FRIEDRICH BERGIUS (1884-1949)

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WHEN Harvard University at its Tercentenary in 1936 conferred an honorary Sc.D. on Friedrich Bergius the citation read: "A modern magician, his knowing touch transforms coal to oil." This reference, of course, was to the Bergius process of "liquefying coal," a popular designation of a most successful method of producing gasoline and other hydrocarbons from coal by treatment with hydrogen at high temperatures and pressures. Another achievement along this line is the Bergius method of producing light oils and gasoline by subjecting heavy petroleum oils to the action of hydrogen during cracking. His pressure method of producing phenol from chlorobenzene is in large scale use, and the transformation of ethylene into glycol has been carried far toward technical realization. The last of his great endeavors was the "saccharification of wood," *i. e.*, the hydrolysis of wood and other vegetable materials, from which, by the action of concentrated hydrochloric acid, there result glucose and syrups. These can be utilized directly for human and animal feeding, or if subjected to fermentation the products are alcohol, albumens, etc. These ideas were carried through laboratory and pilot plant stages and eventually into technical practice. The Bergius processes for obtaining gasoline and making "ersatz" food and fodder from wood were essential factors in Nazi war economy.

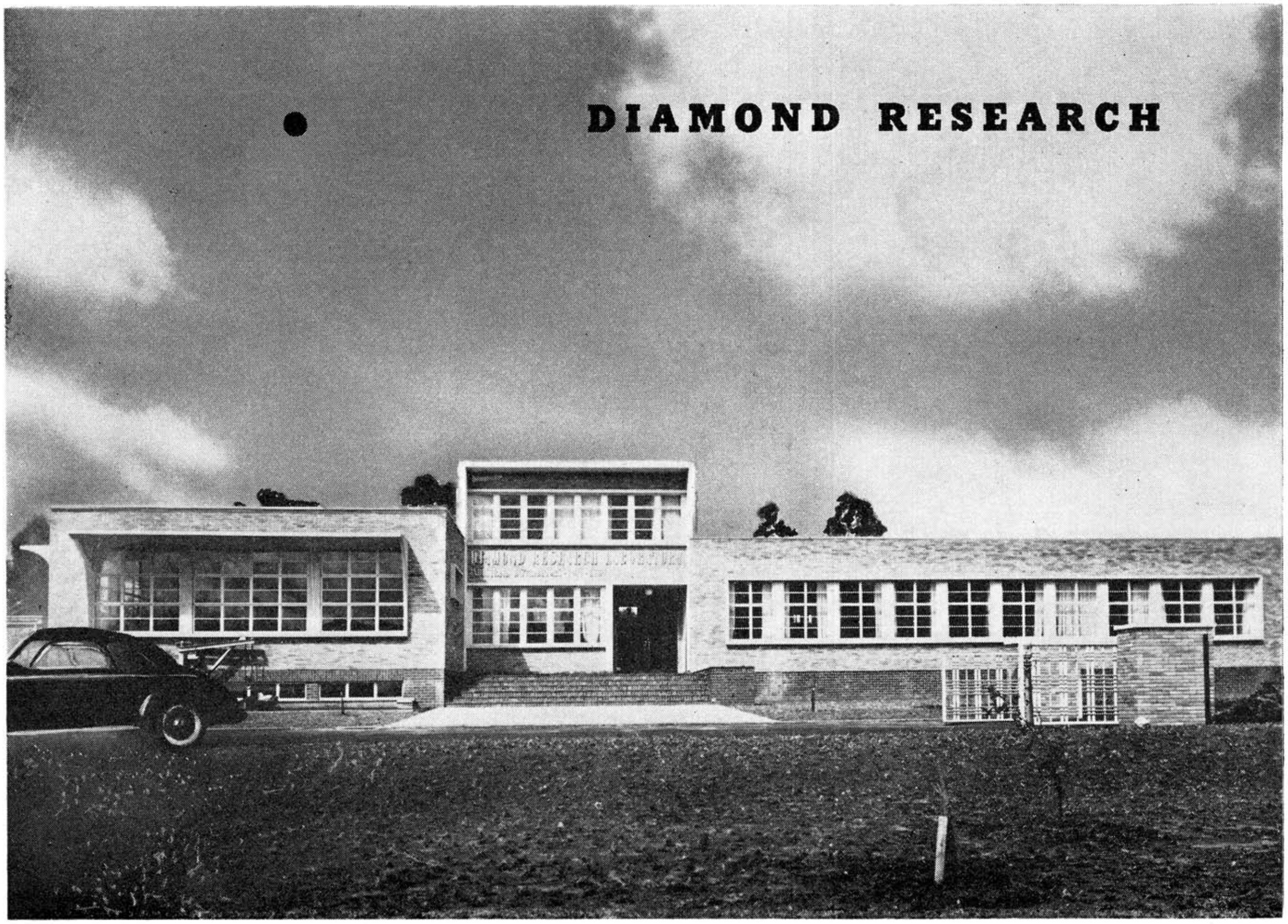
Friedrich Bergius was born at Goldschmieden, near Breslau, on October 11, 1884. His father was proprietor of a chemical plant, and doubtless the son received from him much of the understanding of technical chemistry and economics that characterized his later professional career. After taking his doctorate in chemistry in 1907 at Leipzig, he spent two years in further study, first with Nernst at Berlin and then with Haber at Karlsruhe. The latter introduced him to the reactions carried out under heat and high pressure. In 1911, Bergius became Privatdozent at Hanover, where he lectured on physical and technical chemistry. He also opened a private research laboratory where he began to investigate the difficult problem of the origin of coal. These studies led him into the possibility of hydrogenating coal and oil with the object of converting solid fuels into liquid combustibles. Numerous patents resulted.

