

AUTOMATIC ELECTRIC



History

It is sad but true that many of the world's successful inventors were not capable of turning their invention into a production item. They needed a businessman or syndicate to provide the business and finance skills they lacked. Without these, many good inventions would have languished. These include the telephone itself. Without the business skills of Gardiner Hubbard and his associates Alexander Bell may never have been able to see the potential of his invention fulfilled.

Another such was Almon Brown Strowger. He had invented an automatic telephone switch that showed great promise, and formed a company in 1891 to handle the patents and their licensing. The company had some rather crude demonstration switches made by a Wichita jeweller, but production was still a long way off.

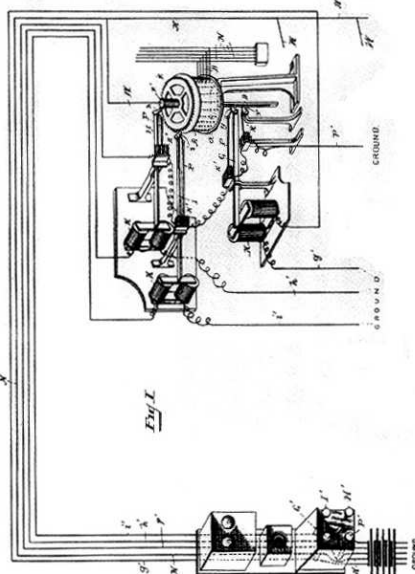


The businessman in the story was Joseph Harris (left). He saw the potential of the Strowger switch in 1890 and formed a new company, the Strowger Automatic Telephone Exchange Company, to build and install the equipment. The company came into being on October 30, 1891. Mr M A Meyer, a Chicago financier, was the company President, Almon Strowger was Vice President, and Joseph Harris was the company Secretary. In the next year another valuable man joined the company, Alexander Keith. He had been sent to evaluate the Strowger system by the Brush Electric Company. His favorable report led to Brush buying a large quantity of shares in the company, which provided some much-needed capital for development work. Keith so liked the system he was persuaded to resign from Brush and join Strowger. He was a very competent engineer with previous telephone experience with a Bell company. He soon redesigned the switch into a production model, and he continued to make valuable developments in the following years. He was joined by John and Charles Erickson, who had made a similar workable system using piano wire and a rotary contact switch at the request of Frank Lundquist, a promoter and businessman. The combination of Strowger's patent, Keith's developments, and the Erikssons' expertise was a winning one.

Twenty switches made by the Union Model Works of Chicago were demonstrated around the U.S. in a fund-raising effort. The company had no telephones to operate the switches at the time, so some were borrowed from the Chicago Telephone Company and suitably adapted. In 1892 the company's first installation was made in La Porte, Indiana, using the latest design of switches made by the Columbia Novelty Works Company. The 99-line exchange was installed free, and no charge was made for calls - it was purely to evaluate the system. This was fortunate, as the Bell company threatened legal action. American Bell's attitude was that A G Bell had invented the first workable telephone and ALL telephone systems therefore were under their control. Since the La Porte service was free, there was not much they could do about it. The exchange was eventually sold to a group of local citizens and continued as a commercial venture. With each new installation Bell would advertise in local newspapers that the system infringed their patents, and threaten legal action against the independent operating company and its subscribers. This intimidation slowed down the rate of sales noticeably. In spite of this, Strowger's patent itself was never challenged in court and it became evident that it would stand up against Bell in litigation. Bell's litigation regarding transmitters and receivers was another matter, and was finally decided against Bell in the early 1900s after the patents had expired anyway.

Keith and the Erickson brothers had by now redesigned Strowger's switch into a precise, extremely complex piece of machinery, as the next pictures show

(No Model.)
A. B. STROWGER.
AUTOMATIC TELEPHONE EXCHANGE.
No. 447,918. Patented Mar. 10, 1891.

