# Explaining the Mysteries of Television

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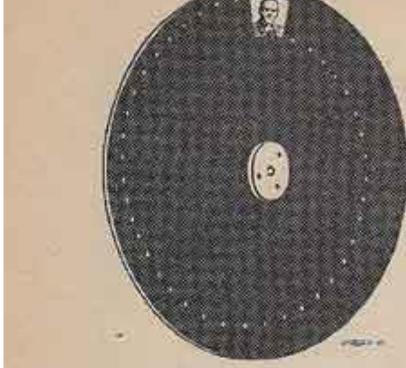


Scanning Disc, showing spiral of holes and position where image seems to appear.

TELEVISION! *It's here!* Telephone and telegraph wires, and even the free air, are transformed in giant telescopes through which may be viewed the actions of persons hundreds, yea thousands, of miles away.

Another modern miracle is wrought. Man scores again in his ceaseless struggle to defy space, to overcome time and to destroy isolation. Success crowns the diligent quest of scientists and experimenters extending over more than sixty years.

Television! It is just what the word implies—*tele*, a Greek word meaning *far off*, and *visio*, a Latin verb meaning *to see*. Electricity has given the "wings of the morning" to human vision and extended the horizon of man's sight to the ends of the earth.

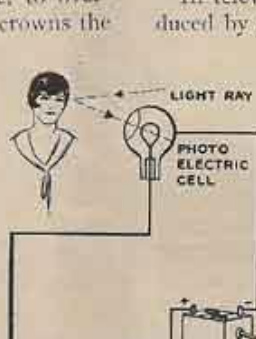
It is true that television, as yet, is not perfect. The images thus far transmitted have been crude. The most enthusiastic experimenter hardly would class them as highly entertaining. But this is merely a matter of mechanical detail compared with the great fact that man is now able to transmit pictures rapidly enough to produce the effect of motion. Improvements in transmission and in reception will come speedily just as they did in aural broadcasting and reception.

## HOW PICTURES ARE TRANSMITTED

Imperfect as it now is, television possesses a keen fascination. Watching a dim and flickering little image that seems to appear on a rapidly revolving disc is awe-inspiring when it is realized that its variations are recording the facial contortions of a living subject many miles away. It holds the promise that one day soon we may be able to view in detail all of the movements on distant fields of action.

No doubt, many readers will wonder why all this rejoicing over television, as if it were a recent and very abrupt development. Transmitting pictures by wire and through the ether has been a commercial reality for several years. It is so common that the metropolitan press has ceased to comment specially upon it.

Isn't television accomplished in the same manner? Fundamentally the processes are quite similar. The picture is transmitted by changing light waves into electrical impulses, which can be sent out over wires or through the ether, just as are the dots and dashes of the Morse telegraph code. In the process now in commercial use, these varying electrical impulses are employed at the receiving station to operate a tracing machine or to affect sensitized paper, thus reproducing the picture. This is known as telephotography. Sending a picture by this means requires several minutes.




This diagram shows how light rays reflected into a photo-electric cell cause fluctuations in an electric current.

There is almost as much difference between telephotography and television as there is between an ordinary photograph and a motion picture. One is a "still," the other a "movie."

In television the sensation or effect of motion is produced by an optical illusion, just as in motion pictures. Views in sequence are presented so rapidly as to give the effect of motion. Because of its "time lag," the eye is not quick enough to detect this speedy shifting of pictures.

In the case of the "movies," sixteen separate and distinct pictures per second are brought before the lens of the projector, each picture coming to a complete stop for just the merest fraction of a second. With each shift the shutter closes. All of this is too speedily done for the eye to detect more than a faint flickering effect. In television the pictures shift with similar rapidity. However, one blends into another without a stop. It is this rapid transmission that is causing the present rejoicing. By producing the optical illusion of motion, it solves the last great riddle of television.

Pointing out this essential difference between telephotography and television does not explain how the pictures are sent. It is easy enough to say that it is done, by changing light rays into electrical impulses at the sending station and changing these electrical waves back into light at the receiving station. However, this is not very illuminating to the average layman.

Here we see a section of the scanning disc showing how the image is divided by the light beams shining through the spiral of holes. In reverse manner the image is reproduced by revolving a disc in front of a neon lamp. Some of the holes may be seen to the right and the left of the image.

