Fulton’s first enthusiasm was for canal development. He designed new types of canal boats, and a system of inclined planes to replace canal locks. Other mechanical problems challenged him. He invented a machine for making rope and one for spinning flax. He made a labor-saving device for cutting marble, and invented a dredging machine for cutting canal channels. In 1796, Fulton published A Treatise on the Improvement of Canal Navigation. About 1797, Fulton turned his attention to the submarine. In 1801, he built a diving boat, the Nautilus, which could descend 25 feet (7.6 meters) underwater. Fulton's work with submarines continued until 1806. He realized the dangers that submarines would bring to naval warfare but thought that they might serve to limit sea war and piracy, for that very reason. Fulton's experimental submarines were able to dive and surface, and he succeeded in blowing up anchored test craft. However, the problem of propulsion underwater was never satisfactorily solved. Fulton's ideas interested both Napoleon Bonaparte and the British Admiralty, but neither ever adopted them wholeheartedly.

In 1802, Robert R. Livingston, the United States minister to France, interested Fulton in turning his attention to the steamboat. Fulton had been interested for many years in the idea of steam propulsion for a boat. An experimental boat, launched on the Seine River in Paris in 1803, sank because the engine was too heavy. But a second boat, which was built in the same year, operated successfully. Fulton returned to the United States in 1806.
Clermont. Fulton directed the construction of a steamboat in New York in 1807. Registered as the North River Steam Boat, the ship was generally called the Clermont after the Hudson River home of Robert Livingston. On Aug. 17, 1807, the steamboat started on its first successful trip 150 miles (241 kilometers) up the Hudson River from New York City to Albany, in about 30 hours, including an overnight stop. After extensive rebuilding, the boat began to provide regular passenger service on the Hudson. The Clermont was not the first steamboat to be built, but it was the first to become a practical, financial, and commercially successful steamboat. Fulton did not try to construct an engine himself, as earlier inventors had done. Instead, he ordered one from Watt and adapted it to his boat.

John Kay

In 1733, John Kay invented the flying shuttle, an improvement to looms that enabled weavers to weave faster. The original shuttle contained a bobbin on to which the weft (weaving term for the crossways yarn) yarn was wound. It was normally pushed from one side of the warp (weaving term for the series of yarns that extended lengthways in a loom) to the other side by hand. Large looms needed two weavers to throw the shuttle. The flying shuttle was thrown by a leaver that could be operated by one weaver.

John Kay was the twelfth child of a farmer and born in Lancashire on July 16, 1704. In 1753, his home was attacked by textile workers who were angry that his inventions might take work away from them. Kay fled England for France where he died in poverty around 1780.

Kay's invention paved the way for mechanical power looms, however, the technology would have to wait another thirty years before a power loom was invented by Edmund Cartwright in 1787.
James Watt

Watt returned to Glasgow in 1756, now a trained instrument maker. His University of Glasgow acquaintances learned of his return, and gave him some work. Watt set up his shop, but found that other instrument makers shunned his credentials and training. He was an outsider in Glasgow, after being trained in London. The University professors recognized his abilities, and did not need to abide by the traditions of the instrument makers. They arranged for permission to set up a shop for Watt on University grounds and created the position "Mathematical Instrument Maker to the University".

Even with the new position, Watt still had trouble finding enough work since the other instrument makers were somewhat hostile. He started making musical instruments to avoid competition. His musical instruments were improvements over existing models and business began to grow. In 1758, an architect gave him backing to open a new shop in the heart of Glasgow. His business and reputation grew steadily and by 1763 he had apprentices of his own, but he was not out of debt.

Watt always had work from the University scientists, so he maintained through the years his shop on the University property. Professor John Anderson was the older brother of a grammar school companion, Andrew. One day in 1763, Professor John Anderson brought Watt a new problem. The University had a lab-scale model of the Newcomen pump to investigate why the full-scale pumps required so much steam. The model suffered a problem. It would stall after a few strokes. Watt recognized that the flaw was due to an undersized boiler that couldn't provide enough steam to reheat the cylinder after a few strokes. (See Newcomen pump details).

Watt was able to get a large engine to work well enough to apply for a patent, and Roebuck
financed the engine patent that was granted in 1769. In exchange, Roebuck agreed to pay off all of Watt debts for his instrument shops but would take two-thirds of the money the invention made. Watt found this agreement acceptable because the large experiments were slow and costly. The invention was far from being ready for production. Then, Roebuck did another thing that helped Watt. He indirectly introduced Watt to Matthew Boulton of Birmingham, England. This last introduction was the one that helped the invention create the steam engine revolution -- but the revolution didn't come easily or fast!

