The March

By Lieut. William

Part

About Television Lieut. Wenstrom Makes the Following Pertinent Remarks—

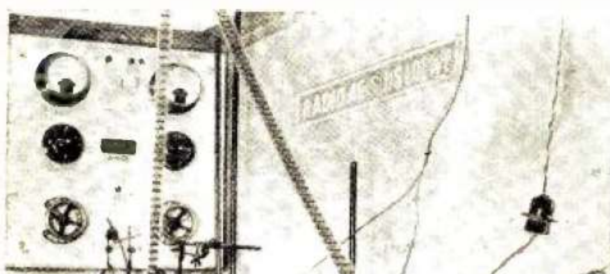
¶ Our present age is distinguished by increasingly rapid technical progress. The entire growth of aviation, for example, has taken place within very recent years, and the extent of this growth has been such as no serious thinker of the nineteenth century would have dared to predict.

¶ It is the same with radio broadcasting. So many new arts have developed in this startling way that we have come to expect like progress of every concerted technical endeavor, and we apply the same rule indiscriminately without regard for history or natural limitations.

¶ Television, introduced four years ago, was looked upon as an entirely new field—an art without a past. Having evolved from nothing to something in no time at all, it would soon evolve from that something to near perfection. When this rapid improvement failed to materialize, public interest turned to impatience if not indifference.

¶ The truth is that television principles are far from new. Their development, having begun long ago, has been rarely rapid and often painfully slow. By the same token, it is unreasonable to expect perfection immediately.

¶ If these tenets are accepted, it is possible to view present-day television not as a disappointment, not as something about to change overnight, but as a creditable achievement, born of past research and privileged to undergo constant improvement in the future. Let us see what evidence there is to support this view.



A FILM TELEVISION TRANSMITTER

This is the apparatus used by Manfred von Ardenne for transmitting moving pictures by means of the cathode ray oscillograph method

ONE hundred years ago the electric telegraph captured the imagination of scientifically inclined men much as radio and its ramifications do now. After the invention of the first practicable system by Morse in 1832, attention centered on improvements in the method of recording signals. Alexander Bain, a Scotch watchmaker, came to London in 1837 and attended some popular lectures in electricity. These set his mind at work upon electric clocks and printing telegraphs to such an extent that by 1840 he had completed models of both. His telegraph receiver used a strip of paper soaked in certain chemicals, moving on a metal cylinder under a metal point. When current flowed between the point and the cylinder, the paper was discolored in dots and dashes corresponding to the transmitted signal. Bain also is said to have devised a crude system of pictorial message transmission using many wires.

The first practical electrical picture-transmitting system, strange as it may seem to us, was actually set up and transmitting recognizable facsimiles between Brighton and London (a distance of fifty miles) before the middle of the century! This system, strikingly similar in principle to those which flash news photographs about the world today, was invented by Frederick C. Bakewell, an English teacher of electricity, in 1847. "The copying telegraph," wrote Bakewell, "transmits copies of the handwriting of correspondents. . . . Every letter and mark made with the pen are transferred exactly to the other instrument, however distant." The invention, as shown in Figure 1, included two metal cylinders about six inches in diameter, one at the transmitter and the other at the receiver. The message (or the picture) to be transmitted was drawn on a sheet of tinfoil with insulating varnish, the tinfoil being wrapped on the transmitting cylinder. As the cylinder rotated, a steel wire bore against its surface and was moved along by a screw. The surface of the cylinder was therefore "scanned" by one continuous spiral line. When the steel wire touched a part of the picture represented by insulating varnish, the line current was cut off until the wire again touched the unvarnished tinfoil. At the receiver a similar cylinder rotated in synchronism with that at the transmitter. The receiving cylinder, however, was wrapped with paper soaked in a chemical solution, as in Bain's printing telegraph. On this paper pressed another steel wire connected to the line, staining the paper under it *blue* whenever line current was flowing. The blank tinfoil at the transmitter was therefore reproduced as a blue background at the receiver, on which appeared white lines corresponding exactly to the varnish lines on the tinfoil.

Keeping the two cylinders exactly in step was of course a problem. Bakewell used the principle of the pendulum in some of his experiments, but he also devised an electromagnetic method, similar in principle to those used in modern television, which made use of a separate wire to transmit synchronizing impulses simultaneously to both the transmitting and receiving cylinders. In fact, so complete and well designed was his apparatus that one can scarcely believe it was actually demonstrated long before the outbreak of the Civil War.

Bidwell's Transmitter

The next forward step in television (or its slowed-down beginnings) had to wait on the discovery that selenium changed its electrical resistance in accordance with the amount of light falling upon it. When the Society of Telegraph Engineers and Electricians met at Paris in 1881, Shelford Bidwell, another Englishman, read before it a paper on some "apparatus . . . merely of an experimental nature." Bidwell's receiving apparatus was exactly like Bakewell's, except for a considerably smaller cylinder giving a picture about two inches square. The transmitter, however, as shown in Figure 2, was radically different. The picture or scene to be transmitted was projected upon a ground-glass screen, behind which a selenium cell moved slowly up and quickly down, gathering light through

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a pinhole from successive portions of the picture in turn. For each upward motion, the selenium cell moved across the image 1/64 of an inch, and on the receiving cylinder a screw thread moved the platinum recording point across an equal traverse at each revolution. Bidwell pointed out that "the pictures to be transmitted are not mere artificial drawings upon tinfoil or some other substance, but the projected images of actual objects. . . ." The system thus might be termed "still television," as the subject would have to hold a given pose several minutes before a picture could be formed at the receiver.

During the sixties and seventies the first motion pictures made their appearance. They depended, of course, upon persistence of vision—the fact that if slightly different poses are seen at the rate of sixteen or more a second, the observer has the sensation of seeing continuous motion. It is not strange that this idea should have intrigued many workers in electrical picture transmission. Among them was the Frenchman, Senlecq, who proposed a multi-wire television system which included, at the receiving end, a commutator sliding over the terminals of many separate wires connected with individual lights on a large screen. Forty-six years later this idea, improved by the use of gaseous glow tubes rather than filament lamps, was used in a large-screen demonstration of sight transmission overland wires by the Bell Laboratories.

The Nipkow System

Undoubtedly the greatest name so far recorded in television history is that of Paul Nipkow, a German who is still living in Berlin. In 1884 the German Patent Office issued to him Deutschesreichspatent No. 30105, setting forth all the details of a complete and workable television system. Figure 3 is based on one of his drawings. At the transmitter and receiver are two disks, perforated with small holes along similar spiral curves, which rotate in synchronism. The small holes, sweeping by the picture along successive horizontal lines, vertically displaced, trace each element of the picture in turn, or "scan" it. This scanning disk was the heart of Nipkow's system in 1884, and it is the heart of most television transmitters and receivers today.

At the transmitter an image of the subject is focused directly on the disk, precisely as it is in the modern television cameras now available. There follows a condensing lens which converges the rays from this image on a selenium cell, the output of which is led over wires to the receiver.

At the receiver an arc light shines through a condensing lens and through a polarizer. Next the poralized light passes through sulphureted carbon gas or some substance which will modulate the light in accordance with the magnetic field changes caused by the changing "picture" currents in the coil. The modulated light then passes through the receiving disk which, in order to save light, is viewed directly by the eye. This electric modulation of polarized light, proposed by Nipkow in 1884, has been applied (*Continued on page* 810)

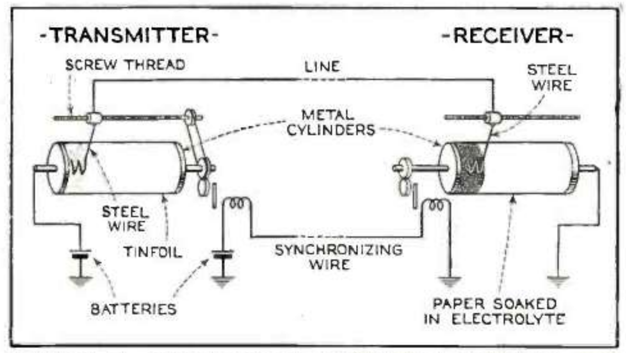


FIGURE 1. BAKEWELL'S FACSIMILE SYSTEM, 1847

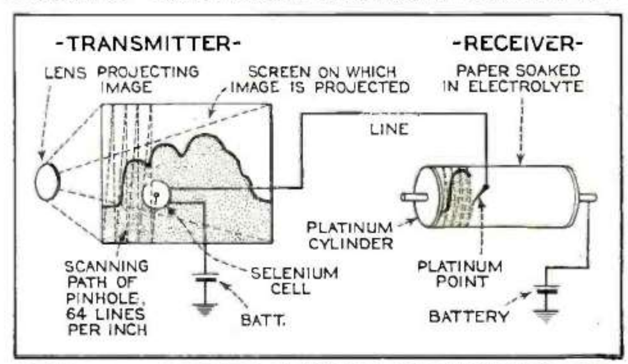


FIGURE 2. BIDWELL'S "STILL TELEVISION," 1881

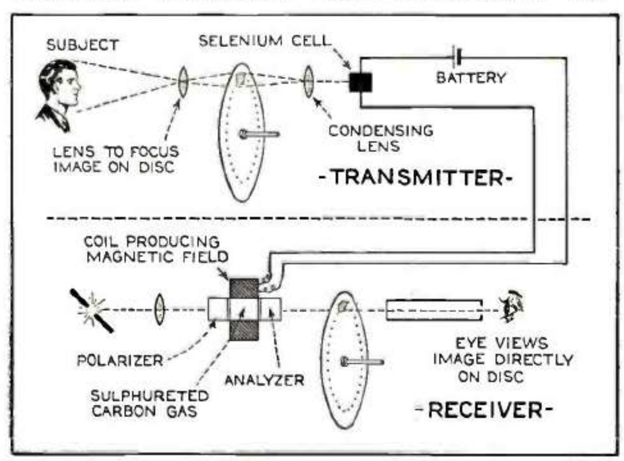


FIGURE 3. NIPKOW'S DISC TELEVISION SYSTEM, 1884

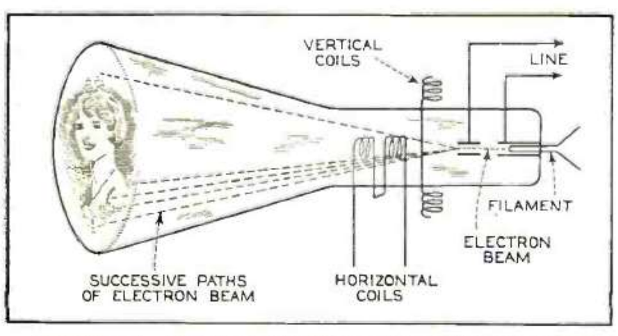
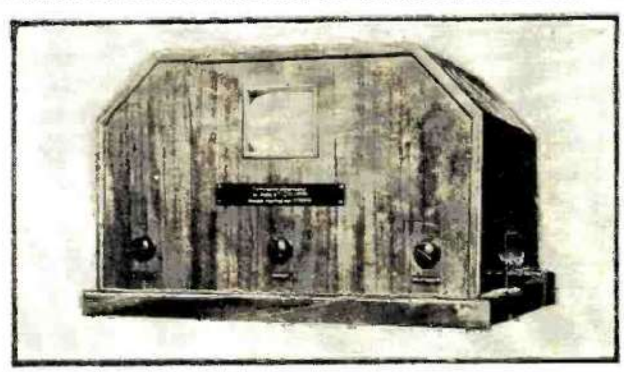


FIGURE 4. CAMPBELL-SWINTON CATHODE RAY RECEIVER, 1908



A CATHODE-RAY RECEIVER

An example of the cathode-ray tube television system as developed by von Ardenne

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(as the widely heralded Kerr cell) to theatre television projection within the last year or two.

Among other things, Nipkow proposed stereoscopic television and the employment of infra-red rays at the transmitter. Both of these ideas were put into practice in England during the last few years, the latter attaining world-wide prominence as Baird's "noctovision." No greater compliment can be paid the great pioneer Nipkow than this simple truth: the method of his invention still remains, nearly fifty years later, the basic method of present television, and practically all of his various devices are used in one or other of the systems of today.

