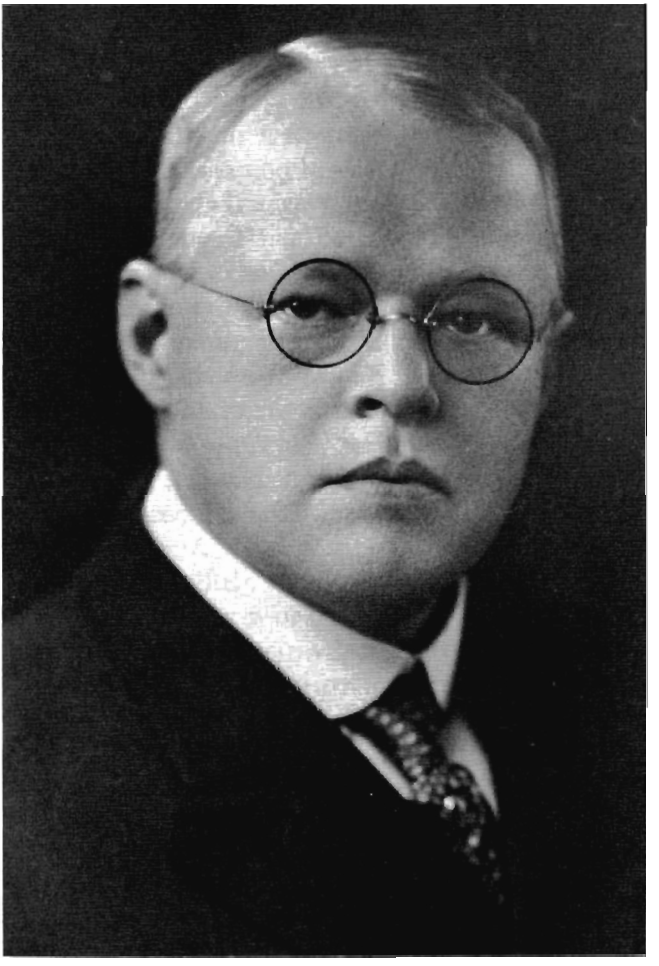
# THE PANCOAST ERA
## 1902–1939



*Henry K. Pancoast, 1903–1937*

## The Department Under New Leadership—1902

By May, 1902, J. William White, Chief of the Department of Surgery, was looking for someone to replace Dr. Leonard and operate the Roentgen Ray Department, a subdivision of the Department of Surgery. He turned to a young surgeon on his staff, and offered the position of Skiagrapher to Henry Khunrath Pancoast should Dr. Leonard definitely decide to leave the hospital.[1] Meanwhile White encouraged Pancoast to speak with Arthur Goodspeed about the basics of the X-ray phenomenon as training for his new work.[2]

Pancoast decided to accept the position, and the hospital staff was very pleased with his leadership of the department. Only a few months after he assumed his new responsibilities, the President of the Board of Managers commended his work, saying: "The X-Ray Department has been materially improved in its usefulness, and is now extensively used in Skiagraphy and Therapeutic work." Faced with severe limitations in space and equipment, Pancoast did manage to make substantial advances in the department's operation during the final months of 1902, and as he clearly stated: "The hospital could not now do without this department, and its support is as essential as that of any other."[3]

The department's physical limitations were the most serious problem which faced Henry Pancoast in 1902. As he later described the situation: ". . . our plant consisted of two 7-inch coils, two or three tubes, a little room on the first floor without windows, an entrance by one door too narrow for a bed to pass, dark, hot, unventilated and overcrowded, and a dark room with just enough room to permit one to turn around."[4] Despite these difficulties, however, he substantially increased the patient load, examining twice the number of patients seen in 1901 during the last six months of 1902, and expanded the department's services to include therapeutic treatment for malignant tumors in addition to the full scale diagnostic program. The therapeutic work was begun by a Dr. Rahte, a resident physician at the hospital, and was carried on during 1902 with the assistance of Mr. Bernstein, a senior in the medical school. Student interest in the project was greater than the number of patients to be treated, and two other

men were ready to help with treatments when an increase in the patient load required additional assistance.[5]

The expansion of services, as well as an increase in personnel, was clearly indicative of Dr. Pancoast's enthusiasm for his new post and of the capabilities of the department. Without evidence that added support was forthcoming from the hospital, though, he remained cautious about the rapid expansion of services like therapeutic treatments, which required considerable time, expense, and assistance, and caused great wear on the apparatus.[6]

## Henry Khunrath Pancoast—Biographical Information

Henry Pancoast was born and raised in Philadelphia, the son of a physician who was also interested in light, light rays, and their relationship to medicine. He graduated from Friend's Central School in 1892, but was forced to delay his plans to study medicine due to the premature death of both his parents. Pancoast worked as a teller at the Centennial Bank, Thirty-second and Market Streets, for two years, and entered the School of Medicine at the University of Pennsylvania in 1894 without any undergraduate premedical preparation. He did very well in medical school, however, and was accorded the honor of an internship at University Hospital upon graduation.

Pancoast remained affiliated with the hospital after completing his internship, serving as an Assistant Instructor in Clinical Surgery and Assistant Demonstrator of Surgery.[7] When Dr. White approached him regarding the position in the Roentgen Ray Department he was serving as an anesthetist at the hospital and attending to a very limited outside practice, so the opportunity was both interesting and timely. He later remarked: "How easy it was in those days to become a radiologist by the shortest affirmative reply!"[8]

## Growth Under Henry K. Pancoast, 1903–04

Pancoast was serious when he spoke of the need for expanded facilities and new equipment in 1902, and in the subsequent two

years the department made tremendous strides. Substantial increases in the patient load necessitated additional staff, so a nurse was borrowed from a nearby ward to prepare the women patients, part-time assistants were recruited from the second and third year medical school classes and fourth year dental school class, and another physician occasionally offered assistance.[9] In addition to his clinical duties Pancoast assumed teaching responsibilities in the medical school as the Lecturer on Skiagraphy, as well as continuing his involvement in surgical instruction.[10]

During 1903 Dr. White and the Executive Committee of the hospital's Board of Managers began to raise money to build a modern and complete X-ray facility, and by the end of the year a considerable sum had been collected.[11] Substantial income came from the Commonwealth of Pennsylvania, totaling $13,000 in 1904 and $30,000 in 1905,[12] in addition to contributions generated by private sources. These monies guaranteed the department's expansion into a first rate operation.

It was some time before the funds for the new facility were in hand and construction could actually begin, however, and in the meanwhile Dr. Pancoast was faced with severe operating constraints. The single workroom was so hot that the department was moved upstairs, to a side room off the men's surgical ward, during the summer of 1903, moved back downstairs during the winter, and back upstairs the following summer. The cramped darkroom facilities became intolerable after a period, and the hospital moved the darkroom permanently to a larger room in the basement.[13] Further improvements were made by the beginning of 1904, and although the department was not yet in its new facility, diagnosis and treatment were carried on in two separate workrooms.[14]

Gradual additions were also made to the department's stock of apparatus, and beginning in 1903 considerable sums were expended to purchase new pieces of equipment and to replace parts on old equipment so that it would be as up-to-date as possible. Three induction coils were in constant use by 1903,[15] including a new 18-inch coil, operated by a mechanical spring interrupter, which was purchased from the local Roentgen Manufacturing Company. This piece was used to make the department's first barium enema exposures, one of the most reliable abdominal examinations at that time.[16] Some other specialized equipment was also purchased, including a Sweet and Lewis tube stand and a Queen X-ray table; prior to this the department had improvised

to provide set-ups with traditional laboratory equipment.[17] By early 1904 the department had also purchased a full line of X-ray tubes, allowing considerably greater flexibility in diagnosis and therapeutic procedures.[18]

The expansion of the department's therapy work was very time consuming, not only because the treatments were often of several minutes duration (fifteen to thirty minutes at times), but also because there were no accurate ways to measure the dose or to recreate identical conditions for a later patient. Much time was spent guessing the current by the "fatness" of the spark, and these rather haphazard therapy treatments were continued for several days or weeks until a visible reaction was achieved. The intricacies of the therapy process, in addition to rather lengthy exposures for many diagnostic examinations (some spinal exposures, plus most chest, body, and hip exposures took as long as ten minutes each at this time), meant that Dr. Pancoast and his student assistants were always busy in their tiny cubical.[19]

## The Fourth Annual Meeting of the American Roentgen Ray Society: Houston Hall, University of Pennsylvania, Philadelphia, December 9–10, 1903

The American Roentgen Ray Society was established in 1900 as the first national organization of physicians, physicists, and other scientists interested in working with the X-ray. Most of its members were residents of the eastern United States, and from the time of its founding it has met annually to discuss new developments and techniques and to exchange information from personal experience working with radiation.

The Fourth Annual Meeting was held in Philadelphia in December of 1903, and was hosted by the University of Pennsylvania. The Local Arrangements Committee for the meeting, Drs. Pancoast, Frazier, and Willard from University Hospital, planned an impressive and extensive two day program for the more than 300 physicians and scientists from the United States and Canada who came to the city, including the presentation of seventeen papers (each followed by a discussion lead by another specialist), a large exhibit of roentgenographic equipment (including dis-

plays by nearly all the leading manufacturers), and exhibits of prints made by a number of those in attendance. The manufacturers' displays were a particularly popular part of the program: so popular, in fact, that there was not enough room to accomodate all the companies who wished to send representatives.

The speakers came from all over the United States and covered a variety of topics, ranging from the pathological effects of X-rays on tissue to accuracy in diagnosis, from skiagraphy of the chest to danger to the operator, and from techniques for dental skiagraphs to the therapeutic effects of the X-ray. One highlight was the address by the Society's outgoing President, Arthur W. Goodspeed, entitled "The Trend of Modern Thought on the Sub-Atomic Structure of Matter" in which he outlined, from a physicist's point of view, contemporary theories about the composition of the atom.[20] Goodspeed also discussed problems arising from secondary radiation, and this concern was voiced with frequency by others in discussions of skin problems and radiation burns.[21]

Although Charles Lester Leonard was no longer affiliated with the University Hospital, his position in Philadelphia's roentgenologic community was still very important, and he presented a paper discussing his work using roentgen rays to diagnose renal calculus. He emphasized the importance of developing the diagnostic capabilities of the roentgen procedure, expressing concern that excitement generated by its newly-discovered therapeutic possibilities might minimize potential work in diagnosis, while also speaking enthusiastically about the opportunities for X-ray therapy. Recognizing Leonard as a pioneer in the field, a physician from Michigan expressed the position that: "Everyone is familiar with Dr. Leonard's work and we ought to be proud of what he has done in this line."[22]

Speaking as Skiagrapher of University Hospital, Henry Pancoast presented two distinctly different papers, one on collapsing X-ray tubes and the other on the utilization of X-rays for therapeutic purposes. The first, although brief, was interesting because it delineated a problem faced by many of his colleagues. His paper on the therapeutic use of X-rays was of major importance, however, and aroused the most interest at the convention and in the press of any presentation made at the meeting.

