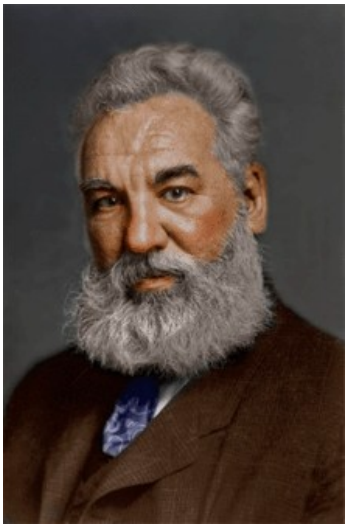
From the Annals of the World History

Alexander Graham Bell

-- March 3, 1847 - August 2, 1922



Alexander Graham Bell was an eminent scientist, inventor, engineer and innovator who is credited with inventing the first practical telephone. His research on hearing and speech further led him to experiment with hearing devices which eventually culminated in Bell being awarded the first U.S. patent for the telephone in 1876. Many other inventions marked Bell's later life, including groundbreaking work in optical telecommunications, hydrofoils and aeronautics. In 1888, Alexander Graham Bell became one of the founding members of the National Geographic Society.

Alexander Bell was born in Edinburgh on March 3, 1847. He had two brothers: Melville James Bell (1845-1870) and Edward Charles Bell (1848-1867). His father was Professor Alexander Melville Bell, and his mother was Eliza Grace (née Symonds).

First invention

As a child, young Alexander Graham Bell displayed a natural curiosity about his world, resulting in gathering botanical specimens as well as experimenting even at an early age. His best friend was Ben Herdman, a neighbour whose family operated a flour mill, the scene of many forays. Young Aleck asked what needed to be done at the mill. He was told wheat had to be de-husked through a laborious process and at the age of 12, Bell built a homemade device that combined rotating paddles with sets of nail brushes, creating a simple de-husking machine that was put into operation and used steadily for a number of years.

From his early years, Bell showed a sensitive nature and a talent for art, poetry and music that was encouraged by his mother. Bell was also deeply affected by his mother's gradual deafness, (she began to lose her hearing when he was 12) and learned a manual finger language so he could sit at her side and tap out silently the conversations swirling around the family parlour. He also developed a technique of speaking in clear, modulated tones directly into his mother's forehead wherein she would hear him with reasonable clarity. Bell's preoccupation with his mother's deafness led him to study acoustics.

Education

As a young child, Bell, like his brothers, received his early schooling at home from his father. At an early age, however, he was enrolled at the Royal High School, Edinburgh, Scotland, which he left at age 15, completing only the first four forms. His school record was undistinguished, marked by absenteeism and lack lustre grades. His main interest remained in the sciences, especially biology, while he treated other school subjects with indifference, to the dismay of his demanding father. Upon leaving school, Bell travelled to London to live with his grandfather, Alexander Bell. During the year he spent with his grandfather, a love of learning was born, with long hours spent in serious discussion and study. The elder Bell took great efforts to have his young pupil learn to speak clearly and with conviction, the attributes that his pupil would need to become a teacher himself. At age 16, Bell secured a position as a "pupil-teacher" of elocution and music, in Weston House Academy, at Elgin, Moray, Scotland. Although he was enrolled as a student in Latin and Greek, he instructed classes himself in return for board and £10 per session. The following year, he attended the University of Edinburgh; joining his older brother Melville who had enrolled there the previous year.

First experiments with sound

Bell's father encouraged Aleck's interest in speech and, in 1863, took his sons to see a unique automaton, developed by Sir Charles Wheatstone based on the earlier work of Baron Wolfgang von Kempelen. The rudimentary "mechanical man" simulated a human voice. Aleck was fascinated by the machine and after he obtained a copy of von Kempelen's book, published in German, and had laboriously translated it, he and his older brother Melville built their own automaton head. Their father, highly interested in their project, offered to pay for any supplies and spurred the boys on with the enticement of a "big prize" if they were successful. While his brother constructed the throat and larynx, Aleck tackled the more difficult task of recreating a realistic skull. His efforts resulted in a remarkably lifelike head that could "speak", albeit only a few words. The boys would carefully adjust the "lips" and when a bellows forced air through the windpipe, a very recognizable "Mama" ensued, to the delight of neighbors who came to see the Bell invention.

