PRESIDENT'S ADDRESS

THE UNSELFISH SERVICE OF SCIENCE.

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Fellow Members of the Indiana Academy of Science: In obedience to a well established custom I solicit your patient indulgence while I attempt to present in a few brief paragraphs what may be charitably designated the Academy President's retiring address. I shall make no apology if my remarks are suggestive of an appeal to the emotions rather than an effort to bring new knowledge for, in all frankness, it is my desire in at least some small measure to stimulate your pride, to encourage your faith, and to confirm your unselfishness—your pride in the recorded achievements of science, your faith in the coming of far greater revelations and attainments, your unselfishness in the continued pursuit of truth and its application to the alleviation of the ills of mankind. Nor shall I make any apology for selecting as a kind of text for the basis of this appeal the words of a great teacher: "And ye shall know the truth and the truth shall make you free".

I appeal to your pride. To speak of making men free implies a state of bondage, and the history of *Homo Sapiens* is in fact a history of man's struggle for freedom. It was for freedom from the beasts of forest and jungle that he sought refuge in a cave and defended himself with clubs and stones. It was for freedom from the assaults of his own kind that he barricaded his hovel and defended his family from pillage and plunder. It was for freedom from social and political servitude that he joined the ranks of his suffering fellows and tore the scepter from the tyrant's hand. It was for freedom from religious tyranny when he defied the priest and the Pope and set his own conscience as the guardian of his religious opinions. It was for freedom from ignorance and superstition and fear that he faced the bewildering mysteries of natural forces and demanded the key to the chamber of knowledge. Through all the long ages of tradition and recorded history the struggle has continued, but it was not until the dawn of the nineteenth century that man moved rapidly into that larger realm of freedom that makes for longer life, loftier thinking, multiplied comforts, and a richer and happier intercourse between men of all nations, all races, all creeds.

And whence cometh so suddenly this larger freedom? "Ye shall know the truth and the truth shall make you free." 'Tis largely the fruit of the labor of the man of science. Repressed from age to age by the combined powers of intolerance, superstition, and selfishness, the spirit of inquiry at last burst upon the world and men went forth to uncover the hidden mysteries, to discover the secrets of earth and sky and the coming and the going of every living creature, from man to amoeba — macrocosm and microcosm — universes infinitely vast and

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planetary systems infinitely small—forces that tear asunder and forces that bind together—integration and disintegration—life, disease, and death—there is no species of matter, no living organism, no manifestation of energy, that the modern man of science has not faced, interrogated, and forced to yield at least a partial answer to his persistent demands for the truth.

So rapid has been the accumulation of knowledge and so vast has become the wealth of material that it has become necessary to divide and subdivide the fields of research and introduce from time to time new titles to designate these newer branches of science. Less than a dozen decades ago one small volume under the general title of Chemistry might have contained all the essentials of this infant science while today we are fairly bewildered with General Chemistry, Inorganic Chemistry, Organic Chemistry, Analytical Chemistry, Physical Chemistry, Industrial Chemistry, Electro Chemistry, Physiological Chemistry, Bio-Chemistry, Colloidal Chemistry—and this does not exhaust the roll. And within the lifetime of some of my hearers the term Biology might have covered the outstanding facts and principles of a science that has moved forward with such strides that its first offspring, Zoology and Botany, have each become the progenitor of a large and respectable family designated by such significant names as Taxonomy, Embryology, Cytology, Parasitology, Entomology, Morphology, Physiology, Ecology, Paleontology—and this list is not exhausted. And from the more staid and less elusive of the natural sciences—Geology—one gathers the classic sounding titles of Cosmical Geology, Geognesy, Dynamical Geology, Structural Geology, Palaeontological Geology, Stratigraphical Geology, Physiographical Geology, Economic Geology, and along with them Petrography, Mineralogy, and in more recent times Meteorology and Climatology. And these are not mere designations of chapters in a volume on chemistry or biology or geology, but each represents a vast accumulation of knowledge in a specialized field where men are still laboring with energy and enthusiasm. What man engaged in the pursuit of truth even in a very modest way does not experience a commendable sense of pride over the additions to human knowledge and the practical utilization of this knowledge that have been made by scientifically minded men these past three generations?

