Circuit Lab History

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Based entirely on wikipedia.

André-Marie Ampère

In September 1820, Ampère's friend and eventual eulogist François Arago showed the members of the French Academy of Sciences the surprising discovery of Danish physicist Hans Christian **Ørsted** that a **magnetic needle is deflected by an adjacent electric current**. Ampère began developing a mathematical and physical theory to understand the relationship between electricity and magnetism. Furthering Ørsted's experimental work, **Ampère showed that two parallel wires carrying electric currents attract or repel each other, depending on whether the currents flow in the same or opposite directions**, respectively - this laid the foundation of electrodynamics. He also applied mathematics in generalizing physical laws from these experimental results. The most important of these was the principle that came to be called **Ampère's law, which states that the mutual action of two lengths of current-carrying wire is proportional to their lengths and to the intensities of their currents** $Biot - SavartLaw(derivedfromAmpere'sLaw)forthemagneticfieldaroundacurrentcarryingwire : B = \frac{\mu_o I}{2\pi r}$. Ampère also applied this same principle to magnetism, showing the harmony between his law and French physicist Charles Augustin de Coulomb's law of magnetic action. Ampère's devotion to, and **skill with, experimental techniques** anchored his science within the emerging fields of experimental physics.

Ampère also provided a physical understanding of the electromagnetic relationship, **theorizing the existence of an "electrodynamic molecule" (the forerunner of the idea of the electron) that served as the component element of both electricity and magnetism**. Using this physical explanation of electromagnetic motion, Ampère developed a physical account of electromagnetic phenomena that was both empirically demonstrable and mathematically predictive. In 1827 Ampère published his magnum opus, Mémoire sur la théorie mathématique des phénomènes électrodynamiques uniquement déduite de l'experience (**Memoir on the Mathematical Theory of Electrodynamic Phenomena, Uniquely Deduced from Experience**), the work that **coined the name of** his new science, **electrodynamics**, and became known ever after as its founding treatise.

Charles-Augustin de Coulomb

In 1784, his memoir Recherches théoriques et expérimentales sur la force de torsion et sur l'élasticité des fils de metal (Theoretical research and experimentation on **torsion and the elasticity of metal wire**) appeared. This memoir contained the results of Coulomb's experiments on the **torsional force for metal wires, specifically within a torsion balance**. His general result is: the moment of the torque is, for wires of the same metal, proportional to the torsional angle, the fourth power of the diameter and the inverse of the length of the wire.

In 1785, Coulomb presented his first three reports on electricity and magnetism: "Premier Mémoire sur l'Électricité et le Magnétisme".[4] In this publication, Coulomb describes "How to construct and use an electric balance (torsion balance) based on the property of the metal wires of having a reaction torsion force proportional to the torsion angle." Coulomb also **experimentally determined the law that explains**

how "two bodies electrified of the same kind of Electricity exert on each other." (Coulomb's law, $F_E : \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$) On page 574 he states: It follows therefore from these three tests, that the repulsive force that the two balls — [which were] electrified with the same kind of electricity — exert on each other, follows the inverse proportion of the square of the distance. (also Coloumb's law)

"Second Mémoire sur l'Électricité et le Magnétisme".[5] In this publication, Coulomb carries out the "determination according to which laws both the Magnetic and the Electric fluids act, either by repulsion or by attraction." On page 579, he states that the **attractive force between two oppositely charged spheres is proportional to the product of the quantities of charge on the spheres and is inversely proportional to the square of the distance between the spheres.** "Troisième Mémoire sur l'Électricité et le Magnétisme".[6] "On the **quantity of Electricity that an isolated body loses in a certain time period, either by contact with less humid air or in the supports more or less idio-electric**."