However, these initial forays into experimentation with sound led Bell to undertake his first serious work on the transmission of sound, using tuning forks to explore resonance. At the age of 19, he wrote a report on his work and sent it to philologist Alexander Ellis, a colleague of his father (who would later be portrayed as Professor Henry Higgins in Pygmalion). Ellis immediately wrote back indicating that the experiments were similar to existing work in Germany. Dismayed to find that groundbreaking work had already been

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undertaken by Hermann von Helmholtz who had conveyed vowel sounds by means of a similar tuning fork "contraption", he pored over the German scientist's book, Sensations of Tone.

Canada

In 1870, at age 23, Bell, his brother's widow, Caroline (Margaret Ottaway), and his parents travelled on the SS Nestorian to Canada. After landing at Quebec City, the Bells boarded a train to Montreal and later to Paris, Ontario to stay with the Reverend Thomas Henderson, a family friend. After a brief stay with the Hendersons, the Bell family purchased a 10-and-a-half acre farm at Tutelo Heights (now called Tutela Heights), near Brantford, Ontario. The property consisted of an orchard, large farm house, stable, pigsty, hen-house and a carriage house, which bordered the Grand River.

At the homestead, Bell set up his own workshop in the converted carriage house near to what he called his "dreaming place", a large hollow nestled in trees at the back of the property above the river. After setting up his workshop, Bell continued experiments based on Helmholtz's work with electricity and sound. He designed a piano, which, by means of electricity, could transmit its music at a distance. Once the family was settled in, both Bell and his father made plans to establish a teaching practice and in 1871, he accompanied his father to Montreal, where Melville was offered a position to teach his System of Visible Speech.

Work with the deaf

Subsequently, his father was invited by Sarah Fuller, principal of the Boston School for Deaf Mutes (which continues today as the public Horace Mann School for the Deaf), in Boston, Massachusetts, United States, to introduce the Visible Speech System by providing training for Fuller's instructors, but he declined the post, in favor of his son. Traveling to Boston in April 1871, Bell proved successful in training the school's instructors. He was subsequently asked to repeat the program at the American Asylum for Deaf-mutes in Hartford, Connecticut and the Clarke School for the Deaf in Northampton, Massachusetts.

Returning home to Brantford after six months abroad, Bell continued his experiments with his "harmonic telegraph". The basic concept behind his device was that messages could be sent through a single wire if each message was transmitted at a different pitch, but work on both the transmitter and receiver as needed. Unsure of his future, he first contemplated returning to London to complete his studies, but decided to return to Boston as a teacher. His father helped him set up his private practice by contacting Gardiner Greene Hubbard, the president of the Clarke School for the Deaf for a recommendation. Teaching his father's system, in October 1872 Alexander Bell opened his "School of Vocal Physiology and Mechanics of Speech" in Boston, which attracted a large number of deaf pupils with his first class numbering 30 students. While he was working as a private tutor, one of his most famous pupils was Helen Keller, who came to him as a young child unable to see, hear, or speak. She was later to say that Bell dedicated his life to the penetration of that "inhuman silence which separates and estranges."

Several influential people of the time, including Bell, viewed deafness as something that ought to be eradicated, and also believed that with resources and effort they could teach the deaf to speak and avoid the use of sign language, thus enabling their integration within the wider society from which many were often being excluded.