A few weeks ago more than a thousand chemists gathered at the last resting place of Joseph Priestley, in Northumberland County, Pennsylvania, to pay once again their tribute of respect and honor to the memory of a genial, modest natural philosopher whose simple discoveries a century and a half ago laid the foundations of the modern science of chemistry. It was at this same spot that a mere handful of chemists gathered fifty years ago, just one hundred years after the discovery of oxygen—gathered for the same purpose—and upon that little group fell the spirit of Priestley, and under the inspiration of that spirit was born the American Chemical Society, destined to become in less than two generations the largest single scientific organization in the world. One stands amazed at the growth of chemical science within the span of these few years. Although for awhile young men interested in

chemistry continued to cross the sea to learn the methods of the recognized masters of chemical research in the old world, it was not long before our own universities became centers of productive chemistry and began to draw unto themselves their own. Today hundreds of students of other countries are themselves crossing the sea to learn of the masters in America. So evident have become the benefits of both pure and applied chemistry that little difficulty has been found in persuading men of wealth to contribute funds for the erection and equipment of the finest chemical laboratories in the world. The magnificent laboratories at Johns Hopkins, Cornell, Yale, Columbia, and the one projected at Harvard are evidences of the confirmed faith in the public benefit to be derived from systematic instruction and research in the field of chemistry. Furthermore, the promotion of chemical investigation by the larger industrial plants at the present time is a matter of favorable comment, for today steel mills, cement plants, dye manufacturers, pharmaceutical establishments, packing houses, and others too numerous to mention maintain a research force and well equipped laboratories for the purpose of solving technical as well as purely scientific problems and opening up new avenues for the application of science.

Nor is this interest and faith limited by any means to the field of chemistry. Research in the various fields of botany, zoology, geology, physics, and even astronomy is being encouraged and supported as never before. In state agricultural stations, state universities, privately endowed institutions, the various bureaus of the national government, and under the aid of various foundations established for public services by public spirited men—everywhere men are busy in every branch of science pushing back the frontier, extending the horizon, bringing to light new truths, discarding or recasting old theories, bringing forth new ones, and adding to and reorganizing the vast accumulations of knowledge.

A little more than a century ago John Dalton was modestly proposing a practical theory of atoms to explain and account for certain fundamental laws of chemistry. Today we have a vastly different theory of atoms and the physical chemist is calculating with some degree of boldness the orbits of the electrons in this microcosmic planetary system known as the atom and measuring the radiant energy produced by the jumping of the electron from one orbit to another. Tomorrow we shall be as familiar with the chemistry of electrons as we are now with the chemistry of molecules and atoms, and soon we may be making ready for the newer chemistry, the chemistry of a sub-electronic world.

Less than a century ago Wöhler was announcing the first synthesis of a natural organic compound while today thousands of such compounds adorn our chemical museums and find their application in the industrial world, while the bio-chemist is now isolating and synthesizing those marvelously active but very elusive products of the ductless glands which were not even known in the early days. From hormones and vitamines will soon be elicited their secrets and in the no distant future we may expect to learn the difference between the chemical

composition of the proteins in pathogenic and non-toxic bacteria and be able to place chemotherapy and serotherapy in the category of exact sciences.

In patience and faith the man of science pursues his way and it not unfrequently happens that discoveries regarded at the time they are made as of little import lead eventually to astonishing results. It has been only a few years since tungsten was little more than a chemical curiosity; the light from hundreds of millions of incandescent lamps now attest the benefits derived from a more thorough acquaintance with its properties. Some sixty years ago the astrophysicist caught the glimmer of a new element in the chromosphere of the sun and named it helium; today pilots are crossing the continent in super-airships lifted by this same element extracted from the natural gas of Texas by the chemical engineer.