Four subsequent reports were published in the following years: (**a bunch of results which are basically special cases of Gauss's Law**) "Quatrième Mémoire"[7] "Where two principal properties of the electric fluid are demonstrated: first, that this fluid ("the electrical aether") does not expand into any object according to a chemical affinity or by an elective attraction, but that it divides itself between different objects brought into contact; second, that in conducting objects, the fluid, having achieved a state of stability, expands on the surface of the body and does not penetrate into the interior." (1786) "Cinquième Mémoire"[8] "On the manner in which the electric fluid divides itself between conducting objects brought into contact and the distribution of this fluid on the different parts of the surface of this object." (1787) "Sixième Mémoire"[9] "Continuation of research into the distribution of the electric fluid between several conductors. Determination of electric density at different points on the surface of these bodies." (1788) "Septième Mémoire"[10] "On magnetism" (1789) Coulomb explained the **laws of attraction and repulsion between electric charges and magnetic poles, although he did not find any relationship between the two phenomena**. He thought that the attraction and repulsion were due to different kinds of fluids. Coulomb also made a significant contribution to the field of tribology. He completed the **most comprehensive study of friction undertaken in the eighteenth century** and was named as one of the 23 "Men of Tribology" by Duncan Dowson.[11]

Gustav Kirchhoff

(KVL KCL) Kirchhoff's first law is that the algebraic sum of currents in a network of conductors meeting at a point (or node) is zero. The second law is that in a closed circuit, the directed sums of the voltages in a closed system is zero.

Also 3 laws of spectroscopy * A solid, liquid, or dense gas excited to emit light will radiate at all wavelengths and thus produce a continuous spectrum. * A low-density gas excited to emit light will do so at specific wavelengths and this produces an emission spectrum. (See also: emission spectrum) * If light composing a continuous spectrum passes through a cool, low-density gas, the result will be an absorption spectrum.

Also Kirchoff's law in Thermochemistry – variation (time derivative) of the heat (enthalpy) of a chemical reaction is given by the difference in heat capacity between products and reactants

Alessandro Volta

Luigi **Galvani**, an Italian physicist, **discovered** something he named, "**animal electricity**" when **two different metals were connected in series with a frog's leg and to one another**. **Volta realised** that the **frog's leg** served as both a conductor of electricity (what we would now call an **electrolyte**) and as a detector of electricity. He also understood that the **frog's legs were irrelevant to the electric current, which was caused by the two differing metals.** He **replaced the frog's leg with brine-soaked paper**, and detected the flow of electricity by other means familiar to him from his previous studies. In this way he **discovered the electrochemical series** (it's the activity series), and the law that the **electromotive force (emf)** of a galvanic cell, consisting of a pair of metal electrodes separated by electrolyte, is the **difference between their two electrode potentials** (thus, two identical electrodes and a common electrolyte give zero net emf). This may be called Volta's Law of the electrochemical series.

In 1800, as the result of a professional disagreement over the galvanic response advocated by Galvani, **Volta invented the voltaic pile, an early electric battery**, which **produced a steady electric current.**[13] Volta had determined that the **most effective pair of dissimilar metals to produce electricity was zinc and copper**. **Initially** he experimented with individual cells in series, **each cell being a wine goblet filled with brine** into which the two dissimilar electrodes were dipped. The **voltaic pile replaced the goblets with cardboard soaked in brine.**

Georg Ohm

Ohm's law first appeared[a] in the famous book Die galvanische Kette, mathematisch bearbeitet (tr., The Galvanic Circuit Investigated Mathematically) (1827) in which he gave his complete theory of electricity.[6] In this work, he stated his law for **electromotive force acting between the extremities** of any part of a circuit **is the product of the strength of the current, and the resistance of that part of the circuit.** (V = IR)[10][11] The book begins with the mathematical background necessary for an understanding of the rest of the work. While his work greatly influenced the theory and applications of current electricity,[5] **it was coldly received at that time**. Ohm presents his theory as one of **contiguous action, a theory which opposed the concept of action at a distance.** Ohm believed that the communication of **[incorrectly assumed] electricity occurred between "contiguous particles"** which is the term he himself used. The paper is concerned with this idea, and in particular with illustrating the differences in this scientific approach of Ohm's and the approaches of Joseph Fourier and Claude-Louis Navier.[12] A study of the conceptual framework used by Ohm in producing Ohm's law has been presented by Archibald.[13] The work of Ohm marked the early beginning of the subject of circuit theory, although this did not become an important field until the end of the century.[14]

