THE DEVELOPMENT OF TELEVISION IN THE UNITED STATES FROM 1923 TO THE PRESENT TIME WHICH IS MAY, 1950

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CHAPTER I

INTRODUCTION

Television, the wonder child of the twentieth century, is not a new idea. From earliest times, man has endeavored to increase his ability to observe happenings which are normally too far away to be seen. The ancients predicted the day when it would be possible to see events at remote spots invisible to the eye. The use of the magnifying glass undoubtedly was known to the ancient Greeks, and many years later a mechanical arrangement of lenses was devised for observing distant objects. Galileo improved upon this first crude telescope, and developed an astronomical instrument by which he was able to see spots on the sun, Jupiter's satellites, and the mountains of the moon.

It has long been the objective of experimentors to find a means by which man could see distant objects and scenes beyond the scope of normal vision with disregard to intervening obstructions and the earth's curvature. Many years passed, and, with the advent of electricity, experimentors began to apply electricity to optics, chemistry, and mechanics to develop a means for transmitting drawings and pictures. It was not until the nineteenth century, however, that any workable instrument was devised.

Television, as defined today, is the electrical transmission of images from some central point to suitable receivers at distant points by means of electromagnetic waves.

I. THE PROBLEM

Statement of the problem. It is the purpose of this thesis to study the early history of television and to trace its outstanding developments in the United States from 1923 to the present time (May, 1950).

Importance of the study. Since research in television has coincided with the development of radio and the electrical arts, the fields are closely interrelated. Because of the comparatively recent public interest in, and acceptance of, television, it would seem that a study devoted to this subject would be of value (1) to have in concise form a record of the progress made, (2) to provide a means by which the progress might be followed, and (3) to anticipate some of the possible uses of this medium.

II. METHOD OF PROCEDURE AND SOURCES OF DATA

The material used in this study has been obtained from periodical literature, text books, and reports to be found principally in the Indiana State Teachers College

Library. In general, the discussion is historical in nature, tracing the development of those aspects which are most significant.

III. ORGANIZATION OF THE THESIS

The thesis is divided into six chapters and a bibliography. The introductory chapter will discuss the efforts of early research men, the difficulties encountered and some of the reasons for their failures, the discovery of the first crude system of mosaic television, and mechanical systems using the scanning disc.

The ensuing chapters will record the development since 1923, when a change was made from electro-mechanical systems to all electronic systems. This change, it will be found, was made possible by the marked development in the use of vacuum tubes and improvement in methods of amplification; of improved methods of transmission, transmission standards, Federal Communications Commission[1] controls and channel allocations; synchronization and reception of the image and television receivers; coast-to-coast networks, programs, audiences and number of stations; and the summary and conclusions.

Following this will be the bibliography.

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[1] Federal Communications Commission will be designated by the initials F. C. C. henceforth in this thesis.

CHAPTER II

THE EARLY HISTORY OF TELEVISION

In tracing the history of television, it should be remembered that every system of electric vision yet devised depends basically upon physical changes produced by light. The possibility of television, therefore, may be said to date from the original discovery of the electro-chemical effects of light, in 1839, by Antoine Cesar Becquerel[1], a professor in the Musee d'Historie Naturalle. In the field of thermo-electricity, Becquerel carried out many experiments on electric currents induced by the heating of two metals in contact with each other, and of electro-chemical effects of light in various reactions. His findings were reported in the "Comptes Rendus" of the Academy and in the "Annales de Chimie et Physique." The chemical changes which he observed and the electric currents which resulted were produced by ultraviolet light-electromagnetic oscillations-having a wave length shorter than that of visible light.

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[1] G. R. M. Garrett, Television (London: His Majesty's Stationery Office, 1937), p. 14.

"Antoine Cesar Becquerel," Nature, 17:244-5, January 24, 1878.

"Antoine Cesar Becquerel," Living Age, 136:574, January, 1878.

These electro-chemical changes, later to be known as photo-electric effects, are produced in many substances by visible light. However, these observations of Becquerel, at the time they were made, had no practical value.

The first actual progress toward television began with the early attempts to transmit drawings by telegraph. Although the principle underlying both is the same, the chief point of variance is in the speed of the operation. In 1862, the Abbe Caselli[2] succeeded in his efforts to transmit diagrams by telegraph, and his system was in actual use between Amiens and Paris between 1865 and 1869. It was reported that he spent ten years in developing and construct-ing the apparatus which was, in reality, a chemical recorder with an iron stylus that made marks on paper which had been sensitized with potassium cyanide.

In 1817, when Baron Jon Jacob Berzelius,[3] a young Swedish chemist, discovered selenium, or the "moon element," as a by-product from the distillation of iron pyrite, it was considered just another chemical element. It was found to be fusible, combustible, and similar to sulphur, phosphorus,

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[2] James Strachan, "The Early History of Television," <u>The Wireless World and Radio Review</u>, 6:305-7, June 11, 1924.

[3] "Action of Light on Selenium," <u>Nature</u>, 13:407, March 23, 1876.

and tellurium. When melted at 217°C. and cooled rapidly, it bacame a brown amorphous mass, and was a non-conductor of electricity, but when heated to 100°C. and held at that temperature for some time, it became crystalline and was a slight conductor of electricity, its conductivity varying with the direction of the current. The element was known to be a metal which possessed enormous resistance and had, therefore, been employed in the construction of some of the high resistances used in the early trans-atlantic telegraph equipment.

One sunny afternoon early in 1873, at Valentia,[4] the terminal station of the Atlantic Cable in southwestern Ireland, the telegraph operator, Mr. May, made a startling observation. He was surprised to notice that every time the sunlight fell upon the selenium resistances, the needle of the galvanometer moved in a very erratic manner. He noted that the conductivity of the selenium increased when it was exposed to sunlight.

It was not until February 12, 1873, however, that Mr. Willoughby Smith[5] reported the extraordinary properties of the light sensitivity of selenium to the Society of Telegraph Engineers,

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[4] E. T. Larner, Practical Television (New York and London: Harper and Brothers, 1944). pp. 65-6.

[5] "Action of Light on Selenium," loc. cit.

The phenomenon was investigated and it was found that the change in the conductivity of the selenium was caused by light, not heat; that a stick of crystalline selenium offered considerably less resistance to a battery current when exposed to light than when kept in the dark; and that light of different portions of the spectrum affected the resistance in different manners. Announcement of these findings led to speculation concerning the possibilities of transmitting pictures and drawings to a distant point by means of photo-electric cells made from light sensitive selenium.

Credit for the construction of the first photo-electric cell using selenium is given to Alexander Graham Bell.[6] He constructed a photo-electric cell by arranging two metal plates, one having fixed to it a number of studs which were slightly smaller in diameter than a corresponding series of holes in the second plate, in such a manner that the studs fitted into the holes but did not allow the plates to touch one another. The two plates were insulated from each other and molten selenium was then poured into the intervening spaces, annealed by heat and protected from the air by shellac.

Although the invention of the photo-electric cell

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[6] Larner, op. cit., p. 70.

was widely acclaimed by scientists and experimentors who were working toward the development of a device by which "electric vision" would be possible, Bell astounded the world with a demonstration of his "telephone."[7] A patent was granted to Bell on January 20, 1876, for the telephone,[8] which was described as "a method of, and apparatus for, transmitting speech telegraphically, by causing electrical undulations, similar in form to the vibrations of the air accompanying speech," to pass from a specially constructed transmitter as electric currents of varying strength to the receiver which in turn set up the same forms of vibrations, and communicated them to the air as sounds like those made at the transmitter. The telephone was immediately accepted by the public, and the Bell Telephone Company became a very profitable industry.

During the experiments with selenium which preceded the development of the selenium cell, and with the behavior of sound waves incident to the invention of the telephone, Bell made certain observations[9] which led to his

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[7] "The Bell Telephone," Scientific American (Supplement No. 455), 50:180, September 20, 1884.

[8] "A. G. Bell and the Telephone," Nation, 29:279-80, October 23, 1879.

[9] A. G. Bell, "Selenium and the Photophone," Nature, 22:500-3, September 23, 1880.

construction of an apparatus for the reproduction of articulate speech by means of light, without wires, over a distance as far as an interrupted beam of light could be projected. The greatest distance obtained was 213 meters.

Although electrical research was concentrated on the development of communications, it was rapidly being introduced into all branches of science. In 1878, Sir William Crookes,[10] British chemist and physicist, invented the Crookes tube, and demonstrated cathode rays. These rays were streams of negatively charged particles shot from negatively charged electrodes, or cathodes, which, when directed against a target, caused radiation produced by a sudden loss of velocity. The more sudden the stop, the shorter the wave length of the emergent rays. The Crookes tube resulted from a study of vacua within a sealed glass tube by means of electricity.

The luminous stream of cathode rays which resulted, he called a "storm of projectiles," and although their nature remained a mystery, he realized that they were different from ordinary molecules. He called them "a new or fourth state of matter."

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[10] Orrin E. Dunlap, Jr., Radio's 100 Men of Science (New York and London: Harper and Brothers, 1944), pp. 69-70.

In later research, J. J. Thomson defined the cathode rays as electrons, and the new improved cathode ray tube became the "eye" of television.

From time to time the subject of television was discussed in the periodical literature, and several schemes which had been devised were explained, but for various reasons these schemes never materialized. Some were obviously doomed because of their impracticability, and others were doomed to await later developments for their ultimate realization.

Another chemical method of recording was announced in 1879. An apparatus called the "telectroscope" had been invented by M. Constantin Senlecq, of Ardres. The English Mechanic,[11] for January, 1879, published a preliminary description of the apparatus. From this brief notice, it appears that Senlecq's apparatus was a lineal descendent of Caselli's recorder. "The image to be transcribed was projected on the ground glass of a camera and traced out by a selenium point in the transmitting circuit, the variations in the current reproducing the effects of light and shade at the receiving end by means of electromagnetism." This published description of Senlecq's "telectroscope" was

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[11] "Senlecq's Telectroscope," The English Mechanic, 28:509, January, 1879.

followed immediately by claims for similar inventions by numerous investigators who had been working on the problem at the same time.

