Television Comes to the Home

by G. C. B. Rowe

BACK a few years—and not so very many at that—it was said that but one human faculty could jump in a fraction of a second from one end of the earth to the other—the imagination. Up to a comparatively short time ago this was true; but, with the advent of radio broadcasting as it is known today, it became possible practically to annihilate the limitations of space, with respect to sound. Is it now considered marvelous when a singer is heard, three thousand miles distant? Indeed, no; the listeners take it as a matter of course, as they do the other wonderful inventions in daily use.

But until very recently it was still up to the overworked imagination to picture the appearance of the performer who was broadcasting. In some cases this may have been for the best; as the imagination is a wonderful artist, and produces often beauty where beauty is not. But, for better or for worse, thanks to the further developments made by Dr. E. F. W. Alexanderson in the art of television, what actually occurs in the broadcast studio can now be seen by the radio audience.

At the top of the page, tuning the television receiver: the image is seen through the small square opening on a level with the operator's eyes. Notice the broadcast receiver and loud speaker. At the left, Fig. D, shows the rear of the receiver: one man is pointing out the universal motor, which drives the scanning disc. Above the motor is the Moore neon lamp. On the lower shelves are batteries and the amplifier and rectifier tubes. Dr. E. F. W. Alexanderson is seen at the left in each illustration.

Although the picture as seen in the television receiver appears no more than three inches square, and there are instants when it is obliterated by static or some other interference, the remarkable part of the story is that the device worked at all. Every so often, during the last few years, enthusiastic articles have appeared, telling how television is rapidly becoming a reality instead of an engineer's dream. But these fulfillments of dreams were in laboratories; now television has been carried to the home.

TELEVISION DEMONSTRATION

In one corner of a vast room in the General Electric Company's research laboratory at Schenectady, N. Y., a few days ago, were set up an arc light, a rapidly-revolving metal disc, four photoelectric cells in a frame, and several boxes. Just around a corner a group of men were gathered in a room totally dark, save for two squares of pinkish light about three inches square. These two squares of light were the cynosure of all eyes; these pinkish squares were what many of the men in that room had travelled hundreds of miles to see; for they were the proof that television in the home is no longer a dream, but an actual fact.

A young woman was seated before the bank of photoelectric cells, with narrow bands of light and shadow playing across her features. She smiled, frowned, rolled her eyes, and smoked a cigarette—and all these actions were instantly and faithfully pictured in the little squares of pinkish light in the adjoining dark room. At the same time, the conversation which she kept up with one of the operators came into the dark room through a loud speaker. Then her place was taken by a young man with a ukelele and, although the instrument was invisible (being below the line of vision of the transmitting apparatus), his voice and the music came from the loud speaker as his face appeared in the magic squares.

The question will present itself naturally to the reader's mind: *"How well* did these faces come over the air?" It was possible to see every detail in the features, the individual teeth, for example; when the eyes were rolled, one could follow with ease the movement of the pupils. In short, the transmission of faces by radio can be compared in quality to moving pictures in their earliest days.

In three homes in different sections of Schenectady, similar television receivers had been installed to show that reception in the home is possible and practicable. A short antenna was employed to pick up the 37.8-meter wave on which the television impulses were broadcast. The results obtained in the homes were of the same excellence as those demonstrated in the laboratory.

THE ELECTRIC EYE

The transmitting apparatus for broadcasting television is not very complicated, as can be seen from Figs. A and B, which show the pick-up. In the left foreground of Fig. A is a powerful arc light, the rays of which are broken up by the spirally-arranged holes in the disc, which is rotating at the rate of eighteen revolutions per second, being driven by a small motor. The light rays are concentrated and focused on the face of the girl by means of the lens held in the square wooden support. See Fig. B.

After the rays of light from the arc have been broken up by the revolving disc and focused on the face of the subject (where they appear to the camera as a series of light and dark lines; see Fig. C), they are reflected from the surface of the face to the four photoelectric cells in the thick, square frame of galvanized iron. These possess the property of changing light energy into electric energy. (These cells were described on page 640 of the December, 1927, issue of Radio News; previous television experiments will be found described in the June, 1927, issue.) The output of these cells, after being amplified, modulates the carrier wave of the 37.8-meter transmitter, the antenna of which is located on the roof of the research laboratory. In Fig. B may also be seen at the right of the table the condenser microphone for picking up the voice, which was simultaneously broadcast on WGY's regular wave of 379.5 meters. A very short wavelength was chosen for broadcasting these "pictures" because a channel 40 kilocycles wide is needed; this is because of the depth of modulation necessitated by the great range of differences in shading, which must be reproduced in the transmission of vision.