A century ago, by the most simple and elementary experiments, Faraday was digging out the fundamental connection between magnetism and electricity; while today man presses a button and the darkness of night is converted into the light of midday; he pulls a lever and electrical forces are set in motion that do the work of hundreds of thousands of men; he speaks into the air and his voice is heard across the sea.

Less than three generations ago, with testtube and beef broth Pasteur was destroying the belief in the spontaneity of life, demonstrating that life is generated from life, and bringing to light astonishing causes with equally astonishing preventatives of virulent diseases. Into this new field of research entered a host of young biologists and today the bacteriologist has robbed many a plague of its terrors, while the embryologist in his patient observations of germ cells and chromosomes and blastomeres is coming to some understanding of the deeper mysteries of life and the underlying principles of heredity, and steadily building for us a practical science of eugenics. Can disease be eradicated, senescence averted, death indefinitely postponed? Surely the combined labors of the bio-chemist and the pathologist are making notable strides in eliminating the causes of disease, while experimental zoology is slowly but surely unfolding the causes of the approach of old age and discovering the means by which we may greatly extend the span of human life. On the basis of the rate at which we have been increasing, during the past generation, the average length of human life, it is predicted that in 1930 it will be 61; in 1940, 65; in 1950, 69; in 1960, 72; in 1970, 75; in 1980, 78; in 1990, 80; in the year 2000, 82; while in 2100 nearly every one should live to be 94 years of age. To Prof. Irving Fisher is credited the statement that "the most sensational conclusion which science has ever reached is this: that life cells and many tissues of man are potentially immortal in the purely physical sense. There will be a time, perhaps, when men will live, if not forever, at least much longer than the century mark which is now practically the limit of the human life span." This rosy anticipation is prompted by such discoveries as that of Professor Woodruff of Yale, who found "that no natural death occurred in 8,500 generations of the minute organism, paramecium, a period of time equal to 250,000 years

of human life"; that of Dr. Alexis Carrel of the Rockefeller Institute for Medical Research, who "has kept a chicken heart growing and alive for over fifteen years, an age that no chicken can attain;" and that of Professor Thomas H. Morgan of Columbia, who found "that 1/250 part of a worm will regenerate and become younger than the original worm." "The time will come perhaps", says Professor Fisher, "when the human being will have an indefinite life span, when his defective and worn-out parts can be replaced and renewed like those of a watch."

Is it strange, therefore, that the results of researches in science should excite our pride, a commendable pride, even though we ourselves may be only remotely connected with its actual progress? But all of us do have a part in this progress. The high school science teacher zealously laboring to awaken a spirit of inquiry in a thoughtless youth; the college instructor training the embryonic scientist in habits of close observation, exact measurement, and logical reasoning; the university professor suggesting the problems and directing the investigations of graduate students; the independent investigator in research foundations or technical laboratories devoting his whole time and strength to the pursuit of some bond of unity in a vast assemblage of bewildering data—all are making some contribution towards the attainment of the final goal, the knowledge of the truth that shall make men free.

How long will this scientific progress continue? Will the cunning to devise and the skill to execute increasingly intricate experiments never run their course? Will the imagination that "bodies forth the forms of things unknown" continue to fashion illuminating theories and guide men to ever increasing marvels of discovery? Is there no limit to the capacity of man's intellect to reproduce the thoughts of God expressed in nature's handiwork? Will the coming years like those now passing experience a constant succession of thrills over scientific discoveries and looking backward wonder that the years behind were relatively so poor in the rewards of scientific endeavor? Or has man reached the zenith of his ability to cope with the problems in the realm of science and arrived at the shores of a sea over which he has no craft to sail?

