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Orphan Films: *Television Pictures* (1931)

INTRODUCTION

By 1931, the date of this film, television experimenters had successfully broadcast images across the ocean, uniting sound and image by using separate wavelengths for each and displayed images on large screens as part of theatrical programs. It seems surprising that by this relatively late date in the development of television technology, that the claim, "You are now looking at the first motion picture of a television image that has ever been produced," would be true in March of 1931. Nearly 75 years after this film was created, viewers can't help but be a little skeptical. In October 2004, our group set out to verify or disprove this statement, and contextualize the footage in terms of the period that produced it. This research led us through the history of television development and what we found out proved to be quite interesting. This film is held in the Newreel Archive at the University of South Carolina, and our research will be used to provide information following a restoration of this footage, which will be presented at the Orphans Film Symposium, in the spring of 2006.

EARLY TELEVISION: TECHNICAL DEVELOPMENTS

Television was not invented by a single inventor; instead, many people working both together and alone contributed to the evolution of TV. One inventor built upon the work of previous inventors, and parallel systems emerged around the same time. This makes the question of who invented television a complicated one, as many inventors around the world were experimenting with television at the same time.[i]

The idea of "seeing at a distance" had been around for along time. As early as the mid-nineteenth century, it was imagined that it would be soon possible. In 1879, George du Maurier drew a cartoon for British magazine *Punch* that showed a mother and a father watching on the wall of their English home a tennis match in Ceylon in which their daughter was playing. They were also able to speak to her over a long-distance telephone. In 1882, the French artist Albert Robida produced a series of drawings in which moving images were transmitted onto the walls of people's living rooms. One of these drawings showed a teacher giving a math lesson; another showed a ballet being performed; another, a desert war being fought.[ii]

The word "television" was first used—and presented to the public—in August 1900, in a paper by Russian scientist Constantin Perskyi at Paris World Exhibition.[iii]

Mechanical Television

Although television in the form of a mechanical scanning system developed at full speed in the 1920s, it had a long story. Modern development started with the 1873 discovery by Joseph May and Willoughby Smith that the element selenium was capable of conducting small amounts of electricity in direct response to the amount of light falling on it. Later inventors, such as George Carey in 1877, found that banks of selenium cells placed in a mosaic analogous to the human eye and wired individually, could send the elements of a picture as electrical signals from each cell simultaneously to a bank of lamps that lit in response to electricity. In 1880, Maurice Leblanc and others developed the principle of scanning, or viewing pictures elements successively rather than all at once as in a mosaic device, and transmitting them sequentially over a single circuit. A major refinement was a mechanical device, George Nipkow's scanning discs, capable of scanning and transmitting even a moving picture.[iv]

In 1884, the German scientist patented his disc, which had one spiral of holes or apertures spread equally around the outer part of a flat disc. The path each aperture swept out (through the angle between apertures) corresponded to a line in the image. The radial distance of each successive aperture changed in equal steps so that, in one revolution, all the apertures swept out the area of one TV frame. By masking off that area and placing a photocell behind it, we have a television camera. By placing a variable light source (usually a neon) behind a similar disc, we have a television display. With synchronization of camera and display, we have the vision channel for television. The mechanical nature of systems based on Nipkow discs, and the sensitivity and bandwidth of photocell amplifiers, initially constrained the television image to mere tens of lines rather than the hundreds of lines of the electronic systems emerging in the thirties.

Although he had devised the theory of scanning, Nipkow failed to put it into practice. Of the many inventors and experimenters who worked on mechanical television in the 1920's, three made outstanding progress: Herbert Ives of Bell Telephone Laboratories; John Logie Baird, a self taught Scottish inventor; and Charles Francis Jenkins, an American inventor.

Ives was assigned, with the help of substantial funds and staff, to keep AT&T "abreast of the general advances in the art of television." His work culminated with wire transmissions in 1927 of still and moving image pictures over hundred of miles. Bell Labs never promoted its system commercially.

One of the better-known experimenters with mechanical television was Charles Francis Jenkins, a prolific American inventor. In May 1920, at the Toronto meeting of the Society of Motion Picture Engineers, Jenkins introduced his prismatic rings as a device to replace the shutter on a film projector. This invention laid the foundation for his first "radiovision" broadcast. He claimed to have transmitted the earliest moving silhouette images on June 14, 1923, but his first public demonstration of this did not take place until June 1925. Jenkins Laboratories constructed a radiovision transmitter, W3XK, in

Washington, D. C. The short-wave station began transmitting radiomovies across the eastern U. S. on a regular basis by July 2, 1928.

