THE DEVELOPMENT OF SCIENTIFIC INDUSTRIES.

ONE interesting feature of the British Scientific Products Exhibition, arranged by the British Science Guild at King's College, London, is the series of short lectures and demonstrations given with the special aim of directing public attention to the necessity of developing the scientific industries of the country. These lectures cover a wide range, and by reminding us how ill-prepared we were at the outbreak of war to cope with the vast industrial tasks involved in the supply of munitions of war, they should help to stimulate effort with the view of preventing the occurrence of a similar disadvantage in commerce when hostilities cease.

Lord Sydenham, who opened the exhibition on August 14, pointed out in his address that the Germans with deliberate design had penetrated our whole commercial system, and had obtained control of some of our key industries. We were at first not in a position to start the new industries which were vital to success, and which the Germans had laboriously built up. At present, as Lord Sydenham pointed out, there is not a single branch of the industries of war in which we cannot excel the Germans, and from this fine achievement we can draw lessons of supreme importance for the future. Lord Sydenham also emphasised a lesson which the war had taught us, that small quantities of material had enormous influence in determining production, and large industries were vitally affected by small industries. The dye industry, which Germany had largely developed with an eye to war as well as to industrial supremacy, was quoted as an example of this. We paid Germany nearly 2,000,000*l.* per annum for dyes, upon which depended an industry of more than 200,000,000*l.* per annum. The great chemical works of Germany had almost monopolised this and other key industries, and when war broke out the works engaged thereon were ready to be turned on to the production of explosives and propellants. Lord Sydenham expressed the opinion that the new Education Act, if properly used, would provide the machinery to add largely to the number of our science-workers. When the Bill was before the House of Lords he endeavoured to introduce the word "science" into it, but the official objection was that it would be inappropriate to specify a particular item in such a Bill. In conclusion, Lord Sydenham pointed out that two factors were operating to bring about certain victory in the field. The first was the splendid gallantry and devotion of our fighting men; the second, the resourcefulness and hard work of our men and women, which had enabled them to be supplied with the best weapons science could produce. If, when victory was ours, we diligently applied that resourcefulness to the arts of peace, we should be able to recreate national prosperity on a broader and more enduring basis than it had possessed in the past.

A German chemist, Dr. Otto N. Witt, soon after the declaration of war, expressed the opinion that the manufacture of dyes could never be established in this country because we lacked the knowledge and experience as well as, according to his view, the moral qualities requisite for so great an undertaking. Sir William Tilden, in the first of two lectures on "Lessons of the Exhibition," pointed to the products exhibited, which, he said, demonstrated that these estimates of the British men of science were altogether mistaken, and he claimed that we had every reason to be proud of the result. Sir William Tilden explained and illustrated the use of the word "research," which is now so freely used, but the true meaning of which is rarely understood. Some of the modern applications of scientific knowledge in chemical manufactures afford excellent examples, such, for instance, as the successful establishment of the contact process for making sulphuric acid, the production of ammonia from gaseous hydrogen and atmospheric nitrogen, and the oxidation of ammonia into nitric acid. In the second of his lectures Sir William Tilden mentioned that research in science is undertaken by two distinct classes of people. There is, first, the divinely gifted genius who pursues investigation for the purpose of finding out the laws of Nature and answering the eternal question, Why? Such a man was Faraday, and such a man is the president of the Royal Society, Sir Joseph Thomson. These lead the way, and provide stepping-stones for the second type of man, who wants to get practical results from his labour; and so we have what is called pure science and applied science. In both directions the first requirement is exact observation. This generally means measurement of weights, volumes, temperatures, times. In the first lecture Sir William Tilden illustrated this by referring to progress in chemistry; in the second, he referred to the modern developments in the use of steel. This is an age of steel. But the steels in use at the present time present extraordinary characteristics in strength, hardness, and cutting properties. These are produced by adding small quantities of manganese, nickel, chromium, tungsten, or other metals, of which practically nothing was known in the pure state until the use of the electric furnace by Moissan twenty-five years ago. Moissan was the pioneer in pure science whose discoveries rendered possible the practical achievements of Sir Robert Hadfield and other great steel-makers.

Metals generally are distinguished by their remarkable surface actions. The property possessed by platinum of causing the combination of oxygen gas with hydrogen and other combustible substances was discovered by Sir Humphry Davy just one hundred years ago. But many other metals present still more remarkable powers. One of the most valuable is the power possessed by nickel of causing hydrogen to combine with heated oil, converting it into a fat which is solid when cold. A substance which acts in this way is called a catalyst, and catalytic actions are now being turned to account on a large scale in a great variety of ways in making sulphuric acid, nitric acid, and ammonia, in the surface combustion of gas, in obtaining solid fats from whale-oil, and in a variety of manufacturing processes. Here again the pioneering study of the facts precedes their application. A great field is open in the study of catalytic effects.

In both his addresses Sir William Tilden referred to the question of training chemists. We are still very short of chemists, physicists, and skilled technologists, and he emphasised the fact that, unless steps are taken to train a large number of boys and girls, we shall be as badly off as ever after the war. In passing, he mentioned the valuable work done by many women chemists, and expressed the view that this was a calling to which many educated girls might advantageously devote themselves. The supply of men, he said, will depend chiefly upon the use of scientific method and the more extensive teaching of facts and principles in the secondary and greater public schools, where the education of the governing class is chiefly carried on, and where reform is most urgently needed.

