What We Found Behind the Scenes in European Research: [Observations on the Tour of Forty Research Laboratories in England, France and Germany (1937)

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FIRST ANNUAL

Reunion Dinner

OF THE

NATIONAL RESEARCH COUNCIL
EUROPEAN LABORATORY TOUR

THE WALDORF-ASTORIA

Friday, October 29, 1937

Mr. Chauncey L. Williams, *Presiding*

PICTORIAL MOTION PICTURE OF THE TOUR
Edited by Mr. Richard T. Leatherbee

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"HOW WE PUT THE RESULTS OF THE TOUR TO WORK"

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An Industrial Executive's Viewpoint - - - Mr. Junius D. Edwards

Research and National Life - - - - - - - Mr. Maurice Holland

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Guest of Honor

Doctor Vannevar Bush
Chairman, Division of Engineering and Industrial Research,
National Research Council

. . . MENU . . .

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Chilled Honey Dew Melon with Lime

~

Petite Marmite Henri IV

Golden Croutons

~

Celery Olives

~

Saddle of Lamb Persillé

Red Currant Jelly

New Peas with Mint Anna Potatoes

~

Autumn Salad

~

Coupe Monte Carlo

Fancy Cakes

~

Demi Tasse

WHAT WE FOUND
BEHIND THE SCENES
IN EUROPEAN RESEARCH

WHAT WE FOUND BEHIND THE SCENES IN EUROPEAN RESEARCH

WHEN, EARLY IN 1937, Maurice Holland said there was to be a Tour of European Research Laboratories and that he would take behind the scenes those fortunate enough to go, many thought it would be a somewhat leisurely and interesting tour —more in the nature of a Cook's tour than anything else. But they didn't know enough about kinetic Maurice and the plans he had laid so solidly six years before.

Those who thought the scenery would be mostly out of doors, and those who pictured a vacation were all wrong! It turned out to be the real work of meeting dozens of boat, bus and train schedules, of walking, observing and thinking all day long, and of visiting forty research laboratories in twenty-seven working days in Europe. The boat trips—once a hope for rest—were also almost strictly business because of organization meetings, a panel discussion with Alexis Carrell, visits to bridge and engine rooms, and the speed of express liners—Normandie, Europa and Bremen.

We travelled 10,000 miles; we saw far behind the scenes; we saw all we wanted to and sometimes more. The trip was a glorious adventure and successful in every way. It was an intelligent use of time and money and an experience that no tour member will ever forget.

It would be ungrateful not to mention the splendid hospitality of our hosts and sub-hosts in all three countries—Lord Rutherford, Undersecretary Jean Perrin and Doctor Matchoss especially. Dinners and luncheons were uniformly excellent and glasses were perpetually full of choice vintages. The high spot in this line was the luncheon on June 11th at the Ministère des Affaires Étrangeres.

But what has happened since? What did tour members bring back and how did they put it to work?

This booklet includes copies of observations, reports and articles received to date and edited, more or less, by the compiler. The authors have been promised a limited and numbered edition. Their modesty or trust prohibits republication or any other than your confidential use unless, of course, you get their permission.

CHAUNCEY L. WILLIAMS.

New York, October, 1937.

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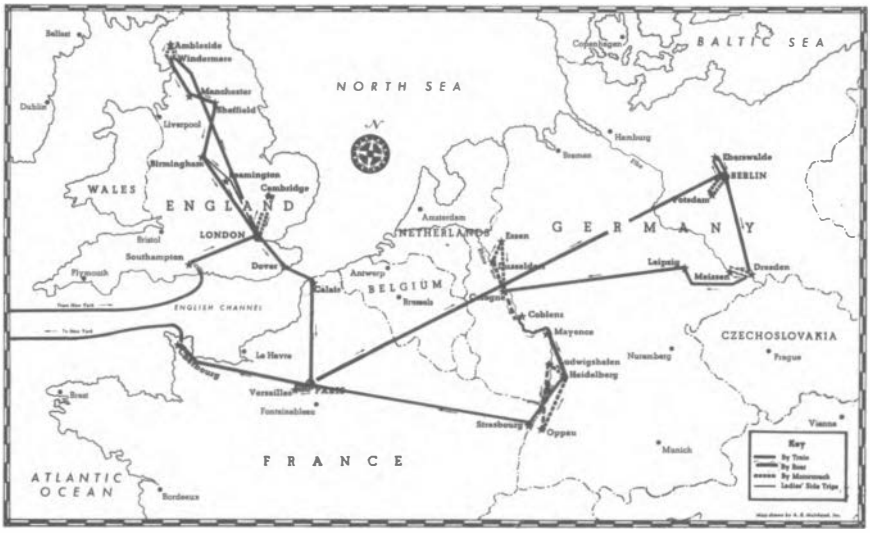

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RESEARCH CONSCIOUSNESS AMONG LEADING INDUSTRIAL NATIONS

Edward R. Alexander

ONE OF THE VITAL QUESTIONS of this age is how far national governments are what we may call research-conscious in scientific and industrial fields.

Those in closest touch with the trend of events in our modern world have become convinced that the extent to which each nation is alive to the importance of scientific research and its practical application will determine largely the degree of its economic security. And—the degree of its economic security will, in turn, determine the measure of its good-will with the rest of the world.

Let us see, then, what the history of the last few decades has to show us of the attitude of four of the world powers on this vital question of scientific and industrial research, namely, the United States, England, France and Germany.

It was not until the World War that the United States government began to consider the importance to the nation of scientific and industrial research. Just before we became involved in that war, President Wilson took under consideration what our government might do to assist or encourage research in industry. Various industries of this country, on their own initiative, had already developed their own research laboratories. Research divisions were operating in a number of our universities with gratifying success, usually assisted in their enterprises by industry itself, while several important independent research laboratories had been created and financed by interested individuals.

The Bureau of Standards at Washington prior to the War was one of the few government-fostered institutions contributing directly or indirectly to scientifie research, and this without broad contact with industry generally. Thus it will be seen that practically all of the research work in the United States up to that time must be credited to private initiative and foresight.

During the Civil War, President Lincoln, recognizing the growing importance of applied science in industry, had encouraged Congress to create by Congressional Charter the National Academy of Sciences. This Academy is largely of honorary nature, consisting of distinguished American scientists elected by their colleagues and limited to two hundred and fifty in number. It serves in an advisory capacity to the United States government upon request of department and bureau chiefs.

President Wilson's active interest gave impetus to the establishment of the National Research Council, which is a co-operative organization of scientific and technical men of America. Its members include also business men interested in engineering and industry. Established under the auspices of the National Academy of Sciences, it enjoys the co-operation of most of the major scientific and technical societies. Its membership is largely composed of representatives of eighty of these societies. The Council was organized in 1916 to co-ordinate the research facilities of the country for work on war problems. In 1918, by executive order of the President of the United States, it was reorganized as a permanent body, for the

promotion of scientific research and of the application and dissemination of scientific knowledge for the benefit of the national strength and well-being. Its administrative expenses are largely paid from an endowment provided by the Carnegie Foundation. In most cases actual research work must be financed by interested industries or from other than government sources.

The United States government has not provided and does not now provide funds for the carrying on of this important work. So we begin to see that we have a government that is not research-conscious.

England during the War found itself short of many important goods which it had been relying essentially on Germany to supply, such, for example, as magnetos for igniting internal combustion engines, optical glass of various characteristics and dye-stuffs. The War over, England's government, by then definitely aware of the importance of the application of science to industry, began to create and subsidize numerous research institutes whose work it considered would be of vital importance to the future of the nation. Among these were the Cotton Research Institute at Manchester and ones for fuel, rubber, leather and building research, near London.

Prior to this, about 1900, at Teddington, outside of London, the National Physical Laboratory was formed under the control of the Royal Society. Its purpose was to carry out research especially required for the determination of physical constants and to establish and maintain precise standards of measurement and to make tests of instruments and materials. Until 1918 its activities largely corresponded with those of our Bureau of Standards, then it was made a part of the newly established Department of Scientific and Industrial Research, whereupon it became more actively engaged directly than theretofore with various industries of the Empire in the solution of important scientific and research problems. England had had for many years large research operations undertaken by certain of her industries on their own initiative, such, for example, as the chemical, electrical and metal industries having close operating relations with corresponding industries of Germany and the United States and has, through some of her university laboratories, like Cavendish at Cambridge, reached the very pinnacle of pure research achievement. When, however, the British government after the War began the creation and maintenance of state-subsidized research laboratories for certain industries, it cannot truthfully be said that industry in general in England was research-conscious, and undoubtedly some of the State Research Institutes experienced difficulty at the start in getting industry co-operation, particularly among the older industries, largely family controlled and quite self-satisfied as was to be humanly expected with empirical formulas of manufacture upon which their respective experiences, knowledges and judgment acquired through the years, were largely based. But England has had an outstanding good fortune. She succeeded in selecting for the directors of her state-created laboratories men of great foresight, executive and organizing ability, inspirational force and personal charm. They were able quickly to surround themselves with loyal, hardworking and competent staffs of associates, and today they have the wholehearted co-operation and support of the industries in which they are so effectively helping to point the way. Visiting one or all of these laboratories, you come away with one idea uppermost in your mind, having to do with a save-the-nation incentive which motivates every man and woman of each laboratory staff. England grows less than fifteen per cent

of her foodstuffs necessary for national sustenance. For the balance thereof she must exchange goods in the international markets. With France, Germany, Japan and the United States among others, competing with her in those markets England must rely on efficiently directed and applied research *to live.*

In France an entirely different situation prevails. She is practically self-sustaining so far as food is concerned. It is a question if the French government, other than from time to time, is definitely research-conscious. Undoubtedly Ex-Premier Blum was, for French scientists are his friends and they have in him a sympathetic listener. And who would not always be glad to listen to a French scientist, a man completely inspired by his devotion to the seeking out of the laws of nature, a fervent disciple of Pasteur in his devotion to work, and such a brilliant conversationalist that he completely enraptures you with his sheer exuberance of spirit and happiness resulting from his scientific contributions to mankind. But, alas, is he really appreciated in his own country? Apparently the French industrialist does not know of or believe in constructive co-operation in industry in any such measure as we know it in this country. Only recently the French government has felt called upon for national safety's sake to buy up all of the principal airplane manufacturing companies in France. The inspirational director of one of the outstanding government laboratories in France advised us that French industry did not freely cooperate with his institution and that he did not have free access to any of the industrial laboratories in his country. We came away from France in love with the French scientist and deeply grateful to him and to the French government for the many things they did to make our visit there so interesting and instructive.

Of the four governments above-mentioned, the German alone recognized the importance of research in science and industry before the World War. In the early part of the nineteenth century, Von Humboldt had laid down the necessity of encouraging research in Germany free of restraint of any sort. About 1870, almost coincident with the Franco-Prussian War and the creation of the German Empire, the open-hearth process of making steel was invented. Germany's iron ores were of too low grade for successful use commercially in earlier steel-making processes. Her major industrial progress dates from the invention of the open-hearth process, which gave her good, cheap steel. Her scientists henceforth were encouraged by the application of their discoveries and inventions to the up-building of her great steel, electrical and chemical industries, the latter including dye-stuffs.

The government of Germany, however, apparently did not begin to appreciate the true value of scientific and industrial research until Von Harnack, a disciple of Von Humboldt, succeeded about 1910 in getting the ear and financial backing of Kaiser Wilhelm II. Then Germany, as a government, began to become really research-conscious with the result that a number of research institutes were created, of which the earliest, established in 1911, were those for chemistry, physical and electro-chemistry and biology at Dahlem in the outskirts of Berlin. Since then, upwards of thirty such institutes have been started, fostered and maintained by the government and industry jointly.