In 1914 Bergius became associated with the Goldschmidt Aktien Gesellschaft at Essen and took over the headship of its scientific laboratory. The famous Bergin Works at Mannheim-Rheinan were begun in 1916, but the Bergius process of coal liquefaction required ten years of research and the expenditure of $3,000,000 before its practical success was assured. Factories were built in various parts of Germany. The I. G. Farben Industrie purchased rights to the process and Standard Oil of New Jersey secured the American rights.

The story of the Bergius process of wood hydrolysis is told by Glesinger in his recent "The Coming Age of Wood." According to this author, the inspiration came from Erik Haegglund, the internationally known Swedish authority on wood chemistry. Haegglund worked on the problem around 1917, took out the basic patents, and then devoted himself to other topics. Bergius persuaded Haegglund to join forces with him and the Bergin corporation was formed. Bergius induced Dutch capitalists and Scotch distillers to invest $1,000,000. After preliminary tests in Switzerland, a full sized plant was erected at Rheinau. "Soon the first money was spent, and Bergius got his backers to put up another million dollars. In 1936, however, when Bergius suggested that they double the stakes once again, they balked and let the Nazi government secure for almost nothing the complete control of a process which was to attain crucial importance for Germany's war effort." In 1945 Bergius sought permission from the American authorities to resume production of protein food and sugar from waste wood, but the request was not granted. He then left Germany and after several years in Spain went to Argentina late in 1948. Here he was engaged as technical adviser in the Combustibles Division of the Ministry of Industry. At Buenos Aires, however, his death came only a few months later, March 30, 1949.

This eminent chemist, successful industrialist, and keen business man visited America on several occasions, participating particularly in international bituminous coal conferences at Pittsburgh. The record of his publications from 1925 to 1938 shows at least one important, comprehensive discussion almost each year, many of these representing major addresses at international conferences. Honors came to him from U.S.A., England, and his own country. These included numerous medals, honorary memberships in scientific and technical societies, and honorary degrees. In 1931, the Nobel Prize for chemistry was equally divided between him and Carl Bosch (chiefly responsible for the technical application of the Haber process) "for their services regarding the invention and development of chemical high-pressure methods."

