# FRANCOIS-PIERRE AMI ARGAND: LET THERE BE LIGHT*

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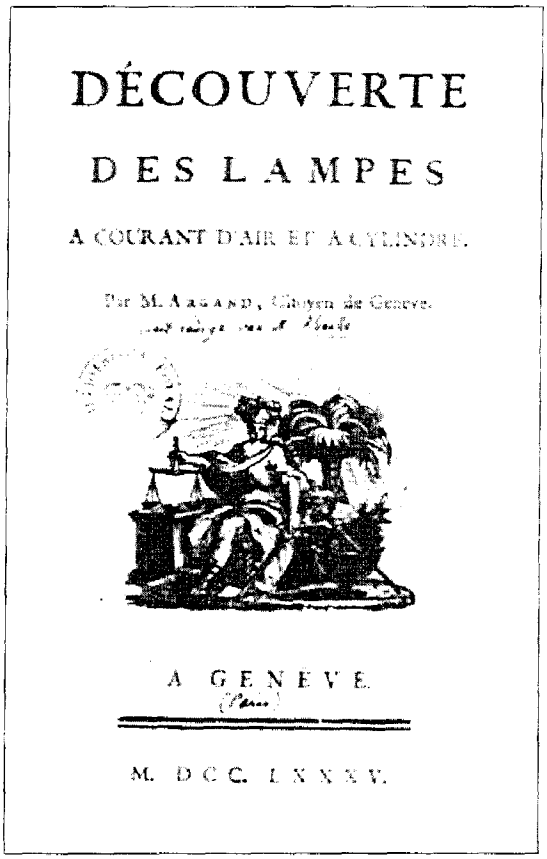
Ami Argand(1750-1803), during his short lifetime, contributed several innovations that would have a profound impact on future generations; yet his work is relegated to at best a footnote if mentioned at all. Argand's most productive years coincided with the tumultuous decades of the Chemical Revolution. He was acquainted with many of the major protagonists on both sides of the debate concerning the new chemistry.

Argand was born in Geneva on July 5,1750, the son of a watchmaker. His father was able to provide a university level education for his very talented son. At the University of Geneva Argand's studies were directed by Horace Benedict de Saussure(1740-1799), an internationally known scholar who made significant contributions in the fields of natural history and physics (1). De Saussure had studied chemistry in Paris in 1768 and had kept up a relationship with many of the leading Parisian scientists. Thus it made it possible for his protégé to be admitted into Parisian scientific circles. Much of what is known about Argand comes from the correspondence he maintained with de Saussure and others throughout his life.


A. Argand

Arriving in Paris in 1774, Argand became immersed in the scientific life of the city. He became acquainted with Lavoisier who, although not involved in teaching as a profession, welcomed young students into his laboratory to assist him with his experiments. Argand's first significant contribution was an improvement in the technique of distillation. It has been suggested that Argand may have become interested and learned the technical details of the process from his association with Lavoisier. In 1773 Lavoisier was commissioned by the Minister of Marine to investigate reports of a desalination plant for use on ships that had been demonstrated in London by a Portuguese scientist Jean de Magellan (1722-1790) (2). Lavoisier corresponded with Magellan and prepared a report in 1775 which also included further investigations he carried out himself. This report, *Memoire sur une Nouvelle Methode Distillation appliquee a la distillation des Eau-de-vie-et a celle de l'Eau de Mer*, dated July 1, 1775, also included a consideration of the problems associated with the distillation of spirits, a very important industry of the day. The major problem associated with the dis-

