Harold B. Law

1911–1984

By Humboldt W. Leverenz

Harold B. Law, the inventor and developer of methods and structures for making video devices that are now used worldwide, especially for television, died on April 6, 1984, at the age seventy-two. He retired from RCA in 1976 as director of its Electronic Components, Materials, and Display Device Laboratory. In his retirement, he devoted himself to farming his acreage near Hopewell, New Jersey, and took agricultural courses to enhance his proficiency. He died suddenly in the "saddle" of his tractor.

Law conceived and applied the method of using light to simulate electronic beams for printing phosphor screens in color picture tubes for television and computers and for multicolor displays used in many other devices. An earlier achievement was his method for making the delicate glass/mesh target required for image orthicon camera tubes; the method included a technique for making very fine high-transmission metal meshes from a ruled glass master.

Harold Law was an active, quiet, kindly man, who delighted in helping those he knew and in benefiting countless others through his inventions. Whether seated or afoot, he always looked as though he was thinking—mainly because he *was* thinking.

He was born on September 7, 1911, in the small town of Douds in southeast Iowa, where his father taught school and had a small farm. The family moved to Kent, Ohio, around 1914, but Law returned during the summers to his grandfather's farm, where he enjoyed doing the chores.

In high school he applied himself to school subjects, manual arts, band, and sports, as well as such extracurricular activities as building and flying gliders. After some gliding practice, he persuaded a local airplane pilot to teach him to fly a power plane—lessons that included a solo flight—in one morning.

Law financed his undergraduate years at Kent State University by working six hours a night; he graduated in 1934 with a B.S. in liberal arts and another in education. After teaching mathematics for a year in Maple Heights, Ohio, he entered graduate school at Ohio State University and received his M.S. in physics in 1936. He again taught mathematics, this time for two years, and then returned to Ohio State, receiving his Ph.D. in physics in 1941.

During his graduate work, Harold read an article about RCA's research on electron multipliers, and he attempted to duplicate some of the reported results. After he graduated, he applied for a position in RCA's research division in Camden, New Jersey, and began work there in June 1941. He was assigned to a group that was trying to make more sensitive electron emitter surfaces and to use electron multipliers in camera tubes. He found that he liked designing, fabricating, and testing experimental electron devices because, as he said, "it suited my do-it-yourself nature."

When RCA consolidated its research in new buildings near Princeton, New Jersey, in 1942, the newly married Law moved there and became part of a group whose task was to develop the image orthicon tube invented by Albert Rose. Rose guided the overall effort; Law worked on the secondary-electron-emitting target (a very thin sheet of special glass mounted a few microns from a very fine mesh metal screen); and Paul K. Weimer worked on the electron multiplier and the electron optics of the scanning beam.

Ideally, the image orthicon could have a thousand times the sensitivity of the iconoscope, but the techniques and materials needed to make the tube with the required precision were not available. Law attacked the target problems with his hands-on, "mind-on" vigor and serendipity. Out of his efforts evolved the technique of using a fine diamond point to rule grooves on a glass plate. This step was followed by evaporating platinum to a thin film over the plate and then rubbing off the surface film. The platinum left in the grooves was electroplated with copper and pulled out intact; it was then welded to a frame and heated to about 500°C, at which point the screen was pulled flat by internal cohesion, as manifested by surface tension.

Rose stated: "This remains the classic way of making fine mesh (1,000 lines/inch) screens, highly transparent (80% open area), and highly uniform." Yet the heating-to-tauten technique was so unusual that the patent examiner said that it could not work because it was well known that metal expands when heated. Law took heating equipment, frame, and mesh to the Appeals Board in Washington to demonstrate the efficacy of the procedure.

Harold Law also made the thin, uniform glass emitter target by heating it to temperatures high enough for cohesion to pull it flat. After the Law-Rose-Weimer team achieved practical image orthicons, they attended the first public demonstration by RCA in which it was shown that the tube could give a television picture of a young woman's face illuminated by the light from a single match. The image orthicon was the acme of the photoemitter-type camera tubes and was in commercial use for many years.

