Complex Televisors to Give Large Images

Imitating the Action of Eye with Myriad Cells Eliminates Scanning Disc, and Bank of Lamps Reproduces Televised Scene with Light Enough for Magnification

By Herndon Green

ONE of the most interesting of recent television stories is the development by C. Francis Jenkins of Washington, D. C., the well-known inventor, of a television system from which the usual scanning disc has been eliminated and replaced instead by a picture-analyzing frame containing 2,304 separate photoelectric cells. The disc has been removed from the receiver also; the received images being built up on a frame of similar construction containing 2,304 little flashlight lamps. The latter give white light, and thus produce images considerably brighter than those possible with the usual neon-gas glow lamps.

Because of the high light-sensitivity of the image-analyzing frame, and the brilliance and size of the image-reproducing frame, Mr. Jenkins predicts that within a year he will be able to transmit views of baseball games, inaugural ceremonies and other outdoor events, and to reproduce them before large audiences in theatres. He estimates that his apparatus handles 100,000 times more light than do the present scanning-disc machines; in which the amount of light actuating the photoelectric cells is limited by the tiny apertures in the revolving discs.

FRAME HOLDS 2,304 CELLS

As shown in the illustration on page 537, the image-analyzing frame at the transmitting end consists essentially of a wooden board slightly more than two feet square. The 2,304 photoelectric cells, each only one-half-inch square, are arranged in 48 parallel rows of 48 each. In the base of each cell is a tiny fixed condenser, connected directly across the electrodes. The condenser is an integral part of the cell, and plays an important part in the operation of the system, as will be explained.

One terminal of each cell is connected to the corresponding terminal of its neighbor; a single wire, common to all these 2,304 terminals, being one of the external connections of the frame.

Separate wires are run from the free terminals of the cells to 2,304 separate little contact points mounted on the inside of a drum of insulating material about fourteen inches in diameter and two inches wide. Revolving against these points, and making contact with only one at a time, is a contact-arm which is driven at the rate of 900 revolutions a minute. A single wire is connected to this arm; in company with the wire from the common side of the cells, the two form the "output" wires. These are led to a powerful audio-frequency amplifier, which in turn is made to feed the radio transmitter.

The receiving end of the system is practically identical in construction with that of the transmitter. The board on which the receiver images appear is also slightly more than two feet square, and contains 2,304 ordinary flashlight bulbs, in 48 rows of 48 each. These are connected in the same manner as the photoelectric cells, the switching drum being of exactly the same size and design.

HOW THE SYSTEM WORKS

The operation of the system is simple. The subject to be televised sits in front of a lens which projects his image on the bank of photoelectric cells, just as if the latter were the ground-glass screen or the plate of a camera. Each of the tiny photoelectric cells generates an electric current, the strength of which depends upon the amount of light falling on the cells. For instance, the cells covered by the darker image of the hair will create comparatively weak currents; those on which the lighter portions of the face and skin are projected will generate stronger flows. The whole image is thus broken up or analyzed by the cells, each of which represents a unit area of it. The current produced by each cell charges the condenser contained in the latter; and this operation is continuous, not intermittent as in the scanning-disc systems, in which the cell is exposed to light but 1/2,304th of a second.

Now, when the contact-arm of the commutator is started, it will first touch the contact to which the first cell of the first row is connected. The fixed condenser in that cell then discharges its energy through the circuit. The arm swings to the next contact, discharges the condenser of the second cell, and continues along the line. When the 48th cell of the first row has been discharged, the first cell of the second row is contacted and so forth, down the lines.

As the arm revolves at the rate of 900 revolutions per minute, the whole bank of 2,304 photoelectric cells, or rather their associated condensers, is discharged in one-fifteenth of a second. The stream of 2,304 impulses from the condensers flows into the amplifier practically as a continuous current, varying in amplitude in accordance with the potentials of the condenser charges at the instant the contact-arm passed over the respective contacts. The process keeps repeating itself, fifteen complete streams of current, representing fifteen images, being transmitted during one second.

At the receiving end these impulses are picked up, amplified, detected and amplified again, just as if they were regular radio signals from a disc-television system. The energy from the local audio amplifier is

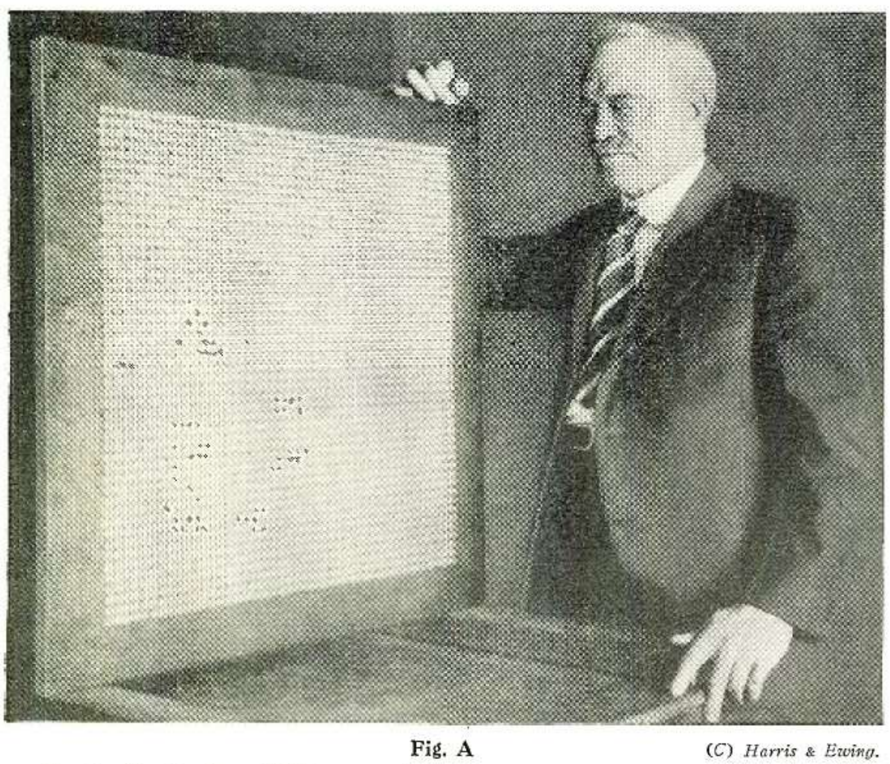

Fig. A (C) *Harris & Ewing.*

Mr. Jenkins is shown holding one of the receiving frames, which is studded with small lamps so close together that they produce a complete image at a short distance. Their light will be sufficient to cover a moving-picture screen.

led to the two input wires, running to the commutator and the common side of the flashlight lamps.

HOW THE LAMPS WORK

Suppose that, at the very instant the contact-arm at the transmitter touches the contact of photoelectric cell No. 1 of row No. 1, the arm on the receiver's commutator touches the contact for lamp No. 1 of row No. 1 on the receiving board. This lamp will immediately light up, to a degree depending directly on the amount of light falling on the corresponding cell at the transmitter. The arms move 1/2,304th of a revolution, and actuate the second photoelectric cell and flashlight lamp, respectively. This lamp flashes. The process continues until all 2,304 lamps have been lighted (in the time of 1/15th of a second), and then it repeats itself.

It so happens that a flashlight bulb will stay illuminated for just about 1/15th of a second after the current through it has been turned off. From this fact it can be seen that the first lamp is still burning when the current to the last one has been turned off; in other words, all 2,304 cells glow together, and present, in graduations of light, an image which is a reproduction of the one on the transmitter's analyzing board during that same 1/15th of a second. This persistence of the light is a second important factor in the operation of the Jenkins system.

Of course, at the end of the first 1/15th of a second, the contact arms begin their second revolution. The first lamp of the first row, which has just about died out, is again operated, and the light for the second image is built up. The process being continuous, the images appear on the screen at the rate of 15 per second,—a rate only one picture per second slower than the rate at which "movies" are unreeled. If the observer stands at a sufficient distance, from the board, the lamps on the latter will lose their identity as separate sources of light, and the image will appear in its natural shading. It may be cast by lenses on a large screen.

THE RADIO "MOVIE"

"Actual tests of the fundamental mechanisms involved have convinced us," says Mr. Jenkins, "that we have more available light than is now employed in theatres for illuminating the picture screens. And the light is white light, not neon-pink; and fortunately the light source is readily available in the open market."

In explaining the operation of his apparatus, Mr. Jenkins stated:

"In the art of transmitting pictures electrically, the accepted plan is to *synthesize* (build up) as well as *analyze*, the picture surface in a *linear* consideration of successive elementary areas of the surface. For example, if the picture surface is divided into forty-eight horizontal lines, each of these lines is assumed to be divided into elementary areas for the whole picture surface.

