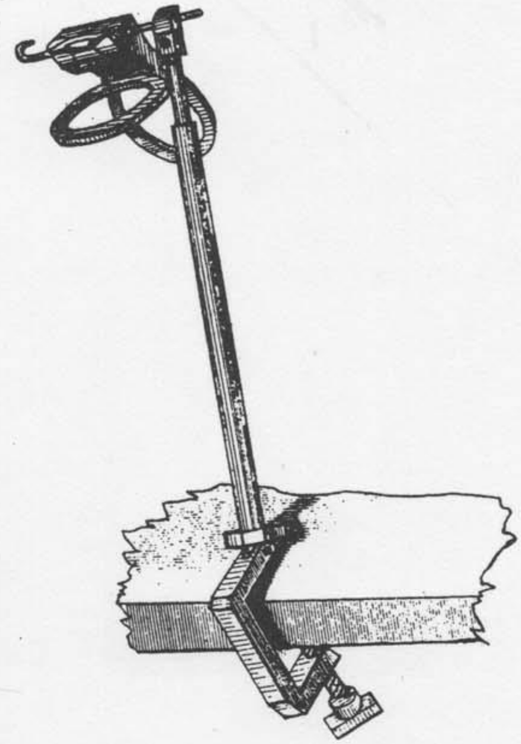


CHAPTER 7

ROSCOE GEORGE AND TELEVISION

Roscoe George is one of Purdue's best remembered pioneering scientists. He was director of Purdue's first high-voltage laboratory, the first to make an all-electronic television receiver, and the first to build a television station that broadcast programs from the Purdue campus in the 1930s. How these events occurred is a fascinating story of the way in which the solution of one problem led directly to the solution of another.

Roscoe George enrolled in Purdue in 1915. He received his BSEE in 1922—his undergraduate studies having been interrupted by military service—and his MSEE on August 17, 1927. From 1919 to 1922, he worked as an assistant in the first high-voltage laboratory in the first EE Building; and, on his graduation, he became director of the laboratory. For his master's research, he developed a cathode-ray oscilloscope to study the transients on high-voltage transmission lines. His oscilloscope had a much shorter response time than the optical galvanometer oscillographs then available. George studied lightning-protection systems for high-voltage transmission lines by photographing the transients appearing on his oscilloscope.

Camera lucida.

In 1929, the Grigsby-Grunow (Majestic) Radio Company desired to advance television, which, although mechanically based, was attracting much attention. On May 7th of that year, Roscoe George and his colleague, Howard J. Heim, entered into a contract to develop an improved all-electronic television receiver. They conducted their research in Rooms 20 and 22 in the present EE Building.

The concept and method of transmitting pictures by wire had been patented by Paul Nipkow in Berlin in 1884; the patent outlined the concept of scanning a scene to acquire picture information and reassembling it for viewing. However, this mechanical system could not be reduced to practice for some time, not because of a lack of photodetectors, but because amplifiers had to await development of the vacuum tube by DeForest in 1906. The photoconducting property of selenium had been described by May in 1823 and photoemission was described by Hallwachs in 1888. Only after DeForest developed the triode amplifier in 1906 was it possible to enlarge photoelectric (and other) signals to a level suitable for display.

In the first television system, the brightly illuminated scene was focused to form an image near the perimeter of a rotating disk about two feet in diameter, as shown in Figure 7.1. A series of holes was drilled in the disk, each hole being displaced from its neighbor by the image width and at a slightly less radial distance to form a spiral-hole pattern on the disk. As the disk rotated, a photodetector

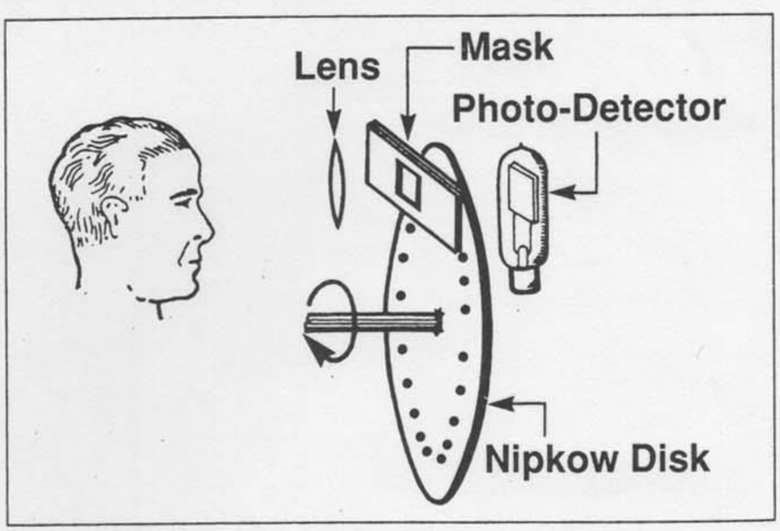


Figure 7.1 The mechanical scanner used in the first television systems.

