WHAT KIND OF TUBE DID RÖNTGEN USE WHEN HE DISCOVERED THE X-RAY?[1]

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I FEEL that we should not let this great meeting at which we heard so many excellent reports on the use of the roentgen rays go by without calling attention to the fact that we celebrate this year, the fortieth anniversay of the discovery of the x-ray or roentgen ray. Forty years have passed since Wilhelm Conrad Röntgen, Professor of Physics at the University of Würzburg, saw a strange phenomenon—the bright fluorescence of some barium platinocyanide crystals near an excited evacuated tube. He pursued the study of this effect in a most masterly and thorough manner, and discovered it to be due to a "new kind of rays," which he called the "x-rays."

Many stories and fables have been woven around this famous discovery, some of which I have attempted to unravel in my book on the life of Röntgen (1). Even now, forty years later, discussions about the details of the discovery continue. Only recently, a discussion was again begun about the type of tube which Röntgen used when he made the discovery. Several articles have appeared in the last few months in German journals attempting to prove that Röntgen's work with a Lenard cathode-ray tube and not with a Hittorf-Crookes tube, led to the discovery. The titles of three of the communications are: "On the History of the Discovery of the Roentgen Rays," by J. Stark (2), President of the Physikalisch-Technische Reichsanstalt; "On the Roentgen Rays Emitted from the Platinum Seal of a Lenard Window Tube," by F. Schmidt (3), Professor of Physics at Lenard's Heidelberg Institute, and "On the Discovery of the Rays Named after Röntgen," by O. Rössler (4), a Baden-Baden pharmacist and former co-student of Lenard.

The tendency in these articles is to credit Lenard, the famous Heidelberg physicist.[2] This is perhaps best summarized by Rössler in his short article in the Münchener Medizinische Wochenschrift" in which he states: "In 1895, Röntgen became very much interested in Lenard's work and experiments, and asked Lenard to assist him in the repetition of these experiments. Lenard had built his first tube himself but then had ordered an improved tube from a shop for physical instruments. Since this tube was expensive, and since Lenard had only a very moderate income, he could not acquire it. He, therefore, wrote to Röntgen and asked him to buy this instrument with which he could make further studies. Röntgen did so and was able to find with this tube those rays which have become so useful in practical medicine." These statements which link the name of Lenard with that of Röntgen in the history of the discovery unfortunately come at a rather late date. They should have been proposed while Röntgen was still alive. However, they recall some remarks which Lenard made on various occasions in past years.

Phillip Lenard, who is now Emeritus Professor of Physics at the University of Heidelberg, is one of the few surviving predecessors of Röntgen in the genealogy of x-rays (5). There is no doubt but that Lenard's outstanding investigations on the various properties of cathode rays formed the most significant basis for the discovery of the roentgen rays, a fact which Röntgen mentioned in his first communication, by speaking of Lenard's "wonderful experiments."

When I began to collect the material for my historical studies on the roentgen rays, I wrote to many of the early pioneers and,

[1] Presented before the Radiological Society of North America, at the Twenty-first Annual Meeting, in Detroit, Dec. 2–6, 1935.

[2] A rather mysterious article with similar suggestions was written by one Erhard Grieder and appeared in the March 1, 1935, issue of the "Zürcher Illustrierte Zeitung." It is, however, so full of untruthful statements that it is not worth while to discuss it here.

among them, Lenard. At various times, Lenard very cordially gave valuable information regarding the circumstances surrounding the discovery of the roentgen rays, but in his letters, as well as in his printed communications on the subject, he frequently hinted at some as yet unknown connection between the discovery proper and the part which he played in it. On Aug. 18, 1929, he wrote, for instance, in a personal communication: "There is no doubt that the road to the discovery led over my researches. At that time I was prevented by external circumstances from pursuing to my satisfaction in every direction the great number of new phenomena which appeared in my studies on cathode rays. But in my opinion, this is not yet the proper time to express myself more thoroughly on the subject than I did in my Nobel prize lecture (6). That would be only biographical anyway and what has already been said must suffice for the judicious. With this I believe that I have done everything that the history of science can expect of me on this point at this particular time." In a previous publication (7), during a controversy about the discovery, Lenard also intimated that perhaps more data in regard to the discovery might be produced at a later date.

