A HISTORICAL LOOK AT TELEVISION

Television technology is progressing at a rapid rate—but the major advances were really made years ago.

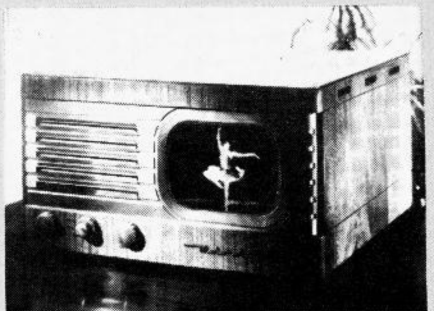
KATHY GOFORTH

IN 1929, WHEN THE FIRST ISSUE OF **Radio-Electronics**—then *Radio-Craft*—took up the discussion of an infant technology called television, the consensus at the neighborhood tavern (where television would eventually find its first mass audience) was that communication had reached its zenith with radio. To the general public of 50 years ago, the idea of sending moving images through space seemed the impossible dream of over-optimistic engineers. Today Americans alone own as estimated 146 million television sets—more than the number of telephones, refrigerators, automobiles, or bathtubs. TV has moved from the impossible to the indispensable. A viewing audience, including some who once considered video communications as remote a notion as a spaceship to the moon, already looks back a full decade to the time when it watched, from the comfort of the living room sofa, that first human step on the moon.

But astonishing as television's future is certain to be, its phenomenal success story already lies in the past—in the drama of its early development, the quantum leap from mechanical to electronic, and the metamorphosis from black-and-white to color. The subplots to the tale include global neglect through two world wars, a perpetual and frustrating lag between theory and workable hardware, a series of lively disputes over uniform standards, and an out-and-out battle between two early color systems.

The beginning

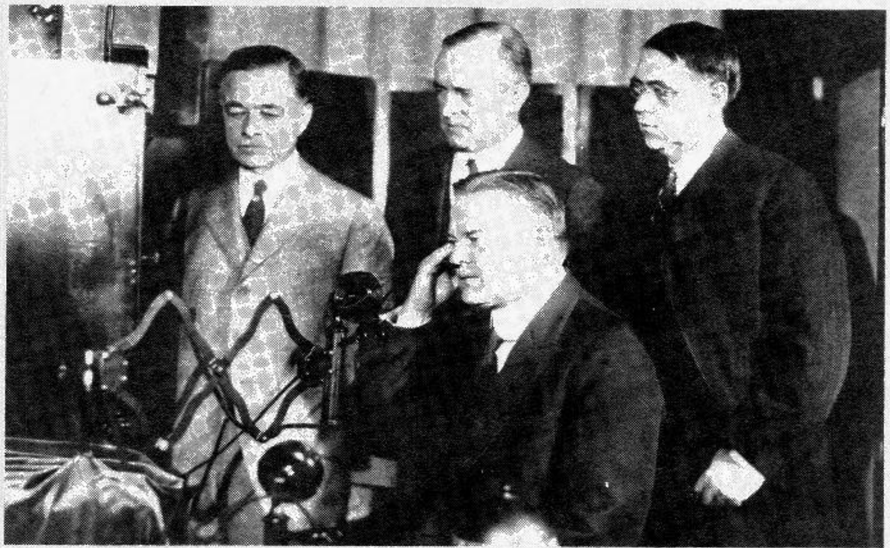
The story begins at that unidentified moment in the distant past when man first hatched the dream of extending human vision beyond the limitations of location. But television's practical history begins only about 100 years ago, with the discovery of the early principles needed to make it possible. By 1929, milestones already included the 1873 discovery of the photoconductivity of selenium and the idea of scanning a picture's elements in rapid succession, line by line and frame by frame, with reliance on the persistence of human vision—proposed about 1880. That important theory established the possibility for single-wire transmission and led in 1884 to the patent by German scientist Paul Nipkow of a complete television system characterized by the spirally-perforated rotating disc. The Nipkow disc, as it came to be called, would be used in one form or another in all workable television systems until the advent of electronic scanning.