behind it was exposed to the scene via each hole which moved across the image to trace out one line. The next hole (below the first) scanned the second line of the image, and so on. The whole picture was formed by 60 lines which repeated with the next revolution of the disk 1/20 of a second later. In modern terminology the image consisted of 60 lines and 20 frames per second.

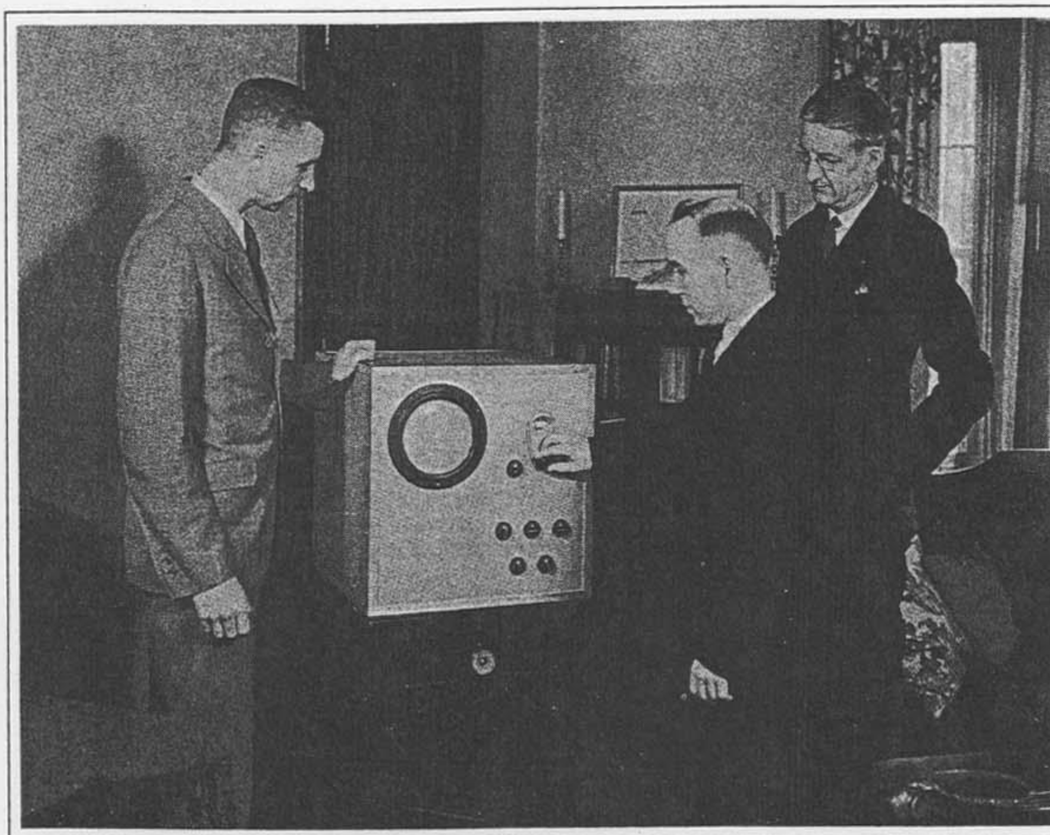
To receive the image, the amplified output of the photodetector was applied to a glow discharge (neon) lamp, the brightness of which was proportional to the brightness of the point in the image at that instant. The light from the glow modulator was focused on the back of another disk, identical to that used for scanning the scene and rotating at exactly the same speed and in phase. When the disk was viewed from the side opposite the glow modulator, the 60-line, 20-frame/second picture could be observed. Persistence of vision made it possible to perceive motion as smooth. (As time passed, there were many variants of this mechanical system.)