Both Stark (2) and Schmidt (3) in their recent statements may now have furnished the information to which Lenard referred many years ago. Stark (2) presents copies of the original correspondence in 1895 between Lenard and Röntgen regarding the acquisition of the Lenard tube from the glass technician, Müller-Unkel, then analyzes the circumstances surrounding the discovery and comes to the definite conclusion that Röntgen must have used the Lenard tube when he made his discovery. Stark then enumerates three important experimental conditions which favored Röntgen rather than Lenard in preparing the ground for the discovery: (1) Röntgen had obtained the best Lenard tube available; (2) Röntgen surrounded his tube with black cardboard, which reduced the intensity of the then unknown x-rays much less than the zinc box which Lenard always used to shield his tube; (3) Röntgen used in his observations on cathode rays, a barium platinocyanide screen, which responds much more to x-rays than the pentadecylparatolylketone screen which Lenard used. Thus, Stark concludes that under the given experimental conditions, it was inevitable that Röntgen should make his discovery.

J. Schmidt's (3) paper, which appeared in the "Physikalische Zeitschrift," immediately follows Stark's publication and describes his successful attempts to demonstrate the existence of x-rays near the platinum seal window of a Lenard tube, using an exact replica of the one which Röntgen bought from the firm of Müller-Unkel prior to his discovery. This proof also includes a study of the efficiency of various fluorescent screens. Schmidt explains again that Lenard, in his investigations of cathode rays, observed certain strange phenomena, the investigation of which he postponed, however, in order to study more thoroughly the primary objects of his interest, the cathode rays; thus Lenard missed the interpretation that these strange phenomena were due to a hitherto undiscovered kind of rays. Both Schmidt and Rössler (4) conclude their articles in a vein similar to that of Stark's article.

On the other hand, the view that Röntgen used a Hittorf-Crookes tube at the time of the discovery has been and is held by many. I proposed this view in my book on Röntgen (1) after having closely examined several sources for this report. One of the most reliable of these sources comes from L. Zehnder, who was a good friend of Röntgen and his assistant and co-worker for many years. Zehnder definitely states in his recent book (8), "Letters of Röntgen and Zehnder," that Röntgen used the Hittorf tube when he discovered the x-ray. Zehnder's own words are: "When I saw Röntgen after the discovery, he told me that he discovered the rays with the Hittorf tube and not with the Lenard tube. Friends of Lenard are spreading the myth that Lenard was the real discoverer of the roentgen rays, and they believe that Röntg-

gen, working with the Lenard tube, did not discover anything essentially new, even though Röntgen in his famous original communication (9) on the x-ray spoke first of the Hittorf tube and mentioned the Lenard tube only in second place. One must always remember that Röntgen was extremely careful in his scientific statements."

Are these two points of view in regard to the tube used at the time of the discovery irreconcilable? I believe that they are not. A careful analysis of the situation would seem to present the following picture: Röntgen himself stated (1) that he became interested in the problem of cathode rays from vacuum tubes as studied by Hertz and Lenard, and that in October, 1895, he began to make researches of his own. There seems to be little doubt but that in these early experiments he used the Lenard tube described above. It is probable that in investigating the cathode rays emitted from this tube with his barium platinocyanide screen, he found that he obtained an effect at distances and angles greater than those described by Lenard. This made him look for similar effects on windowless tubes which, according to previous experience, did not permit the cathode rays to penetrate the wall and reach the outside air. Such a windowless tube was the Hittorf or Crookes tube. Still, he observed effects on his screen also with these tubes. Since the properties of cathode rays known up to that time did not account for the effect, Röntgen realized that he had to deal with either a type of cathode rays of hitherto unknown penetrability, or with a new kind of ray. His thorough researches which proved that they were the latter are well known and need not be repeated here.

The new material brought forth by Stark and Schmidt is valuable since it gives a better insight into some phases of the actual discovery. As far as their conclusions are concerned, I feel that they have to be modified to the degree explained above. Whichever of the two tubes was actually used in the first crucial observation which made Röntgen feel that he had something new, really does not matter. The discovery itself is one of the greatest of all times and the discoverer has earned immortal fame.

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