In Germany today, we find a government which is, above all, work-conscious, and which is successfully teaching the nation that the real rewards of life come through *work*. And, consequently practically everybody in Germany is at work. The present government is distinctly research-conscious. Within the past year it

has promulgated what is commonly referred to as the "New Thought Movement." This comprehends the idea that the cultural future of Germany lies in the application of science to industry and the arts of life. The German scientist has become completely re-inspired. When he addresses you, you feel that his innermost soul has been released, that hope again springs eternal from his mind and that he looks to the future with confidence reassured. The German people is being shown what the nation has accomplished through the application of science to industry by means of inspiring expositions most carefully planned to appeal to the mind through the eye. So that not only are the people being taught the vital importance to the nation of *work*, but also that the cultural future of the nation resides in mass co-operation with industry and science in the application of science to industry. And why, under such conditions, should not the people become research-conscious, with artificial rubber, artificial leather and gasoline and oil from coal now available to it and artificial wool from beech trees and artificial silk from pine roots and synthetic fats practically ready for the market? Germany grows upward of eighty per cent of the foodstuffs necessary for national sustenance. She only has to exchange goods in the international markets for about seventeen per cent of such foodstuffs in order to live, and she is rapidly gaining confidence in the ability of her scientists and industrialists to insure any such exchange that may be necessary.

To sum up, in England, today, the government is research-conscious, and industry is increasingly so. For the nation as a whole,—which lives so much in the past and which has placed so much of a social handicap on work throughout its history,—it would be difficult to estimate or prophesy in regard to the people's attitude toward research. In France, you see the pure scientist at his scintillating best, and he is seen very clearly indeed—outstandingly so, in fact, for the very reason that he appears quite alone, receiving apparently touch-and-go encouragement from government and little co-operation from industry. In Germany, both government and industry are research-conscious, and the nation is rapidly becoming so.

As for the picture in the United States, only industrial organizations, scientists, engineers and those constituting the staffs of university, government and private laboratories are essentially research-conscious. The government is not; the mass of the people is not. Will it require another World War to make our government research-conscious?

If it desires to become so before such another catastrophe, it might well profit by a study of England's government-created research institutes—the cotton and the fuel, for example, and in mentioning these two specifically no reflection in the slightest degree upon any of the others is intended. It might examine the work of the institutes of optics and welding in Paris, the only ones we saw in France where the government and industry co-operated directly with scientists. And—it might look into the many outstanding government-created institutes in Germany, notably the Iron and Steel at Düsseldorf, which insures Germany's future in steel; the Silicate Institute at Dahlem, responsible for keeping Germany in advance in optical glasses and automobile roads, among other things, the Wood Research at Elberswald, which keeps the nation in a dominating position with products from forestry—and last but by no means least, the Diesel Engine Laboratory at Dresden, where apparently real history is in the making.

EUROPEAN RESEARCH TOUR

Perrin N. Collier

THE MOST STRIKING IMPRESSION I received from the National Research Council's tour of European industrial research laboratories was the remarkable advances that have been made in practical research and in its application to industry, its products, methods and problems. Some of the finest laboratories in England, France and Germany were opened to our party. We saw research, as it is being carried out in all kinds of industry, in connection with chemical processes, metallurgy, aviation, rubber, leather-research, glass manufacture, Diesel-engine research, textiles and in the fields of pure science.

We were amazed to see the extent to which industry in the countries we visited is sponsoring, encouraging, financing, and using its research activities. There was evident everywhere a close relationship between those engaged in research study and those engaged in industry itself. We investigated research in several forms, some of it being subsidized by the governments, wholly or in part; some being conducted by co-operative organizations within the industries affected; some being carried out by private corporations. Everywhere we saw evidence that industry abroad has for years accepted research as an essential tool of industry. The recognition it receives is demonstrated by the large sums of money being expended for research, privately and co-operatively; by the character of equipment provided for this work; and by the high caliber of the men engaged in it, who obviously command the respect and attention of the men in industry.

Patience and Faith in Research Evident

We were struck, also, by the universal attitude of patience and faith in research demonstrated by those who support and use it. Sir Robert Pickard, head of the Shirley Institute, which is perhaps the outstanding cotton research organization in Europe, stated that he felt that 10 years is not too long a time to await results of a fundamental research project. This organization maintains a full-time staff of 300 trained men, and over 90 of these are recognized scientists with college or university degrees. The Shirley Institute further maintains large laboratories for scientific study of the cotton fiber and its processing, and operates as well a well-equipped practical mill laboratory for actual operating tests. In addition to their research activities at the Institute, the staff is available for study of day-to-day mill problems submitted by the member mills. In addition, they maintain the closest contact with the every-day operation of the members' plants. In visiting some of the cotton mills in England, it was very evident to me that the methods and systems worked out by the Shirley Institute are being used in actual practice by the manufacturers.

While we were visiting Shirley Institute, we saw in process a number of practical mill problems being handled by the staff; for example, a mill had submitted a sample of ribbed cloth that was wearing unduly from laundering. Thorough

tests demonstrated the need of better cotton in the ribbed portions, which received the severest strain in laundering. The report of the Institute resulted in a correction of the trouble.

For the inspection of cloth for defects, the Institute maintains a most complete department, furnished with snow-white walls, with indirect lighting reflected back from the walls; and equipped also with ultra-violet lighting, and with spot-lights in the corners of the room which throw slanting rays from different angles on the cloth being examined. It was remarkable to note the effect of these different types of light in looking at a sample of cloth. I mention this only as an inadequate illustration of the methods and thoroughness of the practical research work being done at the Institute.

Everyone in our party—and we represented a great many different kinds of American industry—was particularly impressed by the fact that practically everywhere we visited, in all three countries, we encountered many engineers and scientists who had spent a great deal of time in the United States, studying not only our research, but our manufacturing and processing as well. We found many of them exceptionally well-posted on our own methods and practices, in all of the major industrial fields.

In England I had the pleasure of renewing acquaintance with Mr. Alexander F. W. Coulson, who spent 12 months in the United States several years ago, as a research fellow of the Shirley Institute, devoting his entire visit to a study of cotton manufacturing in detail, and specializing on the particular subject of methods and speeds used in American mills in twisting yarns. The report he made to the Institute members was a comprehensive study of American mill practice. Mr. Coulson is now a director of a large English spinning and twisting mill, and in his own research on cotton fiber and processing methods is carrying out thorough tests of his own and working closely in conjunction with the staff of the Institute and its facilities. I take the liberty of mentioning this specific case as an illustration of the thoroughness of the work of the Institute and of its intimate working relationship with the industry itself.

In every country we visited, particularly Germany, which is now operating under a strict nationalistic policy, we found research laboratories and mills expending much time and effort toward the development of satisfactory synthetic fibers to substitute for cotton. Incidentally, almost every textile man I encountered had strong criticism of "false packing" in the cotton received from America. This seems to be a paramount complaint abroad of the cotton they are importing from the United States.

In France we paid a visit to Madame Curie, daughter of the world-renowned co-inventor of radium, and in her own right a distinguished French scientist who is devoting her talents to research. One of our party told Madame Curie that he was engaged in research work, and would appreciate any suggestion as to how he might best direct his efforts, and we were all forcibly impressed by her significant reply. "Why," she said, "you simply can't *direct* research; you must let research direct *you*."

The schedule of the research party was so full that little time was available for visiting cotton mills, but I did have the privilege of going through three mills in England, and two in Germany. One of the English mills was the Dunlop Cotton

Mills, Ltd., operated by the Dunlop Tire and Rubber Company. This plant is the "largest cotton mill in the world under one roof." It has 286,000 spinning spindles, making yarns from 2 to 36-ply; it is housed in one large seven-story building, with two large one-story sheds. The twister (doubling) room contains 3¼ acres of floor space, and the twisters require 2,000 h.p.

Visits to English and German Textile Plants

A great percentage of the English industry is located in the Lancashire section, of which Manchester is the center. This section was selected because of the naturally humid climate, and in those mills I visited (other than Dunlop, which is relatively new) humidifiers were the exception rather than the rule. The English mills use a much larger percentage of female labor than we do in the United States; I was told the percentage of the labor force is between 80 and 85 per cent female, and they are for the most part younger women. There are no mill villages, as we know them, in England, the help residing in privately owned tenement buildings in the mill centers. It is a custom for the operatives to wear wooden shoes with hob-nails (called clogs); and on a change of shifts it is quite a sight to see and hear them cluttering down the street in these clogs. The working time in English mills is 48 hours per week; a large number of the mills are running two shifts.

Trade unionism has advanced to a high degree in England, and wages, hours of works, duties of jobs and work assignments are all governed by rules by which all mills must abide. Work assignments there seem to be about in line with ours —a spinner on 8s yarn attends 12 sides, for example—but their wage rates may be said to be about half of ours. I saw no long draft spinning, except in experimental stages, in the English mills I visited, and no evidence of long draft roving.

In Germany I saw two mills—one a spinning plant of 300,000 spindles, and the other a weaving mill with 150,000 spindles. These are in Augsburg, in Bavaria. The larger mill was celebrating its 100th anniversary when I was there. I was greatly interested to find that this mill maintains a complete village, composed of stucco flats; they have more than 400 units in these flats. The village maintains as well ample school facilities, an adequate bakery and dairy and a home for retired workers.

As a result of our tour of the research laboratories in England, France and Germany, I returned home with a new conception of the achievements of research in those countries, and with a firm conviction that industry of all kinds in the United States can reap handsome returns from research, patiently sponsored, adequately financed, properly directed and intelligently related to the problems of industry. Textile manufacturing in this country is lagging, in comparison to the industry abroad and in relation to newer industries in this country and over there, in acceptance and application of the benefits of research, privately and as an industry. We have no more than scratched the surface, and I am convinced that a fuller recognition of research and an application of it to our work will pay us great dividends.

EUROPEAN LABORATORY TOUR IMPRESSIONS

R. C. Harris

THE EUROPEAN TOUR OF LABORATORIES in England, France and Germany, arranged under the auspices of the National Research Council, provided most unusual opportunities for observing the methods prevailing in the countries visited and discussing the progress and results of research with those directing not only the programs of work in the laboratories but, to a large degree, also the trends of thought in a national way on the subject of industrial research.

The history of the advancement of nations industrially seems to show that the rate of advance depends largely upon the thoroughness of their organization for research, either privately or publicly supported.

A difference was evident in the way in which the national attitude toward research was expressed in the various countries. The governments in all three countries provided agencies, usually by national enactment, for encouraging such research. The real difference lies in the way in which industry enters into the activities, that is, to what extent industry co-operates in making it a national affair rather than one of competition between individual companies.

It is quite evident that when industry fails to co-operate, governmental departments are created to perform such research work as may be necessary for the welfare and safety of the public. After such departments are organized, the tendency is to expand their activities to obtain the information which industry may already have developed, but which is unknown and not available to those departments.

The most effective plan seems to be one properly balanced between governmental research and industrial research, whereby the merits of competitive action may be retained and yet make available to the public the important results of scientific and industrial research if the public welfare or safety is affected.

In England that plan is most nearly approached. The co-operation of industry in that country is not made compulsory, but it is made desirable as a patriotic duty by creation of advisory committees on research, composed of men of national prominence in the field of research under consideration. Appropriations are made by the government for certain types of research and in return, the government has access to the results.

The one outstanding characteristic of laboratories visited was the enthusiasm of the workers and ability of those workers to concentrate upon the work in hand.

Libraries containing up-to-date information of recent developments were found to be imperative for successful research work.

In the absence of data prepared on a comparative basis, it appears that the smallest spread between wages and living costs exists in Germany, where labor unrest is not encountered. This condition can be explained only by the fact that Germany has now a fiery enthusiasm in a cause which has as its foundation national supremacy. The average workman is as proud of his opportunity to help this

movement to succeed as the leaders of the movement. It is a most unusual situation in the history of nations and is certain to succeed if the present enthusiasm lasts. The youth of the country are being trained to believe in the movement and their enthusiasm is constantly adding to its momentum. The majority of the people are willing to discipline themselves by the use of food and materials which only Germany produces, and to impose upon themselves such rules as will promote their own health and that of the next generation. They believe in Germany's ability to succeed and apparently there is no serious internal opposition now. The question arises as to whether this self-discipline will continue after the German people have made the nation self-supporting and the people become, individually, more prosperous.

Research in England

The Department of Scientific and Industrial Research under a Cabinet Minister (the Lord President of the Council) was established to foster the continuous and organized application of scientific knowledge in the problems confronting British industry.

A few laboratories already in existence were placed under the direction of the Department and others established as the need developed for research into problems of direct national interest.