Mr. R. R. Bennett, of the British Drug Houses, Ltd., in the course of a lecture on "Progress in Pharmaceutical Products," said that the total number of vegetable drugs which have become unobtainable owing to the closing of enemy countries is remarkably small, but the cultivation of drug-yielding plants should be prosecuted in this country to the utmost, and the resources of our Colonies should be developed to an increasing extent for the supply of vegetable drugs which cannot be grown in this country. In dealing with fine chemicals Mr. Bennett said that quinine, morphine, and strychnine, three of the most important of the vegetable alkaloids, and ether and chloroform, the two most important anæsthetics, have all along been British products, while the production of many other alkaloids, such as atropine, hyoscine, eserine, and emetine, and very many synthetic organic chemicals, has been stimulated during the war. In 1914 the manufacture of salicylates was practically a German monopoly, but in 1918 it is an established British industry. So far, during the war, whenever a particular substance has been required for a particular purpose, whether it be for medicinal, technical, or war purposes, British chemical science, *plus* British chemical industry, have not failed to produce it in requisite amount and of requisite purity within a reasonable time. Mr. Bennett next reminded his audience that for analytical and research purposes chemical reagents are required to be of a very high degree of purity. Previous to the war such chemicals were to a large extent, though not exclusively, imported from a few well-known German manufacturers, but several British firms have successfully undertaken the manufacture of these chemicals, so that the supply of analytical reagents has not failed. The lecturer next showed a series of dyes used as microscopic reagents. These dyes were from two to four times the strength of the microscopic reagents by German manufacturers. Mr. Bennett said that if the fine chemical industry is to be developed in this country on a scale anything like commensurate with its importance—and it must be borne in mind that it is a key industry, and therefore of paramount importance to the general development of national industry—Government assistance at the conclusion of hostilities will for a time be absolutely essential.

Mr. Edmund White, managing director of Hopkin and Williams, Ltd., lectured on the monazite and thorium industries as key products, pointing out their importance in relation to the gas-mantle industry.

Before the war the German ring had secured almost complete control of monazite, not only in Brazil, but also in Travancore—a protected native State in our Indian Empire. During the year preceding the outbreak of war this trust was endeavouring to bring about a virtual monopoly of the gas-mantle business, and had called in Berlin a meeting of the chief manufacturers of the world. Thorium nitrate is the one essential constituent of gas mantles, without which they cannot be made, and the trust notified these manufacturers to join the combination under threats to withhold supplies of thorium nitrate if they refused to do so. This would mean closing down the business of any manufacturer who would not come into the arrangement. A further proposal was to add 1*d*. on the price of each mantle sold, of which two-thirds of a penny should be taken by the German trust, and one-third of a penny retained by the manufacturer. The world's consumption of gas mantles is estimated at 400,000,000 per annum, and the two-thirds of a penny to be abstracted from the public on each mantle meant an additional profit of about 1,000,000*l*. sterling per annum for the German ring. In September, 1914, Mr. White, thinking the time propitious, proceeded to India and succeeded in obtaining concessions to work monazite sand in private lands outside the territorial limits controlled by the Travancore Minerals Co., which was under contract to dispose of the whole of its sand to the Berlin Auer Co. The Travancore Minerals Co. had been financed from Berlin, although it was nominally an English company registered in London. Messrs. Hopkin and Williams, Ltd., have now established their works in Travancore, and have also founded a thorium nitrate factory in England, which is actually working to-day and producing thorium nitrate of unquestionable quality at an increasing rate. Mr. White exhibited a series of lantern-slides showing the different stages in obtaining monazite in Travancore, and finally stated that this country was now absolutely independent of Germany in these important branches of industry. He also stated that his firm was quite able to hold its own with the Germans in the markets of the world, even though our post-war arrangements gave them no assistance. If the Government so desired, arrangements could easily be made by which Germany should receive for its gas-mantle industry a quantity of raw material in the form of monazite sand or thorium nitrate under the control of ourselves and our present Allies, thus reversing the conditions which existed before the war.

Prof. A. Keith lectured on Monday, August 19, on the value of science to medicine. He remarked that it was not the medical men in hospitals who discovered the scientific principles on which their instruments were based, but the physicists and other workers in laboratories. Beginning with a case just brought from the field of battle into the operating-theatre of a London hospital, he pointed out that the iodine with which the inflamed limb was painted was discovered by a chemist; that Davy, who was one of the first to study the element closely, was the discoverer of the nitrous oxide used as the anæsthetic for the operation; that it was by microscopic observations of a frog's tongue that the method of formation of new nerve-fibres when an injured part has been cut away was found; and that the valuable X-ray bulb was the outcome of purely scientific investigations by Sir William Crookes and others. Finally, Prof. Keith pleaded for more generous provision of laboratories for scientific research carried on solely with the intention of increasing natural knowledge. It used to be said that wars were won on the playing-fields of Eton, but in future they would be won in the laboratories of the country.

Dr. F. Mollwo Perkin, lecturing on the same day on oil from mineral sources, took a broad view of his subject, and referred to oils produced by the distillation of bituminous materials as well as to oils produced directly from the earth. He described the various methods employed for obtaining oil from bituminous materials, and dwelt at length on the means of obtaining these from gas-works retorts. Experiments had been made by the Admiralty with the object of carbonising cannel-coal in vertical gas retorts and producing the fuel-oil. Under the conditions of carrying out these operations it had been found that low-temperature products could be obtained and a good yield of gas produced, together with a rapid throughput, if a large amount of steam were passed through the incandescent coke at the bottom of the retort and then through the descending coal mass. Another source from which low-temperature oils are obtained is producer-gas plant tar. The chief difficulty met with, according to Dr. Perkin, is to design a retort which will carbonise at a low temperature, and at the same time give a rapid throughput of coal—that is, a unit which will pass a large tonnage of coal through in twenty-four hours and at the same time give a maximum yield of oil.