Making Light:
Francis Hauksbee and the Isolation of Electric Fire

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Summary

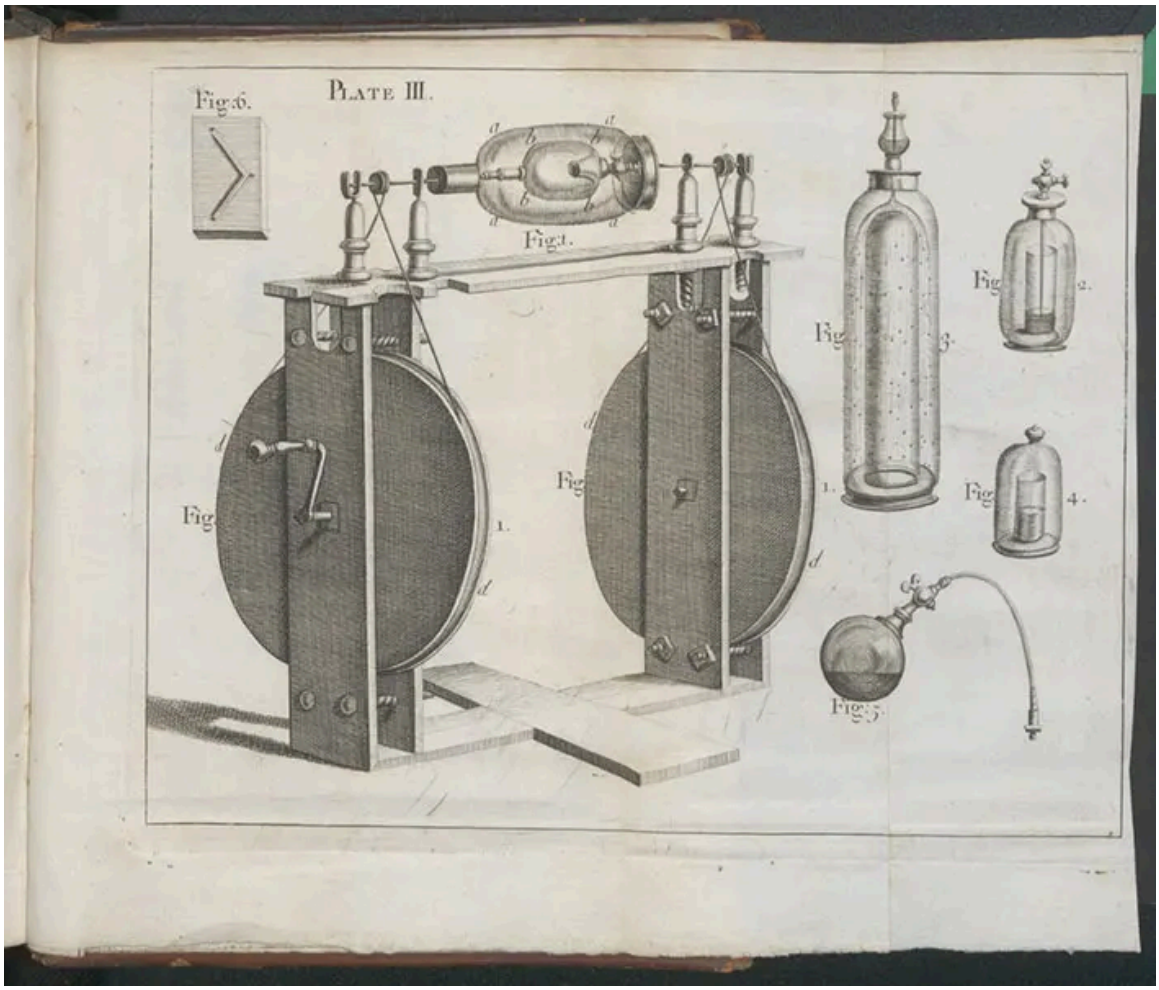
Francis Hauksbee was an instrument maker and experimenter working in the early 1700s. He was the first person to experimentally isolate electric light. Relying on advances that had been made in glassmaking, Hauksbee was able to improve on Robert Boyle's earlier design to create a higher-quality air pump. Using the air pump, he was able to conduct a series of experiments designed to test the characteristics of several phenomena under vacuum. Among these phenomena, Hauksbee investigated the "mercurial phosphorus," light reported to occur in mercury barometers. In the course of this study, Hauksbee was led to investigate the effects of friction on glass vessels under vacuum. Hauksbee designed and built several novel instruments to pursue these experiments, some of which would continue to be used by electrical researchers for decades afterward, such as the glass rod and the globe generator. Like some of his contemporaries, Hauksbee turned his attention to "electricks," materials known to produce electrical attraction. Recognizing a connection between electrical activity and light, Hauksbee constructed a further device to monitor the presence of electrical attraction during his experiments, and found that the light produced in his experiments was accompanied by electrical attraction. Conducting his experiments in a vacuum produced by the improved air-pump showed that light produced by rubbing electricks was different in nature than ordinary fire or other forms of light.

