# Television Today... and How It Grew

Napoleon had a painting on the wall of one of his conference rooms showing himself watching a battle taking place some distance away from where he actually was located. He had this vision of being able to see his battles going along without actually being on hand. This was his conception of what was going to come—and today that is practical in the field of television.

In 1886 an English scientist put into practice the first principles of television by breaking pictures into spots and transmitting the spots from one end of the building to the other and reconstructing the picture. This was the first transmission of pictures from one place to another and was impractical for any normal use until the coming of radio.

Radio communication began with the use of code, moved on into speech transmission, and later facsimile was sent over the air. Facsimile was transmitted by a system of photo-electric scanning but was extremely slow and useless for anything other than motionless type or pictures.

In 1929 the whirling scanning disk made television practical for the first time. This was a mechanical method of breaking the picture down into small spots and positioning a photo-electric cell back of the whirling disk which was perforated with a series of small holes, each holding a tiny lens. For practical broadcasting, the disc was three to five feet in diameter with the holes spiraling from the periphery toward the center.

**THIS ARTICLE, in the main, is based on a lecture delivered to Electronics upper-classmen by Harold V. Nielsen, President of the Nielsen Television Corp., an engineering graduate of Cornell University and a former Chief Engineer of the Sparks Withington Co. He is the inventor of the first electric push button radio. The article has been revised by William A. Van Zeeland, Instructor in Electrical Engineering, and additional material has been added by the Editor of TRANSMITTER.**

As each hole with its lens passed the scene to be transmitted, light shining through the lens was focused upon the light-sensitive cathode, producing a photo-electrical current containing intelligence and then set over the air by radio. At the receiving end, a similar disc was spun around at the same speed as the one at the transmitter. There was difficulty in synchronization, but in the

**Harold V. Nielsen**

same town on the same power with a synchronous motor geared to the disc, it would work quite well. There was a bit of drift, but for that period it gave a usable picture.

In 1934 the iconoscope was developed; this was the first electronic method of scanning pictures. A non-conducting material was coated with many thousands of separate globules of photo-sensitive material. The scene to be televised was focused on this plate causing the globules to take on individual charges proportional to the light striking them. A narrow electron beam in the tube would scan the photo-electric substances on the front and as this spot passed along, discharge the particles of the mosaic on the front of the tube. The light hitting that part of the mosaic would determine how much electricity would represent that particular portion of the picture.

The next step was getting the same scrambled picture back into shape in the receiver. On the receiving end there was a kinescope, commonly called a cathode ray tube. As electrons were squirted from the neck toward a phosphor screen, the intensity of the beam of electrons would cause the front of this tube either to glow brightly or not to glow at all and give a black appearance.

Reconstructing the picture at the receiver was like unscrambling a plate of scrambled eggs. The horizontal lines at the picture had to travel the proper distance and begin at the proper time. Also, the vertical displacement between horizontal lines had to be even. The vertical motion must begin at the proper time and speed. In sweeping from left to right, dark or light impressions were made on the screen. When the beam reached the right side of the picture, the spot was cut off and moved back to the left side again, besides moving down 1/128 of an inch. When the bottom line was completed, the beam was cut off again, returned to the top and construction of the next picture begun.

If the spot was not perfectly timed, the picture came out distorted. The spot and the actual time control circuits have to be timed to less than one tenth of a micro second. Variation of a small part of that would distort the picture.

**The Protelgram-equipped television set brings the picture out of the box and projects it on a home-movie screen up to three by four feet in size. The set is the cabinet in the foreground and the image is projected through a lens in the front of the case. The receiver shown is the Ansley "Tele-movie" which along with a number of others, uses the system.**

The television receiver, starting at the front end, consists of a selector circuit. The first function is to select the channel you want to listen to. It picks out the carrier frequency of the picture in order to get a particular station, then amplifies, then unscrambles the pictures. The sound and picture signals are separated and amplified in separate sections. Along with the video signals, the broadcasting station inserts synchronizing pulses so that the picture will be reconstructed in the same fashion as it was scanned at the station. These pulses are used to trigger generators which will produce a voltage capable of deflecting an electron beam in the receiving tube.

This tube consists of an "electron gun" which produces a steady stream of electrons toward a phosphor coating on the face of the tube. The number and velocity of the electrons striking this coating determine the brightness of the particular region being scanned.

In order to operate this tube and make the white spot do what is wanted, a horizontal deflection coil is employed. Moving the spot from the left side to the right side is the only function of that coil. The vertical deflection coil is mounted 90 degrees from the horizontal, and the sole function of that coil is to cause the horizontal lines to be displaced from each other by the proper amount. This is accomplished by slowly moving the beam in a downward direction during the same time that the horizontal lines are being scanned.

In producing one picture, the horizontal coil moves the beam across 525 times from left to right, producing 525 lines. In order to keep from having flicker, the picture frequency is set at 30 complete pictures or frames per second, exactly one and a quarter times the sound moving picture rate of 24 frames per second. The little spot is actually travelling at the rate of six miles per second.

An important adjustment in every TV set is the focus of the electron beam. The magnetic field from the current through that coil concentrates the electron stream to a spot on a ten inch picture from about a 64th of an inch in diameter up to about an eighth of an inch diameter. The average person's ear will not notice a distortion up to ten or fifteen percent, but the same person's eye can spot the difference easily.

