LETTERS TO THE EDITORS

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Secrecy and Industrial Research

In his presidential address to the British Association, on "The Ethical Dilemma of Science", Prof. A. V. Hill referred to the problem of secrecy in relation to the results of industrial research. I believe that the difficulty arises from confusion of technology with science.

These two fields of human endeavour are really quite distinct. Technology is the art of making things. It deals with the methods used for production. In this sense, even animals practise technology, and the evolution of men and the growth of civilization have depended upon the advance of technology. Technology advances by trial and error and by specific inventions. Much of the advance of technology is empirical, and, as Dr. J. B. Conant says, it is by the application of science to technology that the degree of empiricism in technology is reduced. Thus, when we speak of applied science, we mean science applied to technology. In industrial laboratories, the primary purpose of the laboratory is to advance technology, and, in order to do this, scientific work is undertaken so that the scientific results can be applied to advance the technology and reduce its empiricism.

This distinction between the technological work and the scientific work of an industry suggests a policy for the publication of new results. This is that industrial companies should publish their scientific work, but are under no obligation to publish their technological advances.

Scientific advances must be published even when they are applicable to technology because science advances as a whole, and any attempt to withhold the publication of scientific work reacts to the disadvantage of the withholder. Moreover, scientific men will not continue to do satisfactory work unless they can publish that work and feel they are taking part in the advancement of science. The great advance in applied science in the past fifty years is undoubtedly due to the general publication of scientific work done in industry as well as in the universities.

In my opinion, on the other hand, an industrial company is under no obligation to publish information as to its manufacturing technology. Publication is of value only to other firms who use that particular technology. In practice, however, it is impossible to keep technological methods secret for a long time. Often it is necessary to obtain the protection of patents, since otherwise a patent may be obtained by someone else, and a firm that has been using a secret process may find itself unable to use the process. To avoid this difficulty, firms often take out patents even though they desire no monopoly, and thus a great deal of technology is published which would otherwise remain secret.

Technical advances are also often published for purposes of prestige. Sometimes they are published because the applied science cannot be made known without publishing information as to the technology. Holding a technological process secret, therefore, merely delays the publication, and eventually the technology, for a few years before it becomes public knowledge.

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Oct. 14.

N-Nitration and *C*-Nitration by the Nitronium Ion

Aromatic *C*-nitration through attack by the nitronium ion was kinetically established by the work of Benford and Ingold[1], and of Hughes, Ingold and Reed[2]. The central point in the evidence was the observation of zeroth-order kinetics in the nitration of suitably reactive aromatic compounds, for example, of toluene, by a constant excess of nitric acid, in organic solvents such as nitromethane or acetic acid. All those aromatic compounds which are sufficiently reactive to take up the nitronium ion as fast as it is formed from nitric acid obey this law, and, for the same medium and temperature, can be observed to become nitrated at an identical rate, which is simply the rate of formation of the nitronium ion.

The zeroth-order form, and the associated absolute reaction-rate, constitute, therefore, a highly diagnostic test for the intervention of the nitronium ion in any reaction in which it is consumed as fast as it is formed. Thus the *N*-nitration of a secondary amine or the *O*-nitration of an alcohol, supposing the amine or the alcohol to be reactive enough, must, if the substituting agent is indeed the nitronium ion, be observable as zeroth-order reactions, having, in fixed conditions, rates identical with each other, and with the rate of nitration, say, of toluene.

We have used this criterion in order to show that the formation of nitroamines from secondary amines, and the formation of alkyl nitrates from alcohols by the action of nitric acid, involve attack by the nitronium ion on the nitrogen or oxygen atom. All kinetic measurements were made by the dilatometric method, controlled by chemical analysis. The course of the conversion of N-methyl : 2 : 4 : 6-trinitroaniline ('methylpicramide') into N-methyl-N : 2 : 4 : 6-tetranitroaniline ('tetryl') by 4 *M* nitric acid in nitromethane at 25° is illustrated in Fig. 1. This *N*-nitration is evidently a zeroth-order reaction. The con-

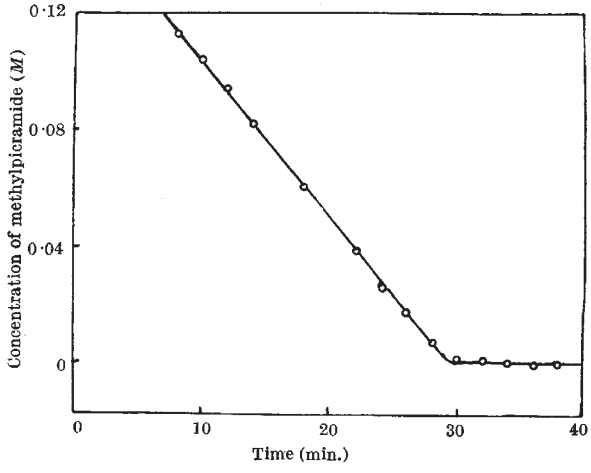

Fig. 1. Nitration of methylpicramide by 3·95 *M* nitric acid in nitromethane at 24·9°