TELEVISION *Through a* CRYSTAL GLOBE

New Cone-shaped Tube Reproduces 4 x 5-Inch Picture, Is Quiet in Operation and Does Away With Need of Mechanical Parts in Home Receiver

By V. Zworykin

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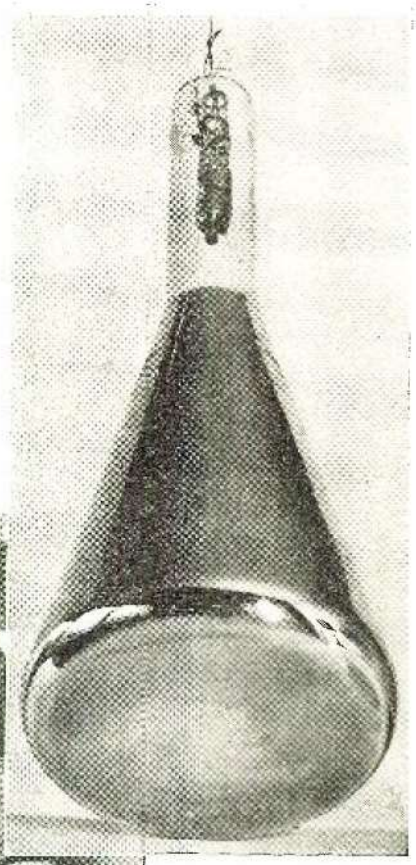
THE problem of television has interested humanity since early times. One of the first pioneers in this field, P. Nipkow, disclosed a patent application in 1884 describing a scanning of the object and picture, for which purpose the familiar perforated disk was employed and at present the rotating disk is giving excellent results within the mechanical possibilities of our time. The cathode-ray tube, however, presents a number of distinct advantages over all other receiving devices. There is, for example, an absence of moving mechanical parts with consequent noiseless operation, a simplification of synchronization permitting operation even over a single carrier channel, an ample amount of light for plain visibility of the image, and indeed quite a number of other advantages of lesser importance. One very valuable feature of the cathode-ray tube in its application to television is the persistence of fluorescence of the screen, which acts together with persistence of vision of the eye and permits reduction of the number of pictures per second without noticeable flickering. This optical phenomenon allows a greater number of lines and consequently better details of the picture without increasing the width of the frequency band.

This paper will be limited to a description of an apparatus developed in Westinghouse Research Laboratories for transmission by radio of moving pictures using the cathode-ray tube for reception.



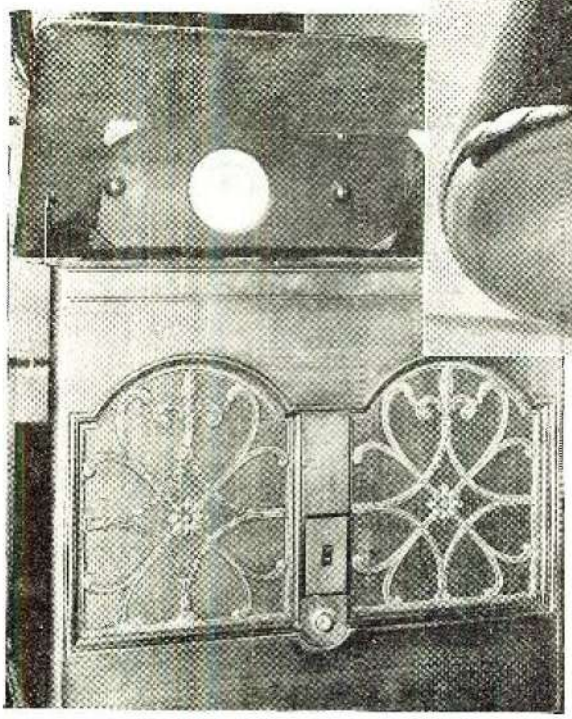


Fig. 1 (above)—A cathode-ray tube—the heart of the Zworykin receiver. Fig. 2 (left)—One type of cabinet receiver housing the Zworykin apparatus

In the author's opinion, if a receiver is to be developed for practical use in private homes, it should be designed without any mechanically moving parts. The operation of such a receiver should not require great mechanical skill. This does not apply to the transmitter, since there is no commercial difficulty in providing a highly trained operator for handling the transmitter, which consists of a modified standard moving (*Continued on page* 949)

