antedate the famous experiments of Hertz by about a dozen years, and, as far as I have been able to ascertain, constitute the first experiments on the propagation of electric waves and wireless signaling, with the sole exception of some experiments conducted still a dozen years previous to his by Joseph Henry in Princeton. These earlier experiments of Henry's were apparently never published.

Immediately upon the announcement of the discovery of Röntgen rays, Professor Thomson began a series of interesting experiments and valuable developments in connection with the x-ray art. The foundation for this work had been laid by previous experiments on electric discharge through gases at low pressures, and led to the first application of stereoscopic methods in Röntgenology only one year after the publication of the Röntgen rays themselves had been announced, and led also to various practical improvements in the design of x-ray tubes, as, for example, the double-focus x-ray tube and a cooled-target tube within less than a year after the discovery of Röntgen rays. In connection with these experiments Professor Thomson also took a lively interest in the physiological effects of x-rays, including x-ray burns, and in the laws governing diffusion of x-ray matter, subjects which have been developed on the one hand to exceedingly important applications in medical therapy, and on the other hand to give some of the most intimate knowledge which we possess of the internal constitution of matter, such as the arrangement of atoms in crystals and molecules, and the arrangement of electrons in atoms.

Things like these, and many more of them, constitute the tangible contributions of Professor Thomson to electrical engineering. His intangible contributions are less easy to talk about, but are none the less real and important. I can not close without mentioning a few of them.

Still quite tangible are his services to engineering education. From his earliest work as a teacher of science in the Boys' High School of Philadelphia, to his many years of service to the Massachusetts Institute of Technology as member of its corporation and executive committee, its acting president during a critical period, a frequent member of the visiting committee of its department of electrical engineering and non-resident professor in that department, he has been a continual inspiration and source of help to students and colleagues.

Rather less tangible is his influence in the many professoinal engineering and scientific bodies of which he is a member. Not only have his scholarly contributions been many and important, but he has consistently been an ideal connecting link between the practical and the theoretical, the commercial and the academic, by his example keeping them from being too narrow and maintaining a generous spirit of mutual appreciation and cooperation.

Still less tangible, but perhaps most important of all have been his inspiration to his thousands of business and research colleagues, his example of enthusiasm, perseverance, ingenuity, unselfishness, love of truth, generosity and broadmindedness.

As I have come to know it, the electrical engineering profession is on a remarkably high plane, both technically and also in general attitude. I believe its debt to men like Professor Thomson for making it a good profession in which to work is at least as important as its debt to him for so much of its basic technical development.

IN HONOR OF PROFESSOR ELIHU THOMSON[1]

By Dr. VANNEVAR BUSH

DEAN OF ENGINEERING AND VICE-PRESIDENT OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THERE are many titles which I might use in presenting to you these greetings on the occasion of your birthday; but I feel sure that that of "Professor" is most welcome to you. It emphasizes an aspect of your accomplishments which I know is close to your heart. Great material changes have followed upon your scientific and engineering accomplishments, and these are visible to all of us in our daily lives. More subtle but none the less lasting is the influence of your many contacts with academic affairs. You have touched and moulded many institutions which are dedicated to the education of youth, and I bring you the felicitations of your colleagues everywhere.

Sixty-three years ago you were a professor in Philadelphia. We take great pride that you are still, and we hope will long be, professor of applied electricity at the Massachusetts Institute of Technology. Through these years your interest in collegiate affairs has been continuous. I need recite but a few instances. In 1890, just as I was born, and when you were thirty-seven, Yale recognized you as a master of arts. Tufts has the distinction of having conferred upon you your first doctorate, that of philosophy. Harvard made you doctor of science, and the University of Pennsyl-

[1] Address given at the dinner to mark the eightieth birthday of Professor Elihu Thomson, March 29, 1933.

vania, doctor of laws. Victoria University reached across the ocean to confer the degree of doctor of science.

