store for us in this direction. We must, however, face the problem that confronts us to-day. In tropical countries large areas of land exist that are now sparsely inhabited and unproductive. That these tropical regions can be made healthful to men from the colder regions of the earth has been proved again and again by various nations that have founded colonies in the torrid zone. To do this it has only been necessay to control certain diseases, and these diseases have been for the most part due to animal parasites or their transmitting agents.

My remarks this evening may lead you to believe that we think we really know something about the protozoa of man. This, however, is far from the truth. One has only to look back to the situation that existed 30 years ago to realize our own position to-day. Zoologists in 1900 believed that they were living in an enlightened age, but now we know that they were densely ignorant. It seems probable that in 1960, 1931 will likewise be considered among the zoological dark ages. Hence, although we have made a good beginning in the study of parasitic protozoa we must continue our efforts until we are able to escape from the humiliating condition that exists at the present time and man ceases to be held in bondage by his invisible fauna.

OUR DEBT TO FARADAY'S EPOCH[1]

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ONE hundred years ago the first third of the nineteenth century was drawing to a close, as now is the first third of the present century. You may reflect that the stated facts are obvious and that the whole statement is a platitude. I center your attention on them with the clearly defined purpose of emphasizing the debt which we, in this first third of the present century, owe to discoveries originating in that significant first third of the immediately past century.

Using that first third as a landmark: James Watt, the founder of mechanical engineering, had already proved the usefulness of his conception of the steam engine; Lavoisier, the father of modern chemical thought, had just been guillotined by the revolutionists in Paris. Science and engineering had taken on new aspects, and the spirit of inquiry was abroad in a newly felt freedom.

Exclusive of those features of sentiment and religion, which must be dealt with independently because they are primarily of intellectual and spiritual moment, rather than pertaining to the physical conditions of health, comfort and convenience of the body, we are primarily dependent in our present-day living methods on a few great modern developments. Preventive medicine, sanitation, sound food preservation, transportation by water, rail and highway, electric quick communication, ready transmission of power, convenient artificial illumination, largely determine our relatively great assurance of health and comfort in life compared with the conditions of a couple of centuries ago.

I wonder whether any of you express to yourselves and associates doubts regarding the relative advantages in favor of our present status measured in health, comfort and opportunities for all men and women in the democratic countries, compared with the conditions of the common people of the great countries of a few generations ago. If you do, I assure you that it is because you have failed to study the effect of the changes of conditions; or, having studied them, you have failed to accurately interpret their meaning. When I speak thus in comparative favor of our own times I refer not only to average opportunities for health, comfort and happiness in life, but also to the conditions available particularly for those who are little favored with influence or money.

If you wish a bit of my meaning more fully illustrated, I invite you to drive through the Värmland and Dalecarlia provinces of Sweden, as my wife and I did last summer in a pigrimage to the birthplace, school place and tomb of John Ericsson. And then compare, feature by feature, the present comfortable, well-supplied life of the present dwellers, living secure in that community, with the sordid hardships of the life there several generations ago, which are identically described by Selma Lagerlöf in her distinguished saga of Gösta Berling. I am sure that the sordidness and hardships of the older life and the relatively healthful, comfortable and happy conditions of the present life in the area will impress you. The changes are revolutionary and heavily favorable to the present. Food is now certain for all. Children are born under sanitary conditions and with suitable medical aid. The sick are properly cared for. Products of the farms, forests and mines are of definite value. Reasonable periods of sleep and recreation are within command of all. Shelter and clothing are assured. This makes a deep-seated contrast with the

[1] Address delivered at the celebration of Faraday's life held in New York on November 18, 1932, by the New York Museum of Science and Industry.

conditions in the older period; and the healthier and happier hues are mostly associated with the later period.

We may reasonably ask how this difference has come to pass. The answer is in terms of enlarged science and broadened engineering; in rail transportation and steam navigation, automotive highways, quick electrical communication by telegraph and telephone, ready transmission of electric power generated from water-power, convenient sources of artificial illumination, preventive medicine and sanitation. One swallow does not make a summer nor one snowflake a winter, but the given example is indicative. A scientist is skeptical in drawing conclusions (and the competent engineer is a scientist), but he does not misconstrue facts and determined relationships. One of the hindrances which occur when one tries to secure a fair and accurate understanding, from such a comparison of the present with the past, lies in the difficulty of divesting a mind of present-day knowledge when considering the past, and thus the conditions of the past are given an interpretation which is unduly favorable because it is flavored by knowledge extracted from the present. Critics of our present-day social organization frequently fill with this error the comparisons which they make. Obviously there are faults in our present social organism. We all know that they are many and are sometimes grossly unfair as between men; but they are not so many or so unfair as in previous centuries. To prescribe a cure calls for keener relating together of facts than usually characterizes self-constituted social physicians.

But that first third of the nineteenth century—what of it and why our debt to it?

In the early part of that period, Fulton, the father of steam navigation, produced the first operating embodiments of the steamboat, the conception of which had come to him a few years earlier. George Stephenson, the father of railroad transportation, in this period wrought out in metal his conception of the iron horse as a device with smooth wheels running on smooth rails and yet capable of drawing after it great loads; and in 1829 he conclusively proved against all skeptical opinion that his device outclassed horses as a motive device. Morse had his great conception of the electric telegraph during the period, although it was some years later before he succeeded in embodying his conception in a successfully working telegraph structure, and it was some decades more before Bell produced the telephone. Faraday, the gifted experimenter in the fields of chemistry, metallurgy, electrochemistry, electricity and magnetism, in that period laid the foundation for all our electrical power and electrical illumination developments.

There, in that one third of a century, lie the roots of all our developments of steam navigation, rail transportation and electric communication which have made, for most of the world, one harvest; and in the end will apparently succeed in making it of one heart.