THE ELECTRIC PAINTBRUSH

The average radio enthusiast is most likely much more interested in the apparatus for reception than in that just described. Compared with the television receivers that have been described in this magazine previously, the latest one is simplicity itself. In place of the loud speaker, a Moore neon tube is connected in the output of a short-wave receiver of the regenerative type. The most interesting property of the neon lamp, which was invented by D. McFarlan Moore (as related in Mr. Moore's biography, "Thirty years in the Dark Room," which appeared in Radio News, from December, 1925, to May, 1926), is that it responds to the changes in intensities of the current and causes fluctuations in the intensity of the emitted light; just as the diaphragm of a loud speaker produces pulsations in the air in response to alternating-current impulses. It is said that this lamp will go on and off in a millionth of a second; so that in its

D. McFarlan Moore (left) and E. F. W. Alexanderson discussing the neon lamp used in the television receiver

use there is none of the "time lag," which is the greatest problem those working in television have had to meet.

The plate of the Moore tube, on which the image is built up, is about 1½ inches long and 1 inch wide. The scanning disc, which can be seen in front of the lamp in the rear view of the apparatus (Fig. D), is of the same size as that used in the transmitter, 24 inches in diameter. The 48 holes (which have a diameter of 35 mils each—or about 1/30-inch) trace successive lines on the picture, literally "painting" it in one revolution. The disc is turned by a standard "universal" motor; which is to say that it can be operated from either direct or alternating current. The speed of this motor and, therefore, of the disc, is controlled by a push-button. In order to enlarge the image as much as possible, a magnifying lens is placed between the scanning disc and the observer's eye; thus bringing the image up to 3 inches square.