Your contacts with educational institutions have been much more than occasional, however. They were bound to be, for your interest in their affairs has always been constructive. I find you, very early, organizing a scientific society, lecturing to audiences in an artisan's night school, at the Franklin Institute, and at many other places. And in later years, you have served on the visiting committees of this institution and of several departments of Harvard University.

Your contacts with the Massachusetts Institute of Technology have been particularly close. It was a fortunate thing for us when your acquaintance with Professor Cross brought you to lecture here fifty years ago on electrical machinery. Since that time we have always felt your presence. For thirty-five years a member of the corporation, and for twenty years on its executive committee, you have guided our steps. One of the most helpful things you have ever done for us was when you were highly instrumental in bringing to the institute the president we all so deeply honor, Dr. Maclaurin. Another act, a small one this time, but one that reminds me of you every time I look out of my window, was when you classified for him the names that appear graven on our buildings. And finally, when he died, you became for two years our acting president and gave of your time and effort to steady us on our feet as we staggered from that blow. And now you are still "Professor" and our colleague.

There has long been, on the part of the layman, an inclination to associate the title "professor" with the pedantic and the cloistered. To fully earn the title it is sometimes popularly supposed that one must cultivate an intense absent-mindedness and a lack of knowledge of the every-day affairs of the world. You have certainly done much to dissipate this idea, and your colleagues rise and call you blessed. That there exist professors who can put up a window-shade while conversing in ordinary language, or who can set the timing of an automobile as a form of recreation, is a fact of the modern world which is still incredible to the laity. That there is one who has hundreds of patents to his name for all sorts of things which very practical men have been very glad to use has given the title a significance which is well added to its dignity. I hope that every farmer who uses a cream separator will realize that it was invented by a professor, for it will do much to counter that persistent fallacy that those who think deeply are necessarily beings apart.

The world progresses only so fast as it learns to pass on its accomplishments from one generation to the next. The material things, those that are of direct utility, machines and structures, can hardly be passed on at all to-day, for obsolescence is much more rapid than deterioration. The written word, the recorded science of yesterday, is here to-day, and we may delve and explore for the thoughts of the pioneer in order that the gains made by those who blaze the path may not be lost to those who follow. But there is a means of transfer of accomplishment which transcends either of these, just as the speed of thought is greater than the working of tools or the reading of words. It is the direct contact between the alert mind of youth and the seasoned and inspiring mind of experience. This is education in its essence. All the paraphernalia of the college, the faculties and curricula, the tall towers and the basement laboratories, have but one purpose, to bring together in an atmosphere of progress the youth and his teacher, and to make it possible for them to work.

It is not by chance that you, who have been scientist, inventor, organizer, engineer, man of business, have been for sixty-odd years professor. It is because that profession holds for you, as it does for us your colleagues, the key to an accomplishment that is more truly satisfying even than the pushing back of the boundaries of science or the application of the fruits thereof to the material benefit of man. There must have been a glorious feeling of triumph when you first watched an electric arc stream out and attenuate in a magnetic field. The satisfaction of electrically making one piece of metal where there were two before was intensified by the realization of what the process would mean in the comforts of life to all. But I venture the thought that these were not as stimulating or as lasting as the satisfaction which was yours when you first caught in the eyes of a youngster that gleam of fire which told you that a spark of your own wisdom had transferred to another mind. The joy of teaching is deep seated in our primary instincts, and there is an immortality more specific than fame.

