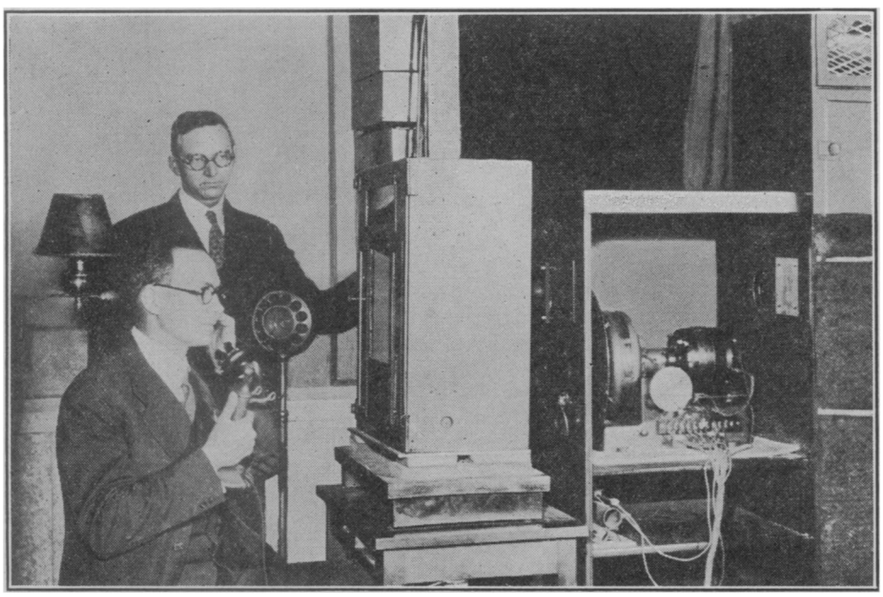
Science News-Letter
Reg. U. S. Pat. Off.
The Weekly Summary of Current Science
A Science Service Publication

Edited by Watson Davis
Vol. XI No. 314

10¢ a copy $5 a year
April 16, 1927

PHYSICS

How New Television Process Works



THE TELEVISION TRANSMITTER. R. C. Mathes, of the Bell Laboratories technical staff; seated in front of the box containing the three photo-electric cells. The moving spot of light shines through the hole in the box. The motor which runs the revolving disc and part of the disc itself, can be seen in the opened cabinet, while at the extreme right is the lamp house containing the arc light. Standing behind Mr. Mathes is J. W. Horton, also of the technical staff which contributed to the development of the television system

By James Stokley

Described as one of the greatest triumphs in the history of communication methods, the television process of the American Telephone and Telegraph Company is the product of many minds working together in the Bell laboratories in New York under the guidance of Dr. Herbert E. Ives. Despite the elaborateness of the apparatus, television depends essentially upon the fact that a film of potassium metal in a vacuum tube can be made to give a small electric current when light shines on it. This is in the photoelectric cell. The method of its use in the new process is quite different from previous attempts to attain the same result.

In other methods, the subject, whose visage is to be transmitted, is flooded with brilliant light and a lens picks up the illumination and focuses it on a small photoelectric cell. In the new method, by the idea of Dr. Frank Gray, the subject is illuminated with a tiny moving spot of light, which is picked up by a battery of large photoelectric cells—the largest yet made. The result is the most successful transmission of the actual view of the human face that has yet been achieved.

As seen on the small receiving screen, the scene looks like a halftone two inches high, printed in the pink sheet edition of a daily paper, except it has come to life. Most newspapers print photographs in what is known as halftone—small dots spaced 50 to 60 to the inch and blended by eye into a continuous picture — a process, incidentally, which was the invention many years ago of Frederic E. Ives, the father of Dr. Herbert E. Ives, who is immediately responsible for the new process.

In the television receiver the picture is also made up of 50 eye-blended rows of light and dark, which appear pink because the light in which they are painted comes from glowing neon gas—a rare element found in the atmosphere. Like its relatives—helium, argon, krypton and xenon—the neon used in the receiving lamp is peculiar because it will not combine with any other chemical substance. When two metallic electrodes are sealed into a glass tube from which all air has been exhausted, but which contains a little neon, and an electric current is passed through, the gas glows with a pinkish light. Unlike the ordinary electric lamp with a filament of tungsten, which continues to glow for an instant after the current has been disconnected, the neon light goes on and off as instantaneously as the current itself.