Senlecq developed the original idea of the moving selenium point into a more complicated multiple-cell apparatus for direct vision. A detailed description of this may be found, with illustrations of the apparatus and comments regarding his French patent rights, in The English Mechanic for February, 1881,[12] and in The Scientific American Supplement, No. 1667.[13] A single line wire was used, with the electrical impulses being derived from a slide pulling under the influence of gravity and making contact during the fall, with connections to the multiple-cell on which the picture was projected. Reproduction at the receiving end was accomplished by means of synchronous clockwork, and the incandescence of fine platinum wires, occupying similar positions to the selenium cells in the transmitter. The clockwork scheme looks impracticable, but it was stated that "vivid but fugitive pictures were obtained, leaving an impression of the transmitted light and

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[12] "The Possibilities of Television," The English Mechanic, 32:534-5, February, 1881.

[13] "The Senlecq Telectroscope," Scientific American Supplement, No. 1667:372-3, December 14, 1907.

shade on the retina of the eye. However, other investigators who tried to duplicate this device did not obtain such gratifying results.

In 1880, while working to perfect the incandescent lamp, Thomas A. Edison[14] noted a black deposit on the inside of his carbon filament lamps which was caused by a bombardment of carbon molecules. He tried several methods to eliminate these deposits. During his experiments, he found that by covering the outside of the bulb with tinfoil to which a counter or negative charge was applied, a direct current was made to flow through the galvanometer. However, when a negative charge was applied to the foil, no current was observed. This was called the "Edison Effect" and was demonstrated in 1883. Further experimentation led to the placing of a metal plate on the inside of the bulb connected to the outside by a wire sealed through the glass. The same results were obtained as with the foil.

In 1883, Edison applied for a patent on an electrical indicator, employing an "Edison Effect" lamp bulb, in which he had found that the current varied sharply with the variations in voltage. As an electronic voltmeter, it was found to be impractical; but it is the father of the radio tube,

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[14] Dunlap, op. cit., pp. 82-3.

and led Fleming to invent the first electronic tube detector, and DeForest to invent the audion.

In another series of experiments, Edison used two filaments in the same bulb, the second to be used when the first burned out, in order to increase the life of the bulb. By means of a galvanometer, he found that a current was set up in the idle filament. It was another manifestation of the "Edison Effect."

Briefly stated, the electron discharge or "Edison Effect" is the passing through space of an electric current from a burning filament to an adjacent filament or metal plate. An illustration of the bulb used to demonstrate this phenomenon can be found in the February, 1947, issue of Science Illustrated.

By 1884, less than ten years after the invention of the telephone by Bell, the American Bell Telephone Company and its subsidiary, the Western Electric Company, had grown into a multi-million dollar organization. Many improvements had been made in the efficiency and design of the instrument, and an exhibit of the history of the development of the telephone was on display at the Electrical Exhibition in Philadelphia.[15] This success stimulated the imaginations of

[15] "Telephone at the Exhibition," Scientific American Supplement, No. 455, 50:180, September 20, 1884.

workers to devise a workable system of "electric vision." They reasoned that if a telephone, which was patterned after the principles of the human ear, had been devised, a system of television based on the principles of the human eye could be devised also. The sensitivity of selenium provided a means by which light could be turned into electricity, and experimentors saw that an electro-chemical eye could be devised. When selenium was subjected to very bright light, its resistance dropped; and when it was placed in the dark, its resistance rose. These were the essentials for a device which could be made to produce variations of electric current through fluctuations of light intensity. If the circuit could be made to carry currents of varied strength and transform them into variations of light and shade, the problem of television would be solved.

In comparing the human eye to a camera, the crystalline lens and retina of the eye correspond to the lens and ground-glass screen or sensitive plate of the camera. Millions of light rays pass through the lens to produce an image on the retina or ground-glass screen.

The surface of the retina in a normal human eye consists of a mosaic made up of several million microscopic hexagonal cells, each of which is connected directly to the brain by a number of nerve filaments. Light falling on an object is communicated to the brain by impulses of varying intensity, depending upon the intensity of the light falling upon the surface of the retina. Thus, an image in the brain is built up of an extremely fine mosaic of microscopic hexagons of varying degrees of light and shade.

This arrangement was imitated by inventors who endeavored to construct an artificial retina out of a mosaic of selenium cells which could be exposed simultaneously to an image, and a separate electrical circuit connected with each cell carrying electrical signals to a distant point, where again a bank of lamps would be controlled by the signals, and an image would be reproduced from a mosaic of light spots. A man called Carey[16] published details of an instrument of this type in 1880, and twenty-five years later Professor Ernst Ruhner, of Berlin, transmitted simple figures by television with a bank of selenium cells.

The maximum sensitivity of the most efficient type of selenium cell is comparable with that of the human eye. However, the response of the cell to illumination is not the same for all wavelengths of visible light. Its greatest response lies in the region of the red rays and decreases in response as the wave length decreases. The

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16 W. J. Brittain, "The Beginnings of Television," Quarterly Review, 250:276-8, No. 496, April, 1928.

disadvantage of using the selenium cell in television work is its slowness in recovering its resistance after exposure to light. The period taken for recovery increases with the intensity of the light to which it is exposed. Obviously, no light-sensitive cell is suitable for television work unless it responds instantaneously to rapid variations of light and shade. Selenium, therefore, has been discarded because of its lag in recovering its normal resistance value. However, in spite of the disadvantages of using selenium in building a television system, the American Telephone and Telegraph Company,[17] during its New York to Washington television demonstrations in 1927, used a four-foot screen with 2500 wires leading from it. This was not done with the idea of adopting it for television experimentation because it was too costly; but Mr. Hoover, who was then Secretary of Commerce, was visible to people in New York from his office in Washington, D. C., two hundred miles away.

Aside from the inefficiency of the selenium cell, such a multichannel system with its thousands of cells, shutters, and wires made the adoption of such a scheme impractical, and all successful methods of television have

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17 *Ibid*., p. 279.

resorted to a process of scanning, by means of which the whole image is traversed point by point and the signals corresponding to the various degrees of light and shade are transmitted in sequence rather than simultaneously. The failure of the mosaic system made this fact evident, and various methods of scanning were proposed.

In 1884, Nipkow[18] patented a scanning device for transmitting pictures of coarse structure. This device employed a flat disc of large diameter provided with a series of small holes arranged in the form of a spiral. The disc was rotated at a speed of 20 to 30 revolutions a second, during which rotation each hole of the spiral passed in turn across the field of vision so that upon each complete rotation, the whole image had been traversed.

In working with such a disc, light from the image to be transmitted, after passing through an appropriate lens, formed an image on the front of the disc. The image which was transmitted through the holes in the disc appeares complete instead of as a series of light spots. However, the brightness of the scene was greatly reduced because of the comparatively short time that any particular portion of the image was visible. The area of the image which could be

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[18] Dunlap, op. cit., pp. 128-9

scanned by this arrangement was small in comparison with the area of the disc.

Although this method was simple and convenient for analyzing an image into a small number of elements, it was inefficient and had to be extremely large if acceptable images were to be produced.

Besides the Nipkow disc, various devices,[19] such as vibrating mirrors and walls of lenses, were proposed for the rapid scanning of the image for television purposes.

One type is known as a mirror drum[20] and consists of a drum upon the periphery of which a number of mirrors was mounted, each set at a slightly different angle to the drum axis. When the drum was rotated, a narrow beam of light passing through a lens was projected on each mirror in turn. The reflected light scanned the image on a screen in a series of parallel lines.

After 1882, Practically nothing appeared in the pages of scientific journals or periodical literature on the subject of television, with but few exceptions, until 1923. Advances in the other branches of electrical research, however, provided the tools which later were to be developed in the laboratory into the essential elements of

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[19] H. J. Barton Chapple, Popular Television (London: Sir Isaac Pitman and Sons, Ltd., 1935), pp. 65-67.

[20] Ibid., pp.67-70.

present-day electronic television.

The existence of electro-magnetic waves had been reported by Cambridge University in 1864,[21] but little had been discovered of their character and behavior until 1888, when Heinrich Hertz,[22] eminent German physicist and scientist, actually created and measured electro-magnetic waves. He found that there was a close relationship between these waves and light, and observed that the velocity of electric impulses was the same as that of light, and that the laws of optics governing reflection, refraction and polarization also governed electric waves.

It was from reports of Hertz's findings that, in 1894, Guglielmo Marconi[23] became interested in electric waves. He conceived the idea of increasing, developing and controlling radiation sufficiently to signal through space. He attacked the problem without bias or preconceived ideas, and assembled an induction coil as the electric wave emitter, a spark gap, telegraph key, batteries, and a coherer, into sending and receiving stations. With these he was able to

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21 Philip Kerby, The Victory of Television (New York and London: Harper and Brothers Publishers, 1939), p. 5.

22 Loc. cit.

23 "Marchese Guglielmo Marconi," Encyclopaedia Britannica, 14th edition, XIV, pp. 869-70.

send signals for a distance of three-quarters of a mile. From that time on, Marconi dedicated himself to "wireless."

Marconi's original patent, granted on July 13, 1897, was for a single circuit transmitter and receiver. The low frequency current discharged through a spark gap, produced high frequency oscillations. The tuning of this original model was fixed by careful calculations of the length and height of the antennae. Then, on June 28, 1904, a patent was granted covering "improvements in apparatus for wireless telegraphy by means of Hertzian aerials or electric waves." This marked a great step forward because tuning prevented overlapping of signals, reduced interference, and permitted sultiple signals to be broadcast.

On December 12, 1902, the letter "S" was sent across the Atlantic, 2,000 miles, from England to St. Johns, Newfoundland. On December 17, 1903, the first west-east transatlantic message was sent from Glace Bay, Newfoundland, to England. After these successes, the transatlantic wireless service opened on January 19, 1903, with an exchance of greetings between President Theodore Roosevelt and King Edward VII.

Wireless had become a reality and improvements were constantly being made in construction and design. Fleming,[24]

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24 Dunlap, op. cit., pp. 90-94.

who had been appointed electrical adviser to the Marconi Wireless Telegraph Company in 1899, developed the valve detector in 1904. Ordinary carbon filament bulbs to which he had added metal cylinders were found successful for rectifying the high frequency currents. It was to this valve detector that DeForest added the frid to create the three-element audion.