Nevertheless, full practical exploitation of Nipkow's suggestions had to wait on three developments in other fields of science. The selenium cell follows light changes too slowly for efficient television use. Something quite inertialess was needed, and it appeared as the photo-electric cell of Elster and Geitel in 1890. Similarly, the weak picture currents at the receiving end balked the early experimenters. This difficulty was removed by De Forest's invention, in 1907, of the triode amplifier. Finally, although the modulated arc-light receiver may still be the best system for the theatre, in small installations the gaseous glow tube is simpler and more efficient. This inertialess light was invented by Moore in 1910.

Later Progress

In the meantime there occurred other events, removed from the main current of television progress but nevertheless notable because they paved the way for modern developments. In 1891 Amstutz, an American, sent the first half-tone picture over a twenty-five mile line, using celluloid sheets etched in relief. In 1898 Szczepanik proposed color television, lately staged as a practical demonstration. In 1902 Korn sent the first photograph by wire, using at the transmitter a powerful Nernst lamp as the source of a narrow beam of light, which was directed through successive elements of the "negative" to a compensated selenium cell. In 1909 Kundsen sent the first line drawing by radio, using one metal plate at the spark transmitter, and at the receiver a second plate, covered with lampblack, on which the drawing was scratched by a coherer relay.

Not until after the World War did Nipkow's television principle bear actual fruit in the work of C. Francis Jenkins in America and John L. Baird in England. Even so, at first the images were very crude; they appeared only as outlines, showing no detail. In April, 1925, Baird transmitted vision of this sort over the distance of a few feet before the patrons of a London department store. The unimpressed subject was a ventriloquist's doll. In most of Baird's laboratory work a similar doll sat patiently before the transmitter.

Progress continued. One cloudy Saturday in June, 1925, a distinguished group of Washingtonians, assembled in the Jenkins laboratory on Connecticut Avenue, watched the flickering image of a toy windmill which was seen to revolve. The windmill itself was turning in Anacostia, five miles away, and radio was bridging the visual gap. During the following January, Baird demonstrated an improved television system before members of the Royal Institution assembled in London. They saw recognizable faces and were much impressed. Single faces have been prominent in many television experiments since, because they reproduce satisfactorily where a larger or more comprehensive scene would be hopelessly blurred.

In 1927 television *in the grand manner* was demonstrated in New York by the Bell Laboratories. This great research organization quite naturally eclipsed the best efforts of the two pioneers. The Bell screen was about two feet square; the faces and speech came in twenty miles by radio and three hundred by wire. The hundreds of able men who planned and built the Bell equipment made vast improvements in existing technique, but they discovered no new principles.

Cathode Rays

With the limitations of Nipkow's disk and other mechanical scanning methods ever more apparent, it is not strange that someone should have thought of using, in preference to mechanically directed light rays, the inertialess electron beam of a Braun cathode-ray oscillograph tube. Here again the idea roots in the past. It was familiar to the Germans Lux and Dieckmann in 1906, and came to the attention of the English-speaking world in 1908 through a letter to *Nature*. In June of that year Mr. Campbell-Swinton wrote: ". . . may I point out that . . . this part of the problem of distant electric vision can probably be solved by the employment of two beams of cathode rays (one at the transmitting and one at the receiving station) synchronously deflected by the varying fields of two electromagnets placed at right angles to one another and energised by two alternating currents of widely different frequencies so that the moving extremities of the two beams are caused to sweep synchronously over the whole of the required surfaces within the one-tenth of a second necessary to take advantage of visual persistence. Indeed, so far as the receiving apparatus is concerned, the moving cathode beam has only to be impinged on a sufficiently sensitive fluorescent screen, and given suitable variations in its intensity, to obtain the desired result." Cathode-ray receivers, now widely hailed as the last word in television, are thus in principle over twenty years old.

With the Experimenters

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measured resistance determine the actual percent of error. If thought desirable, this percentage could be used in correcting future measurements.

Part of this error, however, may be due to inaccuracy in reading the instruments, especially with the cheaper sort, using rather coarse graduations and wide pointers.

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