Baird is generally credited with establishing television in Great Britain. Baird used a ventriloquist dummy called Stukey for his experiments on Frith Street, since no human was likely to tolerate for hours the extremely bright lighting that Baird needed in his efforts to obtain a decent picture. On October 1, 1925, Baird managed to get Stukey's head to appear on screen. Inspired by this achievement, he arranged a demonstration for members of the Royal Institution on January 26, 1926. Turning next to live action scenes as a source, in February 1928 he televised a woman's image from London to New York. Later that year he transmitted to the liner *Berangaria* a thousand miles at sea. And in 1932, he transmitted the English Derby to a large screen in a London movie theater, where 4000 people watched the race. This was similar to what Alexanderson was doing in Schenectady in 1930.

In 1935, when the Television Committee of the British government had to decide which television standards they would use, comparative tests were held of the Baird mechanical system and an electronic system controlled by Electrical and Musical Industries Ltd. (EMI), a company based partly on Zworykin's work in the United States. They decided in favor of the latter because they believed Baird's system was near the end of its potential development, while the electronic system could be improved.

Electronic Television

Although a number of other scientists became interested in the possibility of television, not all of them approved of Nipkow system. Its main drawback was that the scanning disc had to be rotated mechanically, limiting the speeds that could be achieved and, therefore, the clarity of the picture. The two pioneers of an "alternative" method were A. A. Campbell Swinton, a British scientist, and Boris Rosing, a Russian engineer, working independently. Campbell Swinton concluded that an electronic cathode ray tube, in which the image would be picked up on a thin plate coated with photosensitive substance, should replace the mechanical scanning disc. The plate would then be bombarded with electrons form a "gun" at the other side of the tube.

A German named Karl Braun had invented the cathode ray tube in 1897, but it was Campbell Swinton and Rosing who showed how it could be used for television. Rosing filed a patent in 1907. In 1908, unaware of this, Campbell Swinton wrote a letter to *Nature* magazine, revealing his proposals. The system described in *Nature* is, with some refinements, still the basis of television today. What he did not do was to put his principles into practice. This was what John Logie Baird did.[v] But his misfortune was that when he began experimenting with television in 1922, he used the Nipkow disc, even though it had been superseded by the work of Rosing and Campbell Swinton; and as evidence accumulated that he ought to change to electronic scanning, he still obstinately refused to do so.

Early Experimentation[vi]

While Baird was transmitting images in London, other people were working along the same lines elsewhere in the world. Denes Von Mihaly, a Hungarian scientist, was also committed to mechanical scanning, but instead of Nipkow disc, he preferred a revolving drum that contained mirrors tilted at different angles. This mirror drum was later adopted by Baird and Alexanderson because of the better quality of the mages it could get. Nevertheless, it still suffered from the essential defects of all mechanical systems. Mihaly, like Baird, Alexanderson and other pioneers, was transmitting 30-line pictures[vii]. In Japan, a young lecturer called Kenjiro Takayanagi managed to transmit the Japanese character "I" in 1927. Meanwhile in the Soviet Union, scientists at the Leningrad Polytechnic Institute "were under the impression that *they* were inventing television"[viii]. But they pursued electronic television right away, instead of going through a mechanical phase.

In addition, the Americans were "inventing" television, too. Charles Francis Jenkins had started experimenting in 1923 using Nipkow discs. In 1925, shortly after Baird's first show, Jenkins gave a similar demonstration in the United States. Different corporations involved in radio and telephone technology were sponsoring research on television. At General Electric, Ernst Alexanderson was working on mechanical scanning. At Westinghouse, Vladimir Zworykin, who had experimented with television in Russia before emigrating in 1919, was more interested in electronic scanning. David Sarnoff, head of RCA had no doubts as early as 1923 that television was here to stay: "Every broadcast receiver for home use in the future will also be equipped with a television adjunct by which the instrument will make it possible to see as well hear what is going on in the broadcast station."[ix]

On April 7, 1927, the American Telephone & Telegraph Company (AT&T) gave a public demonstration of the apparatus that had been developed in its Bell Laboratories.[x] In the course of it, the U. S. Secretary of Commerce, Herbert Hoover, gave a speech, which was broadcast from Washington and watched in New York by an "invited audience of business executives, editors, and bankers." The following day, the event was a lead story on the front page of the *New York Times*: "Far Off Speakers seen as well as heard here in a test of television." The audience in New York saw two broadcasts: the first, in which Hoover spoke, was transmitted by wire from Washington; the other was sent by radio from AT&T's experimental station in Whippany, New Jersey. The Whippany broadcast featured a comedian called A. Dolan.