You have taught us many things of less tangible nature than how to make a transformer yield constant current. You have showed us that a man may be truly a professor and at the same time very practical. And one thing more which I wish to emphasize. You have shown us that a scientist or engineer may be, even in this complex modern world, versatile and yet not superficial. I recall that you were first a professor of chemistry and of mechanics, and you are now professor of applied electricity, and you have been organizer, inventor, man of business, engineer, astronomer, executive, philosopher. In these days, when there is a tendency to specialize so closely, it is well for us to be reminded that the possibilities of being

at once broad and deep did not pass with Leonardo da Vinci or even with Benjamin Franklin. Men of our profession—we teachers—are bound to be impressed with the tendency of youths of strikingly capable minds to become interested in one small corner of science and uninterested in the rest of the world. We can pass by those who, through mental laziness, prefer to be superficially and casually interested in everything. But it is unfortunate when a brilliant and creative mind insists upon living in a modern monastic cell. We feel the results of this tendency keenly, as we find men of affairs wholly untouched by the culture of modern science, and scientists without the leavening of the humanities. One most unfortunate product is the type of engineer who does not realize that, in order to apply the fruits of science for the benefit of mankind, he must not only grasp the principles of science, but must also know the needs and aspirations, the possibilities and the frailties, of those whom he would serve. There are students who may realize this fallacy only when it is too late. To those we would say: "There is one of your professors to whom we would call your attention. He exemplifies that combination of breadth with a definiteness of grasp of the affairs of this world to which we may humbly aspire. He has made significant advances in many diverse branches of engineering, represented by many inventions relating to such things as the uniflow steam engine, the lightning arrester, the cream separator, the electric meter, the resistance welder, x-rays, the automobile muffler, the use of helium in diving, the heat treatment of steels and various chemical processes. He has written of such matters as the nature of comets, the light of the firefly and the aurora. He has organized and guided business and one of the great electrical companies of the world bore his name. He has many, many friends. May some of you follow in his distinguished footsteps that the world may be brighter and more replete with the opportunity which comes with material advance! May you make many friends, as he has, that those who inherit these benefits may know and understand each other better. May you grasp his kindly philosophy, that you may be happy as you create."

I bring you, sir, not only the salutations of your colleagues, but also their heartfelt gratitude that you have dignified and enriched the title of professor, and that we may hail you as friend and colleague.

SCIENTIFIC EVENTS

INDUSTRIAL RESEARCH LABORATORIES

WE learn from Science Service that while over 55 per cent. of the research laboratories serving America's industries have either maintained their staffs of investigators at the same level or actually increased their workers, there has been a decrease of over 12,000 in the staffs of other industrial laboratories in the past three years. However, at least 90 per cent. of the concerns reporting have maintained at least a skeleton research organization. This is shown in a survey just completed by Dr. C. J. West and Miss Callie Hull, of the Research Information Service of the National Research Council.

This year 1,467 laboratories reported 21,464 scientists on their staffs, while in 1930 there were 33,596 scientists on the staffs of 1,420 laboratories. This is taken to mean that at least 10,000 highly trained industrial research scientists are not engaged in scientific research due to the economic depression. The potential value of the lost services of these scientists must run into millions of dollars annually. Some of these scientifically trained workers have been transferred to plant and sales jobs, it is believed.

The 500 laboratories that reported decreases in staff employed 23,783 in 1930 and now have at work only 9,686. The 628 laboratories that reported no change employ 5,268 investigators. In 186 laboratories the staffs were increased from 3,768 in 1930 to 5,338 in 1933. The number of laboratories discontinued during the three-year period between the National Research Council surveys numbered 106 and they employed 775 scientists in 1930. In the course of the survey 153 laboratories now employing 1,172 scientists were included in the survey for the first time. Some of these may be new laboratories, but most are small research organizations that were not discovered in the course of the 1930 survey.

THE FIELD MUSEUM OF NATURAL HISTORY

THE annual report of the director of Field Museum of Natural History to the board of trustees, a book of 141 pages with nine photogravure illustrations, has been published by the Field Museum Press. In this book Director Stephen C. Simms outlines the activities of the museum during the year 1932.

The fact is emphasized that the museum has been able to continue its full service to the public, and has even extended its educational influence to a greater number of persons (attendance in 1932 having been 1,824,202) than in any previous year, despite having, like other endowed institutions, suffered a heavy decline in revenue. With income in 1932 $267,000 less than that in 1931, the museum reduced its expenses