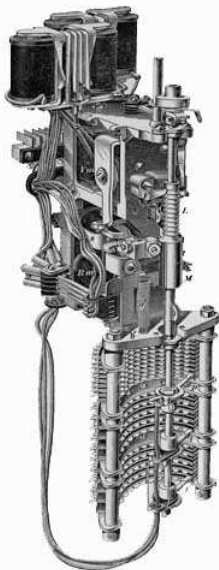


Witnesses:
R. H. (Balderson)
Ch. H. Strowger

Inventor:
Almon B. Strowger

No. 638,249. Patented Dec. 5, 1899.
A. E. KEITH & J. & C. J. ERICKSON.
ELECTRICAL EXCHANGE.
(Application filed Dec. 10, 1898.)
(No Model.) 5 Sheets—Sheet 1

The diagrams above are taken from (top) Strowger's original Patent application, and (bottom) Keith and Ericksons' patent. They show how much design work was needed to turn Strowger's simple idea into a practical switch.

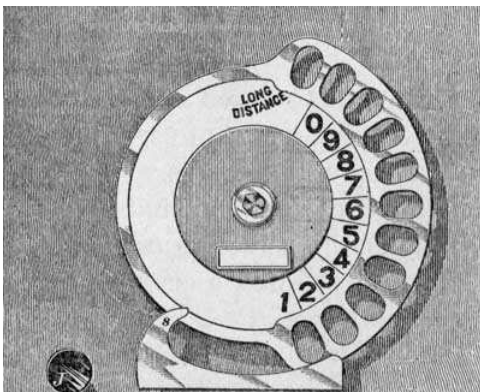


The 1906 version of the step switch. It is now a highly complex and accurate piece of machinery, designed for mass production. It bears little resemblance to Strowger's design.

developing payphones.

The trio went on to develop a method of extending an exchange's capacity by adding more switches, and even to

Several more exchanges were installed in the following couple of years, allowing the company to refine its system and manufacturing processes at a fairly gentle rate. It is probably accurate to say that they never built the same exchange twice, since each new installation incorporated the latest advances and developments.



The early telephones did not have a dial as we know it. Calls were "dialed" by pressing a button the appropriate number of times to force the switch in the exchange to "step" up and then across to the appropriate terminal. This gave the system its common name of "step by step". There is an excellent picture of a pushbutton wall phone at Lee Goeller's website at <http://leegoeller.com/VC1/VC1-23.htm>. The push button dialing method was quickly replaced with the world's first rotary dial in about 1896, once again invented by Keith and the Ericksons. It received a Patent in January 1898 and was called a "Subscribers Selector Calling Device". The word "dial" came into use as a carryover from the failed Lorimer system, where a lever-controlled selector showed the digits in a "dial" window.

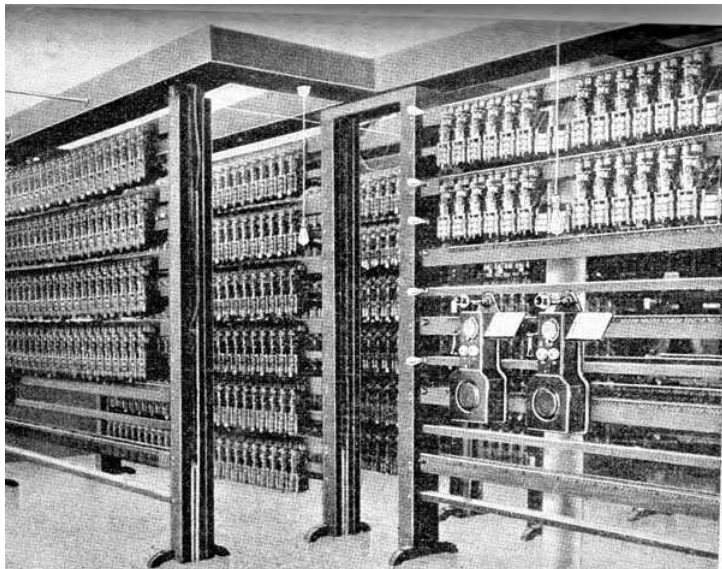
Almon Strowger retired from the company in 1896.