With the assistance of Dr. Harvey Bartle and Henry C. Welker, a second year medical student, Dr. Pancoast discussed a sample of nearly 100 patients who had been treated with X-rays for therapeutic purposes in the eighteen months that he had run the

department at University Hospital. Concentrating this presentation on the treatment of tumors, Pancoast detailed both successful and unsuccessful cases, and cautioned his fellow roentgenologists against the application of X-rays as a "cure-all" for tumors, especially malignant ones. Analyzing the results of his work to date, he expressed the sentiment that ". . . up to the present time I have been very much disappointed in the results obtained from the X-ray in the treatment of cancer and sarcoma."[23]

As Dr. Pancoast pointed out, however, it was important to realize that the University Hospital X-ray laboratory was considered a "dumping ground" for all incurable cases, and a high rate of cure would be very unlikely, and could occur only if many of the department's potential patients refused treatment. In addition, most of the department's therapy patients were treated as out-patients, making only sporadic visits for treatment, and for some reason these patients seemed to arrive simultaneously, necessitating the rapid treatment of a great many persons, rather than the deliberate and individualized treatment which each patient ideally deserved.

Overall, Pancoast presented a cautious but optimistic view of the prospects for the roentgen ray therapy program: "I am not discouraged by our failures to effect cures in more cases, as I feel that we are apt to be over-enthusiastic and to expect too much of a practically new and not thoroughly understood therapeutic agent." He advised the initial removal of diseased areas by surgery wherever possible, followed by X-ray therapy, and strongly emphasized the continued necessity of surgical intervention.[24]

Dr. Pancoast's paper was interesting not only for its comments about the advances in the use of X-rays for therapeutic purposes, but also because it provided considerable insight into the situation at University Hospital in 1903. The staff, including the surgeons, was obviously willing to allow Pancoast to develop a program of X-ray therapy, but at the same time the surgical staff wanted to make certain that they were given every opportunity to remove diseased tissue surgically prior to the commencement of a radiation therapy program. DeForest Willard, a member of the Local Arrangements Committee and a surgeon at University Hospital, clearly outlined this position:

I have great confidence in the X-ray in selected cases, but I also believe that it should be employed in connection with surgical measures wherever possible. Of course, there is a large class of inoperable cases, and

another class that is absolutely hopeless, and yet even in these we can remove much tissue with the knife and then fall back upon the X-ray to do the rest.[25]

The Philadelphia meeting was very successful, and attracted much notice in the local newspapers. Philadelphia roentgenologists were recognized for their many and varied contributions to this new branch of medicine, and both Charles Lester Leonard and Henry Khunrath Pancoast were elected members of the American Roentgen Ray Society at this meeting; Pancoast, in fact, had been told that he would be elected, and that he should go ahead and organize the entire program. The participation at the meeting by members of the staff of University Hospital from departments other than the X-Ray Department underscored the importance of the new specialty, as well as the status achieved by Pancoast and the department in the year-and-a-half in which he had operated it.

## The New Facility: 1904–05

Especially important advances were made by the X-Ray Department in 1904, because in that year the hospital built and equipped an addition to the Agnew Pavilion, specifically for roentgenology, with the money received earlier from private sources and the Commonwealth of Pennsylvania. The expansion covered an entire floor over one of the wings of the building, facing south over the hospital grounds, and although the department began to move into the new facility in the late summer and early fall of 1904, the formal dedication was delayed until November 28th, concurrent with the Commencement Exercises for the hospital's School of Nursing.[26]

The new facility contained nine rooms, a toilet, and a sun parlor. The rooms permitted some separation of activities, and included an office and consulting room, a laboratory for pathological work (with storage space for plates), a waiting room for private patients, a waiting room for male dispensary patients, a waiting room for female dispensary patients, a store room and workshop, an X-ray room for treating gynecological patients, and a room for the major part of the therapeutic and diagnostic work. There was also a separate darkroom located, for the first time, in

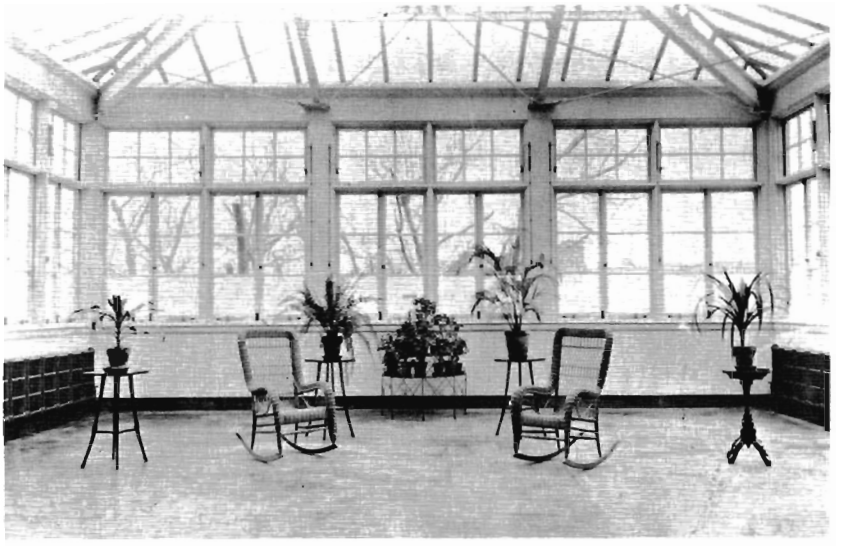
space adjoining the rest of the department. A glass skylight occupied two-thirds of the roof of the sun parlor, an area to be used for photography and Finsen sunlight therapy apparatus.[27]

A number of pieces of new apparatus were purchased to furnish the new facility, including a 24-inch induction coil; it was one of the largest ever made for X-ray work and was equipped with a milliammeter to ascertain the amount of current in the secondary circuit, and thereby provide some reference point for repeating procedures under similar conditions. This new coil supplemented both the 18-inch coil purchased late in 1903 and the two smaller coils, enabling the staff to transport the smaller pieces and make exposures almost anywhere inside or outside the hospital building. Two Finsen-Reyn lamps were purchased for phototherapy, in addition to a Finsen sunlight lamp and coil to provide "high frequency" treatments. Although some reservations were placed on the relative success of these Danish Finsen lights in comparison to X-ray treatment, the department made the investment to insure the absolute completeness of its new installation.[28]

Numerous purchases were also made during this year to stock the department with modern pieces of small apparatus, reflecting recent advances in X-ray technology. These included a variety of models of X-ray tubes and the most sensitive X-ray plates; various combinations were best suited for different types of exposures. The laboratory was equipped to carry out pathological and experimental work, in addition to routine urine analysis and blood examination.[29] The department was also attractively furnished, and decorated with a variety of plants and fresh flowers.

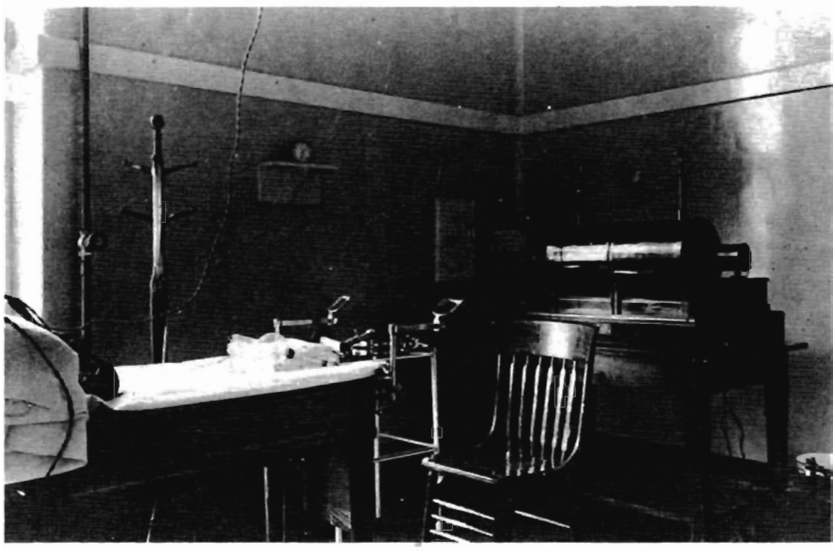
The hospital's Board of Managers was exceedingly proud of this new facility, and by the time of its completion it was ". . . believed to be the finest and most perfect of its kind in the United States."[30] Writing in the the mid-1940s Mary Virginia Stephenson, for many years Director of the hospital's School of Nursing, related that "it was stated conservatively at the time that no hospital in the country had a larger or better equipped laboratory than that of the University Hospital."[31]

It is interesting to note, however, that despite the department's enormous expansion from a single room and darkroom to a suite of nine rooms plus a sun parlor, only two rooms were designed for the utilization of X-rays and Finsen light for diagnostic and therapeutic work. The new facility enabled a great many more patients to wait for examinations and treatment, and with the



*Departmental sun parlor, 1907*

*Plate storage room, 1907*



*Gynecological examination room, 1907*

new apparatus a great many more patients were actually seen as well, but the available working space was not actually increased very considerably.

Dr. Pancoast's report for the year ending August 31, 1905 provides some particularly interesting insights into the expanded operation and the new facility, approximately nine months after the beginning of routine activity. The space was utilized at all times, and the laboratory and workrooms enabled the application of surgical dressings in the laboratory instead of in the wards or surgical dispensary, as well as the performance of necessary minor surgical operations in the department itself. There was a marked increase in the amount of diagnostic X-ray work performed during the year, and an even greater increase in the application of X-ray and other treatments for therapy. X-rays, radium, Finsen light, and high frequency (Finsen sunlight) therapy were all used in treatment, and there was an encouraging increase in the percentage of patients cured, rising to 23.5 percent of the cases treated.[32] This figure is especially impressive in view of the 10 percent cure rate quoted by Dr. Pancoast in his 1903 observations on the success of X-rays as therapeutic agents.

The increase in the patient load undoubtedly necessitated staff increases, and it seems very likely that students from the University's medical and dental schools continued to participate in the

department's work, both in treatment and research projects. The expansion did require the addition of a full-time nurse to attend to the women patients, and a second or third year student nurse was assigned this responsibility.[33]

The extension of University Hospital's roentgenology program was further reflected in the work being done independently by Dr. Louis Duhring in the Dispensary for Skin Diseases. Dr. Pancoast had made it clear from the beginning that he felt skin diseases were the responsibility of the dermatologists, since they had the necessary expertise in this field, and early in 1904 Dr. Duhring purchased a roentgen ray plant, including an 18-inch coil, for his own work. The expansion of Dr. Pancoast's program is particularly remarkable, therefore, since he was not seeing patients with skin diseases or counting them among his ever increasing patient load.