In an address on "The Evolution of Intelligence" delivered at Yale a few years ago President Angel raised this question: "Is the evolutionary process at an end so far as concerns the human brain and human intelligence?", and he followed the question with these statements: "Assuming some extra-mundane observer of the primeval slime out of which organic life has come, it would certainly have seemed to such an one grotesque to predict such changes as have actually come to pass, and particularly as regards intelligence. Similarly it is entirely impossible to surmise at what point progress beyond present human capacities may occur, but to conclude with any certainty that such further progress will not occur, much more that it cannot occur, seems hardly warranted. Whether this view regarding the further evolution of intrinsic human capacities is right or wrong, there would appear to be no practical limit to the changes which man can hope to bring about in the conditions of his life by the further application of the same

technique which has produced the highest forms of modern civilization, has produced our fine arts, and, particularly, has produced our modern science. Conceivably we shall never have greater epic poetry than that of Homer, greater sculpture than that of Phidias, greater architecture than that of the Parthenon, greater drama than that of Shakespeare, greater painting than that of Raphael and Titian, greater symphonic music than that of Beethoven. There is, however, nothing to prevent advance upon such achievements and in the range of the natural sciences at least, thanks largely to the perfection of experimental technique and the utilization of mathematics, there seems to be literally no limit in sight to the further mastery which man may achieve over the forces of nature and consequently no limit to the alterations which he may be able to introduce to the enrichment of civilization."

And so *I appeal to your faith in the coming of yet larger things.* As vast as have been the accumulations of scientific knowledge these past seventy or eighty years, as wonderful as has been the development of scientific theories, as marvelous as has been the practical utilization of this knowledge and the application of these theories to the extension and enrichment of human life, far greater achievements are awaiting the men who are zealously devoted to the pursuit of truth.

It has been almost a hundred years since Liebig and Wöhler and a few other kindred spirits began their investigations in what might then have been called animal and vegetable chemistry in contradistinction to mineral chemistry. Little did they dream that in a few decades the development of synthetic organic chemistry would reach such proportions as to merit the encomium, "the eighth wonder of the world". The organic chemist had largely to do with substances, their composition and molecular structure, and the steps by which complex molecules could be constructed from simpler ones. He delighted to tackle the problem of reproducing the products of nature in plant and animal and was not baffled by the complexities of such substances as carbohydrates, proteins, tannins, camphor, indigo, or rubber. Theory and practice developed together and the linking of atoms, the benzene ring, isomerism, and stereoisomerism proved valuable mines from which many a priceless nugget was extracted. And then interest began to wane and one might have asked: has chemistry reached its climax, the chemist his limit? It was but the beginning of a new day, a change of direction rather than a halt in progress. It was the day that marked the beginning of a closer relation between chemistry and physics, the day when the chemist trained in physics as well as in chemistry, or the physicist trained in chemistry as well as in physics began to study the dynamics and kinetics of chemical reactions, the day that marked the birth of a new science—phsical chemistry—a science built upon the efforts to apply exact physical methods to the study of chemical reactions and to express results in mathematical terms. Chemical action rather than mere products elicited the chief attention and reversion, equilibrium, mass action, and ions vied with synthetic dyes and carbon rings in their contention for popular favor. Today the physical chemist still occupies the center of the stage and with his X-rays, cathode rays, electrons, radio-activity and all the other electrical phenomena associated

with matter and the transformations of matter he seems to be pointing to the kaleidoscopic rearrangement of the various fragments of chemistry and physics into three distinct sciences: the science of gases, the science of liquids, and the science of solids. But suddenly there come intimations of a renewed activity in organic chemistry, for we are learning that not only can higher petroleum hydrocarbons be cracked—larger molecules broken down into smaller ones—but to these smaller molecules oxygen can be added, which means that petroleum is likely to become in the near future as prolific a source of synthetic wonders as the proverbial tar barrel. Not to be outdone, the physical chemist announces the discovery of a process of splitting hydrogen molecules into their atoms and the recombining of these hydrogen atoms into molecules with the production of a temperature of 7000 degrees Fahrenheit. This may prove to be but the beginning of another series of new wonders.

