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The design of a complete television system‡

By C. E. HUFFMAN*

THE television system about to be described is a partial answer to an outstanding problem.

That problem is to provide a means by which visual representations may be sent broadcast from one point and received at many others. Several methods might be used in solving this problem.

It is conceivable that some combinations of lenses or mirrors might be arranged whereby this broadcast could be effected by purely optical methods.

By purely optical methods we mean the linking of an observer with an observed object by light from that object directly and without the interposition of any auxiliary system of transmission.

It is understood, of course, that lenses or mirrors would only modify the direction of light and would therefore not introduce any new system.

A purely optical system would be dependent upon atmospheric conditions and its operation would presuppose the absence of intervening obstructions. Its many other limitations are quite evident and the broadcasting of visual presentations by optical means alone is obviously impractical.

It is necessary then for the practical solution of the problem to provide some auxiliary system interposed between the observer and the observed to effect visual broadcasting.

A system, electro-mechanical in nature, has been devised and today visual broadcasting is being effected by interposing that system between the observer and the observed.

A simple optical system includes a source of light, an object to be viewed, light given off by the object, an eye to intercept some of this light and a nervous system wherein would be created the sensation of seeing.

That is, in order to be seen an object must give off light. This light may emanate from the object itself or from another source and be reflected by the object. The object radiates this light, some of which reaches the eye of an observer. Entering the eye it falls upon thousands of sensitive nerve ends stimulating them to send pulses to the brain. The brain integrates these pulses into a sensation peculiar to that object and forms a vision of it.

A television system includes a light sensitive device and an electrical circuit interposed in the path of the light waves to convert them to electrical waves which may be transmitted with greater facility. It also includes a device for reconverting the electrical waves to light waves at the receiving end.

Photocell

A device called a photoelectric cell is placed in the path of the light from the object. This cell allows current to pass in proportion to the amount of light falling upon it. More light more current and vice versa. This current is amplified and transmitted to the other end of the circuit where it excites a lamp to give off light in proportion to that intercepted by the photoelectric cell. Now, it is evident that if the light from all parts of the object were allowed to strike the photocell at one time the lamp at the other end of the

‡*Presented before the Club, April* 8, 1931.
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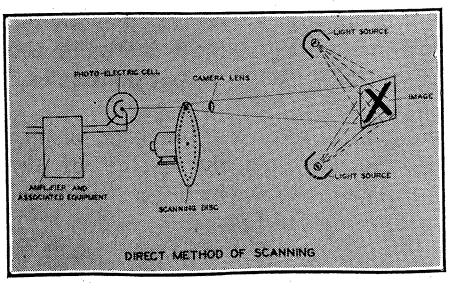

Fig. 1. Direct method of scanning.

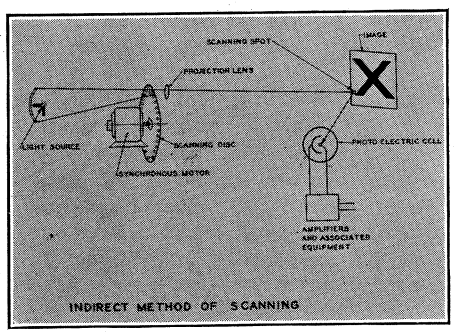

Fig. 3. One method of reduction of apparent brilliancy of light.

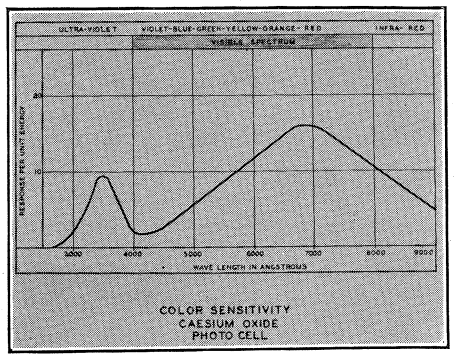

Fig. 2.

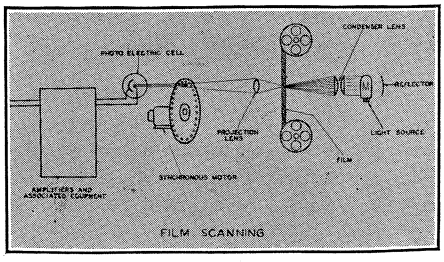

Fig. 4. Scanning motion picture type film.