Five months later, in Los Angeles, there was an equally historic development: Philo T. Farnsworth produced an electronic television system that worked. What it made it particularly extraordinary was that the inventor himself was only twenty-one years old; a most unlikely figure to be involved in the creation of television. He came from a poor farming family in Idaho. When he was fifteen, and after reading a stack of popular science journals, he found at home, he drew on a blackboard a complete plan for an electronic television system, to the astonishment of his chemistry teacher, who encouraged him to persevere. After some years of experimentation, Farnsworth felt

confident enough to apply for a patent. This was strongly contested by RCA, whose president, David Sarnoff, had decided that television had a future and that RCA, through its subsidiary company NBC, ought to dominate it. Nevertheless, the mighty corporation was unsuccessful, and in August 1930, the 24-year-old Farnsworth won his patent for electronic television. Soon afterwards, Vladimir Zworykin, then working on electronic television for RCA, visited Farnsworth in San Francisco. RCA's lawyers then began the long and expensive process of trying to buy Farnsworth's patents.[xi]

Even though they were stuck with mechanical equipment, other American pioneers were making progress. In May 1928, General Electric began making regular thrice-weekly broadcasts from radio station WGY in Schenectady, New York. Ray Kell, who was one of General Electric engineers at the time, says that on Christmas Eve, 1928, he sent a greetings message that was picked up by his parents on a television receiver in Indiana. Most of the broadcasts from Schenectady were less adventurous (only the faces of men talking, laughing, or smoking) but there were a couple of notable breakthroughs. On August 22, 1928, WGY transmitted Al Smith's speech accepting his nomination for the U. S. Presidency. The event took place in Albany, New York, and 24-line pictures were sent back to Schenectady over a telephone wire.

In September 1928, WGY broadcast the world's first television drama, *The Queen's Messenger*, by J. Hartley Manners. The play had only two characters in it, which was just as well, since anything with a large cast would have defeated General Electric's primitive equipment. Each camera could only scan an area twelve inches square, enough for a human head and not much else. Three cameras were used: one for the actress, one for the actor, and one for the two "doubles." These doubles had an essential part to play, as the main actress and actor could not move their heads without going out of focus. Whenever the script called for some other shot—a hand holding a glass of wine, for instance—there was a switch to the third camera, where one of the double's hands would be seen. By the time WGY transmitted its second play, eight months later, the cameras had been improved, and the 12-inch frame was replaced by a stage eight feet wide, eight feet high and six feet deep.

WGY was not the only American television station operating in 1928. From June onwards, Charles F. Jenkins was broadcasting four-line silhouette pictures from Washington Monday, Wednesday, and Friday evenings. By the end of the year there were eighteen experimental television stations licensed in the United States. Progress was spurred by the Americans' knowledge that they were engaged in a race with the British. Research into the new equipment took place in secrecy. NBC's owner, RCA, was doing well: late in 1928, it began secret tests with Zworykin's Iconoscope, a cathode ray tube camera, which differed from the other cameras, both electronic and mechanical, by "storing" an image before scanning it, thus reducing the amount of light that needed to be cast on the image.

RCA's first experimental television transmissions began in 1929 by station W2XBS New York in Van Cortlandt Park and then moved to the New Amsterdam Theater Building, transmitting 60 line pictures in the new 2-3 mHz band allocated to television. A 13" Felix

the Cat figure made of papier-mâché was placed on a record player turntable and was broadcast using a mechanical scanning disk to a scanning disk receiver. The image received was only two inches tall, and the broadcasts lasted about two hours per day. By 1931, the station became part of NBC and began to transmit from 42nd Street. After many years of research and development, an all-electronic television system emerged from the laboratory in 1933 for actual field tests. These tests were carried out in Camden, New Jersey, using a video transmitter and connected to it by a coaxial line. Iconoscopes (television cameras) were used to pick up scenes in both the studio and out-of-doors. The use of the iconoscope permitted transmission of detail, outdoor pick-up, and wider areas of coverage in the studio. A scanning pattern of 240 lines made it possible to obtain a picture with good definition, but as the frame frequency was 24 cycles, without interlacing, flicker was quite noticeable. In 1934, the number of lines was increased to 343, and an interlaced pattern having a field frequency of 60 cycles and a repetition rate of 30 frames per second was adopted.