Dr. Pancoast's enthusiasm for the potential of X-rays and related procedures for both diagnostic and therapeutic purposes did not blind him to the very present dangers from overexposure to the rays, however. The painful and tragic experience of his predecessor, in addition to those of a number of Philadelphia roentgenologists, was an ever present caution, and he was mindful to purchase lead foil and other protective devices to shield both operator and patient from secondary radiation and prolonged exposure to the still-mysterious X-rays.

## The Establishment of the Philadelphia Roentgen Ray Society—1905

Philadelphia was the home of a number of pioneers in the field of roentgenology, and in February, 1905, Charles Lester Leonard invited a dozen of these men to his private office to organize a local society for the ". . . study of the roentgen rays and the formation of friendly intercourse." The group included the physicians responsible for roentgenology departments in Philadelphia hospitals, plus specialists in other medical fields and scientists and engineers who were in some way involved in the development of this new specialty. A number of corresponding members, individuals prominent in roentgenology in other cities, were also elected, and some were occasionally able to attend meetings.

From its beginning the Society was interested in protection for the X-ray operator, as well as in new developments in the field. A number of early discussions concentrated on protection, the introduction of new devices to provide safer working conditions, and the treatment of X-ray dermatitis. Members also brought plates from unusual or difficult cases to the meetings, and informal discussions evolved, providing an early precedent for the city-wide film reading sessions which were later organized at University Hospital and at Society meetings.

Through the enthusiastic efforts of Drs. Leonard, Pancoast, and others, the Society organized symposia on topics of interest and importance to the growing number of roentgenologists in the Philadelphia area, in addition to providing input at national meetings. Throughout its history the roentgenologists from University Hospital have actively supported the programs of the Philadelphia Roentgen Ray Society and played an important role in its expansion and growth.[34]

## Continued Expansion of Services: 1905–11

The X-Ray Department firmly established its permanency and professionalism with the move to its new facility in 1904, but a fire in the University's power house in 1905 caused many frustrations for Dr. Pancoast and his staff. The hospital turned to the city for temporary electrical current, but the alternating current thus supplied was not compatible with the department's apparatus and it was necessary to string wires from Philadelphia General Hospital to University Hospital for four months during the winter of 1905–06 to supply the X-Ray Department with direct current. The arrangement proved very inconvenient at times, because the voltage was likely to drop considerably in the course of a roentgenographic exposure, but after a while the staff learned to compensate and minimize the difficulty.[35]

During these years the department experienced an overwhelming increase in its patient load in response to both diagnostic and therapeutic innovations. Dr. Pancoast's work with salts of bismuth in 1906 enabled diagnosis of obscure conditions of the gastrointestinal tract, and for the first time analysis of many of

these deep areas of the body was possible.[36] The Finsen light treatment proved rather unsuccessful for therapeutic purposes, but the department relied on the high frequency treatment with increasing regularity during this period. In addition, more and more X-ray treatments were administered each year.

The fluoroscope was introduced into the department's diagnostic procedure on a large scale for the first time in 1906, but concern for the operator minimized the utilization of this equipment during this period. In addition to difficulties suffered by Philadelphia roentgenologists, the department's first permanent nurse had received a partial epilation due to overexposure. She returned a few years later to be treated for leukemia, from which she died shortly thereafter. Dr. Pancoast was continually concerned about safety and protection, however, and it was not until 1913, when improvements in design minimized the danger to the operator, that fluoroscopes were used extensively.

Early in this period the department began to use filters in addition to taking the precaution, when possible, of surrounding the tube with a box covered with lead paint. Lead foil was frequently employed for filters, as was leather soaked in water to resemble skin. The leather proved rather unsuccessful, and was soon replaced by metal and wood.[37]

The department's equipment was kept up-to-date, and Dr. Pancoast had at his disposal a variety of tubes and other pieces of apparatus with which to perform many different procedures. The department's new 24-inch coil was used for both therapeutic and diagnostic work, but with different interrupters to provide different kinds and amounts of current. A mechanical spring interrupter was used for therapy because it provided minimum secondary current and softer, more absorbent rays, while an electrolytic interrupter was used for diagnosis because it produced harder rays.

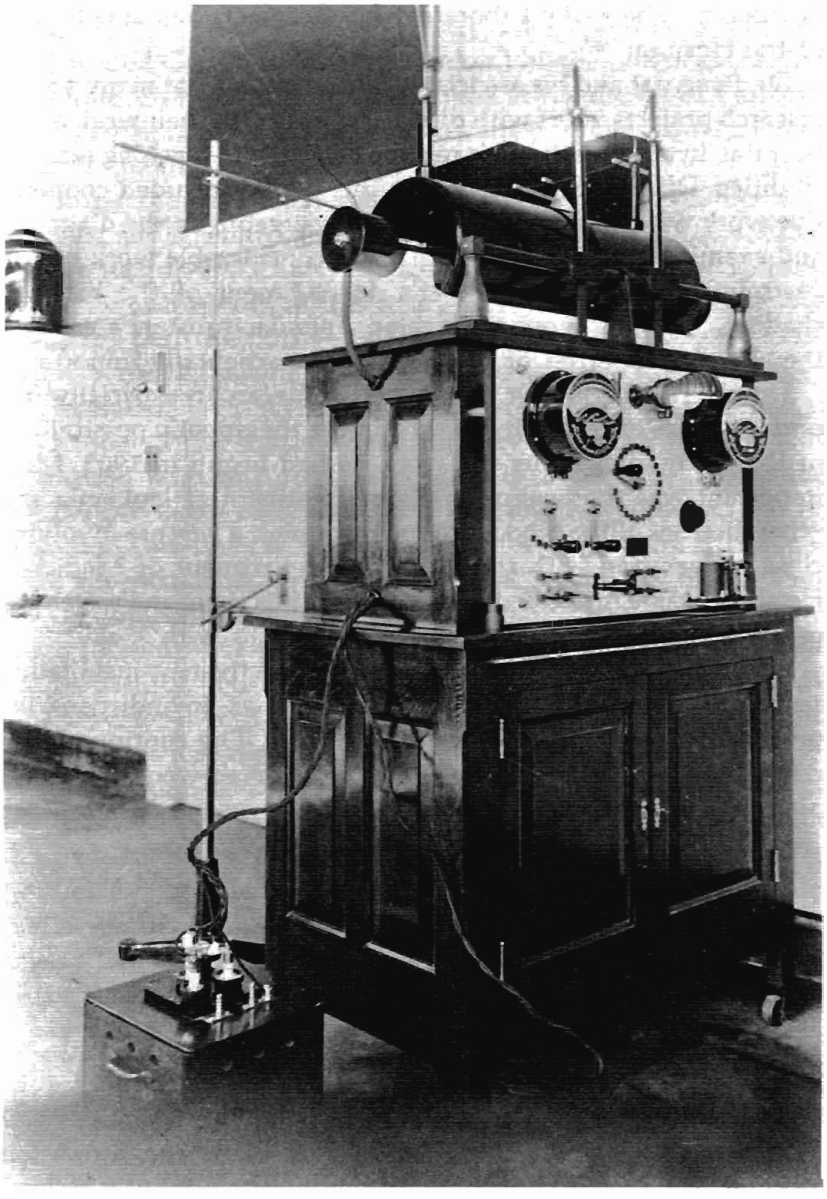
Dr. Pancoast used many different brands of gas tubes, trying new designs as they were introduced on the market, and found that a good gas tube could be used to make several hundred exposures, barring an accident. The vacuum within individual tubes changed frequently, however, even though the self-regulating tube was used extensively. Sometimes the vacuum dropped so much after three or four minutes of operation that it was necessary to use three or four different tubes to complete a lengthy therapy treatment. Success varied more with individual

tubes than individual manufacturers, and Dr. Pancoast and his assistants each developed pet tubes which they would use again and again.[38]

A particularly important development in X-ray equipment, the Snook transformer, simplified the department's work immeasurably during this period. H. Clyde Snook, a Philadelphia engineer and founding member of the Philadelphia Roentgen Ray Society, had been involved for some time in the development of a new and improved apparatus for X-ray production. He designed the milliammeter for the department's 24-inch induction coil, built an improved induction coil, and in 1908, after experimentation in the University's Department of Physics, provided the department with its first transformer. The most important advantage of this new apparatus was the elimination of the need for an interrupter to change the available direct into alternating potential for the X-ray equipment. This meant that the department could use powerful alternating current, available from the University's power plant or directly from the city, and transform it into the voltage required for X-ray production.

The Snook transformer made the process of diagnostic examination both easier and more effective, and in 1908 and 1909 the department began extensive stomach roentgenology in earnest. A device built in the department's workshop enabled the exposure of plates in an erect position, thereby minimizing the difficulty of examining this portion of the anatomy. In 1909 the department also added an "Improved Sweet Localizer," a piece of apparatus used primarily to locate foreign bodies in the eyes, thus reinforcing cooperative activities with other departments in the hospital. Dr. deSchweinitz, the chief ophthalmologist, was particularly interested in this apparatus, and he raised most of the money for its purchase.[39]

Henry Pancoast encouraged students to assist him in the X-ray laboratory soon after he became hospital skiagrapher in 1902, and over the years students had participated in a variety of projects, particularly ones related to studies of the therapuetic capabilities of the X-ray. After the opening of the large facility, participation gradually increased, and by 1909 the department's status was such that the *Annual Report of the Board of Managers* listed additional personnel, including a physician serving as Assistant in the X-Ray Department, along with the rest of the hospital's medical staff.[40] This recognition of importance was relayed in other publications as well, including the 1910 issue of the Medical School



*24-inch induction coil in the main examination room, 1907*

yearbook: "The X-ray Laboratory has become a valuable branch of the Hospital."[41]

Dr. Pancoast and his associates carried out a great many varied research projects, most with direct application to their work at the hospital, in addition to their routine clinical and teaching responsibilities. Diagnostic work during this period included cooperative work with Charles Frazier, a neurosurgeon, on the diagnosis and examination of brain lesions, and considerable work on the gastrointestinal tract. Pancoast's development of the bismuth shadow, and later work to develop a similar substance without the allergic properties of bismuth, were particularly important.

During this period Dr. Pancoast also began an especially important series of research projects on the therapeutic possibilities of the X-ray, expanding the work he had begun in 1903. Most important was the beginning of the treatment of leukemia and other diseases of the blood-producing organs, a venture involving close cooperation with the hospital's Department of Medicine. He also became interested in the chest at this time, and expended much energy in the treatment of tuberculosis with X-rays.

