of this society seems to be a very timely one. Recently we have been hearing frequently of other large societies who are dispensing with their annual meeting for the duration of the war and who are substituting other means of carrying on their function. With the American Federation for Clinical Research, if it becomes desirable, or even necessary, to eliminate the national meeting for the duration, the local research clubs can and should carry on, to maintain an interest in investigation and to take the place of the annual meeting.

According to the policies of this organization, the dues have been set at the maximal figure of one dollar a year. This is to pay for necessary correspondence in the society and for printing the program of the annual meeting. With an adequately large membership a dollar a year should be sufficient. However, with the work carried out in the formation of this new society our funds have not been adequate. The secretary requires more help, so it becomes necessary to increase temporarily the dues, which were set at $2.00 a year. After the treasury contains adequate funds, and when our national membership becomes large enough, the amount should be reduced to that which is just sufficient to carry on the necessary program.

These then are the simple principles upon which the American Federation for Clinical Research is founded and upon which it must prosper. I know that numbers of members can not be here to-day because of military service, and undoubtedly we will be hampered in our growth and activity during the period of this war. But prosper it will, if these simple principles are adhered to rigidly. That there is a definite place for such a society as ours is attested by the fact that it has met with a great deal of enthusiasm and by the fact that other societies have started out along somewhat similar lines, but in the course of time have made themselves complicated and out of reach of the majority. Furthermore, in complicating their organization some of the other societies have lost sight of what they set out to do, namely, to stimulate interest in and to give a place to those who are beginning in medical research. Let us hope that the American Federation will always abide by these principles and remain a society whose prime purpose is the stimulation of investigation among the younger members of our profession.

RESEARCH LABORATORIES IN INDUSTRIES[1]

By Dr. O. E. BUCKLEY

PRESIDENT, BELL TELEPHONE LABORATORIES, INC.

INDUSTRIAL research is my own line of work, so perhaps I can best illustrate it and tell how it has grown by choosing an example from the field with which I am connected, that is, telephony.

There is scarcely any feature of telephony that has not been the subject of research in Bell Telephone Laboratories. Take, for example, the telephone receiver that you hold to your ear when you use the telephone. It is just one of a large number of devices that work together to make up the complex telephone system of to-day. It is a little thing, about the size of a watch, and very simple in construction, but there are embodied in it many great scientific achievements.

The present telephone receiver is a direct descendant of the original telephone invented by Alexander Graham Bell. Bell wound some insulated wire around an iron bar, mounted an iron reed close to the end of the bar and so made the first telephone receiver to convert electric currents into sound waves. You will find these same basic elements in the telephone receiver of to-day. The iron bar has evolved into two pieces of permalloy welded to two pieces of remalloy. Permalloy is an alloy of iron and nickel very easily magnetized. Remalloy is an alloy of iron, cobalt and molybdenum, which makes a good permanent magnet. The iron reed has become a diaphragm of iron, cobalt and vanadium which has other desirable magnetic properties. These are only three of the fourteen special materials which go into the modern telephone receiver. Each of these materials is the product of painstaking investigation, not just testing to select the best materials from those available, but research to discover all the hidden factors that determine behavior. The shapes and dimensions of the parts of the receivers are as important as their composition. Simple though the structure is, the design of the telephone receiver called for intricate mathematical analysis, and to test its performance required the devising of new methods of measurement. There even went into its development a study of the nature of speech and an understanding of the physiology of the ear.

Bell was a researcher as well as an inventor when he devised the telephone. He was then studying the nature of speech. He was, if you please, carrying on a kind of industrial research, but of a very different pattern from that of to-day. Bell himself had a good working knowledge of the essential science of his

[1] World-wide broadcast of the American Philosophical Society and WRUL, Philadelphia, July 10, 1942.

time. Now, the bounds of science have extended so far that specialists in many fields—acoustics, magnetics, metallurgy, mathematics, chemistry and even physiology—work together to perfect the instrument which Bell invented almost single-handed.