Nikola Tesla

Born and raised in the Austrian Empire, Tesla studied engineering and physics in the 1870s without receiving a degree, gaining practical experience in the early 1880s working in telephony and at Continental Edison in the new electric power industry. In 1884 he emigrated to the United States, where he became a naturalized citizen. He **worked for a short time at the Edison Machine Works in New York City** before he struck out on his own. With the help of partners to finance and market his ideas, Tesla set up laboratories and companies in New York to develop a range of electrical and mechanical devices. His **alternating current (AC) induction motor and related polyphase AC patents**, licensed by Westinghouse Electric in 1888, earned him a considerable amount of money and **became the cornerstone of the polyphase system which that company [Westinghouse Electric] eventually marketed.** Attempting to develop inventions he could patent and market, Tesla conducted a range of **experiments with mechanical oscillators/generators, electrical discharge tubes, and early X-ray imaging**. He also built a **wireless-controlled boat**, one of the first-ever exhibited. Tesla became well known as an inventor and demonstrated his achievements to celebrities and wealthy patrons at his lab, and was noted for his showmanship at public lectures. Throughout the 1890s, Tesla pursued his **ideas for wireless lighting and worldwide wireless electric power distribution in his high-voltage, high-frequency power** experiments in New York and Colorado Springs. In 1893, he made pronouncements on the possibility of wireless communication with his devices. Tesla tried to put these ideas to practical use in his **unfinished Wardenclyffe Tower project, an intercontinental wireless communication and power transmitter** [that] ran out of funding before he could complete it.[9] After Wardenclyffe, Tesla experimented with a series of inventions in the 1910s and 1920s with varying degrees of success. Having spent most of his money, Tesla lived in a series of New York hotels, leaving behind unpaid bills. He died in New York City in January 1943.[10] Tesla's work fell into relative obscurity following his death, until 1960, when the General Conference on Weights and Measures named the SI unit of magnetic flux density the tesla in his honor.[11] There has been a resurgence in popular interest in Tesla since the 1990s.[12]

Michael Faraday

Chemistry

- assistant to Humphry Davy
- Study of chlorine
  - Liquified it
  - discovered CCl_6 and C_2Cl_4
  - Composition of chlorine clathrate hydrate
- experiments on the diffusion of gases
- investigated the alloys of steel, and produced several new kinds of glass intended for optical purposes
  - glass was placed in a magnetic field Faraday determined the rotation of the plane of polarisation of light
  - first substance found to be repelled by the poles of a magnet. **discovered diamagnetism**
- Invented Bunsen Burner & Discovered Benzene
- Laws of electrolysis
  - Popularized Terms: cathode, anode, electrode, ion
- metallic nanoparticles in colloidal suspension, incl. optical properties of gold

Electromagnetism

- voltaic pile with seven British halfpenny coins, stacked together with seven disks of sheet zinc, and six pieces of paper moistened with salt water
  - Decomposition of magnesium sulfate
- build **two devices** to produce what he called **"electromagnetic rotation"**. One of these, now known as the **homopolar motor**, caused a continuous circular motion that was engendered by the circular magnetic force around a wire that extended into a pool of mercury wherein was placed a magnet; the wire would then rotate around the magnet if supplied with current from a chemical battery
- published results without acknowledging Wollaston or Davy, leads to controversy
- study whether a magnetic field could regulate the flow of a current in an adjacent wire, but he found no such relationship
- discovered electromagnetic induction
- wrapped two insulated coils of wire around an iron ring, and found that upon passing a current through one coil, a momentary current was induced in the other coil (mutual induction)
- **changing magnetic field produces an electric field**; this relation was modelled mathematically by James Clerk Maxwell as **Faraday's law**
- construct the electric dynamo (a motor)
- electromagnetic forces extended into the empty space around the conductor – lines of flux
- Faraday's ice pail experiment demonstrated that the **charge resided only on the exterior of a charged conductor**, and exterior charge had no influence on anything enclosed within a conductor (Faraday Cage)
- plane of polarization of linearly polarized light can be rotated by the application of an external magnetic field aligned with the direction in which the light is moving