Overall, the years following the move into the new installation served firmly to establish the department as an indispensable professional service to University Hospital. The continuous increases in staff and the scope of services offered were the beginning of a process which still continues.

## The Nation's First Professor of Roentgenology—1911

Henry K. Pancoast was appointed Lecturer on Skiagraphy for the 1903–04 academic year, and held that position until the spring of 1911 when the University's Trustees received the somewhat unusual nomination of Pancoast as a full professor in the School of Medicine, bypassing the usual intermediate ranks. His election as a Professor, recommended at the March Trustees' meeting, was delayed a month until a legal quorum was present, and on April 4, 1911 "a ballot was so cast and Dr. H. K. Pancoast duly elected Professor of Roentgenology."[42]

Controversy has arisen over whether or not Henry Pancoast was the first physician to achieve the rank of full professor in the

relatively new field of roentgenology, and a number of authors have named George E. Pfahler, another Philadelphian, as the first man to receive this honor. A close look at the details of Pfahler's particular situation, however, refutes any possible claim he might have to the first professorship.

During the years just prior to 1911 George E. Pfahler was working and teaching at the Medico-Chirurgical College, located at Seventeenth and Cherry Streets in Philadelphia. In recognition of his excellent work at this institution, and the service he was rendering both the College and the Hospital, he was elected to fill a newly-created position of Clinical Professor of Roentgenology in December, 1909. At the meeting of the Medico-Chi Trustees in October, 1912, it was evident, however, that Dr. Pfahler was displeased with this position because it did not include all the normal privileges associated with the rank of Professor, and he indicated that he was likely to leave the institution if changes were not forthcoming. The situation was resolved at the December, 1912 meeting, when ". . . Doctor Pfahler was elected Professor of Roentgenology, said election to include a chair in the voting Faculty." His election to a full professorship came twenty months after that of Henry Pancoast, making Pfahler the second Professor of Roentgenology in the city and nation.[43]

The creation of a Professorship in Roentgenology for Henry Pancoast in 1911 was indicative of the prestige which he and his department had achieved in both the hospital and School of Medicine. The new appointment also changed his hospital title, and thereafter he was the Roentgenologist.[44] His promotion occasioned the first roentgenology course description in the *University Catalog,* and the program for the 1911–12 academic year was delineated as:

ROENTGENOLOGY. Professor Pancoast.—A series of lectures and demonstrations covering the diagnostic and therapeutic application of X-rays, and the interpretation of radiograms.[45]

Equally rewarding, perhaps, was Pancoast's acceptance by the medical students as a full-fledged member of the teaching faculty. His tribute in the 1911 yearbook seems most clearly to reflect this position:

Our Pancoast thinks everyone crazy
Who works without skiagrams hazy,
    In fact you would laugh

To hear the whole staff
Rave on as if they were X-rasy.[46]

## Growth and National Recognition Before World War I

The X-Ray Department's reputation extended far beyond the University, and within a short period of time Henry K. Pancoast was a leader of both the Philadelphia and national roentgenological communities. He was an active participant in the Philadelphia Post-Graduate School of Roentgenology, organized by the Philadelphia Roentgen Ray Society in 1913 to provide graduate training to interested physicians, and he always encouraged interested persons to visit the department at University Hospital.[47] After Charles Lester Leonard's death in 1913, the Philadelphia Society which he had established was reorganized, and Pancoast was elected Vice President that year and President two years later.[48]

Pancoast's reputation had spread far beyond the city, and following the 1903 meeting of the American Roentgen Ray Society in Philadelphia people remained interested in this young physician. He was elected Secretary of that Society in 1911, and elected President the following year, thus involving him in considerable outside activity in addition to his continually expanding responsibilities at University Hospital. Pancoast's accomplishments, capability, and cordiality continued to impress his colleagues, and he was elected a charter member of the American Radium Society when it was established in 1916, its Secretary in 1917, and its President two years later.[49]

Through their joint activities in Philadelphia roentgenology, Pancoast and Leonard remained close friends, particularly since they shared an interest in the diagnostic examination of the gastrointestinal tract. Leonard was asked to give a paper on the history of gastrointestinal examinations at the Radiology Section of the International Congress in London in 1913. He was too ill to complete the work so he called on Pancoast, and the younger man abstracted the topic and presented it to the gathering for Leonard. Such a request indicates the extent of their friendship, as well as Leonard's confidence in Pancoast's abilities.

The most exciting development in the department during the years before the war was the introduction of an extensive pro-

gram of radium therapy. Radium had been used briefly by Dr. Pancoast in 1905,[50] but the lack of sufficient financial resources had prevented the implementation of a full scale program at that time. In 1914 George H. McFadden, a member of the hospital's Board of Managers, gave money to purchase 100 milligrams of radium.[51] The following year Dr. Charles H. Frazier arranged for an additional 125 milligrams, provided by another generous donor, to be transferred to Dr. Pancoast for safekeeping and use in treatment.[52] Pancoast was enthusiastic about the possibilities for therapeutic advances using radium, but unfamiliar with the techniques of its application, so shortly after the department's acquisition he spent a day in New York for instruction and advice in the proper application of radium for treatment with Dr. Robert Abbe, a physician whose work with radium had brought him national prominence.[53]

Dr. Pancoast used radium to treat a variety of symptoms and diseases, including inoperable carcinoma, brain tumors, uterine hemorrhaging, warts, and moles.[54] A Caldwell cavity tube was used to treat tumors in inaccessible locations such as the mouth, rectum, and uterus.[55] Radium treatment of gynecological cases was so successful that Dr. Pancoast, realizing his limitations in this specialty, encouraged Dr. John G. Clark to procure his own radium supply,[56] and by 1917 Clark was treating these cases himself.[57]

New equipment was purchased as the need arose and the patient load increased, and beginning in 1913 the fluoroscope was used extensively. Improvements in this apparatus had now alleviated earlier fears, and it was used on hundreds of patients. Coolidge tubes were also introduced in 1913, eventually replacing gas tubes and promoting much greater efficiency in the department's work. Intensifying screens, purchased from a German firm at the beginning of the decade and from an American firm just prior to and during the war, substantially improved the quality of the exposures.[58]

By 1916 the department was very cramped in its quarters in the Agnew Wing, and plans were begun to move it to space in the new surgical building, a tribute to J. William White, which was then under construction. This building had been started several years before but never completed, and in 1916 a special fund was initiated to raise money so that a portion of the first floor of the building could be finished immediately for use by the X-Ray Department. Space in the Agnew Wing office was at

such a premium, in fact, that no increases in diagnostic work were possible. All unnecessary work was reduced to a minimum, and all work from the Dental Department was transferred to the Dental School, thereby slightly decreasing the overall patient load.[59]

Henry Pancoast's interest in a variety of diagnostic and therapeutic research projects continued during this time, and he expanded the program, begun earlier with the assistance of Dr. Alfred Stengel, of treating bone marrow as the primary site of leukemia. Dr. Pancoast's earlier interest in research on the chest, and the analysis of roentgenographic examinations of tuberculosis patients, expanded in 1915 to include the study of workers in environments where organic dusts were produced and settled in the lungs. This project was an ongoing one and was enthusiastically expanded by his associates in subsequent years.[60]

The real urgency requiring the move of the X-Ray Department to new quarters was gradually realized by the hospital's Board of Managers, and during 1917 they raised nearly $25,000 for the completion of the available space in the White Building. The situation was particularly critical since the Agnew Wing office had only enough space to handle one treatment case at a time, and since most patients made between one and ten visits in the course of the year, often for rather lengthy periods of time, there were serious backlogs in the therapy program. The construction of the new facility was well underway during the summer of 1917, and the project's necessity was publicly affirmed by the Board of Managers: ". . . it will provide the Hospital with adequate facilities for the housing and equipment of the X-ray Department, the use of which has become of such increasing importance in all branches of the Hospital's work."[61]

The department's growth during this period also extended to the expansion of graduate medical education, since the 1916 merger of the Medico-Chirurgical College with the University's School of Medicine formed the beginning of the Graduate School of Medicine of the University of Pennsylvania. The opportunities for graduate education in roentgenology, organized as a formal curriculum, promised expansion of the earlier efforts of the Philadelphia Roentgen Ray Society, and offered the initiation of new projects at University Hospital to support this growing program.

## Departmental Operations During the War Years

Planning for the department's cooperative efforts in graduate education in roentgenology continued during the war years, although the formal classes in the Graduate School of Medicine did not begin until 1919. The Philadelphia Polyclinic Hospital and College merged with the University's School of Medicine in 1917, and the faculty of the Polyclinic became the nucleus of the graduate school's clinical staff. Dr. Pancoast and one of the Assistant Roentgenologists on his staff, as well as staff and faculty from the other institutions, presented formal lectures from the outset of the program.[62] Unlike the organization at University Hospital and the University's School of Medicine, however, roentgenology was recognized as a separate discipline in the graduate school structure, and a Department of Radiology, charged with developing its own curriculum, was established under Dr. George E. Pfahler.[63]

Soon after the beginning of United States involvement in the First World War, Dr. Pancoast and his staff became involved in a program to educate medical officers in the specifics of roentgenologic technique, adding another responsibility to their already overtaxed schedules. Some portions of the instruction were routine and taught in conjunction with the undergraduate medical school courses, but additional instruction placed special emphasis on the various methods of foreign body localization. The use of the roentgenoscope was encouraged, as was the value and necessity of methods of localization which were faster, though less safe, than those in use in regular civilian practice. Most of Dr. Pancoast's students were surgeons, and it was his responsibility to teach them all the available methods and to encourage them to use their own judgment to determine which would be the most speedy, accurate, and comfortable for a particular patient.[64]

The hospital records indicate that there were two Assistant Roentgenologists associated with the department during these years, but since these physicians also spent time at other hospitals, Dr. Pancoast still carried most of the departmental workload. Visiting graduate students, from other parts of the nation or abroad, often spent two or three weeks in the department, but they were here for training and were not part of the productive staff.[65]

In 1918 University Hospital offered the customary internships

to the students graduating at the very top of the class from the University's School of Medicine. A great many of these young men enlisted in the service, however, and the hospital soon found itself without an adequate supply of interns to function effectively. The President of the University persuaded the Navy to send a number of the doctors working at the Philadelphia Naval Yard, who had originally planned to do internships, back to University Hospital. Among the group was Eugene Percival Pendergrass, who was assigned to assist Dr. Pancoast in the Department of Roentgenology.