Karl Ferdinand Braun,[25] whose research in physics began in 1895, discovered a means for showing the variations of alternating current in a vacuum tube, and the means by which the streams of uncontrolled electrons in the Crookes tube could be deflected electro-statically to produce a narrow guided stream, and made to trace patterns on a fluorescent screen. He developed the theory that the fluorescent spot could be made sharper and clearer by setting up a magnetic field from a coil around the tube. This became the cathode-ray oscillograph, by means of which fluctuating voltages and currents of extremely high frequency could be studied. For the development of the oscillograph, he shared the Nobel prize for physics with Marconi in 1909.

A short time later, a Russian scientist, Baron Boris

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[25] Ibid., pp. 97-8.

Kerby, op. cit., p. 6.

von Rosing,[26] while experimenting with the Braun tube, discovered that scanning the fluorescent surface at the end of the tube would cause the original image to be recreated at the receiver. Rosing in Russia, and A. A. Campbell-Swinton in England,[27] working independent of each other, published methods of electro-megnetic means of scanning in 1907. In an address before the Roentgen Society in 1911, Campbell-Swinton proposed the first all-electronic television system utilizing cathode-ray scanning at both transmitter and receiver.

The editors of Literary Digest, in commenting on Campbell-Swinton's proposal,[28] published an article on January 6, 1912, entitled "New Scheme for Distant Vision," beginning with "Plans for television by electricity crop up frequently, but nothing has come of any of them," and ending with "This is only theory." Public opinion was not encouraging, and articles appearing in periodicals, were very brief. In this article the editor reviewed briefly

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[26] Dunlap, loc. cit.

[27] Ibid., p. 241

[28] "New Schemes for Distant Vision," Literary Digest, 44:17, January 6, 1912.

"Seeing Electrically," Scientific American Supplement, No. 1611:25809, November 17, 1906.

Campbell-Swinton's plan for television, but went on to state that it "has not even reached the experimental stage, although it is perhaps the most promising of any yet proposed."

Campbell-Swinton's plan involved the use of cathode rays, deflected by a magnetic coil to move the mechanical elements which were practically devoid of weight. The image to be transmitted was thrown on what was called a photo-electric screen through a metallic gauze which was connected with the line wire. The photo-electric screen was made up of cubes of rubidium, which, like selenium, had the property of discharging electricity under the influence of light. The cubes of the screen were successively electrified very rapidly by passing a beam of cathode rays over them, causing those cubes which were in the light parts of the image to electrify the gauze through a layer of gas behind them. In turn the electricity passed from the gauze along the line wire to the receiver, which was so constructed that another cathode beam, moving in exact harmony with that of the transmitter, would act on a phosphorescent screen only when the current passed. A whole image was formed by persistence of vision.

Campbell-Swinton[29] predicted that the future

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[29] Milton S. Kiver, Television Simplified (New York: D. Van Nostrand Company, 1948), p. 7.

development of television would be along electronic lines using cathode ray tubes, and that mechanical scanning would be supplanted by electronic scanners. His failure was caused by his inability to find a means of strengthening the weak impulses generated in the scanning device after an image had been televised.

Telebision research was halted throughout the world by World War I, and all efforts were turned to the development of radio as a means of communication. This research brought about a change from code to voice radio.

Following the war, America took the lead in television research. Several substances were discovered which had greater light sensitivity than selenium, and as a result photo-electric cells were greatly improved. The three-electrode vacuum tube, which Dr. Lee DeForest discovered for use in radio, was found to be useful in boosting the power of the electric impulses generated in mechanical scanning.

C. F. Jenkins[30] in the United States, and John L. Baird in England, demonstrated mechanical scanners; but, since the rate of scanning was at the rate of thirty lines for each picture and twelve and one-half pictures each second, there was a distinct flicker. The rate of scanning

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[30]Kerby, _op. cit._, p. 11.

was increased from thirty to two hundred forty lines for each picture and from twelve and one-half to twenty pictures each second, but the pictures were not yet sufficiently clear and free from flicker to compete with sound motion pictures as a medium of entertainment. Since mechanical scanning had reached its practical limit, the industrial laboratories of the radio industry turned their efforts to the development of a more efficient method of scanning.

In the early 1920's, backers, with money to invest to promote the progress of television, turned to sound radio because of greater profits to be made through advertising by radio on a coast-to-coast network basis.

Television, unlike most other inventions, had grown from the combined efforts of many scientific investifators and experimentors all over the world for centuries. This type of investigation was slow, and often much time was wasted by work on some useless phase of the subject. Individual investigation practically had ceased by 1923, when the radio industry took over the development on a commercial basis.

CHAPTER III

THE BEGINNING OF ORGANIZED RESEARCH

In 1923, when the radio industry began actively to develop television, the leading radio and electronic scientists were hired by these great corporations and assigned to television research in the industrial laboratories maintained by them.

The outlook was not very bright, but from early research there was a fairly clear conception of what was required. Three main principles were evident: (1) a single wire line was required both in transmitting and receiving circuits; (2) all moving parts must be eliminated; and (3) all-electronic scanning devices must be relied upon for rapid scanning. The task ahead was difficult but not insurmountable. Security was assured the investigators and the desire to succeed encouraged rapid progress.

The optimistic attitude of the industry can best be exemplified by quoting from a memorandum on "Radio Broadcast Activities," submitted by David Sarnoff to the directors of RCA on April 5, 1923. In part General Sarnoff said:

> I believe that television, which is the technical name for seeing instead of hearing by radio, will come to pass in due course. . . . It is not too much to expect that in the near future when news is telegraphed by radio--say to the United States, of important events in Europe, South America or the Orient, that a picture

> of the event will likewise be sent over by radio and both arrive simultaneously. Thus it may well be expected that radio development will provide a situation whereby we will be able actually to see as well as read in New York, within an hour or so, the event taking place in London, Buenos Aires or Tokyo.
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> . . . .
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> The problem is technically similar to that of radio-telephony though of more complicated nature; but, within the range of technical achievement. Therefore, it may be that 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 for those at home to see as well as hear what is going on at the broadcast station.[1]

Such enthusiastic expressions of hope and encouragement as this were heartening, as the public became aware of the possibilities of television.

Meanwhile, with research on television progressing in the laboratory, two independent workers patented scanning devices which to a great extent determined the future pattern of electronic television scanning.

Philo T. Farnsworth,[2] a nineteen year old Brigham Young University sophomore, patented his "Image Dissector" and an all-electronic television device; and Vladimir K. Zworykin[3] filed an application for a patent on the first form of modern television tube, later to be developed into

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[1] David Sarnoff, Pioneering in Television (New York: Radio Corporation of America, 1946), p. 7.

[2] Lowell J. Thomas, Magic Dials - The Story of Radio and Television (New York: Lee Furman, 1939), p. 38.

[3] *Loc. cit.*

his "Iconoscope," the "eye" of RCA's television equipment.

Early in the twentieth century, inventors had learned how to turn light into electric impulses and efforts had been made to produce pictures electrically, but the images were poor and the illumination almost too weak to be seen. The electric currents were feeble, and there was no means available for amplifying them sufficiently for broadcast purposes. Although investigators had been able to scan an image successfully, they did not try immediately to use the vacuum tube to amplify the feeble currents set up by the scanning devices. Vacuum tubes had come into use in radio research, but the knowledge of their behavior had not been linked with the problem of the amplification of very weak television signals.

In 1907, Lee DeForest[4] had added a third element, or grid, which was a screen of fine wire, between the filament and plate of Fleming's diode to produce a controlled electron flow that could be varied by small changes in potential for use in radio broadcasting and receiving circuits.

The three elements of the vacuum tube are the electron-emitting filament or cathode, the plate or anode, and the control grid which determines the flow of electrons

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[4] Philip Kerby, The Victory of Television (New York: Harper and Brothers Publishers, 1939), p. 9.

from the filament to the plate. As soon as the functions of these three elements were understood, many improvements were made. It was discovered[5] that some metals were superior to others as electron emitters, that the cathode was rendered more efficient if heated by a heating filament enclosed within the tube, and that additional grids helped control the electrons. Some tubes were constructed with as many as three or four grids in addition to the plate, the cathode and the heating filament. Thus, various types of vacuum tubes were developed to perform the three distinct functions of amplification, oscillation, and modulation and detection.

When used as an amplifier, the amplification obtainable is limited only by the attendant amplification of noise. Both in broadcasting and receiving, very weak currents are amplified in such a way as to increase the magnitude of the current variations and at the same time to preserve the general form of the impulse.

When used as an oscillator or generator, the vacuum

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[5] Ervin S. Ferry, General Physics (New York: John Wiley and Sons, Inc., 1925), pp. 478-91.

C. J. Hylander and Robert Harding, Jr., An Intrpduction to Television (The Macmillan Company: New York, 1941), pp. 57-86.

John Mills, Electronics (New York: D. Van Nostrand and Company, Inc., 1944), pp. 56-67.

tube is capable of generating very high frequency alternating current which may be caused to radiate into space, and produce electromagnetic waves of definite frequency which serve as carriers for radio and television signals.

As a modulator and detector or demodulator, another type of vacuum tube is capable of imposing the signal on the carrier wave at the broadcasting station, and separating the signal from the carrier wave at the receiver.

Since 1923, there has been marked development in the use of vacuum tubes in both transmitting and receiving television circuits. It was the vacuum tube which gave the television experimentors a means by which weak currents might be amplified, modulated, and placed on the carrier wave. The same principles govern the cathode-ray tube from which the modern camera tubes were developed.

Two types of camera tubes were developed after the principle of the cathode-ray tube. The instantaneous type of camera tube is represented by the Farnsworth image dissector, and the storage type tube by the Zworykin iconoscope. In both of these devices, an image of the scene to be televised is projected by means of a lens onto a photosensitive plate which emits electrons in proportion to the brightness of the image falling on that part of the plate. The image dissector operates on a slightly different principle from that of the iconoscope.

The image dissector[6] consists of a glass tube surrounded by a focusing coil and two pairs of deflecting coils.

At one end of the tube is a photo-electric cathode upon which the image is projected through a system of lenses. The cathode is a metal plate with a fluorescent or light sensitive surface which is given a negative potential, thus causing electrons to be emitted from it in response to the light projected upon it, the number of electrons being dependent upon the intensity of the light. The tube is surrounded with a focusing coil which produces a constant magnetic field of the proper intensity within the tube, to ensure identical focus of the invisible electron image when it reaches an imaginary plane in the anode end of the tube where it is projected upon the photo-electric cathode.

