History Page

The First Clinical X-Ray Made in America—100 Years

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On the occasion of the 100th anniversary of Roentgen's discovery in November of 1895, it is appropriate to commemorate the circumstances surrounding the first clinical X-ray made in America, which was published in an issue of *Science* in the Winter of 1896, 3 months after Roentgen's announcement.

"On January 19, 1896, young Eddie McCarthy of Hanover fell while skating on the Connecticut River and fractured his left wrist" [1]. He was attended to by Gilman D. Frost, M.D., Professor of Medicine at Dartmouth Medical School and Medical Director of Mary Hitchcock Hospital. Frost's brother, Edwin B., was Professor of Physics and Astronomy at Dartmouth College. A week later, a New York newspaper, *The Sun*, carried a front-page article that described Roentgen's discovery of the X-ray in more detail than earlier dispatches and observed that:

> Never in the history of science has a great discovery received such prompt recognition and has been so quickly utilized in a practical way as the new photography which Professor Roentgen gave to the world only three weeks ago. Already it has been used successfully by European surgeons in locating bullets and other foreign substances in human hands, arms and legs and in diagnosing diseases of the bones in various parts of the body. [2]

Edwin Frost, in an article written many years later in the *Dartmouth Alumni Magazine*, recalled reading the article in *The Sun*: "When the cable hints were received about Roentgen's success, it immediately seemed worthwhile to test the numerous vacuum tubes in our laboratory for their capacity to produce the mysterious rays" [3].

It was Howard H. Langill, a prominent local photographer and member of the Dartmouth Scientific Society, who saw this newspaper story first. He inspired Frank Austin, a recent graduate and an assistant in the Dartmouth Physics Laboratory, to test each of the dozen or so Crookes vacuum tubes in the Dartmouth collection to see which ones would produce the new X-rays. Many institutions and scientists in possession of Crookes tubes were also searching for ways to produce the "new kind of rays":

> The tubes were donated to the college by a friend of the college. It was said at that time to have been the finest collection of vacuum tubes in America. These tubes were designed in Austria, I think, to show the colors given off by different gases and substances when "energized" by high-pressure discharges from induction coils. Mr. Austin became interested in the collection and hit upon the idea of testing them for the newly discovered X-rays. He arranged a battery with so called "Grenet" cells to operate a large induction coil and with ordinary photographic glass negatives in camera plate holders began a systematic exposure of the plates placed beneath the tubes with a number of objects placed on the outside of the plate holders, which were of hard rubber. After a dozen or so tubes were used Mr. Austin found just one that would give off X-rays. (Personal communication, Professor Frank E. Austin, September 13, 1957)

The tube was connected directly to a Holtz static machine or batteries through an Apps inductions coil[a] to produce the high voltage necessary to power the tubes. Photographer Langill provided 25 gelatin plates to make the search possible. Austin's initial subject was probably his keys, but he also X-rayed a wooden case of Leyden jars that had been used by Benjamin Franklin, some of which are still in the Physics Department at Dartmouth College. He also X-rayed his own hand, a photograph of which survives, but the date is uncertain.[b] Only one tube produced X-rays. It was a Puluj tube made by Stoehrer of Leipzig and numbered "1147" in the manufacturer's catalog, and it differed from the other Crookes' tubes because it had a piece of mica coated with a phosphorescent material across its interior in an oblique position. "This was an oblong cylindrical glass tube about two

[a] Many physicists at the time were studying cathode rays produced in many variations of the original Crookes vacuum tube. Equipment to produce high voltages was also commonly used with Crookes tubes. Induction coils such as the Apps coil changed low voltage, high amperage primary current into a very high secondary voltage by rapid breaks and reconnection in the current flow. This was, therefore, alternating current, of a sort, at approximately 500,000 volts, although precise parameters are not known. The Holtz static machine was a glass disc that was crank-turned between two brushes to collect the discharge.

[b] "In the early 1880's Professor Johann Puluj of the University of Vienna devised a type of Crookes tube which was splendidly adapted for the production of X-rays, although he was quite unconscious of this fact. He placed a sheet of mica obliquely across the interior of the tube and covered the mica with phosphorescent material. This gave a fine display of phosphorescence and the cathode rays developed a large quantity of X-rays as they fell upon the salts. There is no doubt that many of these tubes had been generating X-rays in laboratory demonstrations for more than a dozen years before anyone knew it." (Notes from Professor E. B. Frost made later at Yerkes Observatory, probably about 1920)

In keeping with the 1995 centennial celebration of the discovery of the X-ray, the *AJR* will periodically publish historical articles that describe events leading up to and occurring around the time of Roentgen's discovery or those having special significance to the American Roentgen Ray Society.