"If the reception of the picture takes five minutes to be completed, obviously a recording surface must be employed; for example, a photographic film or plate, an electrolytic (chemically treated) paper or a plain piece of paper which ink or other means of coloration is used. However, if the speed of completing each picture is reduced to one-fifteenth of a second, and repeated every fifteenth of a second, no recording surface is needed; for, because of the persistence of vision, the picture can be assembled directly on the eye, and radio-vision, radio "movies" and television are accomplished facts.

"The picture scanning mechanism employed by Nipkow in a telegraphic device in 1884, and by others since, consists of a rotatable disc with, say, forty-eight miniature apertures therein, the diameter of each aperture being about 1/48th of the length of the scanned line, or 1/2,304th part of the whole scanned area, and conveniently termed the 'elementary area' of the image surface.

HOW THE DISC WORKS

"As each aperture in the disc lies on its particular one of forty-eight such radii, and each aperture is located, by approximately its own diameter, nearer than its neighbor to the axis of the spiral, it will be seen that, when the disc is rotated, the locus of each aperture in succession produces a linear scanning of the whole picture area. Because this scanning disc limits the illumination to the light which can pass through a single one of these tiny holes, a powerful source of light is required for adequate lighting; just as it is required for a pinhole camera, to which the apparatus is comparable."

This light limitation is overcome in the picture-board of Mr. Jenkins, which employs 2,304 cells instead of a single cell as in one disc system, or three or four cells, as in the systems now in general use at stations like WGY, WRNY and W2XAL, W1XAY, WIBO, WMAQ, etc. The switch gear reduces the 2,304 wires from the cells to virtually a single connection, and makes the application of the board to a standard radio transmitter a comparatively simple matter.

The frequency band covered by this system is not any wider than that covered by a 48-hole disc driven at the same scanning rate, 15 pictures per second. The actual figure is about 10,000 cycles, depending on the particular subject being televised. The width of this band will, of course, prevent the application of the system to the regular broadcast band, but not to the short waves.

Such a system may be used to receive images from a 48-hole disc, as well as those from the cell frame described. So far as the reproducer is concerned, the signals from both types of transmitters are alike if speeds are the same.

The idea of mounting a great number of small photoelectric cells on a board for analyzing a scene for electrical transmission is not new. In fact, Mr. Jenkins himself suggested the scheme more than thirty years ago; but at that time it was impracticable because of the lack of suitable photoelectric cells, for one thing, and the necessity for thousands of connecting wires between transmitter and receiver. At that time the practicability of wireless telegraphy itself had just been demonstrated, broadcasting was undreamed of, and the vacuum tube, then containing but two elements, only an electrical toy. With the development of the art, Mr. Jenkins is now realizing what was once a mere dream.

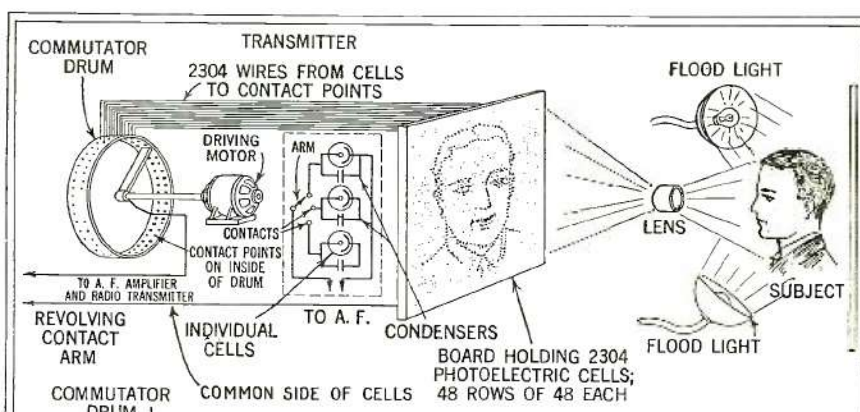

Fig. 1

The Jenkins multiple "camera" is shown above. The image of the subject is not "scanned," but kept continually on all the little cells, each of which charges its condenser in proportion to the light it is receiving. These charges are collected by the commutator and converted into impulses, later impressed in the same order on the receiver, shown below; so that each lights the lamp corresponding to its photoelectric cell. The lamps have also a persistence of illumination after the current has been turned off each, thus holding the image almost continually.