In this invisible plane facing the cathode, encased in a small tube with a minute aperture, is an anode having a high positive potential. Because of the attraction imparted by the positive field to the negatively charged electrons, the electron image is drawn forward, causing the electrons to pass through the aperture to the cathode.

Scanning is accomplished by the mounting of two pairs of coils at right angles to one another and at right angles

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[6] Hylander, op. cit., pp. 130-4.

to the body of the tube. The magnetic fields set up by these two sets of coils cause the electron image to move both horizontally and vertically across the aperture in the small tube containing the anode.

The constantly varying current causes the electron image to move from left to right and back to its original position and at the same time from top to bottom and back again. In a 240-line picture which is repeated 25 times a second, the horizontal image would be displaced 6000 times and the vertical one 25 times. This displacement causes an electron signal varying in intensity, depending on the degree of light and shade of the original object, to be produced. The signal is amplified and passed to the transmitter for broadcasting.

The iconoscope,[7] which Zworykin patented in 1923, was a storage type of tube. It is a direct "pick-up" device and its principle simulates the human eye action in that it contains a light-sensitive mosaic which is a plate about four inches square, upon which the image is focused by a system of lenses. The tube itself is a glass tube which resembles a dipper. In the handle or neck of the tube is the electron gun which is an arrangement of cathode and anode to direct the stream of electrons into the large end

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[7] Hylander, op. cit., pp. 106-125.

of the tube where the light sensitive mosaic plate is located. This plate is made up of a mosaic of millions of minute globules of caesium and silver oxide, each acting as a minute photo-electric cell, deposited so close together that they appear to form a smooth surface upon a sheet of mica backed by a metal plate. The plate is connected to the external circuit by means of a terminal on the outside of the tube, and it is from this plate that the electrical impulses are obtained.

In order to scan the image projected on the mosaic, the beam of electrons is made to move across the mosaic from side to side and downward line at a time. To do this, two sets of coils are placed around the neck of the tube in such a manner that two magnetic fields are formed at right angles to each other to control the direction of the electron beam both horizontally and vertically.

A ring, connected to a terminal outside of the tube, is placed inside the main portion of the tube, and given a high positive potential to attract the electrons which are thrown off from the light sensitive globules to prevent their accumulating and causing interference in the succeeding scannings.

As the scanning takes place, varying discharges from the globules and the signal plate produce a series of electrical impulses varying in intensity according to the intensity of the light and shade of the image projected on the mosaic plate, and leave the signal plate to pass through a series of amplifiers to the transmitter for broadcasting.

The present-day iconoscope is very much like the original iconoscope which, it is said,[8] that Zworykin developed with the aid of other Russian refugees in Greenwich Village in the early 1920's. Westinghouse recognized his genious and gave him a position in their department of original research. While there, he took out his first patent on the iconoscope, but it took ten years of constant work to produce the efficient device to be used in television cameras. It remained the same in principle, but the shape of the tube was altered, and the plate and controls were made more sensitive. During this time, Zworykin left Westinghouse and took a position with RCA, and all of his subsequent patents on this improved iconoscope were taken out by RCA.

Since 1925, modifications of the cathode-ray tube, of which the image dissector of Farnsworth and the iconoscope of RCA are representative, have proved to be very satisfactory for use both in transmitters and receivers for scanning and building up television pictures from electric impulses.

The iconoscope, or its equivalent, together with the

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8 Kerby, op. cit., p. 12.

necessary electrical equipment, is mounted in a camera[9] which, on the outside, looks very much like an ordinary oversized motion picture camera. It is equipped with lenses of suitable speed and focal length for focusing the scene or image on the sensitive plate of the camera tube. For studio and outdoor work, a view finder is provided, and the camera is mounted on stationary or mobile mounting which permits both horizontal and vertical adjustment to bring the actual object into electrical impulses of corresponding values by scanning. The cathode ray tube, having no moving parts, can scan electrically with almost unlimited speed. From the sensitized plate of the picture tube, the signal is fed through amplifying circuits within the camera. Two or three amplifying tubes are used to increase the signal, and the synchronizing impulse is added to the signal before the signal is completely amplified, preparatory to using it to modulate the carrier wave. Along with the picture signal, the accompanying sound signal, which also has been amplified and controlled, is fed to the transmitter in the same manner as in any standard radio pick-up.

The amplified and controlled picture and sound signals are fed from the camera through specially designed flexible

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[9] Hylander, op. cit., pp. 102-125.

William C. Eddy, Television The Eyes of Tomorrow (New York: Prentice-Hall, Inc., 1945), pp. 32-44.

coaxial cables to the transmitter where it is further modified and amplified before it is put on the air.

Various modifications of the iconoscope have been made and used. In 1939, the orthiconoscope, or "orthicon,"[10] which had a greater sensitivity than the original iconoscope, was adopted for both outdoor and studio use because it required less light upon the subject being televised.

In this tube, the image is projected on one side of the light-sensitive mosaic and picked up on the other side by scanning with an electron beam. This necessitated changing the characteristic dipper shape of the iconoscope to a simple straight cylindrical tube having a diameter of about four inches. The electron gun is located in one end of the tube and the mosaic in the other end. The electron beam is focused to a point by means of a magnetic field, set up by a coil on the outside of the tube. The vertical deflection of the beam is controlled by a magnetic field produced by a set of coils on the outside of the tube, whereas the horizontal deflection is produced by a pair of plates, mounted on the inside of the tube and given specific potentials controlled by the horizontal sweep circuit.

In 1943, a still more sensitive tube was developed

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[10] Hylander, op. cit., pp. 128-9.

whereby ordinary conditions of interior illumination were sufficient for satisfactory televising.

During the year of 1945, RCA announced[11] the development in their laboratories of a new pick-up tube which promised a satisfactory solution to the problem of televising scenes under unfavorable lighting conditions. The new tube, called the Image Orthicon, has a light sensitivity of at least one hundren times greater than any of the pre-war tubes. It was tested by NBC in the camera used to pick up the Navy Day dinner which was held in the ballroom of the Waldorf-Astoria where the light was quite dim. This initial test indicated that the Image Orthicon was even more sensitive than claimed by its inventors.

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[11] Benjamin E. Shackelford and George L. Beers, "Television," 1946 Britannica Book of the Year (Chicago: Encyclopaedia Britannica, Inc., 1946), pp. 726-7.

CHAPTER IV

TRANSMISSION

The basic functions of the television transmitter are three-fold: (1) to amplify the signal impulses developed in the television camera and microphone; (2) to create the required carrier wave; and (3) to impress the picture and sound signals on the carrier wave.

In theory the process is much the same as the transmission of the regular high frequency sound broadcast, but in practice it is complicated by the exceedingly wide band of frequencies which must be transmitted. Television is the most extravagant of all forms of communication. When the image is scanned and divided into 525 lines and 30 pictures per second, a frequency channel width of approximately 4,250,000 cycles per second is required. For sight and sound, television requires a channel width of about 6000 kc. or enough for 600 ordinary sound broadcast channels and 6 times as great as the entire band allocated for all standard sound broadcasting. If a picture of more lines is adopted for greater detail in the picture or if color is added, requiring additional signals, the band will be further broadened.

Because of the very high frequencies, and consequently the very short wave lengths, of the television carrier waves, a single transmitter is able to serve only a limited area. These high frequency waves[1] are known as quasi-optical since they possess many of the characteristics of light waves. They travel in a straight line and shoot off into space at the horizon visible from the top of the antennae, except in rare instances when they are reflected from ionized layers of the atmosphere. They also are reflected and absorbed by various objects such as buildings, hills, mountains, and the earth. These deflected signals often result in a second image or ghost.. Therefore, the television transmitting antennae should be at the highest possible point in the area to be served by the station. For example, the television antennae of NBC is located on top of the Empire State Building, that of CBS is on the Chrysler Building in New York City, and the Don Lee studios and transmitter are at the top of Mount Lee in Hollywood.

Long wave broadcasting stations require long antennae systems for efficient radiation, but a television antennae[2] is short, the same length as the carrier wave. Since there

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[1] C. H. Hylander and Robert Harding, Jr., An Introduction to Television (New York: The Macmillan Company, 1941), p. 99.

[2] William C. Eddy, Television, The Eyes of Tomorrow (New York: Prentice-Hall Company, 1945), pp. 53-61.

is a tendency for these short waves to radiate stronger in one direction than in another, there may be as many as four different antennae for the picture signals and another for the sound. In the United States, the antennae elements extend in a horizontal direction, because horizontal polarization is used for broadcasting the television signals which are fed to the antennae through special coaxial lines from the transmitter, which may be quite a distance from the antennae.

When the radio industry took over the task of research in television, there was danger of the various laboratories developing systems along different lines, systems which could not operate together. Recognizing this possibility, the Radio Manufacturers Association[3] was organized and, in 1929, began a study of standards. In 1935, they demonstrated a system of electronic television which employed 343 lines. The next year television transmission systems were further studied and tested, and in November they published a report of standards proposed by the committee, which recommended a 441-line picture,

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[3] Elmer W. Egstrom, "Recent Developments in Television," The Annals of the American Academy of Political and Social Science, New Horizons in Radio, Vol. 213, January, 1941 (Philadelphia: The American Academy of Political and Social Science, 1941), pp. 130-37.

interlaced, two fields per second, and 30 pictures per second. By using interlacing, which is the process of scanning alternate lines of a field to reduce the possibility of flicker, the odd lines of the picture were scanned and then the even lines of the same picture. It was also proposed to use a carrier with double side bands as in regular sound broadcasting.

With further developments in the system and more experience gained in operation, some of these standards were questioned, and the questions submitted to the committee. Accordingly, in 1938, the committee made another report in which several changes in standards were made. It recommended the use of attenuated side band transmission with the carrier near the lower limit of the band, which permitted additional detail or information to be sent. The committee submitted a report of its findings to the FCC. Because of differences of opinion within the industry on important aspects of these standards, the FCC set up a committee of its own members to study the entire problem presented by television. This committee submitted its report late in 1939. Two public hearings were held in 1940, but because of lack of agreement between the FCC television committee and the Radio Manufacturers Association, a new committee, made up of members of both previous committees and representatives of industries concerned with television, was appointed in May, 1940. This committee, known as the National Television System Committee, was charged with the task of a thorough review and study of the subject, and the formulation of a set of standards to be proposed to the FCC. When the report was submitted on March 20, 1941, two principal changes in the existing standards were recommended: (1) to increase the number of lines of the picture from 441 to 525, and (2) to provide for a flexible specification for the synchronizing of signals. However, the signal must operate adequately any receiver which is responsive to a particular synchronizing wave form included in the specification.

