subsequent fractionation on Claude's system; the hydrogen is made by passing steam over red-hot iron or heated coke. The ammonia is converted into nitric acid by oxidation under the influence of a catalyst. The same principle is adopted in the method of Ostwald, by which ammonia, obtained from "nitrolim," or, as it is called in Germany, "Stickstoffkalk," by a process to be described later, is mixed with air and passed through iron tubes into a chamber containing the contact-agent. The resulting products are led to a condensing plant, whereby, by suitable arrangements, which cannot be here described but are well known, it is claimed that from 85 to 90 per cent. of the theoretical yield of nitric acid can be obtained of a strength and purity suitable for the manufacture of explosives. The Ostwald process has been worked for some time at Gerthe, near Bochum, where it is said to have produced upwards of 1800 tons of nitric acid annually; but the experience of other countries where it has been in operation has been far less favourable, and it is doubtful whether a single Ostwald plant is now in use outside Germany.

Up to the present time, the most successful of the factories which have been established for the utilisation of atmospheric nitrogen would appear to be that of the North-Western Cyanamide Company, at Odda, on the Hardanger Fiord, Norway. This concern, which is largely financed by British capital, is operated by electrical energy furnished by a water supply capable of producing 80,000 horse-power. This factory and the associated Alby works together produce calcium carbide, and "nitrolim," a mixture of calcium cyanamide and carbon. Pure nitrogen is obtained from the

air by a Linde plant driven by a 200 horse-power electric motor, and capable of producing 13,000 cubic feet of nitrogen per hour. This gas is caused to react on calcium carbide (made by fusing lime with Welsh anthracite in electric furnaces) in electric retorts heated to a temperature of 800° . "Nitrolim," by treatment with superheated steam, yields calcium carbonate and ammonia, which latter substance can be converted into nitric acid by combustion, as already stated.

The methods for the direct combination of nitrogen and oxygen to form nitric acid depend upon a reaction first pointed out independently by Priestley and Cavendish upwards of 130 years ago, and further elaborated, towards the close of the last century, by Sir William Crookes and Lord Rayleigh, who established the theoretical principles upon which the reaction proceeds. They showed that under the influence of a high temperature, produced by electric sparking, or by the passage of a strong induction current, oxides of nitrogen, and ultimately nitric acid, were formed in notable quantity. Indeed, it was in the course of the experiments which served to establish the composition of water that Cavendish incidentally discovered the true nature of nitric acid. But, as the history of science so frequently reveals, although the fundamental discovery was made by English observers, it was left to foreign technologists to turn it to practical account. This was first accomplished by Birkeland and Eyde in 1903, who established a factory at Notodden, in Norway. In their process, air is driven by a Roots blower through a powerful arc flame, operating in a magnetic field, in a specially constructed furnace. At the high temperature of the flame (3000° - 3500°) about 1 per cent. of nitric oxide is formed, equal to about 30 milligrams of nitric acid per litre. The actual volume of air operated upon in each furnace is nearly 800,000 litres per minute, and in all about three dozen furnaces are in use. The nitric oxide thus produced is rapidly cooled, when it combines with a further amount of oxygen in the escaping gases to form nitric peroxide, which by treatment with water in absorption towers is changed into dilute nitric acid, to be subsequently concentrated or converted into nitrates.

Various modifications in the mode of producing the arc flame, either with or without a magnetic field, have been introduced by German and Russian engineers, and different methods of absorption and concentration of the acid have been suggested, but the essential principles of the processes are practically identical in all of which published accounts are at present available.

It will be seen from the foregoing statement that the Germans have by no means an exclusive monopoly in the production of synthetic nitric acid, and there is no reason to believe that the modifications they have been able to make in pre-existing processes not of their own invention have placed them in an independent or greatly superior position. It must be remembered that they are at present driven to work under abnormal and

utterly uneconomic conditions, and it remains to be seen how far they will be able, as a manufacturing nation, and in face of the world's competition, to make good their boast that they have rendered themselves permanently independent of outside supplies of nitrates. Their strenuous labours, under the sharp spur of necessity, will at least serve to demonstrate what is to be the ultimate future of synthetic ammonia and nitric acid.

THE ROYAL DUBLIN SOCIETY.¹

THE history of the Royal Dublin Society is that of an extensive and efficient group of educational institutions, which still cluster, in appropriately classical buildings, round about the

adorned at this period with the handsome public buildings which remain its chief glory at the present day. Wealthy residents occupied town-houses, decorated internally in the most exquisite Georgian taste; among these, Lord Kildare, afterwards first Duke of Leinster, built a mansion on the eastern margin of the city in 1745. In 1814 the Royal Dublin Society purchased this building, and obtained a habitation worthy of the position it had gained (Fig. 1).