1947 TELEVISION BREAKTHROUGH. Motorola introduced first black-and-white TV receiver to sell for under $200.

As early as 1897 German inventor Karl Braun had devised the cathode-ray tube, and in 1907 Russian scientist Boris Rosing reproduced crude geometrical patterns using a cathode-ray television system with a form of mirror-drum scanning at the camera end. A year later, Scottish electrical engineer A.A. Campbell-Swinton outlined a method for television using a cathode-ray tube at both receiver and camera ends—in all essentials the basis for modern TV, but an idea too advanced to be put into practice in 1908. (In 1904 English physicist J.A. Fleming had contributed the two-electrode valve; in 1906 American inventor Lee deForest had provided the grid for amplification.)

Early television research came to an abrupt halt with the outbreak of World War I, and although full-time experimentation wasn't resumed until the return of peace, by 1923 scientists in both the U.S. and England were at work on television systems using the Nipkow principle and the neon gas-discharge lamp, invented by D.M. Moore in the U.S. in 1917. In 1925 Charles F. Jenkins used such a system to broadcast silhouettes from his Washington, D.C. workshop, and in 1926 John Logie Baird in England transmitted moving pictures in halftones—scanned in only 30 lines, repeated about 10 times a second—to



FIRST PUBLIC DEMONSTRATION of inter-city television broadcasting took place in 1927. Herbert Hoover, then Secretary of Commerce, was speaking in Washington and seen on television screens at Bell Telephone Laboratories in New York.

give what might be called the first demonstration of "true" television. Baird's system formed the basis of the experimental broadcasting that began in England in 1929.

The post-war years also brought the landmark invention of the iconoscope by Vladimir K. Zworykin, a Russian scientist and recent immigrant to the U.S. The 1923 breakthrough put Campbell-Swinton's advanced theory into practice, giving the camera its "eye" and providing the final missing element needed for modern television. The crude but workable, partly-electronic TV system Zworykin developed that same year became the basis for the system used in 1939 for the first public demonstration of television, by RCA, at the New York World's Fair.

The 20's continued as a decade of enthusiastic research, and a variety of experimental television systems were demonstrated. The new technology left much to be desired, however, and even when experimental broadcasting began television made little headway toward public acceptance. Its audience remained limited to small numbers of engineers and a slowly expanding coterie of home kit-builders. The latter had a chance to become acquainted with terms such as "automatic synchronization" and "interlaced scanning" before the electron beam swept the whirling disc into discard, bringing the early period of television's development to a close. By the early 30's scientists had come to pin their hopes for improved pictures on the all-electronic systems and had turned their attention in that direction. TV's future mass audience still clustered contentedly about its radios, unimpressed by fuzzy pictures on tiny, inordinately expensive screens. And the more resolute of the home experimenters withdraw to their basements and garages to experiment with the new tubes.

Standards

It has also become apparent by this time that if television were to grow, broadcasters and set manufacturers would have to accept uniform standards. Engineers argued hotly over what those standards should be, and just what form a national television system should take, and in 1933 hearings by the FCC began in the U.S. in an effort to establish the necessary guidelines. Meanwhile, scientists and engineers continued to chalk up contributions to the growing science: Philo T. Farnsworth's electronic scanning system improved pictures; electrical engineer Allen B. DuMont streamlined the workings of the cathode-ray tube; continuing research on the electronic systems, carried out in the U.S. mainly in RCA labs, soon increased the number of scanning lines to 343. German scientists, too, were active, especially in the development of high-vacuum cathode-ray tubes, and by 1935 a regular broadcasting service had begun in Germany. A team of researchers under Isaac Shoenberg at Electric Musical Industries (EMI) in Great Britain also produced a complete and practical system based on the Emitron camera tube, and the world's first public high-definition service was launched in London in 1936—in time to broadcast the coronation of George VI over a broad area. Its 405-line standard remained the basis of the British system for nearly three decades—until 1964, when it was superceded by the 625-line standard.

French engineers had begun work on a 1,000-line system, which eventually resulted in France's 819-line standard. Japan pressed TV research in hopes of telecasting the Olympic games from Tokyo in 1940, and in April, 1939, regular television service began in the U.S. with NBC's broadcast, emanating from a transmitter atop the Empire State Building, of the opening ceremonies of the World's Fair. President Franklin Roosevelt, on hand for the occasion, became the first President to be televised. Technological capability had narrowed the gap between theory and practice, enthusiasm was fired, and the rapid development of commercial television seemed assured. Four months later, Hitler's troops assaulted Poland, and declarations of war by England and France marked the beginning of World War II and the second hiatus for television research.

