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The history of batteries

Prehistoric origins

The earliest known form of the modern-day battery dates back 2,000 years to the Parthian Empirei (present-day Iran and Iraq).

In June 1936, workers constructing a railway in Khujut Rabu, a town just outside of modern Baghdad, found an ancient tomb. In it, they found a prehistoric battery, now known as the 'Parthian Battery'ii.

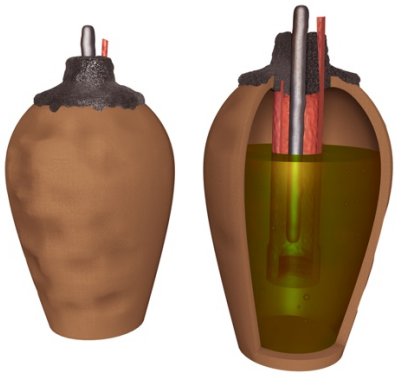

Figure 1. The Parthian Battery

The Parthian Battery consists of an earthenware jar with an asphalt 'cork'. Sticking out of the asphalt cork was an iron bar, surrounded by a copper cylinder. When filled with a liquid like vinegar, the jar produces between 1.1 to 2.0 volts[iii]. The vinegar acts as an electrolytic solution[iv], which is a liquid that conducts electricity.

It is uncertain whether this prehistoric battery was used as a source of energy, or for electroplating. Electroplating is a process of adding a thin layer of a precious metal to another surface. There is some archaeological evidence to suggest that the ancient Egyptians and Babylonians used similar devices[v].

Battery pioneers

The first attempts at generating electricity were experiments with static charge. Static charge is caused by an imbalance between negative and positive charges in an object. This imbalance leads to build up of electricity on the surface. You can discover static electricity for yourself by rubbing a balloon on your hair.

A pioneer in static electricity experiments was German scientist, Otto von Guericke (1602-1683)[vi]. He invented an electrostatic generator using a Sulphur globe attached to an iron rod[vii]. Rubbing the globe created a charge, allowing objects like feathers and paper to be attracted to or repelled from it[viii].

German physicist Ewald Georg von Kleist (1700-1748)[ix], and Dutch scientist, Pieter van Musschenbroek (1692-1761)[x] also experimented with static electricity, inventing the 'Leyden Jar'. This was a glass jar lined inside and out with metallic foil that could store static charge[xi].

It was Italian physicist, Alessandro Volta (1745-1827)[xii], however, who is credited with inventing the modern battery.

Figure 2. Alessandro Volta

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Volta's early work built on previous experiments with static charge. In the late 1700s, he began experimenting with the movement of currents between different metals by placing them on his tongue[xiii].

This line of experimentation was inspired by his colleague, Luigi Galvani (1737-1798), who was studying the effects of placing metallic objects on the legs of dead, skinned, frogs. Through this work, Galvani is known as the discoverer of 'animal electricity'[xiv].

Volta's experimentation found that the frog was not needed, and that certain fluids worked as a conductor for electrical currents[xv].

This discovery led to the invention of the 'voltaic pile' – the world's first electric battery[xvi]. See Figure 2.

The voltaic pile consisted of alternating copper and Zinc discs (electrodes), separated by cardboard, or felt spacers soaked in salt water (electrolytic solution)[xvii].

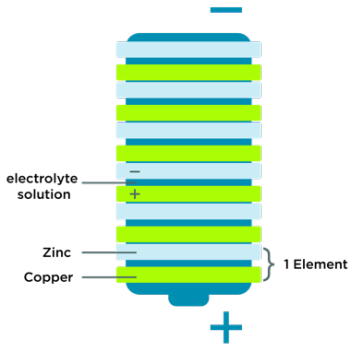

Figure 3. By Borbrav, svg version by Luigi Chiesa - Image: Voltaic pile.png, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=5091724

The modern era

A period of development and innovation followed the invention of Volta's Voltaic Pile.

English chemist Sir Humphry Davy (1778-1929) installed an electric battery at the Royal Institution of London in 1800[xviii]. Then in 1802, English chemist William Cruickshank (1760-1811)[xix] designed the first mass-produced electric battery[xx].

Rechargeable batteries came a few years later. In 1859, French physician Gaston Planté (1834-1889)[xxi] invented the first, rechargeable lead-acid battery[xxii], which is that same system we use today.

The Nickel-Cadmium (NiCd) battery came next, and was invented by Swedish engineer, Waldemar Jungner (1869-1924) in 1899[xxiii]. Over the next five decades, this technology was further developed, and in 1947 German inventor, Georg Neumann (1898-1976) invented the first fully sealed NiCd battery[xxiv].

Lithium batteries were developed by American chemist, Gilbert N. Lewis (1875-1946)[xxv], with non-rechargeable versions becoming commercially available in the early 1970s[xxvi].

Figure 4. lithium batteries.

Unfortunately, the chemistry of these early lithium batteries could cause electrical short circuits. A short circuit happens when excessive electricity flows down an unintended path (for example, if two wires touch). This can lead to 'thermal runway'[xxvii], where one exothermal (heat releasing) process triggers other exothermal

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processes. This results in an uncontrollable increase in temperature, and in extreme cases, fire[xxviii].

Further research and development followed, which saw a move away from metallic lithium-based batteries to lithium-ion batteries. These batteries use a compound of lithium plus a second molecule, with a net electrical charge[xxix]. Lithium-ion batteries were first commercialised by Sony in 1991[xxx].

In 2008, Tesla unveiled the Roadster, making it the first car company to commercialise a battery-powered electric vehicle vehicle.

Figure 5. Tesla Electric Vehicles

Today, there are six main types of lithium-ion batteries[xxxi]:

- **Lithium cobalt oxide** – used in mobile phones, laptops, and digital cameras.
- **Lithium manganese oxide** – used in medical equipment, power tools, hybrid, and electric vehicles.
- **Lithium nickel manganese cobalt oxide** – used in power tools and e-bikes.
- **Lithium iron phosphate** – used to replace lead acid batteries in vehicles.
- **Lithium nickel cobalt aluminium oxide** – used in medical equipment and electric vehicles.
- **Lithium titanate** – used in uninterrupted power supply (UPS), electric vehicles and solar-powered street lighting.

The future of batteries

Future innovations are likely to increase batteries' length of charge and power capacity. It's also likely that batteries will move away from the use of rare metals, which are a finite and limited resource. IBM Research, for example, are working on a new type of battery that uses materials extracted from seawater

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B-cycle Battery Recycling

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