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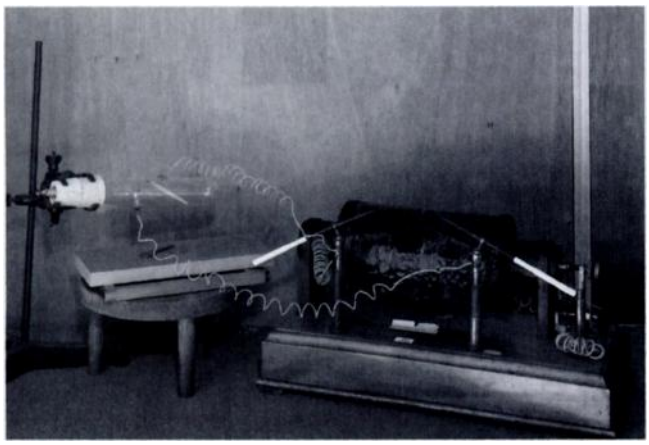

Fig. 1.—Puluj Tube and Apps induction coil utilized for first X-ray in Hanover. Apparatus is on display in Physics Department of Dartmouth College.

inches in diameter and ten inches long" as stated in a letter from Austin (personal communication, Professor Frank E. Austin, September 13, 1957), who later became a professor of electrical engineering.

Platinum electrodes on opposite sides of the tube were spaced about 2 inches apart, between which was mounted a thin mica sheet at a 45° angle. Professor Austin also stated "one surprising (at the time) feature of the tube was that there was a certain substance on the surface of the mica that would glow with phosphorescent light for quite a time after the X-rays were discontinued." (personal communication, Professor Frank E. Austin, September 13, 1957) (Fig. 1). This later led Austin and others to experiment with different minerals and chemical substances to serve as phosphorescent coatings for use in fluoroscopes. They worked on this concept and subsequently developed two hand-held fluoroscopes, which were first demonstrated by Professor Albert Crehore at a meeting of the Dartmouth Scientific Association on May 20, 1896. One was portable, and he carried it with him to demonstrate the utility of X-rays for physicians in New England. Austin's daughter describes that "at one of my birthday parties we had fancy rings for the children to wear and showed them their skeletal hands to loud shrieks of excitement: knowing what we do today, of course, he wouldn't have done it." (personal communication, Miss Maude N. Austin, January 14, 1973). Professor Austin died in 1964 after a satisfying career, but he never received proper recognition for his contributions to radiology.

On Monday, February 3, 1896, Gilman Frost brought 14-year-old McCarthy to the apparatus room in Reed Hall, where the Department of Physics was located. Using the Apps coil, a battery consisting of seven Grove cells, and a Puluj tube, Edwin Frost made a diagnostic X-ray examination of Eddie McCarthy's wrist. In his article dated February 4, 1896, Frost wrote:

> Of four Crookes tubes first tried, but one emitted rays which (with the exposure given) made a visible impression upon a photographic place protected from the ordinary luminous rays....We have thus far usually excited the tube by a current from an efficient induction coil, but a Holtz machine has served about equally as well. The first successful experiment gave, after 12 minutes of exposure, a picture of a knife, scissors hung on the side (1 cm. thick) of a whitewood box, within which the photographic plate had been placed....With the tube 9 cm. above the plate an exposure of 15 minutes clearly brought out the bones of a hand laid upon the plate holder....It was possible yesterday to test the method on a broken arm. After an exposure of 20 minutes the plate on development showed the fracture in the ulna very distinctively. Comment upon the numerous applications of the new method in the sciences and arts would be superfluous. [4] (Figs. 2 and 4)

Also present on this occasion were Mrs. Gilman Frost, then the head nurse at Mary Hitchcock Hospital, and photographer Howard H. Langill. Langill provided and developed the photographic plates for both the testing of the tubes and exposure of the forearm itself. His assistant, Henry Barrett, photographed the momentous event for history (Fig. 3). This report in *Science*, with its attention to scientific detail, establishes that this was the earliest medical X-ray made in America and certainly the first pathologic X-ray. Reports in the same issue of *Science* by Drs. Pupin of Columbia [5] and

