Photo (right): International News

Television —How Soon?

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TELEVISION IS like a promising child who is being trained for the stage, jealously guarded by her fond parents and teachers, schooled with loving care, blossoming into adolescence, throwing surreptitious kisses to the peeking public, but not yet ready for her debut.

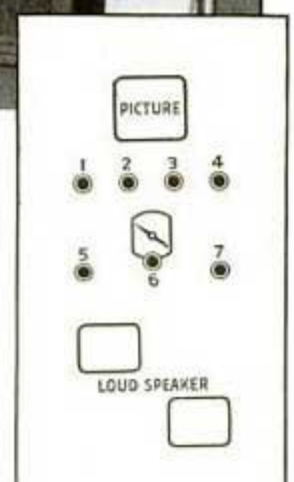
This new addition to the youthful family, surnamed Radio, reverses (as all normal children do) that old adage about children being "seen but not heard." Television is sometimes heard but seldom seen. In the ultrashort wavelength bands something that sounds like a queer kind of static can be heard with a radio set capable of tuning to that range. But it is most unsatisfactory to attempt such seeing through one's ears, and those who may chance upon the sound of television transmission will hardly appreciate it.

Among those who have the opportunity of seeing present-day television, and the number is very limited indeed even within the companies pushing forward the experimental work, there is genuine praise for the abilities of the growing child and rosy prediction of her future in the world.

Radio has progressed mightily since the first few years of the 1920's when nearly everyone was making his own receiving set out of 5-and-10-cent-store parts. Now there is no more need of building one's own radio set than there is to assemble an automobile in the basement workshop. Television has passed beyond the stage at which the

Philo Farnsworth, discoverer of a new principle in television, is here (above) tuning in on a studio dance act.

By adjusting the seven knobs (note diagram) he controls: 1, brilliance of picture; 2, pictures per second; 3, number of lines; 4, focusing of picture; 5, picture contrast; 6, sound and vision tuning; 7, sound volume.



John L. Baird, of London, England, shown (left) in a laboratory experiment in television of a decade ago.

Below: A special television camera of the British Broadcasting Co., London, which records a scene, the electrical equivalent of which is then transmitted by cable to the television transmitter, whence it is broadcast to home sets.

Photos: Wide World; International News

novice can hope to build his own. There was a time, about ten years ago, when it seemed probable that television would get its start through a "make-it-yourself" craze. But that was before streams of electrons, cathode rays to scientists, chased light beams off the television stage. That was when inventors placed their bets on the scanning disc for chopping up the scene to be translated from light into electricity, sent over wires or through space, and then converted back into light again. That was when television was mechanical and not electronic.

Cathode rays are at the heart of television today. Their great superiority arrives from their independence of moving mechanical parts and momentum in the sense that these terms are applied to ordinary machinery.

Allow me to quote from a scientific description of such a utilization of cathode rays, which can be swept over the surfaces televised and the area upon which the scene is being re-created:

"Indeed, so far as the receiving apparatus is concerned, the moving cathode beam has only to be arranged to impinge on a sufficiently sensitive fluorescent screen, and given suitable variations in its intensity, to obtain the desired result.

"The real difficulties lie in devising an efficient transmitter which, under the influence of light and shade, shall sufficiently vary the transmitted electric current so as to produce the necessary alterations in the intensity of the cathode beam of the receiver, and further in making this transmitter sufficiently rapid in its action to respond to the 160,000 variations per second that are necessary as a minimum.

"Possibly no photoelectric phenomenon at present known will provide what is required in this respect, but should something suitable be discovered, distant electric vision will, I think, come within the region of possibility."

I know that you are a bit puzzled by the rather tentative tone of "region of possibility" and perhaps, too, you noted the absence of the word "television." It must be confessed that this quotation was written 28 years ago, long before any really practical work, from our progressed viewpoint, had been done on television. Campbell Swinton, a Britisher, wrote it in a prophetic letter to the famous science journal, *Nature* (June 18, 1908).

Twenty-two years passed before Baron von Ardenne, in Germany, made use of cathode ray oscillograph tubes for the transmission and reception of images. That was only six years ago.

As so often is the case, ideas, and even fairly detailed methods of materializing ideas, are very old before the invention is ready for the public. The technologic path is steep and stony, even after the cherished goal is in plain sight.

It will surprise many to be assured that at the time Swinton wrote his letter, electric transmission of photographs had been achieved, scientifically, and it was thought that distant electric vision was an easy natural step in the development of the process! Even 30 years earlier than Swinton's letter, Ayrton and Perry worked out a system of television based upon the use of a mosaic of minute selenium cells. This is strikingly similar in basic idea to one of the pickup systems used today. One all-important difference, however, is that the modern system works and none of the early suggestions was practical.

For half a century the idea of television has teased the minds and inventive skill of the world. Successive generations have been promised the novelty of seeing afar, wherever electricity can be the eye's messenger. The quest has been lengthy but before many months have passed the public shall see the fruits of the thousands of experiments.

One curious fact about television is that there are now actually fewer stations transmitting television programs in the United States than there were in 1929. But to leave this quite unqualified would give a decidedly wrong impression.