The outstanding laboratory of its kind under the direction of the Department is the National Physical Laboratory at Teddington with a staff of nearly 700 constantly engaged in testing work for industry and in pure and applied research work.

No less important to public welfare is the Fuel Research Station at East Greenwich, where studies are constantly being made of the characteristics of the coal produced in England, for the purpose of improving and extending the field of utilization.

Other laboratories directly under the jurisdiction of the Department are:

Geological Survey and Museum at South Kensington
Building Research Station at Garston
Forest Products Research at Aylesbury
Food Investigation at Cambridge
Road Research at West Drayton
Chemical Research at Teddington

In addition to laboratories directly controlled, the Department encourages Industrial Research Associations which are self-governing bodies formed on a national basis in various industries for research in the interest of the members they serve. All British firms are eligible for membership and there are now eighteen of those Associations actively at work.

By this plan the initiative of industry may be retained and encouraged and, at the same time, the unnecessary duplication of work may in a large measure be prevented. It is obvious from a review of the work undertaken, that the Department furnishes research personnel and facilities for the work of industries and associations having an insufficient volume to justify separate organizations of their own.

Where work is undertaken for associations, technical institutions, industrial

firms or others outside the national government, payment is made by the client on the basis of the time occupied in the work.

Special committees are appointed from time to time to advise on particular sections of research work.

A few large corporations such as the Metropolitan Vickers Electrical Company, Mond Nickel, General Electric, Brown Firth Co., and others having highly specialized or exceptionally large volume of research work, maintain their own laboratories and operate independently of the national Department.

When independent laboratories are maintained, the directors of those laboratories are members of one or more, usually several, committees appointed by the Executive Committee of the General Board. In this way the director of each independent laboratory is intimately in touch with the research work carried on by the National Department of Scientific and Industrial Research. A common characteristic in the operation of these laboratories is that they maintain a close liaison with the sales and manufacturing departments and in some cases employees engaged for research work must serve a period in each of those departments.

Industry in England is "research minded" and apparently feels that the future prosperity of their own companies and the nation depend upon the results of research.

Research in France

Scientific and industrial research in France is not co-ordinated as closely as in either England or Germany. The French government had at the time of the visit, a Department for Scientific Research headed by M. Jean Perrin, Undersecretary of State.

That Department conducts and encourages scientific and industrial research throughout the nation but on account of the attitude of industry—explained by the fact that French industries are small and highly specialized—the Department has little knowledge of the results of such research carried on by industry, nor do those industries exchange information among themselves as is done in England, Germany and America. The result is a lack of the momentum and balance which would result from a free exchange of ideas and policies between government and industry.

The College of France located in Paris under the direction of the Undersecretary of State provides an agency for stimulating public thought. It has about forty professors who are engaged to give at least thirty lectures each per year on subjects which each professor is permitted to select. Students may come and go as they like and no examinations are required nor are any degrees conferred. The only requirement of professors is that they bring to the student something new. The professors are entirely without governmental dictation. The purpose of the college is to provide the means for defending and preserving the principles of western civilization. The work done in its eighteen laboratories is purely scientific research without thought of how the results of each experiment may be useful in industry.

The Municipal School of Industrial Physics and Chemistry of the City of Paris also under the direction of the Undersecretary of State for Scientific Research, having about one hundred students from the City of Paris, provides another means for interesting and training students in the methods of research. The course covers

three years work at government expense. Pure research work is carried on by the students without contacts with industry or its requirements.

Large expenditures are made by the government to create an interest in research work. The government apparently does not follow up that interest and the training it gives to be certain that the nation profits by the expenditure. The French opinion is that the expenditures pay, and they cite several outstanding discoveries made by sudents and teachers at the school, the most important of which was radium, discovered several years ago.

The effect of this attitude, as it appears to the observer, is to build up a highly trained and very able personnel in pure research without the advantages of the practical training which industry might supply. The French people are by nature idealists, however, so their system of research is probably in keeping with their temperament. It unquestionably lacks the "team work" which the more practical mind thinks necessary for well-balanced progress.

Research in Germany

Notwithstanding the concentration of governmental activities in Germany, the direction of research work remains much as it was before the war. Applied research, however, has greatly increased in volume and is performed by the state and by industry.

At Berlin-Dahlem is located the chief laboratory supported by the government for standardized testing and for applied research. Throughout Germany are other laboratories subordinate to and directed by the Control Board at Berlin, under the Minister of Science, Education and Art. These branch laboratories are located in industrial territories and specialize on the kind of work predominating in the respective territories. They may and do perform work for industry. For example, a firm may obtain from the government a certificate of inspection of a product, providing representative samples are submitted and tested. The apparatus and buildings are modern and manned by a highly trained personnel.

The directing force in both pure and applied research is the Kaiser Wilhelm Institute, a society of outstanding men in the scientific field. It is free from dictation from government or industry, although it is supported by both in the ratio of about sixty per cent government and forty per cent industry. The Society maintains a central laboratory at Berlin-Dahlem for research work at a cost of from five to six million marks per years and gives advice on policies and methods of research. The results of the Society's research are given to the public free of charge. Since government officials having the necessary qualifications may be members of the governing body of the Society, they have thereby access to the results as the experiments progress. Other laboratories for specialized research are maintained in the same way at other locations.

Under this system, the government has the power to instantly place all research work under one authority and obtain complete co-ordination of research personnel and facilities. The outstanding characteristic of German research is the training of many boys and men in the spirit and methods of research. Emphasis is laid now on applied research, but pure research is not being neglected; and out of the training may readily emerge the men with the type of mind necessary for pure research.

The power of Germany in the research field in from five to ten years, if present

policies are maintained, will be enormous. Germany is short of certain materials. Research to find substitutes is developing an intensity of purpose and an ingenuity in technique which seems likely to produce results of world-wide significance.

Conclusion

Laboratories for research in the three countries visited are equipped and manned much as American laboratories. It is evident that ideas are freely exchanged between scientists of the various countries particularly regarding equipment and methods. However, there is now evidence of an increased impetus being given research in foreign countries. Students are being trained extensively in methods of research which will probably result in producing a personnel qualified to carry on the work in a much wider field and more intensively than ever before.

HIGH-SPOT IMPRESSIONS OF SIGNIFICANT TRENDS IN RESEARCH IN ENGLAND, FRANCE, GERMANY

Maurice Holland

Germany

THE UNITY OF PURPOSE and closely integrated research program of the present-day German Reich, bringing into play the entire resources of science personnel, new and extended laboratory facilities and generous government subsidy, is the most vivid and significant impression of research organization and current activities in three industrial nations covered by the National Research Council European Laboratory Tour of 1937.

Government laboratories, the Kaiser Wilhelm Institute of associated laboratories, university and private industry, are all contributing their share in a speed-up program of science which is directed toward balancing national economy through the substitution of synthetic products for natural resources. The national development of the "Ersatz" (substitute) materials program has produced notable technological advances in major fields of industry, including Buna (artificial rubber), Zellwolle (artificial wool), new plastic products, solid gasoline sold in tubes under the trade name of "Bonalin" which exposed to air becomes liquid, alpha cellulose of ninety-five per cent purity from tree stumps, laminated wood products using newly developed synthetic resins, fire-resistant lacquers which when applied to woods, textiles and paper, produce a foam as the fire extinguisher, and sold under the trade name of "Locron." Natural leathers are being embossed, coated with pyroxalin lacquers, tanned with an iron compound as the substitute for the chrome tanning process; while artificial leathers are receiving particular attention in the development of highly polished surfaces using wax; and furs of common animals produced in large numbers, such as rabbit, are being dyed and the natural markings of other animals are reproduced by photographic methods, which make possible perfect imitation of higher value furs such as leopard, mink, otter, silver fox, chinchilla.

Research in the tanning of leathers at the Kaiser Wilhelm Institute for leather research is illustrative of the fundamental scientific approach to technical problems of major fields of industry. This laboratory has succeeded (under the direction of Doctor Grassman) in extracting single fibres from the fresh hides and has experimented with tanning processes on the single fibre to determine its shrinkage, and has subsequently examined the fibre structure by means of X-ray analysis. This laboratory has also developed synthetic tanning materials and has reduced the percentage of damaged hides by a campaign to eliminate animal pests in the cattle raising sections of Germany. The iron compound tanning process developed by this same Institute has large possibilities in heavy footwear, particularly for military purposes and for harness equipment. This Institute has an annual budget of about $50,000, forty per cent of which is supplied by the government and

sixty per cent by industry on the basis of one cent for every hide tanned. Beech wood, laminated as plywood with a synthetic resin similar to Bakelite, is finding extensive application in silent gears and bearings for heavy machinery and other industrial uses where noise elimination and comparative resilience are required.

In Diesel engine research Doctor Nagel (a contemporary research worker with Otto Diesel) is currently engaged in fundamental and basic scientific studies of flame propagation, jet emission and atomization development of new Diesel fuels. A purely theoretical problem of electrolysis of water in hydroelectric plants, to make economical use of the night accumulation of power and the small volume production of hydrogen and oxygen by electrolytic methods, is in the laboratory stage of development.

Siemens-Halske and Siemens-Schukert, one of the largest electrical manufacturing companies in the world, employing 137,000 persons, has a staff of scientists of 2,000. One of their leading executives stated that in the last few years their research budget had exceeded the dividend payments to shareholders.

These illustrative items selected at random as representative of major trends with respect to chemicals, woods, fuel oil, coal derivatives, leather, Diesel engines, might be supplemented by equally important new advances in dyes, synthetic resins, nonferrous alloys and recent extensive developments in new scientific instruments, apparatus and techniques.

German scientists are concentrating on supplying to the new Germany by synthetic chemistry, those products which have been denied her by Nature. Their unrivalled knowledge of atomic structure and behavior has pushed back frontiers of new knowledge and provided a solid foundation for at least a dozen new industries. Germany has had the rare foresight and imagination to direct the energies of the combined forces of her scientists (said to number 70,000) in hewing out of bedrock basic science the foundation stones of industries undreamed of at the time of my last visit, six years ago.

The work of German science today will startle the industrial and commercial world of other nations during the next five to ten years. Other large industrial nations of the world and the executives responsible for the planning of the future course of their industrial development will have to decide whether they will compete or co-operate with the scientific organizations of Germany or meet competition in world markets.

The present science program of Germany is but a reflection of the men at the helm of science in important posts. At every hand, whether in government, university or private industrial laboratories, most of the men in key positions are young, enthusiastic and eager to contribute their share in lifting the Fatherland out of its present economic slump with the aid of science. National economy is being balanced by the levers of applied science and backed by generous subsidies from the government as well as from industry, while the direction of the science programs is unhampered by political control.

In one of the research institutions in a suburb of Berlin, in which no less than twelve Nobel Prize winners are in key positions, the writer was impressed by the almost patriotic fervor with which these men pursued their daily tasks. He was particularly struck by the youthfulness of men in positions of high administrative responsibility. For instance, a man in his late forties is in complete administrative

control of several thousand trained scientists, all working at top speed in a single private industrial corporation. This corporation, the largest in the chemical industry, if not the largest single industrial enterprise in Germany, has spent 1,000,000 gold marks and ten years of time in the preliminary scientific research work necessary to develop Zellwolle. All of those with whom I came in contact, whether scientists or industrialists, were willing, even eager, to answer the most searching questions about industrial research and the development of new processes. They patiently explained in elementary terms and by means of simple, graphic charts the most detailed steps in processes of catalytic chemistry, for instance. The broad fundamental problems in which catalytic chemistry is being used as a scientific tool are based on raw materials at present available in large quantities in Germany. These raw materials are limited to water, air and coal; even the soil of Germany is poor and supports only second grade agricultural production. Principal raw materials produced from coal and lime include hundreds of chemical compounds as well as some of the recently and extensively publicized new products, such as Buna, Bonalin, dyes and other coal derivatives.

German scientists display unusual eagerness to co-operate with scientific research institutions in America and to exchange industrial technology with our leading American corporations. They are apparently in intimate contact with our present processes in the major fields of industry. New York offices are maintained by several organizations for the purpose of licensing American companies in newly discovered processes and for the sale of manufacturing rights to new products. They believe that German and American industry and science have common interests and that with a mutual understanding of respective national objectives an increasing volume of trade can be developed between the two countries through the exchange of industrial technology.

