a history of medicine in pictures

by George A. Bender

painting by Robert A. Thom

Röntgen: Invisible Rays that Save Lives

THE NEW YEAR of 1896 had dawned, and the postholiday party at the home of Franz Exner was a gay one. The Professor of Physics at the University of Vienna looked about to see that his guests were well cared for, then turned to a young colleague, physicist Ernst Lecher, and said: "You'll be interested to know that I have just received a most remarkable pamphlet from my good friend, Professor Röntgen, in Würzburg. You remember, we used to work together in Professor Kundt's laboratory. It seems that Professor Röntgen has discovered a remarkable new ray. You can't see it —but it passes right through wood, paper, and almost anything. You can photograph weights in a box without opening the lid. You even can see the bones in your own hand. Here, let me show you the photographs he sent along..."

Ernst Lecher looked at the photos; read a few lines from the little pamphlet which bore the title: *On A New Kind of Rays.* Excitedly, he called to his father, who was standing near by. Z. K. Lecher, the father, was editor of the Vienna *Presse.* At first astounded, he soon recovered his aplomb and recognized the ingredients for a great news story.

The story appeared on the front page of the *Presse,* Sunday, January 5, 1896. To the facts set forth in Professor Röntgen's pamphlet, the editor added a few


ROBERT

enthusiastic conjectures of his own. He predicted many possible uses for these mysterious, newly discovered "x-rays," as they were called. He even contended that they might find a place in medicine, perhaps in diagnosis of diseases and in treatment of injuries of bones.

The Vienna representative of the London *Daily Chronicle* cabled the story to his paper, wherein it appeared the following day. The *Frankfurter Zeitung*, the Paris *Matin*, and many others soon had the story, as did New York newspapers. By the second week in January, leading medical journals world-wide were commenting on the possibilities of x-rays. Physicians, physicists, and photographers were repeating Röntgen's experiments, and devising new ones. Within four days after arrival of the news in the United States, x-rays had been employed by a physician to locate a bullet lodged in a patient's hand.

Thus in a few weeks was Wilhelm Conrad Röntgen, Professor of Physics, Director of the Physical Institute, and Rector of the University of Würzburg, Germany, catapulted from the semiobscure, quiet life of a researcher and teacher to that of an international celebrity. It came about because his research-trained mind demanded that he look into the cause of what at first seemed a minor laboratory curiosity.

Professor Röntgen had first observed the phenomenon he named x-rays, on Friday, November 8, 1895. Over the week end, he took advantage of absence of students to reconfirm his findings. Then came weeks of feverish experimentation, and writing of notes on findings. Röntgen did not tell students or fellow teachers of his experiments for fear they would think him out of his mind. Rays that could penetrate flesh, paper, wood, most metals; that could cause a screen coated with barium platinocyanide to fluoresce, even in the next room, with the door closed! Röntgen himself could hardly believe his eyes. Cathode rays created in the Hittorf-Crookes tube he was using, would cause fluorescence if the screen were held only a few centimeters from the tube. When the tube was covered with a black cardboard mask, such as he was now using, cathode rays were shut in, just as were visible light rays. But the x-rays—they penetrated the cardboard; they penetrated a 1,000-page book; they penetrated wood; they penetrated flesh, showing bones clearly as darker shadows; they exposed photographic plates that were securely protected from visible light. Here, indeed, was a phenomenon unheard of before.

Convinced at last that his observations were sound, proved by repeated experimentation, Röntgen realized the need for immediate publication. Just after Christmas, he presented his manuscript to the secretary of the Würzburg Physical Medical Society. It was published in the last pages of the year's final issue of the *Sitzungsberichte der Physikalisch-Medizinischen Gesellschaft zu Würzburg*. On New Year's Day, 1896, Professor Röntgen mailed reprints, together with prints of his photographs, to a number of his physicist friends. Among them was Professor Exner of Vienna.

The fame that was about to come to Professor Röntgen in his fiftieth year of life was not achieved easily. Born March 27, 1845, in the German town of Lennep in the Ruhr valley, the son of a textile merchant, Wilhelm Conrad Röntgen grew up in Apeldoorn, Holland, to which city his parents had moved when he was three years old. An only child, his schooling was somewhat erratic. He demonstrated an ability for making mechanical gadgets, and had no difficulty with schoolwork until the prank of a schoolmate got him into trouble. Refusal to reveal the name of the offender resulted in Röntgen's expulsion without being admitted to examinations so necessary to accreditation for higher education. Röntgen was allowed to study, without credit, at the University of Utrecht, and was accepted at the Polytechnical School at Zurich, Switzerland, from which he received a degree in mechanical engineering, August 6, 1868. Strangely enough, Röntgen, the great experimental physicist, never had a basic college course in physics.

Staying on at the Polytechnical School in Zurich after graduation, Röntgen took some additional courses, and attracted the attention of August Kundt, professor of physics. After a year in Kundt's laboratories, Röntgen submitted a thesis on *Studies on Gases* to the University of Zurich, and on June 22, 1869, received a doctor of philosophy degree from that institution. In Zurich, too, he met Bertha Ludwig, whom he married in 1872.