tillation of spirits such as brandy was the slowness of the process with the equipment available at the time. By 1778, Argand developed an improved distillation technique by introducing a preheater step in the apparatus. The spirits to be distilled were used as the cooling fluid in the worm-cooler belonging to the still. Argand attempted to enter into an agreement with the Director General of Finances in Paris to give the government the rights to the process. In return Argand wanted a limited, though exclusive privilege to produce brandy and other spirits derived from wine. A test of the new distillation technique was deemed necessary before any decision could be made. After several years of delays it was decided that Argand's apparatus would be tested by the *Societe Royal des Sciences de Montpellier.* Montpellier is in the region of France where the greatest production of wine was and still is taking place and thus was a suitable venue for the test. With his preheater Argand was able to distill almost twice the amount of spirits using less coal in about the same time as compared to conventional stills. The academicians reported to the Director General that the process was a significant improvement but in their opinion insufficient to warrant the monopoly that Argand had sought. "The success was so striking that his pre-heater was introduced in a period remarkably shorter than that of most other improvements of the distilling trade (3)."


DÉCOUVERTE

DES LAMPES

A COURANT D'AIR ET A CYLINDRE.

A GENEVE.

M. DCC. LXXXV.

Argand's 1785 Monograph

Argand had impressed one of the most prominent members of the Montpellier academy, Philippe-Laurent de Joubert, who hired Argand and his brother Jean(1744-1834) to construct a distillery using his design on Joubert's estate. The next several years were spent by Argand in the south of France in connection with the distillery and other projects. It was during this period that Argand realized the necessity for improved lighting in the distillery. As Argand stated in his 1785 monograph Decouverte des Lampes (4):

> It was in 1780 that he produced the first one. Actively and continually occupied with a large distillery, which he had founded in Languedoc, it was sufficient at that time to produce a large amount of light in his factory. He delayed to quieter times the development of methods which were indicated by his theory, and the precision of the details, without which the major effect of these Lamps would have been missed. He made an addition to this first Lamp in 1782 during the Assembly of Estates of Languedoc. It commanded the attention of the most eminent and respectable people....it was at Montpellier that M. Argand produced his Lamps; which he proposed to improve more and more; that he kept it secret from the public as it should be (served), that is to say, in presenting to (the public) only complete instruments, and constructed with the precision which was practically impossible in the Provinces, and rare in the Capital, for new instruments. M. De Saint-Priest and M. De Joubert in particular were so struck by the increase in light produced by this Lamp, that they foresaw all the advantages which one could derive from it...

The construction of the lamp about 1780 was not an isolated technical feat, but represented the practical application of Argand's theory of combustion, which he called his principle.

Argand and all his contemporaries were well versed in the phlogiston theory of combustion and the phlogiston nomenclature. His arrival in Paris in late 1774 coincided with the emergence of Lavoisier's combustion theory (5). Lavoisier by 1775 had already demonstrated that when lead or tin was heated in a sealed container there was no change in weight. Opening the sealed vessel led to a rapid inrush of air and an increase in the weight of the system. The fateful dinner meeting with Joseph Priestly, hosted by Lavoisier, where he described his newly discovered dephlogisticated air, had already taken place in October, 1774. The Easter Memoir of 1775 "On the Nature of the Principle which Combines with Metals during Calcination and Increases Their Weight" had been writ-

ten and read before the *Academie.* In the next five years Lavoisier was to present as well as publish numerous papers including his *Memoire sur la Combustion en General (1777)* as part of his program for the reform of chemistry.

Argand's concept of combustion was a mixture of old and new ideas. He believed that "inflammable air" (hydrogen) was responsible for combustion and not phlogiston. However, combustion required "dephlogisticated air" (oxygen) in order for burning to occur. The "dephlogisticated air" was destroyed, and the fire-producing material from the "inflammable air" formed the flame itself. Light was considered by Argand to be an element and was a byproduct of the flame that produced the illumination during combustion. The flame itself provided the heat produced in combustion. The observation that combustion produced "fixed air" (carbon dioxide) and water as byproducts for organic fuels had to be explained. Argand rationalized this as the combination of part of the "dephlogisticated air" with material in the substance from which the "inflammable air" had been liberated. The key to the process was the amount of "dephlogisticated air" and its heating principle that mixed with the "inflammable air." At higher temperatures Argand believed that all the fuel would be converted to "inflammable air" and only would combine with the "dephlogisticated air" to produce water and a flame that would have great clarity and brilliance.