Throughout the world, intense investigations were under way with spinning-disk television systems. Baird successfully demonstrated image transmission by wire in the United Kingdom in 1925. Two years later, a similar demonstration was presented in the United States by AT&T, using its New York-Washington land lines. In the late 1920s attempts were well under way to transmit pictures by wireless, but these efforts had only limited success. The two main problems were in the receiver: synchronization of the receiving disk with the transmitting disk and low-level illumination in the display. The problem of synchronization of the rotating disk in the receiver was extremely difficult and occupied the talents of many engineers. While others, notably Zworykin and Farnsworth in the United States, tackled the problem of making an all-electronic camera, George and Heim began the task of eliminating the rotating disk in the receiver by creating the first successful all-electronic television receiver.

George and Heim added a second (vertical) sweep circuit to George's newly developed cathode-ray oscilloscope to permit display of television images. They created a linear sweep by charging a capacitor through a pentode (57), which operated as a constant-current device. A thyratron (885) was used to discharge the capacitor to return the sweep to its starting point. They solved the synchronizing problem by cutting a notch in the spinning disk camera so that a pulse was obtained for each revolution of the scanning disk. They also built a spinning disk camera and conducted closed-circuit TV transmissions in the EE Building. Meanwhile, they applied for a license to broadcast TV and received it on October 27, 1930.

Figure 7.2 illustrates the all-electronic TV receiver being viewed by Heim (left) and Harding (right); George is in front of the receiver. This receiver has survived and can be seen in the Museum of Broadcast Communications at River City in Chicago.

Figure 7.2
The first electronic television receiver developed by Professors George (center) and Heim (left), being demonstrated to Professor Harding (right), head of EE (1912-42).



The license permitted W9XG to transmit television pictures with 1,500 watts on a frequency of 2,050 kHz. A 78-foot tower and a transmitter building were erected on a hill

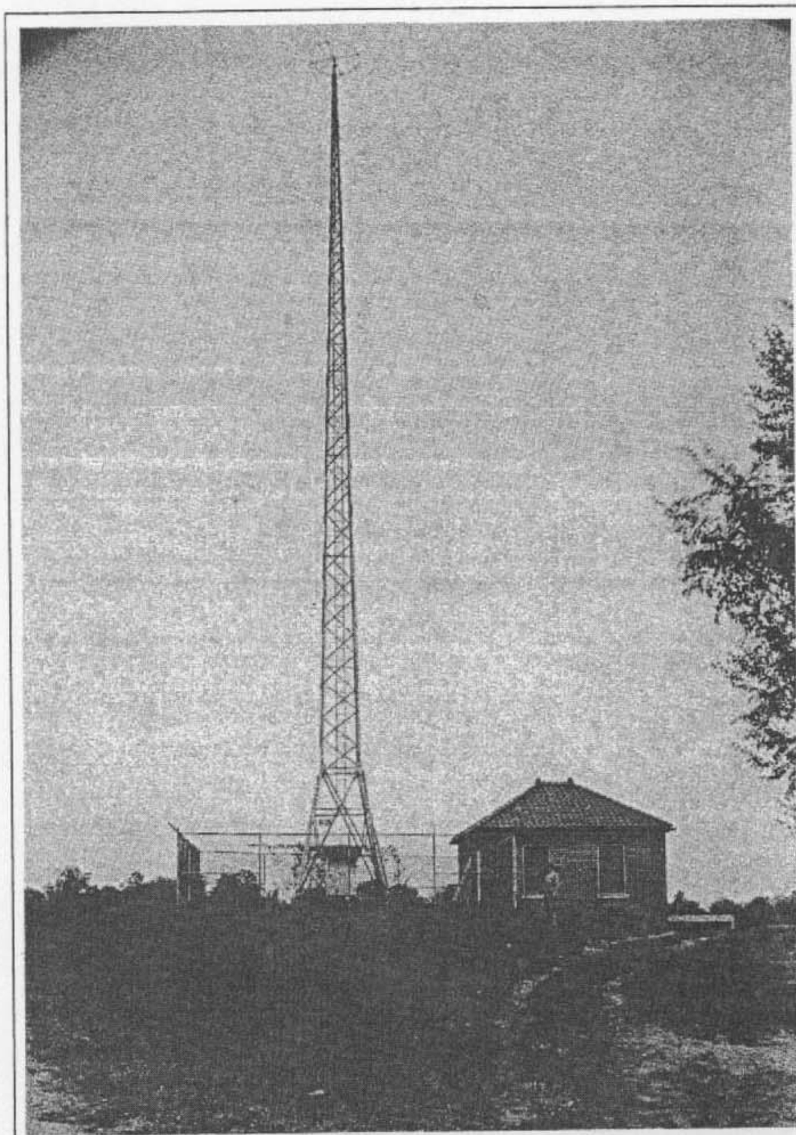


Figure 7.3
Roscoe George's Television Station, W9XG, near the Ross-Ade Stadium.