But the spirit of co-operation manifest between chemist and physicist is active in other quarters and with beneficial results. During the past twenty-five years, by a noiseless evolutionary process, botany and zoology have emerged from the category of descriptive into that of experimental sciences and they have begun to find a powerful ally in the science of chemistry. Is it not true that today it is the chemist who has been trained in biology as well as in chemistry, or perhaps the biologist who has been trained in chemistry as well as in biology who is attracting the greatest attention and making the most significant advances towards the discovery of the truth that shall make men free? Would a pure chemist or a pure biologist have discovered and synthesized adrenalin and thyroxin and isolated a vitamin or a hormone? Is it not the bio-chemist to whom we owe some of the most significant discoveries of very recent years and is it not in the realm of what is commonly called biology but through the labors of the bio-chemist in the study of chemical phenomena in the realm of living matter that we shall find the most valuable contributions to human knowledge during the next quarter of a century? Is it not true that just as the larger development of chemistry came from the co-operation of chemistry with physics so the larger and more fruitful development of biology is coming through the co-operation of biology with chemistry and physics?

It seems quite evident that there are two words that loom large when we are considering the advances in science anticipated in the near future—*specialization* and *co-operation*. An examination of the current literature of any branch of science confirms the impression that no one can hope to make any notable contribution toward this progress unless he has mastered the technique and become thoroughly acquainted with the known details in a very highly specialized field. To make any real discoveries, discoveries that really mark some advance in the development of science, necessitates intense specialization with reference to the problem attacked and the technique by which the data may be collected. But the investigator may be so completely submerged in his highly restricted field of investigation that he is unable to understand and evaluate new discoveries being made in other highly specialized fields. The result may be something like that of a widely scattered

army on the march where the individual troops are beyond the sight of each other, with no communication between them and no commanding officer to maintain the whole line in an orderly and progressive movement. In order that the specialist may not be lost in this maze of specialization is it not essential, therefore, that the young men who are today cherishing hopes of making some contribution to this development of science be urged to take the time not merely to acquire a somewhat general acquaintance with, but to really master the outstanding facts and the fundamental methods and principles of the several sciences most nearly related to that in some restricted field of which they expect to labor for years to come?

And will it seem ludicrous to suggest that the world will be the richer if certain individuals of unusual intellectual capacity and brilliancy of imagination could be induced to dedicate themselves to the sole purpose of observing, correlating, and organizing these individual collections of knowledge being dug up by this increasing army of specialists? Unless these widely separated laborers in even a single science and the still more widely separated laborers in the several sciences are brought into a closer mutual acquaintance and can come to some understanding and appreciation of the deeper significance of the results of the labors of all the research workers, or unless we shall be able to find and lay hold of a few super-minds who will be able to unify and harmonize these individual accumulations of knowledge how shall we hope to make much further progress towards that day when men shall know the truth in its larger aspects, the truth that shall make men free?

But we look into the future with confidence. The advance in pure science these past seven decades has been so rapid and the practical utilization of scientific knowledge has been so extensive and so ingenious that the very momentum of this progressive movement will carry us far into the future. We entertain a lively faith that the most astonishing discoveries and applications are yet to come. Towards this end we must have ever increasing specialization but at the same time, in order that we may not be lost in a confusing mass of technical details, we must have at the same time more cooperative and unified effort on the part of the outstanding leaders of the different branches of science. New discoveries will necessitate the abandonment of some theories now regarded as well established but they will likewise bring us new vantage points from which to reorganize all of our knowledge and postulate other theories yet more comprehensive. In this connection we may all take to heart the sentiments expressed by Prof. Robert A. Millikan in one of the Terry Foundation Lectures delivered recently at Yale: "We had not come quite as near sounding the depths of the universe in 1900, even in the matter of fundamental physical principles as we thought we had. Today we can still look out with a sense of wonder and reverence upon the fundamental elements of the physical world as they have been revealed to us in the twentieth century. We know that the childish mechanical conceptions of the nineteenth century are grotesquely inadequate. We have now no one constant scheme of interpretation of physical phenomena and we have become wise enough to see and to admit that