Boulton recognized that the engine had potential applications for much more than pumping water! Boulton was an industrialist with an extraordinary vision to have all craftsmen work in a common building -- a "manufactory" (later shorted to "factory"). Previously, craftsmen had all maintained individual shops. Further, Boulton had the desire to furnish the manufactory with the best equipment and finest craftsmen. Boulton was certain that he could sell the engine.

On March 1776 the Bentley Mining Company started their newest piece of equipment, a Boulton-Watt engine. The Bentley Mining Company had taken a substantial risk by abandoning a half-built Newcomen engine and replacing it with the Boulton-Watt engine.

James Hargreaves

James Hargreaves invented an improved spinning jenny, a hand-powered multiple spinning machine that was the first machine to improve upon the spinning wheel.

James Hargreaves was born in Oswaldtwistle, England in 1720, he received no formal education and was never taught how to read or write. James Hargreaves worked as a carpenter and a weaver. Legend has it that Hargreaves' daughter Jenny knocked over a spinning wheel and as Hargreaves watched the spindle roll across the floor the idea for the spinning jenny came to him. However, that story is just a legend. Jenny was rumored to have been the name of Hargreaves' wife and that he named his invention after her.

The original spinning jenny used eight spindles instead of the one found on the spinning wheel. A single wheel on the spinning jenny controlled eight spindles which created a weave using eight threads spun from a corresponding set of rovings. Later models had up to one-hundred and twenty spindels.

Hargreaves patented a sixteen spindle spinning jenny on July 12, 1770. The courts rejected his patent application for his first spinning jenny because he had made and sold several too long before he filed for a patent. The labor saving
devices threatened workers and in 1768 a group of spinners broke into Hargreaves' house and destroyed his spinning jenny machines, fearing that the machines would take work away from them.

James Hargreaves' invention did in fact decrease the need for labor. The only drawback was that his machine produced thread that was too coarse to be used for warp threads (weaving term for the series of yarns that extended lengthways in a loom) and could only produce weft threads (weaving term for the crossways yarn).

Henry Bessemer

Englishmen, Sir Henry Bessemer (1813-1898) invented the process for mass-producing steel inexpensively, essential to development of skyscrapers. An American, William Kelly, had patent for "a system of air blowing the carbon out of pig iron" a method of steel production known as the pneumatic process of steelmaking. Air is blown through molten pig iron to oxidize and remove unwanted impurities.

Bankruptcy forced Kelly to sell his patent to Bessemer, who had been working on a similar process for making steel. Bessemer patented "a decarbonization process, utilizing a blast of air" in 1855.

Modern steel is made using technology based on Bessemer's process. Bessemer was knighted in 1879 for his contribution to science. The "Bessemer Process" for mass-producing steel, was named after Bessemer.

Invention Impact

British inventors Henry Bessemer’s creation of the Bessemer converter was a major
advancement for steel making. Prior to his work, steel was scarce, made through a costly and arduous process. His technique prompted a revolution in manufacturing.

Bessemer’s interest in steel came from an idea he had during the Crimean War to make a new type of artillery. Existing cannons were not strong enough, so he thought to improve the cannons by strengthening the steel. In doing so, he created the idea for the Bessemer converter, which allowed unskilled workers to make vast quantities of quality steel cheaply. An egg-shaped vat held molten iron, and cold air was blown into perforations in the bottom to remove the carbon and other impurities in the iron. The process only took 20 minutes and raised annual steel production enormously while reducing cost dramatically. Vital in propelling the Industrial Revolution, the Bessemer converter ceased being used in the mid-1900s.

Elias Howe

Elias Howe was the inventor of the first American-patented sewing machine. Elias Howe was born in Spencer, Massachusetts on July 9, 1819. After he lost his factory job in the Panic of 1837, Howe moved from Spencer to Boston, where he found work in a machinist's shop. It was there that Elias Howe began tinkering with the idea of inventing a mechanical sewing machine.

Eight years later, Elias Howe demonstrated his machine to the public. At 250 stitches a minute, his lockstitch mechanism outstitched the output of five hand sewers with a reputation for speed. Elias Howe patented his lockstitch sewing machine on September 10, 1846 in New Hartford, Connecticut.

For the next nine years Howe struggled, first to enlist interest in his machine, then to protect his patent from imitators who refused to pay Howe royalties for using his designs. His lockstitch mechanism was adopted by others who were developing sewing machines of their own.
During this period, Isaac Singer invented the up-and-down motion mechanism, and Allen Wilson developed a rotary hook shuttle. Howe fought a legal battle against other inventors for his patent rights and won his suit in 1856.

After successfully defending his right to a share in the profits of other sewing machine manufacturers, Howe saw his annual income jump from three hundred to more than two hundred thousand dollars a year. Between 1854 and 1867, Howe earned close to two million dollars from his invention. During the Civil War, he donated a portion of his wealth to equip an infantry regiment for the Union Army and served in the regiment as a private.