Dr. Pendergrass's tour of duty with the Navy was begun as an intern at University Hospital, and after a while he persuaded Dr. Pancoast that he, too, should enlist. Dr. Pancoast did join the Navy, and soon became an important consultant to the Philadelphia Naval Hospital and other Navy medical installations.[66] His work required a fair amount of travel, which resulted in his absence from the hospital. During this time Dr. Pendergrass was of great assistance in coordinating the move of the department from its quarters in the Agnew Wing to the new installation on the first floor of the J. William White Surgical Pavilion.[67]

While at University Hospital Dr. Pendergrass was asked to undertake a roentgenologic study of a number of British seamen who arrived in Philadelphia very ill, and who, it was later discovered, brought the influenza virus to the city that caused the 1918 epidemic. Dr. Pendergrass's assignment to work with Dr. Pancoast at University Hospital was cut short because the Navy needed his expertise to diagnose sailors suffering from influenza, but he later returned to the hospital and completed the full rotation of his internship.

During these years all actual X-ray examinations were made by physicians in the department, with nurses assisting as technicians. Dr. Pancoast was very particular about his personnel requirements for staff members: except for a few special cases all of the technicians were registered nurses. The calibre of his staff and his concern for protection for both operator and patient were but two indications of Dr. Pancoast's demand for excellence and the very best in roentgenologic procedures. His reputation was international by this time, and physicians from all over the world would visit him when they were in the United States.[68]

Dr. Pancoast was able successfully to keep the hospital's X-ray plant modern and up-to-date, although during these years batteries connected by bare wires were still used to make exposures

outside the hospital. The same unreliable gas tubes were still used, and each physician continued to reserve a pet tube—or tubes—for his own use.[69] Therapy work was not limited to the Department of Roentgenology. In addition to Dr. Clark's work in the Department of Gynecology, Dr. Pancoast's first memory of losing a tube of radium involved its loan to a laryngologist to treat a growth on the nose.[70]

The therapy cases in the Department of Roentgenology were just about equally divided between treatment of malignant disease and treatment of inflammatory conditions at this time. Gas gangrene was treated primarily with X-rays, as were leukemia, Hodgkin's Disease, skin cancer, and recurrent breast cancer. Radium was used to treat cancer of the cervix. The department experienced some success in controlling brain tumors, and treatment of tuberculosis of the lymph nodes was very common. In general, the roentgenologist was usually consulted as a last resort when there was no other alternative for patient treatment. The more experience a roentgenologist gained treating a variety of symptoms and diseases, the safer he was considered to supervise a course of treatment.[71]

Despite the move to the White Pavilion, Dr. Pancoast's sporadic absence for consulting work for the Navy and the absence of several members of the staff due to long term military obligations, the department continued to increase its patient load and expand its services to the hospital community during the war years. Eugene P. Pendergrass's brief assignment to the department in 1918 convinced him to return to work with Dr. Pancoast after completing his internship at the hospital. His participation would shape much of the department's future.

## Eugene Percival Pendergrass—Early Biographical Information

Eugene Percival Pendergrass was raised in South Carolina, the son of a merchant. He wanted very much to go to college, although difficulties in the cotton market prevented his father from sending him, but a kind gentleman agreed to loan Eugene Pendergrass the necessary funds, and in the fall of 1912 he began studying at Wofford College in Spartansburg, South Carolina.

Pendergrass spent his summers grading cotton and working in laundries, and after two years of college decided to apply to medical school rather than complete his undergraduate degree at Wofford. He was accepted into the two year medical program at the University of North Carolina and entered classes there in the fall of 1914. The North Carolina program did not offer a Doctor of Medicine degree, however, so in the fall of 1916 he changed institutions once again and was accepted as a member of the third year class in the School of Medicine at the University of Pennsylvania. He graduated among the top twenty-five students in his class in 1918, and was offered an internship at University Hospital which he accepted.

Pendergrass was in the Army in 1918 when the United States became involved in the war. He feared he would never leave Philadelphia if he remained in the Army, however, so he took the examination for the Navy, passed it, and was immediately sent to the Naval Hospital on Greys Ferry Road. Unfortunately for him, though, he was one of the interns sent back to University Hospital when their staffing shortage became critical. He was assigned to the Department of Roentgenology, and his initial reaction was one of displeasure and frustration: "I thought I had spent four years in medicine and two years in college, and to end up taking pictures just didn't appeal to me very much."[72] He quickly discovered just how lucky he was to be working with Dr. Pancoast in roentgenology, however, and soon his fellow interns were all quite jealous.

Due to staffing shortages caused by the war, he remained in the department for several months longer than he might have under a regular internship rotation and might have remained even longer had the city not been hit by the influenza epidemic. After working with Dr. Pancoast on the carriers of the virus, he was reassigned to the Naval Hospital to care for the marine and naval personnel who had also contracted the disease. When the epidemic became more severe, he was put in charge of an emergency hospital set up at the Medico-Chirurgical College Hospital at Seventeenth and Cherry Streets, serving as officer of the day there. He eventually contracted influenza himself, and was confined to the Naval Hospital until he recuperated.

Following his illness Pendergrass was sent to sea, and he served on four or five Atlantic crossings on a transport ship. He was offered the opportunity to study abroad after his tour of duty with the Navy was completed, but had already returned to the

United States when the delayed offer reached him. Instead he returned to University Hospital to complete his internship, and spent time rotating through a number of departments in the institution. After his training he decided he would like to specialize in roentgenology. He had an offer to return to his home town, as well as one to study at the Medical College of Virginia. However, Dr. Pancoast offered him the opportunity to remain at University Hospital and study with him. Dr. Pendergrass chose to remain in Philadelphia.

Eugene Pendergrass formally joined the staff of the Department of Roentgenology in 1920, after completing his internship, but it was a year or two before he was licensed to practice medicine in the Commonwealth of Pennsylvania. The difficulty arose over a 1914 Pennsylvania law requiring that medical students complete all their premedical training before entering medical school, and the fact that Pendergrass had taken a premedical botany course during his first year in medical school. In order to resolve the situation a new law had to be passed, outlining exceptions to the earlier one.[73]

## Growth and Expansion During the 1920s

During the early 1920s there was a steady increase in the amount of therapeutic and diagnostic work carried on by the department, but no increase in the number of physicians on the staff. From 1923 until 1928 Eugene Pendergrass, serving as Assistant Roentgenologist and Assistant Director of the Clinic, was the only staff physician working with Dr. Pancoast. Interns seem to have begun rotating through the department again in 1924; they were responsible for providing twenty-four–hour emergency roentgenologic service, but during these years Dr. Pendergrass came in to take every night call, with the intern serving as his technician.[74]

The early 1920s showed an enormous growth in the number of patients treated in the department, as well as additions in space and apparatus for therapy. In 1922 a one-story building was erected south of the surgical building to house the orthopedic gymnasium while the space formerly occupied by the gymnasium, on the south side of the main corridor across the hall from the X-ray department, was given to the department to permit

expansion of the therapy facilities.[75] The space was partitioned into a number of rooms, and one of the old therapy machines was remodeled and installed there. In 1923 Mr. and Mrs. Caleb F. Fox gave the department a high-voltage, deep therapy apparatus, that was also installed in the new therapy facility. Other available space was remodeled into examination and treatment space for patients receiving radium therapy, thus enabling the entire therapy program to operate in a single area. The department, always well known for its diagnostic work, could now be equally proud of its therapy facilities: "The added room and the new high-voltage deep therapy X-Ray equipment make it possible to handle all varieties of cases in which radiation treatment is indicated and have placed this Hospital in the front ranks of those in this counry for the administration of X-Ray and radium treatment."[76]

Radium played an important part in the department's therapy program, and gifts of radium or money with which to purchase radium were always necessary and welcomed. Professor R. A. F. Penrose, Jr., who had given radium to the hospital in 1918, donated $1,000 in 1924 to the Radium Fund,[77] and the following year George H. McFadden, a member of the Board of Managers who had been treated in the department, raised $3,000, enabling him to present 50 milligrams of radium to the department in the form of needles.[78] Radium in this form was first used in the department in 1921, after Dr. Pancoast requested permission from the Board of Managers to have some of the radium supply on hand put into needles. These were inserted into a growth, particularly to treat an area like the tongue.[79] When Dr. John G. Clark died in 1927, Dr. Pancoast was given responsibility for the 100 milligrams of radium which Dr. Clark had used to treat gynecological patients.[80]

The department made a major technical change about 1923, changing from single-coated glass plates to single-coated and double-coated X-ray film. The plates produced beautifully clear X-ray exposures, because there was emulsion on only one side of the glass, but they were cumbersome to handle, and since only one intensifying screen could be used the patient had to be exposed to the X-rays for a considerable period of time. The double emulsion film enabled the utilization of two intensifying screens, considerably decreasing the length of exposure, although the small added depth of the second emulsion had a tendency to produce a double image. This film not only decreased the expo-

sure time, thereby minimizing danger for the operator and patient, but it also eliminated a great deal of motion blurring since it was easier for the patient to hold his breath. The decreased period of exposure also made it much easier to examine children.[81]

The expansion of the department's therapy program in the early 1920s was paralleled by expansion and improvements in the diagnostic program during the second half of the 1920s. The vastly increased patient load and continual utilization of equipment necessitated substantial renovations. In 1926 the hospital undertook such a program. Approximately $10,000 was spent to remodel and design the rooms, and new equipment was purchased to enable two independent diagnostic groups to work simultaneously. More than half of the money, some $7,000, was appropriated by the Board of Managers, and the balance was contributed from other sources. These improvements kept the diagnostic division apace with the impressive additions to the therapy program, and helped to maintain the high calibre of the department's operation.[82]

Expansion of the diagnostic program continued in 1927 with research on technique and equipment to more capably assist the Bronchoscopic Clinic. Many patients visiting this clinic arrived as emergency cases, and the recent modifications to the X-ray department and purchase of new equipment enabled it immediately to care for these patients when they reached the hospital. Equipment was also modified to enable the utilization of fluoroscopic procedures to extract foreign bodies from the esophagus and air passages, providing a technique for which patients were formerly sent to other institutions.[83]

By 1928 the department had developed along two lines: two general examination units, with rooms, apparatus and staff, used continually for routine diagnostic work; and separate arrangements for special, time-consuming diagnostic procedures. This separation of diagnostic activities enabled the department to function as effectively as possible in its limited space, and minimized delays in service to other departments in the hospital. The entire institution had grown to rely so heavily on the X-ray department's work that delays in diagnosis often increased the period of hospitalization of patients, at a considerable expense to the hospital. The new system of operation was designed to prevent this from happening.[84] There were further physical renovations in the department in 1929 that facilitated procedures and

increased protection for the staff. A considerable amount of new equipment was also added, enabling the department to keep abreast of new technological developments.[85]

The department showed considerable growth during the decade of the 1920s: in the expansion of services and space, in the installation of up-to-date equipment, and in the gradual addition of staff at all levels. The first residents began working in the department in 1928,[86] representing a commitment to an extensive graduate training program by the department's staff. By the end of the decade there was an additional staff physician, plus one or more resident physicians, but the increase in the patient load and in the scope of the department's operation meant that the two senior staff men were incredibly busy, particularly since the residents rotated throughout the hospital during a portion of their training and were then not available as assistants. The department's spirited response to its growth and expansion during the 1920s laid a strong foundation for the following years, however, and placed the department in the forefront of the field of roentgenology.