Television then was mechanical and not electronic. It started off with a great rush of commercial enthusiasm in some quarters but, after the novelty had worn off, the quality of the image received (compared with motion pictures or present-day electronic television) was not sufficient to enlist wide-spread acceptance.

This matter of quality is extremely important. The early attempts at television were little better than the transmission of shadows or silhouettes. Then came images with real gradations of tone, but lacking in detail, equivalent to a very poor halftone of coarse screen such as might appear in a struggling, badly printed country weekly newspaper. This was about the acme of quality for mechanical television, the images of which were formed of some 60 lines.

Below: German television receiving sets reproduce the "news" at the instant it occurs, through this camera.

Photos: Arme

Above: This television set attracted much attention at a recent radio show in Paris.

Motion pictures become a very simple achievement when contrasted with the requirements of television. In the movies about 24 (at least 16) successive photographs are projected upon the screen in each second. The human eye is tricked into believing that it is seeing continuous motion. The pictures flash on and off the screen too fast for the eye to detect the deception. This psychological limitation is the basis of the wide-spread movie industry.

Television also tricks the eye. But what a more colossal deception! The picture must be produced 16 to 24 times each second just as in the movies, but in television each picture must be synthesized out of light, spot by spot, requiring at least hundreds of spots, all in the fraction of a second.

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mechanical eye of television must sweep its glance over a scene 60, 120, 240, or 343 times each 24th or 30th of a second. And upon each sweep it must perceive as a minimum hundreds of differences in gradation of tone. These changes of light must be converted into variations of electricity—the scene becomes attenuated into a fluctuating electrical impulse, just as the beauty of a singer's voice on the radio is a mere flickering electrical impulse when it is sped along wires or through space by radio.

The scene in electrical form is handled like a telephone or radio signal, except that greater fidelity is necessary, which means that television takes much more electrical space on wires or in the ether.

At the receiving point, the television image must be reassembled. Variations in electricity must become light again, light that can be sprayed into faithful replicas of what the distant television eye perceived a few fleet fragments of a second before.

This complex and swift picture-building in the latest television far exceeds the 160,000 variations per second that Swinton considered a minimum in 1908. The variations are closer to 3,000,000. How long a time the wink of an eye becomes in comparison with the necessary performances of television apparatus!

Let us peer into laboratories in which television is being readied. Two are in America, and there the most serious and probably the commercially important research and development are being done. Dr. V. K. Zworykin of the Radio Corporation of America, and Philo T. Farns-

Pioneers in radio and television: Dr. Lee De Forest (left), and Dr. V. K. Zworykin of Radio Corporation.

worth of Farnsworth Television Incorporated are the two American pioneers in electronic television. Both are now carrying on their researches largely in the Philadelphia area.

Encouraging reports about television progress in England and Germany are made from time to time. There, too, scientists are at work. As is customary in such technologic developments, RCA is understood to have patent and licensing agreements with Germany's Telefunken and England's Electrical and Musical Industries, while Farnsworth has exchanges of patents and techniques with England's Baird Television, Ltd., and Germany's Fernseh A.G.

IN modern television there is less mechanical motion than in motion-picture cameras and projectors. There is considerably more apparatus than in a radio set, but as in sound radio, the principal actors within the tubes are electrons, particles or units of electricity. The electron is one of the fundamental and omnipresent building blocks of everything about us and in the universe. Streams of electrons, known as cathode rays, play a major part in television.

Television's eye as devised by Zworykin is called the iconoscope, literally "image observer." The "seeing" end of the instrument is within a vacuum tube and consists of a flat plate, representing the retina or sensitive inner surface of the eye. On this, as on a photographic plate, the scene to be "televised" is focused by a lens system exterior to the tube. This retinal plate contains many thousands of tiny silver globules, each turned into a minute photoelectric cell by chemical treatment with the element caesium. On a 4 by 5-inch plate such as used there are three million of these little photocells.

The trick of this nonliving "electrical eye" apparatus is that it has persistence of vision similar to that of the human eye. It is an electrical latent image mechanism that stores electrically the information given it by the projected optical image. It can reproduce its electrically stored information when it is desired. Older television systems were instantaneous in their action and could use only the light of instant of scanning.

A simple electrical experiment illustrates the principle behind the iconoscope. A condenser is connected in series with a photocell. The photocell is illuminated. The light on the photocell is converted into electricity which flows and charges the condenser. The condenser is made to discharge by flashing upon it a beam of electrons shot from a cathode tube.

The screen in the iconoscope is a thin sheet of mica coated on the back side with a continuous metal layer. On its front is the mosaic of small isolated photosensitive globules. Dr. Zworykin makes this mosaic very simply by evaporating a thin film of silver upon the mica, then breaking it into separate particles by heat and sensitizing the silver with the element caesium.

The globules "soak up" the light converted into electricity when an image is projected by lenses upon the screen. Each photosensitive globule gets a positive electrical charge in proportion to the amount of light that falls upon it.