One of the major faults of Argand's principle was that he had never attempted to verify it experimentally. Because he was able to produce a lamp which was so far superior in its illuminating ability, he felt his theoretical framework was correct. Argand did not initially look at his invention in a commercial sense. Later when he did it was to cause him no end of trouble.

Argand went to England in 1783 and remained there working on his lamp enterprise until 1785. He became acquainted with Joseph Priestly and Richard Kerwin, the leading English supporters of the phlogiston theory. Because of his prolonged absence from France he was probably not fully informed of the definitive experiments and papers being presented by Lavoisier in support of the oxygen theory of combustion and acidity.

One of the major problems with the new theory of Lavoisier was the combustion of hydrogen and the water question. In 1783 Argand had noticed the formation of water during combustion. His lamp when designed with an attached chimney, allowed for the condensation of water which ordinarily would have been lost. However his interpretation of this observation was along the lines of that of his English colleagues. Indeed, Argand had used his lamp as a means to demonstrate to his English colleagues the validity of his combustion principle. Cavendish had explained the formation of water as the combination of two gases which he assumed were really water with or without phlogiston. Combustion released the phlogiston and hence water would result. Lavoisier in that same year reported the experiments he had performed in collaboration with Pierre Simon de Laplace on the combination of oxygen and hydrogen in the presence of an electrical spark. His interpretation of the formation of water as a compound was the proverbial final nail in the coffin of the phlogiston theory. By 1786, Argand had returned to Paris because of his lamp business; after long discussions with Claude-Louis Berthollet (1748-1822), he became a convert to the oxygen theory. Argand lost further interest in his lamp except for the commercial aspects of the invention.

There seem to have been two periods involved in the construction of the Argand lamp: 1780-82, when the basic model was produced; and 1783-84, when certain improvements were made. These improvements were the addition of a wick-raising mechanism and the chimney. The first technical description of the lamp appeared in a paper by the Comte de Milly in 1784 in Observations sur la physique(6):

> To construct a lamp on these principles it is necessary only to have two cylinders of the same length, but different diameters, one of which enters into the other, leaving between them a space in proportion to the effect you want. These two cylinders are placed vertically and parallel to each other, and are soldered to a common base, leaving the inner cylinder hollow and open from one end to the other. The hollow space between the cylinders, which is closed at the base is and open at the top, serves to contain the oil that feeds the flame. You fashion a circular wick with cotton cloth, which will enter, in a circular manner, the space between the cylinders. This wick will roll along on a circle of tin-plate or copper placed in the space between the cylinders, which is filled with oil. If you light the wick with everything set up in this way, the hollow cylinder which is open from one end to the other ,will act as a pipe conducting air which will be rarefied by the flame of the wick. Thus, the flame will be animated by both the interior and exterior air, and the size of the flame and the intensity of the heat will be prodigiously increased.

Milly adds in his description how he came to write about the lamp as follows (6):

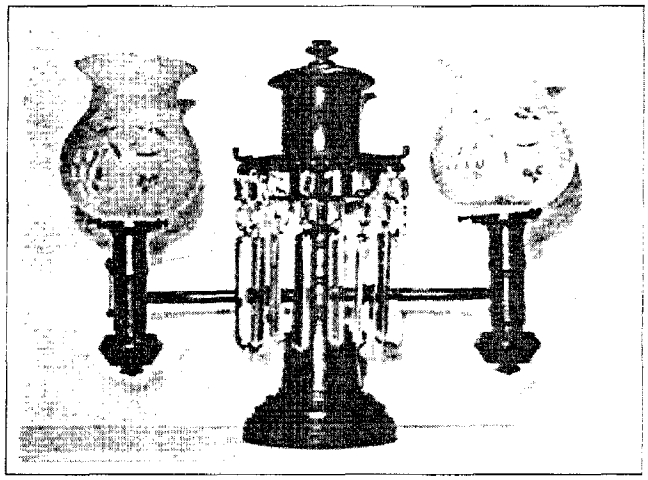
> This ingenious lamp was, as I have said, invented by M. Argand, a skillful chemist of Geneva. Monsieur Fanjas De Saint Fond (7), to whom Monsieur Argand had shown the mechanism and from whom I received these details, decided to communicate them to me only with the intention of preserving for the author the merit of its discovery, which has been disputed by people who have wanted to copy it.