Our hearts are torn by pathetic accounts of drought and flood and succeeding famine in the central provinces of China. We, in this country, which is bound indissolubly together with bonds of quick communication and efficient transportation, find it difficult to believe that starvation following failure of crops in inland China is due mostly to ancient and rudimentary means of communication and transportation, and not to mismanagement. But such are the facts. A short century ago, starvation of populations by famine was of common-place occurrence after the failure of crops in almost any of the inland provinces of India, which country has a population measurably in keeping with that of China. Today the occurrence of famine in acute degree in India is beyond the margin of our thought. This change in India has been wrought mostly by the wonders of electric telegraphy and steam railroad transportation.

As recently as when I was a boy severe shortages of the potato crops in some districts of Ireland caused famine-starvation to a degree and with a frequency that led that island to be sympathetically referred to as the Stricken Isle. What of the present day in that isle? How many of you under forty have thought of ravages of famine decimating the Irish population? The differences distinguishing the present conditions and those of the not far distant famine days of Ireland include the influences of more scientific cultivation of crops, improved sanitation, and recently the convenient provision of electrically transmitted power; but the major changes have been in the wake of railroad transportation and electrical communication.

When the great people of China have knit their nation together with bonds of electric telegraphy and telephony, railroad transportation, automotive highways and convenient electric power lines, their inland provinces will no longer be periodically ravaged by famine and pestilence, as the facilities for transportation and communication will give means for forefending against those great disasters.

This is enough of the "particular instance" to emphasize the point, and perhaps as much as your interest will support. You will observe the ameliorating influence of rail transportation, electric communication and electric power on the conditions of life. This may seem purely materialistic to some; but that is a misinterpretation, since intellectual qualities grow greatest where material opportunities are favor-

able, even though such opportunities may be embraced in only a Bohemian or partial manner. Moreover, improved communication and transportation have strongly advanced the influence of the premier invention of printing on the culture and mutual sympathies of the world, and have largely expanded the radius of spiritual influences.

You will note also the insistence with which electric communication and electric power appear in the recital. These have their roots in the magnificent discoveries of Faraday, Joseph Henry and others in that third of a century which we have been considering. Their growth has been extended by the discoveries and inventions of many others working in distinguished ways from then until the present day.

Fundamental discoveries which bring such great results are the fruits of curiosity working under ideal conditions; that is, of the spirit of inquiry applied to the disclosure of new facts or inferred relations. With increasing rarity they are the result of one scientist's efforts, although that was a characteristic of Faraday's days. An entire laboratory group, perhaps working under some inspired leader, nowadays more often brings projects to successful conclusions. Utilizing both of these sources—individual genius and group cooperation—we have admirable centers in the university laboratories (including therewith laboratories of the engineering schools) to carry forward in paths corresponding to those that have led to such impressive improvements in the conditions of healthfulness, comfort and happiness of life for all individuals coming under their influence.

The extraordinary influence of the universities heretofore is worth briefly enumerating, but I have time to sketch the affair in one branch only, and I will choose electrical engineering, in regard to which I am best informed. Galvani, Volta, Oersted, Ampere, Ohm, Joseph Henry, Maxwell, Kelvin, Helmholtz, Hertz, Roentgen, Pupin and other discoverers of natural phenomena or expounders of relations upon which most of the structure of electrical engineering is founded, worked in university circles. Alexander Graham Bell was professionally a teacher, although his great invention of the telephone can not fairly be accredited to educational laboratories. Elihu Thomson was originally in the post of a teacher and many of his widely influential inventions arose from experimental investigations performed in those days. Faraday's location during his great discoveries in chemistry, electromagnetism and other branches of physics was in the Royal Institution, which was founded by Sir Joseph Banks, Count Rumford and others with objects which include "the facilitating of mechanical inventions, the promoting of their use, and the teaching of science and its applications by means of lectures and experiments."

The impulse of curiosity or spirit of inquiry, of which scientific investigation or research is the embodiment, is well nurtured in the university atmosphere, where the relations of science are brought to bear on enthusiastic young minds. It is an integral part of properly conceived engineering education, and is especially serviceable in those institutions where the students are encouraged to independent scientific investigation and thought. The result of newly vitalizing this view in engineering education is bringing good results where it is in effect. This experience gives assurance that we may rely on our present generation to work some of the faults out of our social organism and carry forward the improvement of modes of life by farther application of scientific discovery. One of the needs is to provide the better engineering schools with means to as closely associate their work with fundamental economics as they are now associating it with fundamental science.

We have now considered briefly some of the achievements which were made in the first third of the nineteenth century, that expired nearly one hundred years ago, and also the effects of those influences on our present-day life. Shining forth amongst it all is the glorious significance of Faraday's own work, which exemplifies

> . . . the vital words and deeds
> Of minds whom neither time nor change can tame.

OBITUARY

IN COMMEMORATION OF STEPHEN TYNG MATHER

IN memory of Stephen Tyng Mather, founder and former director of the National Park Service, who died two years ago, the first of the bronze plaques designed by Mr. Bryant Baker, of New York, for The Stephen T. Mather Appreciation, of which Mr. John Hays Hammond is chairman, will be unveiled in Mount Rainier National Park on July 4, Mr. Mather's sixty-fifth birthday anniversary.

The plaque is oblong in shape, measuring 30 by 35 inches. The deep interest of Mr. Mather in outdoor life inspired the design, at the right of which, against a background of mountain ranges, is presented in *bas relief* his portrait looking toward a group of trees. Above the portrait is the legend:

Stephen Tyng Mather, July 4, 1867—January 22, 1930.

Below it, across the base of the plaque, is the following inscription: