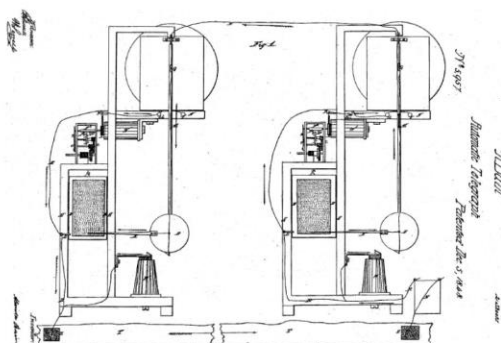


## Alexander Bain Introduced the Concept of Scanning for Image Transmission

Alexander Bain published the concept, including linear (horizontal) scanning lines, pixels, and both line and frame synchronization in British patent 9,745, May 27, 1843, "Certain Improvements in Producing and Regulating Electric Currents, and Improvements in Electric Time-pieces, and in Electric Printing and Signal Telegraphs." The section of that patent specific to image scanning was issued as Bain's first U.S. patent, number 5,957, December 5, 1848, "Improvement in copying surfaces by electricity." A figure from the U.S. patent (same as in the British one) is at right. The dotted rectangles are the images; the dots, effectively, are pixels.



Most histories of television technology credit Bain with the introduction of image scanning. Perhaps this paragraph, from page 150 of the 1984 IEEE Press book *Engineers & Electrons: a Century of Electrical Progress* by John Douglas Ryder and Donald G. Fink (the latter the secretary of both National Television System Committees, NTSC), says it best:

"An alternative [to connecting each camera pixel to a receiver pixel by a separate circuit] would be to send the currents associated with the picture elements one at a time over a single circuit. This would require exact synchronization of the successive views of the elements at transmitter and receiver. This scheme has been the basis of all television systems from 1925 to the present. In an early exemplification of this idea, Alexander Bain, a Scottish watchmaker, in 1843 suggested a telegraph which would transmit the characters for messages by producing stains on chemically treated paper. The concept embodied all the geometrical and timing methods of the modern television system."

In his original patent, Bain was clear that the system could transmit images other than "for instance, the surface of printers' types." "It is also evident that a copy of any other surface composed of conducting and non-conducting materials can be transmitted and taken by these means." The reason for describing the "copy" of a "surface" rather than the transmission of an image is that no technology for converting variations in light intensity to electrical signals existed at the time of Bain's patent.

Here is historian George Shiers writing about the development of television in the *SMPTE Journal* (March 1977): "The instrument described in Bain's patent is important for present purposes because it embodies the principle of automatic synchronous control, sequential scanning line by line, and transmission along a single wire with a ground return."

Here is Kodak's L. R. Lankes in his "Historical Sketch of Television's Progress" in the *Journal of the SMPE* in 1948 (the *T* wasn't added until 1950): "Bain's plan was so correct basically that it embraced the fundamentals of all picture transmission, having recognized the particular problems posed by the need for synchronization between transmitter and receiver."

There does not appear to have been any image-scanning system prior to Bain's, and it's possible to trace a direct line from Bain to the first television systems. Even William Henry Fox Talbot's patent for "photolyphic engraving," which led to halftone images, was issued in 1852, long after Bain's patent, and the first actual printed halftone image was decades later still.

Four other names might be considered, but then rejected, for this concept: Charles Wheatstone, Frederick Bakewell, Giovanni Caselli, and Paul Nipkow. Wheatstone and Bakewell were direct Bain rivals (and, in some senses, partners) at the time.

Wheatstone published "A New Optical Experiment" in the Royal Institution's *Quarterly Journal of Science, Literature and Art* in volume 23 (1827), page 351. In it, he suggested spinning an opaque disk with a missing wedge in front of a backlit transparent painting for testing persistence of vision. In *Perception and Illusion: Historical Perspectives* (Springer Science 2005), Nicholas J. Wade called Wheatstone's proposal not image scanning but "successive exposure of a moving window in front of a

fixed scene” and traces the idea back to the time of Leonardo da Vinci. It had no transmitter, no receiver, and, therefore, no form of synchronization. It was not used for any form of transmission. Bain and Wheatstone often claimed the same inventions in the telegraphic and other fields, so it seems likely that Wheatstone would have done so in this case, too, if he thought it were the same invention. As Russell Burns put it in his 1998 IEE book *Television: an international history of the formative years*, “Scanning is a vital requirement requirement in all facsimile and, *mutatis mutandis*, television systems, but had not been proposed prior to Bain’s 1843 patent.”

Bakewell was an inventor, entrepreneur, and journalist. In 1847, four years after his patent, Bain repeatedly showed and explained to Bakewell the scanning system with the goal of Bakewell’s publishing stories about it. Bakewell did publish a story in *The Spectator* crediting Bain with the invention of the printing telegraph but used the story to promote his own form of image transmission, using a spinning cylinder, which Bakewell patented while Bain was in America. Reprinting that story, *Mechanics’ Magazine* added a note that Bakewell seemed to be copying Bain’s idea. The *Journal of the Franklin Institute* put it this way: “This is a modification of the instrument of Alex. Bain, Esq.” *Scientific American* similarly cited Bain’s precedence when mentioning Bakewell’s concept.

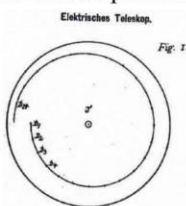
Bakewell’s scanned cylinder was used in Edison’s phonograph and in a 20<sup>th</sup>-century form of fax machines. It’s possible that Bakewell was the first to implement scanning sufficiently well to transmit an image (left), but the date most associated with Bakewell’s successful transmission is November 12, 1850; a comparable-looking image transmitted by a Bain system appeared on the cover of *Mechanics’ Magazine* earlier, on February 9, 1850 (right). Bakewell clearly did not add to the concept of image scanning as it applies to television.



Caselli was the first to develop image transmission to the point of commercial use. Such use (beginning in 1865) occurred after Bain’s patent expired, and Caselli had reverted from Bakewell’s cylinder to something closer to Bain’s original pendulum-based design. He transmitted the image at left from Paris to Lyon in 1862. Caselli is very important in the history of fax transmission, but he added nothing to Bain’s original concept as regards television; he merely continued the thread from Bain toward television.

Caselli’s was also not the first successful implementation; *Scientific American* reported on October 14, 1848 on seeing working machines in Bain’s New York offices, and in 1997 Masayuki Miyazawa published his successful reconstruction of Bain’s machines, using only the 1843 patent, in *The Journal of the Institute of Image Electronics Engineers of Japan*.

Nipkow applied for the first television patent in Germany 1884 and received it in 1885. Two important television-technology historians, Albert Abramson and George Shiers, referred to Nipkow’s patent as “the master television patent.” It does appear to be the first complete, end-to-end television patent, but that’s not necessarily because of the introduction of new technology; the first person to achieve crude television images (by 1879), Denis Redmond of Dublin, for example, wrote *The Times* (of London) in a letter published on May 13, 1880, “I think this of interest to the public, as I have not patented it.”



Nipkow’s scanning was based on a spiral of perforations of a rotating disk, shown at left from his patent. Shiers noted, however, that spiral scanning for television was earlier proposed by such other inventors as George Carey and William Sawyer, who both had their systems described in *Scientific American* (and other publications) more than four years before Nipkow’s patent, though Nipkow was probably the first to suggest a scanning disk. Television systems since 1938, of course, have used neither spiral nor disk-based scanning.

The inevitable conclusion is that Alexander Bain, and he alone, came up with the concept of scanning for all forms of image transmission, including television.

**Courtesy of Mark Schubin**