DIAMOND RESEARCH



R. S. YOUNG

Diamond Research Laboratory, Johannesburg, South Africa

In the city of Johannesburg, South Africa, is situated a unique organization, The Diamond Research Laboratory, devoted to investigations in all phases of the diamond. This laboratory was established two years ago by the leading diamond mining companies of the world to assist all who produce or use diamonds.

Although a great deal of work has been done in several universities and research institutes on the crystal structure of the diamond, the Diamond Research Laboratory is the only institution in the world investigating the diamond from the earliest stage of extraction to its final disposition in a tool or as a gem. It is appropriate that such a laboratory should be located in Africa, since nearly all the world's diamonds are obtained from that continent. The international scope of the diamond industry is indicated by the support of the Laboratory from South African, British, Belgian, and Portuguese diamond mining corporations.

The work done may be divided into two categories:

(*a*) Short-term, practical problems, submitted by the primary producers to increase output, by manufacturers or users of industrial diamonds to improve performance of tools, etc., or by cutters and polishers to assist the gem side of the industry.

(*b*) Long-term, theoretical studies on the chemical, physical, and mechanical characteristics of the diamond which determine its industrial and engineering properties.

For administrative purposes the Laboratory is divided into six sections, and a good idea of the research facilities available may be gleaned from a brief description of these divisions.

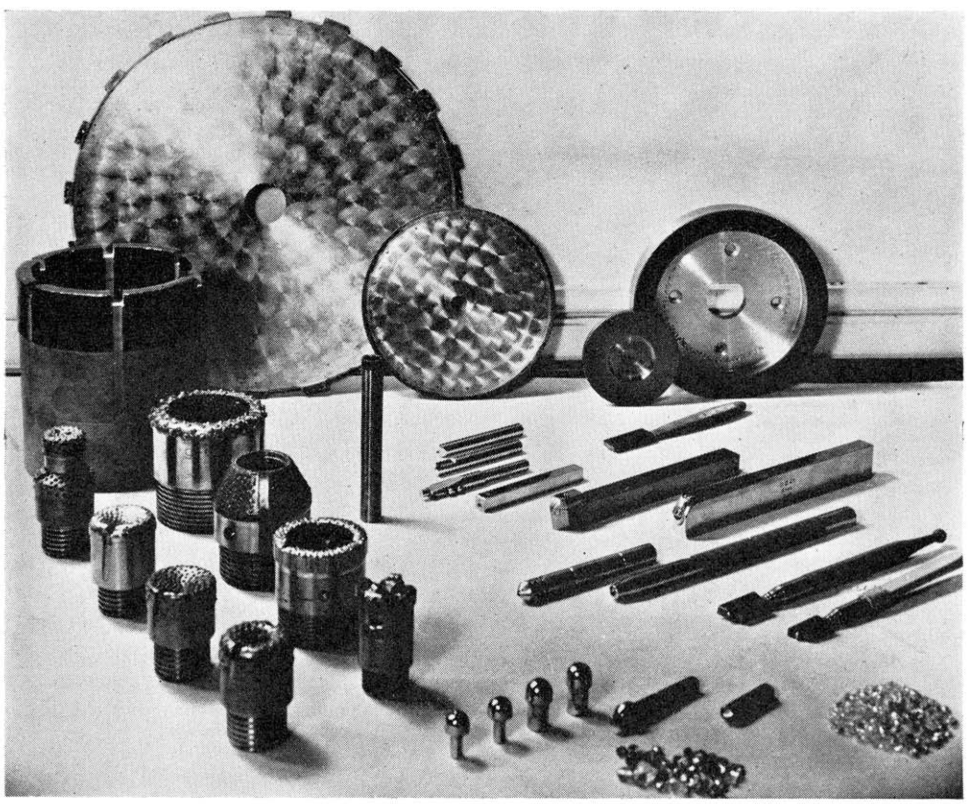
Chemical. A well-equipped chemical laboratory enables analytical and chemical engineering studies to be made on the ores, waters, and mineral dressing reagents of the mining companies; on the metals and alloys, ceramic materials, and plastics used as matrices for diamond tools, grinding wheels, and drill crowns; on cleaning diamond powder and the determination of impurities in diamonds; the reclamation of diamonds from used bits and tools.