GENERAL ELECTRIC'S ROLE

Ernst Fredrik Werner Alexanderson
b. January 25, 1878; d. May 14, 1975

The man speaking in the second section of the clip, applauding the success of the recording and explaining its significance, was confirmed to be Ernst F. W. Alexanderson. Alexanderson was born in Uppsala, Sweden, on January 25, 1878. He received a degree in engineering from the Royal Technical University in Stockholm in 1900. He arrived in the U. S. in 1901 and by 1902, he was working at General Electric, first as a draughtsman, but was quickly transferred to Steinmetz's Consulting Engineering Department. He received his first patent in 1904 and eventually became the holder of some 350 patents, the last of which was issued in 1973, when he was 95 years old.

Alexanderson made significant contributions to the advancement of radio and television, in addition to fields such as railway electrification, direct-current power transmission, telephone relays and gun control systems, to name a few. He became the leading authority on the design of high power, high frequency alternators for wireless communications shortly after he was employed by GE. The high frequency alternator he invented enabled Reginald A. Fessenden to transmit the world's first long-range radiobroadcast of both voice and music on Christmas Eve, 1906. He later developed a 200 kW alternator that was used by President Woodrow Wilson to send messages to commanders in Europe. This alternator was completed at the end of the war, when President Wilson delivered the ultimatum to Germany that led to the Armistice. Shortly after this, he sent the first facsimile around the world.

Some of GE's Contributions to Television
GE's experiments with various schemes for practical television led Alexanderson to suggest a method employing multiple spots of light (instead of one that had been used in previous experiments) and a mirror drum. The drum, coupled with a high speed electric motor, projected light onto a screen about 4 x 4 feet. Seven light sources were arranged

close together in a star formation. This experimental machine was tested on September 18, 1926. Because each light source would have required an independent control (a problem that was never practically solved) the images produced were quite crude. Overall, the machine had a number of disadvantages, and when R. D. Kell became supervisor of Alexanderson's television laboratory in 1927, he implemented the use of equipment that was already being widely used in the U. S., U. K., Germany, and France. Alexanderson continued make significant contributions to television experiments at GE.

Some major historical moments in television testing at GE include:

- January 13, 1928. Television broadcast demo received by three television sets in Schenectady, in the homes of Alexanderson and two GE executives. Images were said to be as good as those in a lab and detail in faces could be seen.
- August 21, 1928. First outside television broadcast by GE. Listeners and viewers tuned into WGY or into the shortwave radio stations 2XAF and 2XAD and were able to see and hear Governor A. E. Smith, Democratic candidate for President, make his acceptance speech for the nomination in Albany, NY. By September 1928, WGY was making four weekly television broadcasts of 15 to 30 minutes.
- February 12, 1931. GE reported successfully transmitting images of Professor Karolus to his home Leipzig, Germany. Images were said to be so clear that the professor's eyeglasses could be distinguished. Same report discussed GE's ability to film motion pictures of television images that have quality as good as or better than the television image itself.[xii]

OUR FILM: TELEVISION PICTURES

The Demonstration

The man who appears in the television image follows a traditional demonstration pattern that was fairly standard and familiar at this point in time, moving his head from side to side and smoking a cigarette to illustrate the resolution of the image. During the first public demonstration in the U. S. of television broadcasting, on January 13, 1928, a man reportedly smoked a cigarette, and then turned his head from side to side. Similar demonstrations followed.

Because this demonstration was recorded on film, it could not exploit the spectacular "liveness" of television, as many previous demonstrations did. It was, however, an attempt at recording the live television transmission, which up to this point seems to have been unsuccessful.

The People

The man speaking on the success of the filming of the television image was easily confirmed to be Dr. Ernst F. W. Alexanderson of the GE Company by consulting numerous websites with photographs of him. Information on the man doing the demonstration in the clip, noted by the Fox Hearst Corporation library index card to be Mr. Lowell J. Hartley, has proved difficult to find. The only mention we have found of

him was in a book entitled *Alexanderson: Pioneer in American Electrical Engineering*. He is briefly noted to have worked extensively in television and radio experiments at GE. In this book, his name is spelled "Hartly."[xiii] We made a call to the Schenectady Museum, which holds many GE-related materials, including a photographic archive, which unfortunately has not been able to give us any more information.