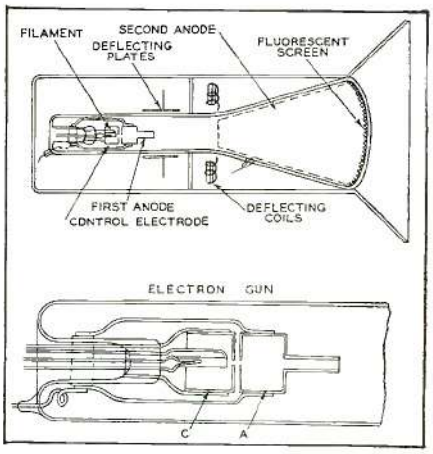
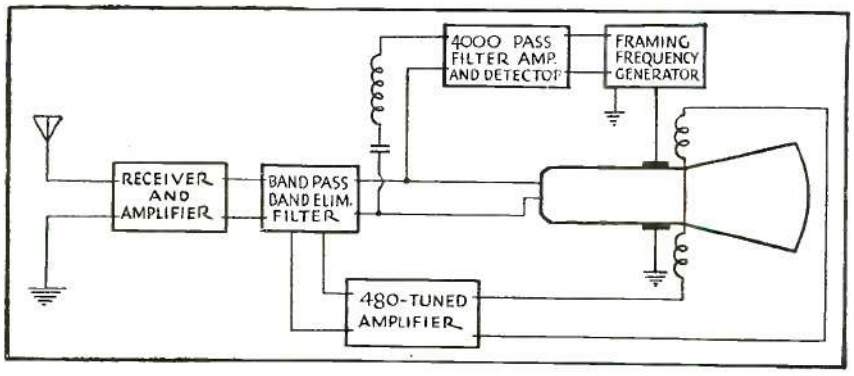


Fig. 3 (above)—Cross-sectional view of cathode-ray tube, including an enlarged drawing of the electron gun. Fig. 4 (left)—Diagram of the band-pass filter which divides the local receiver output into the picture and synchronizing frequencies



Tune In as You Travel

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to get consistent radio reception. This will also offer a means whereby recorded talks describing hotels and points of interest along the company's right-of-way can be featured.

To provide the alternating current necessary a special motor-driven unit is used.

Each radio-equipped car is fitted with headphones for each traveler in addition to a loud speaker for use when required.

Specially arranged programs for train reception are a feature of the Canadian National Railways broadcasting. These include brief summaries of the news, market quotations and baseball scores.

Current Comment

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development of radio receivers for automobiles, which are just about reaching perfection. It is the desire of these corporations to have their equipment available for the radio automobile market this summer. It is not my purpose to enter into any public argument with you concerning the desirability of automobile radio equipment, but I shall be very pleased to wait upon you at any time you see fit, in order that we may have a chat about this situation and in the meantime, merely suggest that you give some consideration to the serious-minded folks who are bending a real effort to do an outstanding service for your State as well as the others in our country without first letting them present their case to you.

Sincerely yours,
ARTHUR H. LYNCH,
Editorial Director.

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picture projector, at the broadcasting station.

The receiver consists of a cathode-ray tube especially designed for this purpose. The principles of the cathode-ray tube are well known from their application for oscillographs. The low-potential type of cathode-ray oscillographs is of the sealed-off type, but the amount of light available from the screen is far too small. In order to give sufficient brilliancy for the picture of 5-inch size, the tube should operate at least at 3,000 volts. For larger pictures still higher voltage is required, since the brightness increases with the accelerating voltage. According to these requirements, a new type of cathode-ray tube was developed. This is shown in Figs. 1 and 3. An oxide-coated filament is mounted within a controlling electrode, C. The cathode beam passes through a small hole in the front part of the controlling element and then again through a hole in the first anode, A. The first anode accelerates the electrons to a velocity of 300 to 400 volts. There is also a second anode consisting of a me-

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tallic coating on the inside of the glass bulb. This second anode gives to the elyectrons a further acceleration up to 3,000 or 4,000 volts. The velocity of the electrons at this is about one-tenth that of light. An important function of this second anode is also to focus electrostatically the beam into a sharp spot on the screen. The target wall of the bulb is about 7 inches in diameter and is covered with a fluorescent material such as willemite prepared by a special process so as to make it slightly conductive. Conductivity is required to remove the electrical charges from the screen supplied by the electron beam. This tube will be referred to hereafter in this paper as the kinescope.

The beam of electrons can easily be moved across the screen either by an electrostatic or an electromagnetic field, leaving a bright fluorescent line as it passes. For this purpose a set of deflecting plates and a set of deflecting coils are mounted on the neck of the kinescope, outside the tube. The plates and coils are adjusted in the same plane, so as to give vertical and horizontal deflection at right angles to each other. As a result of the location of the deflecting elements between first and second anode, the deflecting field is acting on comparatively slowly moving electrons. Hence the field strength required is much less than that which would ordinarily be used to deflect the beam under the full acceleration of the second anode voltage.

The brightness of the line can be controlled to any desired extent by a negative bias on the controlling element. The bias controls the mean intensity of the picture whose lights and shadows are superimposed upon this mean intensity. It is evident that if we apply to this controlling electrode the amplified impulses from the transmitter and at the same time deflect the beam in synchronism with the motion of the light beam across the picture on the film, the picture will be reproduced on the fluorescent screen. Fig. 2 shows a general view of one type of receiver.

If separate channels are available for each of the synchronizing signals, the problem of synchronization of the receiver with the transmitter is very simple. For horizontal scanning, it is necessary only to transmit the scanning frequency operating the mirror as a sinusoidal voltage and to impress it on the deflecting coils of the kinescope. The cathode beam will follow exactly the movement of the light beam across the film.

For the framing or picture frequency, a voltage is generated at the receiving end and merely controlled by signals from the transmitter. A condenser is charged at constant current through a current limiting device, such as a two-electrode tube, so that the voltage at the condenser rises linearly. The deflecting plates of the kinescope are connected in parallel to this condenser, and therefore, when the condenser is charging, this cathode beam is deflected gradually from the bottom to the top of the fluorescent screen at constant speed. This speed is regulated by the temperature of the filament of the charging tube to duplicate the downward movement of the film. An impulse is sent from the transmitter between pictures, which discharges the condenser, quickly returning the beam to the bottom position, ready to start upward and reproduce the next picture.

For transmission of the complete picture, three sets of signals are therefore required: picture signals, horizontal scanning frequency, and impulses for framing. It was found that it is possible to combine all of these sets of signals into one channel. In this case the photo-cell voltage of the transmitter is first amplified to a level sufficiently high for transmission. There is then superimposed upon this a series of high audio-frequency impulses lasting a few cycles only and occurring when the light beam passes the interval between the pictures.

The picture frequencies together with the framing frequencies are then passed through a band eliminating filter, which removes the picture component of the same frequency as that of horizontal scanning. Following this, a portion of the voltage which drives the transmitter vibrator is impressed upon the signals, passed through the filter, and the entire spectrum is used to modulate the radio-frequency carrier.

At the receiving station the output of the local radio receiver is amplified and divided by a band-pass band-elimination filter into two parts; one the synchronizing frequency, and the second the picture frequency plus the framing frequency. The synchronizing frequency is amplified by a tuned amplifier which supplies current to the deflecting coils of the kinescope, Fig. 3.

The picture and framing frequencies are applied directly to the control electrode of the kinescope.

The same voltage which modulates the light is impressed upon a band-pass filter, which is tuned to the frequency of the a.c. voltage used for the framing impulses. The output of this filter is amplified, rectified, and used to unbias a discharging triode which is normally biased to zero plate current, and which takes its plate voltage from the condenser which provides the vertical scanning voltage. Thus, the picture signals and both synchronizing and framing frequencies are transmitted on one channel, and fully automatic synchronization is obtained.

Those who are accustomed to the conventional scanning disk type of television notice a number of differences in the appearance of the picture as viewed on the end of the cathode-ray tube. The picture is green, rather than red (as when a neon glow tube is used). It is visible to a large number of people at once, for an enlargement by means of lenses is unnecessary. The framing of the picture is automatic, and it is brilliant enough to be seen in a moderately lighted room.

Technically, the kinescope type of receiver presents added advantages. The high-frequency motor for synchronization, together with its power amplifier, is not required. The power required to operate the grid of a kinescope is no more than that for an ordinary vacuum tube.