

Elisha Gray is one of our more important and prolific inventors, yet today his almost unknown.

He was born in 1835 in Ohio. He was raised on a farm where he was expected to be able to solve all types of mechanical problems with minimal resources. He went on to attend Oberlin College for several years, though he never received a diploma. While at Oberlin, he taught classes in electrical theory and built specialized equipment for the science labs.

In 1865, Elisha had his first invention – a self-adjusting relay for the telegraphic system. You recall a relay is a form of electrically controlled switch. Relays are useful in many applications and Gray's invention was specifically to help address the problem of coping with the electrical differences between disparate cross country telegraph lines.

He received his first patent on this device two years later. He would be granted more than seventy in his long career.

In 1869, Elisha partnered with Enos Barton to found Gray & Barton Company in Cleveland, Ohio. This company manufactured telegraph equipment for the Western Union Telegraph Company – the largest telegraph company in the world. Eventually, this company split into two parts with the parts distribution business moving into the new company called Graybar Electric company. Today Graybar employs more than eight thousand people and has annual sales of over six billion dollars. Very few businesses survive for a century and a half, much less prosper.

In 1872, Western Union, using money from the Vanderbilts and JP Morgan bought into Gray & Barton Company and renamed the new company Western Electric Manufacturing Company of Chicago. This company manufactured typewriters, lighting equipment and a variety of other electrical equipment. It was also a major supplier to Western Union during a period of growth. Western Electric would be absorbed in 1915 by AT&T, American Telephone and Telegraph – the monopoly telephone vendor in the US. The business continues today though the names have changed along with multiple mergers and reorganizations.

One important byproduct of the Western Electric/AT&T operation was the founding of Bell Telephone Laboratories in 1925. This legendary lab, where our mentor Bill Cheswick, once worked, produced many inventions including the LASER, the transistor and transformed computer science through the development of the UNIX operating system, the C and C++ programming languages. They also pioneered radio astronomy and satellite communications. In all, eight Nobel prizes were awarded to Bell Labs researchers.

So it is clear that Elisha Gray could invent and develop useful technologies and build companies what could stand the test of time, but his greatest contribution was yet to be seen. In 1874, he retired to continue his research. His current project was to create a practical way to send several telegraph messages over a single wire at the same time.

In 1874, the transcontinental railroad had only been operating for five years. Already the need for communications around the country was straining Western Union's ability to string wire and keep the system operating. Adding additional capacity between two cities meant adding additional wires – an expensive and slow solution.

William Orton, the president of Western Union contracted with Gray and Thomas Edison to develop a way to send multiple messages per wire. In other words, he wanted a way to add a device at each end of a telegraph wire that would have the same effect as having a dozen or more new wires.

Gray reasoned that one way to send multiple messages concurrently would be to encode each message using a different tone or vibration. Mathematically, this is much the same way that AM radio operates even today.

Gray's idea required that the sending telegraph key not send a pure DC voltage but a modulated tone which corresponded to the channel over the wire. By 1874, Elisha had demonstrated this invention several times.

Just after Christmas, he demonstrated his transmitter, connecting it to a piano keyboard and using it to play music. He also had to invent the loudspeaker so that people could hear the tones. This was the direct ancestor of today's electronic music and musical synthesizers. In 1875, he was issued a patent for his tonal telegraphic system.

But Gray had done more than just improve the telegraph. He had found a way to transmit sounds over a wire and then convert them back to sound on the other end. He was very close to having a telephone. The one thing he did not have was a microphone or way to convert sound into electrical signals.

On St. Valentine's day, 1876, he filed a patent caveat – what would now be called a provisional patent application – describing a functional telephone with a liquid-based microphone. In his design a conductive diaphragm was placed into a conductive liquid such that electricity could pass from the diaphragm to the liquid. If the diaphragm barely touched the liquid, the circuit would have a high resistance and therefore would only allow a small amount of electricity to flow. However, if the diaphragm was nearly immersed in the liquid, the resistance would be reduced allowing more electricity through the circuit. The key point was that sound, such as the spoken voice, could vibrate the diaphragm, producing a varying electrical current corresponding to the vibrations of the sound.

Gray had a workable telephone system.

On the exact same day, Alexander Graham Bell's attorneys filed a patent for his version of the telephone. The designs had amazing similarities.

To this day, we cannot be sure of what happened next. After extensive courtroom battles, Bell was awarded the patent for the telephone. There have been accusations that the patent examiner was bribed to allow Bell's side access to Gray's filing. It is clear that whatever happened, Bell's side bent the rules severely if they were not broken. Bell likely perjured himself in testifying how some last minute modifications were made to his patent filing—after Gray's side claimed Bell had reviewed Gray's filings.

It is also important to note that Bell developed a reputation for trying to steal inventions from other inventors including the Wright brothers.

But the courts ruled that Bell was the inventor of the telephone.

Interestingly enough, Gray went on to create the telautograph. This device allowed writing over long distances. Someone could write with a pencil in one city and a mechanical pencil in another city would mimic the writer's motion making it possible to send a written message from place to place. This was most valuable as a way to sign legal documents remotely.

The telautograph is the precursor to the FAX machine, but it also much more. It is a pioneering use of servo controls – devices that react in proportion to their inputs. Today you see servo controls in many places. Most RC cars are steered by servomechanisms. The key to servos is that internally they compare the input signal with a measurement of the current output, using the difference to control the operation. This is a form of feedback that is very important for any adaptive system. Elisha Gray was decades ahead of his time.

Gray also pioneered television by developing a device he called the telephote. It used the fact that selenium can be sensitive to light to create a crude camera. The display was made by opening or closing an array of small shutters. A similar selenium grid is the basis of modern Xerox copiers and many scanners.

Gray continued his research projects up until his death in 1901 at the age of 65.

Today Gray is usually discussed in the context of his fight with Bell. Gray spent half a century studying and developing new electrical equipment. Bell was a relative newcomer to electricity, having spent his time working with deaf students. When he consulted Joseph Henry at the Smithsonian for help in 1875, he confessed that he did not have the necessary knowledge to create a telephone. In fact, Bell's telephone first worked in March of 1876 – months after Gray's design.