Personally I refuse to believe, after direct contact and observation with research directors and staffs of twenty-odd research laboratories in Germany confirmed by personal discussion with a number of leading industrial executives, that the present regime could pump up enthusiasm among such a large and representative group of scientists if the main objective of the present science program were preparation for war. Economic war for the salvation of their Fatherland, yes. Aggressive military war, no. There are too many of these German scientists who are veterans of the last war. They made major sacrifices; they and their families gave their all and they emphatically remind one that they are still paying the price for that heroic demonstration of futility.

These German scientists impressed me as being purely objective in their work as it relates to the national economy. They are dealing with facts; their daily contact is with the realities of tested practice and proven principles. I therefore refuse to accept the opinion of "unofficial observers" as a substitute for my own on-the-ground observations that the rank and file of German scientists in the new Germany are inspired by anything less than the conquest of the Unknown—and anything more than to provide the sinews of a strong industrial and commercial future for their native land.

"Science before all" is the graphic phrase which one eminent scientist used in summing up their present program. "Science not solely for the material way and things of life," he continued, "but science as a cultural development which permits

the freedom and creative work and spiritual satisfaction of contributing to man's progress."

These German scientists know their atoms. They can literally take materials apart and put them together again in new combinations. They have demonstrated in their laboratories that they can produce materials as hard as diamonds, as soft as silk, with all the colors of the rainbow and can control the characteristics in the whole range of materials. More important than this, they know exactly what is going on at each stage in the process of development. Following a visit to one of the largest and most representative laboratories in Germany, I came away with the impression that these men of science were "playing at being God." They were prying into Nature's treasure box in quest of eternal truths; they were listening to the language of Nature and they seemed to understand it.

My advice to American industry is to co-operate with German science, make them your partners. Science is international. Research respects no tariff walls. Germany today is the most highly organized, completely integrated scientific machine of any industrial nation in the world.

The co-ordination of effort, efficiency of management combined with singleness of purpose, only duplicated in other countries during times of national emergency, will produce results which will cause new economic agreements and technical alliances among the industrial nations of the world. The rest of the industrial world will pay tribute directly or indirectly to present-day German technology until they catch up with it; meantime it would be a tactical error not to co-operate.

England

Speed-up and the extension of industrial research in the national program of England, particularly the scientific refinement of existing processes and technology and the fullest utilization of the natural resources and advantages which it now possesses, is the keynote of current organized research in England. The extensive work of the Cotton Research Association at Didsbury, under the able direction of Sir Robert Pickard, can be traced to the intensive threat of Japanese competition, particularly directed at the textile industry, the industrial backbone of Great Britain. The recent devastating inroads on colonial and export markets which have been hitherto the exclusive trade territory of England (particularly in India, China and South America) have directed public attention towards the need of expanded research and basic technical science investigation.

Executives and financial backers of the cotton textile industry continue to demand of the government more protection in the form of tariff walls and increased subsidies through the medium of export committees. Those who have studied the problem objectively, however, recognize that the basic problem is one in which further technical development and fundamental research is the only permanent answer. If the Department of Scientific and Industrial Research had not already made a commitment for visits to the Cotton Research Association Laboratories when the original arrangements for the tour were made in 1931, we were definitely informed that our inspection tour would not have been possible under present conditions. The significant reason for this refusal to permit foreign visitors at the Association Research Laboratories is that after ten years these

laboratories, supported by the cotton textile industry as a whole, are just beginning to "bear fruit."

Leading industrial executives believe that the present research will provide the basis for competitive advantage to recapture lost markets. New developments are closely guarded until they reach the markets in commercial form. A single illustration of the development by a mathematician and a physicist of a flotation process, using air as the medium for cleaning cotton fibres and the sorting of them by length and quality, is one of the new developments of these laboratories.

In the metals industry, Mond Nickel Company (subsidiary of International Nickel Company) have established at Birmingham the newest modern-equipped research laboratory in England. The development of new nickel alloys, new applications for nickel in industrial and consumer markets is closely linked with similar developments in America, on the Continent and in Japan. Technical co-ordination of effort in this international company is affected through a central clearing house, operating in New York.

The laboratories of the Brown Firth Company (one of the largest steel corporations in Great Britain, which makes everything from cutlery and machine tools to motor power equipment, and which built the *Queen Mary* and her sister ship) carries on the classic research work of Brielly in the development of stainless steel alloys. Basic research in steel manufacture including long time tests of fatigue and high temperatures, and particularly emphasis on steel manufacturing processes using electrical furnaces are typical of the current research in that industry.

In the electrical industry, Metropolitan Vickers Electrical Company, connected technically and commercially with the American General Electric Company, are moving forward in parallel lines of research in the heavy electrical equipment manufacturing industry closely following American practice. One unique feature of the work of the Brown Firth laboratories is the training of a squad of technical observers kept in the field for periodic visits to all of the important pure and applied research laboratories in Europe. The research laboratory also serves as a training school for student engineers, who later occupy key engineering positions in utility and electrical firms throughout the world.

In addressing the National Research Council party, Doctor A. P. M. Fleming, able director of research for the Metropolitan Vickers Company, summed up the philosophy of their operations along these general lines:

> "We believe that every new discovery, product, material or process, has its birth in the first instance in some new mental discovery, usually arising in some field of pure science. Then there is the problem of seeing whether this discovery has any possible bearing in the industrial field that we occupy. If it has, the next problem is to develop the experiment on a sufficiently large scale to establish economic facilities for production and selling. Then there is the problem of finance, then that of training the personnel required for production and selling, and lastly the setting up of the organization for manufacturing. We are in the unique position of being able to deal with every one of these links in the chain."

The Metropolitan Vickers laboratory is the oldest established industrial research organization in Great Britain. It was established in 1900.

In the realm of pure science the Cavendish Laboratories at Cambridge University are the largest single and most advanced research agency in England. Compared with impressions on an earlier visit the most notable difference is the number of younger men who are engaged in pure science research in the fields of physics, low-temperature research and the liquefaction of gases, cosmic ray investigations, high-tension research and magnetic properties of metals. Recently a grant of the Austin Foundation made available a capital sum of five million dollars for the building of new laboratories and the purchase of new equipment. Through the Royal Society, Sir Alfred Mond provided a gift sufficient to equip the Mond laboratory and provide for its maintenance with modern scientific apparatus and equipment.

Two national institutions which rank high in the international world of pure science and applied technology are the Fuel Research Station at East Greenwich operated under the direction of the Department of Scientific and Industrial Research and directed by Doctor Sinnatt, and the Building Research Station at Watford.

Current research at the Fuel Research Station follows closely the research developments of the coal research laboratory at Carnegie Institute of Technology and the work of Doctor Bergius in Germany, on the constitution of coal and the development of processes for the production of coal derivatives. Doctor Sinnatt summed up the philosophy of current research by saying:

> "The last and least intelligent use of natural coal is to burn it. First study its fundamental constitution, process it and extract all the available, usable derivatives, and then burn the residue."

The possibility for the use of pulverized coal in Diesel engines and the combination of coal with other forms of liquid and gaseous fuels, are illustrations of one line of research. Hydrogenation of coal, cleaning, grading and the use of low grade fuel are receiving considerable attention. Some theoretical investigations are now being directed towards the use of ash from coal burned in industrial plants as a component element of fertilizer. One member of the party brought up the point that coal ash contained some of the essential elements in the production of aluminum. Doctor Sinnatt paid high tribute to the coal research work now in progress in America.

The Building Research Station at Watford under the Department of Scientific and Industrial Research, indicates that Great Britain feels that housing is a national problem. The most important single interest is the home owner. In the modernly equipped laboratories small scale models of houses and rooms are tested for heat insulation characteristics, noise abatement, construction techniques and weathering properties. All types of building materials and equipment are submitted to the Building Research Station for test. Accelerated life tests on roofing material, which expose the material to electric heat, ultra-violet rays, water-spray and freezing, through unique equipment have been developed at this laboratory. The weathering properties of stone used in historic buildings in England, such as Portland stone in the St. Paul's Cathedral and other monumental structures, are

being studied for those characteristics upon which synthetic building materials could be developed. The laboratories are supported largely by government subsidy, although part of the costs are defrayed by the manufacturers of building material and equipment, who submit their products for test to an independent and unbiased research agency.

France

The detachment of France's scientists from its industrial life has resulted in the country's making great contributions to the advance of pure science, but falling behind other nations in applying these discoveries industrially.

The College of France is unique as a scientific research institution. The United States is sorely in need of such an organization for bringing together really creative minds for constructive, individual, objective thinking, unhampered by routine and supervision. The spirit of pure science itself and creative research is fully displayed there. The men work with a freedom of thought which is absolutely necessary for real scientific advance. Scientists in France are searching for knowledge pushing back the frontiers of the unknown. One of the chief differences between France and other countries is that French scientists are less occupied with marketing their discoveries. The Frenchman discovers something, publishes a paper on it in some scientific journal and then goes to work on something else.

Where France has "missed the boat" in making itself an industrial success is in bringing industry into line. The United States is admittedly the foremost nation in the world in the application of science to industry, and France is one of the most backward. There are not enough trade association research organizations there. Too many of the industries hand down secret processes from father to son.

Madame Jolio-Curie, who personally escorted the party through the laboratories of the Radium Institute, in reply to the question: "What are the qualifications of an ideal director of research" made this reply:

> "You cannot direct science; science must direct you. If you attempt to direct it, you will find little things, not big things. Imagination cannot look into the unknown."

And Madame Irene Curie illustrated her epigram by stating that her mother, Madame Curie, would never have made the discovery of the radioactive properties of uranium if she had deliberately set out to direct her research toward a then unknown element.

NATIONAL RESEARCH COUNCIL—EUROPEAN TOUR 1937 TO ENGLAND, FRANCE AND GERMANY

Johannes Nielsen

A TOUR LIKE N.R.C.—European Tour 1937 doesn't give an opportunity of judging exactly to what extent the use of scientific research is employed by industry as a whole, but it gave us the opportunity to observe its application in many of the most important branches of industry.

In England especially, after the war, a great many important people seem to have gotten a clear understanding of the importance of industrial research. A considerable number of great firms, after having established research laboratories, have changed their organizations in such a way as to base their production on scientific research. It was striking to note to what extent the government seemed to understand the importance of systematic research for the whole industrial development. They must have had clever and foresighted advisers. The English have established a great number of public research-stations, the importance of which to the whole community cannot easily be over-estimated. In England it further may be mentioned that a number of industries of the same kind are co-operating in the foundation of research laboratories, in which problems of common interest may be examined. In this way a great number of smaller firms have been able to benefit by a scientific working research laboratory without having to establish their own individual research laboratories.

Even for the greater firms research associations have proved useful and economic in sparing them from the purchase of expensive, special apparatus which in their own laboratory perhaps would find insufficient application to warrant their purchase, but which on the other hand are indispensable when working on certain fundamental problems. While a great difference between the facilities of various laboratories could be noticed, they all seemed to have come to the same understanding that to secure results it is necessary for research to be carried on quietly without being pressed in any way.

One thing particularly impressed me about the English research laboratories: great weight is attached to the procuring of the right personnel, and they are allowed to work individually in developing their special abilities. The expectations of results are based not chiefly on the few leaders but on the individual abilities of all the collaborators. The result of this principle seemed to be satisfaction at the work, and a spirit which without doubt is a great incentive to progress in the research laboratories.

In France the laboratories visited did not give us the impression of the degree to which the French industry is using research. With regard to the government's relationship to industrial research, I got the impression that the government was beginning to consider it necessary to sponsor research to a greater extent, espe-

cially with regard to war necessities. Thus there have been established some research stations, but only in fewer fields than in England and Germany. In France they seem to take more interest in the single genius or the great individuals and their development rather than to consider scientific research as a nationally organized system. Concerning the problems, they keep in view the great lines and study the details less. Often the problems are studied for their own sake, rather than to try to make money by their solution.

