zation of the Peking Society of Natural History in 1925. The call was issued by Dr. N. Gist Gee, the ornithologist, as organizing secretary, and myself as convener, and the first meeting was held on September 21, with thirty-eight charter members.

Monthly meetings have been held ever since, with lectures and discussions on Chinese natural history. During the first year the membership rose to 101, including eighteen foreign correspondents and two honorary members. The society began at once to issue a bulletin, the first volume of 450 pages appearing in 1926. The present membership is 160 active members, 26 foreign correspondents and 4 honorary members, and the bulletin is now in its eleventh volume.

Besides this the society has undertaken the issue of the handbooks, of which four have appeared: (1) "Flowers of Peitaiho," by R. D. Wickes; (2) "Shells of Peitaiho," by Grabau and King, second edition; (3) "Hand-book of North China Amphibia and Reptiles," by Drs. Boring, Liu and Chou, and (4) "Familiar Trees of Hopei," by H. F. Chow.

In addition the society has issued five monographs on Chinese medicinal plants and animal drugs, by Dr. Bernard Read, and one on minerals and stones used in medicine, by Drs. Read and Pak. It has also brought out a profusely illustrated manual of the dragon-flies of China, by Dr. J. G. Needham.

The scientific study of natural history is now a recognized intellectual pursuit in China, and those of us who were privileged to be present and in a measure give aid, during the early years of development, feel confident that in the years to come geological, paleontological, biological and archeological contributions by Chinese naturalists will become of increasing importance, not only to their home country, but to the world of science at large.

Chinese naturalists feel as I do, that in honoring me to-night you are giving recognition to the progress of the scientific work in China, and they take it as an encouragement for the unabated continuance of their endeavors.

With this interpretation of your award to me of the Thompson Medal and with my sincere personal thanks, I accept the honor.

THE SOCIAL RESPONSIBILITY OF THE ENGINEER.[1]
II

By Dr. F. G. COTTRELL

RESEARCH ASSOCIATES, INC., WASHINGTON, D. C.

The particular project out of which have thus far evolved the Research Corporation and the Research Associates, Inc., originated over 30 years ago at the University of California primarily in the attempt to make certain technical developments arising in the laboratories more certainly and usefully available as practical results to the public on the one side and on the other securing therefrom some financial return toward further research in these laboratories.

The idea was not a new one even at that time, but concrete systematic attempts at its realization were few and scarcely any had as yet attracted much public attention.

The particular technical developments and patents giving us a basis to work on at the time happened to concern the application of electricity for the suppression of dust and smoke discharge from smelters and chemical works, some of which were then in serious litigation with surrounding agricultural regions. The scientific and technical side of this story though interesting in itself is not what I wish to cover to-night, as it is already fully available in the now voluminous published literature on the subject.[2]

Suffice it to say that these electrical methods, though originally proposed and even patented in their broadest general terms a quarter of a century earlier, had never up to then been successfully engineered and applied in industry. The work started purely as a private venture, a summer vacation's excursion into the technical commercial field when it was drastically necessary to supplement a university instructor's salary by outside work of some sort. It soon involved three associates besides myself, all alumni of the university, *viz.*, Dr. Harry East Miller, a consulting chemist (the only other member of our group still living), Professor Edmond O'Neill, of the Chemical Department, and Mr. E. S. Heller, a lawyer of San Francisco. They jointly financed the undertaking, including patents and early experimental work. As we proceeded, the scope and importance of the field we had stumbled upon gradually became evident.

None of us looked to this particular work as anything but a passing, though interesting and useful, incident of our chosen careers. Early in its development we therefore planned for its eventual liquidation as far as we as a group were concerned, but agreed that in so doing we would if possible segregate a part of the patent rights and turn them over to the univer-

[1] Address on the occasion of the presentation of the Washington award at a meeting of the Western Society of Engineers, Chicago, February 23, 1937.