In addition to standards of picture definition there were other standards recommended, some of which were: (1) the standard television broadcast channel width was set at 6mc. per second, a sound carrier 0.25mc. per second below the upper frequency limit of the channel, and a picture carrier 4.5mc. per second below the sound carrier; (2) frequency modulation with a maximum frequency swing of 75kc. was standard for the second carrier; (3) eighteen 6mc. channels were made available for television assignment in the band from 50 to 294 mc. and (4) horizontal polarization was made standard for television broadcasting.

These standards were adopted by the FCC in 1943. Further work was to be undertaken in improving the synchronizing signals, and the development of color television.

On June 27, 1945[4], the FCC announced frequency allocations for television broadcasting. Thirteen 6mc. channels were established. Six channels were located between 44mc. and 88mc. A 4mc. band between 50mc. and 54mc. was allocated for amateur use, and a 4mc. band between 72mc. and 76 mc. was allocated for non-government and fixed mobile services. The other seven 6mc. television channels were located between 174mc. and 216 mc. The commission, at the same time, assigned the frequencies between 480mc. and 920mc. for experimental monochrome and color television broadcasting.

The FCC estimated that more than 400 commercial television stations could be accomodated by these thirteen channels, but that there would be a limit of seven in any metropolitan area, and that interference between stations would limit the total number of stations in congested metropolitan regions like the eastern seaboard, which includes the cities of Washington, D. C., Baltimore,

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4 Benjamin E. Shackelford and George L. Beers, "Television," 1946 Britannica Book of the Year (Chicago: Encyclopaedia Britannica, Inc., 1946:, pp. 726-7.

Philadelphia, and New York. By the end of the year the FCC had more than 130 applications for commercial television broadcasting licenses in their files.

In the spring of 1947,[5] the FCC announced its decision regarding the adoption of standards for color television on a commercial basis in the frequency band from 480mc. to 920mc. It stated that there had been insufficient field testing to prove that satisfactory color television was available to the public at the time.

At the end of the year ten new stations had been established, making a total of eighteen stations operating on a commercial basis, and the FCC had either licensed or authorized more than 70 stations.

During 1948,[6] the number of television broadcasting stations had increased from eighteen to forty-six, and construction permits had been granted to an additional seventy-eight, with more than 300 applications pending at the end of the year. The commission had allocated channel

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[5] George L. Beers, "Television," 1948 Britannica Book of the Year (Chicago: Encyclopaedia Britannica, Inc., 1948), p. 721.

[6] George L. Beers, "Television," 1949 Britannica Book of the Year (Chicago: Encyclopaedia Britannica, Inc., 1949), p. 692.

1 to the fixed and mobile services and abolished the shared use of the other channels by them. This decreased the number of channels to twelve and made revisions of channel allocations in some areas necessary.

On September 20, a hearing was held at which witnesses agreed that some of the band between 475mc. and 890mc. should be allocated for 6mc. bands for commercial monochrome television.

On September 29, 1948, the commission issued an order withholding the granting of new construction permits until the seriousness or the problem of co-channel interference between television stations caused by tropospheric propogation had been anylized. The investigation was to determine whether or not 150 miles between co-channel stations was a sufficient distance.

Since frequency channels needed for television are strictly limited, government allocation and regulation was necessary. Although this gave the government the power to advance or delay progress in television, it has really acted to stimulate private enterprise. The establishment of transmission standards assured the manufacturer that any receivers that he built would be built with the assurance of reception from any or all transmitters.

The regulatory body of the FCC has the task of making decisions, which will establish a system of television harmonizing the interests of all interests concerned on an economically sound basis.

One of the reasons for the tremendous strides made by sound broadcasting has been the coast-to-coast network systems which have enabled two or more stations to broadcast simultaneously[7] programs originating at one point. These stations are linked together by telephone wires which have been made available for network use, and the programs are sent by wire from the point of origin to the various stations. This is possible because sound broadcasting requires approximately 5,000 to 10,000 cycles a second and this is well within the limits of ordinary telephone wires. Television, on the other hand, has no such lines available, because the wide range of frequencies required, 4,250,000 cycles a second, is beyond the range which any single wire could carry.

This inability of television to broadcast over a national network[8] was a serious handicap. A single transmitter was able to serve only a limited area of approxi-

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[7] Allen B. DuMont, "Television Predictions for '49," Radio and Television News, 41:3:40, March, 1949.

[8] "How to Give a Short Wave a Long Range," Science Illustrated, 2:2:52-5, March, 1947.

mately 50 miles in diameter. Although much of the population of the United States is centered in about one hundred metropolitan areas, twenty-five miles in radius, millions live in villages and sparsely populated rural areas.

In 1936,[9] the Bell Telephone Company announced the development of the coaxial cable for carrying great numbers of telephone signals simultaneously and experiments proved that it was able to carry the wide frequency bands of television. While the theory of using a coaxial conductor for electrical currents was not new, its application to telephone and television is very recent. The name "coaxial" indicates that it is composed of two conductors with a single axis. The inside wire which is about the size of the lead of a pencil is suspended by means of insulating discs at inch intervals in the center of the copper tube, which is the other conductor. Although television broadcasts could be carried with comparatively small loss, the cost of a coast-to-coast coaxial cable with 90 to 100 outlets was estimated at $100,000,000, which was more than television broadcasters could afford to spend at the time.

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[9] Philip Kerby, The Victory of Television (New York: Harper and Brothers, 1939), p. 20-22.

[10] Charles M. Mapes, "Carrier is King," Telephone Magazine, 28:41; 199-200, Winter, 1949-50.

Another means of networking television transmitters was demonstrated by RCA in 1939.[10] By using two intermediate receiving-transmitting stations, or radio relays, Empire State broadcasts were transmitted to Riverhead, Long Island. In 1940, this system was extended and transmissions were made from Camp Upton, on Long Island, to the RCA Building in New York City.

By this time the American Telephone and Telegraph Company had connected New York and Philadelphia by coaxial cable, and the Republican National Convention, which was in session at Philadelphia, was telecast to New York audiences. Either the coaxial cable or the radio relay system, or a combination of the two promised eventual coast-to-coast television coverage.

During 1945, the American Telephone and Telegraph Company had completed its coaxial cable[11] installation from New York through Philadelphia to Washington D. C. and had begun the construction of a radio relay link, between New York and Boston, which was intended for purposes of

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[10] Hylander, op. cit., pp. 156-7.

- "How to Give a Short Wave a Long Range," loc. cit.

[11] Shackelford and Beers, loc. cit.

comparison. Then in 1946, microwave relay[12] equipment was developed for relaying television signals from remote pick-up points to the transmitters. Programs from Washington, D. C. were carried to Philadelphia, New York, Albany, and Schenectady by the use of radio relays and coaxial transmission lines.

In 1947, a microwave relay system[13] was completed between New York and Boston. To cover the distance of 200 miles, seven repeater stations with highly directional antennae were required. This system was formally demonstrated in November. Transmissions were made in both directions.

By the early part of 1948, the American Telephone and Telegraph Company announced in rapid succession, the completion of sections of coaxial cable installations. On February 14,[14] Terre Haute, Indiana, and Chicago, Illinois, and Terre Haute and St. Louis, Missouri, were linked by coaxial cable installations. Amplifier stations were

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12 Benjamin E. Shackelford, "Television," 1947 Britannica Book of the Year (Chicago: Encyclopaedia Britannica, Inc., 1947), p. 746.

13 Beers, "Television," 1948, loc. cit.

14 News item in The Terre Haute Tribune, February 14, 1948.

situated at eight-mile intervals along the routes, each completely automatic and requiring only periodical inspections. All the lines were underground and connected with the Bell System network covering most of the country.

A Central Press article[15] was released on August 15, announcing the completion of the southern trnascontinental coaxial cable installation from Florida to California by the Bell Telephone Company. In places where the route crossed the desert it was necessary to bury the cable six feet in the ground to maintain a constant temperature, and to encase it in a heavy copper tube to prevent gophers from nibbling away the lead sheath. In California, in the section from the Colorado river to the Whitewater river, the cable was buried from six to eight feet beneath the surface of the ground to protect it from flash floods. Where the two earthquake faults were crossed along the California route, the cable crossing was made at sharp angles using excess cable to allow for motion without breaking. The Bell Company expected to have 12,000 route miles of coaxial cable in service by 1950.

A United Press article,[16] dated November 13,

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[15] Central Press dispatch, The Terre Haute Star, August 15, 1948.

[16] United Press dispatch, The Terre Haute Star, November 14, 1948.

announced that "television was sent over a 500-mile wire-radio circuit today, linking Washington, New York and Boston." This system included the use of coaxial cable between New York and Washington and microwave radio relay between New York and Boston. Officials of the American Telephone and Telegraph Company, and the Bell Laboratories, which developed the system, announced that the network to Chicago was nearing completion.

Other links in the network system completed in 1948, connected Boston, Massachusetts; Schenectady, New York; New York City; Philadelphia, Pennysylvania; Baltimore, Maryland; Washington, D. C.; and Richmond, Virginia. A midwest network interconnected Milwaukee, Wisconsin; Chicago, Illinois; St. Louis, Missouri; Toledo, Ohio; Cleveland, Ohio; Detroit, Michigan; and Buffalo, New York.

A nationwide television network system is rapidly becoming a reality, bringing television within the reach of additional thousands of viewers each time another link is completed.

CHAPTER V

TELEVISION RECEIVERS

Many different types of television receivers had been suggested and tried, including such devices as the disc scanner,[1] the mirror drum receiver,[2] the mirror screw scanning device,[3] and others too numerous to list. At each stage in the development of a system of television, the receiving device was similar in almost every respect to the transmitting device. Receivers with moving parts produced low definition pictures which made them undesirable and unacceptable, and, since mechanical methods of scanning had reached all practical limits in the early part of the twentieth century, research turned to the development of an all-electronic system employing the cathode ray tube for scanning.