Continuing experimentation

In the following year, Bell became professor of Vocal Physiology and Elocution at the Boston University School of Oratory. During this period, he alternated between Boston and Brantford, spending summers in his Canadian home. At Boston University, Bell was "swept up" by the excitement engendered by the many scientists and inventors residing in the city. He continued his research in sound and endeavored to find a way to transmit musical notes and articulate speech, but although absorbed by his experiments, he found it difficult to devote enough time to experimentation. While days and evenings were occupied by his teaching and private classes, Bell began to stay awake late into the night, running experiment after experiment in rented facilities at his boarding house. Keeping up "night owl" hours, he worried that his work would be discovered and took great pains to lock up his notebooks and laboratory equipment. Bell had a specially made table where he could place his notes and equipment inside a locking cover. Worse still, his health deteriorated as he suffered severe headaches. Returning to Boston in fall 1873, Bell made a fateful decision to concentrate on his experiments in sound.


Bell speaking into prototype model of the telephone

Deciding to give up his lucrative private Boston practice, Bell only retained two students, six-year old "Georgie" Sanders, deaf from birth and 15-year old Mabel Hubbard. Each pupil would serve to play an important role in the next developments. George's father, Thomas Sanders, a wealthy businessman, offered Bell a place to stay at nearby Salem with Georgie's grandmother, complete with a room to "experiment". Although the offer was made by George's mother and followed the year-long arrangement in 1872 where her son and his nurse had moved to quarters next to Bell's boarding house, it was clear that Mr. Sanders was backing the proposal. The arrangement was for teacher and student to continue their work together with free room and board thrown in. Mabel was a bright, attractive girl who was ten years his junior but became the object of Bell's affection. Losing her hearing after a bout of scarlet fever at age five, she had learned to read lips but her father, Gardiner Greene Hubbard, Bell's benefactor and personal friend, wanted her to work directly with her teacher.

Telephone

By 1874, Bell's initial work on the harmonic telegraph had entered a formative stage with progress it made both at his new Boston "laboratory" (a rented facility) as well as at his family home in Canada a big success. While working that summer in Brantford, Bell experimented with a "phonautograph," a pen-like machine that could draw shapes of sound waves on smoked glass by tracing their vibrations. Bell thought it might be possible to generate undulating electrical currents that corresponded to sound waves. Bell also thought that

multiple metal reeds tuned to different frequencies like a harp would be able to convert the undulatory currents back into sound. But he had no working model to demonstrate the feasibility of these ideas.

In March 1875, Bell and Pollok visited the famous scientist Joseph Henry, who was then director of the Smithsonian Institution, and asked Henry's advice on the electrical multi-reed apparatus that Bell hoped would transmit the human voice by telegraph. Henry replied that Bell had "the germ of a great invention". When Bell said that he did not have the necessary knowledge, Henry replied, "Get it!" That declaration greatly encouraged Bell to keep trying, even though he did not have the equipment needed to continue his experiments, nor the ability to create a working model of his ideas. However, a chance meeting in 1874 between Bell and Thomas A. Watson, an experienced electrical designer and mechanic at the electrical machine shop of Charles Williams, changed all that.

With financial support from Sanders and Hubbard, Bell was able to hire Thomas Watson as his assistant and the two of them experimented with acoustic telegraphy. On 2 June 1875, Watson accidentally plucked one of the reeds and Bell, at the receiving end of the wire, heard the overtones of the reed; overtones that would be necessary for transmitting speech. That demonstrated to Bell that only one reed or armature was necessary, not multiple reeds. This led to the "gallows" sound-powered telephone, which was able to transmit indistinct, voice-like sounds, but not clear speech.

Later developments

Continuing his experiments in Brantford, Bell brought home a working model of his telephone. On August 3, 1876, from the telegraph office in Mount Pleasant five miles (8 km) away from Brantford, Bell sent a tentative telegram indicating that he was ready. With curious onlookers packed into the office as witnesses, faint voices were heard replying. The following night, he amazed guests as well as his family when a message was received at the Bell home from Brantford, four miles (six km) distant along an improvised wire strung up along telegraph lines and fences, and laid through a tunnel. This time, guests at the household distinctly heard people in Brantford reading and singing. These experiments clearly proved that the telephone could work over long distances.