In 1897 a privately financed company, Automatic Telephone Exchange Company, Ltd., of Washington, D. C. was formed by Col. T W Tyrer to exploit the Strowger system by manufacturing and renting out exchanges to other operating companies, and to handle overseas sales. Although this looked like a good move to the almost bankrupt Strowger company, by June 1900 the Washington firm was in arrears and using legal tactics to prevent

Strowger from manufacturing or selling any more exchanges itself. In a well-planned move, Meyer and Keith managed to seize their equipment from the Washington company's factory and return it to their own works in Chicago.

Meanwhile in 1898 Keith had gone to Europe on one of a number of visits to promote the Strowger system, with considerable success. The La Porte exchange was now six years old and the Strowger system was becoming regarded as proven technology. Overseas franchises were arranged over the next few years, and the income from these was useful to the Company. The first AE exchange in Europe was in Amsterdam in 1898, their second in Berlin in 1899. Each had a few hundred subscribers and was as much for evaluation as for usage.

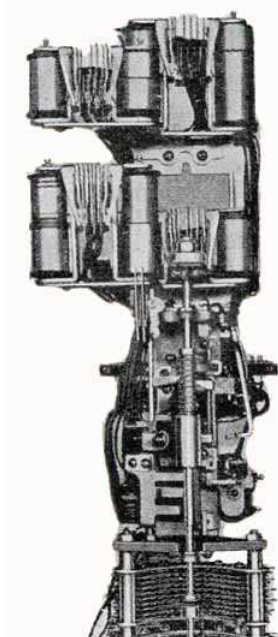
In 1901, the Strowger company formed a new company, the Automatic Electric Company, to handle marketing and production. The Strowger company now acted only as a holder of the patents. Meyer retired and Harris became Vice President. Keith became General Superintendent. The design and manufacturing staff still included the Erickson brothers. By 1910 the company employed 850 workers.



Interior of an early step exchange, from Poole (1912).

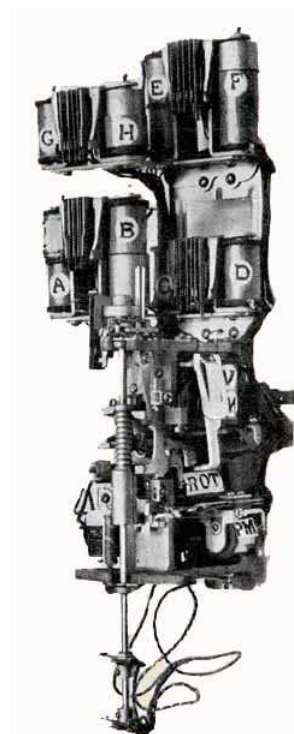
The new company's first contract was for a 6000 line exchange at Dayton. This gives an idea of the size of the exchanges now being installed, and the faith of the independent telephone companies in AE. The Dayton exchange was guaranteed for ten years, with no-cost replacement of any faulty parts at the end of that period. After the ten years period expired a representative of AE went to Dayton to meet with the owners. They asked AE to replace some deteriorating insulation on some switches, a matter of a few hundred dollars worth, but otherwise had no complaints and had not really intended to make any claim at all - the equipment had completely lived up to their expectations. A similar situation occurred at the 10 000-line Grand Rapids exchange. After seven years, around \$900 of maintenance parts had been used. AE credited this amount to the company's account and everyone was well satisfied.

Development of features to add to the exchanges was especially important at the beginning of the 1900s. In 1900 at the New Bedford installation, a "selector" switch detected that a phone had been picked up and then searched for the first available free line switch. This was more efficient, since each customer did not require their own switch. A Chicago installation in 1902 included automatic metering; a 1904 Los Angeles exchange had a third wire in the exchange for internal control and only two wires to the customers' premises instead of three. Improvements to the line switch were eventually made by Siemens & Halske, ATEA, Kellogg, Peel Conner and Keith.



Left: British switch 1908

In the next decade automatic exchanges were installed in increasing numbers. Los Angeles had 19,300 lines of Strowger by 1905 and there were 8000 lines in Chicago. The British Post Office accepted Strowger as its standard automatic switchgear after World War 1, as did Australia and Japan. Siemens and Halske in Germany had signed a license agreement in 1909 that saw them building automatic switchgear for Germany and many other European countries.