Germany, before the war, established a great number of excellently working research laboratories, some at the universities and some at special research institutes, where they worked scientifically on the fundamental problems. A great many in German industry knew how to get and use the results of these laboratories. After the war a number of great firms and industry associations established their own research laboratories, patterned partly, I understand, on American organizations. Now, however, all industrial research has come under the control and administration of the government, the reason being to avoid waste of work and to make research a part of the nation's plan. International development or competition is no longer so much the guide to problems. Political conditions govern research and the future will depend on the political developments. The aim now is Germany's self-sufficiency, and the authorities are inclined to a certain scientific isolation to prevent other countries from benefiting by Germany's research results. This tendency is the reverse of that in the free countries where they wish to promote scientific co-operation. Many of the most excellent scientists in Germany don't agree with this tendency. In connection with the whole education and systematization of the country, however, the control of research certainly means great strength to the state. Whether other countries, where the principle of individual liberty is predominant, will be able to compensate for this is perhaps questionable.

NUTTER SEES BEHIND THE SCENES IN EUROPE'S INDUSTRIAL GROWTH

William S. Nutter

SIX WEEKS IN EUROPE to most people sounds like a pleasure jaunt, but the six weeks the writer spent recently as a member of the National Research Council's industrial tour party examining leading laboratories, while certainly a pleasure, was at the same time one of the most exhaustive educational ventures I have ever made.

With Maurice Holland, director of the National Research Council's division of engineering and industrial research, as our leader, we visited a total of more than thirty laboratories in England, France and Germany. Some of them were under government supervision, some were university laboratories, the rest were research laboratories either of private industry or of industrial trade associations. Directors of the laboratories took us behind the scenes, showed us exactly what is going on in their industrial research—in other words, we had a glimpse of European industry as it will be tomorrow.

Frankly, I was astounded. I have arrived at the stage where anything seems possible.

It wasn't only the actual products being made in their laboratories that impressed me—though they are doing some remarkable and amazing things—but the young people in Europe, their seriousness of purpose and the thorough and practical training they are given, that was decidedly impressive.

Each country varies in its system but the results are the same. Every country has a group of highly skilled youth ready to take over the tasks for which they are needed. In England, Dr. Fleming's method is to take a student from high school and put him to work for a year, giving him a taste of the business world, then he is sent back to school with more of an idea of what he wants to do. College isn't considered always the best step, for it is just as important to develop skilled watchmakers, skilled textile workers, mechanics or carpenters, or any other technical occupation.

This building up of a group of skilled hand-workers has resulted in a balance between professional and skilled mechanical workers which has gone a long way toward the solution of unemployment in Europe. And who isn't interested in a method that helps solve unemployment problems?

Substitutes for Natural Resources

One thing that makes the situation in Europe entirely different from ours is their scarcity of natural resources. We don't really have the great need for synthetic products that they have. But take Germany where they have a limited supply of raw material; they've done some amazing things in substituting synthetic materials for those they lack.

A good example is their "Zellwolle." Real wool fibre when it's examined

under the microscope is seen to have tiny scales all along the fibre which produces millions of tiny air pockets when the fibre is woven into cloth. This is what gives it its warmth. The "Zellwolle" is made of wood, but it has tiny scales very closely resembling those of the real wool fibre and the finished synthetic material actually provides warmth. In Germany today you'll find men wearing coats and suits, and women wearing dresses, made entirely of this synthetic "Zellwolle."

An entirely different situation exists in England. In Manchester, heart of the great English cotton industry, they found themselves faced with a decrease in the export demand for cotton. Things looked pretty black for a while with countries that formerly imported English cotton goods now making their own. Then scientists at Shirley Institute set to work and created new products, many of which are using cotton as a base where cotton had never been thought of before. New synthetic materials were made and mixed with other materials, and there's a new cotton so treated that it has much of the richness of pure silk. Today in England they have regained a lot of their lost export business and have also created a demand for the new products in England itself.

Demand for nickel was also slackening. At Birmingham, England, research men in the Nickel laboratories created a new product essential to high speed motors which revived the use of nickel. This product has lightness and durability —an essential in airplane motors—and it withstands chemicals without staining or rusting, which makes it very valuable to the textile industry.

The English scientists seem to be particularly ingenious in this way—developing new products to keep the market steady where old products are no longer in such great demand.

Eliminating "Nuisances"

Then there's another way in which they are ingenious. What are the two greatest modern nuisances? My answer—and I believe yours, too,—would be "smoke" and "noise."

Well, smoke is caused by coal, and those in the coal industry could foresee coal being displaced as a fuel, so they have been tackling the problem of smoke elimination. They are finding ways to eliminate it, too. But at the same time they are finding new uses for coal—to produce gasoline, and to use in the manufacture of synthetic rubber.

It's interesting, by the way, to see the factories that have been erected without any boiler house or chimney because all their power and heat is produced by electricity. And the result is better ventilation and more suitable working conditions.

Where motors and other electrical equipment are too costly, Diesel engines are being used a great deal. Dr. Nagel in Germany has done a lot to make the Diesel engine more in demand but the developments made here in America have also been adopted over there.

Just imagine entering a railroad station of artistic colored glass—that's what we can look forward to in a few years with diesel-engined trains eliminating the grime which we associate with railroad yards today. Landscapes, too, will be improved when this change becomes more general.

Remarkable developments to eliminate noise are being made in England. They are experimenting with leather walls, pile fabrics and other types of

insulating materials to absorb sound. Rubber is being placed between floors to deaden vibration, and proving very effective.

Pure Science Industrial Asset

I've talked mostly about Germany and England, so far, but we found developments in France every bit as interesting. In France the emphasis is placed more on pure science, which has contributed greatly to all industries. I admired their method of choosing scientists there. Here we wouldn't even consider a man who would apply for a position as scientist unless he has a college degree, but in France any man or woman who has accomplished something in science has the same opportunity as a man with formal training. In fact, we found that in many of the laboratories absolutely no questions are asked as to degrees or training. The result is that the door is open to men who have not had the opportunity to attend college, and there is more than one example of a man without formal training who has turned out to be a great scientist and whose brain-flashes have indirectly affected industries all over the world.

We were constantly observing instances where recent inventions had created new industries. These discoveries tend to create a balance in prices, too, by creating new uses and enhancing the demand for the old raw materials. In our own country, this has been evidenced by the consumption of cotton. There used to be some talk of the rayon industry stepping on the toes of the cotton industry, yet in 1936 our consumption of cotton was 3½ billion pounds of cotton against 500 million pounds of rayon; as a matter of fact, the use of rayon has actually increased cotton consumption.

That brings me to the inevitable comparison between European industry and American, which isn't easy to make because, as I have already mentioned, their problems are different from ours. However, I did make a similar trip a few years ago also arranged by the National Research Council, to a dozen of our large laboratories in America, and I must say that we can hold our heads high with pride for our own scientific advance. It was the general feeling of all our party that the United States is well equipped to solve its practicular problems intelligently. The nice part is that European scientists apparently have an equal amount of respect for American scientists. Everywhere we heard praise for our research laboratories and the work our research men are doing.

But we can also learn something from European laboratories about industrial research if what our group saw in the thirty-odd laboratories we visited is any indication. Our country can well profit by keeping informed on what the other fellow is doing.

IMPRESSIONS OF ENGLAND, FRANCE AND GERMANY GIVEN BY SUPT SHERTS ON HIS RETURN FROM EUROPE

James H. Sherts

BOTH THE COUNTRYSIDE and the cities in England were all that we anticipated. The beautiful green, undulating countryside in the southern part of England, with hedge fences and canals, gradually merging into the very hilly country with lakes and stone fences in the northern part, provides a most pleasing variety of country scenery. The countryside in general was not being farmed in small truck fields as I had expected; quite the contrary was true. It consisted principally of small, well kept green pastures for cattle and sheep. Roads were generally narrow and winding. Homes were of brick and stone with tile roof. It was not uncommon for the houses and barns to be connected in such a way as to enclose a barnyard. Needless to say such a house-barn, livestock and family group was most quaint and picturesque. Life seemed to be moving along slowly and peacefully and happily.

Here and there throughout the country may be seen the remains of castles and roadways, some of which date back to the Roman Era. Other crude column-like ruins mark a prehistoric era and are of unknown origin. One is conscious of being in a very old country, shrouded in legends, history, poetry and romance.

In the industrial cities conditions are pretty much as they are in America. Certain factories are very busy, while others are not, and there are therefore certain sections where there are large numbers of unemployed. Automobiles are few, as compared with America. They are generally smaller, slower and are driven on the left-hand side of the road. Automobiles have the appearance in many cases of having been used for a much longer time than we are accustomed to using them in America. Bicycles are plentiful, and of all descriptions. On a Sunday afternoon the roads within a radius of 25 miles about the cities are so filled with cyclists on their way to the country and seashore that driving an automobile becomes very difficult and tedious in the attempt to avoid accidents. One not accustomed to this type of traffic holds his breath many times as the bus appears to plow its way through the cycle filled roads. It seems to simply brush them aside, and I saw more than one spilled because the bus was a fraction of an inch wider than he allowed for it to get by.

In London, particularly, an American is naturally very much impressed with the pomp and ceremony. State occasions, plumed guards in brilliant colors, officials and those of rank, particularly members of the Royal Family, always appear to be on parade, and strange to say, always apparently willing to do their bit. Their museums, parks, art galleries, towers, castle ruins and the like, as well as their still inhabited castles, such as Windsor, all impress one with the important part that tradition plays in the English mode of living.

There are great Association Laboratories in which all of the manufacturers of a certain industry, such as, for instance, the cotton industry, woolen industry, leather industry, iron and steel industry, and so on, contribute annually for a common research laboratory and program. These laboratories are large, well equipped, ably manned and impress one with their thoroughness and their progressiveness.

Our first stop was in London. London is different in many respects from any other city in the world. Months could be spent in this city alone without completely satisfying one's interest. There are no high buildings, such as exist in New York, Chicago and our large cities, and the city spreads out over so much territory that it seems almost endless in driving across it.

From London we went to Windermere in the northern part of England, and in what is known as England's Lake District. It represents an excellent place for vacationing. On this trip we noticed a large number of "hikers" (no hitch hikers) with packs and canes, traveling from place to place throughout the country on foot, putting up wherever and whenever they chose, thereby enjoying what is known as a "hiking vacation." Others were vacationing on bicycles instead of on foot.

Manchester, Sheffield and Birmingham were all busy manufacturing cities. A side trip was made from Manchester to Stratford-on-Avon, the birthplace and home of William Shakespeare. In his honor the town has erected a large theatre in which his plays are still enacted.

Another very interesting side trip was made to Stoke Poges, where we visited the country graveyard where Gray is buried and where Gray's "Elegy in a Country Churchyard" was written.

In addition to the Associated Laboratories referred to above, we visited in a thorough manner the Burroughs Wellcome Laboratories where research work is principally on chemicals for medicinal purposes, and the study of prevention and cure of all types of diseases. The old and world-famed Cavendish Laboratories, in which so many far-reaching discoveries were made, particularly during the early days of our present chemical era, was also visited. We also visited the British Science Museum, in which are preserved for posterity the original apparatus and equipment of the great discoverers, such as Priestley, Newton, Watt, Rutherford and many others.

Besides these relics of the past, they have very elaborate and complete models of all kinds of production equipment, factory layouts and the like, covering all types of scientific applications. Practically all scientific principles are also illustrated in a graphic manner so that students are able to study the principles of pure science as applied in industry. Many of the models can be manipulated by the students so as to produce results, and in this way serve to teach one in a practical way.

In the General Electric Laboratory of England television, about which we read so much at present, was demonstrated and explained in much detail.

A number of other laboratories visited were:

The Leather Research Laboratory.

Boot and Shoe Industry Laboratory.

Rubber Laboratory.

Metropolitan-Vickers Electric Co. and Laboratory.
Cotton Research Association Laboratory.
Firth-Brown Steel Co.'s Plant and Laboratory.
Building Research Station.
British Fuel Research Station.

MRS. J. H. SHERTS WRITES IMPRESSIONS OF FRANCE

CROSSING THE ENGLISH CHANNEL from Dover to Calais takes only about one hour. In that short time, however, the traveler is transplanted from one type of country, inhabited by its kind of people, to a completely new and different land with a people wholly foreign to those so recently left behind on English shores.