Röntgen's relations with Kundt were such that when, in 1870, the professor was called to the chair of physics at the University of Würzburg, he took Röntgen along as his assistant. At Würzburg, Röntgen met with double disappointment: first, the surroundings of the physics laboratories were poor, and the equipment meager; second, Röntgen was denied appointment as *Privatdozent*, or unpaid instructor (first step in the academic ladder) because of lack of the diploma denied him when he was expelled from preparatory school.

However, in 1872, a few months after Röntgen's marriage, Kundt took his assistant with him to the newly reorganized Kaiser-Wilhelm's University at Strassburg. In this new and broader minded university, Röntgen, after two years of hard work, was appointed a *Privatdozent* in 1874. By that time, his interest in conducting physical experiments equaled that of teaching. Consequent to investigations he had conducted with Kundt, Röntgen was offered a full professorship in physics and mathematics at the Agricultural Academy in Hohenheim. Due to inadequate equipment and facilities there, Röntgen was happy to return to Strassburg a year and a half later to accept appointment as an associate professor.

Meantime, Röntgen was developing a remarkable ability for conducting research, and for measurement of minute quantities of substances and of changes in their temperature due to altered physical conditions. His publications began to appear regularly in leading journals on physics.

In 1879, friends, including von Helmholtz, recommended Röntgen for the chair of physics at the University of Giessen. In 1880, a new physics building was built there, and Röntgen headed the institute.

Röntgen's interests were rapidly turning to problems of electricity. In 1888, his reputation was enhanced by experiments that proved and measured magnetic effects produced when a glass plate, or other suitable medium, was moved between two electrically charged condenser plates.

Röntgen received several flattering invitations to take professorships in physics at other universities, including Jena, and Utrecht (where he had once been denied enrollment as a regular student). These offers he declined; but when, in 1888, the University of Würzburg (which had denied him *Privatdozent)* offered him the post of professor of physics and director of the newly built physical institute, Röntgen could not resist. The Röntgens returned to Würzburg. Six years later, Röntgen was elected Rector of the University—its highest office.

As he reached his fiftieth year, Röntgen was a typical successful professor in a large university. His publications had made him well known among his colleagues. His abilities as researcher and teacher were recognized by his university, and flattering offers came from others; but the Röntgens preferred Würzburg. It was in this setting that Röntgen, in 1895, became interested in cathode rays, and in the work that had been done on them by Hertz, Lenard, Hittorf, and Crookes. Röntgen secured several types of cathode ray tubes, a Ruhmkorff induction coil, a Depres interrupter, and other apparatus, including a Raps vacuum pump. Repeating experiments of his colleagues with cathode rays, Röntgen confirmed them, and made some additional observations: the rays from the tubes darkened photographic plates, and they produced fluorescence in certain salts, notably, barium platinocyanide.

Working alone, as was his habit, on the afternoon of November 8, 1895, he had covered a tube completely with black cardboard. Wishing to test the opacity of the cover, he darkened the room. It was then that he discovered the screen, across the room, fluorescing. Unbelieving, Röntgen searched for an overlooked light source. Cathode rays could not be the cause of fluorescence. He checked and rechecked his experiments; he hardly took time to eat and sleep. This must be a new kind of ray—no known rays would penetrate opaque substances so readily; nor would they travel in a straight line, as did those produced in his experiments. The new rays also differed from cathode rays in that they were not deflected by a magnetic field. To them, Röntgen attached the mathematician's symbol for the unknown: he thought of them as x-rays; and as such, he reported them in his paper, *On a New Kind of Rays*.

Reactions were not long in coming. In addition to newspapers and medical journal reports, electrical, photographic, and general interest publications carried articles of varying reliability. From physicists and other scientists came congratulations, in the main; and a few disagreements, as well as insubstantial claims to priority. On January 13, 1896, Röntgen was called to Berlin to demonstrate his apparatus before the Emperor, Wilhelm II, and his guests. The Emperor decorated Röntgen with the Prussian Order of the Crown, II Class.

Meantime, Röntgen's colleagues at Würzburg were urging him to reveal his discovery

---

the picture At his first public demonstration of newly discovered x-rays, the evening of January 23, 1896, Wilhelm Conrad Röntgen (1845-1923) astounded a room filled with scientists. Professor of Physics and Rector of the University of Würzburg, Germany, Röntgen completed his demonstration by taking an x-ray photograph of the hand of the famed Professor of Anatomy, Albert von Kölliker. This led to discussion of possible medical applications, and within a year, x-ray equipment was being employed by medical men around the world as a diagnostic tool. Later research revealed many therapeutic applications, as well as the dangers, of x-rays.

