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British Chemical Industry.

DURING the past hundred and fifty years or less, scientific method in general and chemical research in particular have gradually invaded the industrial arena. Some of the results of this invasion are patent even to the least initiated, whilst others are accepted without a thought of their origin. Popular interest in scientific research is a thing of recent development; it is only in quite recent years that science, even industrial science, has been 'news', but there is now no lack at least of lip service to the part which it plays in industrial prosperity, as well as in providing the minor needs and newer comforts of everyday life. A few casual preparations excepted, chemical manufacture scarcely existed at the close of the eighteenth century; fifty years ago it was still but an apprentice in the world's workshop. Now it is one of the great fundamental businesses of the civilised world, and one which plays a large part in the maintenance of Britain's industrial, and therefore political, equilibrium. The industry is peculiarly one which depends for its very existence on discovery and invention; it is born in the test tube and nurtured on the laboratory bench in universities and in the research departments maintained by the State and by industrial concerns. It is an industry which demands continuous improvement in its methods, and offers unlimited opportunities of development and expansion; it cannot stand still, but must ever move forward along the paths mapped for it by an army of trained investigators.

Chemical industry is not, of course, exempt from the operation of the so-called laws of economics, and in the present period of world-wide depression it shares in the common suffering; how far the state of the market may be attributed to overproduction, to irrational or antiquated technique, or even to fundamental defects in our commercial methods or in our social system itself, must remain for the present a subject for study and discussion. Nevertheless, reports of progress assure us that the chemical industries are, on the whole, affected less than others, and that this circumstance is largely owing to the astonishing technical progress which is being made in every direction. It may also be due—in fact, it can scarcely fail to be due in some measure—to the familiarity of the directors of such concerns with the results accruing from the daily application of scientific methods of research and control, and to their determination to apply similar methods to management and salesmanship. The customer has to be studied no less critically than the process;

and to preach co-operation while ignoring the advantages of standardisation is to invite a well-founded charge of inconsistency. Standardisation is a word which, rightly, assails our social and artistic feelings, but in industry it is a potent economiser and an efficient lubricant; the attention which it is now receiving—exemplified by the formation of a new Standards Association which includes the chemical industries—is therefore a matter of surprise only in respect of its somewhat tardy appearance. In another report on applied chemistry we read that "in spite of the world-wide depression in the iron and steel industries . . . much attention has been devoted to improvements . . . and modifications . . .", whilst from yet another we learn that "the experience of the oil-seed, fatty oil, and allied industries has proved no exception to this general phenomenon [of depression, loss, and unemployment]. . . . These industries, however, owe much of their present strength to the extent to which rationalisation has proceeded in them, commercial foresight having made much use of scientific discovery and technical development."

One reason, evidently, for the citizen's new interest in scientific discovery and invention, and therefore in scientific education, is to be sought in a realisation of the close connexion between the acquisition of new knowledge and the stability of his own economic position; at the same time he may fairly be credited with an increasing interest in the knowledge itself, an interest which deepens as his own education widens. He will shortly have an opportunity of displaying that interest, and of surveying the circumstances in which the chemical industries have reached the position which they now occupy in Britain. This year the Society of Chemical Industry celebrates the fiftieth anniversary of its foundation. A scientific society fifty years old does not now rank as juvenile, yet how short a period is fifty years in a nation's life! As a contribution to the jubilee celebrations, Dr. Stephen Miall, editor of *Chemistry and Industry*, has written an account * of the development of chemical manufacture in Great Britain. For reasons which we have examined, his book will be regarded by many intelligent, although not scientific, people as one of the more important publications of recent years; scientific people will welcome it as a noteworthy work of reference which is unique in its authority and scope. Dr. Miall has accomplished a task of some difficulty, for until 1882 there was no journal devoted to British chemical industry, and, moreover, there were few books that attempted to describe the progress of any considerable parts of the industry. By combining the advantage of personal contact with its leaders with the goodwill shown by members for an object undertaken by their society, he has received a great mass of valuable information which otherwise might, in a few years, have been irretrievably lost; it is this fact, no less than the attractive manner of presentation, which recommends his story to chemists and non-chemists alike.

It might be thought that the manufacture of 'heavy' chemicals, such as alkali and sulphuric acid, is at least a simple, self-contained, and established process which offers little bait to the pioneer; yet we learn how complex it has become, how one part is dependent on others, and "almost every effort to prevent waste involved the manufacture of some new product". Unfamiliar names and unsuspected associations will whet the curiosity of the student of chemistry: Josias Christopher Gamble, who, like Joseph Priestley, was a minister of religion and devoted much attention to chemical experiment, became a manufacturer of bleaching powder, alum, sulphuric acid, and Glauber's salt; whilst Walter Weldon's fame is reputed to be shared by the history of bleaching and of ladies' fashions.

