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Last Big Cookie

City of Light

The Story of Fiber Optics

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He never got that far. In 1927, he collected 340 metal tubes two inches long and a tenth of an inch in diameter, and stacked them in a 17 × 20 array that he used to scan an image. He abandoned that approach without trying fibers or glass rods.[10] The mechanical television system he pioneered in Britain used spinning disks.[11]

C. Francis Jenkins: An American Inventor

Born on an Ohio farm in 1867, C. Francis Jenkins began thinking about television in 1894 and dabbled with it most of the rest of his life. A founder and the first president of the Society of Motion Picture Engineers, Jenkins helped develop early motion picture projectors,[12] but his most profitable invention was a spiral-wound waxed paper container.[13] He was neither rich nor beyond embellishing his achievements, but nobody was about to throw him into the streets. Compared to the impoverished Baird, he had made a successful business of invention, and turned to television with a solid track record behind him.

In late 1923, he brought two leading radio-magazine editors[14] to his Washington, D.C. laboratory, where they saw the shadow of Jenkins's hand waving on the screen. However, Jenkins fell behind Baird. His first public demonstration came two months after Baird's, and Jenkins transmitted only black-and-white silhouettes while Baird showed shades of gray.

Thanks to his years of movie experience, Jenkins knew more about optics.[15] He tested several types of television cameras and receivers, and one of the receivers used quartz rods to carry light.[16] He mounted 48 three-inch rods in a screw-thread pattern around the inside of a cylinder that spun 3600 times per minute. As they spun, they collected light from a central stationary bulb with four filaments turned on and off by radio signals. The other ends swept by the viewer's eyes, creating 15 new images every second. A magnifying lens and mirror showed a flickering silhouette about six inches square made up of one line per quartz rod. The images weren't very good, but at the time any image was impressive.[17]

The rotating drum receiver proved impractical; the quartz rods transmitted only 40% of the lamp light, and the lamps lasted just a few hours. Full of energy in his sixtieth year, Jenkins quickly devised a different receiver, which he used to transmit "Radio-Movies" across a room on May 5, 1928. He boasted to the *New York Times* that he would soon be able to project pictures on the wall.[18] Jenkins coaxed vacuum-tube pioneer Lee De Forest and New York bankers to invest $10 million in the Jenkins Television Company. The company made some receivers and built television stations in Washington, D.C., and Jersey City, but soon ran out of money. In September 1929, a month before the stock market crash, De Forest Radio took over Jenkins Television. Ill with heart trouble, Jenkins sold his laboratories at the end of 1930. De Forest Radio and Jenkins Television both failed during the Depression, and Jenkins died in 1934.[19]

By then, Baird had become a reluctant convert to a newer technology, electronic television, in which electron beams instead of spinning disks scanned images. The impetus came from America, where a young inventor-businessman named Philo Farnsworth was struggling to stay ahead of a well-funded team at RCA.

C. W. Hansell Sees the Problem Clearly

The magical allure of radio attracted a host of bright young engineers after World War I. Many of the best of them joined the fast-growing RCA. It was a golden opportunity to ride the breaking wave of a new technology at a company with ample resources to support innovative engineers. Among them was Clarence Weston Hansell, who went by his initials C. W. He was in the first generation of engineers trained in electronics, a man with a gift for invention and a wide-ranging mind. Pondering the problem of reading an instrument dial that was annoyingly out of sight in late 1926, Hansell realized that a flexible bundle of transparent glass fibers could do the job.

That was a vital step. Colladon, Babinet, Saint-René, Baird, and Jenkins all saw the potential of light guiding by total internal reflection. But none of them grasped the elegant simplicity of image transmission through a flexible bundle of thin glass fibers. Align the fibers in the same way on both ends of the bundle, and they should carry a pattern formed on one end point by point, fiber by fiber, to the other end. Bend the bundle, and you could see into otherwise inaccessible places—from automobile gas tanks to the human stomach.

Born January 20, 1898, in Medaryville, Indiana, Hansell was the oldest of eight children in a poor farm family.[20] After earning a degree in electrical engineering at Purdue in an Army training program, he worked briefly for General Electric before it divested its radio business to the newly formed RCA. In 1922, he developed and installed the first vacuum-tube transmitter for commercial wireless telegraphy across the Atlantic.[21] In 1925, the young engineer founded the RCA radio transmission lab at Rocky Point, Long Island, which he headed for over 30 years. He bought a house on Long Island Sound and raised a family there.

Short and stocky, Hansell had a mind that bubbled with new ideas.[22] In his 44-year engineering career, he collected over 300 US patents, plus many more issued overseas. His specialty was radio transmission, and he was good at it, helping perfect short-wave radio antennas and building the world's largest radio transmitter at Rocky Point. Like other forward-looking radio engineers, Hansell hoped to adapt radio technology to sending pictures, including the "wirephoto" services that evolved into what we now call facsimile, as well as television.