In the U.S., as in other countries, the need for military preparedness led to increasingly heavy demands on industrial research, engineering, and production facilities. By the time the Japanese attacked Pearl Harbor (December 1941) virtually all U.S. electronics facilities were devoted to military projects—radar, radio, special tubes, acoustical devices, and navigational systems. What television broadcasting remained began to serve the needs of civil defense, air-raid warden training, Red Cross instructions, and war bond sales.

Network television

But television's crucial momentum had been gained before the war, and peacetime returned the medium was poised for unprecedented expansion. Both NBC and CBS had developed surprisingly extensive schedules of programs for the several thousand sets in use before the U.S. joined the fighting in 1941. The first official network broadcast in the U.S had come in February 1940, when a program from NBC in New York City was picked up and rebroadcast by General Electric's station in Schenectady, N.Y. At about the same time, Zenith Corp. had begun regular program service in Chicago. Parts of the 1940 Republican National Convention in Philadelphia had been televised after transmission to New York via coaxial cable, and films of the Democratic Convention in Chicago had been broadcast in New York.

Commercial television had begun officially in 1941, when both NBC and CBS were granted licenses on July 1. Standards for a commercial system had been worked out before the war by the National Television System Committee, and wartime engineering paid off in a harvest of technological advances: the image orthicon; more powerful transmitting equipment; improved picture-display techniques based on radar developments; more effective network relay techniques, and major advances in high-frequency techniques. Television celebrated the war's end and its own return to the commercial arena by broadcasting coverage of V-E Day and the Japanese surrender. An American public weary of wartime austerity, and a business world thrilled by a potential new advertising tool, both looked forward to television's widespread use.

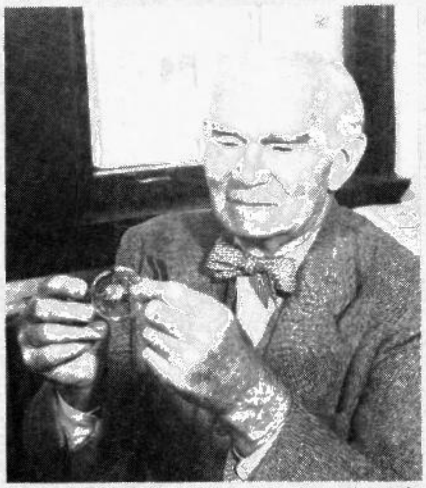
In 1946 NBC in New York linked up with Washington, D.C. by coaxial cable, creating the first real network, and RCA placed the first post-war TV sets on the market—the famed 630TS, television's equivalent to the Model T Ford, and the nation's first quantity-produced and marketed receiver, selling for $375. By midsummer, 1947, 12 broadcasting station were in operation and a larger number under construction. The same year brought the premier of Kraft Television Theater—the first regularly scheduled network drama series and the first show blessed with sufficient financial backing to ensure consistently high quality productions. The big show of 1947, however, was the first televised World Series, viewed by an estimated 3.9 million people, the majority of them in local bars, where commercial television got its test run by many consumers.

By the following year, the vote was in. Americans had taken to the idea of going to the theater and the ball park via the easy chair, and television antennas sprang up like mushrooms on the roofs of homes across the nation. The number of receivers snapped up by an eager public jumped from 136,000 in 1947 to 800,000 in 1948. Television was accepted by the service technician, and test equipment appeared. The number of stations tossing images from batwing to dipole grew with an expanding web of networks: East Coast television cities were linked to Chicago, St. Louis, Pittsburgh, Buffalo, Cleveland, and Toledo, with microwave relays adding Detroit and Milwaukee to the circuit.

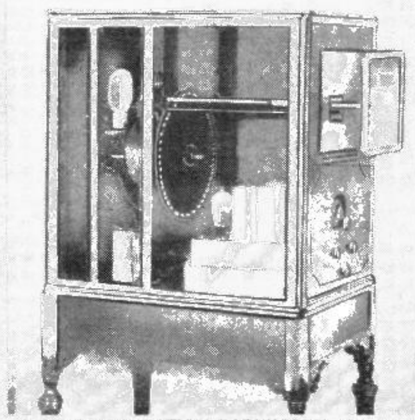
Innovations tumbled out of the labs and into the stores: "convenience" accessories such as the viewer-controlled zoom lens and the one-way mirror that made a turned-off television a decorator piece; the first portables—37 pounds light; more rugged antennas, designed to better withstand the rigors of rain, snow, and wind; directors and reflectors for more selective reception and to battle the increasing problem of interference from different stations. Television's expansion had surpassed even the most optimistic forecasts, outstripping even the phenomenal growth of the auto, moving picture, and radio industries.