[2] For brief summary and selected bibliography see "Fume Precipitation, Electrical," Encyclopaedia Britannica, 14th Edition, Vol. 9, p. 914, *et seq.*

sity or some other appropriate body as nucleus and example of this particular sort of endowment for further scientific research.

It took five years and an investment of over $20,000, tenfold the original estimate of both time and money, before we reached even a promising point to pause and attempt such liquidation and transfer of patent rights. In the meantime (1907) we found it expedient to incorporate two companies, the Western Precipitation Company, handling actual installation of the process at home, and International Precipitation Company, holding the foreign patents for which our perhaps amateurish enthusiasm had led us to apply in some sixteen countries.

Our five years' experience made us skeptical of the expediency of universities themselves attempting to administer the commercial development or licensing of patents, partly from the difficulty and financial hazards of the business but even more from the danger of its reaction on the aims and outlook of the institutions, including the possibility of gradual development of commercial competition among them and resulting interference with free exchange of scientific ideas.

This led to our turning to the national scientific societies as possible trustees in such matters for all the universities and other academic research institutes as a group, but none of these national societies felt they could undertake it. The quest finally led us to the Smithsonian Institution, which, though hesitating to undertake the task itself, sponsored an attempt to get together a volunteer group of nationally recognized men, representing both business and science, to form a business corporation to take over these and any other patent rights that might be offered from time to time from any source as endowment for science. It took two months to get a board of 15 together and perfect plans. As the result Research Corporation was chartered on February 26, 1912, just 25 years ago next Friday, under the laws of New York State with an authorized capital of $20,000, of which $10,100 was paid in practically as a loan without interest by the directors themselves and a few others interested in the experiment.

I well remember one of these latter remarking at the time: "Your project of a non-profit but business corporation strikes me as too bizarre and self-contradictory to succeed, but if these busy and successful business men you have secured as directors are willing to give their time and effort to the experiment, they can count on me for a thousand dollars toward trying it out." Nor do I recall that he was any more frankly surprised three years later when he got his money back out of earnings than some of the directors themselves. At the start it was frankly "An Experiment in the Public Administration of Patent Rights." At least that is what I called it in the title of a paper written at the time, though I am not sure that even a majority of its original board of directors took that aspect of the project as seriously as I did. They saw it primarily as just so much more endowment for science and possibly if successful, as facilitating and encouraging future additions in kind, but even of this latter some were frankly skeptical.

Nor was there lack of justification for this skepticism. It has taken good hard work over the years by an intelligent and devoted staff sympathetically supported and guided by an interested and unselfish board to accomplish the success manifest to date.

At the time of organizing Research Corporation the investment of the original California group had not yet even begun to be repaid, but the business outlook for the Western Precipitation Company seemed encouraging. I was leaving the university faculty for service with the U. S. Bureau of Mines especially on smelter fume problems closely connected with litigation thereon, so it was necessary to completely separate myself from any financial interest bearing on the subject. This precipitated similar action on the part of my three associates. Some of our clientele among the smelters and chemical works where a number of electrical precipitation plants were under construction were somewhat perturbed at the prospect of becoming guinea pigs in the Research Corporation experiment through absorption of Western Precipitation Company therein and so expressed themselves. Some of the younger men in our technical staff were quite anxious to carry on by themselves, and this permitted a very happy solution by which one of them, Mr. Walter A. Schmidt, another University of California alumnus and former student there of mine, headed a group to take over, refinance and practically consolidate the Western and International Precipitation Companies under the former, after we had segregated and turned over to the Research Corporation entirely unencumbered all the United States patent rights to the precipitation business east of the Rocky Mountains except the one application to the Portland Cement industry which Mr. Schmidt had already personally built up over several years under an earlier license from us.

This also incidentally provided a very interesting yardstick alongside of the Research Corporation experiment, for Western Precipitation Company continued on as a normal privately owned enterprise operating under the same patents and among the same industries in a different geographic field in part of its work and with a different industry but in the same geographic field as Research Corporation in another. An agreement was early reached between the two corporations for the free exchange of all new information and patents on electrical precipitation and has later

grown to include similar organizations in many foreign countries.