Cutting and Polishing. This section, comprising a small but complete commercial cutting shop, has two main functions. Investigations are made into the ancient art of diamond cutting and polishing to determine whether improvements can be effected by the application of scientific and engineering principles. Is it possible for instance, to speed up sawing and polishing operations by the aid of an electric current?

The second function of this section is to cut and shape diamonds for the research purposes of the other divisions. If it is desired, for example, to study the effect of various orientations and types of mounting on resistance of abrasion of diamond tools, stones may be cut at the laboratory to any required specification.

Drilling. Although a diamond drill may be considered a tool, the great importance of diamond drilling as an outlet for industrial stones, and the peculiar problems of this field, demand a separate section for its investigations. A small pit adjacent to the basement serves as a test chamber into which blocks of rock may be lowered for drilling work. Research will be conducted on the variables in drilling, such as speed and pressure, composition of crown matrices, and improvements in setting diamonds.

Engineering. The engineering section is attempting to improve existing types of diamond tools and to extend the uses of the diamond in industry. The diamond is used in lathe tools, grinding wheels, wire drawing dies, gages, masonry saws, thread grinders, glass cutters, and many other purposes in fabricating industrial material where its great hardness ensures high accuracy and fine finish. Diamond-impregnated tungsten carbide now fulfills the demand for a super abrasive in many applications.



Various Types of Diamond Tools for Cutting, Drilling, Machining, and Grinding

The improvement of diamond tools not only entails better preparation of diamond powders to give greater uniformity in size and shape, improved orientation of diamond, possible heat treatment, but also includes the development of harder and stronger matrices which will hold the diamond particle rigidly and tenaciously. Since the diamond is adversely affected by high temperatures, powder metallurgical processes for forming a holder for diamond tools are growing in popularity.

Metallurgical. In this division research work is proceeding on improvements in the recovery of the smaller sizes of diamonds. The latter are greatly in demand for industrial purposes and extraction methods hitherto employed have not given satisfactory recovery of these sizes.

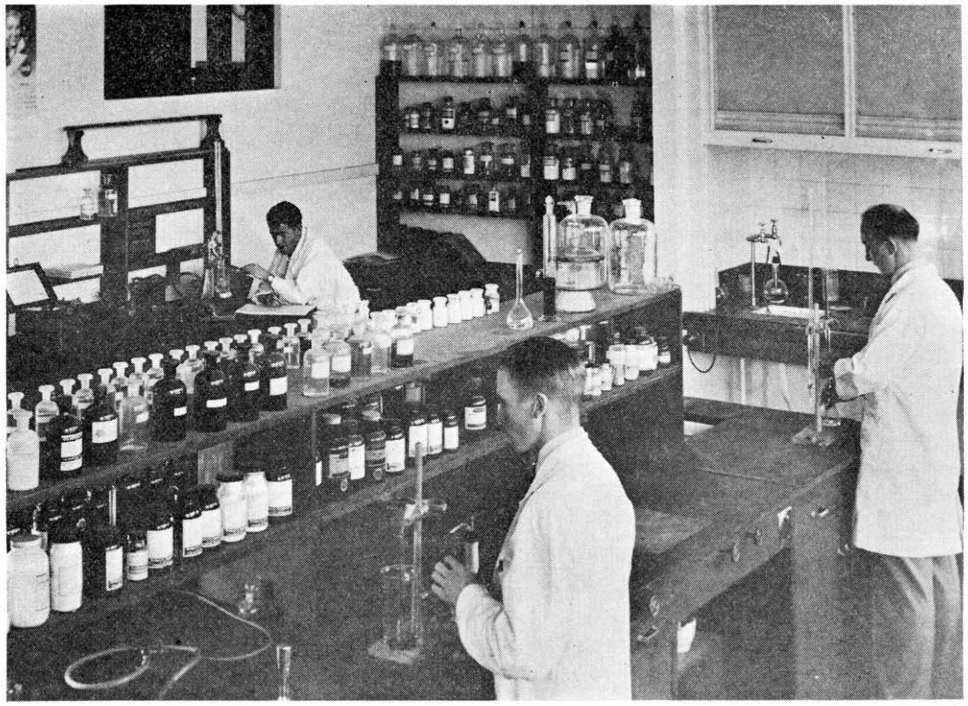
Processes employed for recovery of diamonds from gravel or ground have until recently depended upon two properties, gravity and adhesion. Diamond, with its specific gravity of 3.5, is appreciably heavier than the usual silicate rock having a gravity of 2.8, and gravity methods of separation can be employed to obtain a concentrate of diamonds together with the heavier minerals. This concentrate, in the form of a wet pulp, is then passed over an inclined table covered with grease. Diamonds have a water-repellent surface and adhere to the grease, whereas most of the gangue minerals are wetted by water and will not stick to the grease surface.