Bell began a series of public demonstrations and lectures in order to introduce the new invention to the scientific community as well as the general public. Only one day after, his demonstration of an early telephone prototype at the 1876 Centennial Exposition in Philadelphia made the telephone the featured headline worldwide. Influential visitors to the exhibition included Emperor Pedro II of Brazil, and later Bell had the opportunity to demonstrate the invention personally to William Thomson, a renowned Scottish scientist and even Queen Victoria who had requested a private audience at Osborne House, her Isle of Wight home; she called the demonstration "most extraordinary". The enthusiasm surrounding Bell's public displays laid the groundwork for universal acceptance of the revolutionary device.

The Bell Telephone Company was created in 1877, and by 1886, over 150,000 people in the U.S. owned telephones. Bell company engineers made numerous other improvements to the telephone, which emerged as one of the most successful products ever. In 1879, the Bell company acquired Edison's patents for the carbon microphone from Western Union. This made the telephone practical for long distances and it was no longer necessary to shout to be heard at the receiving telephone.

On January 25, 1915, Bell made the first transcontinental telephone call. Calling from 15 Day Street in New York City, Bell was heard by Thomas Watson at 333 Grant Avenue in San Francisco. The New York Times reported:

On October 9, 1876, Alexander Graham Bell and Thomas A. Watson talked by telephone to each other over a two-mile wire stretched between Cambridge and Boston. It was the first wire conversation ever held. Yesterday afternoon [on January 25, 1915] the same two men talked by telephone to each other over a 3,400-mile wire between New York and San Francisco. Dr. Bell, the veteran inventor of the telephone, was in New York, and Mr. Watson, his former associate, was on the other side of the continent. They heard each other much more distinctly than they did in their first talk thirty-eight years ago.

Family life

On July 11, 1877, a few days after the Bell Telephone Company was established, Bell married Mabel Hubbard (1857-1923) at the Hubbard estate in Cambridge. His wedding present to his bride was to turn over 1,487 of his 1,497 shares in the newly created Bell Telephone Company. They had four children: Elsie May Bell (1878-1964) who married Gilbert Grosvenor of National Geographic fame, Marian Hubbard Bell (1880-1962) who was referred to as "Daisy", and two sons who died in infancy.

Later inventions

Although Alexander Graham Bell is most often associated with the invention of the telephone, his interests were extremely varied. According to one of his biographers, Charlotte Gray, Bell's work ranged "unfettered across the scientific landscape" and he often went to bed voraciously reading the Encyclopaedia Britannica, scouring it for new areas of interest. The range of Bell's inventive genius is represented only in part by the 18 patents granted in his name alone and the 12 he shared with his collaborators. These included 14 for the telephone and telegraph, four for the photophone, one for the phonograph, five for aerial vehicles, four for "hydroairplanes" and two for selenium cells. Bell's inventions spanned a wide range of interests and included a metal jacket to assist in breathing, the audiometer to detect minor hearing problems, a device to locate icebergs, investigations on how to separate salt from seawater, and work on finding alternative fuels.

Bell worked extensively in medical research and invented techniques for teaching speech to the deaf. During his Volta Laboratory period, Bell and his associates considered impressing a magnetic field on a record as a means of reproducing sound. Although the trio briefly experimented with the concept, they were unable to develop a workable prototype. They abandoned the idea, never realizing they had glimpsed a basic principle which would one day find its application in the tape recorder, the hard disc and floppy disc drive and other magnetic media.