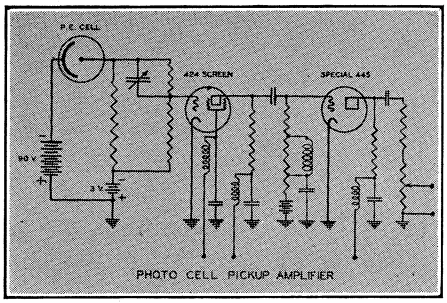

Fig. 5. Schematic of photocell amplifier.

circuit would light with an intensity proportional to the overall brilliancy of the object. Therefore, no details of that object would be transmitted and it is necessary to scan the object a step at a time and view the light at the receiving end so that light from it reaches the eyes from the same angle as it would if the object were being viewed directly.

The explanation of how this is done has been given so often that it will not be gone into here.

The purpose of this paper is rather to describe the component parts of a television system and show their relation to each other.

Referring to Fig. 1 we have what is known as the direct method of scanning. Here the entire object to be viewed is illuminated by light which reflects into the photocell. A lens collects as much of this light as possible and passes it through a hole in the disc a unit at a time in rapid succession. The photocell delivers current to the amplifier in proportion to the amount of light reflected from the successive units.

As only a small part of the light

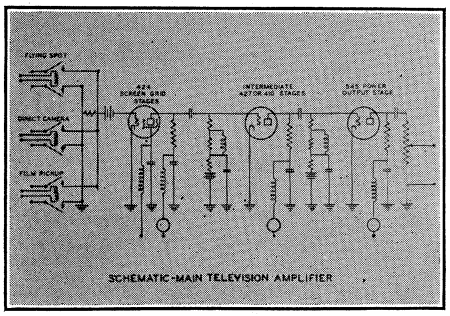

Fig. 6. Simplified schematic of amplifier.

thrown on the object reaches the hole in the disc, it is necessary that the object be illuminated strongly over its entire surface.

As shown in Fig. 2 the photocells in use are sensitive to invisible light as well as visible and by the use of proper filters a subject being scanned is unaware of the intensity of light thrown upon him.

It is possible, however, to reduce the apparent brilliancy of visible light by the method shown in Fig. 3. In this method the scanning disc is placed between the light source and the object so that only a small portion of it is illuminated at one time. The illumination can therefore be much more intense without causing discomfort when a person is being scanned. Also the photocells may be placed closer to the object and thus pick up more reflected light.

Motion picture films are scanned as shown in Fig. 4. Here the light passes through the film to the scanning disc. The holes in the disc allow light from each unit area to affect the cell in succession as in the other methods.

The discs shown rotate at a speed of 1200 r.p.m. and scan the object 20 times per second. There are 60 holes around the circumference of the disc so that the picture at the receiving end appears as an image constructed with 60 lines.

Scanning at this speed will cause the photocell to release currents varying at

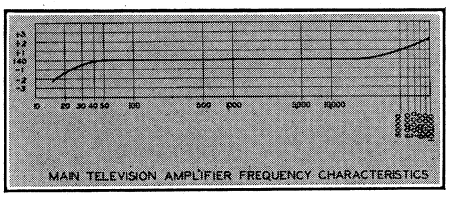

Fig. 7. Frequency characteristic of main amplifier.

a rate as high as 43,000 cycles per second.

Fig. 5 shows a schematic circuit of the amplifier associated with the photocell in each of the pickup scanners.

The network shown between the photocell and the grid of the first tube serves to equalize the response to varying rates of light fluctuation. The network shown at the grid of the second tube tends toward uniform transmission of the desired frequencies.

A special 445 type Audion is used in the output circuit so that signals are fed through a 75-ohm line to the main amplifier without undue attenuation at the higher frequencies.

Fig. 6 is a simplified schematic of the main amplifier which supplies signal to the modulator grids in the radio transmitter. Incoming lines remotely controlled by relay connect any of the photocell amplifiers to the input of this amplifier. One pickup may be faded out as the other is faded in.

Fig. 7 shows the frequency character-

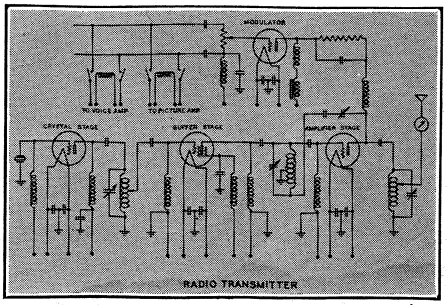

Fig. 8. Radio transmitter of 250 watts output.