To television a speaker's face from Washington to New York, for example, the light starts from the carbons of an automatic arc lamp. In front of the lamp is a disc with 50 holes around its edge in a spiral, each hole a little nearer the center than the one before it. A lens projects an image of the holes out into space, just as the lens of a movie machine projects an image of the moving film on to the screen, but in the television device the screen is the subject's face. And just as the movie film travels through the machine so fast that the single pictures are not seen, but are combined together by the eye into a continuous picture, so does the rapidly moving disc, containing the holes, move so rapidly that the 50 holes, each

(*Just turn the page*)

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a little lower than the one before it, sweep across the facial screen in less than a fifteenth of a second. The person being televisioned has this light spot swept over him 17.5 times a second. To a person standing beside the subject, his face seems to be illuminated by a slightly flickering but single area of light. The single holes, or even the rows of holes, are not seen separately.

Outside of the light from the arc, shining through the holes in the disc, the subject is in semi-darkness. In front of him are three photoelectric cells, the eyes of television. They turn the light into electricity. The production of these cells itself is a triumph accomplished by Dr. Ives. They are the largest that have yet been constructed. When the moving finger of light, a fiftieth of an inch in diameter, sweeps across the face, it encounters the light-colored flesh; light is reflected to the sensitive photoelectric cells. By means of amplifiers like those used in radio stations, the photoelectric cells' tiny current, the electrical counterpart of the light, is magnified thousands of times. And when the spot of light reaches a dark part of the face—the pupil of the eye perhaps—and no light is reflected, no current flows from the cells to the amplifiers.

Thus the lights and shades of the face are transformed into a varying electric current, just as the ordinary telephone transmitter transforms the sounds of the voice into a pulsating current. It travels over the telephone lines for hundreds or thousands of miles, or else on the radio carrier wave for even greater distances. The receiving end picks up the current, amplifies it some more to make up for any losses in transmission, and connects it to the receiver with its neon tube.

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SCIENCE NEWS-LETTER, The Weekly Summary of Current Science. Published by Science Service, Inc., the Institution for the Popularization of Science organized under the auspices of the National Academy of Sciences, the National Research Council and the American Association for the Advancement of Science.

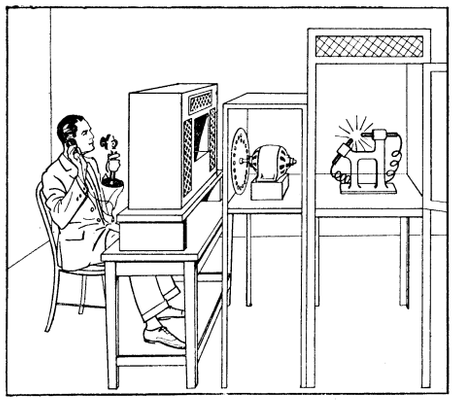
Publication Office, 1918 Harford Ave., Baltimore, Md. Editorial and Executive Office, 21st and B Sts., N. W., Washington, D. C. Address all communications to Washington, D. C.

Entered as second class matter October 1, 1926, at the postoffice at Baltimore, Md., under the act of March 3, 1879. Established in mimeograph form March 13, 1922. Title registered as trade-mark, U. S. Patent Office.

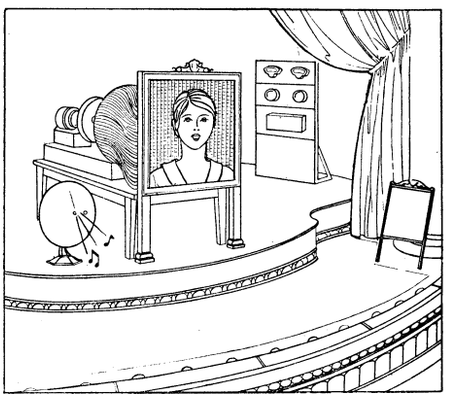
Subscription rate—$5.00 a year postpaid. 10 cents a copy. Ten or more copies to same address, 6 cents a copy. Special reduced subscription rates are available to members of the American Association for the Advancement of Science.

Advertising rates furnished on application.

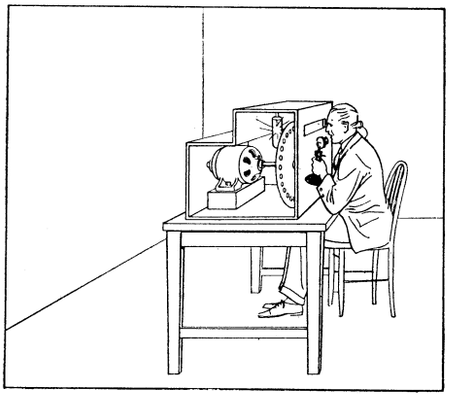
ESSENTIAL PARTS OF THE APPARATUS FOR SEEING BY TELEPHONE OR RADIO



THE TELEVISION TRANSMITTER. Light from the arc shines through the holes in the spinning disc, successively lighting different parts of the speaker's face. The reflected light is picked up by three photo-electric cells in the large box in front of the speaker, where it is converted into a pulsating electric current. Greatly amplified by vacuum tubes, this can be transmitted long distances by radio or telephone lines