The first all-electronic system of television transmitter and receiver was patented by Philo T. Farnsworth[4] in

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[1] H. J. Barton Chapple, Popular Television (London: Sir Isaac Pitman and Sons, Ltd., 1935), pp. 63-7.

[2] Ibid., pp. 67-70.

[3] Ibid., pp. 70-1.

[4] Lowell J. Thomas, Magic Dials, The Story of Radio and Television (New York: Lee Furman, 1939), p. 33.

1923, and on November 18, 1929, Dr. V. K. Zworykin[5] demonstrated an all-electronic receiver using the kinescope, or picture tube, which he had developed.

Cathode ray tubes were only a laboratory tool until 1928, and time was required to apply the principles which had been established and to bring about the development of a satisfactory picture tube for use in field tests of all-electronic television. By 1932,[6] work on the picture tube had progressed to the point where RCA was able to begin field tests with 120-line, all-electronic television. The picture tube[7] used was a modification of Zworykin's original kinescope. This tube contains an electron gun similar to the gun used in the iconoscope and is similarly controlled. The beam of electrons is made to scan the fluorescent screen at the viewing end of the tube by horizontal and vertical magnetic fields controlled by sweep circuits. The sweep of the electron beam in the picture tube is accurately synchronized with the sweep of the electron beam in the camera tube to assure the exact

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[5] David Sarnoff, _Pioneering in Television_ (New York: Radio Corporation of America, 1946), p. 95.

[6] _Loc. cit._

[7] C. H. Hylander and Robert Harding, Jr., _An Introduction to Television_ (New York: The Macmillan Company, 1941), pp. 164-9.

duplication of the original image. This synchronization is accomplished by the transmitting of a series of pulses as a part of the broadcast signal. These pulses are capable of activating the scanning coils on the picture tube at the exact instant they are produced by the scanning coils of the camera tube.

Two schemes for controlling the electron beam had been developed. The electromagnetic method of beam control was accomplished by external coils which set up magnetic fields within the tube. The kinescope is an example of this method. The other is the electrostatic method,[8] in which two sets of metal plates were mounted within the tube in such a position that the beam of electrons was made to pass between them to reach the screen. By changing the potential between the plates, the path of the beam was altered in relation to the changes in voltage and made to scan the fluorescent screen at the viewing end of the tube to reproduce the image. Although these two methods for controlling the electron beam differed in details, they followed the same lines of development and use.

The television receiver[9] for home use is a complicated affair. It consists of a station selector and

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[8] Ibid., pp. 169-70.

[9] Ibid., pp. 170-8.

amplifier which picks up both the television carrier wave with its signal and the sound carrier wave with its modulation from the antenna, separates the picture wave and sound wave, and sends them to their proper circuits. The sound signal, which is higher in frequency than the television signal, is separated from its carrier wave, amplified as in an ordinary radio receiver, and then delivered to the speaker or speakers. The picture signal, after being separated from its carrier, passes through a series of amplifying tubes and finally reaches the picture tube where the synchronizing pulses pass to the deflecting circuits and the remaining portion of the picture signal is sent to the grid of the picture tube causing beams of electrons to reconstruct the picture on the fluorescent end of the picture tube where it may be viewed. The cabinet is constructed to conform to the size and shape of the picture tube and to house the other electrical units and the speaker, which is usually mounted either below or to the side of the image screen along with the necessary tuning controls. Home television receivers were not generally available to the public until satisfactory service could be assured.

In 1936,[10] RCA began field tests of ultra high

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[10] Sarnoff, loc. cit.

frequency television broadcast of 343-line pictures from the transmitting station located in the tower of the Empire State Building. Two hundred receivers had been distributed to persons living within the New York broadcast area to test the results of the broadcasts. Programs for these field tests originated in studios located in Radio City and were relayed to the transmitter by radio links and coaxial cable. As changes in standards were made by the FCC, the receivers were adjusted to operate in conformity with the changed standards.

In 1939,[11] when television service was introduced to the public at the opening ceremonies of the New York World's Fair, the sale of television receivers for home use was begun.

Because of the uncertainty of the standards and questions of policy within the television industry, the sale of television receivers to the public was suspended, and the establishment of regular programs was delayed until July 1, 1941. On that date television station WNBT became the first commercially licensed station to go on the air.

The popularity of television grew rapidly, but the entry of the United States into war necessitated restrictions which practically halted further development

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[11] *Ibid.*, p. 96.

for the duration of the war.

One of the first advancements in television in 1945[12] was RCA's demonstration of a projection-type home receiver, featuring a screen approximately eighteen by twenty-four inches in size. RCA had announced the development of the electron projection "gun" in 1937, but at that time it had been used for projecting pictures onto a large screen which was not practical for home use.

This projection type tube[13] was similar to, although somewhat smaller than, the kinescope. More power was required for its operation and a system of lenses was necessary for projecting the picture upon the screen. The pictures produced were very brilliant and could be projected to sizes as great as fifteen by twenty feet.

Other projection tubes were made available for use in home type receivers for producing brilliant pictures up to three feet in size, but for practical purposes, the screens ranged in size from five inches to fifteen inches.

The direct viewing tube also was improved, not only in the electron "gun," but also in the control mechanisms

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[12] Loc. cit.

[13] Hylander, op. cit. p. 178.

M. S. Kay, "Television Projection Systems," Radio and Television News, 41:5:47-9, May, 1949.

and in the fluorescent materials, which made available tubes as large as fifteen inches across the viewing screen.

Improvements in television receivers, which were introduced in 1946,[14] included simplified tuning systems, more freedom from noise and interference by the use of automatic frequency control systems, and the addition of a radio frequency amplifier stage which produced stronger and clearer signals.

Picture tubes were coated with aluminum[15] which acted as a mirror to reflect light, which otherwise would have been lost through the screen as useful light. Deflection circuits operated on higher voltages made possible by the aluminum coating, and many 1946 tubes were equipped with an ion-trap gun to eliminate the "ion-spot" which was a small discolored area on the screen caused by the absorption of ions.

In 1947[16], television broadcasting became a firmly established broadcasting service. Approximately 170,000 television receivers were manufactured, the majority of which were table models having ten-inch directly viewed

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14 Frank G. Back, "Television Optics," _Tele-Vision Engineering_, 1:4:4-5. April, 1950.

15 _Loc. cit._

16 L. T. Steele, "Report on TV," _American Mercury_, 66:555-62, May, 1948.

tubes, although the sizes ranged from seven to twenty inches. Combination receivers which included television, AM, FM, short-wave, and phonograph were also offered. The manufacture of television receivers was begun by many radio manufacturers who had entered the field because of the rapidly growing public acceptance of television.

Two projection type receivers were introduced:[17] one with a screen of the reflection type and the other a translucent type. Directional viewing screens of this type produced pictures of greater contrast and were affected less by ordinary room lighting than the directly viewed tubes.

In 1948,[18] more than 800,000 television receivers, with a retail value exceeding $300,000,000, were offered to the public; but the supply was not equal to the demand. Receivers equipped with direct viewing tubes ranging in size from three inches to twenty inches were available, but the ten-inch table model was the most popular.

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17 M. S. Kay, loc. cit.

K. A. Hoagland, "TV Picture Tube Trends," Tele-Vision Engineering, 1:4:16-7, April, 1950.

18 "TV Audience Problem," Business Week, p. 70, September 13, 1947.

A sixteen-inch metal kinescope was announced.[19] This tube was like the glass kinescope in design and function, but unlike it in materials used in its construction. The faceplate and neck, made of glass, were attached to a metal cone to produce the new tube. Low cost, light weight, and improved optical characteristics were claimed to be the principal advantages of the metal and glass combination.

From a telephone survey for CBS[20] to 500 set owners during a baseball telecast, it was found that more than one-half were tuned to the game, that three out of every four called could name the sponsor, and that there was an average of more than six viewers at each receiver. The C. E. Hooper Company reported that on January 1, 1949 there were 12 licensed TV broadcasting stations, 55 construction permits for 1949, and 10 construction permits pending FCC action.

On May 8, 1950,[21] Broadcasting and Telecasting

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[19] K. A. Hoagland, "TV Picture Tube Trends," Tele-Vision Engineering, 1:4:16-7, April, 1950.

[20] David Sarnoff, "Radio and Television in 1949-1950," Radio Age, 9:2:4-5, January, 1950.

[21] "Telecasting Survey," Broadcasting and Telecasting, p. 23, May 8, 1950.

reported 104 licensed TV broadcasting stations, serving 61 market areas, in operation; and estimated the number of receiving sets in use to be 5,584,344. This number, however, is only approximate because the figure is based on data available from dealers, distributors, TV circulation committees, electric companies and mnaufacturers.

When NBC first began television field tests[22] from the tower of the Empire State Building in June, 1936, there were only a few television receiving sets in the metropolitan area, and it was necessary to build an audience to receive the programs. This was accomplished by distributing two hundred receivers to individuals in the area who were sufficiently interested in the development and advancement of television to report their reactions to the content of the programs and the quality of the pictures received.

This experimental period[23] lasted for three years. During this time the programs were broadcast at irregular intervals. Estimates varied as to the size of this viewing audience. Some estimated an average of five persons viewing each receiver; others estimated nearly

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22 Sarnoff, loc. cit.

23 C. W. Farrier, "NBC Television Sets the Pace," Radio News, 21:5:28-9, May, 1939.

double that number. It should be safe to say, however, that NBC's New York audience between 1936 and 1939, numbered between 1,000 and 2,000 viewers. The programs liked best were detective stories from the adventures of Sherlock Holmes and Dr. Watson, and scenes from a Broadway play, "Susan and God," starring Gertrude Lawrence.

On the West Coast, Mutual-Don Lee[24] produced a dramatic comedy serial called "Vine Street." The fifteen-minute episodes, presented twice weekly, gained quite a following.

Television was publicly introduced in 1939, at the New York World's Fair, and a potential audience began to assemble. Public interest had been stimulated and the demand for receivers was greater than the available supply. On April 30, 1940, NBC estimated that there were 3,000 receivers in the metropolitan district of New York. By 1942 it was estimated that there were 10,000 receivers in use in the United States, but because of war restrictions no television receivers were available until well into 1946.