Acknowledgment of helpful assistance in historical research basic to preparation of the text and of the picture, Röntgen: Invisible Rays that Save Lives, *is extended to Erwin H. Ackerknecht, M.D., Professor and Director of the Institute of the History of Medicine and Biology, University of Zurich, Switzerland; to Professor Robert Herrlinger, M.D., PhD., Director of the Institute of the History of Medicine, and to Privatdozent Dr. Heinrich Schröer, Physiologisches Institut, University of Würzburg, Germany; to Diplom-Physiker Helmut Schmiedel, Deutsches Museum, Munich, Germany; to W. R. Jeeves, Vice President and Director of Overseas Operations, to Carl Johnson, Vice President, Advertising and Public Relations, and to H. E. Carnes, M.D., Parke, Davis & Company, Detroit, Michigan.*

Printed in U.S.A.

to them. This event took place in the auditorium of Röntgen's own institute, the night of January 23, 1896. Every seat in the auditorium was filled. After explaining his experiments and demonstrating various properties of x-rays, Röntgen invited Albert von Kölliker, famous anatomist at the University, to have his hand photographed. Von Kölliker agreed, and within a short time an excellent photograph, revealing bones, flesh, and a ring in graduated shadows, were shown to the audience. Von Kölliker praised Röntgen's work as of the greatest significance, and suggested that the new force be designated "Röntgen rays." He also conjectured as to the possibility of photographing other structures of the body. Röntgen, who himself was never to use the term, Röntgen rays, expressed his willingness to give the benefit of his experience to anyone wishing to carry on further research in medical institutions. He refused to apply for patents.

Within the first year, experimenters learned to respect x-rays, and that they are agents of destruction and of death as well as being useful in diagnosis and in therapy. Physicians learned to shield themselves, as well as their patients, from unwanted effects.

Two further papers were published by Röntgen on the physical aspects of the new kind of rays: the second, March 9, 1896, in the same journal as was his first; and the third, March 10, 1897, in the bulletin of the Prussian Academy of Sciences, in Berlin. Meanwhile, dozens of honors were bestowed upon him. Röntgen was made an honorary citizen of Lennep, the town of his birth; he received the Royal Order of Merit of the Bavarian Crown, but turned down a proffered grant of nobility, which would have added the prefix *von* to his name. He continued his work in Würzburg until April 1, 1900, when he accepted an appointment as Professor of Physics and Director of the Physical Institute at Ludwig-Maximilian's University in Munich. In December, 1901, he traveled to Stockholm, and, in the year of its inception, he received the Nobel prize for his contribution to physics.

Röntgen continued his work at the University in Munich until retirement in 1920. Even then, two small laboratories were made available to him for continued work. At seventy-five years of age, however, he was a tired and lonely man. Once comparatively secure financially, World War I and the collapse of the German economy virtually impoverished him; and Mrs. Röntgen had died, October 31, 1919. Many of his friends were gone, too. Honors still came to him, but now they meant little. He experienced a feeling of great satisfaction from the progress that had been made in use of x-rays in medicine, and in industry. The demands of World War I had proved their value in both fields.

A victim of carcinoma of the gastrointestinal tract, Röntgen died, February 10, 1923.

What of Röntgen rays—or x-rays—over the ensuing years? Their diagnostic applications offered almost endless possibilities for development—but virtually all basic physical facts about the rays were established within two years after their discovery. As a medical student, Walter B. Cannon (later to become a famous physiologist at Harvard) demonstrated experimentally that a contrast meal could be followed through the stomach and the intestinal tract by use of x-ray equipment. Along with radium, discovered by Mme. Curie some three years later, x-rays were found to be valuable as a therapeutic agent.

The first twenty years of employment of x-rays were years of trials and errors, due to crudeness of equipment and to lack of understanding of their behavior. The next decade, which began with World War I, brought many advances. The 1930's placed a firm foundation under radiotherapy; and by 1940, reliable systems for calculation and control of x-ray dosage had been devised. The next twenty years, encompassing World War II, brought still greater advances in application of x-rays. Powerful machines that would have astounded Röntgen were developed, the rays of which may be focused effectively to alter malignant growths deep in the body.

From the pioneer research begun by Röntgen came the science of roentgenology. Following in rapid succession came related discoveries by other scientists: radium, the electron, radioactivity, nuclear fission, nuclear fusion, and preparation of radioisotopes. Each has been demonstrated to have power to improve and to save lives—as well as to destroy them. Only history, with benefit of perspective of centuries to come, will be able to evaluate truly the use which man will have made of the forces unleashed when Wilhelm Conrad Röntgen saw a ghostly green glow in his darkened laboratory.

REFERENCES

Ackerknecht, E. H., unpublished monograph.

Ackerknecht, E. H., *A Short History of Medicine.* New York, Ronald Press Co., 1955.

Bleich, A. R., *The Story of X-Rays from Röntgen to Isotopes.* New York, Dover Publications, 1960.

Burry, James, *A Preliminary Report on the Röntgen or X-Rays.* Journal of the American Medical Association, Vol. 26, No. 9, Feb. 29, 1896.

Fletcher, Gilbert H., *Recent Advances in Radiotherapy.* The New Physician, Vol. 10, No. 12, December, 1961.

Glasser, Otto, *Dr. W. C. Röntgen.* Springfield, Illinois, Charles C Thomas, 1958.

Illuminated Tissues. Medical Record, Vol. 49, p. 71, Jan. 11, 1896.

Leucutia, Traian, *Roentgen Therapy of Skin Cancer.* The New Physician, Vol. 10, No. 12, December, 1961.