FOR EXHIBITION TO A LARGE AUDIENCE the receiver uses a large neon tube of four square feet. This is made up of 2,500 separate elements, each with a separate wire connected with a commutator which runs in step with the revolving disc of the transmitter, so that as the spot of light shines on a particular part of the subject's face, a corresponding part of the neon tube is connected. A loud-speaker reproduces the voice



WHEN ONE PERSON wishes to talk to and see a friend by telephone, a smaller neon tube is used, which presents a surface of two by two and a half inches. A revolving disc like the one in the transmitter, also in step with it, exposes a part of the glowing surface which corresponds to the part on which the transmitting light is shining at the moment. To keep the two motors at the receiving and sending end running precisely together, was in itself a great achievement

Television

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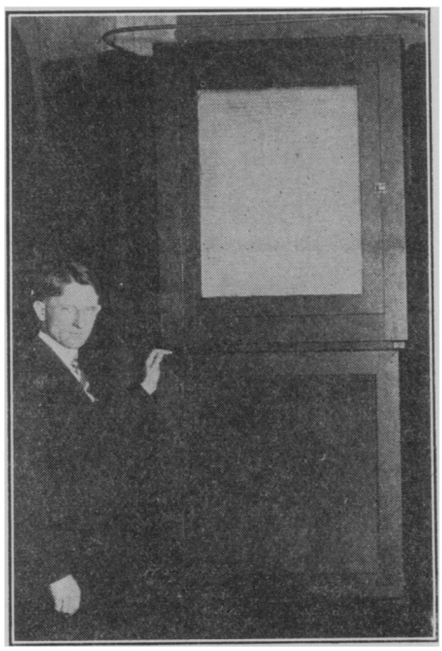
The variations in current are translated by the neon tube back into variations of light. But the tube shows an extended surface of light—an inch or more square—with no semblance of a picture of a face or anything else. Here the revolving disc again plays a part. A disc the exact duplicate of the one at the sending end revolves in front of the neon tube. Another ingenious invention, made by H. M. Stoller and E. R. Morton, permits the motor running the receiving disc to keep exactly in step with the one at the sending end.

If the spot of light in the sending apparatus is shining on the bright flesh, the receiving screen shows a corresponding bright area through the hole. And then as the sending light spot moves to the dark pupil of the eye of the subject, the neon ceases glowing and the screen shows a dark spot. As the spot moves to another white portion, such as the bridge of the nose, the neon again shines through the hole, which has also moved. The receiving disc, like the transmitting one, moves so rapidly that the light appears to the person observing as a continuous surface, blended into a motion picture of the sending scene. The individual changes from light to darkness and back to light again may be over in a twenty-five thousandth of a second.

The 2 by 2½-inch picture produced by the small neon lamp is intended for individual reception. It is the first form of the apparatus that may in future years be attached to the individual desk telephone. But sometimes a large audience may also wish to receive television, as when Secretary Hoover, in Washington, spoke on April 7 to the audience in New York and was seen by them more than life-size.



THE LARGE RECEIVING TUBE on which Secretary Hoover's face appeared in New York as he talked in Washington. His voice was reproduced by the loud-speaker behind the screen below. Dr. Frank Gray, chiefly responsible for this method of receiving, stands beside it

This is accomplished with glowing neon also. But a much larger tube is used; in fact, the whole screen, four square feet in area, is made up of a lengthy continuous tube, covering its surface much as lines of type on this page cover the area of this paper. This system is used instead of the revolving disc of the smaller receiver, because a revolving disc so large would not be practicable. The tube is a multiple one, really 2500 separate lamps in one. A commutator, a disc which makes contact successively with each of the 2500 separate glowers, is the substitute for the disc with the holes. It also revolves in step with the disc at the transmitter. A spot of light travels in rows across the surface of the large tube, reproducing as it goes, the variations of light "seen" by the photoelectric cells at the sending station. But the big tube is expensive and complicated, as a separate wire must go to each of the 2500 separate electrodes.

With the complicated apparatus necessary to accomplish television, the time is not yet in sight when it will be an appurtenance to every telephone. But with the initial success, the future is a matter of simplification, and it is in this task that the modern scientist shines.