we have none. We have learned to work with new enthusiasm and new hope and new joy because there is still so much we do not understand and because we have actually succeeded in our lifetime in finding more new relations in physics than had come to light in all preceding ages put together, and because the stream of discovery as yet shows no sign of abatement."

And now I would close with a few words of appeal to your spirit of altruism for the title chosen for this very brief address is "the unselfish service of science." The scientist is the laborer and science is the fruit of his toil. In every age there have been at least a few unselfish souls who have endeavored to understand something of the world in which they lived. Moved by the spirit of curiosity and urged by a desire to know they have followed the stars across the firmament, observed the effects and sought the causes of the recurring seasons, taken cognizance of the crumbling rocks, noted the life history of beast and bird and flower, and with kettle and alembic in dark cellars and smoky kitchens they have tried to extract the secrets of herbs and roots and stones. Sometimes this curiosity has been repressed and not infrequently these natural philosophers have been charged with being in league with the devil, reviled as promoters of a black art, branded as heretics worthy of the dungeon and the stake. But from generation to generation, from century to century, at least a spark of this natural curiosity survived and from time to time it burst into flame and lighted pathways through the encircling gloom. And when the truth is known, it must be recorded as an outstanding characteristic of these inquisitive souls, these nature lovers, these men of science, that they labored from no selfish motive, sought only to know, pursued truth for its own sake, and gave freely to mankind what in patient and unremitting toil they garnered from the fields of investigation and research. Galileo, Newton, Priestley, Faraday, Maxwell, Tyndall, Liebig, Darwin, Agassiz, Pasteur, and others of their kind are names revered by every man of science, honored for the persistency with which they followed the gleam, the unselfishness with which they pursued the truth. Has this spirit continued down to our own day? Several years ago a foreign student entered the research laboratory of Ira Remsen and asked to be assigned a problem for investigation. A problem was assigned him and in the course of the research a compound was obtained which proved to have a remarkably sweet taste. The student soon took his departure and in a short time announcements appeared of his having secured patents in this and other countries covering the manufacture of saccharin. A legal friend remonstrated with Professor Remsen for not contesting the patentee's claim on the ground that he himself was entitled to the fruits of the discovery. But Professor Remsen's reply revealed the spirit of the older masters: "I am not pursuing investigations in chemistry for financial purposes but only with the hope of making some contribution towards the development of science."

Is this the spirit of the man of science of our own day? Or has the scientist also become possessed by the spirit of materialism? Are investigations now conceived and experimental data collected with patents

in view? Is the research now prosecuted in feverish haste lest a rival worker be the first to reach the goal and secure the glory? Are men of talent now selling their brains and their scientific skill to captains of industry whose sole interest lies in the development of some new process, product, or method that will insure greater profits on invested capital? There are some who would answer these questions in the affirmative. It is well to remember, however, that it is neither in good taste nor a mark of sound wisdom for one to pass judgment upon the motives of others. It will probably be admitted that in these matters the university professor occupies a rather enviable position. Although his salary may not provide him with all the luxuries of the age, he is free to pursue his investigations along any line whatever that may give him the greatest satisfaction. In the choice of his field of labor he is the most independent man in the world and he is circumscribed only by the limitations of the resources the university may be able to provide. He is at liberty to seek truth for its own sake and he will find great satisfaction in giving to humanity the results of his investigations.