## The Moore School X-Ray Laboratory

Research using roentgenology was being pursued elsewhere in the University as well, and in 1923 F. Maurice McPhedran, M.D., an affiliate of the Henry Phipps Institute at the University, approached Harold Pender, Ph.D., Dean of the Moore School of Electrical Engineering, for assistance with his X-ray apparatus. Dr. McPhedran was a specialist on tuberculosis, but was having difficulty producing the quality X-ray films he wanted and needed for his work. He was hopeful that one of the electrical engineers at the Moore School might be able to assist him. Charles Weyl, an Instructor at the Moore School, expressed an interest in the project, and in 1924 the two men began work on a pulse relay device which caused exposure of the X-ray at a predetermined phase in the cardiac cycle.

Charles Weyl served as Director of the Moore School X-Ray Laboratory, which was formally established in Room 210 of the Moore School building and was equipped to test X-ray equipment and to conduct experiments on roentgenographic proce-

dures. McPhedran and Weyl began studies of apparatus and techniques for chest roentgenography in 1924. This work was eventually supported by the National Tuberculosis Association, through its Medical Research Committee, and by a number of life insurance companies which were concerned about their losses from tuberculosis.

The funding from the National Tuberculosis Association began in 1929 and supported a program with three specific goals: the determination of the most effective X-ray equipment on the market and the analysis of ways to improve the apparatus; the analysis of chest roentgenography in tuberculosis sanatoria and the delineation of the best techniques to produce the optimum exposure possible in chest roentgenography; and the education of physicians in the peculiarities of chest roentgenography and in the latest developments in improved technique. The program was funded by the National Tuberculosis Association until the mid-1940s and produced many important developments in the field of chest roentgenography.

The staff of the Moore School Laboratory included S. Reid Warren, Jr., Dallett B. O'Neill and, for brief periods of time, C. Justus Garrahan and Ralph M. Showers. They were able to persuade three manufacturers of X-ray equipment to lend them apparatus to make exposures under controlled conditions in the laboratory. The results of their analyses were reported to the manufacturers as well as referred to in subsequent publications. The results of their research on various types of apparatus also proved useful in the second phase of their research for the National Tuberculosis Association, a series of site analyses of apparatus and techniques for chest roentgenography in tuberculosis sanatoria.

From 1933 until 1938, consultation visits were made to about two hundred sanatoria and hospitals in the United States and eastern Canada. Dr. Warren, usually with the help of an assistant, analyzed apparatus and procedures in each institution and made recommendations for changes which would produce an improved roentgenographic product. In addition, the laboratory's staff was involved in a considerable amount of consultation work and prepared specifications for new equipment purchases for various institutions. These specifications were unique, because they described the results that should be achieved by a specific piece of equipment, rather than a description of design and dimensions.

The third goal of the program, the dissemination of informa-

tion to physicians concerning advances and improvements in the roentgenographic process, was carried out through a series of published papers and through exhibits at national meetings of the National Tuberculosis Association, the American Medical Association, the Radiological Society of North America, and the American Roentgen Ray Society.

By 1943 it became obvious that the goals of the work for the National Tuberculosis Association were nearly achieved, and that work was terminated in 1945 when the grant from the Association was expended. The faculty of the Moore School continued to work cooperatively with a number of medical departments at the University, including the Department of Roentgenology, but the Moore School's own laboratory completed its independent work in chest roentgenology with the completion of work for the National Tuberculosis Association. For a period of twenty years, however, this laboratory made extremely valuable contributions to the improvement and development of techniques and apparatus in chest roentgenography.[87]

## National Participation and Awards

The high national regard held for University Hospital's Department of Roentgenology and its staff was evident in the honors achieved by members outside the University community and by the participation of these physicians in a number of national projects.

Henry Pancoast, long interested in chest roentgenology and the study of various lung diseases, was appointed chairman of a committee from the American Roentgen Ray Society which studied the appearance of the healthy chest in children and adults for the National Tuberculosis Association. His election as chairman from 1920 until 1926 was only one indication of his prominence, particularly in this branch of roentgenology.[88]

In 1928 Henry Pancoast served as chairman of the committee from the American Roentgen Ray Society charged with recommending an official nomenclature for the specialty. The American Medical Association appointed a committee composed of members of the Radiological Section and other allied radiological organizations at their annual meeting that year to consider the same

questions. The report submitted by Pancoast on behalf of the American Roentgen Ray Society was adopted by the Section on Radiology of the American Medical Association, even prior to its adoption by the American Roentgen Ray Society.[89]

The expansion of the department's staff to include residents permitted the staff some free time to pursue areas of special interest in individual and joint research projects. Physicians in the department received a great many awards for research projects, papers, and exhibits at various meetings of radiological and medical societies in the late 1920s and early 1930s, for projects covering a variety of fields of interest.[90]

The greatest recognition of Dr. Pancoast's contributions to the science of roentgenology and of his accomplishments at University Hospital was his election as President of the First American Congress of Radiology in 1933.

## Roentgenographic Assistance at Nearby Hospitals

In addition to expanded services and facilities at University Hospital and considerable participation in activities on the national level, the Department of Roentgenology also provided advice and assistance for roentgenographic operations at nearby hospitals.

In the late 1920s Henry Pancoast was closely involved with the establishment, in the northeastern section of the city, of Jeanes Hospital, a hospital and rest home for ailing members of the Society of Friends. Serving as consultant, he was to set up the X-Ray Department, and he asked Eugene Pendergrass to design this installation and choose a physician to run the department, which he did. The staff at University Hospital remained in close touch even after the department at Jeanes began to function, although they had no direct responsibilities there. In later years residents from University Hospital served rotations in this department, giving them an opportunity to work in an entirely different hospital setting from that at the University.

The staff at University Hospital became directly involved in the roentgenographic operation at Chestnut Hill Hospital in the late 1920s when the roentgenologist there died suddenly. Dr. Pancoast agreed to take over the operation of that department, and Dr. Pendergrass was assigned to spend several hours there

each day. Severe time constraints hindered this operation somewhat, since Pendergrass routinely made rounds to speak to each patient prior to his examination, and thus many nonemergency examinations were postponed until the morning following the consultation. The patient load was sufficiently large that additional assistance was soon needed, and beginning in 1930 residents from the department at University Hospital spent time at Chestnut Hill Hospital, working with Dr. Pendergrass.

Working at Jeanes and Chestnut Hill Hospitals enabled the staff and residents from University Hospital to spend time in community hospital settings and to gain exposure to the unique aspects of this kind of roentgenographic operation. It was particularly valuable for physicians still in training, because it provided experience in the kind of environment in which many would later find themselves working permanently.[91]

## New Approaches to Radiology in the Early 1930s

The decade of the 1930s had an auspicious beginning when the Department of Roentgenology at University Hospital and in the School of Medicine officially became the Department of Radiology and the staff titles were changed accordingly.[92] This followed Dr. Pancoast's term of service as chairman of the American Roentgen Ray Society's committee on nomenclature, and represented a change of mental attitude as well as semantics.

By this time radiology was beginning to be accepted as a precise, scientific field of medicine, much as surgery, and was no longer regarded unilaterally as "picture-taking" or only as a final alternative for patients whose diseases and conditions were incurable. The acceptance of radiology as a field of specialization was still in its infancy, however, a fact clearly noted by Henry Pancoast when he spoke before the First American Congress of Radiology in 1933. He stressed that in order to provide the best service possible it would be necessary to educate and train radiologists properly and, at the same time, to teach medical students and interns enough about radiology so that they would be able to make intelligent use of available radiological assistance. Furthermore, it was necessary to limit the practice of radiology to the medical profession to the exclusion of commercial laboratories, to

cultivate an ethical role for the various radiological societies, and to create a board to certify specialists in the field.[93]

The precise, scientific nature of radiology was impressed upon interns who passed through the department in the 1930s. Although most remained for only two months, serving simultaneously on the Eye and Receiving Wards as well, many of them expressed interest in the present capabilities and potential for future development of radiology, particularly in new forms of treatment. The staff emphasized a broad, general knowledge to orient specialists in other fields comfortably and stressed both the capabilities and limitations of the radiological approach. Many interns were exposed for the first time to chronically ill patients while working in the therapy division and found this experience to be particularly helpful in their overall medical education. They were also generally impressed by the staff's medical expertise, especially outside their field of specialty.[94]

The introduction of interns and residents in the department in the 1920s initiated a profound change in the orientation of the teaching program, since staff members thus became responsible for individual, preceptor instruction to these graduates. At the same time staff members were beginning to spend more time on their own research projects, as residents became skilled enough to assume responsibility for some of the routine operation of the department. Students were also sometimes given special research projects, instead of or in addition to the routine work assignments. For example, Philip J. Hodes worked on a mammography project during his radiological rotation as an intern, learning the required techniques and then examining about 500 patients. This project proved so interesting that he decided to specialize in radiology.[95]

The interns had close to unilateral praise for the department's teaching program, and special mention was made of the willingness of the staff physicians to explain information in detail to the interns, as well as to explain what was and was not being seen, for example, in fluoroscopy sessions. Working in the department in conjunction with two other services meant that different interns spent varying amounts of time in radiology, so there was a considerable variation in the actual training that was received. Some preferred fluoroscopy, since it was thought likely that the individual physician might perform this procedure in his own office; others were particularly interested in therapy and the treatment program; and many aimed for as complete an overview

as possible. Although the interns suffered definite scheduling difficulties, and many were unable to gain any exposure to some aspects of the specialty, the calibre of their instruction was nearly always praised.[96]

Although the department's staff was larger than it had been during the 1920s, including three or more staff physicians and a number of residents and rotating interns, it maintained an informality and congeniality in the interactions between the permanent and transient medical professionals. The staff's interest in teaching, and its cooperation and genuine friendliness, were emphasized repeatedly by interns on the service: "The radiographic and fluoroscopic work were extremely interesting and especially so, because of the time and pains spent discussing the interne's questions . . . . The spirit of fellowship and *esprit de corps* in the department I shall always remember."[97] Because there was such a limited number of Fellows, the residency training program was informal and tailored to the individual interests of each person. Radiology residents spent a portion of their time rotating through other departments in the hospital, and occasionally became involved in a research project while on one of these rotations in which they remained active for a considerable length of time. These outside interests were encouraged, and many worthwhile contributions to medical research were made by residents from the department.