Left: U.S. switch, 1912. The contact bank has been removed from the base of the switch.

Harris was instrumental in promoting sales and signing contracts (he had been a travelling salesman in his younger days) for overseas licensing. This as much as any US sales kept the company going. We will look at some of these overseas companies later. Harris was also sorting out the mess made of overseas contracts and licenses by the defunct Washington company. There was strategic value in securing sales in overseas countries. The various competing systems were incompatible, so the first company to sell its systems into a country was likely to tie that market to its products in the future.

The competitors to AE included Siemens & Halske (Germany, with a modified version of Strowger); [Canadian Machine Telephone](#) (Lorimer system, confined mostly to Canada after unsatisfactory trial installations elsewhere); IT&T (based at Bell Telephone Manufacturing Co, Belgium, with their Rotary system developed from the Lorimer switch); Automatic Telephone Manufacturing Co (Britain, with an increasingly modified Strowger system); Ericssons (Sweden, with an early form of crossbar); Relay Automatic Telephone (using a system developed by Betulander); as well as U.S. competition from Stromberg Carlson and Kellogg.

In the United States the situation was again becoming difficult. AT&T, who had so far ignored automatic switching, could no longer do so. Many independent companies were buying from Automatic Electric, and AT&T's own operating companies were becoming dissatisfied with the lack of a competing product. AT&T responded with a campaign of buying out independent companies, ripping out the Strowger equipment, and replacing it with their manual switchboards. Each replacement was advertised as a return to personal service and easier calling. Automatic Electric's equipment was now so reliable that they could offer extended warranties of up to eight years on new installations, but the pressure from AT&T's cheaper manual systems was increasing. Automatic Electric was heading back into financial trouble. AT&T's engineers were questioning the safety of running AE's 48 volt system on lines designed for CB exchanges' 24 volts. AE had to point out in their catalogs that practically all the world's automatic systems were running on plant designed originally for CB. They compromised by making their telephones in styles to which a dial could be easily added later when the telephone company was ready to upgrade.

Overlooking the growth of automatic switching was an unusual mistake on the part of American Bell and its AT&T successor. John Carty, Western Electric's chief engineer, seemed to be set against it, partly because of its early inability to handle party lines. He had some research going but it was chronically underfunded. WE had an automatic system of sorts under development, the Panel system. It was descended from a much earlier failed automatic system built by the Lorimer Brothers' Canadian Machine Telephone, and it still had a long way to go to be a satisfactory performer. There was a "not invented here" attitude in Western Electric which effectively locked out products from other manufacturers. Patent conflicts with Automatic Electric's dial were another problem. Through this period of indecision, both American Bell / AT&T and Western Electric, its sole supplier, were concentrating on improving the reliability of their equipment and producing enough manual switchboards to meet the fast-growing market. Lady switchboard operators were cheap, plentiful, and dedicated to their work, so there was little pressure to invest in an entirely new system.

In April 1919 the unthinkable happened. AT&T's manual operators in Boston went on strike for a decent wage. The entire city was crippled for a week by the loss of the very operators whose services Bell had been promoting to their public. The attitude in AT&T changed almost overnight. They had to give in to the operators' demands for a pay rise, and shareholders were made painfully aware of the hidden cost of manual switching. With operating costs now dramatically increased, automatic switching (they called it "machine switching") suddenly looked much more attractive.

At the same time, an astute businessman named Theodore Gary, owner of a number of independent telephone operating companies, was holding an option to buy out financially troubled Automatic Electric. He hurriedly visited Theodore Vail, head of AT&T, and offered a long term agreement for AT&T to produce automatic equipment under license from Automatic Electric (which he didn't actually own yet). With funding assured by AT&T on a five year contract and a ten percent deposit in his pocket, he then took up the option to purchase AE. And so Automatic Electric became part of the Gary group of companies, later known as Associated Telephone and Telegraph. Gary also started buying into the overseas licensee companies, gradually widening AE's influence in its market areas. This often allowed them to appoint their own men to the Boards, and these were generally men of great ability and local influence. As an example, in 1928 the Board of ATEA in Belgium consisted of

Sir Alexander Roger (British businessman and financial wizard, head of British Insulated, and on the Board of Midlands Bank),
 Charles Holder: a banker
 Geo Roberts: accountant
 Edward Mellinger: an AE engineer from the United States
 and a number of influential local businessmen.