Sometimes his inventive mind wandered. On December 30, 1926, he filled two pages in his engineer's notebook tight to their edges with a concise proposal, neatly written with a fountain pen: "Method for transferring a dial reading to a distance." He started with his initial goal: "reading the dial of an instrument from points at some distance away and from points obstructed for vision. It would be a great help if the vision of such an instrument could be piped from one place to another around corners, curves, etc."

He did not say where he got the idea of piping light. It could have been a decorative lighting fixture or fountain, or perhaps an illuminator he saw at his dentist's office. He must have seen curved glass rods guide light; his patent application says "experimentally, the remote end of such a rod may be used to ignite paper even though the conductor is quite cool along its surface, and may be held without any sensation of heat."[23] It's easy to imagine him focusing sunlight into a bent glass rod to burn holes in pieces of paper.

The inspiration added up to a simple solution to his problem:

> It is only necessary to make up a cable of parallel laid quartz hairs or strands of similar material, the ends of which can be cut off plane. One end of this cable can face the instrument and another can face toward the observer. The light from the instrument will fall on the ends of the quartz fibers and be transmitted through them coming out as an image in the other end visible to the observer. No light will pass from one quartz hair to the other due to the total reflection from the walls of the quartz. Of course, the area corresponding to the cross section of each hair will have its particular part of the image mixed up so that its detail is lost, but the image as a whole can be made quite good by using a great many very small hairs.[24]

Except for one crucial detail, Hansell had nailed dead-on the idea of bundling glass fibers together to transmit an image. His agile mind saw many other ways to use imaging bundles. He jotted a few in the notebook. One was "a flexible periscope, which could be quite useful in the army and navy." He proposed relaying "the reading of a gasoline meter from the tank on the back of an automobile to the dashboard." The same idea could be extended to airplanes and ships, though in some cases a lamp might have to illuminate the meter to get enough light. Surgeons could thread similar cables down the throat to examine the stomach.

By the time RCA's patent department filed an application the following August, Hansell had added another potential use that was a closer match to RCA's electronics business—a "picture transfer cable" for facsimile transmission. Newspapers were the main customers; they wanted to transmit news photos around the globe, just as they could wire articles by telegraph. RCA, AT&T, and telegraph giant Western Union had demonstrated wirephoto systems in 1924.[25] Hansell thought he could speed image scanning by using a several fibers instead of a single light collector. Scanning with 20 fibers spaced along a straight line delivering light to 20 separate detectors could collect information 20 times faster than a single detector. Likewise, 20 fibers in the receiver could deliver light from separately modulated bulbs and write 20 times faster. In addition to speeding the system, Hansell hoped to simplify alignment.

(Hansell's patent also contains another prescient concept. He realized that the signal transmitted depended on how the fibers were arranged in the bundle. If they were scrambled at the transmitter, they would have to be scrambled in the same way at the receiver or different lines would appear in the wrong places, jumbling the entire image. He suggested that intentional scrambling could prevent nonpaying customers from "stealing" pictures by picking up RCA's radio-facsimile transmissions.)

Yet despite Hansell's uncanny vision, there is no evidence he went much further than writing down his ideas for the RCA patent department. Colleagues recall him as more likely to sketch new ideas on paper than to build anything.[26] He was an energetic man but a busy one; not yet 30, he directed research at the RCA Rocky Point Lab. Imaging was peripheral to his job of developing new radio transmission systems, and the often-modest Hansell never worked up enough enthusiasm to push it. But the time his patent was issued in 1930, he was on to new inventions.

Fiber optics wasn't the only bright idea that Hansell never found the time to pursue. When Edwin Land showed him the young Polaroid Corporation's plastic polarizing material, Hansell suggested it might make good sunglasses. His family recalls that Land rewarded him with the first pair off the production line.[27] And Hansell was the first person to write on paper by controlling the flow of an ink jet. His prototype printer could record 7500 words per minute from a radio telegraph—an astounding speed in the 1930s. It was far too fast for RCA's radio-transmission manager, who took one look and decided the miles of paper tape would overwhelm his operation.[28] Hansell reluctantly put the idea on the shelf. Today, millions of low-cost inkjet printers are used with personal computers.

Heinrich Lamm and the Legacy of Sword Swallowers

As Hansell and RCA moved on to other things, a medical student in Germany came upon the same idea from a different direction. Heinrich Lamm wanted to build a flexible gastroscope that a physician could thread down a patient's throat to peer into the stomach.

Physicians had tried to build instruments to look into the human body since the early nineteenth century, with no real success. The feats of sword swallowers inspired one physician to try looking down the throat through a rigid tube, but it wasn't a viable approach.[29] The esophagus is reasonably straight, but the entrance and exit are not, so thrusting an inflexible tube through delicate body passages could be catastrophic. One physician later called the rigid gastroscope "one of the most lethal instruments in the surgeon's armamentarium."[30]

Some progress came after World War I. Rudolf Schindler, a specialist in gastrointestinal disease, spent a decade developing a semiflexible gastroscope that could be bent up to 30 degrees.[31] It was an improvement, but not much from the patient's viewpoint.[32] Lamm took a course from Schindler at the University of Munich and decided the instrument wasn't flexible enough after watching Schindler use it.