By the early 1930s the residency program in radiology was a full two year course,[98] and the Fellows were gradually delegated responsibility for routine work in addition to their own research projects and teaching assignments. Accomodations were eventually found within the hospital to enable one of the Fellows to live there and be responsible for emergency work as it arose.[99] This arrangement replaced the interns on the hospital staff who had previously covered the department at night with the personal assistance of Dr. Pendergrass, who had always come in to take charge of the procedures.

Even though there was a very heavy workload for the physicians in the department, the overall operation was efficient, occasionally allowing them some flexibility in their schedules. Residents were, of course, expected to learn their specialty and to carry a share of the responsibility, but their constant presence was not always demanded in the department. The informality of the department at that time was recollected by Dr. Robert P. Barden, a resident during the mid-1930s:

I quickly discovered that the internes played tennis in the afternoons in the summer, therefore I played tennis almost every day that summer. First of all, there isn't a tennis court in the back of the University anymore. And secondly, the residents wouldn't be caught dead on the tennis court now, but it didn't seem to hurt anybody, I mean they still managed to learn and have some fun, so that's one little glimpse of the difference.[100]

It was during this period that Dr. Pendergrass actively worked to include a course in radiological physics in the department's educational offerings. As radiology gained nationwide acceptance it became increasingly evident that fully trained radiologists needed a good foundation in this area, and in 1934 Dr. S. Reid Warren, Jr., C. Justus Garrahan, Dallett B. O'Neill, and Charles E. Weyl began a series of lectures on the subject. This course was attended by physicians in the Department of Radiology and physicians in the Graduate School of Medicine, as well as outside physicians and student technicians. The physicists also taught special seminars for members of the Philadelphia Roentgen Ray Society.[101]

In 1932 the department began a School for X-ray Technicians to augment the supply of trained personnel in this field. In the early years the department's technical work had all been executed by physicians, with technicians merely assisting the doctors, although Drs. Pancoast and Pendergrass had employed one male technician during the 1920s who also performed some repairs on equipment. Generally Dr. Pancoast had insisted that each of his technicians also be a registered nurse. Student nurses had been rotated through the department, but as their curriculum expanded this rotation was eventually discontinued. Dr. Pendergrass felt it was a luxury to attempt to attract nurses to work as technicians, particularly since many women were concerned about exposure of the ovaries to radiation, so he suggeted that the department specifically train persons as technicians for future positions at University Hospital and at other institutions.

There was no precedent for this type of program. The department's approach combined both work experience and organized instruction. Residents were responsible for teaching anatomy, physiology, and some pharmacology, and the student technicians sat in on graduate courses in radiological physics. In later years the program became more structured, but in the early years instruction centered on practical experience, concentrating on fun-

damental procedures and on protection for both the operator and patient.[102]

The individual attention and atmosphere of genuine interest and concern, so strong in the teaching program, was also extended to the department's entire concept of service and patient care. It was a policy that each patient spoke personally to a physician, and students often accompanied staff members on the daily ward rounds which preceded diagnostic examinations and therapy treatments.[103]

The growth of the Department of Radiology was especially important because it incorporated a new emphasis on education and the delineation of a real scientific approach within the medical specialty, while maintaining its personal approach and real concern for both patients and students. Drs. Pancoast and Pendergrass were highly respected radiologists, destined to achieve unqualified recognition and acceptance within the University community; however, they were most concerned with their service to people.

## Department Activity in the Early 1930s

There were still difficulties for the Department of Radiology during the early 1930s despite progress in achieving recognition as a specialty. Within the organizational structure of both the School of Medicine and University Hospital, the department operated as a subdivision of the Department of Surgery, creating administrative and financial headaches and maintaining a psychological barrier to the complete acceptance of radiology as an independent function.

The therapy division of the department was deeply in debt during this time, but Drs. Pancoast and Pendergrass felt a responsibility to treat the patients who came to the hospital, whether or not their funds were sufficient to cover the cost of their care. Most patients, in fact, had spent their available savings on diagnostic work, and had little or nothing left to cover the expenses of therapy. The department underwrote the therapy operation with funds from the diagnostic division, however, and continued to serve an ever increasing number of chronically ill patients.[104]

The fully-affiliated staff remained small: Dr. Pancoast, Dr. Pendergrass, and, for six years from 1928 until 1934, Dr. Karl Kornblum. Despite the considerable assistance provided by residents, the entire responsibility for the operation of the department was left to these men. Research work was continued throughout these years, but such work usually occurred after hours, when the day's routine duties were completed.

There was no sharp distinction between training for diagnostic and therapeutic radiology, and although the work was divided for administrative purposes the staff physicians were generalists, assigned varying duties. Not a great deal was known about radiation therapy, and for a considerable period of time the department's reputation stemmed from its diagnostic advances. Dr. Philip J. Hodes was head of the therapy division from 1936 until World War II, and as he recalled the operation: ". . . radiation therapy was being done, but a great deal of emphasis was not placed upon it because little was known about radiation therapy. As a matter of fact, soon after I finished my residency I was placed in charge of radiation therapy, which gives you an idea of how little I knew."[105]

Cramped facilities and a lack of radium seriously hampered the progress of the department at the beginning of the decade,[106] and the only physical expansion during these years involved the construction of a new darkroom in 1935.[107] New techniques were developed and implemented, and the patient load did not plunge too dramatically during the Depression, but the adverse financial climate did slow down the department's growth.

Some new therapy equipment was installed during the early 1930s, including a deep therapy unit to replace the one given by Mr. and Mrs. Caleb F. Fox in 1923. Another new unit was purchased in 1935, and with the addition of a machine to administer superficial therapy, the department had three pieces of new apparatus for its therapy operation.[108] In 1934 Dr. Floyd E. Keene, the physician who raised the money in 1930 to replace the original deep therapy unit, placed 100 milligrams of radium at the disposal of the department for use when it was not otherwise needed to treat patients by the staff of the Department of Gynecology. This gift raised the department's supply of radium to approximately one-half gram.[109]

During these years the department operated efficiently, and though small, its staff accomplished a great deal of work, generated considerable research, and expanded its education program

within a confined space and with somewhat limited equipment. Although the department was firmly established nationally and internationally, and its staff members continued to be instrumental in the coordination of national radiological activities, neither the School of Medicine nor University Hospital was convinced of its importance as a completely independent activity.

## Pendergrass's and Pancoast's Departure Plans

By the mid-1930s Eugene Pendergrass's national reputation was so established that he received invitations to chair Departments of Radiology at both the University of Michigan and the University of Wisconsin. He visited these institutions, but was seriously concerned about the prospects for financing from the state legislatures of the respective states and, largely for that reason, turned down the two offers.

Shortly thereafter he received an invitation to head the department at Temple University in Philadelphia, and to design an entirely new installation for that operation, which he decided to accept. Pendergrass designed a new Department of Radiology for Good Samaritan Hospital, then the teaching hospital of Temple University, as well as a department in the medical school itself. The latter was physically located between the Department of Anatomy and the Department of Pathology, and presented an outstanding opportunity for cooperative teaching and research. Dr. Pancoast planned to join Dr. Pendergrass at Temple in 1940, following his retirement from Pennsylvania.

Several months before Dr. Pendergrass was to leave for Temple, however, Dr. Pancoast suffered a small stroke, and for the first time the University of Pennsylvania began to consider the question of a successor to Dr. Pancoast. The position was offered to Dr. Pendergrass, but he had already accepted Temple's invitation and was therefore placed in a particularly difficult position.

Eugene Pendergrass was actually more enthusiastic about staying at Pennsylvania where he could carry on the ideals and goals set by Dr. Pancoast, and the Dean at Temple graciously understood this. Dr. Pendergrass promised Dean Parkinson that he would find a replacement to head the department at Temple; after

consultation with a number of prominent radiologists he recommended Dr. W. Edward Chamberlain, Professor of Radiology at Stanford University. Dr. Chamberlain was contacted, came to Philadelphia for an interview, saw the newly constructed department designed by Dr. Pendergrass, and accepted the position.[110]

Dr. Pancoast never completely regained his health after the stroke, and did not resume full responsibility for the day-to-day operation of the department. Dr. Pendergrass was appointed Professor of Radiology in 1936, and had already accepted the responsibility for short- and long-term planning in the department as well as for its routine activities.[111]

## Initial Contacts with William Henry Donner

Eugene Pendergrass began to plan ahead during these years, contemplating programs which might prove feasible at a later date. He became involved in a project to develop X-ray equipment which would produce identical images at sea level and several thousand feet above sea level, to enable radiologists to determine standard appearances of the human anatomy on X-ray film, and persuaded the Moore School of Electrical Engineering and the Johnson Foundation of Medical Physics to lend assistance. In his search for funding for this project Dr. Pendergrass contacted William Henry Donner, a well-known philanthropist and head of the International Cancer Foundation.

William Henry Donner established the International Cancer Foundation in 1932, in memory of his son Joseph, who had died of cancer three years earlier, at the age of 35. Until the end of his life Donner devoted time to philanthropic causes, and his interest in cancer research supported scientists all over the world. His association with University Hospital's Department of Radiology was to be a natural outgrowth of this concern.[112]

Dr. Pendergrass explained his apparatus design project to Mr. Donner, who eventually offered to finance the Department of Radiology's portion of the work, but not the work in the Moore School or the Johnson Foundation. Dr. Pendergrass thanked him for his interest, but declined the funding, knowing that he could not obtain the necessary matching contributions. This association, however, was to be sustained.

Late in 1935 Mr. Donner called Dr. Pendergrass and asked him whether he knew anything about Chaoul therapy, a new approach to contact therapy devised by a German physician. Dr. Pendergrass had read about the procedure and had been so interested that, after reading a translation of an article by Dr. Chaoul, he had gone to Atlantic City to see an exhibit of the apparatus at the International Cancer Congress. Dr. Pendergrass was optimistic about the potential for this new procedure and intended to investigate it in much greater depth.

Mr. Donner told him that he had given Chaoul therapy units to two physicians in New York City, but that neither was particularly interested in this type of treatment. Dr. Pendergrass's enthusiasm motivated Donner to suggest that he might be able to give him one of the units in New York. He called shortly thereafter to ask Dr. Pendergrass to go to Europe to see the apparatus in operation, and to speak to Dr. Chaoul. Pendergrass was too busy to go. He planned to send an Associate, Dr. George W. Chamberlain, but after persuasion by the University's Vice President for Medical Affairs, Dr. and Mrs. Pendergrass found themselves on their way to Europe. The Pendergrasses spent several weeks abroad, during which time they visited Dr. Chaoul and a number of other physicians in Germany and England. By the completion of the trip Dr. Pendergrass was fully trained in the operation of the Chaoul apparatus, and aware of its potential; in March, 1936, after his return from abroad, the department received its Chaoul therapy unit.

