GABOR, DENNIS

June 5, 1900- Scientist; educator; inventor
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Although the Nobel Prize in Physics is rarely awarded to an inventor, Dr. Dennis Gabor received that honor in 1971. Gabor was cited for his invention and development of holography—a lenseless system of three-dimensional photography that is probably the most important development in optical science in the twentieth century. Currently a staff scientist at the Columbia Broadcasting Systems laboratory in Stamford, Connecticut, and professor emeritus at the Imperial College of Science and Technology in London, Gabor spends about half of each year in the United States and the rest of the time in London or in his villa near Rome. The idea of holography, which first occurred to him one day in 1947, while waiting for his turn at a tennis court in Rugby, England, has had many practical applications in industry, medicine, and communications and promises broader future application.

Dennis Gabor was born on June 5, 1900 in Budapest, Hungary, the first of three sons of Bertalan and Adrienne (Jacobovits) Gabor. His father, the director of the great Hungarian General Coal Mining Company, helped inspire his son Dennis to become an inventor by telling him about the careers of such men as Thomas Alva Edison. He still remembers the excitement that he felt on his first trip to the museum of technology in Budapest when he was thirteen. After graduating from a secondary school in Budapest in 1918, the final year of World War I, Gabor briefly served in the Hungarian artillery. Following his discharge in November 1918 with the rank of sergeant, he enrolled in the Technical University in Budapest. In 1921 he left Budapest for Berlin, whose educational institutions were then attracting students for advanced degrees. Gabor chose the Technische Hochschule in Berlin, which granted him a diploma in electrical engineering in 1924. He received his doctorate in electrical engineering in 1927 for a thesis on the development of a high-speed cathode ray oscillograph for recording microsecond phenomena.

One of Gabor's laboratory assistants at the Technische Hochschule was Peter Goldmark, a fellow Hungarian who later became president of the Columbia Broadcasting Systems laboratory in Stamford, Connecticut. Goldmark remembers how Gabor built his own research instruments with infinite patience and superlative skill instead of relying on the primitive electrical engineering equipment of that period. Gabor often rewarded Goldmark's good work by providing him with a generous supply of Hungarian salami. In 1927 Gabor became a research engineer with Siemens and Halske, a large electrical company in Berlin, where he worked on gas discharges and invented a molybdenum ribbon seal in quartz.

DENNIS GABOR

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The rise to power of Nazism in Germany forced Gabor to flee the country in 1933. He returned to Hungary and shortly afterwards went to England, where he found himself unemployed and without a work permit because Britain refused to grant work permits to foreigners during the Depression. However, one of his early inventions—a plasma lamp—so convinced the Thomson-Houston Company of Rugby of his talents that they overcame government regulations and hired him as a research engineer. Gabor, now a naturalized British citizen, looks back on the plasma lamp as a failure: although it was more efficient than an incandescent light bulb, the lamp was not as long-lived.

During his years with the Thomson-Houston Company, Gabor invented holography. The problem of how the image of an object is trapped by a photographic plate had intrigued him from the time he was seventeen, but it was not until thirty years later that he could devote intensive research to it. Trying to overcome defects in the resolving power of the electron microscope, he used a beam of light with wavelength or color as his light source. He found that not only were the limitations in the resolving power transcended but, more importantly, that the image so photographed appeared in three dimensions when illuminated.

"It is often stated that I invented holography by watching the flight of tennis balls," Gabor wrote in a questionnaire submitted to him by *Current Biography*. "In fact, I was sitting on a bench before our tennis club in Rugby one fine Easter morning in 1947, thinking how to improve the electron microscope." The New York *Post* (November 6, 1971) quoted him as explaining: "I put the problem into my own consciousness, and it came out of my unconsciousness when I was sitting on a bench in a tennis court. . . . One never gets ideas at a desk. One gets intuitions in the bath, while shaving in the morning, or in railroad trains." He has described holography as an invention as well as a discovery. The name "holography" derives from two Greek words—one *holos*, meaning "whole," and the other *graphos*, meaning "something written or described." By using the principles of holography, a scientist can now take a three-dimensional photograph of an object that he happens to be studying.

In Dr. Gabor's original experiments a beam of coherent light—a light of uniform wavelength—was split by a mirror so that it was simultaneously directed at the object being photographed and at a photographic plate called a hologram. The design of the object—its interference pattern—was caught on the photographic plate. The picture on the hologram has been variously described as having the appearance of grainy wood or drifted sand when observed with the naked eye under ordinary light. When the same coherent light used to make the photograph illuminates the hologram, however, a full-sized, three-dimensional picture of the object appears. An observer can peer around the object in the hologram by simply changing his position. much as one could see the other sides of the real object by moving his position. The hologram also offers the extraordinary advantage of being able to project, even when mutilated, a complete image of the object originally recorded. The early results of Gabor's work on the electron microscope were published in his book *The Electron Microscope* (Hulton, 1946). His most famous article on holography is "Microscopy by Reconstructed Wavefronts" (1949).