**Eli Whitney**

In 1794, U.S.-born inventor Eli Whitney (1765-1825) patented the cotton gin, a machine that revolutionized the production of cotton by greatly speeding up the process of removing seeds from cotton fiber. By the mid-19th century, cotton had become America's leading export. Despite its success, the gin made little money for Whitney due to patent-infringement issues. Also, his invention offered Southern planters a justification to maintain and expand slavery even as a growing number of Americans supported its abolition. Based in part on his reputation for creating the cotton gin, Whitney later secured a major contract to build muskets for the U.S. government. Through this project, he promoted the idea of interchangeable parts—standardized, identical parts that made for faster assembly and easier repair of various devices. For his work, he is credited as a pioneer of American manufacturing.

Whitney received a patent for his invention in 1794; he and Miller then formed a cotton gin manufacturing company. The two entrepreneurs planned to build cotton gins and install them on plantations throughout the South, taking as payment a portion of all the cotton produced by each plantation. While farmers were delighted with the idea of a machine that
could boost cotton production so dramatically, they had no intention of sharing a significant percentage of their profits with Whitney and Miller. Instead, the design for the cotton gin was pirated and plantation owners constructed their own machines—many of them an improvement over Whitney's original model.

One inadvertent result of the cotton gin's success, however, was that it helped strengthen slavery in the South. Although the cotton gin made cotton processing less labor-intensive, it helped planters earn greater profits, prompting them to grow larger crops, which in turn required more people. Because slavery was the cheapest form of labor, cotton farmers simply acquired more slaves.

**Alexander Graham Bell**

(1847-1922), the Scottish-born American scientist best known as the inventor of the telephone, worked at a school for the deaf while attempting to invent a machine that would transmit sound by electricity. Bell was granted the first official patent for his telephone in March 1876, though he would later face years of legal challenges to his claim that he was its sole inventor, resulting in one of history's longest patent battles. Bell continued his scientific work for the rest of his life, and used his success and wealth to establish various research centers nationwide.

Never adept with his hands, Bell had the good fortune to discover and inspire Thomas Watson, a young repair mechanic and model maker, who assisted him enthusiastically in devising an apparatus for transmitting sound by electricity. Their long nightly sessions began to produce tangible results. The fathers of George Sanders and Mabel Hubbard, two deaf students whom he helped, were sufficiently impressed with the young teacher to assist him financially in his scientific pursuits. Nevertheless, during normal working hours Bell and Watson were still obliged to fulfill a busy schedule of professional demands. It is scarcely surprising that Bell's health again suffered. On April
6, 1875, he was granted the patent for his multiple telegraph; but after another exhausting six months of long nightly sessions in the workshop, while maintaining his daily professional schedule, Bell had to return to his parents' home in Canada to recuperate. In September 1875 he began to write the specifications for the telephone. On March 7, 1876, the United States Patent Office granted to Bell Patent Number 174,465 covering "The method of, and apparatus for, transmitting vocal or other sounds telegraphically . . . by causing electrical undulations, similar in form to the vibrations of the air accompanying the said vocal or other sounds.

In 1880 France honoured Bell with the Volta Prize; and the 50,000 francs (roughly equivalent to U.S. $10,000) financed the Volta Laboratory, where, in association with Charles Sumner Tainter and his cousin, Chichester A. Bell, Bell invented the Graphophone. Employing an engraving stylus, controllable speeds, and wax cylinders and disks, the Graphophone presented a practical approach to sound recording. Bell's share of the royalties financed the Volta Bureau and the American Association to Promote the Teaching of Speech to the Deaf (since 1956 the Alexander Graham Bell Association for the Deaf). May 8, 1893, was one of Bell's happiest days; his 13-year-old prodigy, Helen Keller, participated in the ground-breaking ceremonies for the new Volta Bureau building—today an international information centre relating to the oral education of the deaf.

Thomas Edison

Born in Ohio in 1847, Thomas Edison was one of the world's most prolific inventors, awarded a record 1,093 individual patents. Working at the tail end of the Industrial Revolution, Edison was one of the first inventors to embrace the concept
mass production, and created the world's first industrial research laboratory, in Menlo Park, New Jersey. Known as the "Wizard of Menlo Park," Edison created or improved dozens of items which would revolutionize the way the world communicates including the phonograph, and the motion picture camera. His work in the field of electricty resulted in the commercial lightbulb and the generation and distribution of electricity to the world.