By the end of 1947,[25] the radio manufacturers

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24 Harry R. Lubke, "With the West Coast Televisors," Radio News, 21:5:11-12, May, 1939.

25 Thomas, loc. cit.

"Assaying Television," News Week, 31:56, January 5, 1948.

estimated from sales figures that there were approximately 170,000 receivers in operation in the United States. A survey made for General Foods of the metropolitan New York area, gave the following: 64% of all television sets were located in the area served by New York City stations; 71% of the owners were enthusiastic in their praise of their sets; the average size viewing screen was seven inches; the sets were from four to twelve months old; television owner families consisted of 3.3 persons; the average evening viewing audience consisted of 3.47 persons to each set; the average weekly tune-in time was seventeen hours, and the audience wanted to see more new movies by television.

As sales and installation of new receivers progressed and television audiences expanded in size, a new interest within advertising groups was developed for sponsoring television programs. Several stations began broadcasting on a commercial basis, selling time at newly established rates.

In 1948, several surveys of television listening habits were conducted. A survey was conducted by Audience Research, Inc.,[26] to determine the potential market for receivers for the year. Their studies indicated that an

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26 "TV Audience Problem," <u>Business Week</u>, p. 70, September 13, 1947.

estimated 825,000 sets might be in operation in United States by April, 1949. Lennen and Mitchell, Inc., advertising agency, estimated that television was available to only 28% of the population.

By this time the television audience had grown large enough whereby worthwhile studies of audience viewing habits, reactions and evaluations of the service could be made. One such study[27] was made of the viewing habits of teen-agers living in an area where television was new. This inquiry was conducted among 1700 students of South Shore High School in Chicago to determine some of the impact of television on teen-agers. Chicago had recently been linked to the East Coast Network by coaxial cable and for the first time dependable TV service was available in that area. Of the 1700 students questioned, 100 came from TV equipped homes. These 100 students spent an average of 23½ hours each week viewing TV, and in one case the time spent was 49 hours a week, the effect of which is equivalent to a three hour moving picture every night including Saturday and Sunday. The majority of the children came from homes where there were two to three children in the family, only 12% were only children, and the viewing

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27 "Video Up, Radio Down," <u>News Week</u>, 32:44-5, December 27, 1948.

audience consisted of an average of $4\frac{1}{2}$ persons.

As a result of the study, the investigators found that television viewing was a detriment to normal conversation, that it interfered with school work as indicated by lower grades, notwithstanding the denial of 50% who reported that school work had not been affected. The investigators concluded that teen-agers' TV viewing should be regulated and that parents should feel it their responsibility to regulate their children's viewing time.

Television audiences generally have become increasingly more discriminating in the type of program which they admit to their homes. The FCC offices[28] and Congress were flooded with complaints from the public, protesting crime and humor material, carried over some stations and some networks. As a result of these protests, the FCC, in March of 1950, issued a warning to radio and television to "clean house" in the matter of crime programs and crude humor. The broadcasters were warned that if they did not act on their own motion, public opinion would demand government action, probably in the form of restrictive legislation by Congress. A spokesman for the FCC paid tribute to much that was seen and heard on the air

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28 Associated Press dispatch, Indianapolis Star, March 15, 1950.

waves, but he emphasized that the warning applied to every radio and television broadcaster in the United States. Some broadcasters had been admitting for broadcast, program material which came close to the prohibition against the "obscene, indecent, and profane." If the industry wished to continue broadcasting without censorship, it would be necessary to observe the rules of propriety and assure the viewing audience of television that which was not off-color.

By polls and questionnaires, the radio broadcasters and advertising agencies have determined the types of programs the listening public desires, and have endeavored to produce them. If television broadcasters follow the same procedure, and it is reasonable to expect that they will, the television programs of the future will be whatever the viewing audience demands.

The earliest programs were sponsored by the companies which sponsored the original research and which were manufacturing receivers. To sell their sets, it was necessary for them to provide outstanding programs for the potential purchasers, and to bear the cost of production. The earliest programs included detective stories, light comedies, newscasts and many old movie films. When mobile television vans were introduced for remote pick-up in 1937, "man-on-the-street" programs came into being. Scenes from popular Broadway plays were presented. Vaudeville was revived. Station W2xbs presented a trained dog act, a juggler of Indian clubs, a world champion fencing master, and tumbling acts.

In 1939, President Roosevelt was televised[29] at the opening ceremonies of the New York World's Fair, and later, when King George VI and Queen Elizabeth of England visited the Fair, they were televised as they came out of the Federal Building. They walked to within a few feet of the television cameras and spoke briefly into the microphones.

Many television "firsts" in sports events occurred in 1939. On August 26, the Brooklyn Dodgers and Cincinnati Reds were televised at Ebbets Field. Bill Stern announced the Columbia-Princeton baseball game at Bakers Field, New York. The Fordham-Waynesburg college football game was televised on September 30. Then, on March 6, 1940, New York was televised from the air by a plane equipped with a portable transmitter.

During 1941, prize fights from Madison Square Gardens and scenes from Camp Upton, Long Island, were presented. Indoor and outdoor sporting events were the most popular subjects for televising, and the sports fans

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[29] David Sarnoff, Pioneering in Television (New York: Radio Corporation of America, 1946), p. 96.

eagerly gathered around the receivers to see and hear the action; but with the entry of the United States into the war, all this was changed, and television broadcasting was limited. Its entertainment value had to be forgotten for the duration of the war. However, in 1942, the first mass education[30] by television was initiated in the training of thousands of air-raid wardens in the New York area.

And on September 9, 1945[31], over station WNBT, television audiences saw a televised film recording of the Japanese signing surrender documents on board the U. S. S. Missouri. Improved visual effects and elaborately realistic stage settings were among the leading post-war television program developments.

At present, televised programs may be divided into two broad classifications. The first group includes those which originate outside the studio, such as baseball, football, horse racing, tennis and golf matches, skulling, prize fights and other similar sporting events, on-the-spot news events, political gatherings, fairs, parades, rallies, and man-on-the-street programs. The second group includes the shows which originate within the studio. Some of these are newscasts and commentators, open forums, quiz shows,

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30 _loc. cit._

31 _loc. cit._

audience participation shows, dramatization of the classics and popular literature, detective thrillers and westerns, drama written especially for television presentation, comedy and variety shows, music, musical comedies, great artists and conductors, interviews, and television "rebroadcasts" of film recordings and motion pictures.

Information gained through the eye makes a far more lasting impression on the memory than that which is heard through the ears alone; therefore, much use has been made of silent and sound films in the modern classroom. Studies have been made to evaluate the effectiveness of films as an instrument to supplement classroom instruction. Much of that learned about the use of sound films as audio-visual aids in education can be applied directly to television.

Several factors have been responsible for its lack of widespread use in the schools. The foremost factor is the limited availability of regular television service, but as more cities are served by coaxial cable and radio link on which network programs can be carried, reception will become increasingly available to education. Another factor is the difficulty of selecting programs which are suited to the school curriculum and fit into the school schedule. The factor of cost is a prominent consideration, but television-receiving equipment is so designed that it will, with proper care and maintenance, cost very little over a long period of time.

It is quite possible for a local school system to have classrooms equipped with television receivers to receive both film and direct pick-up educational telecasts especially planned for use in the schools.[32] Experiments have been conducted in both types of presentation of televised material but very little is available as yet concerning the results.

In 1945, in Chicago,[33] the first school library television production was presented as the first in a series "A View to Education," which was produced and directed by station WBKW. This was the televised version of one of the regular school radio programs "Battle of Books."

On January 20, 1949,[34] thousands of children in the schools of St. Louis, Chicago, Philadelphia, New York,

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[32] "Philadelphia Experiments with TV," Elementary School Journal, 49:315-6. February, 1949.

E. L. Henderson, "Education Invades Video," School Review, 57:398, October, 1949.

[33] Margaret I. Rufsvold, Audio-Visual School Library Service (Chicago: American Library Association, 1949), pp. 36-38.

[34] "Hail to the Chief," Time, 53:55, January 31, 1949.

Asbury Park, and other cities connected by television networks were able to view the inauguration ceremonies in Washington by means of special television installations.

Early in 1949,[35] the NBC through the cooperation of the National Education Association and the boards of education of New York City, Philadelphia, and Baltimore, inaugurated the first major television network series of educational programs. The programs were planned for pre-high-school children for after school hours at 5:00 EST Mondays through Fridays, with the purpose of bringing together student, teacher, and parent activities. The first programs planned were: "Little Theater," children's plays; "Explorers Club," geography; "Your Uncle Sam," visits to government centers; "Science in Your Life," physical and biological sciences; and "Folkways in Music," folk music and folk dancing of the United States and other countries. These programs were to be available to East Coast NBC network television stations. With the expansion of network facilities, the program was to be made available to other NBC television stations throughout the network.

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35 "Television and Radio in the News," <u>See and Hear</u>, 4:29, January, 1949.

The Massachusetts Department of Education[36] announced "The School of the Screen," a series of motion pictures to be televised on Channel 4 over WBZ TV. The series was to begin on April 10, 1950, and end on June 26, 1950. A copy of the schedule is reproduced below:

MASSACHUSETTS DEPARTMENT OF EDUCATION
BOSTON UNIVERSITY SCHOOL OF PUBLIC RELATIONS

"The School of the Screen"
on Channel 4, Station WBZ TV

SCHEDULE OF TELEVISION PROGRAMS:

Date	Day of Week	Time	Motion Pictures to be Televised
April 10	Monday	3:40 3:50	Introduction of Series by: Dr. Daniel Marsh President of Boston University and Dr. John J. Desmond, Jr. Commissioner of Education Commonwealth of Massachusetts
		3:50 4:00	Children of China
April 12	Wednesday	1:35	English Children
		1:55	British Isles
April 17	Monday	3:40	Honey Bee
		4:00	Irish Children
April 19	Wednesday	1:35	Arts and Crafts of Mexico
		1:55	People of Mexico
April 24	Monday	3:40	Care of Pets
		4:00	Colonial Children
April 26	Wednesday	1:35	Development of Transportation
		1:55	Peru

36 Schedule of Telecasts of The Massachusetts Department of Education, April 10, 1950.

May 1	Monday	3:40	Common Animals of the Woods
		4:00	Children of Switzerland
May 3	Wednesday	1:35	Autumn on the Farm
		1:55	Land of Mexico
May 8	Monday	3:40	Farm Animals
		4:00	French Canadian Children
May 10	Wednesday	No program	
May 15	Monday	3:40	The Hare and the Tortoise
		4:00	French Children
May 17	Wednesday	1:35	Conservation of Natural Resources
		1:55	People of the Congo
May 22	Monday	3:40	Poultry on the Farm
		4:00	Navajo Children
May 24	Wednesday	1:35	The Sunfish
		1:55	Alaska
May 29	Monday	3:40	Fox Fables
		4:00	Eskimo Children
May 31	Wednesday	1:35	Black Bear Twins
		1:55	Children of Japan
June 5	Monday	3:40	Gray Squirrel
		4:00	Mexican Children
June 7	Wednesday	No program	
June 12	Monday	3:40	Robin Redbreast
		4:00	New England Fishermen
June 14	Wednesday	1:35	Summer on the Farm
		1:55	People of Hawaii
June 19	Monday	3:40	Ants
		4:00	Children of Holland
June 21	Wednesday	1:35	Weather
		1:55	West Indies
June 26	Monday	3:40	Spring on the Farm
		4:00	People of Western China

Other educational experiments in television are in progress, but it is too soon to forecast the outcome. However, as soon as the results are available, a comparative study of these various projects should be a valuable contribution to the existing store of audio-visual material.