Unfortunately, diamonds from many localities will not adhere to a grease surface, and a final separation cannot be carried out by this means. Hand sorting of the entire gravity concentrate must be resorted to, and it is manifestly impossible to recover all the small diamonds by this means. One of our major projects is to find out why certain diamonds are hydrophilic, and to modify their surface by addition of reagents to render them water-repellent and therefore adherent to a grease surface.

Another process which the Laboratory is developing to improve the recovery of smaller sizes of diamonds is electrostatic separation. This is based on the nonconductance of diamonds and the weak conductance of gangue minerals when a dry stream of diamondiferous gravel is dropped through a high tension discharge passing between two electrodes. By recirculating the feed several times an excellent separation of diamonds from gangue can be effected.

Alone of all the mining and metallurgical industries, diamond companies have never been able to determine the value of their incoming feed and outgoing tails, owing to the impossibility of chemically differentiating diamond from other forms of carbon. We hope that laboratory model electrostatic separators will enable an accurate determination to be made of the diamond content of representative samples of mining products.

Physical. This section embraces microscopical, spectrographical, and X-ray investigations on the diamond itself, on ceramic and metal matrices for diamond tools or crowns, and on complementary or competitive products like tungsten carbide and synthetic sapphire.



A Section of the Chemical Laboratory

The diamond has long attracted the interest of crystallographers, but their investigations have been nearly invariably concerned with gemstones, and the effect of color, flaws, inclusions, and coatings found in industrial diamonds on their physical properties has not been studied.

The experimental facilities of the Diamond Research Laboratory at Johannesburg, together with the abstracting and bibliographical services of the Industrial Diamond Information Bureau at London, provide users of diamonds throughout the world with data and advice on problems of the industry. Close cooperation is maintained with workers in the abrasives and related industries, precision engineering, diamond drilling, and gemstone production.

The great abrasive companies in the United States stand as monuments to the laboratory and research programs of these organizations. There is no reason why the progress in the field of synthetic abrasives cannot be duplicated for the hardest substance of all.

Chemistry is the cornerstone of the Diamond Research Laboratory, and one or more of the divisions of that science enter into nearly every project in the program. Inorganic chemistry is vital to studies of the impurities in the diamond, to a knowledge of the properties of the metals and ceramics used to hold a diamond in a tool, die, or drill bit, and to an understanding of the behavior of associated minerals in metallurgical processes. Organic chemistry is essential in studies on plastic and rubber-bonded matrices for diamond tools, on greases, wetting agents, and water repellents used in the recovery processes. Analytical chemistry, here as elsewhere in research organizations, is the foundation on which much of chemical science rests. The principles and practices of physical chemistry are brought to bear on problems of wetting of surfaces, surface phenomena in electrostatic separation, the bond between diamond and the matrix, reclamation of diamonds from used drill crowns by electrolysis, the processes of powder metallurgy now so widely used in forming diamond drill crowns, dies and tools, and the preparation and cleaning of diamond powders.

The diamond, for centuries prized only as an article of jewelry, is now in the front rank of key industrial commodities. Its value depends on the distinctive properties of the tetrahedral carbon atom. Its future depends on a vigorous program of research, in which the role of chemistry is fundamental.