at the north side of the east-section seats of the Ross-Ade Stadium (Figure 7.3). According to the Federal Radio Commission, the transmitter was located 1/2 mile north of latitude 42.8°, 9.26'5" and longitude 86.9°, 9.42'30".

The station came on the air on December 31, 1931. On March 29, 1932, a regular telecasting schedule began. Old silent movies constituted the first programs. In addition to the receivers in the EE Building and at the transmitter, there were probably no more than five receivers in all of Indiana. Nevertheless, during each month, a few reception reports were received by mail—one, for example, from Houlton, Maine, 1,050 miles from the transmitter.

TELEVISION STATION W9XG
PURDUE UNIVERSITY
WEST LAFAYETTE, INDIANA

Date Dec 19 31

Dear Mr.

We th ctures.

Remarks:

W9XG

Program: Standard motion picture film, newsreels, etc.
Transmission at 60 lines per picture and 20 pictures per second. Single spiral disc.
No sound accompaniment; voice announcements only.
Frequency: 2050 kc.

Power output: Varies from time to time; maximum of 1,500 watts.
Time of Operation:

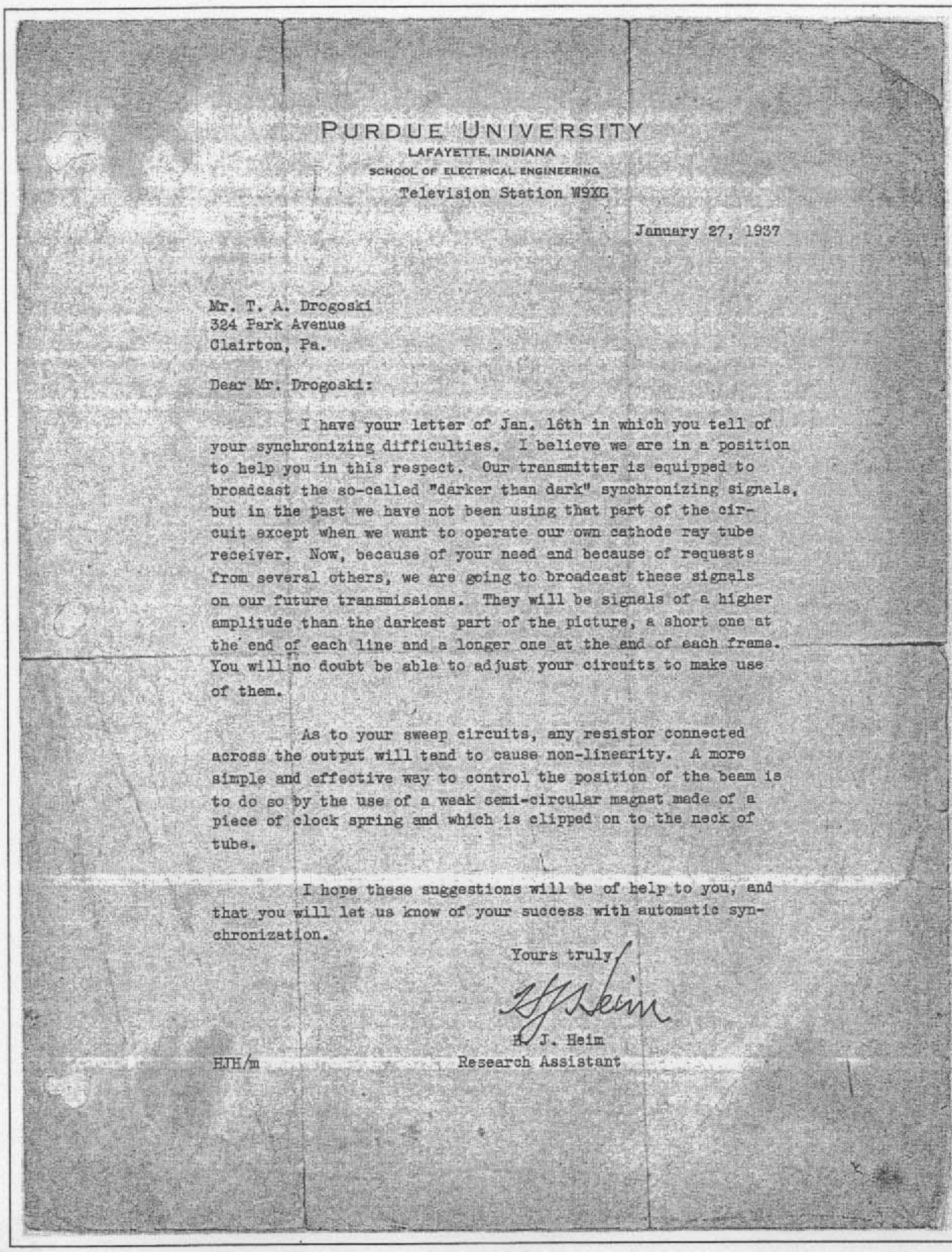
Days:	Hours: (C.S.T.)
Tuesday	7:30 P. M.
Thursday	8:00 P. M.