Since sources of light available at the time of his invention were not strong enough, Gabor's hologram could not at first be utilized. Finally, in 1962, an extremely intense light source—the newly invented laser—was used by three scientists from the University of Michigan, Emmett Leith, Juris Upatnieks, and George W. Stroke, to create a vivid hologram. Not long after that, two teams of scientists working independently at the Bell Telephone laboratories and at the University of Michigan succeeded in producing holographic pictures in natural color that were illuminated by ordinary white light.

The holographic method, which has already had many varied applications, may provide even greater benefits in the future, including three-dimensional movies and television. Industry has used holography to test for defects in solid objects and deformities in such invisible objects as the bonding between layers of rubber in auto tires. It has also been used for precise measurement of finely machined tools and has been applied to component testing and the storage of computer data. In medicine, the National Science Foundation has given a grant to Gabor, Goldmark, and others to develop a technique for ultrasonic holograms, the objective being the production of three-dimensional images of the heart. Such diagnostic pictures would contain more information than X rays, and eventually, the new technique might replace X rays and the hazards associated with them. In communications, Dr. Gabor has recently received a patent for a projection screen on which three-dimensional motion pictures can be viewed without the aid of special glasses. Three-dimensional color television also looms as a possibility.

Long before the development of the laser in 1962, however, Dr. Gabor had been pursuing his research. In 1949 he left the British Thomson-Houston Company to accept an appointment as associate professor in electronics at the Imperial College of Science and Technology of the University of London, where he was able to devote more of his time to research. In 1958 he was appointed professor of applied electronic physics and remained in that post until 1967, when he was made professor emeritus and a senior research fellow of the Imperial College. He has continued to contribute inventions to industry and now has more than 100 patents to his credit. In addition to dedicating much of his time to research, Gabor has given a great deal of his attention to the grave social problems originating from the acceleration of technological advances in the 20th century.

He is far from optimistic about man's future. In an interview with Alvin Krebs of the New York *Times* (November 5, 1971), he noted that "man is a fighting animal" who creates material goods as a sign of growth and is motivated toward self-destruction. In the same interview, he concluded that "the triumph of technology and science has brought us face to face with irrationality. We have to fight not nature but man's nature." His social philosophy includes what he calls the "trilemma," or the three greatest dangers confronting humanity: overpopulation, the nuclear bomb, and an excess of mass leisure. Convinced that they are the root causes of world anxiety, decaying cities, and the boredom afflicting large segments of society, Gabor predicts that urban violence and drug addiction will dominate the human condition as long as those dangers exist. Further technological advances, Gabor believes, will not end those problems but only increase their urgency. Unless there are drastic changes in educational goals and radically new approaches to industrial and urban planning, a great social upheaval will take place, an upheaval that could end in totalitarianism. Dr. Gabor presents his somber reflections in three books: *Inventing the Future* (Secker & Warburg, 1963; Knopf, 1964), *Innovations, Scientific, Technological and Social* (Oxford, 1970), and *The Mature Society* (Secker & Warburg, 1972; Praeger, 1972).

Before receiving the Nobel Prize in 1971, Dr. Gabor had received many other awards and honors for his work. He became a fellow of the Royal Society in 1956 and has been an honorary member of the Hungarian Academy of Sciences since 1964. He has been awarded the Thomas Young Medal and Prize of the Physical Society, the Cristoforo Colombo Prize of Genoa, the Rumford Medal of the Royal Society, and the Michelson Medal of the Franklin Society. His other honors include the Medal of Honor of the Institute of Electrical and Electronics Engineers, the Semmelweiss Medal of the American-Hungarian Medical Association, and the CBE (Commander of the

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Order of the British Empire). Since 1958 his club has been the Athenaeum in London.

In 1936, while working with the Thomson-Houston Company at their Rugby works, Dennis Gabor met Marjorie Louise Butler, whom he married on August 8, 1936. In an article in the New York *Post* (November 6, 1971), he described his wife as "one of those rare people who can be perfectly happy without an occupation and can make other people happy. . . . It's a rare talent." The couple have no children, and the only other surviving member of Gabor's immediate family is his brother, André, a professor of economics at the University of York in England.

The Hungarian-born scientist is a relatively short and sturdy man with a gray mustache and thinning brown hair. He speaks softly but with a strong Hungarian accent, is meticulous in dress, and courtly in manner. Although Dr. Gabor says that he would not be able to live without working, he still finds time for swimming, sunbathing, reading, and writing. His reading is wide enough in scope to include poetry, particularly Rilke and Valery, from whom he can quote extensively.

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