Color television

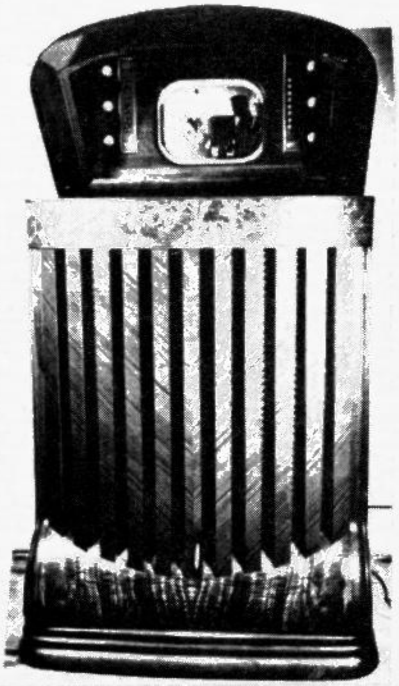
As a result, the problem of one station's signal interfering with another's soon grew to such proportions that, in September of 1948, the FCC declared a freeze on the licensing of any new TV stations. There had to be time to study frequency allocations and to consider the problems posed by another major innovation that sat perched on the horizon: color. Like monochrome TV, color television has its roots in a number of early experiments and in the Nipkow disc—used in threes, in this case, one disc for each of the primary colors.



LEE deFOREST holding his invention, the Audion—the first vacuum tube with a grid for amplification.



JENKINS PROJECTION RADIOVISOR, developed in 1931, used deForest's new neon-crater tube and a 1-inch scanning disc with sixty ½-inch lenses to throw a flying-spot image on the rear of the ground-glass viewing screen.



FIRST ZENITH TELEVISION was manufactured in 1939.

The first practical demonstrations of color came in 1928 when Baird used a system of two gas-discharge tubes as light source at the receiver, one of mercury vapor and helium for the green and blue colors and a neon tube for red, along with a set of discs, an early variety of the "color wheel." In 1930, Ray D. Kell of General Electric patented a color-television system employing a double, spiral scanning disc and only two colors; and in 1931 German engineer Anronheim devised a color system using a 12-color filter disc in conjunction with a scanning disc. Experimental work on color continued in both Great Britain and the U.S. in the late 30's, and similar sequential systems using rotating color filters in the cameras and receivers were demonstrated in both countries.

The drawbacks of the mechanical approach to color TV were that it required an increased rate of scanning to avoid color flicker and it was noncompatible with existing black-and-white television. An all-electronic method proposed by others was compatible with black and white, but it was a much more difficult system than the mechanical one. In 1938, Georg Valensi of France pioneered the path to compatible color television when he patented a method enabling output from a single transmitter to be received by television sets with equipment for color and by ordinary black-and-white sets as well. His proposals were never precisely adopted in practice.

In the U.S. battle lines were drawn between variations of the two systems: CBS developed a mechanical system of whirling color wheels, synchronized at the receiver and camera ends. A transparent disc divided into three segments for the primary colors revolved before the camera, scanning the color elements of a picture and sending them to the receiver disc. The successive primaries flashed to the eye at the rate of 144 per second, and persistence of vision blended them into one. With the system's excellent picture came a counterbalance of problems, including interlacing, flicker, and fringing. Even so, and even though it was incompatible with black-and-white sets, the mechanical system offered the most promise in terms of early commercial advantage. The alternate, all-electronic system developed by

RCA's FAMED MODEL 630TS was television's equivalent to the model-T Ford automobile. The 630TS was the first post-war TV receiver and was also the first mass-produced and marketed TV receiver, selling for $375.

RCA used three lenses and three electronic systems—in effect three cameras in one—to pick up the primary colors. A sampler in the receiver, synchronized with one in the transmitter, took short samples of the composite signal at the instants of red, green, and blue peaks, using three kinescopes whose phosphors glowed in the three primary colors.