Figure 7.4. The postcard used by Roscoe George to acknowledge reception reports.

Figure 7.5
A picture taken from the screen of Roscoe George's receiver. The attractive lady is Rosa George, Roscoe's wife.

Roscoe George acknowledged each with a postcard or a personal letter. Figure 7.4 illustrates the postcard used to acknowledge reception reports. At the bottom of the card the type of signal transmitted is identified (60-line picture, 20 pictures per second). The card shows that the telecasts were presented on Tuesdays and Thursdays starting at 7:30 and 8:00 p.m., CST. No sound accompanied the movies, but voice announcements were made. Figure 7.5 shows one of the pictures taken from George's all-electronic television receiver. The woman shown on the screen is Rosa George, Roscoe George's wife.

Correspondence has been located that identifies considerable interest in Purdue's television station. A frequent writer was Ted Drogoski of Clairton, Pennsylvania, who, with the help of George and Heim, had constructed an all-electronic television receiver to monitor W9XG regularly. A letter dated January 27, 1937 (Figure 7.6), is interesting in that it shows how extraordinarily cooperative Heim was. The letter reveals that George and Heim had developed the modern system of broadcasting synchronization which is part of the picture information. The letter also shows that George and Heim used a C-shaped magnet applied to the cathode-ray tube to center the picture.



PURDUE UNIVERSITY
LAFAYETTE, INDIANA
SCHOOL OF ELECTRICAL ENGINEERING
Television Station W9XG

January 27, 1937

Mr. T. A. Drogoski
324 Park Avenue
Clairton, Pa.

Dear Mr. Drogoski:

I have your letter of Jan. 16th in which you tell of your synchronizing difficulties. I believe we are in a position to help you in this respect. Our transmitter is equipped to broadcast the so-called "darker than dark" synchronizing signals, but in the past we have not been using that part of the circuit except when we want to operate our own cathode ray tube receiver. Now, because of your need and because of requests from several others, we are going to broadcast these signals on our future transmissions. They will be signals of a higher amplitude than the darkest part of the picture, a short one at the end of each line and a longer one at the end of each frame. You will no doubt be able to adjust your circuits to make use of them.

As to your sweep circuits, any resistor connected across the output will tend to cause non-linearity. A more simple and effective way to control the position of the beam is to do so by the use of a weak semi-circular magnet made of a piece of clock spring and which is clipped on to the neck of tube.

I hope these suggestions will be of help to you, and that you will let us know of your success with automatic synchronization.

Yours truly,

H J Heim

H. J. Heim
Research Assistant

HJH/m

Figure 7.6
Letter from H. J. Heim to T. A. Drogoski, January 27, 1937.

Roscoe George conducted field studies to evaluate reception at different distances from the transmitter. The standard 110-volt AC television receiver was energized by a motor-generator set, operated from two six-volt storage batteries (the motor-generator set is extant and in the possession of Ralph Townsley, retired chief engineer of

WBAA). George and Heim took the receiver by automobile to various cities in Indiana and neighboring states. Figure 7.7 is a picture of George, an assistant, and the automobile used in the field tests. The results of these tests revealed that reliable reception was possible within a radius of 150 miles from Purdue.