Argand was to spend a good part of the rest of his life in litigation against all those who copied it in France and England, trying to obtain what should have been the rewards for his creativity. This endless round of court battles as well as the Revolution of 1789 exacted a major toll on Argand's health and wealth and thus his ability to focus on new projects.

While working for Joubert, Argand became acquainted with the Montgolfier brothers, Etienne (1740-1810) and Joseph (1745-1799) (8). The Montgolfiers are generally credited with the birth of aviation(9). On the fifth of June,1783 they launched the first successful hot-air balloon at Annonay, a small city near Lyon. Argand's friendship and collaboration with the brothers would continue throughout most of the rest of his life. An invitation from the *Academie des Sciences* brought the brothers and Argand to Paris that summer of 1783. A demonstration of the balloon was performed at Versailles on September 19, 1783 for Louis XVI and his court. Argand's contribution to this venture seemed to be to help in the preparation and launching of the balloon. For the balloon launched in March,1784 he did contribute a version of his chimney lamp which had been modified by Joseph Montgolfier. This allowed the construction of a balloon with a very small aperture to heat the air in the balloon. "Its fuel was a three-to-one mixture of olive oil and grain alcohol impregnating a circular wick of spun cotton. The principle was that convection draft, air for combustion being carried up through the center of the wick by an iron tube that acted as a blower (9)."

Shortly thereafter Argand went to England with the intention of demonstrating his lamp. He reported to Etienne Montgolfier on November 21, 1783 that the English were enormously jealous of his accomplishment. A friendship began in London with the Swiss-born physicist Jean-Andre de Luc (1727-1817), who was a tutor to the family of George III. This led to an invitation to demonstrate the balloon and the lamp at Windsor. On the 25th of November, 1783 Argand launched a small balloon, to the amazement of George III, while at the same time demonstrating the superior illumination of his lamp. Coincidentally in Paris on the same day, the first manned journey in a free balloon by Pilatre de Rozier and the Marquis d'Arlande took place. Argand was urged by de Luc to obtain a British patent for his invention. Patent number 1425 entitled "Lamp Argand's Specification" was issued to Argand and published on July 3, 1784. In this patent Argand states (10):

> ...that I had, after much trouble and considerable expense, found out and invented A LAMP THAT IS SO CONSTRUCTED TO PRODUCE NEITHER SMOKE NOR SMELL, AND TO GIVE CONSIDERABLY MORE LIGHT THAN ANY LAMP HITHERTO KNOWN.



Double arm Argand mantel lamp

Having secured this patent, Argand, with an eye to its commercial possibilities, entered into a partnership with the firm of Matthew Boulton of Birmingham to manufacture the lamp. Matthew Boulton (1728-1809) and James Watt (1736-1819) were partners in several ventures and were part of the famous Lunar Society (11). It was at the Lunar Society in Birmingham that Argand met many of the defenders of the phlogiston theory.

The time Argand spent in England was the high point of his life. Called back to Paris in 1786 to deal with the numerous cases involving the piracy of his lamp and the claims as to whether he was the inventor of the lamp, Argand suffered both a physical and financial breakdown (12). Even though he was able to establish a factory at Versoix near Geneva, the French Revolution was the final blow to Argand as he lost most of his assets. The invention of the lamp was one of the major reasons that a search began in the 1840s for better fuels than the naturally occurring whale oil. This would ultimately lead to the discovery of coal oil (kerosene) and the beginning in earnest of the hydrocarbon age.

## ACKNOWLEDGMENT

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