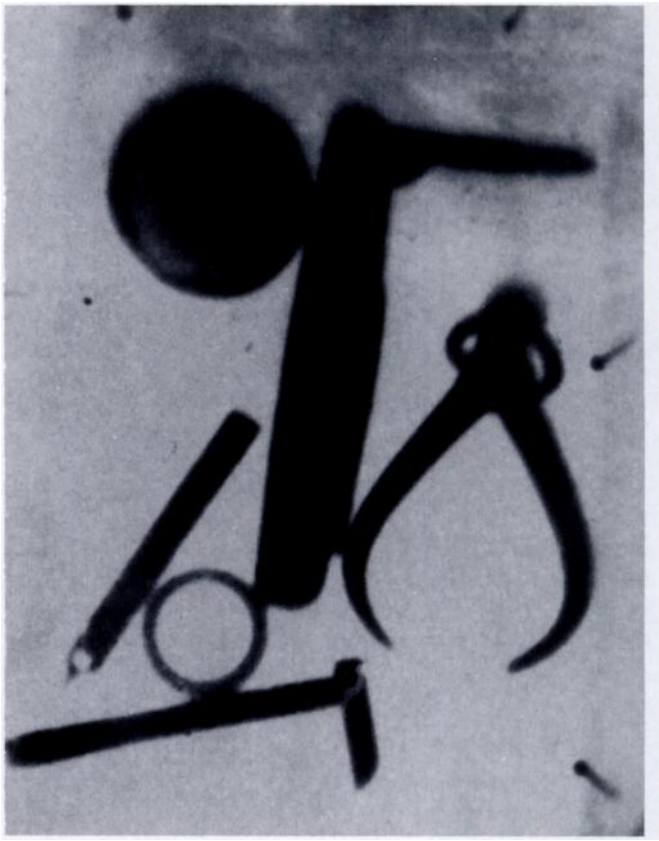

Fig. 2.—Photograph of one of the first "test" radiographs made by Professor Austin on a gelatin plate with coil and tube shown in Fig. 1. Items were placed within a wooden box with sides 1 cm thick.

Fig. 3.—Event captured by photographer Henry H. Barrett on February 3, 1896, in Dartmouth's Reed Hall. Left to right—Professor Edwin Frost, patient Eddie McCarthy, Gilman Frost, and Margaret Mead Frost.

Fig. 4.—Photograph of original gelatin plate made with 20-minute exposure. Ulnar fracture is visible but image certainly shows evidence of significant degradation by motion.

Goodspeed of Pennsylvania [6] described clinical X-rays that were made 5 days later on February 8, 1896.

This event was also presented to the Dartmouth Scientific Association on February 12, 1896, in a lecture room of Reed Hall. Members of the society gathered to watch Frost and Professor of Physics (and Dean of Faculty) Charles Emerson and other faculty explain the history of the process, show a negative sent to Dartmouth by a friend in Germany of an X-ray taken by Roentgen himself, and, finally, demonstrate some of the characteristics of Crookes tubes.

In a more widely published lecture and demonstration later that year, a local newspaper wrote of Frank Austin:

> Carrying his bearers through the natural phenomena of heat, light, magnetism and induction, he brought them to the wonderful Tesla induction coil, whereby the 52-volt current [voltage] of an electric plant was transformed to a high-tension current of over 500,000 volts, and the Crookes tubes were made to glow with the subtle cathode rays. Mr. Austin then requested anyone who wanted his bones photographed to come forward and, by request, Mr. Dewey's hands were clearly shown—with the aid of the fluoroscope. This was the crowning test of the wonderful x-rays. The audience was fully satisfied and the congregational church under whose auspices the lecture was given, was made richer by a number of dollars. [7]

The X-ray rapidly became part of medicine in Hanover and was used for visualizing fractures and foreign bodies. Interestingly, in the same article in the *Dartmouth Alumni Magazine* quoted above, Edwin Frost reported that in August of 1896 he had used X-ray evidence in court to bolster his testimony regarding a fractured limb. In 1903, the first production X-ray apparatus was placed at the Hanover Hospital. Professor Edwin Frost and Austin undoubtedly played a role in operating it, and Langill assisted with processing the plates. Physicians interpreted the findings because Frost and Austin had left Dartmouth by this time.

The original equipment, including the Crookes tube and the Apps coils, is on permanent display in the Fairchild Science Center at Dartmouth College in Hanover, NH. The original glass plates were known to be in existence as late as 1957, as documented in loan receipts from the Dartmouth Museum, but no trace of them can be found, and only photographic reproductions of the X-ray of Eddie McCarthy's fractured forearm remain.

ACKNOWLEDGMENT

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A description of some of these events appeared in an article published in *Radiology* on the occasion of the 50th anniversary of the discovery of X-ray. [8]

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