Figure 7.7
Professor George and assistant (left) beside the automobile that was used to conduct television reception tests in Indiana and neighboring states. Photo courtesy of G. Cooper.

George and Heim became dissatisfied with the blue-green phosphor screen of their cathode-ray tubes; and, with Wilfred M. Hesselberth, they set to work developing a white phosphor (using magnesium tungstate) so that a black-and-white image could be produced. They, meanwhile, perfected and patented their synchronizing circuit for locking the scanning beam in the receiver to the picture information provided by the rotating disk at the transmitter.

In December 1931, just when all was going well, financial aid was withdrawn by the Majestic Radio Company. For the next two years, they continued to work on an informal basis and at a greatly reduced pace. In 1934, the Radio Corporation of America (RCA) provided financial support and the work was under way again. All was not serene, however, for the patent on synchronization was challenged. The RCA attorneys were not able to defend the priority of the art, and both Purdue and RCA lost.

Meanwhile, Zworykin (Figure 7.8) of RCA was having success developing an all-electronic camera tube (the iconoscope). He had filed for a patent in 1925, which was granted in December 1928. The iconoscope made it possible to increase the number of lines in the picture. Because of the photomultiplier it contained, only 1/100,000th of the light was required compared with that demanded by the mechanical scanning camera.

Between 1930 and 1940 there was much discussion over the number of lines a picture should contain—the contenders were 441 and 525. By 1940 the National Television System Committee (NTSC) standardized on 525 lines with 30 frames per second. The increase in the number of lines required a wider bandwidth for the TV signal. After 1936 TV was moved from the 2 MHz region to the VHF band, 54-216 MHz (channels 2 to 13), and to the UHF band, 470-890 MHz (channels 14-83).

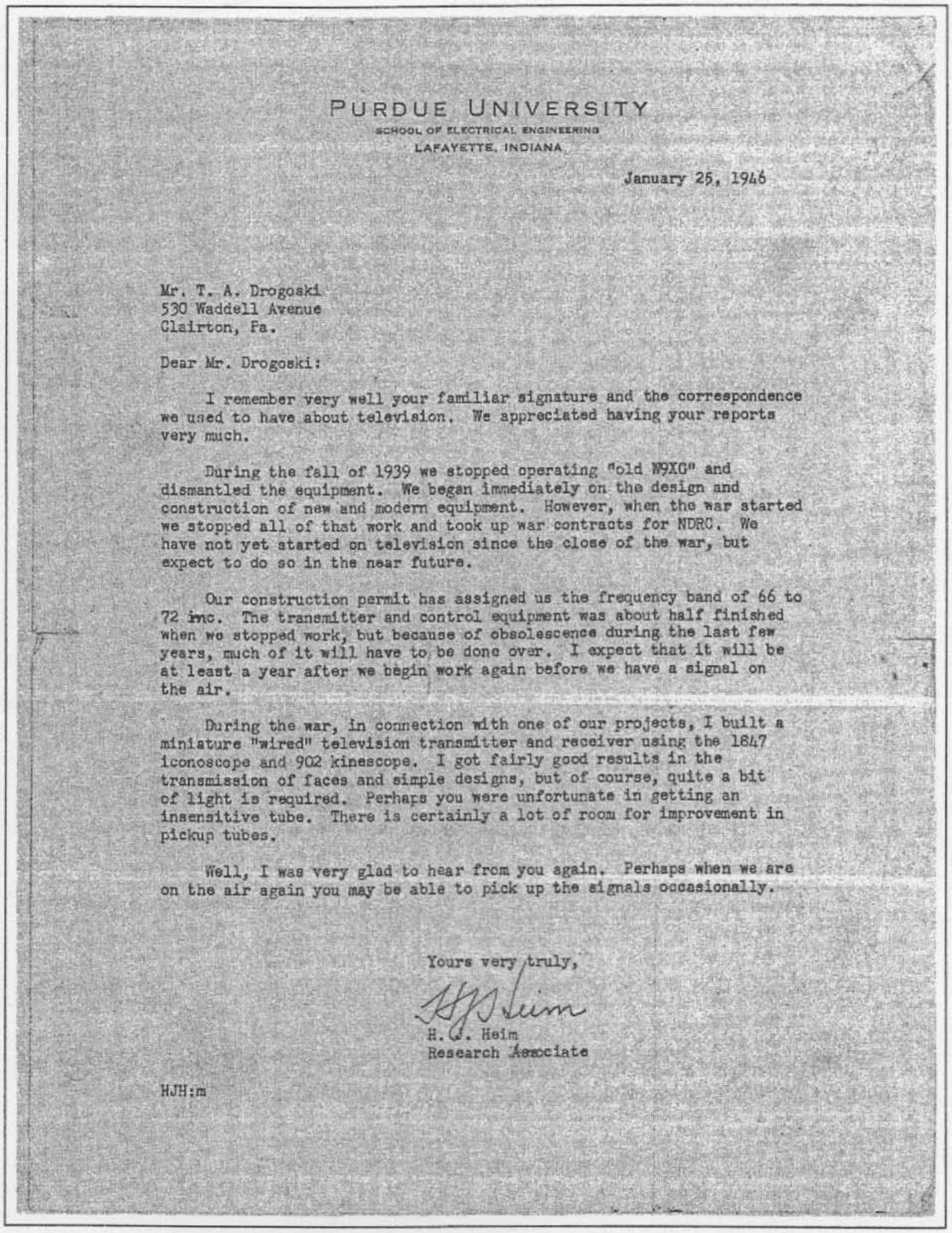
With the creation of new camera tubes and the impending standardization of the number of lines in the picture, the mechanical scanners disappeared. George and Heim immediately began to modify W9XG to produce a 441-line picture, and petitioned the FCC for a new frequency. Meanwhile, their license to operate at 2,000-2,100 kHz was about to expire, but they were able to obtain a renewal for one more year. Unfortunately, the United States soon became engaged in providing war materials, and television developments had to be set aside.