Thus, by private enterprise, a great institution for the promotion of applied science had grown up in Dublin. It must be remembered, however, that its members had considerable influence; they included a large part of the Irish House of Lords, and the meeting for the first election of members,

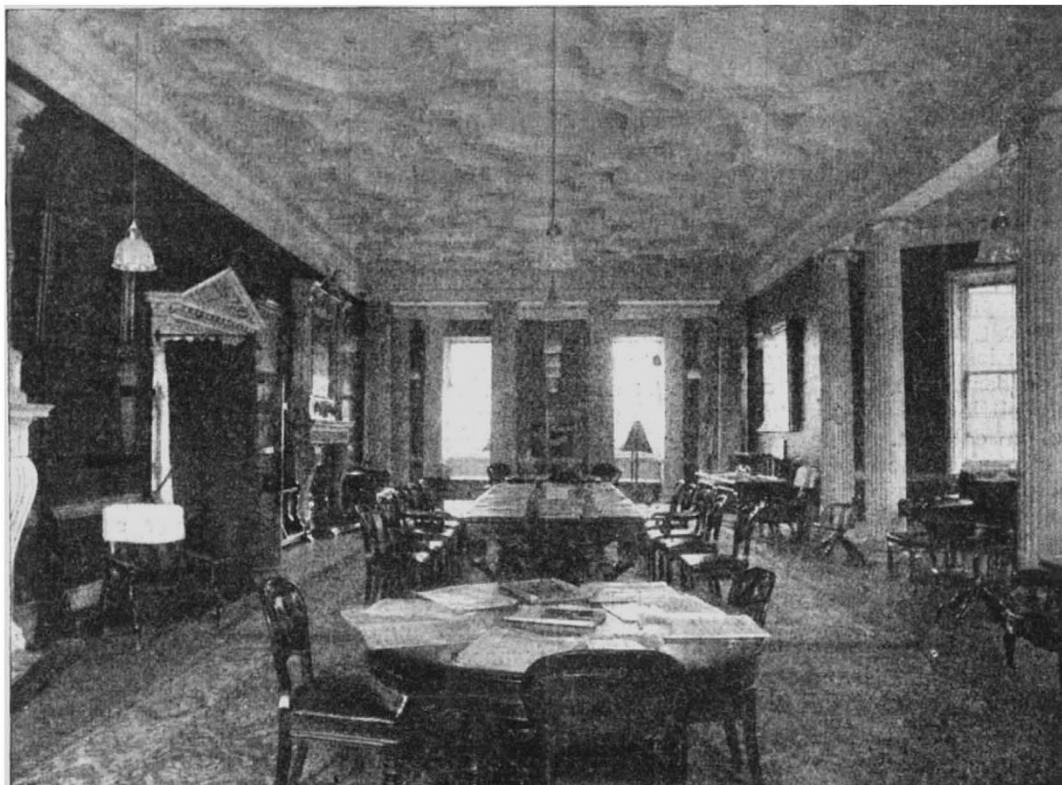


FIG. 1.—Conversation Room, ground floor of Leinster House, Dublin. From "A History of the Royal Dublin Society."

residence of the Dukes of Leinster. The founders of the "Dublin Society" in 1731 were anxious to improve in every way the condition of Ireland, by encouraging "husbandry, manufactures, and other useful arts." The atmosphere of Dublin was at that date eminently progressive. London was reached by a drive to Dalkey Sound, a crossing of very doubtful duration in a sailing-packet to Anglesey, and a journey of some days by chaise and coach, including the troublesome passages of Beaumaris sands and Penmaenmawr. London, moreover, was then a city to be rivalled rather than envied, and the Irish capital became

in 1750, after the society had received its royal charter (p. 76), was held in the Parliament House in College Green. The Irish Parliament (p. 209) was always ready to acknowledge and assist the work of the society, and—though Mr. Berry does not mention the fact—the purchase of the Leskean collection of minerals for the benefit of Irish students (p. 156) was made possible by the zeal of the Speaker, John Forster, and by a vote from public funds.

The story of this collection, which is the basis of that now in the National Museum, illustrates the attitude of the society towards scientific work. Karsten's original German catalogue was translated and published in Dublin as a permanent

¹ "A History of the Royal Dublin Society." By H. F. Berry. Pp. x+460. (London: Longmans, Green, and Co., 1913.) Price 15s. net.