In contrast to the rolling green pasture lands of beautiful England, an interesting and pleasing panorama of carefully tended agricultural land unfolds before the eager eyes of its passengers, as the boat train rolls on toward Paris. Although our trip was made during the late afternoon, we saw entire families at hard work in the fields. We noticed particularly how intensely and steadily the older women, the grandmothers, perhaps, worked the land with their short, grubby hoes, their bodies bent forward in what must have been a most uncomfortable angle. Several times a picturesque group suggested to us Millet's "Gleaners," which we were later to see in the Louvre, Paris.

Here in rural France we saw the peasant villages of which we had often heard, and which were so picturesquely presented in our geography books in school. Sharply pointed, red-roofed houses and barns are grouped together in close and intimate fashion, and from these villages the peasants go out to the surrounding land to cultivate the soil. We saw cattle, goats, sheep, although not so many as in England, and many white horses. The children we saw were plump, brown and happy. The younger ones romped and played within sight of the busy group, or sat contentedly in their carriages near an industrious parent. Altogether the picture was a most gratifying one.

What a contrast to this peace and serenity of rural France, was Paris—teeming with noisy life and excitement. As we stepped upon the balcony outside our hotel rooms, high above the trees flanking famous Hausmann Blvd. we looked down upon the famous sidewalk cafes which line this old city's streets. In these cafes friends sit for a half hour or a whole evening over a glass of wine, or beer, or maybe a cup of tea or coffee, always enjoying much animated conversation. We soon heard what at first might appear to be a heated argument between two people, intensified by many quick and excited gestures, which was only an ordinary conversation. Commonplace matters assume a dramatic significance when discussed by Frenchmen.

To the visitors in Paris this year, the International Exposition is perhaps the place of foremost interest. We were there too early to fully appreciate this

tremendous project. Strikes, sabotage, and general labor disturbances had so interfered with the erection of the buildings that the whole place had a disappointingly unfinished appearance, even at the time of its formal opening.

An exception to this, however, was the Palace of Discovery, a scientific exhibition of amazing scope and completeness. Our group was particularly interested in this, and spent some enlightening hours here under the gracious guidance of our French hosts.

A four-story building of glass blocks was of particular interest and was widely advertised in Exposition literature. We happened to be taking a boat ride on the River Seine the evening they held the formal opening of the Fair, and witnessed a most magnificent and colored illumination of the elaborate fountains.

The famous Eiffel Tower, built for a previous exposition, and ever since a famous point of interest to Parisian visitors, was also beautifully illuminated. The magnificent view of the city and its surrounding country from the very top of the tower was an experience we enjoyed on a bright, clear day.

Several sight-seeing trips through the city proved to be most interesting and delightful experiences. The famous Cathedral of Notre Dame is a place of great beauty and inspiration. The picturesque and well-known book-stalls in its shadows along the Seine offer for sale and display many old and interesting etchings, prints, books, magazines, brasses and other relics of an older Paris. The Church of the Sacred Heart, situated high above the city in the heart of Montmartre is a glorious sight by day or by night from almost any spot in Paris.

The famous Louvre Museum of Art and Sculpture attracts all foreign visitors in Paris. Here are assembled thousands of famous canvases, the best known perhaps, the Mona Lisa by De Vinci, the Angelus and the Gleaners by Millet, Mother by Whistler, and the familiar Venus de Milo and Winged Victory in the Hall of Statuary were seen.

The Paris shops, particularly those along the Rue de la Paix, are most interesting and attractive to the woman visitor to Paris. Here the latest styles in furs, millinery, suits and gowns are on display, and here, too, one finds for sale some of the most gorgeous and precious jewelry in the world. Paris is known for its perfumes, and bottles of these produced by some famous and favorite manufacturer are welcome souvenirs for the folks at home.

From Paris we took the popular and interesting side trip to Malmaison and Versailles. Malmaison is the palace built for the Empress Josephine by Napoleon and within its walls are preserved the beautiful furnishings in their original settings. Here one may wander through the library, dining room, music room and bed chambers of that famous couple. It was in this palace that the saddened Josephine lived during the bitter days of unhappiness following her divorce. To this place have been brought the cot and camping equipment used by the powerful little Bonaparte during the wars in Spain. One room is used to hold the bed in which he died and other tragic relics of his exile.

The Palace of Versailles, the historic home of the French kings before the Revolution, is very grand, indeed. The grounds are magnificent with their beautiful and splendid fountains. The interior of the Palace is gorgeous, and one may wander from room to room and view the tapestries, paintings and elegant pieces of furniture which were once the possessions of the proud and wicked

Louis XIV. The long Hall of Mirrors, which was the scene of many gay and festive balls, is perhaps better known to this generation as the room in which the famous Treaty of Versailles was signed at the conclusion of the World War.

There are smaller palaces known as the Palaces of the Trianon where the kings' favorites lived from time to time. We saw also the Swiss Farm, which was the plaything of the restless Marie Antoinette, and which was within walking distance of the Palace.

So much for points of interest and general impression of them which may be shared by every casual tourist. The tour, after all, was a scientific mission and most of the time of the men in France was spent with French scientists and research experts in their laboratories. The colleges and research institutions visited were the National Laboratory of Radio Electricity, the School of Autogenous Welding, the National School of Arts and Trades, Paris Optical Institute, and perhaps best known of all, the Curie Radium Institute, where the guests were graciously received by Madame Curie's daughter, who is carrying on the enterprise begun by her illustrious parents.

A very beautiful reception and luncheon was held for the entire party at the French Foreign Ministry at No. 10 Quai D'Orsay. Our distinguished host was Monsieur Jean Perrin, Undersecretary of State for Scientific Research. Ambassador Bullitt was a guest at the reception, together with Madame Curie, and many other eminent scientists.

GERMANY HAS MANY PLACES OF HISTORIC INTEREST

Mrs. J. H. Sherts

BEING AWAKENED in our compartment at midnight by a courteous young customs officer was our introduction to German territory. We were traveling on the night train from Paris to Berlin and had crossed a part of Belgium on the journey.

There was, of course, a customs inspection at the Belgian border, but that came in the early evening before anyone had retired for the night. Our German inspector spoke very good English and observed the necessary formalities as simply and speedily as possible. Our two sons in the adjoining compartment were not disturbed from their sleep at all, and our statements concerning them were accepted without question.

In contrast to the rapidly spoken French, which our ears had become accustomed to hearing, we now listened to the low, guttural voices of German officers and station attendants, as the train stood in the borderland station, awaiting the completion of customs inspection and passport examination. Soon, however, all was quiet and on we traveled to Berlin. We were most graciously received in that beautiful city and spent an interesting and profitable week there. We stayed at

the Adlon Hotel, situated on the historic Unter den Linden, close to the famous Brandenburg Gate at the entrance to the old Tier Garten.

Berlin and Vicinity

There was a reception for our entire party, the first afternoon in Berlin, given by the Verein Deutscher Ingenieure, a German Engineering Association, and there we met and were addressed by our American Ambassador Dodds and were received by many distinguished German scientists. A group of charming German women looked after the ladies in the party and during our entire stay in Berlin we were the recipients of their gracious and considerate hospitality.

During the week there was an official reception for us by the City of Berlin at the City Hall. This was followed by a well-conducted sight-seeing trip over the city. The Carl Shurz German-American Union entertained us at the Carl Shurz House one evening. Here too we were most cordially received. There were speeches of welcome and good will, a delicious buffet supper and later we listened to beautiful music in the attractively lighted gardens at the rear of the house.

While the men in the party were being conducted through laboratories and places of scientific and industrial interest, the most important of which will be mentioned later, the women in the group could go shopping or sight-seeing, either with one or more of our German hostesses or independently. Berlin has splendid shops and their windows display a tempting array of linens, some of which are beautifully embroidered by native women, clothing, art objects and very beautiful jewelry. There are several large and very complete department stores and many shops specializing in cameras and photographic equipment.

The Berlin Zoological Gardens are among the finest in the world. They are rightly called "Gardens" for the spacious grounds are beautifully planted and flowers in gorgeous colors abound everywhere. There are attractive outdoor cafes throughout the grounds and one may listen to fine band music every afternoon. The collection of birds, animals and reptiles is very large and complete and they are all carefully tended and effectively displayed. A large Aquarium adjoins the Zoo and is equally fine.

It was our privilege while in Berlin to be entertained at the headquarters of the German Women's Work. The organization was explained to us simply and graphically by Dr. Marta Unger, one of the officers, and we were given during our informal discussions there a new and enlightening picture of woman's place in the present German social scheme.

Another day we were taken about fifty miles out of Berlin to a typical Girls' Labor Camp. We had afternoon coffee with the girls and their director in the camp dining room. They entertained us later by singing German folk songs and by giving us an exhibition of old folk dances in the garden at the front of the camp. The girls represented all types of homes and families but were alike in radiant health and wholesome, happy spirit. From the camp they go out to the surrounding farms to assist with housework, care of peasant children or some of the lighter forms of farm labor. The period of service is six months; it is compulsory only for girls intending to go to the universities for higher education and is optional for all others.

Berlin has fine museums of painting, sculpture and architecture and many

priceless treasures are assembled there. There are two opera houses in the city and it was our privilege to hear "Martha" sung there.

We spent an afternoon at the "Give Me Four Years" Exposition in Berlin. Its purpose was to demonstrate the strides made in industrial developments and generally improved conditions existing under the present regime. Many native Germans as well as visitors view the exhibition with great interest.

Potsdam

Potsdam, outside Berlin, was the former summer residence of the German kaisers. The Palace of Sans-Souci there, built by Frederick the Great, rivals the French palaces of Versailles in grandeur. The gardens are very elaborate and we saw them at a beautiful time of year. In wandering through them we came upon unique and beautiful pavilions and inviting summer houses, and enjoyed seeing the splendid fountains at play.

Dresden and Meissen

After Berlin, we visited Dresden, a city abounding in old world charm and artistic achievement. The name Dresden suggests china and we visited the State China Factory at Meissen, just outside Dresden. Here we saw the actual processes taking place and marveled at the skill with which the delicate and exquisite pieces were given shape. The materials for the most delicate parts, such as lace frills and dainty skirts of some of the figures, are twenty years in the process of preparation and seasoning before they are actually used. Each piece is hand wrought and a corps of artists is constantly at work applying the dainty decorations.

There are wonderful museums in Dresden, the most unusual perhaps being a Porcelain Museum containing the most priceless and rare collection of porcelain and china in the world. There is also a treasure house of ancient jewels, containing complete and elaborate sets of diamonds, sapphires, rubies, emeralds and opals, which belonged to Augustus the Strong, a former ruler of the province of Saxony.

The Museum of Painting is worth many hours of careful study. The best known and most beautiful canvas is the "Sistine Madonna" by Raphael. This is impressively hung in a room by itself.

We visited a large and beautiful Home and Garden Exhibition in Dresden. All types of gardens were planted there, from the simplest home planting to the most elaborate formal arrangements. Many valuable suggestions for every type of homemaker were to be found. Artistic, small houses were erected on the grounds, also, and supplied attractive ideas for the building and furnishing of homes.

Cologne

Cologne, situated on the Rhine River, and famous for its magnificent cathedral and "eau de Cologne," was the next city on our itinerary. The cathedral is the most beautiful one we saw, and contains many priceless artistic and sacred treasures. The streets of the city are narrow and quaint and many intriguing shops entice the visitor. Eau de Cologne is featured everywhere in many varieties,

each dealer representing his brand as the original. Of all the souvenirs from Cologne, some form of this famous preparation is sure to be most popular.

Düsseldorf

We traveled by motor from Cologne to Düsseldorf. Here we were luncheon guests of a German Scientific Society and later visited the Düsseldorf Exposition called "A Nation at Work." This city is a manufacturing center and has some beautiful residential districts. Its hotels and shops are very fine.

Essen

Essen, the home of the Krupp Iron and Steel Industry, is a city we shall long remember. We were delightfully entertained at luncheon by Krupp officials. Later we saw the tiny house which was the humble home of the first Krupp and which has been preserved in its original state, in the midst of the huge furnaces and imposing stacks of the present tremendous plant.