Television brings to the audience both sight and hearing which are the most important sources of information. People are interested in seeing as well as hearing what is happening, and television has become a social and economic factor in American life. It is the responsibility of the television broadcasters to offer a variety of eye-worthy entertainment which is acceptable to an ever-increasing audience.

In New York City, there are seven television broadcasting stations: WCBS TV, channel 2; WNBT, channel 4; WABD, channel 5; WIZ, channel 7; WOR TV, channel 9; WPIX, channel 11; and WATV, channel 13.

How well these broadcasters are succeeding can be estimated by examining a television program for the New York area for a single Sunday's broadcast. A copy of the NBC and CBS Sunday program for May 28, 1950, along with a list of the "Leading Events Today on Television," may be found in the appendix.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

Conclusions. In the foregoing pages of this thesis the history of the development of television has been traced rather briefly from man's first desires to attain "distant vision." By slow tedious stages, an unwieldy electro-mechanical device was produced, but, because of its very unwieldiness and inefficiency, it never became anything more than an interesting scientific novelty. However, in the past twenty years television has emerged from the laboratory a fully developed, efficient, all-electronic instrument which is capable of producing high-definition pictures, comparable in quality to exceptional quality home movies, and of bringing into the home a vast variety of programs of entertainment, comedy, drama, music, news events, sports, or instruction. It has become a potentially great social and economic factor in American life.

The last one hundred years has seen industrial production transferred from the home to the factory, working hours cut in half, and pay increased five-fold. Power, machines, and labor-saving devices had increased leisure time and caused families to seek entertainment outside of the home. Television appears to be bringing the home circle back, but television is too new to be able to determine whether or not concentrated television viewing is just a passing fancy which will be forsaken when it is no longer a novelty.

From a composite of various figures selected from the text of this thesis, a group of very startling facts became apparent concerning the changes in leisure time activities in homes with television receivers. Entertainment outside the home declined one-fourth; attendance at motion pictures decreased one-fifth; daytime radio listening declined one-fourth, and nighttime listening more than one-half; viewing time averaged about twenty-four hours a week; there were from 3.5 to 5 viewers at each receiver; and conversation diminished to the vanishing point. If social and economic changes such as these are permanent, they may force changes in commercial types of entertainment.

The addition of sight to sound enhances the emotional effects, and broadcasters have been experimenting with various types of material to find which lend themselves most effectively to televising. As an effective means of communication, television is unrivaled by any other system; it is timely, personal, and gives a feeling of being on the spot of the action.

Educators have recognized the potentialities of television as a tool in the educational program, and are endeavoring to make it serve them instead of allowing it to function as a detrimental influence. With the aid of television, the best teachers and teaching methods can be made available to aid the inexperienced teachers in presenting specialized materials to their classes, and to enable pupils in the classroom to see history in the making, and to see and hear the great composers and artists of our time. Educators have accepted silent and sound films and radio as aids to teaching, and, since television combines the advantages of all of them, it may logically become one of the foremost of audio-visual instruments. It is not too much to imagine class rooms, in the near future, equipped with television viewing screens.

Motion picture and radio industries, theaters, churches, schools, teachers, and parents are all complaining about the time which is spent to the exclusion of other activities. There has been criticism of practically every aspect of television, but the pictures and radio also have been, and still are being, criticized and they are flourishing. The radio has been in great measure responsible for the rise of appreciation for good music, and there is much of value to be seen on the television screen. Adults should be more discriminating in their choice of programs.

Television is an established force in the American home, and, if parents would acknowledge this one fact, they could regulate their children's listening and viewing time.

Recommendations. From an engineering viewpoint, the present system of television has been developed and improved to the stage where it is acceptable and practical for home use. Its ultimate contribution, however, will be its service toward improving the cultural, educational, and entertainment standards of the American people as a whole.

Information regarding its technical advancement, although not abundant, has been adequately recorded in periodical literature and book form; but definite information concerning the social, economic, cultural, and emotional effects of televised programs upon the viewing audience is incomplete and inadequate from an educational viewpoint. Numerous studies involving different phases of audience reactions are mentioned in recent periodical literature; some studies are partially described, and in a few instances some results have been discussed, but the quantity of such material is very small.

Criticism of the available television programs by various groups has been frequent in the newspapers and popular magazines during the past two years, but data to back up these accusations are usually completely absent. The very absence of such proof, and the scarcity of information regarding the effects of television upon various groups suggests many opportunities for educational studies.

A study involving the accumulating of data on all available past studies which deal with the social aspects of television appears to be needed. Valuable information, which could be used in formulating suggestions for improved program planning, could be obtained from a comparative study of viewing habits of television audiences in established broadcasting areas and new broadcasting areas; an evaluation of programs being used by schools; studies of the viewing habits of children, teen-agers, and adults; the physical and emotional effects of television viewing on children and adults; and changes in audience preferences of program types over a period of several years.

Science has given the marvel of television to the world, but it is the responsibility of the people to use it wisely to make it serve them well in helping to provide a better way of life.

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APPENDIX

ON TELEVISION WNBT, channel 4, SUNDAY, MAY 28, 1950.

AM	10:00	Children's Theatre
	10:10	Film: Don Winslow
	10:30	Children's Hour
	11:30	The Magic Clown
PM	12:15	Interior Decorating, Carl Steinhauser
	3:00	Zoo Parade
	3:30	Current Events Show, Watch the World, John Cameron Swayze
	4:00	Today With Mrs. Roosevelt: America's Role in Germany, Senator Guy M. Gillette, Rep. Jacob K. Javite, Dorothy Thompson, Gen. Telford Taylor
	4:30	Armed Forces Hour: Invisible Ramparts
	5:30	Film: Hopalong Cassidy
	6:30	Say it with Acting
	7:00	Leave It to the Girls
	7:30	The Aldrich Family, Play, with Robert Casey, Jack Kelk
	8:00	Supper Club; Perry Como, Mills Brothers, Guests
	9:00	Television Playhouse: Semmelweis, with Everett Sloane, Felecia Montealegre
	10:00	Garroway at Large
	10:30	Answer Yes or No; Quiz, with Moss Hart
	11:00	Review of the News

WCBS-TV, channel 4.

PM	4:30	Lamp Unto My Feet
	5:00	Overseas Press Club: Col. William F. Helmlich, Louis Lochner, Cecil Brown
	5:30	The Chuck Wagon
	6:30	Mr. I. Magination
	7:00	Starlight Theatre: The Juggler, With Barry Nelson, Betty Garde, Judy Parrish
	7:30	This Is Show Business With Peter Lind Hayes, Mary Healy, Harvey Stone, Ethel Waters, Tommy Wonder
	8:00	Toast of the Town, With Ed Sullivan, Pat C. Flick, Joey Bishop, Others
	9:00	Fred Waring Show
	10:00	Celebrity Time: Garry Moore, Cornelia Otis Skinner
	10:45	TV Week in Review

Sunday, May 28, 1950.

LEADING EVENTS TODAY

ON TELEVISION

PM 2:05 - 4:30 Baseball: Philadelphia vs. Giants - WPIX
3:30 - 4:00 "Watch the World," Current Events Show, with John Cameron Swayze - WNBT
4:00 - 4:30 Today With Mrs. Roosevelt: "America's Role in Germany," Senator Guy M. Gillette; Rep. Jacob K. Javits; Dorothy Thompson; General Telford Taylor - WNBT
5:00 - 5:30 Meet the Press: Senator Robert A. Taft, of Ohio, Guest - WNBT
6:30 - 7:00 "Mr. I. Magination," Children's Show, with Paul Tripp - WCBS-TV
7:00 - 7:30 Starlight Theatre: "The Juggler," with Barry Nelson, Betty Garde, Judy Parrish - WCBS-TV
7:00 - 8:00 Starlit Time, with Phil Hanna, Bill Williams, William Eythe, Others - WABD
7:00 - 7:30 Paul Whiteman Revue: Earl Wrightson, Mindy Carson, Others - WJZ-TV
7:30 - 8:00 This Is Show Business, with Peter Lind Hayes, Mary Healy, Harvey Stone, Ethel Waters, Tommy Wonder - WCBS-TV
7:30 - 8:00 Play: "The Aldrich Family" -WNBT
8:00 - 9:00 Toast of the Town, with Ed Sullivan, Pat C. Flick, Joey Bishop, Others - WCBS-TV
8:30 - 9:00 Play: "South Wind," with William Post Jr., Peggy French - WNBT
9:00 -10:00 Fred Waring Show - WCBS-TV
9:00 -10:00 Television Playhouse: "Semmelweis," with Everett Sloane, Felicia Montealegre - WNBT
10:00 -10:30 Celebrity Time, Garry Moore, Cornelius Otis Skinner, Guests - WCBS-TV
10:00 -10:30 Variety: Garroway at Large - WCBS-TV
10:30 -11:00 Quiz: "Answer Yes or No," with Moss Hart, Jane Pickens, Others - WNBT