The question of how far a set can receive is often asked. Theoretically, a set can receive only the line of sight which varies from 25 to 50 miles depending on the height of the antenna sending and receiving. Transmission from a high building in Chicago to a high building along the shore in Milwaukee may give a very good picture.

The only sure way of carrying television programs over great distances is to send them over a network. The network to Milwaukee is a combination of coaxial cable as far as Chicago, and radio micro-wave from Chicago to Milwaukee. One reason it costs so much to send a signal across the country is the fact that one television program takes up four and a half to six megacycles on a coaxial cable. The same cable, if used for telephone communication, can carry 4,000 conversations simultaneously. Paying for 4,000 private telephone calls over a period of four hours — to pay for a four hour network presentation—runs up quite a bill.

Most people today are interested in the problem of colored television. Color complicates the receiver and transmitter by three times over the present system. At present, the Federal Communications Commission is making a study of the three methods of color TV being tested today.

The first method has been used in tests by CBS and reverts to the old scanning disc. In this instance, the holes are replaced by three complete color filters. Spinning at a certain rate, the first comes out red, the second green, and the third blue; to the human eye, this appears to be a good color picture. The usual 60 Fields per second give 20 to each color. The problem of keeping the discs perfectly synchronized mechanically goes against it in the minds of many electronic engineers.

The second method eliminates the scanning disc but involves the use of three separate tubes, one sensitive to red, one to green, and one to blue. This is run by a combined synchronous system —to pick out the picture from red, green and blue. At the receiving end, three tubes receive their respective picture portions and superimpose them on a common screen.

The trouble with this system is that it is difficult for the service man to adjust the focus. He must focus all of the three tubes so that all three pictures (the red, green, and blue) project to the same point on the screen.

The method which most electronic engineers prefer will take a while to develop completely. Instead of using three different tubes, sensitive to three different colors, a single tube is used with one line sensitive to red, a second to green, a third to blue, a fourth to red, and so on for 525 lines. The receiver employs a cathode ray tube which has the same lines of colors.

In this system there is a synchronizing problem in making certain that the red line as transmitted hits the red line on the receiver. This type of tube has been made by hand in a laboratory, but they have yet to evolve a process whereby they can be made consistently for production. It will probably be from five to eight years before commercial colored television arrives.

The new channels will not affect the present operation of receivers, because they are expected to be assigned to smaller towns and rural areas. They will carry the same networks as the present channels. Ultra High Frequency will not affect the use of the present sets, because it is expected that cities which have stations in the present band will not have UHF stations assigned at any future time.

Within the last year, NBC in New York has installed "radomes" atop the RCA Building at Radio City to provide a reliable all-weather micro-wave radio relay receiving point for receiving video programs from temporary field locations within a radius of approximately 30 miles. They have been installed on each side of the building and between them cover the entire 360 degree horizon.

Another advancement of the year, from the video fan's point of view, is the development of a "home-movie" type of projection receiver system which will throw a three by four foot image. The system, called "Protelgram" by its producers, the North American Philips Company, uses the Schmidt optical system to develop a 1,728 square inch picture from a special two and one half inch magnetic projection tube.

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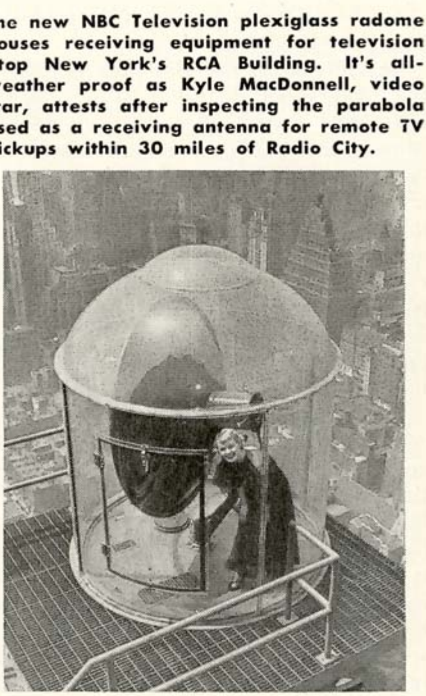
**The new NBC Television plexiglass radome houses receiving equipment for television atop New York's RCA Building. It's all-weather proof as Kyle MacDonnell, video star, attests after inspecting the parabola used as a receiving antenna for remote TV pickups within 30 miles of Radio City.**



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The Lucite and Plexiglass used in the domes' construction are among the few materials which permit the short radio waves (7,000 megacycles) to penetrate them.

The company, which does not make TV receivers, has made the system available to TV manufacturers to incorporate in sets of their own design. Some are building it into table models with a built-in 16 by 12 inch screen.

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Television receivers are designed to keep out as much interference as possible. However, there are some types which cannot be eliminated. One example is that of two stations on the same frequency or the same channel coming in a tuned receiver. If a set is located within receiving range of three cities, each telecasting on Channel 4, all three will come in if a non-directional antenna is used and give interference bars. The only way you can discriminate between signals is by a directional antenna, if they come in from different directions. If they come from the same direction, it is necessary to reduce the sensitivity of the set so that the more distant station cannot come in while the nearby station can.

Another source of interference is diathermy equipment. This gives the appearance of a herringbone stripe running through the picture. Automobile ignition systems also can cause trouble.

Static already is virtually eliminated on television. Often a picture is received from a station 60 miles away, through a thunder storm. When there is a heavy flash of lightning, there may be a flash through the picture, but otherwise there is no indication of static.