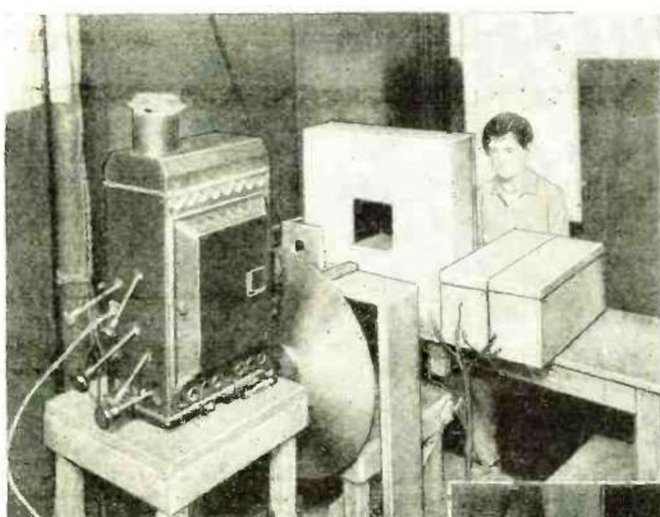
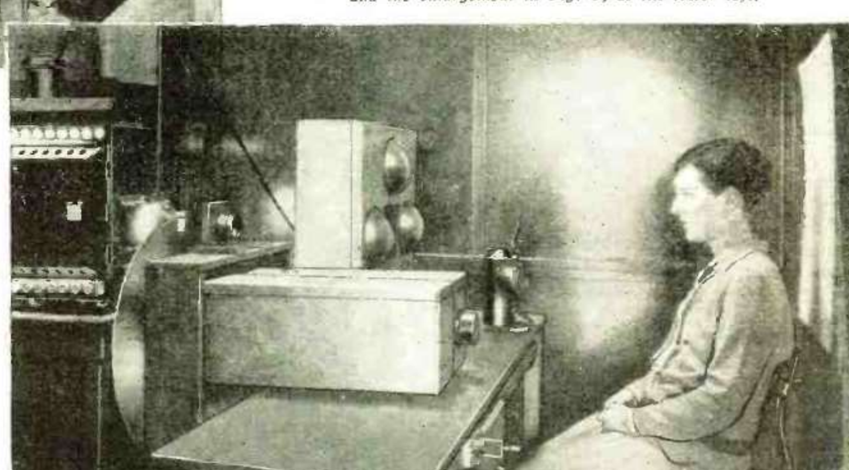
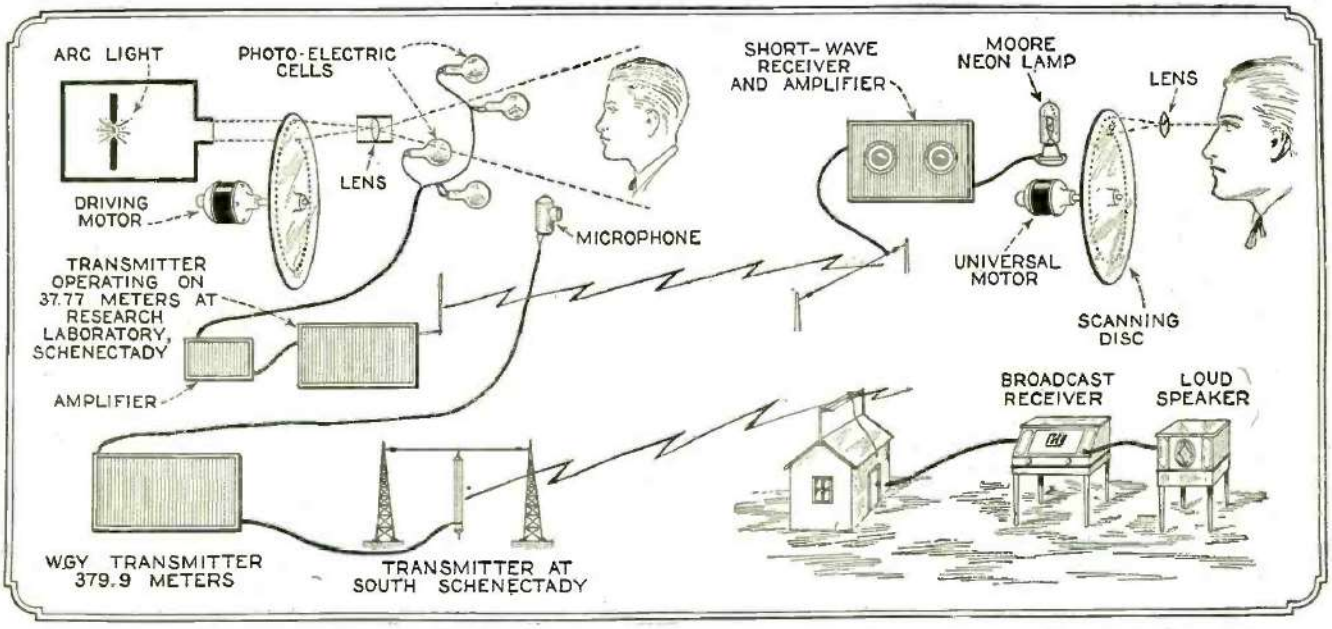


Fig. A at the left and Fig. B below show the relative positions of the apparatus used in transmitting by radio the image of the girl. In Fig. A the arc lamp is at the left and, between the revolving disc and the square frame holding the photoelectric cells, is the small square wooden holder carrying the lens. The amplifier is in the two boxes at the right. The grouping of the photoelectric cells is shown in Fig. B below, three being visible and a fourth behind the amplifier boxes. Note the microphone at the right and the lines of light and shadow on the girl's face in Fig. B; and the enlargement in Fig. C, at the lower left.





A diagram of the Alexanderson method of operation in the transmission and reception of television. At the upper left are the transmitter for the image and the microphone for the voice, which is broadcast on a different wavelength. At the right are the receivers for television and speech.

SYNCHRONIZATION BY HAND

In most of the television receivers built heretofore, there has been employed some automatic means of synchronizing the receiver with the transmitter; such as the broadcasting of a certain frequency that would make two motors run at exactly the same speed. In Dr. Alexanderson's system no such complicated method of synchronization is employed; the simple and only speed control is a push-button that varies the speed of the universal motor turning the disc.

When the receiver is first started the speed of its motor is far below that of the one at the transmitter, and the resultant image is a straight line of light. As the motor is brought nearer and nearer to synchronous speed, this line of light breaks up into a series of parallel lines, slanting first one way and then the other. Then there appears a distorted image of a face, again breaking up into splotches of light and dark. Finally, when the two motors are running in synchronism, a true image may be seen on the lens. This image constantly shifts from one side to the other, as the speeds of the two motors vary; but this shifting from side to side does not interfere with the reception, as the movement can be made to be very slow.