The case study, *Making Light: Francis Hauksbee and the Isolation of Electric Fire*, charts the history of electrical studies in the late seventeenth century, and Hauksbee's work to develop more advanced instruments to generate and monitor electrical activity. It covers advances in glassmaking which made Hauksbee's instruments possible, developments in printing which gave rise to international scientific discourse on light and electrical phenomena, and the role and impact of the Royal Society in shaping Hauksbee's experimental program. It then addresses the experimental work of Francis Hauksbee and his contemporaries, both to illustrate the state of the field of electrical studies, and to provide the necessary context to understand Hauksbee's unique contributions to that field. Finally, the case study shows the impact and influence of Hauksbee's work following his death in 1713. Through the development of specialized instruments, Francis Hauksbee experimentally isolated electric light, determining how to reliably reproduce it, and created a new basis for future studies of electricity and luminous phenomena.

Background

In the seventeenth century, natural philosophers studied electricity using “light bodies” like threads, feathers, and paper. However, these methods were imprecise, and applied inconsistently. Furthermore, all instances of light were understood as a single phenomena, regardless of the manner in which they were generated. Electricity was considered supernatural by many and was comparatively rare due to the material environment. Early modern experimenters relied primarily on frictionally generated electricity, but did not recognize or understand a connection between electricity and luminous phenomena, believing the two to have separate causes even when they were generated together.

Many researchers investigating “phosphori,” or light generating substances and devices, recognized the limits of their theoretical understanding, but lacked the means to test those limits in a meaningful way. Francis Hauksbee’s background as an instrument maker enabled him to overcome these limits.



Triboelectric generator designed by Francis Hauksbee

Research Highlights

The following represent the principal arguments and conclusions of the study. Relevant portions of the case study are provided below each highlight. External references have corresponding bibliography entries at the end of the case study itself.

1) The printing press had facilitated the spread of ideas related to electrical study, and advances in glassmaking enabled the creation of more advanced instruments for studying electricity.

Explanation

The printing press was a significant agent of social change across many contexts, including the development of new scientific and technological advances. So-called "Books of Secrets" were compiled by alchemists and natural philosophers to communicate their discoveries and methods. Publication of these works allowed subsequent experimenters to build on and adapt established practices and tools. Natural histories, such as Johannes Jonstonus' 1631 *History of the Wonderful Things of Nature*, provided detailed descriptions of luminous phenomena which facilitated their study. William Gilbert's *De Magnete* (1600) also provided an important shared understanding and definition of electricity.

Advances in glassmaking, particularly the development of *cristallo*, or Venetian glass, were significant in the study of electrical properties because this highly purified glass was more electrically reactive and also clear, which allowed experimenters to directly observe the phenomena they studied. Although this style of glass was not developed with electrical studies in mind, it provided the material basis needed for instrument makers like Francis Hauksbee to develop apparatus specialized to electrical experimentation.

References

– Glassmaking, pp.6-9
– The development of instrument-quality glass, pp.8-9
– The social impact of the printing press, pp.9-10
– The development of a literature on natural history, including light phenomena, pp.10-12

2) Prior to Hauksbee, researchers had encountered electric light and could sometimes intentionally produce it, but were unable to reliably reproduce it at will. They also did not understand its nature, some treating it as a physical phenomenon, others treating it as a chemical phenomenon.