The phonograph
Edison invented many items, including the carbon transmitter, in response to specific demands for new products or improvements. But he also had the gift of serendipity: when some unexpected phenomenon was observed, he did not hesitate to halt work in progress and turn off course in a new direction. This was how, in 1877, he achieved his most original discovery, the phonograph. Because the telephone was considered a variation of acoustic telegraphy, Edison during the summer of 1877 was attempting to devise for it, as he had for the automatic telegraph, a machine that would transcribe signals as they were received, in this instance in the form of the human voice, so that they could then be delivered as telegraph messages. (The telephone was not yet conceived as a general, person-to-person means of communication.) Some earlier researchers, notably the French inventor Léon Scott, had theorized that each sound, if it could be graphically recorded, would produce a distinct shape resembling shorthand, or phonography (“sound writing”), as it was then known. Edison hoped to reify this concept by employing a stylus-tipped carbon transmitter to make impressions on a strip of paraffined paper. To his astonishment, the scarcely visible indentations generated a vague reproduction of sound when the paper was pulled back beneath the stylus.

Edison unveiled the tinfoil phonograph, which replaced the strip of paper with a cylinder wrapped in tinfoil, in December 1877. It was greeted with incredulity. Indeed, a leading French scientist declared it to be the trick device of a clever ventriloquist. The public's amazement was quickly followed by universal acclaim. Edison was projected into worldwide prominence and was dubbed the Wizard of Menlo Park, although a decade passed before the phonograph was transformed from a laboratory curiosity into a commercial product.

Electricity and Lightbulb - History

Thomas Edison's greatest challenge was the development of a practical incandescent, electric light. Contrary to popular belief, he didn't "invent" the lightbulb, but rather he improved upon a 50-year-old idea. In 1879, using lower current electricity, a small carbonized filament, and an improved vacuum inside the globe, he was able to produce
a reliable, long-lasting source of light. The idea of electric lighting was not new, and a number of people had worked on, and even developed forms of electric lighting. But up to that time, nothing had been developed that was remotely practical for home use. Edison's eventual achievement was inventing not just an incandescent electric light, but also an electric lighting system that contained all the elements necessary to make the incandescent light practical, safe, and economical. After one and a half years of work, success was achieved when an incandescent lamp with a filament of carbonized sewing thread burned for thirteen and a half hours.

Samuel Morse

Morse was traveling to the United States from Europe on a ship, when he overheard a conversation about electromagnetism that inspired his idea for an electric telegraph. Though he had little training in electricity, he realized that pulses of electrical current could convey information over wires. The telegraph, a device first proposed in 1753 and first built in 1774, was an impractical machine up until that point, requiring 26 separate wires, one for each letter of the alphabet. Around that time two German engineers had invented a five-wire model, but Morse wanted to be the first to reduce the number of wires to one.

Between 1832 and 1837 he developed a working model of an electric telegraph, using crude materials such as a home-made battery and old clock-work gears. He also acquired two partners to help him develop his telegraph: Leonard Gale, a professor of science at New York University, and Alfred Vail, who made available his mechanical skills and his family's New Jersey iron works to help construct better telegraph models.

Morse's first telegraph device, unveiled in 1837, did use a one-wire system, which produced an EKG-like line on tickertape. The dips in the line had to be de-coded into letters and numbers using
a dictionary composed by Morse, this assuming that the pen or pencil wrote clearly, which did not always happen. By the following year he had developed an improved system, having created a dot-and-dash code that used different numbers to represent the letters of the English alphabet and the ten digits. (His assistant Vail has been credited by Franklin T. Pope--later a partner of Thomas Edison--with inventing this "dots and dashes" version). This coding system was significantly better, as it did not require printing or decoding, but could be "sound read" by operators. In 1838, at an exhibition of his telegraph in New York, Morse transmitted ten words per minute using the Morse code that would become standard throughout the world.

In 1842, Morse convinced Congress to provide $30,000 in support of his plan to "wire" the United States. Meanwhile, Morse also solicited and received advice from a number of American and European telegraphy experts, including Joseph Henry of Princeton, who had invented a working telegraph in 1831, and Louis Breguet of Paris. In 1844, Morse filed for a patent (granted 1849) of the printing telegraph. He had already proved that his device worked over short distances, and the Federal funds he raised had allowed him to string a wire from Baltimore to Washington. On May 11, 1844, Morse sent the first inter-city message. Soon thereafter, he gave the first public demonstration, in which he sent a message from the chamber of the Supreme Court to the Mount Clair train depot in Baltimore. The message itself was borrowed from the Bible by the daughter of the Commissioner of Patents and said, "What hath God wrought?" By 1846, private companies, using Morse's patent, had built telegraph lines from Washington to Boston and Buffalo, and were pushing further. The telegraph spread across the US more quickly than had the railroads, whose routes the wires often followed. By 1854, there were 23,000 miles of telegraph wire in operation. Western Union was founded in 1851, and in 1866, the first successful trans-Atlantic cable link was established. Though Morse didnât invent the telegraph and did not single-handedly create Morse Code, he may have been telegraphy's greatest promoter, and undoubtedly contributed to its rapid development and adoption throughout the world.