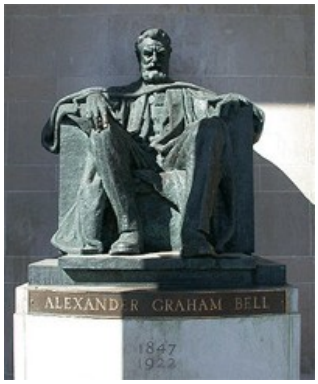
Bell's own home used a primitive form of air conditioning, in which fans blew currents of air across great blocks of ice. He also anticipated modern concerns with fuel shortages and industrial pollution. Methane gas,

he reasoned, could be produced from the waste of farms and factories. At his Canadian estate in Nova Scotia, he experimented with composting toilets and devices to capture water from the atmosphere. In a magazine interview published shortly before his death, he reflected on the possibility of using solar panels to heat houses.

Bell is also credited with the invention of the **metal detector** in 1881. The device was quickly put together in an attempt to find the bullet in the body of U.S. President James Garfield. The March 1906 Scientific American article by American hydrofoil pioneer William E. Meacham explained the basic principle of hydrofoils and hydroplanes. Bell considered the invention of the hydroplane as a very significant achievement. Based on information gained from that article he began to sketch concepts of what is now called a hydrofoil boat. Bell and assistant Frederick W. "Casey" Baldwin began hydrofoil experimentation in the summer of 1908 as a possible aid to airplane takeoff from water. Baldwin studied the work of the Italian inventor Enrico Forlanini and began testing models. This led him and Bell to the development of practical hydrofoil watercraft.

Legacy and honors

Honors and tributes flowed to Bell in increasing numbers as his most famous invention became ubiquitous and his personal fame grew. Bell received numerous honorary degrees from colleges and universities, to the point that the requests almost became burdensome. During his life he also received dozens of major awards, medals and other tributes. These included statuary monuments to both him and the new form of communication his telephone created, notably the Bell Telephone Memorial erected in his honor in Brantford, Ontario's Alexander Graham Bell Gardens in 1917.



Bell statue by A.E. Cleeve Horne, similar in style to the Lincoln Memorial, in the front portico of the Bell Telephone Building of Brantford, Ontario, The Telephone City

In 1880, Bell received the Volta Prize with a purse of 50,000 francs (approximately US$10,000) for the invention of the telephone from the Académie française, representing the French government. Among the luminaries who judged were Victor Hugo and père Alexandre Dumas. Since Bell was becoming increasingly affluent, he used his prize money to create endowment funds (the 'Volta Fund') and institutions in and around the United States capital of Washington, D.C.. These included the prestigious 'Volta Laboratory Association' (1880), also known as the 'Volta Laboratories' and as the 'Alexander Graham Bell Laboratory', as well the Volta Bureau (1887) as a center for studies on deafness. The Volta Laboratory became a permanently funded experimental facility devoted to scientific discovery, and the very next year invented a wax phonograph cylinder that was later used by Thomas Edison.

The laboratory was also the site where he and his assistant invented his 'proudest achievement', the photophone, the optical telephone which presaged fibre optical telecommunications, while the Volta Bureau would later evolve into the Alexander Graham Bell Association for the Deaf and Hard of Hearing (the AG Bell), a leading center for the research and pedagogy of deafness. In partnership with Gardiner Hubbard, Bell helped established the publication Science during the early 1880s.

In 1888, Bell was one of the founding members of the National Geographic Society and became its second president (1897-1904), and also became a Regent of the Smithsonian Institution (1898-1922). The French government conferred on him the decoration of the Légion d'honneur (Legion of Honour); the Royal Society of Arts in London awarded him the Albert Medal in 1902; and the University of Würzburg, Bavaria, granted him a Ph.D. He was awarded the AIEE's Edison Medal in 1914 "For meritorious achievement in the invention of the telephone."

The **bel (B) and the smaller decibel (dB)** are units of measurement of sound intensity invented by Bell Labs and named after him. Since 1976 the IEEE's Alexander Graham Bell Medal has been awarded to honor outstanding contributions in the field of telecommunications.

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