Bell worked with one assistant in an attic room. To-day, Bell Telephone Laboratories, in great buildings, employs 2,000 engineers, physicists and chemists, plus as many assistants doing drafting, mechanical and other service work, to advance the art of electrical communication that has grown from the original inventions of telegraph and telephone.

We have gone from the era of the individual inventor to the era of industrial research. All the mechanical marvels which have revolutionized our lives—the electric light, the automobile, the airplane, talking pictures, radio broadcasting—as you know them to-day are products of industrial research. They are not inventions, not just bright ideas, though they may have got their start as such. They have evolved from painstaking, deep-searching, scientific endeavor.

This applied scientific endeavor is what we call industrial research. It has been brought about by drawing into industry men of inquiring and capable minds versed in the latest discoveries of physical science and trained in the art of uncovering new scientific knowledge. Among them are those who call themselves physicists, chemists and engineers, but they are more than ordinary ones. They are the practical-minded explorers in those fields who can work in teams and aid one another in their efforts. These groups of industrial research workers are mostly to be found in the research departments of industrial corporations, large and small. In some cases, groups of corporations have joined together in trade associations to support industrial research laboratories. In some cases, groups are supported and operated by the government. Some of these groups deal only with immediate practical problems; and some devote part of their efforts to penetrating the very frontiers of science, uncovering new knowledge so that it may later be practically applied.

In the United States, where industrial research has had its greatest growth, there are more than 2,000 industrial research laboratories employing over 70,000 trained workers. Research laboratories are now maintained in nearly all industrial fields, and there are many new industries which got their start in the research laboratory. Truly, industrial research has become one of the major forces in American industry.

This development of industrial research has occurred in a very brief period of time. Almost all the industrial laboratories in the United States were founded after 1900, and most of them within the past two decades. During this period their growth has been at an astounding rate. Its effects on industrial practices and products have been revolutionary.

What are the factors that have made this change in the industrial picture? There are two that seem to me to stand out. They are: the ever-expanding stock of scientific knowledge and the increasing supply of scientific workers.

Prior to 1900, scientific research was conducted almost wholly in universities and chiefly as a part-time activity by teachers of science whose efforts were primarily to increase scientific knowledge so as to gain a better understanding of the workings of nature without particular regard to applying the results of their research to practical needs. New devices in industry were largely the result of individual inventive effort. The independent inventor could carry in his own mind all the world's knowledge in his particular field. Bell was fully versed in the acoustics of his day, as well as in electricity and magnetism. Edison was well versed not only in the electricity and magnetism of his day, but in chemistry as well, though he had only elementary schooling.

To-day the range of scientific knowledge is so wide that no one person can comprehend thoroughly a very wide sector of it. There is no such person as an up-to-date general chemist. There are physical chemists, organic chemists, electro-chemists and other kinds of chemists. Similarly, there are varieties of physicists and engineers. Indeed, on the frontiers of science one can know only a very small sector. Hence, to make practical advances in the complex mechanisms that we deal with to-day, we must put together intelligently knowledge from many fields of science, and this requires that scientists from all these fields pool their knowledge and combine their efforts.

Scientists are drawn by the industrial laboratories from the graduate schools of our great universities and, as I said, the supply of these scientists has been one of the major factors in the development of industrial research.

In the preceding era, that of invention, the supply of new scientists was scarcely adequate to meet the demand for teachers of science. Even up to 1920 in the United States, universities and colleges absorbed for teaching purposes nearly all their output of man-power trained in and adapted for scientific research. A few industries were wise enough to see the need for applying to their own problems the methods of inquiry of the science departments of the universities. They employed a few outstanding university scientists, and as the supply of students became more than large enough to fill educational demands, young scientists were drawn into employment in industry. Those who made themselves effective there stimulated the demand for more, and soon made the opportunity in industrial research quite as attractive as that in academic research. Thus came about the rapid expansion of industrial research of the last few years. This is a movement which we can expect to see repeated in many parts of the world where industrial research is still at an earlier phase of evolution.