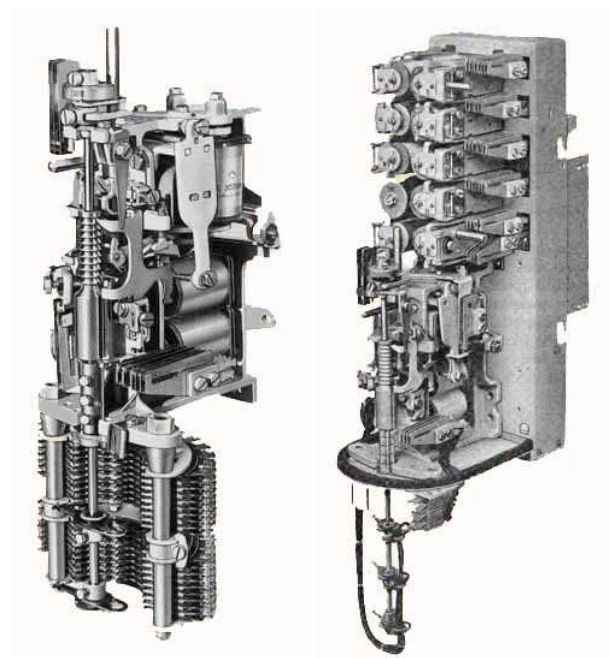
The number of local businessmen on the Boards is significant. Apart from their influence, it gave the companies a local feel rather than an American one. It is also significant that many of the people on the Boards were engineers. This had two advantages for AE. They had some influence over their European markets, and they were able to keep a close eye on developments in technology. In the case of Britain and Belgium, the local firms were doing useful development work which found its way back to the parent company. One such was the RAX, the Rural Automatic Exchange. This was a small self-contained exchange in a transportable building that could be used to rapidly automate rural areas. Typically between 50 and 200 lines, it was developed by the British and Australian Post Offices in conjunction with AE's British licensee ATM. It found ready markets worldwide.

The five year contracts with AT&T were renewed a number of times, and Automatic Electric switches, further developed by Western Electric, became their standard switchgear. AE even supplied switchgear to AT&T until 1936, and installed AT&T's first automatic exchange at Norfolk in 1919. Western Electric continued to develop their Panel system but it was only to be economic in large cities.

In 1920 AE introduced their Director system. Rather than feed the dialling pulses directly to the switch, this system stored the pulses and fed them at a rate that allowed Director to dial its way out of its exchange and into other exchanges in the network, waiting if necessary until the connection was made to the other exchange. During the 1920s, AE built or licensed around 80% of the world's automatic telephone systems.

Joseph Harris had been made Chairman of the Board in 1919 following the takeover by the Gary Group. He retired in 1923 and the man who had nursed Automatic Electric through its early most troubled years died on April 1st 1936.

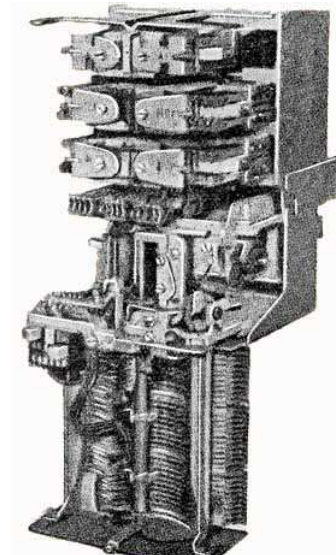
Automatic Electric was now in a financially secure position, and the move into bakelite telephones in the 1930s presented no problems. The styling of their telephones was widely regarded as not being as attractive as the Western Electric telephones, but the independent companies AE was supplying were satisfied.



Left: Automatic Electric Belgium step switch, late 1940s. Note the magnets have been moved to the centre of the switch to make it more compact, a useful feature as exchanges got bigger.