On page forty-seven of this issue will be found a review of a recent book entitled "Practical Television," by E. T. Larner. This review tells of some of the hard work that had to be done before we could have television, even in its present imperfect state.

The discovery that has proved of greatest aid in the realization of television was made quite by accident. In the early days of the Trans-Atlantic cable, an operator in Ireland discovered that his selenium resistors did not function properly when the sun shone on them. This disclosed that when selenium is exposed to light its resistance to electricity is decreased. The invention of the selenium cell resulted. Later it was found that other metals react in greater degree under similar circumstances.

**EXPLAINING HOW IMAGES ARE TELEVISED**

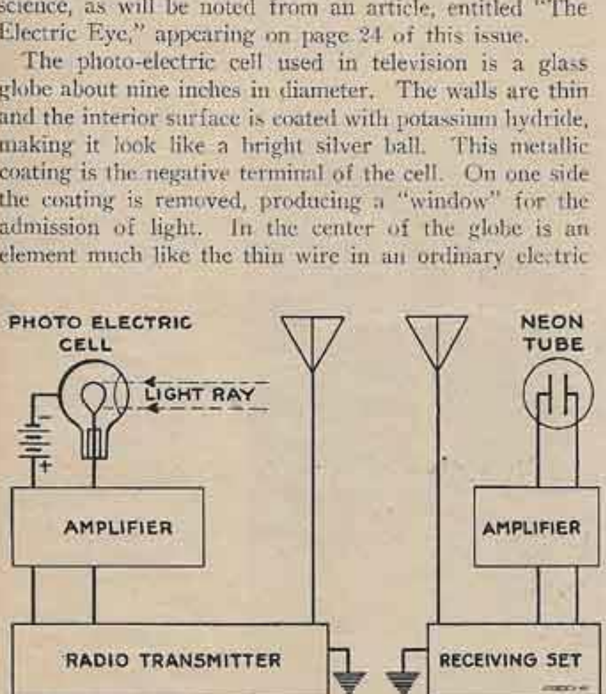
John Fitzpatrick, president of Chicago Federation of Labor, has the distinction of being the first Union Labor president televised. President Fitzpatrick's picture is reproduced here twice to help explain how images are televised. The process is very similar to that by which photographs are reproduced in halftone. The image is divided into thousands of little dots.

The picture on the left is a 120-line halftone. In one square inch there are 14,400 tiny dots—count 'em if you can! Put the picture under a strong glass and the dots will be visible. The picture on the right is a 42-line screen—1,764 dots to the square inch. The dots can be clearly seen. A television disc with sixty-five holes ought to reproduce an image as clearly as does this halftone.

## ELECTRIC EYE FAR KEENER THAN MAN'S SIGHT

In time the photo-electric cell was developed. It is a veritable electric eye, far more keen than is the human eye in detecting light changes. In addition to giving sight to television, the photo-electric cell serves an increasingly great number of important purposes in commerce and science, as will be noted from an article, entitled "The Electric Eye," appearing on page 24 of this issue.

The photo-electric cell used in television is a glass globe about nine inches in diameter. The walls are thin and the interior surface is coated with potassium hydride, making it look like a bright silver ball. This metallic coating is the negative terminal of the cell. On one side the coating is removed, producing a "window" for the admission of light. In the center of the globe is an element much like the thin wire in an ordinary electric




**The diagram at the left illustrates how light rays are transformed into electric rays and made available for broadcasting. The diagram at the right shows how television signals are picked up and changed back into light impulses, reproducing the image.**

light bulb. This is the positive terminal. The cell is filled to low pressure with an inert gas such as helium, argon or neon.

When the photo-electric cell is placed in a circuit in series with a battery, the flow of current from one terminal to the other is very slight. However, when light is permitted to fall upon the potassium hydride coating its resistance is decreased and the flow of electricity is allowed to correspondingly increase. The slightest fluctuation in the light causes an equal variation in the current. These feeble electric fluctuations can be amplified until they are strong enough to be sent out over wires or broadcast by radio.