Bonn

We motored through the ancient city of Bonn, where we saw the birthplace of Beethoven. Here, too, we saw one of the finest and oldest educational centers, the University of Bonn.

Coblenz and Mainz

At Coblenz, where so many Americans were stationed during the days of the army of occupation following the World War, we boarded the Rhine steamer for the historic city of Mainz. It was a beautiful, clear day and as we sailed down that famous old river, along the shores of which rise picturesque mountains, historic ruins and romantic old castles, we could understand the enthusiasm of Longfellow, who said of the Rhine, "Oh, the pride of the German heart is this noble river. And right it is; for of all the rivers of this beautiful earth, there is none so beautiful as this."

The diligence and industry of the German people was perhaps nowhere more forcibly demonstrated than along these shores. Amidst all the ancient beauty of quaint villages and historic castles we saw also carefully cultivated agricultural lands along these sloping shores. There are many vineyards and numerous other crops are grown there too.

We arrived at Mainz early on Saturday evening. There was a festival in the public square and we mingled with the happy crowds there, watching the folk dances and listening to the hearty and spontaneous singing of the natives of the quaint and ancient town. It was in Mainz that the art of printing was first discovered by Gutenberg and one finds there many memorials to this famous son. There is a Gutenberg Museum and a large statue of the inventor is erected in a place of prominence in the city. We regretted the shortness of our stay in Mainz and each left with a desire to return.

Heidelberg

Heidelberg, our next stopping place, is another beautifully quaint and appealing city. The old castle of Heidelberg is situated high on the hillside and over-

looks the town. We wandered all through it, climbing to the highest part of the towers and were thrilled by its ancient charm and beauty. It is in the cellar of this castle that one finds the huge wine cask upon whose top several dozen people can walk at one time.

We saw Heidelberg University and visited the chapel there. We also saw some of the old rooms and were taken into the old University prison where students used to be disciplined. Upon its walls appear the signatures of some of the University's most famous sons.

The cafe, reputed to be the original setting of the "Student Prince," may still be visited. It is said to continue to be a favorite rendezvous for Heidelberg students.

Those delightful days in Heidelberg were our last in Germany. We had spent pleasant weeks there and were sorry to leave.

Industries and Laboratories

Again the statement must be made, however, that the purpose of our trip was more serious than that of the casual traveler. The men spent full and busy days in Germany, and following is a list of some of the outstanding scientific and industrial centers which they visited and studied:

Physikalisch-Technische Reichsanstalt, Technical College, Berlin.
Institute of Technology, Berlin.
Prussian Wood Research Institute, Eberswalde.
State Testings Material Office, Dahlem.
Silicate Research Laboratory.
A. E. G. Research and Factories.
Dresden Technical Academy (Dr. Nagel's Laboratory for Diesel Engine Research).
Kaiser Wilhelm Institute for Leather Research, Dresden.
Kaiser Wilhelm Institute for Iron Research, Düsseldorf.
Krupp Chemical and Physical Research Laboratories and Factories, Essen.
I. G. Farbenindustrie Laboratories, Ludwigshafen.
Oppau Works and Agricultural Research Station, Ludwigshafen.

FEAR OF WAR POINTS COURSE OF EUROPEANS

"Southbridge News"

FEAR OF ANOTHER GENERAL WAR controls the course of European nations, John M. Wells told the Manufacturers and Merchants Association at the first luncheon of the fall season at the Hotel Columbia today.

Mr. Wells recently returned from a three months' tour, which he made with other members of the National Research Council, representing 22 industries. The purpose of the trip was to visit research laboratories and study advances in technology. The United States is by no means in the rear, Mr. Wells concluded after he had seen everything available for observation. Perhaps it is in the lead in many lines.

Busy Five Weeks

The delegation visited 40 laboratories in England, France and Germany in five weeks, but only in England was it possible to see everything freely. The British government helps to finance research, realizing that England may have fallen behind somewhat in technological progress, Mr. Wells said.

England has no home resources in gasoline and fuel oils, and about half a million dollars is spent annually in its fuel research laboratory. How to get gasoline or some equivalent from coal is one of the objectives. At present about four per cent of the motor fuel used in Great Britain is made from coal. Studies are being made also to determine the best methods to get maximum efficiency from coal burned in household grates.

Mr. Wells studied developments in television while in England.

The group was not invited to visit industrial laboratories in France, but was made welcome at university and college laboratories, and at establishments like the Curie radium laboratory and the Pasteur Institute. The American guests were entertained at an elaborate banquet in Paris, and they attended the exposition.

The latter compared favorably, Mr. Wells said, with the Century of Progress Exposition in Chicago. The exhibits are arranged with great artistic skill.

French Discouraged

The French people, the speaker reported, seem discouraged over their financial difficulties, and have lost much of their old gaiety.

In Germany the visitors were shown many interesting things. Mr. Wells did not visit the Zeiss optical laboratories, but from his general observations while abroad he did not discover any developments in the industry in advance of what we know here.

The meeting was fully attended, and the talk was warmly applauded. Mr. Wells did not have time to tell of his visit to Russia, and may be asked later to give an account of what he learned about life among the Soviets.

RABBITS OUT OF EUROPE'S INDUSTRIAL HAT

Bert H. White

RESEARCH IS ONE of the best safeguards for capital invested in industry. That is an obvious conclusion from visiting the industrial laboratories of England, France and Germany. It has a sound basis in the business experience of our own country as well.

Within the past few years there has been a rapid speed-up in the advance of technology, thereby creating new industries and destroying old ones. The investment divisions of several large insurance companies have been working to determine from an actuarial standpoint just what the mortality rate of certain kinds of business is. One point impressed them, and on this there was no disagreement. The company that died invariably did no research. It just went to seed with the same old product, while its competitors developed new methods and machinery with more desirable products.

There is a real effort being made to exchange scientific findings among most of the progressive nations of the world. Those still retaining a closed door are beginning to realize that this keeps more out than it keeps in. For instance, there is Germany with her "buna," a synthetic substitute for rubber which she originated and which we followed with our "neoprene." The German product was first in the field and is still away in the lead, but the other nations, including our own, have made contributions which have enabled the Germans to perfect their product.

German Synthetics Success

German government vehicles which now carry "buna" tires as standard equipment travel six times as far on the synthetic product as they did on the natural one. The synthetic product also has other advantages such as uniformity of texture, and they told us at Ludwigshafen that Germany would no longer use the natural product even if she had plenty of it. Germany had a problem and she also had coal, and through it she found her way out.

England and Germany have chemical plants where hundreds of thousands of tons of coal are converted into lubricants and gasoline. One English plant alone produced 45,000,000 gallons of synthetic gasoline last year, or 4 per cent of the country's requirements, and Germany told us she will be self-sustaining on gasoline not later than 1939. A world authority on fuel with the British Research Station at London told us that the last thing we should do with coal is burn it. He jestingly remarked that the fuel of the future might even be a product of garbage or grass.

At the Shirley Institute at Didsbury, the Lancashire textile laboratories of England, they are trying to help win back an export market that the British have partly lost to Japan, Germany and America, by fostering the use of rayon in cotton

mills on cotton machinery in conjunction with cotton. They told us that the future of their industry lies in the development of textile alloys made up of cotton, wool and rayon. They are doing considerable work on synthetic cotton which, it is believed, will be cheaper, have less impurities, and be easier to weave and dye.

At the Brown Firth Steel & Shipping Co. at Sheffield, one of the biggest shipping and armament plants in the world, they reminded us that one cannot say when the work done under the spur of military needs or economic necessity may not give a valuable by-product. In 1910, at this very Brown Firth Plant, while developing a steel for guns that would be non-oxidizing, stainless steel was discovered, opening a great new field in metallurgy. During the past year they have been working on color-containing steel from which it may be possible to stamp an automobile body that will require no painting.

Cannons as a Cue

In Germany at the Krupp plant we saw engineers working on seamless boilers which can stand pressures formerly believed impossible. They developed this idea from research on cannons.

We visited the Mond Nickel Co. of England, which, together with its parent, the International Nickel Co., Ltd., controls 85 per cent of all the nickel used in the world. They are trying to expand the use of stainless steel, which contains 10 per cent nickel, and also to develop the market for monel metal which is two-thirds nickel and one-third copper. They are also doing considerable work with the aircraft industry where strength with lightness is the objective, and are developing a corrosion-resisting relatively soft cast iron which, if successful, will open a much bigger field than stainless steel.

Much time and money is being spent to find a better element for electric ranges, one that will not deteriorate when salt water or fats boil over on it.

At Metropolitan Vickers Electrical Co. at Manchester, noted for its machine guns during the war, they are doing a great deal of work on the behavior of metals under high temperatures. They are also putting in considerable time studying lightning, inasmuch as this continues to be one of the major sources of interruption to electric service when supplied by overhead wires. They are constantly developing new apparatus to allow the lightning discharge to pass harmlessly to ground, while at the same time preventing loss of system power current.

They are also doing considerable work on acoustics for noise abatement. Study for noise abatement is going on all over Europe. They have definite proof of substantial increases in efficiency and production where noise has been reduced.

People are poison gas conscious in England. They sell gas masks at many places at very low prices. Department and hardware stores freely advertise them, but you begin to wonder about the sensibility of this when you are told at the I. G. Farben Co. in Germany that the old gas masks won't help much, for they have developed a substance which will destroy the soda-lime element in the mask, making it practically worthless.

At the Building Research Station at Walford, England, they are working on a new window glass which is immune to cold and which they claim will cut heating bills of homes and buildings 40 per cent. It is almost ready for the market.

They are studying the blisters which come from water beneath asphalt and

believe they have a method for its elimination. They perfected a colored asphalt block substitute for tile which is considerably lower in price.

They have developed porite with which they use thousands of tons of slag from steel every week to make a concrete that crumbles less and holds nails without cracking. They do considerable work on machinery for building materials, and have developed a new concrete mixer which, by vibration, produces better concrete.

The British are working on a method of removing grit from flue gases. They are working on a means to use pulverized coal directly in an engine which, in their opinion, will be one of the outstanding accomplishments of the future. They have developed a smokeless, dustless fuel, so clean that it is delivered by men in white uniforms.

At the laboratory of the National Office for Research and Invention at Bellevue, France, across from the big Renault Works which can be converted into a war plant in 24 hours, they showed us a place where inventors come to present ideas which they cannot finance. The organization looks into the idea, separates those that have promise, accepts approximately 1 per cent of those presented, assists the inventor in making the invention practical and puts him in contact with financial or industrial interests to commercialize it. For this the institution receives 10 per cent of royalties. It is more than self-sustaining.

They also do research for the government. Here short waves were developed to locate submarines, and much work is now being done to develop apparatus to better detect approaching airplanes. They are making substantial improvements in automatic grenade throwers. They have the largest magnet in the world to study magnetic refraction of gases and liquids. They have developed a new idea for a cosmic radio on which they are working in conjunction with Cavendish Laboratories.

The Vitry Railroad Testing Laboratory, located just outside of Paris, is the principal testing bench for locomotives in Europe. Here they test the locomotives of England, Belgium, Italy and other governments, as well as their own. The laboratory is managed by the six great French railroads which were nationalized and banded together into a single national railway company by decree of the French government, during the past few days. The laboratory was originated to standardize French rolling stock and equipment, and today almost all French railroad equipment is standardized.

Living costs are high in Germany although prices of necessaries are fixed by the government and kept as low as possible. They are trying to foster a national diet to help overcome the shortages in wheat, fats and meat.

Fish Sausage Not Going Over

They have developed a fish sausage similar to our hot dog, which they are insisting that people eat instead of meat. The Germans eat a great deal of meat sausage, but fish sausage is not going over.

Germany is undoubtedly the greatest nation in Europe on applied research. The nature of the people helps make this possible. It took 15 years of hard, tedious plodding and 30,000,000 gold marks to produce the formula for aniline dyes.

The mammoth German dye trust is the I. G. Farbenindustrie Co. at Ludwigshafen. Here buna and synthetic gasoline, products of coal, were discovered and developed. Germany being a country with plenty of coal, but not very good climate or soil, is fortunate that her scientists have been successful in working with coal for so much of her synthetics.