Dr. Pendergrass's conscientious approach to the Chaoul therapy episode, and his economy while abroad, convinced Mr. Donner of his efficiency and dedication to the field of radiology. Thus began a long and cordial friendship. Mr. Donner was to make many generous contributions to the department and the University. Throughout these years he relied on Eugene Pendergrass as an expert authority and consulted him repeatedly for advice concerning the donation of X-ray apparatus to other institutions.[113]

## Anticipation of Future Development: 1936–37

Dr. Pendergrass's promotion to the rank of Professor and his designation as "Chairman-elect" set the stage for long term de-

velopment and expansion. A portion of the department was redesigned in 1936, to accomodate the installation of the Chaoul therapy unit and a 200 kilovolt shock-proof deep therapy unit. These machines doubled the capacity of the treatment division of the department and accounted for a considerable increase in the patient load during that year. Diagnostic work also increased considerably in 1936, as X-ray procedures were expanded to include the examination of patients for more disease conditions than ever before.[114]

An especially important research project was underway at this time: investigating the small intestine. This was one of the first studies of this organ, and the department worked in close cooperation with the gastrointestinal section of the Medical Clinic. With some assistance from the Departments of Surgical Research and Biochemistry in the School of Medicine, the department conducted a series of studies and received awards for the subsequent exhibit of the results at a number of medical and radiological society meetings.[115]

The patient load decreased somewhat by mid-1937, reflecting the national business conditions, but the facilities of the department continued crowded and taxed to their utmost. William Henry Donner's interest continued, and in the fall of 1936 he donated an ionization chamber to determine the dose distribution produced by the Chaoul therapy unit and a generating voltmeter to determine the secondary voltage of a number of pieces of equipment, probably the only one of its kind in the city.[116]

Mr. Donner's contributions satisfied pressing needs. Other additions were a rotating anode radiographic table, three new X-ray therapy tubes, and a filter device to be installed on the new deep therapy unit. The old photographic room was remodeled to permit a more efficient filing system, but the department was as yet unable to implement a master plan for reorganization and renovation. By early 1937 the staff was hopeful that plans for a completely new installation might be forthcoming, and everyone was thinking seriously of a new facility. Anticipating these future developments, the staff made small, urgently needed changes and additions, and waited.[117]

## William Henry Donner's Bicentennial Contribution

In early 1938, William Henry Donner made a contribution of $200,000 to the Department of Radiology, in honor of his deceased son, William Henry Donner, Jr. The gift, although credited toward the University's Bicentennial Fund ending in 1940, was put to immediate use, and offered the department the opportunity to make immediate improvements as well as to plan for an entirely new installation.

Initial expenditures enabled the department to replace much of its old diagnostic and therapeutic apparatus with new, shock-proof equipment. The fluoroscopic rooms were remodeled, and new tables were installed, equipped for both routine radiographic work and fluoroscopic procedures. A radiographic unit designed especially for examinations of the head was also installed, as was a unit for laminography, enabling the physician to obtain an exposure of a special, localized area in any portion of the body, at any depth desired.

Mr. Donner's contribution additionally enabled the installation of new therapy apparatus, ". . . probably without peer in this country."[118] Two 200 kilovolt shock-proof units and a 135 kilovolt shock-proof superficial unit replaced the old therapy equipment, and, with the Chaoul treatment unit, provided highly sophisticated apparatus for the department's operation. The efficiency and convenience of the new machines enabled the staff to accommodate more patients each day, under circumstances considerably more pleasant than was formerly the case. New tube heads, of a unique construction, allowed ranges in target-to-surface distances that had been previously unattainable.

Teaching equipment was also added in 1938, and a projectoscope was purchased which projected a magnified view of an ordinary radiogram onto a screen, enabling an entire audience to see the film simultaneously and to discuss the case easily.

During this re-equipping process, the department enlisted the aid of Dr. S. Reid Warren and Mr. Dallett B. O'Neill from the Moore School of Electrical Engineering to advise them on the purchase of specific pieces of apparatus; at this time and in later years these two men offered much valuable advice.[119]

Additional apparatus was purchased in 1939, including a table for breast radiography and one adapted for ventriculography.

The purchase of three rotating anode tubes provided the capability to make rapid exposures of the spine, esophagus, and urinary tract, thereby expanding the diagnostic procedures available for analysis of these areas.[120]

A portion of Mr. Donner's gift was earmarked for the reinstallation of the department in the new Dulles-Agnew Wing of the hospital, under construction at this time. Donner himself officiated at the groundbreaking ceremonies for the new wing in December, 1939; the Agnew Pavilion replaced the old building of the same name which was destroyed by a fire in 1937, and the Dulles Pavilion, named in memory of a victim of the Titanic disaster, was built to the south and west of the Agnew Pavilion in a reversed "L" shape.[121]

Anticipation of the move to the new facility designed specially to meet the needs of the ever growing department eliminated the necessity to further remodel the White Building facility. A portion of the Donner gift continued to be spent on apparatus which would later be moved into the new facility, however. In 1940 these purchases included: new cones for use in therapy, equipment to permit rapid serial films to study the cardiovascular system, and a variety of other devices which enabled the convenient and efficient use of diagnostic equipment.[122]

The importance of Mr. Donner's gift cannot be overestimated because it enabled the department to replace its apparatus and to create a new physical installation all within a short period of time. The opportunity reinforced the department's reputation and was strong evidence of the calibre of an operation which could generate such interest and funding.

## Cooperative Research: Work for the Air Hygiene Foundation of America

In 1938 the Department of Radiology, in conjunction with the Moore School X-Ray Laboratory, undertook a major analysis of the methods of chest roentgenography available for use in industry. The study was sponsored by the Air Hygiene Foundation. Dr. Pendergrass was the principal radiological investigator, and Professor Charles Weyl, Dr. S. Reid Warren and Mr. Dallett B.

O'Neill were the principal technical investigators from the Moore School. Darrow E. Haagenson, a graduate electrical engineer, was hired to conduct many of the studies.

Increased awareness by employers of preventive measures to minimize occupational disease hazards was beginning to lead to expanded use of physical examinations at this time, both prior to and periodically during employment. The roentgen examination of the chest, a particularly important aspect of this procedure, was expensive when undertaken on a large scale, so the initial research on the project involved the analysis of exposure quality of roentgenograms made on film, and those made on specially prepared, sensitized paper, for industrial survey use. Major X-ray equipment manufacturers made available apparatus, darkroom facilities, roentgenographic paper, X-ray film, and developing chemicals for the investigations. The completed exposures were circulated to nearly fifty radiologists for quality analysis. The roentgenographic exposures made on paper were considerably inferior to those on film, but were considered acceptable for survey purposes in situations where patients with questionable diagnoses would receive more extensive examination.[123]

In later years the research concentrated specifically on silicosis and other occupational diseases caused by dust particles in the lungs. Dr. Eliot R. Clark of the Department of Anatomy joined the investigative team.[124] The Department of Radiology had been involved in work with these lung diseases ever since Dr. Pancoast's initial work in 1916, but this cooperative research venture was a unique opportunity to investigate disease symptoms as shown on different types of exposures, as well as to analyze the comparative technical merits of different methods of examination.

The research for the Air Hygiene Foundation was phased out as the United States entered World War II and a number of the investigators became involved in other projects. The work proved to be of particular importance, however, because the Armed Forces also adopted wide scale chest examination procedures for their recruits. Their primary interest was to diagnose men suffering from tuberculosis, and it was hoped that these precautionary actions would reduce the ultimate cost to the government in medical care and pensions. This consideration was equally valid for occupational diseases in industry.[125]

The Department of Radiology's reputation was clearly evident in the calibre of the cooperative research investigations in which

it participated, and Eugene Pendergrass's expertise, combined with his enthusiasm for such joint investigations, would serve as the catalyst for the department's future efforts.

## The Department Under New Leadership—1939

Henry Khunrath Pancoast died in May, 1939, and at that time Eugene Percival Pendergrass officially became Chairman of the Department of Radiology. The change in leadership caused no dramatic transition, since Dr. Pancoast had never regained his health sufficiently to reassume complete responsibility and Dr. Pendergrass had been running the operation for several years. Dr. Pancoast's death did, however, necessitate some organizational changes in the relationships between the University, the hospital, and the department.

The Department of Radiology had functioned as a subdivision of the Department of Surgery ever since Dr. Leonard began making exposures in 1896, and there was no change in this organizational structure during Henry Pancoast's time. Dr. Pancoast's reminiscences about his lifelong work in the department, published in February, 1938, made peripheral allusions to difficulties arising from this situation and emphasized another difficult problem facing radiologists during the 1930s: national recognition of their field of study as an independent specialization within the field of medicine, rather than as a merely technical operation. He emphasized the fact that it was often easier for a hospital to establish fees for radiological operations than to control activities in specialities like surgery or internal medicine, and that hospitals frequently overlooked the fact that a major component in the analysis of their general capability often involved the calibre of the radiological services available.[126] Pancoast's solution to the difficulties of dealing with the hospital administration was to operate the department much like a private practice, even though it remained a subdivision of the Department of Surgery. When it was given independent status in 1939 (one of Dr. Pendergrass's stipulations for remaining at the University), Dr. Pendergrass continued to operate the department much as his predecessor had.

The department hired its own physicians, technicians, and

nurses, and they were paid on a salary scale determined by Dr. Pendergrass. The department received most of its income from private patients, although a portion of these fees was paid to the hospital. The hospital received all income from patients in the wards and from patients in the out-patient dispensaries. Income from the latter groups of patients was sporadic, though, since a great many individuals were unable to pay for their medical expenses; it was not until the Blue Cross system was established that the hospital received substantial income from out-patients. Expenses for the department's therapy operation were particularly high.

The hospital charged the Department of Radiology for the space which it occupied. This assessment included normal housekeeping services, and in some ways the department was treated as though it were renting space from the hospital. Most often the department purchased new equipment from its own income or with money from private contributions, and although it charged the hospital for films used on ward patients, it did not assess a fee for the processing of the films or for the doctors' and technicians' time. Costs of preparation for hospital seminars, particularly the time spent by the technicians who prepared the materials, were never reimbursed in the hospital-department finances.

The department's participation in the medical education program was extensive at this time, but the funding it received from the School of Medicine was minimal. Even after the department achieved independent status its budget remained very small; the funding received was not enough to pay for all the slides necessary for the teaching program. The department's physicians did receive a contribution toward their salaries from the School of Medicine, but the contribution was exceedingly low relative to their teaching load.[127]

In light of the department's limited funding sources from the income generated by private patients, the contributions made by Mr. Donner and other individuals became even more significant. The only means to purchase large pieces of equipment, or to considerably expand the staff, was by developing the interest of potential donors and soliciting their support. Dr. Pendergrass successfully convinced Mr. Donner of the validity of the program at the University of Pennsylvania in the mid-1930s, and his subsequent Bicentennial contribution proved very important in the department's growth.

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