Here it is that the operator must exercise his skill, in keeping the received image as near the centre of the lens as possible. This is done by "whipping" the motor; *i.e.*, sending an electric impulse to the motor by means of the push-button, and thereby increasing the speed. This is far from being a difficult feat, as it requires no more skill than steering an automobile along a road. Sometimes, when the two motors get slightly out of synchronism, the lower half of the image may be above the upper; so that a man's collar and tie may be seen above his head. This condition can be easily adjusted, however; just as a like condition is remedied by the motion-picture operator when the picture gets out of its "frame."

In the lower part of the cabinet, which (as may be seen) is about the same size as that which houses an ordinary talking machine, is an amplifier with two rectifier tubes. A storage battery and dry-cell "B" batteries for the short-wave unit are on a shelf over this amplifier, which utilizes A.C. house current. By the use of a universal motor and the rest of the equipment as mentioned above, it may be easily seen that the television receiver is one that can be used in almost any home; the only provision being that 110 volts of either A.C. or D.C. be available.

NEW DISCOVERIES IN RADIO

When introducing his apparatus in preparation for the demonstration, Dr. Alexanderson mentioned the fact that he expects television to have within five years the same status that voice transmission has today. Of course, there are still a number of "bugs" that have to be eliminated before the apparatus can be put on the market for general use; but, considering the rate at which television engineers are progressing in their work, the time is approaching rapidly when it will be possible to see as well as hear the artists as they appear in the studio. (*Continued on page 1156*)

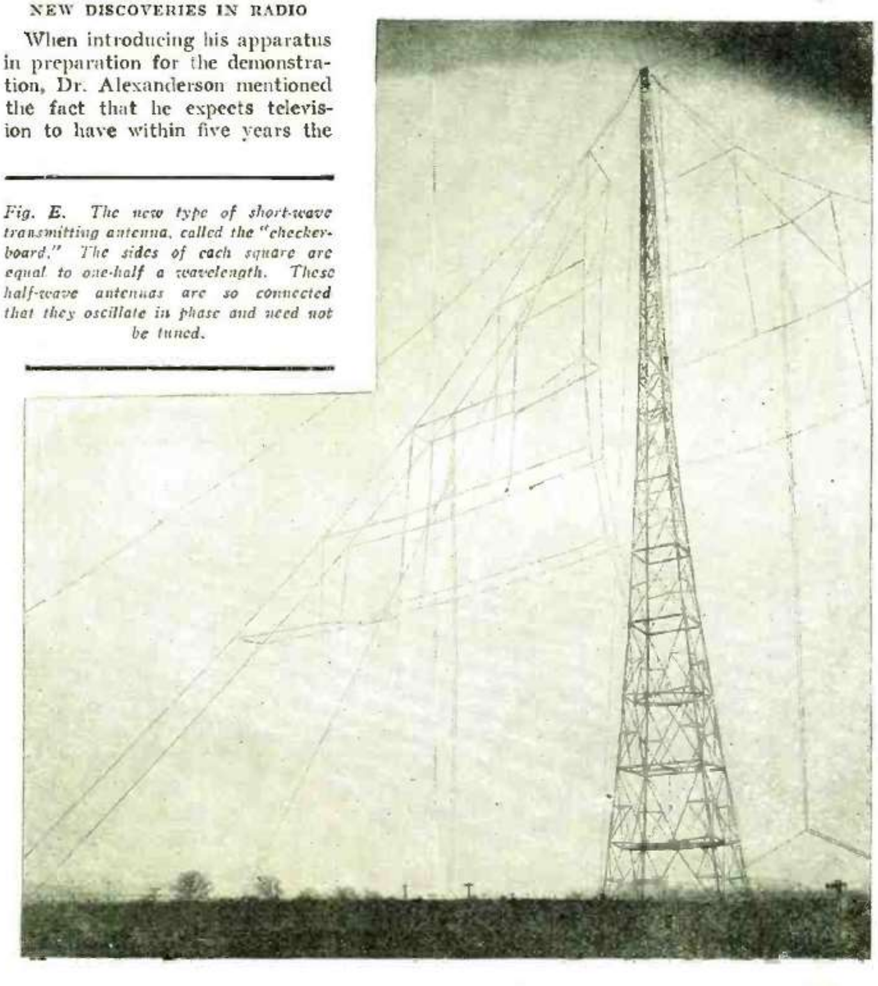


Fig. E. The new type of short-wave transmitting antenna, called the "checkerboard." The sides of each square are equal to one-half a wavelength. These half-wave antennas are so connected that they oscillate in phase and need not be tuned.