The Equipment

The mechanical television equipment Kell introduced to GE's television laboratory is similar to what Alexanderson demonstrates in *Television Pictures*. What we are seeing in the film is an advanced version of the scanning disc system invented by German Paul Nipkow in 1884, which, as discussed above, was used until the late 1930s by many companies, with photo-electric cells for projection illumination. The cells appear to be Alexanderson's version of Dr. A. Karolus's Kerr cell, developed in 1924. The disc in this clip had 48 apertures, although GE often used 24-aperture discs around this time. This disc then would create 48 lines per image on the television display, resulting in the wavy lines that we see in the film.[xiv]

The Date

A library index card from the Fox Hearst Corporation lists the date of this film as March 12, 1931, with Bockhorst Haxton as cameraman and a length of 2500 feet. That the footage from the GE laboratories might have been included in a Fox or Hearst newsreel around this time is indicated by a March 23, 1931, article in the *New York Times* entitled "Newsreel subjects." The article reports that the highlight of the newsreel shown at the Embassy Theatre in New York City that week was a television demonstration from GE's "House of Magic" in Schenectady, NY. The *New York Times* proclaims that the image "appears to justify the company's contention that if the rate of progress is maintained at its present pace the time may not be far distant when home sets will be practicable." The article also lists the other items shown on the newsreel that week, which include an interview the president of Boston University discussing the individuality of various cities, an interview with the President of Poland, a 4-year-old operatic singer in Mexico. The newsreel described was a combination of Hearst and Fox material; unfortunately, neither Fox nor Hearst has a record of a completed newsreel containing the footage in *Television Pictures*.

If this is, as Hartley claims, the first time a television image was captured on film (and, as discussed below, we've encountered no evidence to the contrary), we estimate the filming of the television image to have taken place in January or February 1931, based on a *New York Times* article (as well as a more brief article on the subject in the *Chicago Daily Tribune*) dated February 12, 1931. The article reports a successful transmission of television images by GE from Schenectady to Leipzig, Germany, and notes the successful creation of filmed motion pictures of television images that would soon "be adaptable for news reel display."[xv]

In an attempt to pinpoint the date and other details, we contacted a special collections archivist at Union College's Schaffer Library in Schenectady, which has on hand many of Alexanderson's papers and historical materials from the General Electric Company.

Unfortunately, the files on Alexanderson do not offer any additional information about the material in *Television Pictures*.

The Precedent

Hartley says on the clip, "You are now looking at the first motion picture of a television image that has ever been produced." Is this true? Our research suggests this is quite possible. Experiments in filming television had been attempted for a number of years by various companies around the world, though these always seemed to fail. We have found reports of filmed television that always turned out to be faked; that is, they were demonstrations behind the scenes at laboratories, but the image made was staged, not actually a recording of the television image. Since GE was falling behind in the race for practical television technology, they turned to other ways of contributing to the advancement of television. One of these was successfully filming the television image, which as we see, they managed to accomplish. Prior attempts seem to have failed due to inadequate light source.

Our research turned up these records of TV images on film:

Pathe News, 1927: Pathe News, collaborating with Bell Telephone experts, is the first to show how television operates. It's an apparatus over which calls are made (a telephone with a TV receptor).

British Pathe, "Seeing by wireless," March 6, 1929: Shows early television transmission techniques. But the actual "televised" image is fake (it's a reconstruction).

Significance

GE was working on the creation of a film recording of television about the same time as they successfully transmitted fairly good quality images from Schenectady to Germany. The fact that these two stories were reported in the same newspaper article hints that there is a relationship between the events. As we learn from listening to Alexanderson's short monologue in the clip, they were looking into the use of film as a means to broadcast events from overseas in theaters shortly after they happened. Events could either be filmed and then broadcast on television or broadcast via television and recorded on film for future distribution. GE's proof that a relationship between film and television was possible would excite the public about the broadcast of world news in theaters in almost the same amount of time it would take to hear them on the radio. By showing this television demonstration in theaters as a news event, the audience would be aware of the potential next step in broadcasting.