Right: British switch from the late 1930s (Not to scale, contact bank removed). The extra relays were for extra features. They were later changed to double-

contact relays for better reliability - when one contact became dirty, the other one would still operate the switch.



Left: British Switch, 1940s. This was usually enclosed in a steel "can"

The situation continued this way until after the second World War, when the Bell company AT&T came under increased Government pressure. The sole-supplier arrangement between AT&T and Western Electric was coming under fire as a way to keep the Bell system telephone prices artificially high. Western Electric partly overcame the opposition by making its designs available to firms like Automatic Electric. AE's Chicago works now employed around 8000 people. They adopted the WE designs in the interests of cheaper manufacture and standardization. They modified the WE case design somewhat to produce a phone that was not so obviously a Western Electric (many of their customers in the independent telephone companies wanted their phones to look different, to highlight their independence). Eventually the sheer economics told against AE and they produced the same design as the other manufacturers, based on the WE 500 series phone.

A curious side effect of WW2 was a short burst of growth in step by step production. Many countries had a need to update their elderly, war-damaged or worn out telephone systems, and wanted local manufacture. ATE in Britain was able to help many of these countries set up their own industries, often selling them some of ATE's older equipment to produce British 2000-series step switches and the BPO's proven 300 series telephones under license. Although the designs were old, they were inexpensive and functional - enough to get the developing countries started. Step switches were produced in Portugal, India, Israel, and a number of other countries until Ericssons' crossbar switch started to take over the market. In the U.S., Stromberg Carlson was also selling a simpler competing system, their X-Y step-by-step equivalent. There is a good description at <http://www.privateline.com/TelephoneHistory4/History4A.htm>

The Theodore Gary group still held ownership of Automatic Electric until 1955, when it was bought by GTE (General Telephone & Electric). GTE was more a group of independent operating companies than a conglomerate, and its service record was poor. The efficient AE Chicago factory was moved to Northlake, and the once-proud company was dismantled piecemeal. In the late 1960s and 1970s production was spread over a number of factories. Transmission equipment came from San Carlos, exchange switches from Northlake and possibly Genoa, and telephones were made at Huntsville in Alabama. This reflected the power of the individual companies within GTE rather than economic reasons.

During the 1960s, AE was investigating electronic switching for GTE. It must have been a culture shock to the firm's engineers, changing from a refined seventy-year-old technology. AE realised that its customers would soon want telephone exchanges with new features, and electronic was the way to go. There was a limit to what the step technology could be made to do. Following the move from Chicago to Northlake in 1957, the company also started designing new exchange modules that were compatible with existing networks and could, if necessary, be used to upgrade an existing exchange. Automatic Electric Laboratories was formed to carry out this work, one of GTE's few sensible moves. The new system was christened EAX.

In a wise move, AE employed some engineers from the North Electric Company, an Ericsson company. They were familiar with Ericssons' Crossbar switching and their expertise was badly needed. In a move less wise, they started laying off the step employees and hiring new staff for the new processes. Another development, the production of early Integrated Circuits, helped speed the project and dramatically reduce the cost. The first EAX exchange went into trial operation in September 1972. Like the early step exchanges decades earlier, however, improvements were being designed even as the EAX No 1 went into production. By 1982 there were 3 million lines of EAX installed worldwide.

The introduction of electronic exchanges was rapid, and the last step-by-step exchange in the United States was retired from service in 1999. The last one in Britain was closed in 1995, and in Belgium, home of ATEA, in 1994. There are still some countries using step-by-step, mostly in Central America and Africa, where they do not have the capital to update. Many of these survive on parts bought from closed exchanges in other countries. There is an excellent summary of these "lasts" at http://strowger-net.telefoonmuseum.com/tel_hist_last.html. The average life of a step by step exchange turned out to be around forty years, which represented good value for the telephone companies who used them.

In 1983 GTE merged Automatic Electric and another of their firms. Lenkurt, into GTE Network Systems. In 1989 the company and AT&T merged their holdings into a new company, AG Communication Systems, which later was sold off as part of Lucent.

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I am indebted to Jan Verhelst for the help that he and his associates have given me. Their experience in the factories in the U.S. and ATEA in Belgium is invaluable.

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