Explanation

Numerous prominent natural philosophers conducted experiments related to light, or generated light in the course of other experiments. Robert Boyle published extensive accounts on the

luminous qualities of diamonds, amber, and other resins. Otto von Guericke created a frictional generator which produced light while attempting to create a magnetic model of the earth. Those experimenters who were directly concerned with luminous phenomena generally fell into two broad research programs – one which viewed light production as a chemical phenomenon, and one which viewed it as a physical phenomenon. Among the chemical experimenters were Samuel Wall and Otto von Guericke. Among the physical experimenters were Jean Picard and Pierre Poliniere. Samuel Wall and Pierre Poliniere reliably generated electric and luminous phenomena, but each misunderstood the relationship between those phenomena. Wall believed "electricks" such as amber were composed of coagulated amber mixed with mineral salts; according to prevailing theories of matter substances of that class were "sulfurous" and were therefore prone to creating light, heat, and electrical activity. Wall then explained electricity as a result of an internal light inherent to the chemical composition of certain substances. Poliniere believed that light resulted from the physics of atmospheric pressure interacting with glass.

References

– Robert Boyle, pp.12-14
– Otto von Guericke, pp.14
– Shared definitions of light emission in the seventeenth century, pp.14-17
– Jean Picard, pp.17-19
– Samuel Wall, pp.20-22
– Pierre Poliniere, pp.20-22

3) Francis Hauksbee, an instrument maker by trade, used the now-available higher quality glass to invent and improve upon electrical instruments, including the air pump, the electric generator, and the glass rod. Electricians continued to use these instruments for generations.

Explanation

Francis Hauksbee had a career designing and manufacturing a range of scientific and medical instruments, but rose to prominence by improving on the design of Robert Boyle's air pump. This work brought Hauksbee to the attention of the Royal Society, and opened new possibilities for pneumatic experimentation. Beginning in 1703, Hauksbee worked as the Demonstrator of Experiments for the Royal Society. Initially his work focused on the air pump, but while pursuing experiments for the Royal Society, Hauksbee developed an improved electric generator (based in part on von Guericke's model and Boyle's improvements thereto), and a glass rod generator. These instruments relied upon high-quality Venetian glass, and Hauksbee's experience making instruments out of glass. The resulting generators were capable of producing higher levels of electrical charge than were previously possible.

References

– The development of instrument-quality glass, pp.8-9
– Hauksbee's early life and education, pp.23-24
– Work with the air pump, pp.24-28
– Experiments at the Royal Society, pp.28-32

4) Through the use of these instruments, Hauksbee was able to reliably reproduce electric light and establish experimentally that it was electrical in nature. By showing that a vacuum extinguished ordinary fire, had no effect on chemical or mercurial phosphorus, but increased the intensity of electrical light, he established electric light as a separate category and investigated it specifically.

Explanation
Beginning in 1706, Francis Hauksbee directed his experimental work toward generating electricity. Through this work, he was able to create a more effective triboelectric (friction-based) generator, and when he conducted experimental demonstrations at night, observed bright light emanating from the generator. Through his experiments, Francis Hauksbee created a series of instruments that allowed him to isolate electric light. Others had previously experimented with electric bodies and noticed the effects of light, but none recognized electric light as a special phenomenon. Hauksbee's experimental program, made possible by unique instruments of his own creation, gave him access to evidence that electric light was a special phenomenon, and prompted him to design new experiments to determine the likely nature of that light. He first realized that amber could produce light, and then designed new experiments to test the same ability of other electricity. Realizing that electricks could produce light, he designed a new experiment to monitor the presence of electrical activity while generating light.

References
– Shared definitions of light emission in the seventeenth century, pp.14-17
– Electrical experiments, pp. 31-36
– The impact of Hauksbee's experiments, pp.36-39
– Theories of light and electricity, pp. 35-36, 39-40

5) Hauksbee's research was supported by the Royal Society, where he was the Demonstrator of Experiments. He also benefited from engagement with members of the Royal Society, despite the difference in social class, and may or may not have benefitted from having been Isaac Newton's lab assistant.

Explanation
Beginning in 1703, Hauksbee worked as the Demonstrator of Experiments for the Royal Society. His membership in the Royal Society and his connection to Isaac Newton provided financial resources, premises, and equipment needed to engage in his experimental program. Hauksbee's

early experiments were suggested or directed by the Royal Society, but his most significant discoveries were the result of his own experimental decisions, which would likely not have been possible without the support of the Royal Society.

References

– Hauksbee and the Royal Society, pp.28-32