Although television was a household word in March of 1931, it was not yet physically in the homes of many people. Experiments were still being carried out in the U. S. and Europe, each inventor and institution hoping to be the first to succeed in creating high-definition, practical television. Because a limited number of people would have been able to witness television demonstrations and broadcasts, it's likely this was the first time audiences in theaters had seen television images and were offered insights into the

workings of television. Reaching a mass audience would have given GE an advantage over other U. S. companies attempting to market their systems at the time.

Future Directions for Research

While we were able to locate information about television in this period through books, Web sites, input from archivists solicited via the AMIA listserv, and primary sources such as newspapers, we would like to investigate further the individuals involved in this particular production. We would also like to peruse the archives at the General Electric Company in Schenectady in hopes of discovering additional information about Alexanderson's television research, any extant film footage of this and other experiments, employee records for Lowell J. Hartley, and any paperwork, including a script, that relates to this production. We would like to find out why there are four copies of the same take (Hartley's television image appears four times and, as far as we can discern, is the same take each time) and why one of these takes has no sound, and we'd like to confirm whether this footage appeared in a newsreel released by either Fox or Hearst. (If it didn't, we'd love to know what was in the newsreel described in the *New York Times* and released immediately after *Television Pictures* was filmed at the GE House of Magic!) Given our current restrictions, however, we are content with the information we found: the familiar pattern of Hartley's demonstration, the names of the people involved, the status of television demonstrations and research at this time, details about the mechanical equipment Alexanderson explains, and relative confidence that this is (possibly) the first time a television image was captured on film by a sound Movietone camera.

SUPPLEMENT! BREAKING NEWS! FURTHER RESEARCH!

A trip to the Schenectady Museum and Archives in Summer 2005 clarified a couple points we were uncertain about. In perusing General Electric company documents, including photographs, were able to confirm the identity of Lowell J. Hartley as the other man in the film. Most importantly, an article in the Schenectady Union-Star newspaper (3/23/1931) confirmed that it was specifically a Fox Movietone newsreel that was shown to audiences, announced with the headline: "Television Made Into Sound Picture First Time at G-E". Again, GE had filmed their television experiments before, and the significance of "Television Pictures" was the inclusion of sound.

[i] Abramson Albert. History of Television, 1880–1941. Jefferson, NC: McFarland, 1987. *The* reference book on early television. Extraordinarily comprehensive chronological history of the early days of television technology throughout the world. Also see these Web sites for accounts on different developments in early television: http://www.tvhistory.tv/pre-1935.htm; www.deadmedia.org, and http://www.dfm.dircon.co.uk/tvhist1.htm;

[ii] See pictures of these illustrations on http://histv2.free.fr/, a French Web site devoted to the history of early television.

[iii] Burns, R. W. Television: An International History of the Formative Years. London: Institution of Electrical Engineers, 1998.

[iv] Yanczer, Peter: The Mechanics of Television, self-published, 1987. This s a practical text on understanding and building mechanical television cameras and displays, self-published by an expert on the subject.

[v] Herbert, Ray. Seeing by Wireless. London: self-published, 1996. Biography of John Logie Baird. More information can be found online at http://www.tvdawn.com/index.htm.

[vi] The information about early experiments was compiled from the bibliography cited in endnotes. A useful timeline could be found in http://www.civilization.ca/hist/tv/tv02eng.html

[vii] To have an idea of this means in terms of image quality, compare with current standards: European countries television is transmitted on 625 lines and United States uses 525 lines.

[viii] Abramson 127.

[ix] Abramson

[x] For more information on this demonstration, see http://www.tvhistory.tv/pre-1935.htm

[xi] Everson, George. The Story of Television: The Life of Philo Farnsworth. New York: Norton, 1949.

[xii] The information about Alexanderson is a compilation of details found online at http://chem.ch.huji.ac.il/~eugeniik/history/alexanderson.html and in Burns, R. W. Television: An International History of the Formative Years. London: Institution of Electrical Engineers, 1998.

[xiii] Brittain, James E. Alexanderson: Pioneer in American Electrical Engineering. Baltimore, MD: Johns Hopkins UP, 1992. 263.

[xiv] Burns, R. W. Television: An International History of the Formative Years. London: Institution of Electrical Engineers, 1998. 42, 210.

[xv] "Schenectady-to-Leipzig Television a Success; Movie Also Made of Images Sent by Radio." New York Times 13 Feb. 1931: 15.