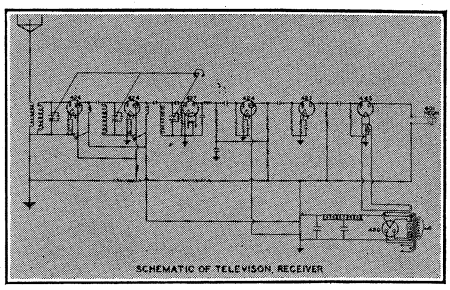

Fig. 9.

istic of the main amplifier. As shown the amplifier has an overall gain of 140 db. plus or minus 2 db. from 15 cycles to 80,000.

Fig. 8 is a schematic of a radio transmitter having 250-watts output. A crystal oscillator excites a radio-frequency amplifier through a screen-grid buffer stage. The output of the r-f. amplifier is modulated by a water cooled modulator controlled by the output of the main picture amplifier just shown.

A separate speech amplifier may be connected to modulator grids for station announcements.

At W2XCD in Passaic sound is broadcast with the television programs over a standard deForest radiophone transmitter located adjacent to the television transmitter. No cross talk is experienced when these transmitters are operated simultaneously. The picture

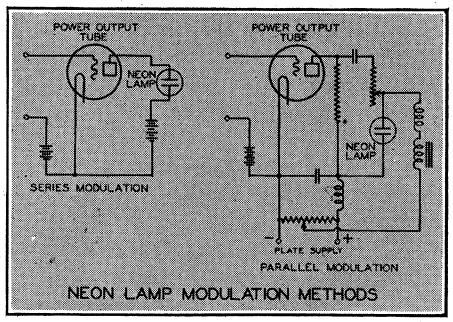

Fig. 10.

transmitter operates on a frequency of 2050 kc.; the sound on 1604 kc.

Changeover from one sound and picture pickup to another is effected by relays operated from a central control panel. Signal lights indicate in the studio and at the control panel just which pickup is connected with the transmitters and signal lights in the studio indicate when transmitters are on the air.

Monitor receivers for both picture and sound allow the quality of the transmission to be checked and adjusted from this control panel.

Fig. 9 shows the schematic circuit of the radio receiver used in picking up the picture transmissions. This consists essentially of four unit parts assembled as a whole.

The first is a power unit which provides power for all filament, plate and grid voltages as well as neon lamp current.

The second unit consists of two screen-grid audions operating between three tuned circuits to select and amplify the desired signals without discrimination against the side frequencies.

The third unit is a detector which recombines the carrier and side frequency to produce the picture frequencies at its output.

The fourth unit is a resistance capacity coupled amplifier for building up the level of these frequencies sufficient to supply the picture reproducer or radiovisor.

No attenuation of picture frequencies occurs between 50 cycles and 20,000 cycles. At 20 cycles and at 50 kilocycles the attenuation is 4 db.

Fig. 10 shows two methods of connecting the output of the radio receiver to the neon lamp. The usual arrangement is to connect the neon lamp in the plate circuit.

A more desirable arrangement is to by-pass the plate current of the output tube through an impedance and operate the neon lamp in parallel, as shown. The signal level and the biasing current through the lamp may then be varied by means of series resistors without affecting the characteristics of the output amplifier appreciably.

SUGGESTIONS TO CONTRIBUTORS

CONTRIBUTORS to the Proceedings, by bearing in mind the points below, will avoid delay and needless expense to the Club.

1. Manuscripts should be submitted typewritten, double-spaced, to the Chairman of the Papers Committee.* In case of acceptance, the final draft of the article should be in the hands of the Chairman on or before the date of delivery of the paper before the Club.

2. Illustrations should invariably be in black ink on white paper or tracing cloth. Blueprints are inacceptable.

3. Corrected galley proofs should be returned within 12 hours to the office of publication. Additions or major corrections cannot be made in an article at this time.

4. A brief summary of the paper, embodying the major conclusions, is desirable.

5. The Club reserves the right of decision on the publication of any paper which may be read before the Club.

* For 1931 the Chairman of the Papers Committee is Mr. F. X. Rettenmeyer, 463 West Street, New York City.