But it will be said that there is not a university professorship in reach of every man interested in science. Quite true, but there are the foundations established and endowed for the purpose of encouraging and promoting scientific research by the aid of liberal grants. Such institutions not only foster pure science but also, indirectly of course, lend encouragement to the conservation of this spirit of altruism. But there are not sufficient foundations to provide places for every one interested in the pursuit of science. Many, therefore, must turn to the doors of opportunity opened by industrial organizations. What is the atmosphere into which they enter and what is their reaction to these conditions? Is it purely a bread-and-butter proposition, a sort of earn-your-salary-or-get-out kind of a situation with research confined to strictly utilitarian ends? Or is there a reasonable degree of freedom with some encouragement for the solution of problems in pure science? Doubtless conditions will differ considerably in different organizations. It must be admitted that any corporation that can produce a Steinmetz, a Langmuir, a Coolidge, and a Whitney is making a larger contribution to the advancement of pure science than many a university. These men have apparently been free to blaze new trails and attack problems of a highly theoretical character and yet while they must be enrolled among the brilliant contributors to pure science, unquestionably they are also a tremendous asset to the corporation they are employed specifically to serve. Such a position for service may be regarded as a more ideal one than that of a university professorship.

But even granting that the research men in the laboratories of our industrial corporations must confine themselves largely to problems having a direct bearing on the practical applications of science, are they not in the end rendering a service to the general public, to humanity if you please, and not merely to themselves or to the stockholders of the corporation? Is it not possible that even these men are actuated by

the spirit of altruism and that the fruits of their labors may rightfully be credited to the unselfish service of science?

A college youth of some eighteen or twenty summers heard his chemistry professor state that any one who would discover a practical way of obtaining aluminium in quantity would confer a benefit upon mankind and reap a fortune for himself. The youth resolved then and there to attack the problem and to stay with it until it was solved. He accomplished his purpose and accumulated a fortune. Professor Richards of Lehigh University is responsible for the statement that "one of the greatest metallurgical achievements of the nineteenth century was the addition of aluminium to the metals of every day life." The world is richer from Hall's process of extracting aluminium from the earth; need we attempt to weigh his motive in the moral balance?

A short time ago it was announced that a certain copper plated alloy of iron and nickel had been found to be a perfectly satisfactory substitute for platinum in making electrical connections through glass. This knowledge did not come over night but was the result of a long series of experiments suggested by certain principles of physical chemistry and carried out with a view to meeting an urgent practical need. Shall we convict the physical chemist of selfishness and greed, or commend him for a public service?

Recently there was successfully laid the twentieth transatlantic cable—the New York-London cable—but the event was not marked by the beating of drums or the blare of trumpets. And yet there is something quite distinctive about this cable for its copper core is wrapped with a tape of "permalloy," another alloy of iron and nickel, an alloy having thirty times the magnetic permeability of soft iron. This makes it possible for the copper core to carry messages eight times as fast as any other ocean cable. Now this remarkable alloy was not the product of a dream or the result of an accident but resulted from investigations carried on by the research engineers in the laboratories of the Western Electric Company. Admitting that these investigations were conceived and executed with a practical end in mind and that some corporation will receive considerable profit from the discovery, does not the benefit it confers upon the public far outweigh the profits to the company? Are we justified, therefore, in charging the research staff with the sale of their scientific skill for selfish aims? On the other hand, is it not another example of the debt of gratitude the world at large owes the man of science, and is the obligation less weighty because the scientist has endeavored to serve the world by the solution of a problem admittedly of a utilitarian character?

In a recent address before the American Chemical Society, Irénée du Pont made this statement: "In a case, the details of which are known to me personally, a company employed men for several years and finally brought out a new product which saved the public many millions of dollars. Out of each hundred dollars saved by the invention ninety seven dollars were passed to the public, two dollars and seventy cents were passed to the pioneer company, and thirty cents to the men doing the

work in recognition of their success. This case is probably fairly representative, though the public believes that both the company and the men instrumental in bringing out the product have been most generously rewarded."