But to return to the Research Corporation itself: We had pictured its functions as primarily hunting up business, negotiating licenses and collecting royalties. However, experience soon showed that even in as new an art as electrical precipitation, where we were the recognized pioneers of its effective industrial application, it was necessary for the corporation to furnish its clientele not only licenses but active and vigorous service in detailed design and leadership in adapting the new art to the special conditions of each industry and even each individual plant. Otherwise failures due to such details were viewed as fundamental limitations of the process as such and seriously cramped further growth and expansion. On the other hand, too, if the client solved the new difficulties unaided he quite naturally and properly was apt to take out patents of his own covering it. Now there is nothing more discouraging to the prospective user of a new process than to find that he may have to shop around among several interests to collect the patent rights he needs.

The realization of this early forced the Research Corporation to take an active and responsible part in the design and supervision of installations under its patents, and finally led it as the only satisfactory way to the building up of its own construction department and contracting to put in and guarantee performance of the whole equipment.

I mention this to illustrate how inexorably responsibilities grow in the economic field even in an organization which started out with apparently so simple a program.

Another important difference in the actual course of events as compared with the original plans and forecasts lay in the slower development of income both from electrical precipitation and from other business than many had expected.

From the very start the corporation was, to be sure, deluged with offers of patents and patentable ideas on all sorts of terms by all sorts of inventors. Hundreds of these cases were carefully investigated at considerable expense. Definite attempts to commercialize a few were made, and much assistance was incidentally given to a large number of applicants in the way of technical and legal advice and in making favorable contacts with firms and industries who might be interested in the further development of projects in cases where the Research Corporation did not feel itself in a position to proceed further.

Only relatively recently, however, has the corporation begun to receive significant financial returns outside the electrical precipitation field, but these seem now to be steadily growing, both in number and importance, and they include as widely different subjects as air conditioning, both for buildings and railway service, sewage disposal and pharmaceutical products.

Perhaps the most significant lesson out of all this, particularly for the purpose of our discussion this evening, is, on the one hand, the demonstration that it is entirely possible to organize and efficiently operate over long periods of years, on a thoroughly sound business basis, a corporation of the type here described in which there are no dividends to individual stockholders, no bonds or other long-term borrowings entailing heavy interest payments which in slack business seasons embarrassingly compete with wages and salaries, while, on the other hand, it equally illustrates the difficulty and general inexpediency of trying to handle intensively more than one new thing at a time, especially when getting under way with a new organization. But this is just the reason why this very method of organization presents, I believe, a particularly suggestive challenge to the engineer with new ideas who may be finding it difficult to get them tried out under conditions acceptable to him, through older established channels in industry and trade.

While the Research Corporation finds itself almost chronically in a condition near saturation and ofttimes actually supersaturated in regard to new commitments in the development field, and therefore must select very carefully and conservatively among them, it has come to be a very large part of its public service functions to aid and advise others who seriously contemplate entering this field.

There has also come to be a constant exchange of information and assistance going on between it and other similar organizations, such as the university research foundations, National Research Council, the various technical departments of the Government, the Chemical Foundation, the Ontario Research Foundation, and many others. So much so in fact that among this group it is being considered whether some sort of intergroup organization, to arrange for regular meetings of representatives for the discussion of common problems and aims, has not already become highly expedient. This might quite conceivably be the next step in the development of this part of our social-economic pattern.