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But there is another side to the story. In studying radio reception, as we know it today, static, interference and fading are factors about which very little is known. These are also present in television, but instead of being audible they are *visible.* Not only that, but the eye is more sensitive to differences in shading and minute changes of position than is the ear to differences in sounds. For that reason, the study of the problems of transmission will be made much more effective by the use of television apparatus.

In television "static" appears on the screen as black splotches, which momentarily blot out the image. "Fading," such as that experienced in voice transmission, results in, literally, the gradual fading out of the image on the lens. When the receiver is oscillating or "squealing" the image has more contrast; *i.e.,* the shadings and shadows become a dead black with a corresponding lightening of the "high lights."

Another interesting part of radio transmission, which is brought out by television, is the "echo image." This condition is evidenced on the lens by a *double image, i.e.,* the appearance of a perfect secondary image beside the fundamental image, and almost as strong. This occurs only under certain weather conditions and is believed to be a visible "echo" of the wave due to vertical reflection from the electronic layer of the upper atmosphere. The echo image is usually displaced on the lens to a distance corresponding to a delay of ***one fifteen-hundredth of a second;*** showing that the echo wave had travelled about 124 miles and yet was nearly as strong as the other, which had only travelled a few miles. Obviously such phenomena as this could never be detected by the ear.

A NEW TYPE OF ANTENNA

Experiments in the fields of television have brought about a new type of antenna, which is illustrated in Fig. E. From the arrangement of the wires it has been named a *checkerboard* antenna; the sides of each square being equal to half a wavelength. All these half-wave antennas are connected in such a way that they oscillate *in phase* and require no tuning.

The checkerboard antenna is ***not*** a beam antenna, although all the energy is projected in the general direction toward which it is desired to transmit. The angle at which the antenna is arranged is of great importance; for example, the one shown in Fig. E is intended for work with San Francisco and the left side of the illustration is toward the west.

As mentioned previously in this article, there are still many mechanical and electrical obstacles that must be overcome before television apparatus, such as that illustrated here, can be available for ordinary home use. But the important thing is that it is at present a reality, and no longer merely an engineer's dream. In three homes in Schenectady today television receivers stand beside the regular broadcast receiver and, although members of the families at present have to crowd a bit to ***see*** what is coming over the air, yet the time surely is not far distant when they will be able to sit comfortably before the television receiver and see with the same ease as they hear today.

There certainly can be no doubt that we are on the threshold of a new era. Television has been demonstrated several times before in this country and abroad; but now it has been brought into the home in a manner that can be readily comprehended and by apparatus simple enough for the average man, who is not mechanically inclined, to operate. And that is a real step forward. Although it is the technical man and the experimenter who have made radio what it is today, the layman—who is typical of the great majority of radio enthusiasts—is the one to be pleased and catered to in the perfection of radio utilities.

A Novel Automatic Volume Control

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while with a "voltage-squared" detector, the average rectified voltage is proportional to the average total power of carrier and side-bands. This last feature is worthy of mention in connection with the control system; since the automatic grid bias should depend on only the carrier amplitude, independent of the modulation.

With the circuit constants shown in Fig. 1, the time constant of the circuit which connects the rectifier to the grids of the control tubes is 1/40 second; so that the control system comes nearly to equilibrium in 1/20 second. This time can be reduced further if necessary, but is ultimately limited by the allowable reduction of the signal modulation at the lowest audio frequencies.

In consequence of the automatic control action, it becomes difficult to tune the receiving set accurately by ear to a desired signal. The amplification is decreased as the response to the signal is increased by tuning, and *vice versa;* so that the point of resonance is indicated by minimum plate current in the radio-frequency amplifier. Taking advantage of this fact, a milliammeter (MA, Fig. 1) is connected in the plate circuit of the first tube, to be used as a resonance indicator, and also to give an indication of relative signal intensities.

USE OF "B" UNIT

There is an incidental problem in supplying the plate current to all tubes of the set described, from a common rectifier-and-filter