THE screen is scanned regularly by the electron beam that releases these charges, and this produces changes in the electrical capacity of the metal layer on the other side of the mica. By attaching an amplifying system to that metal layer, there can be drawn off from the system a fluctuating current that is an electrical representation of the light picture on the screen.

The eye of television in the Farnsworth mode is a somewhat different photoelectric pickup device. The image of the scene is focused upon a disk which is a silver oxide-caesium cathode. This converts the light into electricity or streams of electrons and emits them in numbers proportional to the intensity of illumination of the optical image. At the center of the other or anode end of the tube, there is a hole through which electrons can escape into an amplifying tube called an electron multiplier. The problem is to get all the speeding electrons through that hole in the right order to transmit that necessary electrical equivalent of the image being seen. That is done by impressing upon the "image dissector tube," as the device is called, fluctuating magnetic fields that deflect the electron image back and forth, passing it spot by spot over the hole.

The fact that currents passed through electromagnetic coils surrounding a cathode ray tube are able to switch, somewhat like a horse's tail, streams of electrons to and fro, is basic to all electronic television perceivers and receivers.

In the Zworykin receiver or reproducer called the "kinescope" the current received is fed into a cathode ray tube in which there is created a stream of electrons which varies in strength with the fluctuations in the current. Pulled by a set of electromagnets corresponding to those in the iconoscope, the electron stream plays rapidly back and forth across a screen to paint in fluorescence the original scene. Similar in principle is the Farnsworth "oscillight" receiving tube.

The trick of the screen that gives out light when the invisible cathode radiation (electrons) falls upon it is scientifically old. Yellow-green willemite is used most frequently, and as a result the television images have a greenish tinge. One helpful thing about such fluorescent substances is that they have a time lag and the splash of electrons leaves the material excited and light-producing an appreciable time after the impact. This makes the image brighter than it would be otherwise.

But television may escape the greenish color of its images. There has been considerable research into the possibility of producing a white fluorescence. A combination of green-fluorescing willemite, blue-fluorescing calcium tungstate, and yellow-fluorescing zinc borate gives a brilliant white light.

If you chanced to see one of the modern television receivers, such as are being tested in the homes of RCA officials in the vicinity of New York City, you might mistake it for a large conventional radio receiver. There is a sort of cover on the top with a mirror in which the television image can be seen. There are a number of knobs for tuning and adjusting. It is a receiver for sound as well as sight. Inside there are 33 tubes including high voltage rectifiers that supply 6,000 volts for the kinescope. Its cost, if it were for sale, would be in units of hundreds of dollars. Radio has come a long way from the simple cat's-whisker radio set that you made yourself in the 1920's.

CARRYING the 3,000,000 plus impulses per second from television's eyes in transmitting stations to receivers in homes is in itself an exacting task. The ordinary radio bands or the telephone wires of the sound radio chains just will not do. Each television channel requires much too wide a part of the ether to permit the use of the frequencies now devoted to sound broadcasting. And ordinary, wire channels are too crude and narrow.

Television has taken to the extremely short waves of very high frequency where there is still room for radio pioneering and where, the Federal Communications Commission willing, ether claims can still be staked. That's out where the megacycles begin. (Megacycles are million-cycles.)

The high quality television transmission now being perfected, pictures with some 441 or 450 lines scanned 30 times a second, requires a sight and sound channel of about six megacycles, which is a gigantic piece of the ether considered by the standards of sound broadcasting. But the present area of ether assigned to television by the Federal Communications Commission (42-56 mc. and 60-86 mc.) is broad enough to give seven such channels.

One limiting thing about such ultra-short waves is that they are reliably transmitted only about as far as the eye can see. That is the reason why the television transmitter in the RCA secret tests begun last Summer is on the top of the Empire State Building. And that is one reason why broadcasting companies have not rushed into erecting television stations. Each station can serve only a relatively small area. But this same circumstance makes the same chunk of the ether go farther. The short interference range, which is approximately 100 to 200 miles, will permit duplication of television channels at 200-mile separations.

THIS short range of these very short waves makes it difficult to transmit programs over long distances to various parts of the nation and the world, as is common practice for sound radio. Eventually it may be possible to set up television chain stations by transmitting the chain programs over directionally focused radio beams that have relay stations every hundred miles or so. But there are many economic and technical details to be overcome before this is accomplished.

Wire transmission—a very special sort of wire transmission—is more probable. The American Telephone and Telegraph Company is building an experimental coäxial cable between New York and Philadelphia, not primarily with television in view but as a channel for a large number of multiple telephone conversations or any other purpose that needs a wide frequency band. A coäxial cable is essentially a wire within a shield and the outside itself acts as one of the conductors. Such a cable has a high cost per mile compared with ordinary telephone wires, and this cost will be one of the many limiting economic factors in television.

The task of adding eyes to the ears of radio is obviously not one to be completed in a month or a year. Television is on its way toward wide-spread realization, but the rate at which it is traveling is difficult to determine. One expert estimate is that 1938 will arrive before the engineers and manufacturers can determine just what quality of television is needed and how actual broadcasting can be best conducted.

That postpones television's debut until a couple of years in the future. I know that you'll be pleased if this is somewhat too pessimistic.

Rotarian Magazine, February 1937