This influence of the availability of scientists is interestingly illustrated in the chemical industry in Germany. In the early nineteen-hundreds the German universities turned out many more trained chemists than could find employment in teaching. These sought employment in industry, where great numbers were put to work in organized industrial research. The results of their efforts contributed to the tremendous technical advantage of Germany prior to the first World War, particularly in the field of organic chemistry. Since then the tables have turned, and the advantage in industrial research even in this special line is no longer with Germany. Nazi domination has stultified her science and has diverted its aims to the destruction of man rather than to his welfare. She has forced the rest of us to divert our aims in industrial research to her own destruction.

To-day, our great laboratories are engaged almost wholly in devising tools to destroy the anti-social, anti-scientific forces that threaten to stop the progress of scientific endeavor throughout the world.

When that task is done, industrial research will revert to its peaceful pursuits. As education in science expands, more workers in more lands will join the ranks of explorers who are widening the bounds of human knowledge. A new and larger crop of young scientists will bring forth the products on which new industries will be built. The welfare of all will be advanced to the detriment of none. Science demands a free world, and the workers in science will win it.

OBITUARY

FRANCIS RAMALEY

FRANCIS RAMALEY came to the University of Colorado in January, 1898. In his death on June 10, 1942, his adopted university, community and state lost one who had for forty-four years given unselfish service and loyalty. He left a permanent impression for good on the organizations with which he was associated, and his fine personal qualities will always be remembered by those who knew him.

Francis Ramaley was born at St. Paul, Minnesota, on November 16, 1870. He received his bachelor's and master's degrees from the University of Minnesota in 1895 and 1896. From 1895 until 1898, when called to the University of Colorado as assistant professor of biology, he was instructor in botany at the University of Minnesota. He received his Ph.D. degree from the University of Minnesota in 1899. In April, 1900, following the resignation through ill health of Professor John Gardiner, his predecessor at the University of Colorado, he was appointed professor of biology. From that time until his retirement in 1939 he was responsible for the administration of the department of biology.

Among other responsibilities which Professor Ramaley assumed during this period were those of acting president of the university in 1902, acting dean of the College of Pharmacy from 1917 to 1919, and acting dean of the Graduate School in 1929 and again from 1932 to 1934. He was editor of the University of Colorado Studies from its establishment in 1902 until his final illness this year, this appointment having been continued after his retirement from regular teaching duties. He was secretary of the Arts and Sciences Faculty for twenty years, and was a member of many important committees, some of which were extremely important factors in shaping the development of the university. In large part through his influence, chapters of Phi Beta Kappa and Sigma Xi were organized at Colorado at a time when the institution was still relatively small, the years of establishment of these chapters being 1904 and 1905, respectively. His good judgment was valued by his colleagues in both administration and teaching. Through a natural reserve he was averse to giving advice and help when it was not requested, but those who knew him best did not hesitate to ask for it. His advice was valued not only for its inherent worth but for the spirit of generosity with which it was invariably accompanied. Professor Ramaley never made one feel that he begrudged the time devoted to helping others.

In the classroom Professor Ramaley's lectures were marked by careful organization and perfect clarity. He maintained high standards of achievement and thoroughness, but presented the subject-matter in such a way that the most difficult aspects seemed simple. In spite of other responsibilities, he always assigned himself an average or above average teaching load. Nor was this delegated to others. He even graded his own quiz and examination papers. This was but part of his effort to treat students with complete justice. A few of his advanced students and colleagues have had the rare opportunity of extended field trips with Professor Ramaley. It was on such occasions that his qualities of good humor, patience and friendliness were much in evidence. I shall always look back with pleasure to a week in the San Luis Valley with Pro-