Here they have developed ceramic ware, similar to beetle ware, but cheaper and more transparent; molybdatrot, a new colored paint as fast as lead chromide and not subject to darkening.

They developed I. G. wax, the use of which is now broadening so rapidly. It is used to give a better surface to paper; the quality of pulp or rag going into the paper can be of a considerably lower grade if I. G. wax is mixed with it. This product also develops more beautiful colorings when mixed with paraffin and is the substance that prevents paraffin candles from bending in warm weather.

Another new product developed is locron, used to make cloth and building materials fireproof. A method has been developed to add pigment to it so that it can be applied as paint to furniture and woodwork—painting and fireproofing in one operation. At present the cost is twice that of ordinary paint, but it will decline with production.

New Development in Fire Prevention

Locron is also available in transparent form and it is believed it will have common use in kitchens where there is greater danger of fire. It is now mandatory in Germany that all curtains and draperies in government buildings and trains be treated with locron. Fire will not spread when it attacks a material so treated inasmuch as locron gives it fire-extinguishing properties.

They are also developing plastics and have a new material, vinol, which does not have some of the undesirable qualities of the present plastics. They have developed plastic pipes for plumbing in homes and laboratories so as to use less copper and lead. These pipes are made of a light tan colored material, which has proved so satisfactory and which stands up and looks so well that it may supersede metal pipes for ordinary use.

They are working with an important American company on a substitute for tin cans. These cans will have transparent sides and a tin top and bottom, so that a purchaser of canned goods can see what she is buying.

SELF-SUFFICIENCY THROUGH INDUSTRIAL MAGIC

Bert H. White

THE HITLER GOVERNMENT is making a determined effort to carry through a four-year plan to make Germany self-sufficient. In a recent address before a Nazi Congress, Hitler threatened that the government would take over private industry if it proved incompetent to perform the task which has been set for it. The results

in some industries may have been disappointing, but the research men of the mammoth dye trust, the I. G. Farbenindustrie, appear to be doing their part.

They have perfected a new electron microscope, to aid in the rapid development of synthetic products and the study of atoms. They have devised instruments better to examine the surfaces and interior of metals used for important parts of intricate instruments, to find imperfections which may develop under intense heat. They have now begun to use these instruments in the field to obtain information on conditions in the interior of castings, etc. Obviously, it is desirable to have the finest kind of instruments for this type of work because so often a casting is machined and, after time and money has been spent on it, an interior defect presents itself, causing a total loss.

Here they make synthetic jewels which can hardly be detected from the real ones. They have developed a product called urso for the manufacture of imitation fur. For example, they bleach rabbit skin and starting from there with a cold treatment irritate it and photograph or print the picture of a leopard skin on it; then after proper matting it looks surprisingly like real leopard skin. They make a very good silver fox from opossum, and imitation chinchilla from rabbit. They use the stomachs of large fish for imitation snake skin, and we saw them make artificial alligator skin from a piece of calfskin. In less than 10 minutes they turned out a product that could hardly be detected from the real thing, even to the point of working earth marks into the deeper crevices of the leather.

Improving Airplane Propellers

They have developed a new glue for airplane propellers, which enables them to have a plywood of very light weight with an outer surface of great strength. If the whole propeller were to be made of the outer wood, it would be too heavy to be practical. They have used plywoods in the past, but not until this new glue came along were they able to have the outside veneer of such thinness.

They have developed a new substance to help the medical profession to preserve things now preserved in alcohol. This new substance is a transparent liquid which is poured over the object to be kept and which then forms a solid. It can be shipped around more readily and is soluble when heated.

Two large companies represent the electrical industry in Germany. They are the Allgemeine Elektrizitäts Gesellschaft (A. E. G.) and the Siemens Co. Each compares with our General Electric or Westinghouse in size.

The latest acquisition of the Siemens Co. at Siemenstadt is a super surge testing plant for handling surges of electrical current up to 3,000,000 volts and 23,000 amperes. They have done much work on electric light bulbs and believe that the mercury lamp will ultimately supersede the filament lamp because it gives better light from less current.

A Rapid Fire Camera

The A. E. G. laboratories are working, in connection with the German postoffice, on ultra short wave sound and picture transmission, and have developed new instruments for sound films. They have a new camera which is unbelievably fast, capable of taking thousands of pictures per minute. I know this sounds

impossible, but we checked it and they insisted they knew what they had. It catches very minute movements such as a bullet leaving a gun, and the breaking of a piece of glass.

This camera enables them to study welding and the fusing of metals. It has opened up a big new field for the study of chemical action and they expect that when it is used in conjunction with some of their powerful miscroscopes, they will be able to see just what happens when electrons enter atoms.

The German aviation center at Berlin is similar to our Langley Field. At the present time they are working on very large airplanes which will carry many more people than those in use today, but the plane that they are most enthused about is one in which the body is equipped and sealed, so that the barometric pressure of sea level will be maintained constantly. They expect this plane to be able to rise 50,000 feet in the air, and, knowing the greater speed attainable at these higher altitudes, they are quite hopeful of breaking present flight records.

The Krupp Steel Works at Essen have the largest forging press in the world. They have an excellent method of cleaning smoke, and the air in the vicinity of the plant seems much cleaner than the air around Buffalo. The smoke is taken into tremendous tanks where it is chemically and electrically cleaned. The carbon obtained in this manner has a value equal to the cost of the cleaning.

Germany now imports half of her hides and 80 per cent of the tanning material she uses. To overcome these imports, they are developing substitutes. They admitted that it is almost impossible to find a satisfactory substitute for hides, but they have developed an artificial leather which is working out satisfactorily for shoe uppers.

One method being used to overcome their leather shortage is the elimination of skin diseases in animals. This is a real problem due to the warble fly, an insect which deposits its eggs on the skin of the animal causing holes in the hide, thereby making much leather unfit for use. They are making real progress in coping with this problem, for during the past three years hides so damaged have been cut down to 18 per cent. In some sections of the United States warble fly damage runs as high as 90 per cent.

Much work has been done to obtain substitutes for tanning materials, and one commonly used contains iron, of which they have plenty, instead of chrome, which is scarce. Methods are also being developed to reduce the shrinkage caused by tanning.

At the Institute for Fluid Motion at Berlin, a problem being attacked is the streamlining of high speed locomotives and buses. All through Germany the bottoms of old and new locomotives and railroad cars are being inclosed to get the benefits of streamlining.

The Kaiser Wilhelm Institute for Wood Research at Eberswalde is doing considerable work with plywood impregnated with metals, and has developed a beech plywood impregnated with bakelite which is very strong. They have also developed what they call a radium wood which has been impregnated with oil. They have developed a new wood for beer barrels. This is a plywood, the center of which is beech, with both surfaces oak. The reason for the development of this wood was to enable them to save oak, but, through this plywood, they have also obtained a barrel that wears better.

Combination Floor and Carpet

Here they use the roots of pine trees, which are being dug up all over Germany, to obtain resins. They also use pine for turpentine and artificial silk. I learned, here, of a new development in flooring, perfected right in the United States, whereby the floor and the carpet are laid in one piece, joined together like a plywood. No dust can come between, and, inasmuch as dust causes much of the wear in carpets, this point was considerably stressed. It costs less to lay than when each material is handled separately, and it has other advantages which they believe will ultimately put it in general use for homes, office buildings and auditoriums.

Ship Locks Out of Date?

Just beyond Eberswalde, we saw the Ship Lifting Works, a new type of canal device to take the place of locks. Boats up to 1,000 tons enter into the lift, which looks like a very large bathtub, and the whole thing is raised by a gravity lift. This system is new in Germany, developed only three years ago, and they believe it is much more efficient than locks for speed in lifting. The boat we saw lifted was easily raised 350 feet, and was out of the Ship Lifting Works in less than 20 minutes.

The Brewery Research Laboratory in Berlin is the German center of technical information for brewing. Studies have to do with fermentation and other processes of brewing. They are experimenting to obtain fats, vinegar and sugar from wood, and working on the distillation of potatoes.

While at Düsseldorf, we visited the German Industrial Exhibition. Here they actually were making shoes with synthetic soles and heels as well as uppers; cell wool, a substitute for wool from cellophane; synthetic velvet; cloth out of broken bottles. They also told us they were working on cloth to be made in sheets like paper, rather than woven from thread. The process, however, still has many problems to overcome.

They were building rows of houses with glass tile in the roofs to get light for attics. They have developed wood with resin between narrow sheets, resulting in a material stronger than metal. They have developed a wall material made out of cell wool and cement, which is cheap and nice looking. They have developed railroad car wheels with large rubber inserts to minimize shocks. Here they showed us "mipolan" for flooring, to take the place of linoleum. It is much more beautiful, cheaper, and wears longer.

In Germany the children devote a few hours a week going around their neighborhoods picking up waste material like broken bottles and pieces of metal, paper and rags, and bringing it to central stations. At this exhibition they had a large room with some of this accumulation on one side and the synthetic products manufactured from them on the other side. It was quite impressive.

RESEARCH ASSISTANCE FOR INDUSTRY

"Buffalo-Business"

WHEN A MAN IS ILL, he gets a doctor, and if he is very sick, he has a consultation of the best physicians. If he has a legal problem, he retains a lawyer, and if he has a tax problem, he hires an accountant. But when he has a problem in his plant relating to materials, machinery or packaging, he too often gets into a huddle with his key men and spends time and money working on problems that perhaps are already solved if he only knew where to go to get those solutions.

Research is the remedy for many of the ills which have killed industry in the last lean years. Like a blood transfusion, it has poured new vigor into businesses whose products were outmoded or merely stale to the public appeal. All progressive business men admit the need of the laboratory to keep their industries in line with the very newest methods and products.

The great problem of the industrialist grows from the complexity of research itself. He may not realize that he is not looking in the right place for the solution of his problem, because he selects the laboratory that seems to him the most logical one to answer his question. But a scientist who starts out to find the answer to one need is very likely to discover in his path a number of quite different facts, relating to entirely different industries, from the one who hires him. For example, the Aluminum Company of America, besides being an outstanding authority on aluminum, is exceedingly expert on the manufacture of paper.

A manufacturer of wooden chairs might well try to solve his problems through the representatives of a lumber trade association. But if he knew how to make the right contact, he might find that he could produce a beautiful line with plastics. A hundred illustrations may be found in every-day business.

Obviously, only great corporations with huge funds can maintain elaborate research laboratories, while the small business man cannot even afford the services of a consulting engineer. Yet, if American business, or any business, is to be kept healthy, some connecting link must be made between research and the smaller manufacturer.

After analyzing these conclusions, the Liberty Bank decided to do a little research of its own. It contacted manufacturers of the Niagara Frontier and found that invariably they appreciated the value of research, but many felt they could not afford it. The Bank then called on research laboratories of large corporations such as General Electric, Eastman Kodak, Goodrich Rubber and Gulf Oil, and found that the facilities of these laboratories are available for manufacturers who might be prospects for their products. The idea that a bank might be the connecting link between the smaller manufacturer and the large research laboratory was put forth. Contacts were made so that problems in materials, machinery and packaging could be taken to the proper laboratory to obtain the assistance of specialists. The outstanding research laboratories of England, France and Germany were

visited, and today the Liberty Bank has contacts with laboratories all over the world, where they know definite experts for definite problems. These people are by no means philanthropists. A steel man knows, for instance, that if he assists a manufacturer in obtaining the kind of steel that is better fitted for his work, that manufacturer is quite likely to buy some of his steel.

As every industry has found in recent years, services are often the largest part of selling. When competition is strenuous, as in the gasoline and oil trade, the various companies vie with each other in the number of smiling young men who will rush out to wipe windshields, fill radiators and sell the products. Heating industries offer trained engineers to show the householder how to save money on fuel and never have to shovel coal.

Perhaps the largest part of a thorough public relations system is the offering and maintenance of courteous and really valuable service. When clients are companies, rather than single individuals, the most valuable service that can be offered is assistance in the conduct of business itself. Institutions of all kinds are discovering new ways of giving such assistance to their clients. This is but one of the many interesting ways in which it is done.