At the outset Research Corporation's income was small and slow growing. Its capital was gradually eaten into, reaching a minimum of about $3,000 in the third year of operations, shortly after which the first considerable license contracts were entered into with some of the large smelting companies and the corporation's reserves rapidly increased, reaching a maximum of slightly over $200,000. But conditions of the world war and the post-war depression again ate steadily

into these reserves until in 1926–7 they were once more just about dragging on bottom, when a slow but steady climb again set in with naturally a decided spurt in the boom year of 1929 and lasting well into 1930, again building up a substantial reserve sufficient to more than completely meet actual deficits suffered in 1931 to 1933, as well as to permit the corporation to continue its grants for pure scientific research at the Smithsonian Institution and a number of universities and other research centers, totalling $50,000 to $75,000 a year. The past two years have again been "in the black" and 1937 opens with encouraging prospects.

Nearly a decade ago, when the Research Corporation began to feel itself gradually emerging from the effects of the post-war depression and keenly realizing the difficulties of too closely mixing operation and construction technique with research in a new field, it decided to set up a modest branch laboratory, primarily for this latter purpose, in Washington, D. C., which would also supply a much needed link with a large store of technical information available there through the libraries and information services of the various scientific departments.

Through the friendly cooperation of the Smithsonian Institution modest temporary quarters for this step were soon found and work started, particularly along lines growing out of activities to which the Research Corporation was already committed. One of the more important projects resulting from this move and which will serve to illustrate the work in a general way, was the cooperative investigation undertaken with the Tennessee Valley Authority (then just established) and the Department of Agriculture, having to do with semi-commercial tests and development in the application of blast furnace technique to the production of phosphate fertilizers.

By the end of 1934 the work at Washington had developed to a point where the directors of the Research Corporation felt it expedient, in conformity with the general policy of decentralization indicated above, that this Washington work should be given a more independent status and thus, among other objects, stimulated to become more definitely and rapidly self-supporting and eventually take its place alongside of the Research Corporation, functioning in much the same way but on separate technical projects and with an entirely separate board of its own.

It was felt that this budding-off process might become one of the most effective ways of providing for wider public service in this promising field and also to a drafting in and giving full scope to new personal initiative.

Accordingly, the Research Associates, Inc., was chartered on January 3, 1935, and has been operating ever since with a staff of ten or a dozen people housed in several temporary small laboratory buildings, mostly relics of the chemical warfare unit of war days, on about an acre of ground, part of the campus of the American University and immediately adjacent to the old Fixed Nitrogen Research Laboratory of the U. S. Department of Agriculture.

Thus far the new corporation has been supported almost entirely by grants from the Research Corporation, but it is hoped that by the end of the present year it will have become self-supporting from its own developments. The first to emerge will probably be in the field of non-glare automotive lights on the one hand, and certain improvements in the soap and detergent industry on the other; with a more ambitious long range program already well under way on fundamental improvements in heat exchange, especially in high temperature chemical and metallurgical industries and power production. But the new corporation, though an interesting and lusty youngster, is still distinctly not out of its swaddling clothes, and, as even in this modern age the old adage that "children should be seen but not heard" is still reasonably applicable, Junior, I trust, may, with this brief introduction, be allowed to retire again to the nursery until there are more definite accomplishments to report.

SCIENTIFIC EVENTS

THE BIOLOGICAL LABORATORY AT COLD SPRING HARBOR

THE summer activities of the Biological Laboratory of the Long Island Biological Association at Cold Spring Harbor will open on June 21 with the first meetings of the course in surgical methods in experimental biology and the course of experimental endocrinology. The class in surgical methods, which is now over-registered, is again being given by Dr. George W. Corner, of the University of Rochester, while that in experimental endocrinology is being given by Dr. H. O. Haterius, of the Ohio State University, and Dr. Robert Gaunt, of New York University. The Davenport Laboratory, in which these classes are being held, has been completely remodeled, and accommodations for an animal colony have been added.

The fifth of the Cold Spring Harbor symposia on quantitative biology begins on June 22 and continues for five weeks. This year the subject is that of internal secretions, with special emphasis on their chemical aspects and on bio-assay. The program falls into three main sections—I. Pituitary and gonad hormone chemistry (first week); II. Pituitary-gonad relations (second and third weeks), and III. Hormones and