But existing projection-tube displays, and a very complex direct-view display using three orthogonal picture tubes whose pictures were combined by dichroic mirrors, lacked the convincing evidence of practicality. In 1949, the FCC gave its approval to the mechanical color system, and RCA moved with full speed to develop the final basic element in the compatible system—a single tube capable of producing full color.

In 1950, the company startled the industry with a demonstration of the shadow-mask tricolor kinescope—the reward of the most intensive single research effort in electronic to that time. The color tube was essentially the same as the one now used throughout the world.

After winning FCC approval, CBS had begun limited color broadcasting, but the mechanical color system was to be short-lived. Hit by a serious shortage of parts during the Korean conflict, the color wheel quietly whirred its way out of existence, to the relief of manufacturers and engineers alike (though a variety of the system was later used by Apollo astronauts to transmit their remarkable pictures of the moon and earth). In 1953 came the FCC aproval of the refined RCA compatible color system; and the industry sat back to let RCA and its subsidiary NBC develop and promote color TV. [Ironically, CBS held the patent on the shadow mask and RCA had to pay royalties for 17 years.—*Editor*]. RCA produced the first compatible sets in March 1954, and NBC began to try out its major programs in color.

TV growth

Television had continued to weave its way inextricably into the fabric of American society. Audiences were electrified in 1951 by the televised Senate committee hearings on organized crime. In 1952 they watched TV's first opera broadcast, the televised explosion of the first atomic bomb, and coverage of the presidential election campaign. September 1951 had brought completion of the link to the West Coast—a 3,000-mile network of 107 relay towers—and transcontinental television was now a fact. NBC's coverage of the 1952 conventions in Chicago introduced the portable RF-connected camera and the first "crash truck," a TV newsroom on wheels equipped with self-powered electronic and film cameras and its own darkroom. Cable television got its start in 1950 with the erecting of the first community antenna, in Lansford, PA.

With the imminent lifting of the FCC freeze on TV station construction, a handful of UHF stations demonstrated the technical possibilities—and limitations—of the UHF spectrum and the newly designed equipment to work in it. When the freeze ended in April 1952, with a document that supplemented the existing channels in the VHF band with 70 new channels in the UHF band, it began processing a backlog of 700 applications for new stations, granting 175 new licenses that year. Soon 377 stations were on the air, and by the middle of 1954 almost 90 percent of the country had television coverage.

The 50's also brought continued improvements: the Vidicon camera; in 1953, development of a curved shadow-mask with phosphors deposited directly inside the face of the tube; in 1954 incorporation of internal pole pieces in the three electron guns of the color tube to permit each beam's independent adjustment and an increase in deflection angle; also in 1954 the development of photographic deposition of the three color phosphors. In 1958, we had the replacing of the metal envelope of the color tube by a glass one, made possible by the advent of a new frit-glass seal by Corning Glass; and in 1956 the use of videotape and the first quadruplex (4-head) video-tape recorder.

The 1960's brought the incorporation of solid-state components in color TV, new phosphors to provide brighter colors, more color programming, and an increase in popularity for color TV. NBC was broadcasting as much as 40 hours a week of color programs in 1963 (though CBS had still done little color programming and ABC virtually none), and color was becoming an important element in program costs and set sales. Experimental pay TV began on a UHF channel in Hartford, CT. At the 1964 political conventions in Atlantic City and San Francisco, new RF-connected portable cameras and control units used were much lighter than previous systems—the complete package weighing less than 50 pounds—and for the first time the camera's microwave equipment operated in the 13-GHz band, eliminating most of the noise and interference that had plagued previous microwave-link cameras.

In 1965 color television reached the elite billion-dollar category as an industry. Hand-held minicams appears at the 1969 political conventions; and the Trinitron gun was developed, reducing aberrations with its three in-line electron beams from once source and single large-diameter lens. In 1969 came the shadow-mask tube with a black-matrix faceplate, reducing back-scattered light by 50 percent.

Today countries in every corner of the globe have established privately, publicly, or government-owned television service, and acceptance of the TV screen as man's eye on the world around him is complete; the medium is destined to grow in countless and unexpected ways to accommodate the needs and satisfy the voracious curiosity of its inventers and viewers. Television has come of age, and as a maturing technology it will no doubt continue to astound and delight us. **R-E**