Figure 7.8
Vladimir K. Zworkyin with iconoscope.

A postwar letter from Heim to Drogoski, dated January 25, 1946 (Figure 7.9), states that just prior to the beginning of the war George and Heim started building a new television station to operate on 66-72 MHz. When the war

Figure 7.9
Letter from H. J. Heim to T. A. Drogoski, January 25, 1946.

ended, however, television research was not restored. Because of the technology developed during the war, television became a commercial rather than an academic enterprise.



PURDUE UNIVERSITY
SCHOOL OF ELECTRICAL ENGINEERING
LAFAYETTE, INDIANA

January 25, 1946

Mr. T. A. Drogoski
530 Waddell Avenue
Clairton, Pa.

Dear Mr. Drogoski:

I remember very well your familiar signature and the correspondence we used to have about television. We appreciated having your reports very much.

During the fall of 1939 we stopped operating "old W9XG" and dismantled the equipment. We began immediately on the design and construction of new and modern equipment. However, when the war started we stopped all of that work and took up war contracts for NDRC. We have not yet started on television since the close of the war, but expect to do so in the near future.

Our construction permit has assigned us the frequency band of 66 to 72 mc. The transmitter and control equipment was about half finished when we stopped work, but because of obsolescence during the last few years, much of it will have to be done over. I expect that it will be at least a year after we begin work again before we have a signal on the air.

During the war, in connection with one of our projects, I built a miniature "wired" television transmitter and receiver using the 1847 iconoscope and 902 kinescope. I got fairly good results in the transmission of faces and simple designs, but of course, quite a bit of light is required. Perhaps you were unfortunate in getting an insensitive tube. There is certainly a lot of room for improvement in pickup tubes.

Well, I was very glad to hear from you again. Perhaps when we are on the air again you may be able to pick up the signals occasionally.

Yours very truly,

H J Heim

H. J. Heim
Research Associate

HJH:m

In 1950, the W9XG building was demolished to make room for an expansion of the Ross-Ade Stadium, and the tower was removed. Not a trace of the station remains. Rooms 20 and 22 in the EE Building, where George and Heim conducted their research, are now a student lounge. However, there is a rack near the ceiling in Room 22 that contains several of Roscoe George's cathode-ray tubes—an appropriate reminder of those pioneering days (Figures 7.10 and 7.11). Roscoe George and Howard Heim were engaged in a variety of electronics research projects during World War II. In fact, modern electronics research at Purdue was started by this team (see chapter 8, Circuits and Electronics).