At the receiving station these impulses are again amplified and are fed into a kino lamp or neon tube—a bulb about the size of an ordinary radio tube. The element in the neon tube is flat and about one and a half inches square. The tube is filled with neon gas. The intensity of the glow of this tube varies instantly with the slightest fluctuation in the current.

By the use of the photo-electric cell and its kindred marvel, the neon tube, variations of light at the sending station can be reproduced instantly and faithfully at the point of reception.

## TELEVISION RESULT OF LONG SEARCH

However, conclusions must not be drawn too quickly from this phenomenon. Neither telephotography nor television is produced by it alone. Television is the result of the study and work of hundreds of scientists and inventors extending over nearly two generations.

When the final record is written, and due credit given each worker for his contribution, it may be found that some outside (Continued on Page 59)

# Explaining the Mysteries of Television

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the realm of electricity deserve a bit of the glory. Perhaps honorable mention will be accorded Fox Talbot, who more than sixty years ago invented the half-tone process of photo engraving. Certainly a knowledge of Talbot's discovery helps one to understand how pictures are sent by television. Talbot's invention makes possible the reproduction of photographs and other pictures in newspapers and magazines. When a picture is to be reproduced by the half-tone process, a screen is placed over the camera lens—a coarse screen for a newspaper illustration and a finer screen for printing on coated paper. The screen divides the picture into thousands of tiny dots. In black portions of the picture the dots are very dark, in shaded portions they are gray and in the high lights the dots are faint. This is easily discerned when a half-tone illustration is viewed through a magnifying glass. There is a suggestion that Nature uses a similar process to accomplish the miracle of sight. The retina of the eye is composed of countless microscopic hexagonal cells, each with a nerve thread leading to the brain.

**The frequency chart, broadcast at the beginning of each television schedule over WCFL. If the receiver can tune in this chart, then he is ready for the changing images.**

How to split up the picture to be broadcast into tiny segments, as is done in the case of photo engraving, was for a long time a stumbling block in the path of searchers after television. At present this is done with a perforated disc, called a scanning disc. Many experimenters contend that a better system must be sought.

The scanning disc is usually about twenty inches in diameter. The perforations are hardly larger than a pin and are arranged in a spiral near the rim. While the spacing between holes is equal, the spiral arrangement places each hole on a separate line or separate diameter.

Some engineers insist that for early amateur television experimenting, discs with only twenty-four holes should be used. Others claim that far better results are possible with 48-hole discs. Forty-five is another popular number. Station WCFL is now using a 48-hole disc, rotating at 900 revolutions per minute.

The scanning disc, decorated with its spiral of holes, is the characteristic insignia, emblem or sign of television, just as the outline of a "mike," a loud speaker or ear phones indicates radio. When the scanning disc is revolved so that its rim bisects the light from the projector, rays shine through the holes in the disc and fall with flickering effect upon the face of the person to be televised. With a disc such as WCFL uses, forty-eight lines of light flash across the face of the subject, each like a tiny searchlight traversing its own path. Each line of light recurs 900 times per minute. Thus the subject is completely scanned fifteen times each second. When one of these lines or shafts of light falls upon a light spot on the face, a strong reflection results. Dark spots cause less reflection. These constantly varying light impulses—probably more than two million per minute—are reflected into the photoelectric cells. Four such cells are used in the WCFL television broadcast equipment. As before stated, these changing light impulses cause similar variations in the electric current flowing between the terminals of the photo-electric cells. These electric impulses are greatly amplified and then fed into the regular radio broadcast apparatus.

At the receiving station, the radio impulses are again amplified and are then fed into a neon tube or kino lamp. The glow of this lamp varies faithfully with each fluctuation in the photo-electric cell.

When a disc, with holes in it similar to those in the scanning disc at the sending station, is rotated in front of the glowing kino lamp, so that the light will shine through the holes, and the speed of the two discs is synchronized, the image being broadcast appears to be reproduced on the face of the receiving disc. The image does not actually appear there—it is only an optical illusion. When the images are transmitted in sequence at a speed of fifteen per second the further optical illusion of motion is produced. The receiving disc must rotate in the opposite direction to that of the sending disc—television is a sort of winding and unwinding process, also one of the world's greatest bits of slight of hand.

WCFL Radio Magazine, 1928