During the past two years your speaker has come in almost daily contact with a student who each morning injects into his arm a bit of insulin. This daily act stands constantly between this young man and death. Shall we in the name of pure science ascribe to Dr. Banting the glory of a great discovery and on the other hand charge with selfishness the corps of scientific workers in the pharmaceutical plant that has made insulin available to thousands?

Not infrequently it is deplored that so many men of conspicuous scientific ability are leaving university laboratories to accept positions in industrial plants, the implication being that they have forsaken an honorable career, the pursuit of science for its own sake, and bartered their knowledge and training and skill for a mess of pottage. To those who take this attitude towards the men of science in industry there will come some consolation from the observation that there appears to be a trend in the other direction since, during the past few months, five men of prominence in our own country have left industrial fields to accept university positions.

But after all has been said is not the accumulation of knowledge, the discovery of truth, only the first act in the great drama of human progress? Knowledge is of value only so far as it is put to practical use. It may be of considerable interest from a purely scientific point of view to know the life history of the typhoid bacillus but it is of far greater importance to apply that knowledge in preventing the occurrence and spread of typhoid fever. And here it might be said that since scientific discoveries may be utilized for either constructive or destructive purposes, the true man of science is he who takes no thought of the possible ultimate results of his discoveries but labors on with the sole purpose of finding the truth. 'Tis his to play the first act of the drama. The curtain falls and when it rises again, 'tis the man of applied science who occupies the center of the stage; and he may be hero or villain for dynamite may open roadways through mountain barriers or shatter cathedrals into dust.

But may we not revise the drama, reconstruct the play, and direct it towards a happier conclusion?

Sir Richard Gregory has well said: "When scientific work is instituted solely with the object of securing commercial gain, its correlative is selfishness; when it is confined to the path of narrow specialization, it leads to arrogance; and when its purpose is materialistic domination, without regard for the spiritual needs of humanity, it is a social danger and may become an excuse for learned barbarity."

For more than half a century the world had become increasingly impressed with the beneficent results of the development of science and then suddenly, without the slightest warning, it was given an appalling exhibition of the applications of science for purposes so destructive as to threaten the very foundations of civilization. Perhaps it was in

contemplation of this colossal waste and destruction that President Angel was moved to state a fact and voice a prophecy in these words: "Strangely enough, the scientific mastery of the facts of man's own nature and the laws which control society linger far behind the corresponding insight into the nature of the processes of the physical world. But surely it is only a matter of time when these social sciences, so called, will also have perfected a technique enabling man to secure mastery over himself and his social relations comparable with that which has begun in the control of physical nature."

Is it sufficient for men of science to reply: "'Tis ours to discover the truths of physical nature; let others teach men wisdom and justice and beneficence in the application of her laws"? Shall we not rather expect of men whose ability to discover truths in the physical world has its very foundation in the spirit of truth within themselves, something more than a merely cold intellectual interest in natural phenomena? Shall we not expect of them such a spirit of humility, altruism, and self-sacrifice, born of this spirit of truth and expressed in the spirit of service, as will point the world to a better way of living? Has this not been true of the great men of science in the past, and shall it not be increasingly so with all men of science in the future?

It is to the *unselfish service of science* that we owe our present, still far from complete, control of natural forces, our increased span of human life, our comparative freedom from plague and pestilence, our agencies of relief in time of physical suffering, our means of rapid communication and intercourse, our agencies for the ready diffusion and dissemination of knowledge, and the material comforts and luxuries which soften the asperities and provide the adornments of human living. In all reverence I express the conviction that when the spirit of true science shall have become more completely infused into all races and all classes a great impetus will have been given to the coming of that day visioned by the great Teacher when he went forth "to preach the gospel to the poor, to heal the broken hearted, to preach deliverance to the captive, and recovery of sight to the blind, to set at liberty them that are bruised, and to preach the acceptable year of the Lord."