Economists tell us that prices depend on the gold output; Dr. Miall observes that the increase from about seven million ounces in 1887 to about twenty million ounces now is largely due to the invention of the cyanide extraction process by a chemist named MacArthur and two brothers, Glasgow medical men, named Forrest. It is obvious that material success will always be dependent on business acumen as well as on technical advance, and this subject is discussed in the chapter on the dyestuffs industry in relation to the acknowledged supremacy of the German dye industry during the forty years or so preceding the War. The reasons which Dr. Miall advances are concerned with the patent laws, with the lack of import duties, with relative business ability, with selling organisation, with inadequate opportunities for the publication of new discoveries, with our lack of chemical engineers, and with the fact that in the late 'sixties and early 'seventies there were far greater facilities for learning organic chemistry in Germany than in England. This reason is regarded as almost sufficient without any others, and its prominence is a striking commentary on the anxiety with which professors of organic chemistry in Great Britain recently regarded a proposal—since fortunately postponed—to remove certain importa-

* A History of the British Chemical Industry: Written for the Society of Chemical Industry on the Occasion of the Fiftieth Anniversary of its Foundation. By Stephen Miall. Pp. xvi+273+35 plates. (London: Ernest Benn, Ltd., 1931). 10*s.* 6*d.* net.

tion restrictions on dyes. Their knowledge of the history of the dyestuffs industry in Great Britain and of the intimate relation which subsists between the work of the universities and the future of this and allied industries aroused justifiable fears that organic chemistry itself, and with it the vitality of the dependent industries, would suffer severe damage by premature removal of that protection.

Abounding evidence is presented by Dr. Miall of the generous way in which successful industrialists have endowed the prosecution of scientific researches; the results have proved not merely a source of profit and a means of increasing employment, but also a source of inestimable material benefit to the human race. In some instances the endowment has taken the form of financial aid to existing research departments of academic institutions and of the creation of fellowships for the support of investigators; in others, of the foundation of new centres of research. A notable example of the latter form of service to humanity is to be found in the enterprises of the Wellcome Foundation, Ltd. These include a Bureau of Scientific Research, an Entomological Field Laboratory, a Museum of Medical Science, Tropical Medicine, and Hygiene, Physiological Research Laboratories, Chemical Research Laboratories, and a Historical Medical Museum. Thus a firm engaged in the manufacture of drugs and fine chemicals seeks to promote progress in the discovery, manufacture, and use of new and important means for the alleviation of human ills.

This outlook, this conception of social duty, is typical of a number of members of the British chemical industry, and the nation has reason to be grateful for the public spirit which is thus demonstrated; they will not be grudged the commercial advantages which their policy affords, and their example will be commended to other industrial firms in a position to do likewise. It may be true, as Dr. Miall says, that the man of business pursues money, the man of science pursues truth, and the man who attempts to do both is handicapped in each direction; the shrewd observation can scarcely be claimed to apply to co-operative effort by men of business associated with men of science. The former know that truth pays, and the latter nowadays at least escape the fate of Leblanc or Lavoisier. Moreover, fickle chance may smile upon them, as it did upon Caro's (but not upon Perkin's) alizarin patent, or upon Perkin's failure to synthesise quinine, or upon Spence's basin of alum. But accidents and failures are, on the whole, best avoided. A hundred years ago, Prof. Thomas Thomson published a history of chemistry which is still read with pleasure and profit by students of chemical science. "Let the science advance for another century", he wrote in 1831, "with the same rapidity that it has done for the last fifty years, and it will produce effects upon society of which the present race can form no adequate idea." In 1931 Dr. Miall writes: "Chemical research and technical research proceed in a manner which is satisfactory, and the skill of our chemists and chemical engineers is such that they can cope with all the demands of the industry. We may be confident, notwithstanding present difficulties, that there will be enormous advances during the next twenty years in the application of science to industry, and that much of this advance will be due to chemists." In a foreword, Sir Harry McGowan declares that "To be worthy of our fathers is to surpass them". What will be the historian's verdict in 2031?

Electron Diffraction.

The Wave Mechanics of Free Electrons. By Prof. G. P. Thomson. (The George Fisher Baker Non-resident Lectureship in Chemistry at Cornell University, Vol. 8.) Pp. v+172. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1930.) 12*s.* 6*d.* net.

ALTHOUGH de Broglie's first suggestion that moving particles might be accompanied by a wave system was based primarily on the consideration of free electrons, the first development of the wave mechanics, subsequent to the advance made by Schrödinger, was largely concerned with stationary states of bound electrons and their immediate properties, such as their energies and the possibilities of transitions between them. This is not surprising, since any system of atomic mechanics must at least account for the existence of stationary states and their properties, and Schrödinger's development occurred at a time when the limitations of the orbital quantum theory, after its initial successes in this field, were becoming seriously felt.

Though its success in these applications was the first physical justification for the concept of waves accompanying moving particles, they are primarily theoretical, and to follow them in detail often demands considerable mathematical equipment. They appear somewhat sophisticated, and a physicist might well ask for some simpler and more direct evidence for the waves before taking them seriously and endowing them with some sort of physical reality. Such direct evidence is provided by the