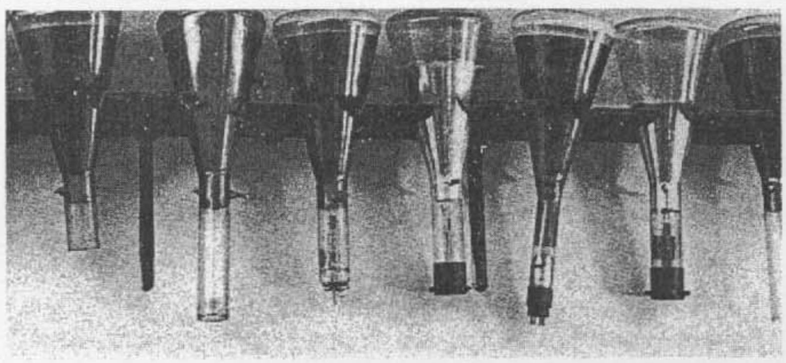
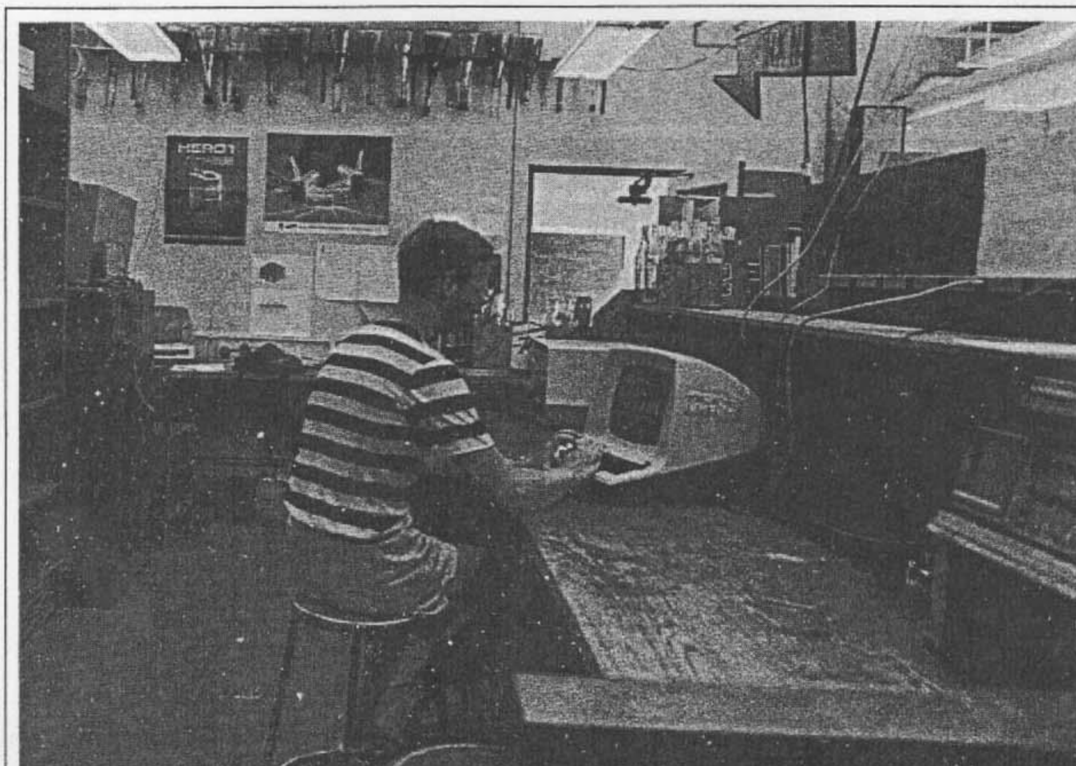


Figure 7.10
Close-up of several of Roscoe George's cathode-ray tubes located in a rack along the ceiling of Room 22 .

Figure 7.11
Room 22, Electrical Engineering Building.



Roscoe George retired in 1965 at age 68 after 45 years on the faculty. He had acquired 35 patents and had received a pioneering scientist award from RCA. He lived at 703 North Chauncey in West Lafayette, where he died on December 27, 1975, at age 79. George is survived by his wife, Rosa, who is still a resident of West Lafayette.

In recognition of the good relationship with Purdue, which began with the research conducted by George and Heim, RCA established the RCA/Zworykin Memorial Grant in the fall of 1983, which provides $20,000 per year for five years. The purpose of the award is to support graduate students who have earned the MS degree and are pursuing the PhD. The award also made provisions for additional funds if the Zworykin family contributed to the program to create an endowment fund. Such a fund was established by the Zworykin family, thereby adding materially to the ability of Purdue to provide training for those who aspire to leadership in electrical engineering.