After World War II, major efforts were initiated to develop color television. The approach advocated by RCA was to provide a compatible color system—that is, one whose pictures could be seen in color on new color sets and in monochrome on existing black-and-white sets. The RCA concept was deemed to be impossible by many because it needed pioneering inventions of systems, circuits, devices, and the methods for making them. RCA engineers devised many potential solutions from which the few practical ones had to be chosen, developed, and demonstrated under time pressures that had been imposed during hearings held by the Federal Communications Commission, which favored standardizing a non-compatible color system.

A key part of the "sought-for" compatible color television was a device to reproduce the color picture, a solution that was then unknown. In September 1949, a special meeting was called at RCA Laboratories, which was attended by Harold Law and other selected members of the technical staff. Those present were invited to participate in a three-month "crash program" to demonstrate the feasibility of a color picture tube. Overall organization and coordination of the effort were assigned to Edward W. Herold.

Law welcomed the challenge and recalled some experiments he had done "on the side" to make color phosphor screens in patterns by using a photographic process. He chose to use a form of three-electron-beam, three-phosphor-element color kinescope invented by Alfred C. Schroeder. In Schroeder's device the beams went through holes in a mask, each beam striking one array of phosphor dots emitting one color.

In mulling over and experimenting with means to deposit the hundreds of thousands of phosphor dots in exactly the right spots, Law conceived the idea of using a light source placed at the deflection center of one electron beam. The light source would shine through the mask apertures and strike a transparent plate coated with a photosensitive binder containing one of the phosphors, affixing the phosphor dots in those locations. The process would be repeated for the other two beams and colors.

Law's invention, with flat masks and flat phosphor screens, was used to show the feasibility of the color kinescope within the three-month deadline, and the RCA compatible color system eventually prevailed. An extension of Law's technique, using curved masks and depositing the phosphor dots on the curved inside end of the kinescope, was announced by N. F. Fyler, W. E. Rowee, and C. W. Cain in 1954. The method is still used to produce color picture tubes worldwide.

As might be expected, Law's important invention was contested, and the patent was not issued until 1968. The turning point in the lengthy litigation came when Edward Herold gave cogent supporting testimony from his records as coordinator of the crash program and subsequent developments.

Harold Law was elected to membership in the National Academy of Engineering in 1979, having previously been named a fellow of the Institute of Electrical and Electronics Engineers (IEEE) in 1955, a fellow of the Society of Information Display in 1971, and a fellow of the Technical Staff of RCA Laboratories. He was a also member of the American Physical Society and Sigma Xi. He received the Television Broadcasters Association Award (1946); the IEEE Zworykin Television Prize (1955); the Consumer Electronics Scientist of the Year Award (1966); the IEEE Lamme Medal (1975); and the Frances Rice Darne Memorial Award (1975). From Kent State University, he received the Outstanding Graduate Citation (1959) and an honorary D.Sc. (1984). RCA gave him five awards.

His thirteen publications include "The Image Orthicon—A Sensitive TV Pickup Tube" (with A. Rose and P. K. Weimer), in *Institute of Radio Engineers Proceedings*, (vol. 34, July 1946); "A Technique for the Making and Mounting of Fine-Mesh Screens" in *Review of Scientific Instruments* (vol. 19, December 1948); and "The Shadow-Mask Color Picture Tube: How it Began" in *IEEE Transactions on Electron Devices* (vol. ED-23, July 1976). Two of his "inventions," the method of making fine-mesh screens and photographic methods of making electron-sensitive mosaic screens, are particularly outstanding among his thirty-eight U.S. patents.

Harold Law met his wife Ruth (née Workman), a gifted mathematics teacher, through his sister, Mabel. He is survived by Ruth; their married daughters, Linda Krantz, Sara Schlenker, and Kathy Orloski; six grandchildren; and his sister, now Mabel Winters. He once told Ruth that he enjoyed his work with RCA as much as his work on the farm. About the farm, he said, "Living on this place is as near to heaven as you can get."